
Burlington to Nanticoke Integrated Regional Resource Plan

November 28, 2024



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List of Acronyms

Acronym	Definition
BESS	Battery Energy Storage System
CDM	Conservation and Demand Management
DESN	Dual-Element Spot Network
DG	Distributed Generation
DLT	Distribution-level Load Transfers
DR	Demand Response
DS	Distribution Station
DVS	Dynamic Voltage Support
FIT	Feed-in-Tariff
GS	Generating Station
HV	High Voltage
IESO	Independent Electricity System Operator
IRRP	Integrated Regional Resource Plan
kV	kilovolt
LDC	Local Distribution Company
LMC	Load Meeting Capability
LTR	Limited Time Rating
NPV	Net-present value
MTS	Municipal Transformer Station
MVA	Megavolt ampere
Mvar	Megavolt ampere reactive
MW	Megawatt
NERC	North American Electric Reliability Corporation
NPCC	Northeast Power Coordinating Council
ORTAC	Ontario Resource and Transmission Assessment Criteria
RIP	Regional Infrastructure Plan
TG	Transmission-connected Generation
TS	Transformer Station
TWG	Technical Working Group



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Executive Summary

The Burlington to Nanticoke Integrated Regional Resource Plan (IRRP) addresses the electricity needs of the Burlington to Nanticoke Region over a 20-year period, from 2023 to 2042. The Burlington to Nanticoke Region is located in southwestern Ontario and includes all or part of the following Counties and Districts: City of Hamilton, County of Brant, the City of Brantford, Haldimand County, Norfolk County, the City of Burlington and the town of Oakville.

For the purposes of the IRRP, the region has been divided into four subregions: Brant, Bronte, Caledonia-Norfolk, and Hamilton. The [Scoping Assessment Outcome Report](#) completed in December 2022, identified no needs for coordinated regional planning in the Bronte subregion, and most needs in the Hamilton subregion will be addressed in an upcoming addendum to be started in early 2025 (see Section 2.5.1). As a result, this IRRP largely focuses on the needs and recommendations for the Brant and Caledonia-Norfolk subregions.

Need assessments for the 115 kV subsystem in the Brant subregion (the “Brant 115 kV Subsystem”) could not be conducted in isolation from the 115 kV subsystem in the Hamilton subregion and the 115 kV subsystem in the City of Woodstock (outside of the Burlington to Nanticoke Region). This is because of interconnections within the 115 kV subsystem. Therefore, the combined 115 kV subsystem spanning from Karn TS in Woodstock through the Brant subregion and into the Hamilton subregion was studied as whole. This combined subsystem is referred to as the “Brant 115 kV Extended Area”, and consists of the: “Hamilton 115 kV Subsystem”, the Brant 115 kV Subsystem, and the “Woodstock 115 kV Subsystem”.

Studies on the Brant 115 kV Extended Area were used to identify needs, assess options, and produce recommendations for supply and station capacity needs in the Brant subregion, and for supply needs for the Hamilton 115 kV Subsystem. Supply needs for the 230 kV subsystem and station capacity needs in the Hamilton subregion will be addressed in the Hamilton addendum. The Woodstock 115 kV Subsystem falls outside of the Burlington to Nanticoke Region and is instead part of the London Area Region. As a result, needs of the Woodstock 115 kV Subsystem will be assessed and addressed in the ongoing cycle of regional planning for the London Area, with the Needs Assessment expected to be published by Hydro One by the end of 2024.

The electricity demand forecast shows substantial growth for the Burlington to Nanticoke Region, with demand forecasted to grow by 50%, 180%, and 80% for the Brant, Caledonia-Norfolk, and Hamilton subregions, respectively, by 2042, relative to 2023 demand. Growth is driven by industrial expansion, housing growth, and decarbonization initiatives. To meet long-term needs, the Load Meeting Capability (LMC) for each of the 115 kV subsystems in the Region must approximately double from its existing value. These 115 kV subsystems are: the combined Brant and Hamilton 115 kV Subsystems, the Brant 115 kV Subsystem, and the Norfolk-Bloombsburg Area. In addition, each of these 115 kV subsystems, and several substations supplied by these subsystems, have immediate capacity needs.

To address needs, wires and non-wires options were considered, and ultimately a combination is recommended by the Technical Working Group. Wires solutions are recommended to address long-

term needs, as the most cost-effective and technically feasible solutions. Non-wires options are recommended to meet near-to-medium term needs, due to: their shorter lead times, the lower magnitude of needs in the near-to-medium term, and their system benefits.¹

To address near-to-medium term needs, the Technical Working Group recommends the pre-contingency opening of bus-tie breakers, and load transfers between nearby stations at the distribution level, where viable and cost-effective. The opening of bus-tie breakers is needed to address near-to-medium term supply capacity needs for the combined Brant and Hamilton 115 kV subsystems, the Brant 115 kV Subsystem, and the Norfolk-Bloomsburg Area, and to address several station capacity needs where load transfers cannot resolve needs.

In the medium-term, the Technical Working Group recommends the procurement of a battery energy storage system, and the construction of a new substation² near Dundas TS. These recommendations will address supply capacity needs in the Norfolk-Bloomsburg Area, and on the Hamilton 115 kV Subsystem and at Dundas TS, respectively. The new substation will also address station capacity needs at Dundas TS.

In the long-term, the Technical Working Group recommends constructing two sets of new 230 kV transmission lines and associated substations, separating the Woodstock 115 kV Subsystem from the Brant 115 kV Subsystem:

- New 230 kV transmission lines from Nanticoke TS into the Simcoe community, and a new station² to entirely offload Norfolk and Bloomsburg 115 kV stations.
- A new double-circuit transmission line constructed as an extension from the existing Middleport-Detweiler corridor (in the Kitchener/Waterloo/Cambridge/Guelph region) into County of Brant, and two new stations² to entirely offload Brant and Powerline 115 kV stations.

Cost-effective CDM at Brantford TS and Caledonia TS is also recommended to defer station capacity needs. Once the Brant 115 kV Subsystem has been offloaded by the above recommendation, the Technical Working Group recommends separating the Woodstock 115 kV Subsystem from the Brant 115 kV Subsystem when the total net load in the Woodstock 115 kV Subsystem exceeds the limit.

Engagement is critical in the development of an IRRP. Providing opportunities for input in the regional planning process enables the views and perspectives of the public, market participants, municipalities, stakeholders, communities, Indigenous communities, and customers to be considered in the development of the plan. Furthermore, engagement helps lay the foundation for successful implementation.

The Technical Working Group will continue to monitor growth at Brantford TS and Caledonia TS, as well as across the region. This includes any future community energy planning, electrification trends, datacentres, or industrial load. The Technical Working Group will meet at regular intervals to complete the recommended Hamilton addendum, monitor developments and track progress toward plan deliverables. If underlying assumptions change significantly, local plans may be revisited through

¹ Non-wires options, such as conservation and demand management (CDM), storage procurement, or generation procurement, help meet the CDM and procurement needs of the provincial grid, thereby providing benefits to the system while addressing local needs.

² Converting the existing 115 kV DESNs to 230 kV is equivalent to constructing new stations when addressing supply capacity needs. The subsequent Transmitter-led Regional Infrastructure Plan (RIP) will identify the most cost-effective solution and develop a detailed plan for implementation.

an amendment, or by initiating a new regional planning cycle sooner than the five-year schedule mandated by the Ontario Energy Board.

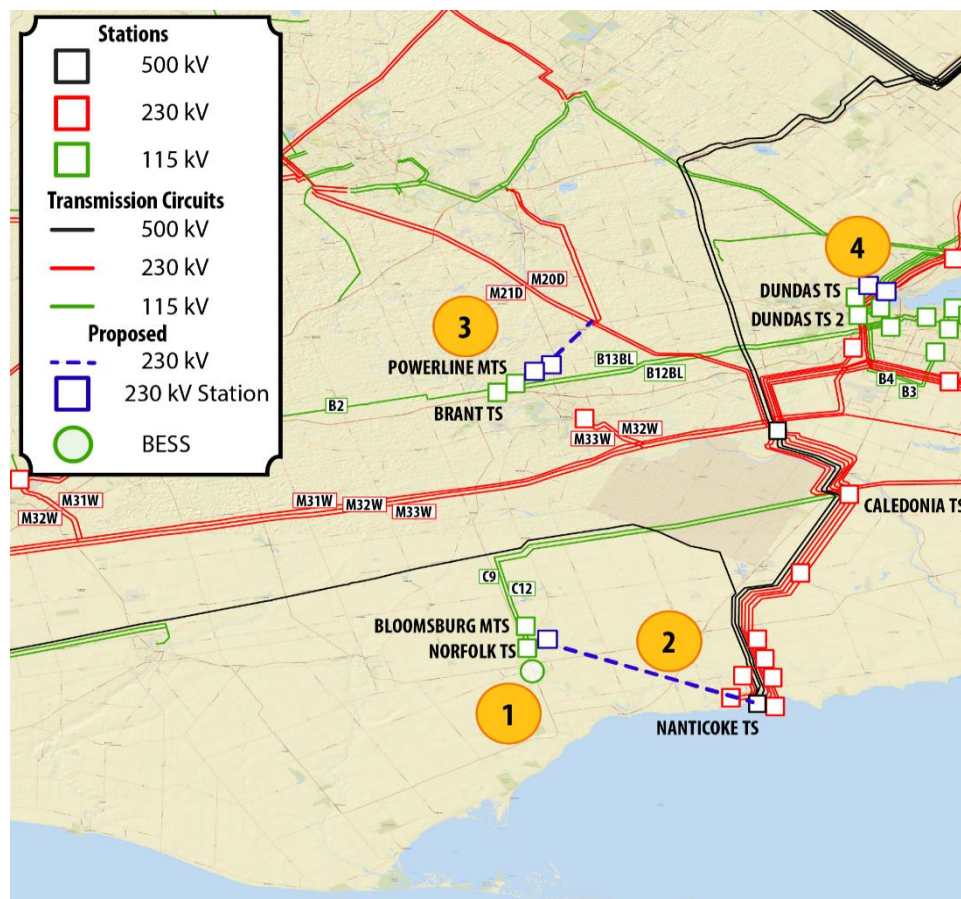
Summary of Recommendations

The medium and long-term recommendations for the Burlington to Nanticoke region are shown in the figure below and include:

1. Build a transmission-connected battery energy storage system (BESS) facility capable of continuously providing voltage support near Norfolk TS.
2. Build new transmission lines from Nanticoke TS into the Simcoe community, and a new station² to entirely offload Norfolk and Bloomsburg 115 kV stations.
3. Build a new double-circuit transmission line as an extension from the existing Middleport-Detweiler corridor (in the Kitchener/Waterloo/Cambridge/Guelph region) into County of Brant, and two new stations² to entirely offload Brant and Powerline 115 kV stations.
4. Build new 230kV stations² at Dundas TS connecting to the adjacent Middleport-Burlington circuits to entirely offload the Dundas load from the 115 kV stations to 230 kV.

In the interim, operational measures such as opening station bus-tie breakers combined with feasible and cost-effective load transfer between stations on a permanent or temporary basis are recommended to resolve supply and station capacity needs.

Medium/Long-Term Recommendations in the Burlington Nanticoke Region



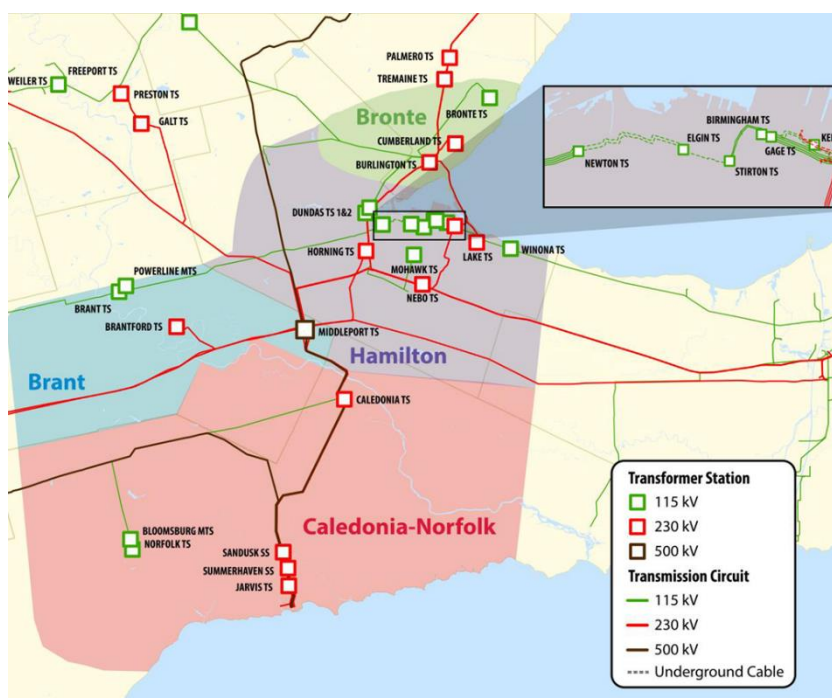
1 Introduction

This Integrated Regional Resource Plan (IRRP) addresses the electricity needs of the Burlington to Nanticoke Region (the “Region”) over a 20-year period, from 2023 to 2042. The Burlington to Nanticoke Region is located in southwestern Ontario and includes all or part of the following Counties and Districts: City of Hamilton, County of Brant, the City of Brantford, Haldimand County, Norfolk County, the City of Burlington and the town of Oakville. For electricity planning purposes, the planning region is defined by electricity infrastructure boundaries, not municipal boundaries.

Several Indigenous communities are located in or near the Region including: Mississaugas of the Credit First Nation, Six Nations of the Grand River, and a number of Métis Nation of Ontario (MNO) councils including MNO Clear Waters Métis Council and MNO Grand River Métis Council.

For the purposes of regional planning, the Burlington to Nanticoke region has historically been subdivided into four subregions: Brant, Bronte, Caledonia-Norfolk, and Hamilton. The electricity infrastructure supplying the Burlington to Nanticoke region and the subregions are shown in Figure 1. The Burlington Nanticoke Region is summer-peaking, and over 2019 to 2023, normal weather peak electrical demand has remained steady at approximately 1,825 MW.

Figure 1 | Overview of the Burlington Nanticoke Region³



The Bronte subregion includes Burlington TS and the 230 kV and 115 kV supply northeast of the station which services Cumberland TS and Bronte TS, respectively. The 115 kV supply southwest from Burlington TS and the 230 kV supply from Beach TS service the 115 kV network in the Hamilton subregion, while 230 kV circuits between Burlington TS and Beach TS, Beach TS and Middleport TS,

³ IRRP regions are defined by electricity infrastructure; geographical boundaries are approximate.

and Middleport TS and Burlington TS supply the Hamilton subregion's 230 kV connected load supply stations. The 230 kV supply south from Middleport TS supplies the 230 kV connected stations in the Caledonia-Norfolk subregion, including Caledonia TS. The 115 kV supply from Caledonia TS then supplies Bloomsburg DS and Norfolk TS. The Brant subregion is supplied from the 230 kV supply west from Middleport TS and a 115 kV supply from Burlington TS. Because of tight connection between i) the Brant 115 kV supply, ii) part of the Hamilton 115 kV supply and iii) the 115 kV supply to the City of Woodstock, the regional plan considered the capability of the broader Brant 115 kV Extended Area which includes these three subsystems comprising the entire 115 kV network between Burlington TS and Karn TS.

The region's electricity is delivered by five local distribution companies (LDCs): Alectra Utilities Corporation, Burlington Hydro Inc. (BHI), GrandBridge Energy Inc., Hydro One Networks Inc. (Distribution), and Oakville Hydro Inc. Hydro One Networks Inc. (Transmission) is the primary transmission asset owner. This IRRP report was prepared by the Independent Electricity System Operator (IESO) on behalf of a Technical Working Group, composed of the LDCs, Hydro One, and the IESO.

Development of the Burlington Nanticoke IRRP was initiated in December 2022, following the publication of the [Needs Assessment report](#) in September 2022 by Hydro One and the [Scoping Assessment Outcome Report](#) in December 2022 by the IESO. The Scoping Assessment identified the area's needs should be further assessed through an IRRP. The Technical Working Group was then formed to gather data, identify near- to long-term needs in the region, and develop the recommended actions included in this IRRP.

This report is organized as follows:

- A summary of the recommended plan for the region is provided in Section 2;
- The process and methodology used to develop the plan are discussed in Section 3;
- The context for electricity planning in the region and the study scope are discussed in Section 4;
- Demand forecast scenarios, and conservation and demand management and distributed generation assumptions, are described in Section 5;
- Electricity needs in the region are presented in Section 6;
- Alternatives and recommendations for meeting needs are addressed in Section 7;
- A summary of engagement activities is provided in Section 8; and
- The conclusion is provided in Section 9.

2 The Integrated Regional Resource Plan

This IRRP provides recommendations to address the electricity needs of the Burlington to Nanticoke Region over the next 20 years. The needs identified are based on the demand growth anticipated in the region and the capability of the existing transmission system, as evaluated through application of the IESO's Ontario Resource and Transmission Assessment Criteria (ORTAC) and reliability standards governed by the North American Electric Reliability Corporation (NERC). The IRRP's recommendations are informed by an evaluation of different options to meet the needs and consider reliability, cost, technical feasibility, maximizing the use of the existing electricity system (where economic), and feedback from stakeholders.

The Burlington to Nanticoke electricity demand forecast, provided by the LDCs, anticipates sustained growth driven by industrial expansion, housing growth, and decarbonization initiatives. These drivers are present across all municipalities in the Region.

In the Brant subregion, residential housing is a primary driving factor in the forecast along with industrial customers which have shown interest and purchased property both within City of Brantford and County of Brant. One customer has already scheduled an expansion project with a significant quantity of new load. With the annexation of 2,720 hectares of land from County of Brant to the City of Brantford, there is an expectation of intense development in the north of Brantford. Beyond 2030, 4 per cent growth is expected for electrification.

In the Caledonia-Norfolk subregion, the forecast is mainly driven by economic factors, e.g. housing and GDP, and community/municipal energy and decarbonization plans. Industrial and residential development in Courtland has a large effect in the Norfolk forecast. New residential and employment growth is forecasted to be 1% per annum into the future.

In the Hamilton subregion, the forecast is driven primarily by economic factors, and supplemented by electric vehicle growth. Economic factors include: population and employment growth, housing activities, and commercial and industrial development.

Following a review on the status of the plans recommended in the last cycles of IRRP, the recommendations in this cycle of IRRP are organized under interim and permanent plans. This distinction reflects the different levels of lead time for development and planning commitment required. This approach ensures that the IRRP provides clear direction on investments needed in the near and medium term, while initiating projects with long lead times that are ultimately needed.

2.1 Status of Plans from Previous IRRP Cycles

Following the previous cycle of region planning, and concluding with the 2nd Cycle RIP report, several projects were recommended which have now been completed or are presently underway. The projects consisted largely of replacements, in addition to two capacitor bank installations, and two sets of distribution-level load transfers. The status of these projects is summarized in Table 1 below.

Table 1 | Summary of Ongoing and Recently Completed Plans

Station/Line Section	Need	Expected In-Service
Cumberland TS	Power factor correction: capacitor bank installed at customer level	2019 (Completed)
115 kV B3/B4	Line section Horning Mountain Jct. X Glanford Jct. replacement	2020 (Completed)
Elgin TS	Transformer and switchgear replacement	2022 (Completed)
Gage TS	Transformer and switchgear replacement	2024 (Completed)
Newton TS	Transformer replacement	2020 (Completed)
Norfolk-Bloomsburg Area Supply Capacity	Load transfers to Jarvis TS: 3 MW	2026
Kenilworth TS	Transformer and switchgear replacement	2023 (Completed)
Kenilworth TS	Power factor correction: capacitor bank installation	2025 (Completed)
115 kV B7/B8	Line section Burlington TS X Nelson Jct. replacement	2024
Dundas TS	Load transfers to Dundas 2 TS: 20 MW	2025
Newton TS	115 kV breaker refurbishment	2022 (Completed)

2.2 Interim Plans

For the interim, until permanent solutions are placed in service, the Technical Working Group recommends operational measures to address near-/medium-term supply and station capacity needs. This includes the pre-contingency opening of bus-tie breakers, as needed, to secure the system and resolve the needs.

The recommended operational measures also include load transfers between nearby stations at the distribution level. The Technical Working Group recommends that LDCs assess the feasibility and cost-effectiveness of transferring loads on a temporary or permanent basis with consideration to the recommended long-term solutions which resolve supply or station capacity needs. Moreover, coordination between load transfer and opening station bus-tie breakers is necessary since opening

bus-tie breakers may still be required either to make the system secure or because the amount of load transferred is not sufficient to resolve the needs. Where viable and cost-effective, the Technical Working Group prefers transferring loads since opening station bus-tie breakers may interrupt electricity service to a higher number of customers following a network outage.

Note that the Technical Working Group makes these interim recommendations strictly on a provisional basis, until solutions with longer lead times are in place.

Table 2 | Interim Plans for Station and Supply Capacity Needs

Need	Recommendation	Lead Responsibility
Various station and supply capacity	As required, open bus-tie breakers at Bloomsburg DS, Norfolk TS, Brant TS, Powerline MTS, Dundas 1 and 2 TS, Newton TS, Mohawk TS, Nebo, Woodstock TS and Commerce Way TS	Hydro One, GrandBridge Energy, Alectra
Various station and supply capacity	If feasible and cost-effective, permanently/temporarily transfer load from Bloomsburg DS, Norfolk TS, Brant TS, Powerline MTS, Dundas 1 and 2 TS, Newton TS, Mohawk TS, and Nebo to nearby stations	Hydro One, GrandBridge Energy, Alectra

2.3 Medium-Term Plans

The Technical Working Group recommends the medium-term plans summarized in Table 3 to bridge the gap between the interim and long-term solutions. Multiple needs are grouped together when they will be resolved by the same solution. The following sections discuss these medium-term plans.

2.3.1 Battery Energy Storage System in the Norfolk-Bloomsburg Area

To address the Norfolk-Bloomsburg Area supply capacity in the medium term ahead of a long-term wires solution, the Technical Working Group recommends a battery energy storage system (BESS). The BESS should be connected to both 115 kV supply circuits (C9 and C12) between the Bloomsburg junctions and Norfolk TS, preferably at Norfolk TS.

To be a viable solution, the BESS must always remain connected to the transmission system and provide reactive power (Mvar) support for extended periods of time, irrespective of its active power output. The continuous reactive power capability would determine the minimum requirements of rated capacity and storage (MW/MWh) for a viable BESS solution. Because of the timing, specific location and combination of active and reactive power requirements, the IESO will investigate the most appropriate implementation mechanism to procure the BESS.

The operational measures described in the previous section may be necessary to secure the system under outages on the BESS solution.

2.3.2 Two New 230 kV DESNs at Dundas Station

As part of the long-term solution, discussed in the next section, and to address the supply capacity needs for the Hamilton 115 kV Subsystem within the Brant 115 kV Extended Area, the Technical

Working Group recommends transferring the loads of both Dundas TS DESNs from the 115 kV subsystem to the 230 kV subsystem. This may be achieved by either: constructing two new 230 kV Dual Element Spot Network (DESN) at the Dundas switchyard, or converting the existing DESNs from 115 kV to 230 kV supply. In either case, the 230 kV supply will be the existing 230 kV Middleport to Burlington circuits, M27B and M28B, which pass next to the station.

If the new DESNs are pursued, each should have an approximate LTR of 200 MVA, and the LDCs (Hydro One Distribution and Alectra Utilities Corporation) should entirely transfer the loads from the existing Dundas TS DESNs onto the new 230 kV DESNs.

The choice between constructing new DESNs or converting existing DESNs will be determined in the upcoming Regional Infrastructure Planning (RIP) led by the transmitter. However, constructing new DESNs will also resolve the Dundas station capacity needs, whereas converting the existing DESNs will not resolve these needs.

Table 3 | Medium-Term Plans for Supply and Station Capacity Needs

Need	Recommendation	Lead Responsibility	Expected In-Service
Norfolk-Bloomsburg Area Supply Capacity	Procure BESSs* capable of always providing reactive power support** connecting to C9 and C12 between the Bloomsburg junctions and Norfolk TS	IESO	2029 or earlier***
Hamilton 115 kV Subsystem Supply Capacity and Dundas 1 and 2 Station Capacity	Construct two new 230 kV DESNs**** each with an LTR of ~200 MVA at the Dundas switchyard connecting to the nearby Middleport to Burlington circuits (M27B and M28B)	Hydro One	2032 or earlier***
	Entirely transfer the Dundas loads from the existing 115 kV DESNs to the new 230 kV DESNs	Hydro One and Alectra	

* Under BESS outage conditions, operational measures discussed in Section 2.2 for the Norfolk-Bloomsburg Area may be required to secure the system.

** Depending on the amount of reactive power (Mvar) support the BESSs can constantly provide, minimum requirements on the rated capacity and storage (MW/MWh) of the BESSs are specified and the BESSs may potentially be combined with other NWAs, e.g., renewables, CDM or load transfer, to make this option viable and cost-effective.

*** Provided years are estimated maximum timelines to bring solution in-service; however, implementation should be expedited to bring in-service as soon as possible.

**** Rather than building a new DESN, the existing DESNs may be converted from a 115 kV supply to a 230 kV supply by replacing all 115 kV station equipment. The subsequent Transmitter-led Regional Infrastructure Plan (RIP) will identify the most cost-effective approach that addresses the needs and develop a detailed plan for implementation.

2.4 Long-Term Plans

The long-term plans comprise several recommendations to resolve needs and to support long-term load growth. These recommendations are summarized in Table 3 and further discussed below. The recommended wires solutions will need to be initiated as soon as possible, starting with the upcoming Regional Infrastructure Planning (RIP) led by the transmitter.

The operational procedures which were recommended as the interim solutions will no longer be required after the needs are addressed with the long-term plans.

Table 4 | Long-Term Plans for Supply and Station Capacity Needs

Need	Recommendation	Lead Responsibility	Expected In-Service
Norfolk-Bloomsburg Area Supply and Station Capacity	Construct one new 230 kV DESN* with an LTR of ~200 MVA within or in the vicinity of Simcoe connecting to the Nanticoke TS with a new 230 kV double-circuit line*	Hydro One	2035
	Entirely transfer the Norfolk and Bloomsburg loads to the new 230 kV DESN	Hydro One	
Brant 115 kV Subsystem Supply Capacity and Brant and Powerline Station Capacity	Construct two new 230 kV DESNs* each with an LTR of ~200 MVA within or in the vicinity of County of Brant connecting to the Middleport to Detweiler corridor with new 230 kV extensions**	Hydro One	2035
	Entirely transfer the Brant and Powerline loads to the new 230 kV DESNs	GrandBridge Energy	
Woodstock 115 kV Subsystem	If the Woodstock Subsystem total net load exceeds 113 MW, separate it from Brant Subsystem by pre-contingency opening the Brant DB2 breaker	IESO and Hydro One	***
Caledonia Station Capacity	Implement targeted and cost-effective CDM to defer the need from 2034 and monitor the demand growth for advancing the need	IESO	****
Brantford Station Capacity	Implement targeted and cost-effective CDM to defer the need from 2035 and monitor the demand growth for advancing the need	IESO	****

* Rather than building a new DESN, the existing DESNs may be converted from a 115 kV supply to a 230 kV supply by replacing all 115 kV station equipment. The subsequent Transmitter-led Regional Infrastructure Plan (RIP) will identify the most cost-effective solution and develop a detailed plan for implementation.

** Since new DESNs are connected to the lines in the Kitchener/Waterloo/Cambridge/Guelph (KWCG) region, the ongoing KWCG IRRP will finalize the connection arrangement and details of this option.

*** The timing of this option is after the load transfers of Dundas 1 and 2, Brant and Powerline Stations from the existing 115 kV to new 230 kV DESNs are complete.

**** CDM program design and implementation start after the IRRP is finished and continue over the planning horizon.

2.4.1 One New 230 kV DESN and Transmission Line into Simcoe

To address the supply capacity need to the Norfolk-Bloomsburg Area and to address station capacity needs at Bloomsburg DS and Norfolk TS, the Technical Working Group recommends constructing a new 230 kV double-circuit transmission line from Nanticoke TS into the vicinity of Simcoe, and either:

constructing one new 230 kV DESN, or converting Bloomsburg DS and Norfolk TS from 115 kV to 230 kV supply.

If the new DESN is pursued, it should have an approximate LTR of 200 MVA, and Hydro One Distribution should entirely transfer the loads from Bloomsburg DS and Norfolk TS onto the new 230 kV DESN.

The line routing and choice between constructing a new DESN or converting existing DESNs will be determined in the upcoming Regional Infrastructure Planning (RIP) led by the transmitter. However, constructing new DESNs will also resolve the Bloomsburg DS and Norfolk TS station capacity needs, whereas converting the existing DESNs will not resolve these needs.

2.4.2 Two New 230 kV DESNs and Transmission Line into County of Brant

To address supply capacity needs to the Brant 115 kV Subsystem and to address station capacity needs at Brant TS and Powerline MTS, the Technical Working Group recommends constructing a new 230 kV double circuit extension of the Middleport to Detweiler corridor into the vicinity of County of Brant, and either: constructing two new 230 kV DESNs, or converting Brant TS and Powerline MTS from 115 kV to 230 kV supply. However, constructing new DESNs will also resolve the Brant TS and Powerline MTS station capacity needs, whereas converting the existing DESNs will not resolve these needs.

If the new DESNs are pursued, each should have an approximate LTR of 200 MVA, and GrandBridge Energy Inc. should entirely transfer the loads from Brant TS and Powerline MTS onto the new 230 kV DESNs.

Since the DESNs (new or converted) are connected to the lines in the KWCG region, the ongoing KWCG IRRP will finalize the connection arrangement and details of this option.

Please note that this plan in combination with the new Dundas 230 kV DESNs (see Section 2.3.2) will address the supply capacity need in the Hamilton 115 kV Subsystem up to the sum of the capacities of the remaining stations, namely, Elgin, Mohawk and Newton TS and CTS3.

2.4.3 Separate Woodstock 115 kV Subsystem from Brant 115 kV Subsystem

To address the supply capacity need to the Woodstock 115 kV Subsystem after transferring the loads to new 230 kV DESNs as explained in Section 2.3.2 and 2.4.2, the Technical Working Group recommends that the Brant DB2 115 kV circuit breaker be opened pre-contingency for a total net load in the Woodstock Subsystem above 113 MW. This will separate the Woodstock from Brant 115 kV Subsystem and increase the LMC of the Woodstock 115 kV Subsystem to 210 MW.

2.5 Ongoing Initiatives

In addition to the plans above, four ongoing actions were identified to manage long-term needs for the Burlington to Nanticoke Region in general and for the Hamilton subregion, in particular.

2.5.1 Undertake a Comprehensive Study of the Hamilton Subregion

Following Public Webinar #1 for the Burlington to Nanticoke IRRP in September 2023, electrification and decarbonization plans were identified which will have a significant impact on the Hamilton area.

In response, a new forecast for Hamilton was produced in June 2024, which resulted in a 230 MW or 11 per cent increase relative to the previous forecast.

Based on the new Hamilton demand forecast, several station capacity needs were identified. To the extent possible, some of these needs were assessed as part of this IRRP. Specifically, assessment of the Hamilton 115 kV Subsystem within the Brant 115 kV Extended Area and subsequent long-term recommendation will help address some of these supply and station capacity needs, namely at Dundas TS. The remaining needs warrant a more fulsome assessment of needs, which were too significant to fully assess and address within the IRRP timelines. Given the rapid growth in the Area, collecting more information on supply options and conducting integrated planning for the revised needs is critical to ensuring the continued reliability of this subregion. Thus, the Technical Working Group recommends that a Hamilton Addendum be undertaken, to fully assess and address the needs of the Hamilton subregion. Please see Appendix J for an initial scope of the Addendum.

The Addendum will kick-off in 2025 and finish within 12 months of formal kick-off. In early 2025, the terms of reference will be published by the TWG and will build upon the scope outlined in Appendix J, by confirming the objectives and establishing timelines. An engagement plan will also be created, which will outline expectations for webinars and targeted outreach with key stakeholders over the 12-month addendum process.

2.5.2 Monitor Load Growth and Continue to Explore Opportunities for Targeted CDM

The Technical Working Group recommends that the LDCs and IESO continue to monitor long-term growth at Brantford TS and Caledonia TS between regional planning cycles to determine when decisions on the long-term plan are required and inform the next cycle of regional planning for the region, as required.

In addition, the Technical Working Group recommends continuing to consider opportunities for targeted CDM, identifying the benefits and potential of incremental, cost-effective CDM particularly if targeted to help manage near-term needs until transmission reinforcements are in-service or to defer long-term needs. The Technical Working Group should continue to support and monitor CDM uptake and bring these insights into the next cycle of regional planning for the Burlington to Nanticoke Region.

2.5.3 Data Centre and Industrial Load Growth

The IESO has been made aware of a growing number of large data centre connection requests (100-1000 MW each) throughout the province, as well as an increase in requests for industrial load growth (see Section 6.2.4). At the time of this IRRP publication, the Technical Working Group is aware of significant interest from multiple potential customers throughout the region at various commitment levels, with interest from 700-1,700 MW of data centre connections within the Caledonia-Norfolk Subregion alone, which have not been captured in this IRRP forecast. Given the magnitude of such load growth, wires solutions are commonly the only technically feasible solution but require a lead time of 7-10 years.

To help mitigate the risks posed by these large but uncertain connection requests, the IESO will continue to monitor data centre and industrial growth patterns within the Burlington to Nanticoke Region and the province at large. The IESO is also undertaking a South and Central Bulk Plan to review the capability of the bulk system to support future generation connections and demand

growth in key areas throughout southern and central Ontario to enable a decarbonized power system in the future. This study will continue the assessment of the bulk transmission system between the Hamilton and Windsor areas to understand future transmission needs that could result from further economic development. In addition, when developing solutions to address needs, the IESO will evaluate different scenarios, to support more complex considerations, to ensure that recommendations are optimal under a range of future scenarios.

3 Development of the Plan

3.1 The Regional Planning Process

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

The current regional planning process was formalized by the Ontario Energy Board in 2013 and is performed on a five-year cycle for each of the 21 planning regions in the province. The process is carried out by the IESO, in collaboration with the transmitters and LDCs in each region. The process consists of four main components:

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

Regional planning is not the only type of electricity planning in Ontario. Other types include bulk system planning and distribution system planning. There are inherent overlaps in all three levels of electricity infrastructure planning. Further details on the regional planning process and the IESO's approach to it can be found in Appendix A.

The IESO has recently completed a review of the regional planning process, following the completion of the first cycle of regional planning for all 21 regions. Additional information on the [Regional Planning Process Review](#), along with the final report is posted on the IESO's website.

3.2 Burlington to Nanticoke IRRP Development

The process to develop the Burlington to Nanticoke IRRP was initiated in December 2022, following the publications of the [Needs Assessment Report](#) in September 2022 by Hydro One and the [Scoping Assessment Outcome Report](#) in December 2022 by the IESO. The Scoping Assessment recommended that the needs identified for the Burlington to Nanticoke Region be considered through an IRRP in a coordinated regional approach, supported with public engagement. The Technical Working Group was then formed to develop the terms of reference for this IRRP, gather data, identify needs, develop options, and recommend solutions for the region.

4 Background and Study Scope

This is the third cycle of regional planning for the Burlington to Nanticoke Region. This Region is located in southwestern Ontario and includes all or part of the following Counties and Districts:

City of Hamilton	City of Brantford	Norfolk County	Town of Oakville
County of Brant	Haldimand County	City of Burlington	

For electricity planning purposes, the planning region is defined by electricity infrastructure boundaries, not municipal boundaries.

This Region also includes several Indigenous communities, located within or near the Region:

Mississaugas of the Credit First Nation	Métis Nation of Ontario:
Six Nations of the Grand River	Clear Waters Métis Council
Haudenosaunee Confederacy Chiefs Council	Grand River Métis Council

Following a Needs Assessment and Scoping Assessment in 2017, an IRRP and subsequent RIP were initiated and published in 2019, concluding the second planning cycle for the Region.

This IRRP develops and recommends options to meet the electricity needs of the Burlington to Nanticoke Region in the near, medium, and long term. The plan was prepared by the IESO on behalf of the Technical Working Group, and includes consideration of forecast electricity demand growth, CDM, distributed generation (DG), transmission and distribution system capability, relevant community plans, condition of transmission assets, and developments on the bulk transmission system.

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

Transformer stations:

Beach TS	Bronte TS	Dundas 2 TS	Kenilworth TS	Norfolk TS
Birmingham TS	Burlington TS	Elgin TS	Lake TS	Powerline MTS
Bloomsburg DS	Caledonia TS	Gage TS	Mohawk TS	Stirton TS
Brant TS	Cumberland TS	Horning TS	Nebo TS	Winona TS
Brantford TS	Dundas TS	Jarvis TS	Newton TS	CTS1 to CTS6

115 kV transmission circuits:

B3	B6G	B10	B13BL	HL3	H6K	K2G
B4	B7	B11	C9	HL4	H9W	Q2AH
B5G	B8	B12BL	C12	H5K	K1G	

230 kV transmission circuits:

B18H	M34H	M20D	M31W	N6M	N20K	Q30M
B20H	H35D	M21D	M32W	N21J	Q24HM	Q29HM
B40C	H36D	M27B	M33W	N22J	Q23BM	S39M
B41C	K40M	M28B	N5M	N37S	Q25BM	

The Burlington to Nanticoke Region covers a large portion of the transmission system in southwest Ontario, and for this reason it has been broken up into four subregions:

- Brant Subregion
- Bronte Subregion
- Caledonia-Norfolk Subregion
- Hamilton Subregion

Based on the Needs Assessment led by Hydro One in the beginning of the planning process, regional planning was required for the Burlington to Nanticoke Region except for the Bronte Subregion. Figure 2 to Figure 4 show single line diagrams of the subregions and subsystems for which the regional plan was conducted.

The Brant subregion consists of the following stations:

Brant TS	Brantford TS	Powerline MTS.
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The Caledonia-Norfolk subregion consists of the following stations:

Bloomsburg DS	Jarvis TS	Caledonia TS
Norfolk TS	CTS1	CTS2

The Hamilton subregion consists of the following stations:

Beach TS	Dundas 2 TS	Horning TS	Mohawk TS	Stirton TS
Birmingham TS	Elgin TS	Kenilworth TS	Nebo TS	Winona TS
Dundas TS	Gage TS	Lake TS	Newton TS	CTS3 to CTS5

Note need assessments for the Brant 115 kV Subsystem, that includes Brant TS and Powerline MTS, could not be conducted in isolation and the area of study was extended to the entire 115 kV system enclosed between the Burlington and Karn 115 kV stations. Therefore, in addition to the Woodstock 115 kV Subsystem in the London Area, CTS3, Dundas, Dundas 2, Mohawk, Newton and Elgin stations in the Hamilton 115 kV Subsystem were also included in the studies. This is referred to as the Brant 115 kV Extended Area and is shown in Figure 2.

The Woodstock 115 kV Subsystem is not part of the Burlington to Nanticoke Region and was considered in the analysis of this IRRP because of its impact on the 115 kV Subsystems in the Brant and Hamilton subregions (please see "Brant 115kV Extended Area" in Section 6.3). The Woodstock subregion is part of the London Area Region, and consists of Commerce Way TS, Woodstock TS and CTS6.

Note that the bulk system transfer capabilities on the Buchanan Longwood Input (BLIP) and Queenston Flow West (QFW) interfaces through the region is not within the scope of the IRRP and would be separately studied in a bulk transmission plan, as required. The schedule of bulk planning activities is identified through the IESO's [Annual Planning Outlook](#).

Figure 2 | Single Line Diagram of Brant 115 kV Extended Area, the Brant 115 kV Subsystem, the Hamilton 115 kV Subsystem, and the Woodstock 115 kV Subsystem

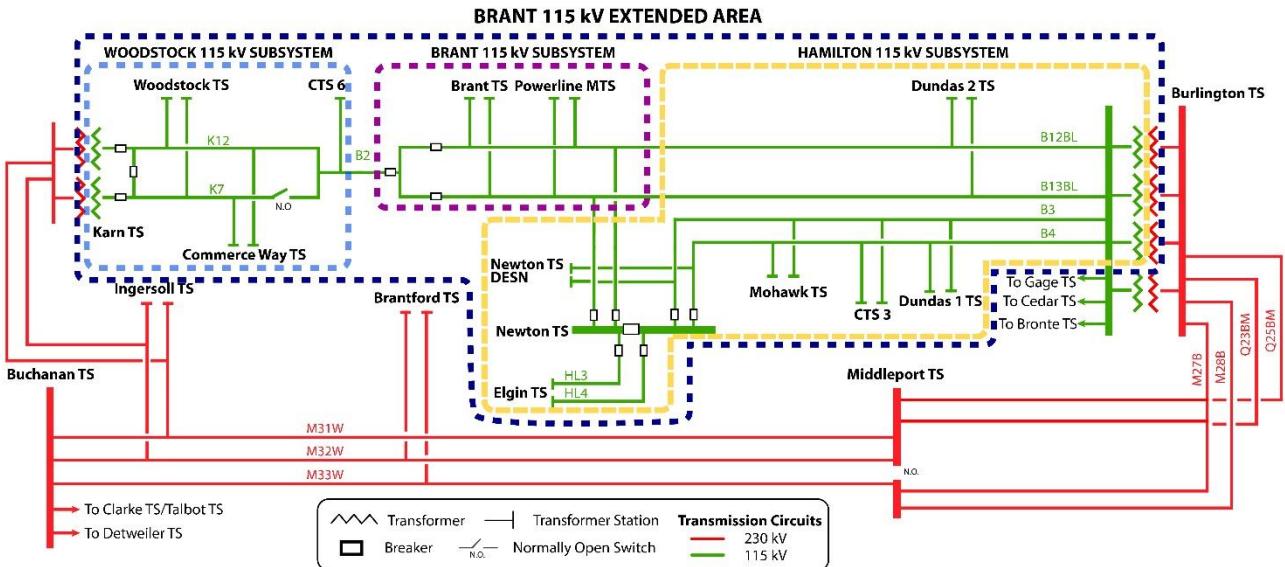


Figure 3 | Single Line Diagram of the Caledonia-Norfolk Subregion and Norfolk-Bloomsburg Area

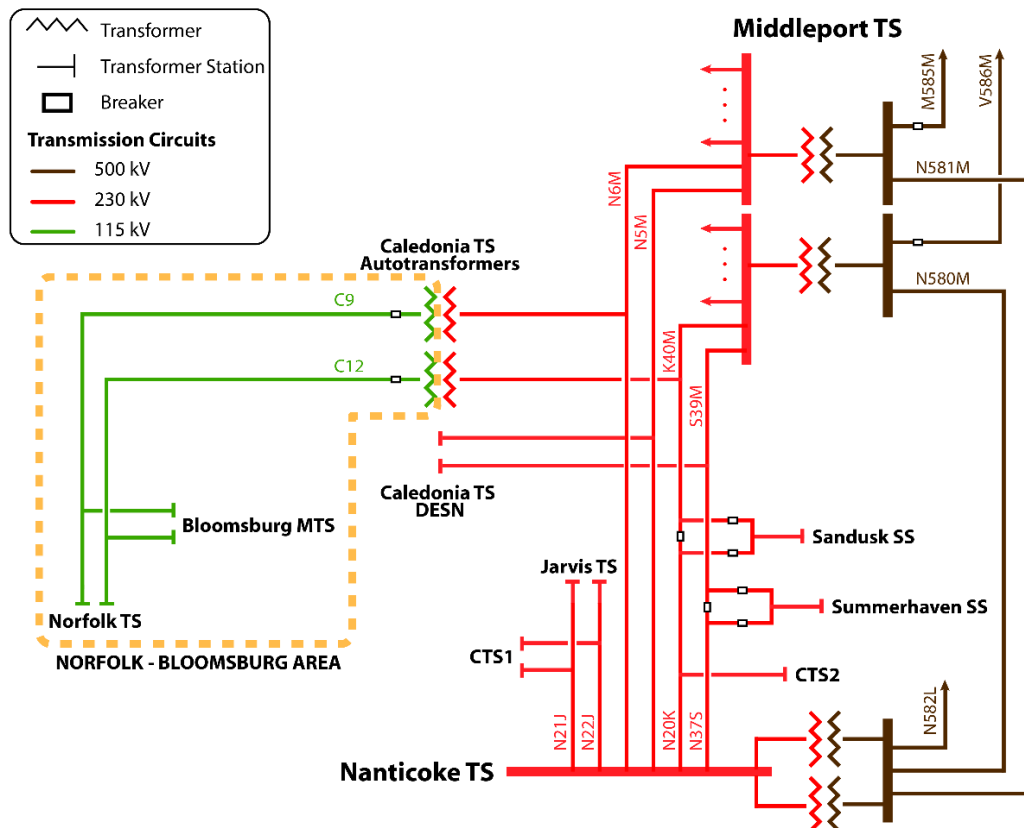
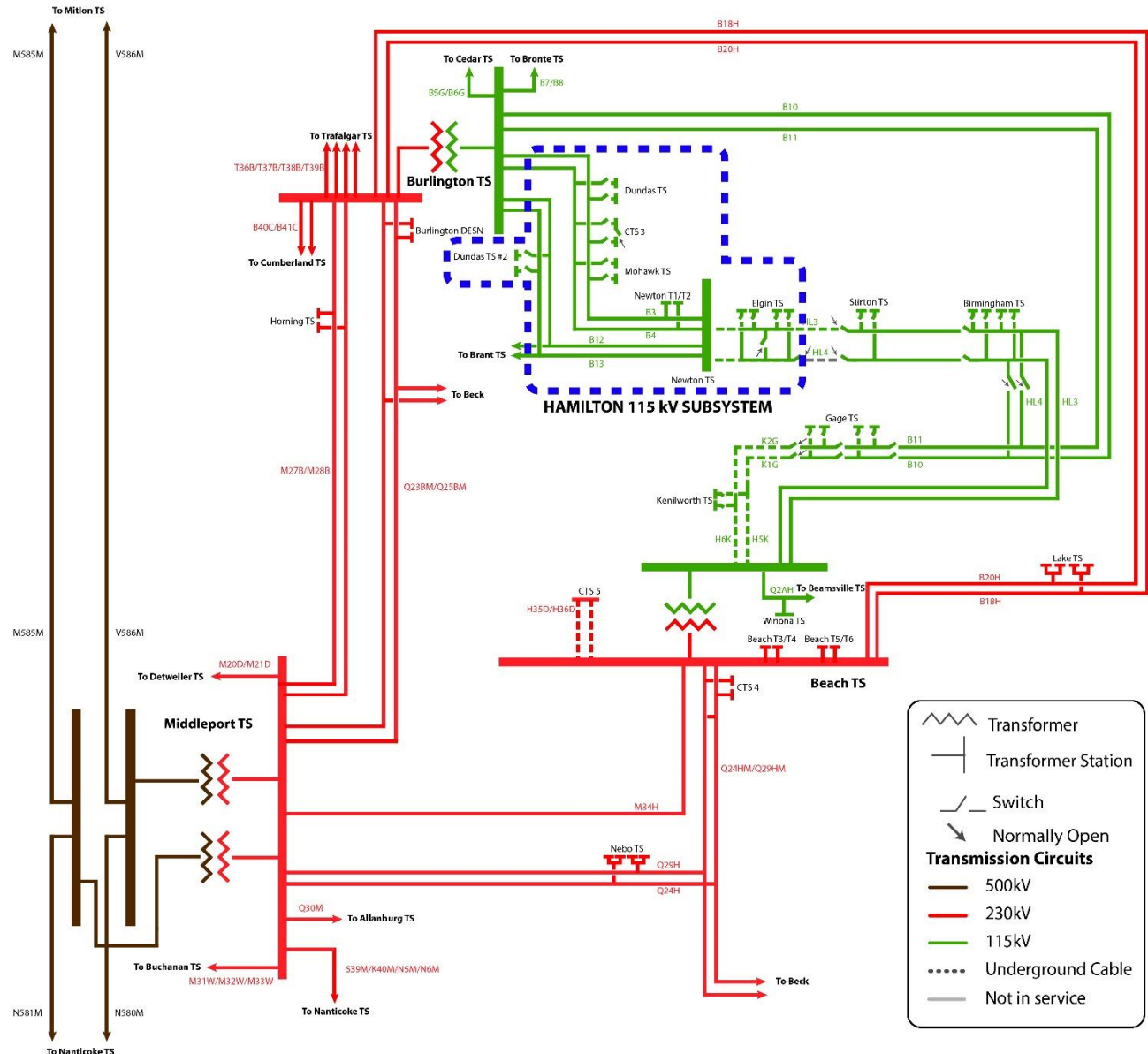


Figure 4 | Single Line Diagram of the Hamilton Subregion and Hamilton 115 kV Subsystem



The Burlington to Nanticoke IRRP was developed by completing the following steps:

- Preparing a 20-year electricity demand forecast and establishing needs over this timeframe (as described in the following steps);
- Examining the load meeting capability (LMC) and reliability of the existing transmission system, taking into account facility ratings and performance of transmission elements, transformers, local generation, and other facilities such as reactive power devices. Needs were established by applying ORTAC and NERC criteria.
- Assessing system needs by applying a contingency-based assessment and reliability performance standards for transmission supply in the IESO-controlled grid.
- Confirming identified asset replacement needs and timing with the transmitter and LDCs.

- Establishing alternatives to address system needs including, where feasible and applicable, generation, transmission and/or distribution, and other approaches such as non-wire alternatives including CDM.
- Engaging with the community on needs and possible alternatives.
- Evaluating alternatives to address near- to long-term needs; and
- Communicating findings, conclusions, and recommendations within a detailed plan.

5 Electricity Demand Forecast

Regional planning in Ontario is driven by having to meet peak electricity demand requirements in the region. This section describes the development of the demand forecast for the Burlington to Nanticoke Region. It highlights the assumptions made for peak demand forecasts, including weather correction, and the contribution of CDM and DG. Both a reference and high growth scenario were provided by Hydro One Distribution for their service territory, while the other LDCs only provided a reference scenario. Compared with their reference scenario, Hydro One Distribution's high growth scenario additionally considered potential upcoming load connections with a lower degree of commitment (e.g., capacity inquiries, long-term assumptions from municipal plans, etc.). The high growth scenario from Hydro One Distribution was used for the "planning" forecast, since the difference with the reference scenario they provided was only marginal.

To evaluate the reliability of the electricity system, the regional planning process is typically concerned with the coincident peak demand for a given area. This is the demand observed at each station for the hour of the year in which overall demand in the study area is at its maximum. In the case of this IRRP, three study areas were developed corresponding to the three subregions: Brant, Caledonia-Norfolk, and Hamilton.

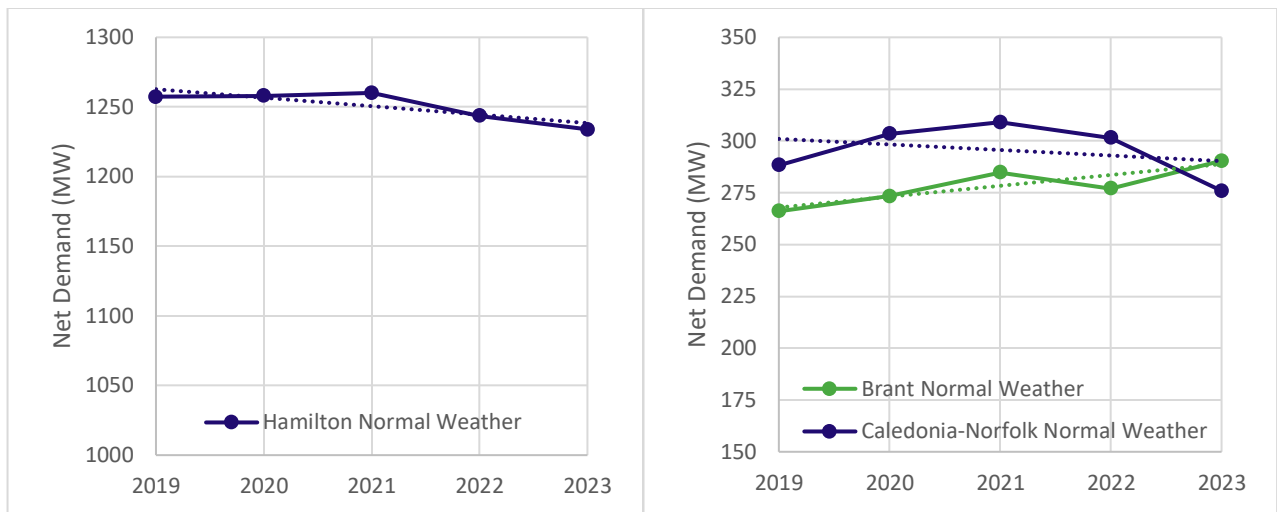
The coincident peak differs from a non-coincident peak, which refers to each station's individual peak, regardless of whether these peaks occur at different times. Each subregion of the Burlington to Nanticoke Region is summer peaking.

5.1 Historical Demand

Peak electricity demand within the Burlington to Nanticoke Region has been on average steady over 2019 to 2023. Figure 5 below shows the coincident net normal weather-corrected (adjusted to reflect normal weather conditions) historical demand for each subregion, which have unique trends. Weather-corrected historical demands have been shown to remove the effect of weather on annual changes in demand. Weather-corrected demand is more appropriate for evaluating growth trends. The peak demand hour for each year occurred consistently in the summer between approximately 2 PM to 7 PM.

The net weather-corrected demand for the Brant, Caledonia-Norfolk, and Hamilton subregions has averaged 278 MW, 296 MW, and 1251 MW, respectively, over the last five years with negligible upward or downward trends. Demand has slightly been increasing for the Brant subregion while slightly declining for the Caledonia-Norfolk and Hamilton subregions.

Figure 5 | Historical Subregion Normal-Weather Demands

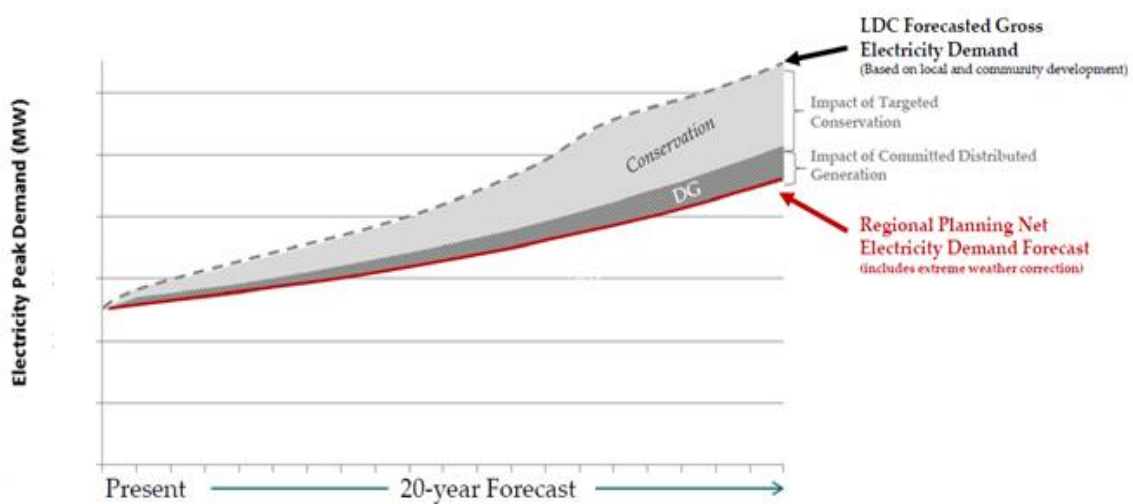


5.2 Demand Forecast Methodology

The methodology used to develop a 20-year IRRP peak demand forecast starting from LDC forecasts is illustrated in Figure 6. Gross demand forecasts, which assume the weather conditions of a normal year based on historical weather conditions (referred to as “normal weather”), were developed by the LDCs. These forecasts were then modified to reflect the peak demand impacts of provincial conservation targets and DG contracted through previous provincial programs, such as Feed-In Tariff (FIT) and microFIT, and adjusted to reflect extreme weather conditions in order to produce a reference forecast for planning assessments. This net forecast was then used to assess the electricity needs in the region.

Additional details related to the development of the demand forecast are provided in Appendix B. The Ontario Energy Board also since published a [Load Forecast Guideline](#) for regional planning, through the [Regional Planning Process Advisory Group](#).

Figure 6 | Illustrative Development of Demand Forecast



5.3 Gross LDC Forecast

Each participating LDC in the Burlington to Nanticoke Region prepared gross demand forecasts at the station level, or at the station bus level for multi-bus stations. These gross demand forecasts account for increases in demand from new or intensified development, plus known connection applications. In addition, when producing these gross demand forecasts, the impact of existing DG was removed, as DG impacts are accounted for later (see Section 5.5). Therefore, gross demand forecasts show the demand expected without any DG contributions, new or existing. Please see Section B.1 of Appendix B for more detail.

The LDCs cited alignment with municipal and regional plans and credited them as a source for input data. LDCs were also expected to account for changes in consumer demand resulting from typical efficiency improvements and response to increasing electricity prices (natural conservation), but not for the impact of future DG or new conservation measures (such as codes and standards and CDM programs), which are accounted for by the IESO (discussed in Section 5.4). The gross LDC forecast assumes normal weather conditions (e.g. median weather, expected 1 in 2 years), and peak station loading which may be non-coincident to the regional peak.

LDCs have a better understanding of future local demand growth and drivers than the IESO, since they have the most direct involvement with their customers, connection applicants, municipalities and communities which they serve. The IESO typically carries out demand forecasting at the provincial level. More details on the LDCs' load forecast assumptions can be found in Appendix B.

5.4 Contribution of Conservation to the Forecast

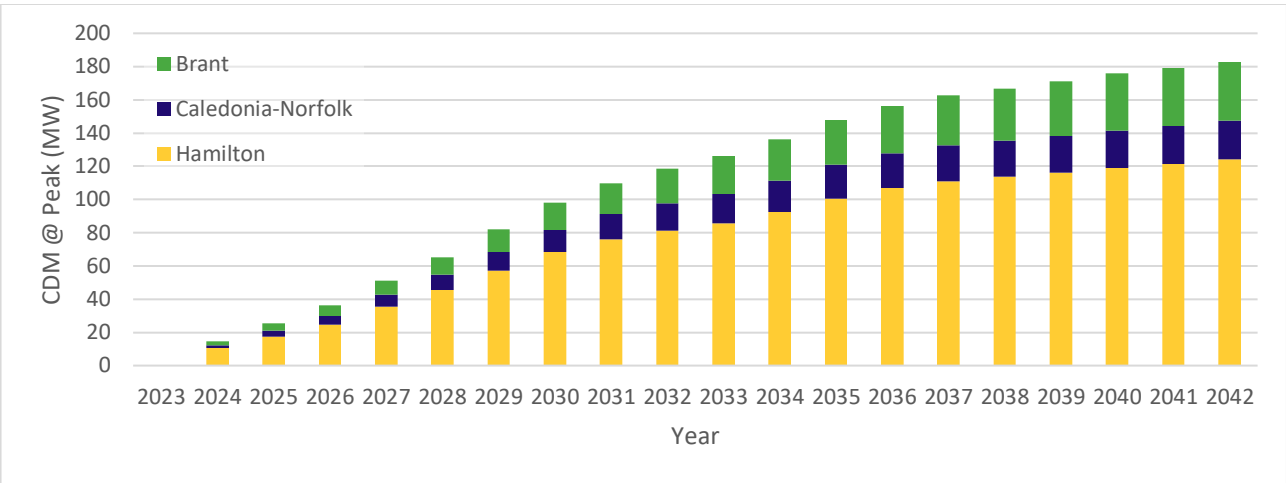
Conservation and demand management is a non-emitting and cost-effective resource that helps meet Ontario's electricity needs by reducing electricity consumption and peak-demand, and has been an integral component of provincial and regional planning. Conservation is achieved through a mix of codes and standards amendments, as well as CDM program-related activities. These approaches complement each other to maximize conservation results.

The estimated demand reduction from codes and standards is based on expected improvement in the codes for new and renovated buildings, and through regulation of minimum efficiency standards for equipment used by specified categories of consumers (i.e., residential, commercial and industrial consumers).

The estimated demand reduction from program-related activities is based on the 2021-2024 CDM Framework, federal programs that result in electricity savings in Ontario, and forecasted long-term energy efficiency programs assumed to be consistent with current framework savings levels. Through the ongoing 2021-2024 CDM Framework the IESO centrally delivers programs on a province-wide basis to serve business and low-income customers, as well as Indigenous communities. At the time of forecast development and IRRP publication, actual energy and peak demand savings targets for the new 2025-2036 framework are not confirmed. Should the new savings targets be higher, it may push out the timing or reduced the magnitude of identified needs.

Figure 7 shows the estimated total yearly reduction to the demand forecast due to conservation (from codes, standards, and CDM programs) for each subregion. Additional details are provided in Appendix B.

Figure 7 | Peak Demand Reduction Due to Conservation and Demand Management



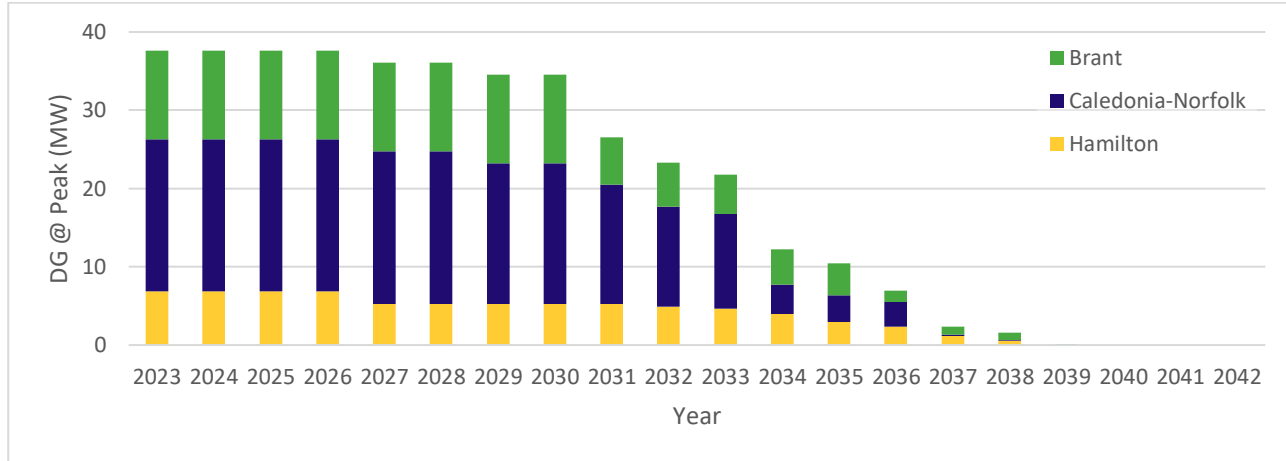
5.5 Contribution of Distributed Generation to the Forecast

In addition to conservation resources, DG is also forecasted to offset peak-demand requirements. The introduction of Ontario’s FIT and microFIT Programs increased the significance of distributed renewable generation which, while intermittent, contributes to meeting the province’s electricity demands. The installed DG capacity by fuel type and the associated contribution factor assumptions can be found in Appendix B. Most of the total contracted installed DG capacity in the Burlington to Nanticoke Region is solar generation, but there is a comparable quantity of non-renewable generation. In the Brant and Hamilton subregions, the split is approximately equal, but in the Caledonia-Norfolk region there is only renewable generation, which is almost entirely solar.

Figure 8 shows the estimated impact of DG on the Burlington to Nanticoke Region demand forecast. Note that any facilities without a contract with the IESO are not currently included in the DG peak demand reduction forecast.

In the long term, the contribution of DG is expected to diminish as their contracts expire. A total of 38 MW of peak contribution is identified for the Burlington to Nanticoke Region in 2023, reducing to zero by 2039 throughout the 2030s. This reduction is reflected in the Planning forecast as discussed in the next section.

Figure 8 | Peak Demand Reduction Due to Distributed Generation



5.6 Net Extreme Weather (Planning) Forecast

The net extreme weather forecast, also known as the “planning” forecast, is traditionally a region-wide coincident forecast, meaning that each station forecast reflects its expected contribution to the regional peak demand. This supports the identification of need dates for regional needs that are driven by more than one station.

Due to the specific needs of the three subregions within the Burlington to Nanticoke Region (the Brant, Caledonia-Norfolk, and Hamilton subregions), and due to the small or lack of excess capacity remaining on these subregions, the “planning” forecast was produced as a subregion coincident forecast. This means that each station forecast reflects its expected contribution to its subregion’s peak demand rather than the regional peak demand. This puts a greater focus on identifying subregion needs, which was required due to the high level of loading in these subregions.

The planning forecast is produced from three main steps: converting to a coincident forecast, adjusting for extreme weather, and converting to a net forecast.

As discussed in Section 5.3, LDCs provide gross forecasts assuming normal weather conditions, and peak station loading that is non-coincident to the region or subregion. Therefore, the first step is to convert this non-coincident forecast to a coincident forecast, by applying a coincidence factor to each station. The factor is based on the station’s historical contribution to the subregion peak demand compared to the station’s non-coincident peaks over the past five years (2018-2022 in this case). This results in a subregion coincident gross forecast which assumes normal weather.

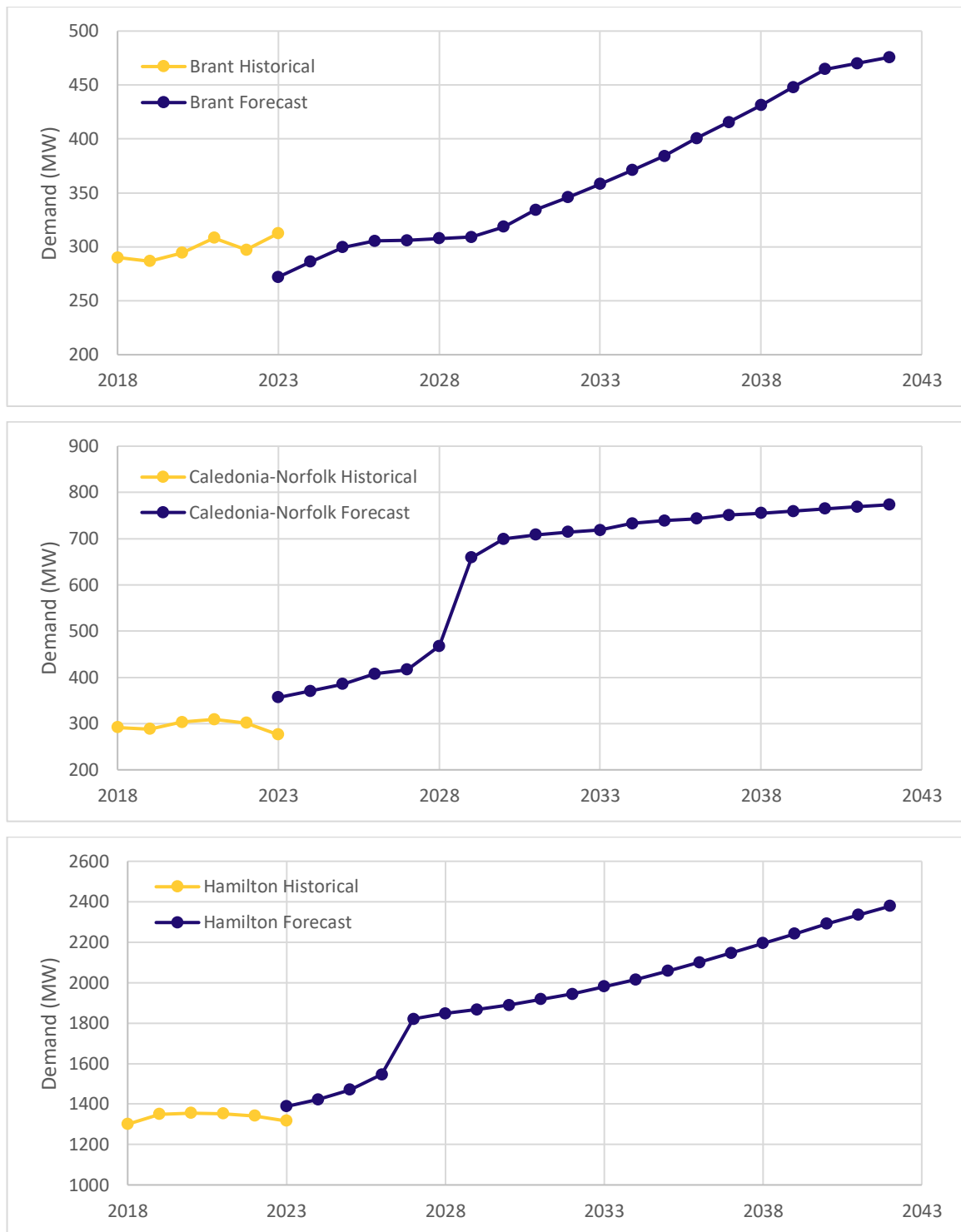
The second step is to adjust the resulting coincident gross normal weather forecast for extreme weather conditions. The weather correction methodology is described in Appendix B. This results in a coincident gross forecast which assumes extreme weather.

The last step is to adjust the resulting coincident gross extreme weather forecast for DG and conservation impacts. This is done by subtracting the forecasted DG and conservation impacts (as described in the above Sections) from the coincident gross extreme weather forecast. Finally, this results in a (subregional) coincident net extreme weather forecast, which is the “planning” forecast used to identify needs.

For station-specific needs, a non-coincident net extreme weather forecast used instead. The process for producing this forecast is similar as described above, except the first step is skipped.

The subregion coincident net extreme weather forecast (“planning” forecast) for each subregion in the Burlington to Nanticoke Region is shown in Figure 9 below. Historical net extreme weather demands have also been added for reference. The large increases in demand between 2026 to 2030 in the Caledonia-Norfolk and Hamilton subregions are caused by demand increases from a small number of existing industrial customers supplied by the 230 kV subsystems. These demand increases are unrelated to the needs and recommendations discussed in the following sections, which concern the 115 kV subsystems.

Figure 9 | Historical Demand and Planning Forecast for the Subregions



5.7 Hourly Forecast Profiles

In addition to the annual peak demand forecast, hourly demand profiles (8,760 hours per year over the 20-year forecast horizon) for the Bloomsburg DS and Norfolk TS stations were developed to better assess non-wire alternatives to address needs at these stations. In particular, these profiles were used to quantify the magnitude, frequency, and duration of needs, as described later in Section

7. The profiles were based on historical demand data, adjusted for variables that impact demand such as calendar day (i.e., holidays and weekends) and weather. The profiles were then scaled to match the IRRP peak planning forecast for each year.

Additional load profile details including hourly heat maps for each need can be found in Appendix D. Note that this data is used to roughly inform the overall energy requirements needed to develop and evaluate alternatives; it cannot be used to deterministically specify the precise hourly energy requirements. Real-time loading is subject to various factors like actual weather, customer operation strategies, and future customer segmentation. Demand patterns can change significantly as consumer behaviour evolves, new industries emerge, and trends like electrification are more widely adopted. Hence, these hourly forecasts are only used to select suitable technology types and roughly estimate costs for the needs and options studied in the IRRP. The Technical Working Group will continue to monitor forecast changes as part of implementation of the plan.

6 Needs

6.1 Needs Assessment Methodology

Based on the planning demand forecast, system capability, the transmitter's identified asset replacement plans, and the application of [ORTAC](#), [NERC TPL-001-4](#), and [Northeast Power Coordinating Council \(NPCC\) Directory #1 standards](#), the Technical Working Group identified electricity needs in the near-, medium- and long-term timeframes. These needs can be categorized according to the following:

Station Capacity Needs describe the electricity system's inability to deliver power to the local distribution network through the regional step-down transformer stations during peak demand. The capacity rating of a transformer station is the maximum demand that can be supplied by the station and is limited by station equipment. Station ratings are often determined based on the 10-day Limited Time Rating (LTR) of a station's smallest transformer under the assumption that the largest transformer is out of service. A transformer station can also be more limited by the thermal ratings of downstream or upstream equipment, i.e., breakers, disconnect switches, medium-voltage bus or high voltage circuits; or, by voltage drop limitations, which are independent of thermal ratings.

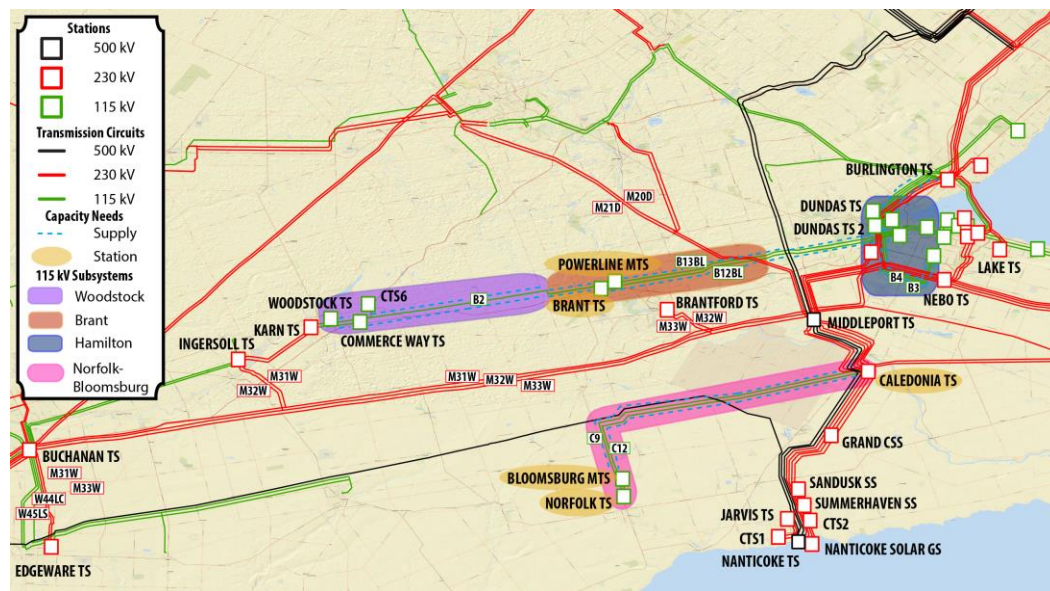
Supply Capacity Needs describe the electricity system's inability to provide continuous supply to a local area during peak demand. This is limited by the LMC of the transmission supply. The LMC is determined by evaluating the maximum demand that can be supplied to an area after accounting for limitations of the transmission elements (i.e., a transmission line, group of lines, or autotransformer), when subjected to contingencies and criteria prescribed by ORTAC, TPL-001-4, and NPCC Directory #1. LMC studies are conducted using power system simulation analyses.

Asset Replacement Needs are identified by the transmitter by an 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. Replacement needs identified in the near- and early mid-term timeframe would typically reflect more condition-based information, while replacement needs identified in the medium to long term are often based on the equipment's expected service life. As such, any recommendations for medium- to long-term needs should reflect the potential for the need date to change as condition information is routinely updated.

Load Security and Restoration Needs describe the electricity system's inability to minimize the impact of potential supply interruptions to customers in the event of a major transmission outage, such as an outage on a double-circuit tower line resulting in the loss of both circuits. Load security describes the total amount of electricity supply that would be interrupted in the event of a major transmission outage. Load restoration describes the electricity system's ability to restore power to those affected by a major transmission outage within reasonable timeframes. The specific load security and restoration requirements are prescribed by Section 7 of ORTAC.

Technical study results for the Burlington to Nanticoke IRRP can be found in Appendices G and H. The needs identified are discussed in the following sections, and are shown in Figure 10 below.

Figure 10 | Needs Identified in the Burlington to Nanticoke Region



6.2 Station Capacity Needs

Many station capacity needs emerge in the Burlington to Nanticoke region as shown in Table 5 with the majority in the near-/medium-term. Please see Appendix I, Figures of Station and Supply Capacity Needs, for graphical representation of these needs.

Table 5 | Station Capacity Needs

Time Horizon	Station	Subregion	Emerging Year	2042 Need (MW)
Near-term	Bloomsburg DS	Caledonia-Norfolk	2023	16
	Dundas 2 TS	Hamilton	2023	40
	Nebo TS (T1/T2) *	Hamilton	2023	142
	Nebo TS (T3/T4) *	Hamilton	2023	50
	Dundas TS	Hamilton	2025	59
	Powerline MTS	Brant	2026	68
	Mohawk TS	Hamilton	2026	46
	Brant TS	Brant	2027	41
Medium-term	Norfolk TS	Caledonia-Norfolk	2031	16
	Newton TS	Hamilton	2031	31

Time Horizon	Station	Subregion	Emerging Year	2042 Need (MW)
Long-term	Caledonia TS	Caledonia-Norfolk	2034	20
	Brantford TS	Brant	2035	54
	Lake TS (T1/T2) *	Hamilton	2035	19
	Elgin TS	Hamilton	2037	23
	Horning TS*	Hamilton	2038	14
	Beach TS (T5/T6) *	Hamilton	2042	2

*The station capacity needs were identified using the station load meeting capabilities (LMC) calculated by the IESO from load flow studies, or, if the LMC calculations were deferred to the addendum, using the station limited time ratings (LTR) provided in the transmitter-led Needs Assessment report.

6.2.1 Brant Subregion Station Capacity Needs

The three stations supplying the Brant subregion, Powerline MTS, Brant TS and Brantford TS, are forecasted to exceed their station capacity within the next decade. For a time, overloading at Brant TS and Powerline MTS can be addressed through distribution-level load transfers to Brantford TS until Brantford TS exceeds its capacity. However, by 2031 Brantford TS would no longer have capacity to provide relief, and new capacity is needed in the subregion. Additionally, the technical requirements and cost of upgrading the distribution system may limit the feasibility or viability of load transfer to Brantford TS.

6.2.2 Caledonia-Norfolk Subregion Station Capacity Needs

Half of the stations supplying the Caledonia-Norfolk subregion, Bloomsburg DS, Norfolk TS and Caledonia TS, are forecasted to exceed their station capacity within the next decade. For a time, overloading at these stations can be lessened through distribution-level load transfers to Jarvis TS. However, by 2035 Jarvis TS would no longer have capacity to provide relief, and new station capacity is needed in the subregion. Additionally, feasibility and economic reasons may restrict the amount of the load transfers.

6.2.3 Hamilton Subregion Station Capacity Needs

In the Hamilton subregion, ten out of 19 DESNs are forecasted to exceed their station capacity within the planning horizon. Notably six of these DESNs, i.e., Dundas TS, Dundas 2 TS, Mohawk TS, Nebo TS (T1/T2) and (T3/T4) and Newton TS, are identified with station capacity needs with a near- or medium-term timeframe.

The majority of needs for the Hamilton subregion will be addressed in the Hamilton Addendum as discussed in Section 2.5.1. However, the needs of the Dundas stations will be addressed by the Technical Working Group recommendations as part of the Brant 115 kV Extended Area as described in Section 6.3.

6.2.4 Customer-Owned Transformer Stations

Two customer-owned transformer stations (CTS) within the Burlington to Nanticoke Region are forecasted to exceed their station capacity. Since these stations are privately owned, the private owners will need to coordinate their solution with the IESO and transmitter (Hydro One) via the [Connection Assessment and Approval](#) (CAA) process.

6.3 Supply Capacity Needs

Supply capacity needs for the majority of the Hamilton subregion will be assessed and addressed in the addendum as discussed in Section 2.5.1. However, a portion of the Hamilton 115 kV system was included in the need assessments for the Brant subregion because of their impact on one another. This larger area is referred to as the Brant 115 kV Extended Area which, similarly, was further extended on the opposite side to include the Woodstock 115 kV Subsystem. In summary, the Brant 115 kV Extended Area consists of:

- **Brant 115 kV Subsystem:** the Powerline and Brant stations in the Brant subregion supplied via B12BL, B13BL, and B2
- **Hamilton 115 kV Subsystem:** the Dundas, Dundas 2, Mohawk, Newton, Elgin and CTS3 stations in the Hamilton subregion supplied via B12BL, B13BL, B3, and B4
- **Woodstock 115 kV Subsystem:** the Woodstock, Commerce Way and CTS6 stations in the Woodstock subregion of the London Area supplied via K7, K12 and B2

Table 6 shows the supply capacity needs identified for the Norfolk-Bloomsburg Area in the Caledonia-Norfolk subregion and various Subsystems in the Brant 115 kV Extended Area. Please see Appendix I, Figures of Station and Supply Capacity Needs, for graphical representation of these needs.

The LMC of the Norfolk-Bloomsburg Area, which is radially supplied via circuits C9 and C12, is limited by voltage constraints to 80 MW, well below the thermal limitation of the circuits at 150 MW. This Area has an immediate need of 33 MW in 2023 which increases to 78 MW in 2042.

Supply capacity needs for the Brant 115 kV Extended Area were identified based on its Subsystems: the Brant, Hamilton and Woodstock 115 kV Subsystems.

- The Brant 115 kV Subsystem has an immediate need of 3 MW in 2023 and a long-term need of 129 MW in 2042. The LMC of the Brant 115 kV Subsystem is presently limited by thermal limitations on circuits B12BL and B13BL to 134 MW, but following that, voltage constraints limit the LMC to nearly the same limit of 137 MW.
- The combined Brant and Hamilton 115 kV Subsystems has an immediate need of 66 MW in 2023 which increases to 483 MW in 2042. The LMC of the combined Subsystems is presently limited by thermal limitations on circuits B12BL and B13BL to 500 MW, but following that, voltage constraints limit the LMC to nearly the same limit of 535 MW.
- The Woodstock 115 kV Subsystem has an immediate need of 20 MW in 2023 which increases to 47 MW in 2042. The LMC of the Woodstock 115 kV Subsystem is presently limited by voltage constraints to 85 MW.

The magnitudes of the needs shown in Table 6 can reach approximately 100 per cent of the LMC. This indicates that significant reinforcements that are required for the 115 kV Subsystems listed in this table.

Table 6 | Supply Capacity Needs

Subregion	Subsystem	LMC (MW)	Need Magnitude (MW)	
			2023	2042
Caledonia-Norfolk Subregion	Norfolk-Bloomsburg Area	80	33	78
Brant 115 kV Extended Area	Brant 115 kV Subsystem	134	3	129
	Combined Brant and Hamilton 115 kV Subsystems	500	66	483
	Woodstock 115 kV Subsystem	85	20	47

6.4 Asset Replacement Needs

At the time of the Burlington to Nanticoke Region Needs Assessment, Hydro One identified a number of assets requiring replacement in the next 10 years. These needs and recommendations from the Technical Working Group have been included in Table 7.

Table 7 | Asset Replacement Needs

Timeframe	Station	Asset	Recommendation
Medium-term	Beach TS	230/115 kV autotransformers DESN transformers	Proceed with like-for-like replacement
	Birmingham TS	DESN transformers and switchgear	Proceed with like-for-like replacement
	Caledonia TS	DESN transformer (T1)	Station capacity need identified; replace with maximum-rated unit
	Gage TS (T8/T9)	DESN transformers and switchgear	Proceed with replacement with nearest standard units
	Jarvis TS	DESN transformers	Proceed with like-for-like replacement; assess if current-limiting reactors can be removed*
	Lake TS	DESN transformers and switchgear	Station capacity need identified; replace with maximum-rated unit

Timeframe	Station	Asset	Recommendation
	Nebo TS (T3/T4)	DESN transformers	Station capacity need identified; replace with maximum-rated unit
	Norfolk TS	DESN switchgear	Defer replacement if possible, New 230 kV DESNs recommended (Section 7.3.2.3)
Long-term	Dundas TS	DESN switchgear	Defer replacement if possible, New 230 kV DESNs recommended (Section 7.3.2.3)

* The current-limiting reactors reduce the station LMC by 25 MW from ~125 MW to ~100 MW.

6.5 Load Security and Load Restoration Needs

The recommended interim solutions to open station bus-tie breakers can be violations to the load security criteria. However, the LDCs and transmitter can apply for exemptions until the medium-/long-term plans to address the needs are placed in service after which opening bus-tie breakers would not be needed.

The Technical Working Group did not identify any restoration needs.

7 Plan Options and Recommendations

This section describes the options considered and recommendations to address the needs in the Burlington to Nanticoke Region. In developing the plan, the Technical Working Group considered a range of integrated options. Considerations in assessing alternatives included feasibility, cost, lead time, system benefits, and consistency with longer-term needs in the area.

Generally speaking, there are two approaches for addressing regional needs that arise as electricity demand increases:

- Build new transmission or distribution infrastructure. These are commonly referred to as “wire” options and can include things like new transmission lines, autotransformers, step-down transformer stations, voltage control devices, upgrades to existing infrastructure, or distribution-level load transfers. Wire options may also include control actions or protection schemes that influence how the system is operated to avoid or mitigate certain reliability concerns.
- Install or implement measures to reduce the net peak demand to maintain loading within the system’s existing LMC. These are commonly referred to as “non-wire” options and can include things like local utility-scale generation or storage, distributed energy resources (including distribution-connected generation and demand response), or CDM.

Section 7.1 begins with a more in-depth overview of all option types considered in IRRPs. Section 7.2 describes the screening approach used to assess which needs would be best suited for a more detailed assessment for non-wire option. Subsequently, Section 7.3 to Section 7.4 present the options that were ultimately developed and evaluated (including a cost comparison) before the Technical Working Group made a recommendation.

7.1 Options Considered in IRRPs

Wire options are always considered in regional planning and while they are always viable options for regional needs, non-wire option may be more suitable for specific need types and characteristics. Hence, to select and appropriately size non-wire option such as generation or battery storage, additional work is required – including creation of an hourly load profile, as described in Section 5.7. The most suitable technology type and capacity is chosen by examining the “unserved energy” profile, which is the hourly demand above the existing LMC. The profile indicates the duration, frequency, magnitude, and total energy associated with each need. Some of these characteristics are shown visually in Appendix D for the Burlington to Nanticoke Region needs.

High-level cost estimates for wire options are based on input provided by the transmitter and transmission benchmark costs. In contrast, cost estimates for non-wire options are based on benchmark capital and operating cost characteristics for each resource type and size. Due to policy considerations and decarbonization efforts, new natural gas-fired generation was not considered as a generation option for local needs identified by the regional plan. Battery energy storage, solar generation, and wind generation were considered for generation options.

New CDM measures can also help decrease the net electricity demand. Centrally delivered energy efficiency measures under the 2021-2024 CDM Framework and [Save on Energy brand](#) are already included in the load forecast, as discussed in the Section 5.4. As part of this current Framework, the IESO was directed to deliver a new program to address regional and/or local system needs. The [Local Initiative Program](#) is now one tool that is available to target the delivery of additional CDM savings at specific areas of the province with identified system needs. LDCs can also use the Ontario Energy Board's [Non-Wires Solutions Guidelines for Electricity Distributors](#) (previously "CDM Guidelines") to leverage distribution rates to help address distribution and transmission system needs using non-wire alternatives. Generally, incremental CDM measures are suitable for needs where growth is slow and the magnitude of the overload relative to the total demand is very small (i.e., on the order of few percent per year). These considerations are discussed further in Section 7.2, as part of the screening of options that was conducted.

For both wire and non-wire options, the upfront capital and operating are compiled to generate levelized annual capacity costs (\$/kW-year). A cash flow of the levelized costs for the options are compared over the lifespan of the wire option (typically 70 years for transmission infrastructure). The net present value (in 2024 CAD for this report) of these levelized costs is the primary basis through which feasible options are compared.

It is important to recognize that there is a significant error margin around cost estimates at the planning stage, as they are only intended to enable comparison between options during the IRRP. The transmitter-led RIP (which is conducted after the IRRP) performs additional detailed analysis and allows the opportunity to refine cost estimates of wire options before implementation work begins. The IESO continues to participate in the Technical Working Group during the RIP and revisits these recommendations if costs estimates differ significantly. Furthermore, pilot or demonstration projects can be explored in cases where other barriers (e.g., regulatory frameworks for cost-sharing and recovery, or operationalization to meet local reliability constraints) impede the adoption of some of these cost-effective options following the completion of the IRRP.

The list of assumptions made in the economic analysis can be found in Appendix F.

7.2 Screening Options

As explained in the previous section, an array of options is developed to meet local needs during an IRRP and then each option is evaluated to recommend the option which is the most cost effective or the option which best balances cost and risk mitigation when substantial additional risks not captured by the Planning forecast are present. This process is complemented by considerations for stakeholder preferences and feedback.

Screening occurs early in the IRRP study after local reliability needs are known but before options analysis. It helps direct time-intensive aspects of detailed non-wires analysis (hourly need characterization, options development, financial analysis, and engagement) towards the most promising options. The three-step, high-level approach is shown in Figure 11 and further discussed in the next sections for the needs identified in the Burlington to Nanticoke region.

Station capacity needs identified for the Hamilton subregion in Section 6.2.3 are not included here, as the needs for the Hamilton subregion will be addressed in the addendum (see Section 2.5.1). More details on the steps and inputs used in the screening mechanism can be found in Appendix C, and a

summary of the options screening results for Burlington to Nanticoke Region is provided in Table 8 for station capacity needs, and in Table 9 for supply capacity needs.

Figure 11 | IRRP NWAs Screening Mechanism

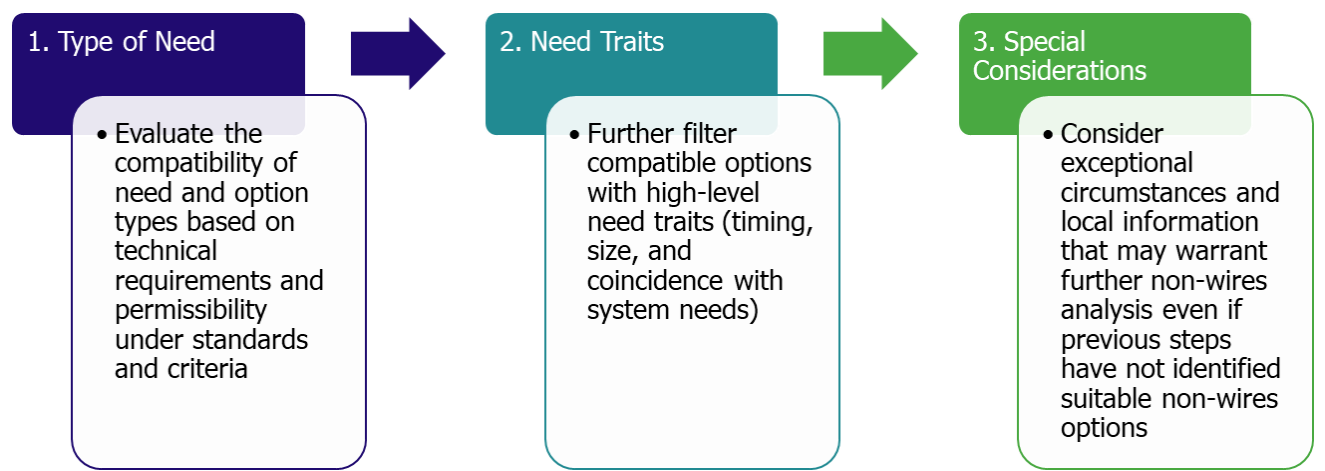


Table 8 | Options Screening Results for Station Capacity Needs

Need	Screened In	Screened Out
Station Capacity: Bloomsburg DS, Norfolk TS, Caledonia TS, Brant TS, Powerline MTS	<ul style="list-style-type: none">• Operational measures• CDM• Distributed generation⁴• Wires options	<ul style="list-style-type: none">• Demand response – due to magnitude and timing of need

Table 9 | Options Screening Results for Supply Capacity Needs

Need	Screened In	Screened Out
Supply Capacity: Line C9 and C12, Brant 115 kV Subsystem, Hamilton 115 kV Subsystem, Woodstock 115 kV Subsystem	<ul style="list-style-type: none">• Operational measures• CDM• Distributed generation⁴• Transmission-connected generation• Wires options	<ul style="list-style-type: none">• Demand response – due to magnitude and timing of need

7.2.1 Non-Wires Options for the Station Capacity Needs

⁴ Later found to be technically infeasible due to short circuit limitations

Non-wires options cannot typically resolve the station capacity needs for the Burlington to Nanticoke region. The magnitude of the needs is too great to be addressed via CDM and DR and significantly exceeds the amount of DG that is technically feasible to connect at the distribution level due to short circuit and thermal constraints. Transmission-connected generation was also excluded because resources must be connected downstream of the limiting step-down transformer to have an impact on the station capacity needs.

Nevertheless, CDM has been considered for deferring long-term station capacity needs.

7.2.2 Non-Wires Options for the Supply Capacity Needs

Non-wires options, except transmission-connected resources, cannot resolve the supply capacity needs for the Burlington to Nanticoke Region since these needs are large in magnitude. Nevertheless, non-wire options can be explored in combination with wire options.

Only non-emitting resources such as battery storage and renewables were included in the option assessments.

7.3 Options and Recommendations for the Brant Subregion

7.3.1 Station Capacity Needs

The three stations supplying the Brant subregion, Powerline MTS, Brant TS and Brantford TS, are forecasted to exceed their station capacity, in the same order, within the next decade.

The needs at Powerline MTS and Brant TS are too large to be addressed by CDM or DR and DG is not viable because of short-circuit and thermal limitations at the stations. For a time, overloading at Powerline MTS and Brant TS can be addressed through distribution-level load transfers to Brantford TS until Brantford TS exceeds its capacity. The technical requirements and cost of upgrading the distribution system may limit the feasibility or viability of this load transfer.

Normally, the wire option, that is to upgrade the Powerline and Brant transformers, is recommended at this point. However, since there is also a supply capacity need for these stations, it would be more efficient and cost-effective to recommend a solution that resolves all supply and station capacity needs in the area, as discussed in the next section.

Therefore, as an interim solution, it is recommended to open bus-tie breakers at Powerline MTS and Brant TS, as required, to resolve their station capacity needs.

Load transfer to Brantford TS on a permanent or temporary basis may be used to reduce or resolve the station capacity needs but should be coordinated with the recommended interim option for resolving the supply capacity needs for the area explained in Section 7.3.2.1.

Since the Brantford station capacity need is in the long term, no immediate action is required. The Technical Working Group will monitor the load growth at the station for any change that can advance the need to take an appropriate action.

7.3.2 Supply Capacity Needs

No supply capacity need was identified for Brantford TS which is supplied from M32W and M33W, the 230 kV double-circuit line between Middleport and Buchanan.

Needs for the Brant 115 kV Subsystem, 115 kV circuits B12BL, B13BL and B2 supplying Powerline MTS and Brant TS, could not be identified and addressed in isolation due to its tight connectivity with the neighboring subregions. As such, the area of study was extended to the entire 115 kV system enclosed between the Burlington and Karn 115 kV stations. This study area is referred to as the Brant 115 kV Extended Area which, in addition to the Brant 115 kV Subsystem, consists of the Hamilton 115 kV Subsystem plus Woodstock 115 kV Subsystem, which are the Dundas, Dundas 2, Mohawk, Newton, Elgin and CTS3 stations in the Hamilton subregion supplied via B12BL, B13BL, B3 and B4 plus the Woodstock, Commerce Way and CTS6 stations in the Woodstock subregion of the London Area supplied via K7, K12 and B2.

7.3.2.1 Interim Solution – Operational Measures

As presented in Section 6.3, there are immediate supply capacity needs in the Brant 115 kV Extended Area.

Therefore, as an interim solution, it is recommended to take some operational measures to maintain system security by opening station bus-tie breakers within each Subsystem to maintain the post-contingency total load within the applicable load meeting capability. Effort should be taken to minimize the overall number of bus-tie breakers that must be open based on system conditions.

7.3.2.2 Non-Wire Options

Due to the large magnitude of the supply capacity needs in the Brant 115 kV Extended Area, CDM, DR and DG were not found to be adequate to resolve the needs. Transmission-connected resources, such as battery storage, are the only non-wire options with the potential to address these needs.

Due to the large area spanned when evaluating the resource option, a minimum of two facilities were needed, one at Brant TS and one at Newton TS with a total capacity of 450-600 MW. To be viable, the battery storage at both places should be paired with wind and solar generation because there are extended periods of time when the batteries cannot be charged from the grid due to extremely limited supply capacities. This implies having 600-1,500 MW wind and solar farms within the densely populated urban areas of Hamilton, which is not practical. As a result, transmission-connected resources were not considered feasible to meet this need and are not recommended.

7.3.2.3 Wire Options

Wire options listed in Table 10 were considered for resolving supply capacity needs in the Brant 115 kV Extended Area with additional information provided in the following sections.

Option 1: Reinforcing 115 kV and Dynamic Voltage Support

Based on load flow studies, almost all the 115 kV lines – 30 km of a single-circuit lines and 80 km of double/quadruple-circuit lines – must be reinforced with higher capacity wires by a factor ranging

from 1.35 to 3 in various sections. Additionally, dynamic voltage support devices, e.g. STATCOM, SVC or synchronous condenser, with a total post-contingency capacity of 500 Mvar at the Karn, Brant and Powerline stations are required to stabilize the voltage. It can take up to \$790 M and 10 years to implement this option and still the long-term needs are not resolved let alone enabling future load growth.

Option 2: Upgrading 115 kV to 230 kV

This option entails replacing towers and wires on 85 km of double/quadruple-circuit lines and 2x8 stepdown transformers serving loads at eight stations. In addition to being prohibitively costly and lengthy, implementing this option is not practical since the lines pass through dense urban areas or along busy roads with a tight right of way.

Option 3: Adding New Supply Point Via 230/115 kV Autotransformers

None of the three alternatives considered for this option showed better load meeting capabilities than Option 1 although similar 115 kV reinforcements and dynamic voltage support were necessary and reinforcing 230 kV system might also be required. This implies this option has a higher cost and longer implementation time than Option 1 with no additional benefits.

Option 4a: Offloading 115 kV System to MxD and MxB 230 kV Circuits

Option 4a is the recommended solution since it can resolve both supply and station capacity needs for the Brant and Powerline and Dundas and Dundas 2 stations within an acceptable cost and timeframe without any negative impact on major bulk interfaces. Furthermore, the 115 kV system can supply the remaining Hamilton stations, CTS3, Mohawk, Newton and Elgin TS, up to their capacities without any additional reinforcement. Supply and station capacity needs, which would still limit the expected load growth for these remaining Hamilton stations, will be further assessed and addressed in the addendum discussed in Section 2.5.1.

To address supply capacity needs, rather than constructing new DESNs, it is possible to convert the existing DESNs at Brant TS and Powerline MTS from 115 kV to 230 kV supply. However, this will not resolve station capacity needs, and additional measures will be needed.

The choice between constructing new DESNs or converting existing DESNs, and the siting of potential new DESNs will be determined in the upcoming Regional Infrastructure Planning (RIP) led by the transmitter. The point of connections to Middleport-Detweiler corridor will be finalized via the ongoing [KWCG IRRP](#) since these circuits are in the KWCG region.

Option 4b: Offloading 115 kV System to MxW and QxBM 230 kV Circuits

Option 4b is an alternative to Option 4a with similar benefits. However, the circuits to which load is transferred are part of major interfaces. Addition of load to these circuits negatively affect power transfer across the province and should be avoided. Otherwise, reinforcements are required to compensate for the negative impact.

Table 10 | Wire Options for Brant 115 kV Extended Area*

#	Description	Cost (\$M)	Note
1	Reinforce 115 kV lines and add dynamic voltage support at Karn, Brant and Powerline	750-800	Does not resolve the long-term needs or enable future growth
2	Upgrade 115 kV lines and stations to 230 kV	1,000-1,500	Impractical and prohibitively costly and lengthy
3	Add new supply point via 230/115 kV autotransformers using either of the following alternative connections: - from Brantford TS to Brant TS on B12BL and B13BL - from Brantford TS to Alford Junctions on B12BL and B13BL - from Horning Mountain Junctions on M27B and M28B to Newton TS	850-1,000	Worse than Option 1; does not resolve the long-term needs or enable future growth; requires similar 115 kV reinforcements and dynamic voltage support as Option 1; may require 230 kV reinforcements
4a	Offloading 115 kV system to 230 kV: - Transfer Brant and Powerline loads to new 230 kV DESNs supplied from new taps on The Middleport-Detweiler corridor** - Transfer Dundas and Dundas 2 loads to new 230 kV DESNs at Dundas switchyard supplied from M27B and M28B***	200-300	Recommended option. Resolve supply and station capacity needs for Brant and Powerline and Dundas and Dundas 2; 115 kV system can supply the remaining Hamilton stations up to their capacities with no additional reinforcement****
4b	Offloading 115 kV system to 230 kV: - Transfer Brant and Powerline loads to new 230 kV DESNs supplied from Brantford TS or new taps on M32W and M33W - Transfer Dundas 1 and 2 loads to new 230 kV DESNs at Dundas switchyard supplied from Q23BM and Q25BM	300-400	Same benefits as Option 4a but not recommended due to negative impact on power transfer across the province as the circuits are part of major interfaces

* Line notations:

B12BL and B13BL: 115 kV circuits between Burlington, Brant and Newton, supplying Brant and Powerline loads

M27B and M28B: 230 kV circuits between Middleport and Burlington

M20D and M21D: 230 kV circuits between Middleport and Detweiler

M32W and M33W: 230 kV circuits between Middleport and Buchanan, part of a major interface transferring power across Ontario

Q23BM and Q25BM: 230 kV circuits between Beck 2, Burlington and Middleport, part of a major interface transferring power across Ontario

** DESN placements and point of connection to the Middleport-Detweiler corridor will be finalized via ongoing [KWCG IRRP](#).

*** Transmitter-led Regional Infrastructure Plan (RIP) assesses and develops a detailed plan for implementation.

**** Woodstock 115 kV System LMC increases to 113 MW after which operational measures should be used to secure the system. Opening Brant DB2 115 kV breaker is recommended.

7.4 Options and Recommendations for the Caledonia-Norfolk Subregion

7.4.1 Station Capacity Needs

Three out of six stations supplying the Caledonia-Norfolk subregion, Bloomsburg DS, Norfolk TS and Caledonia TS, are forecasted to exceed their station capacity, in the same order, within the next decade.

The needs at Bloomsburg DS and Norfolk TS are too large to be addressed by CDM or DR and DG is not viable because of short-circuit and thermal limitations at the stations. For a time, overloading at Bloomsburg DS can be addressed through distribution-level load transfers to Norfolk TS until Norfolk TS exceeds its capacity after which Bloomsburg and Norfolk loads may be transferred to Jarvis TS. However, Hydro One Distribution has indicated limited ability to cost-effectively transfer load to Jarvis TS, and estimates that more than 20 km of new distribution line is needed meet long term needs.

Normally, the wire option, that is to upgrade the Bloomsburg and Norfolk transformers, is recommended at this point. However, since there is also a supply capacity need for these stations, it would be more efficient and cost-effective to recommend a solution that resolves all supply and station capacity needs in the area, as discussed in the next section.

Therefore, as an interim solution, it is recommended to open bus-tie breakers at Bloomsburg DS and Norfolk TS, as required, to resolve their station capacity needs.

Load transfer from Bloomsburg DS to Norfolk TS and additional load transfer from any of these stations to Jarvis TS on a permanent or temporary basis may be used to reduce or resolve the station capacity needs but should be coordinated with the recommended interim solution for resolving the supply capacity needs for the area explained in Section 7.4.2.1.

Since the Caledonia station capacity need is in the long term, no immediate action is required. The Technical Working Group will monitor the load growth at the station for any change that can advance the need, and consider the use of CDM closer towards the needs date to defer needs.

7.4.2 Supply Capacity Needs

As presented in Section 6.3, there is a supply capacity need in the Norfolk-Bloomsburg Area. No supply capacity need was identified for Caledonia TS or Jarvis TS.

7.4.2.1 Interim Solution – Operational Measures

To address the immediate supply capacity need in the Norfolk-Bloomsburg Area, an immediate interim solution is needed until permanent solutions can be put in place.

Therefore, as an interim solution, it is recommended to take some operational measures and open station bus-tie breakers at Bloomsburg DS or Norfolk TS, as required, to ensure the

security of the system by maintaining the post-contingency total load within the applicable load meeting capability.

Permanent or temporary load transfer to Jarvis TS may be used to reduce reliance on opening bus-tie breakers.

7.4.2.2 Non-Wire Options

Due to the large magnitude of the supply capacity needs in the Norfolk-Bloomsburg Area, CDM, DR and DG were not found to be adequate to resolve the needs. Transmission-connected resources, such as battery storage, are the only non-wire options with the potential to address these needs. However, due to the sizeable capacity required to meet needs, this non-wire option is only economically viable when considering the system benefit that resources provide to the provincial system.

Load flow analyses showed battery energy storage systems (BESS) are viable if they:

- constantly control the voltage of the points of interconnection (POI) to the grid by providing enough reactive power (Mvar) support to the system.
- connect on both 115 kV lines, C9 and C12, between Bloomsburg Junctions and Norfolk TS, preferably at Norfolk TS.
- have enough redundancy in components and connections not to lose active/reactive power support and voltage control under any outage conditions; otherwise, the operational measures recommended as the interim solution in the previous section must be taken.

Minimum requirements for the rated capacity (MW) and energy (MWh) of a viable BESS are dependent on the minimum reactive power (Mvar) support that the BESS can constantly provide. Higher constant reactive power support results in lower rated capacity and energy requirements which may imply the BESS reactive power support exceeds the reactive power requirement from [Market Rules Appended 4.2 – Category 5](#).

If the BESS option is found unviable because of low reactive power support, it may be possible to make it viable by pairing with renewables. Further analyses are needed to determine the capacity of wind and solar generation needed for this, and the associated feasibility of building sufficient wind and solar farms in the area.

As discussed in the next section, the recommended long-term solution for the Norfolk-Bloomsburg Area is a 230 kV wire option. However, since the needs are immediate and the implementation of the wire option can take up to 10 years, to bridge the gap until the Norfolk-Bloomsburg long-term wire solution is placed in service, a medium-term solution is also recommended.

Therefore, as a medium-term solution, a BESS capable of continually providing reactive support to control the voltage at the points of interconnection is recommended. The BESS may potentially be combined with other NWAs such as renewables.

7.4.2.3 Wire Options

The transmission-connected resources recommended in the previous section would not enable future long-term growth in the Area. In addition, a heavily loaded Norfolk-Bloomsburg 115 kV system would significantly restrict the load meeting capabilities of the upstream 230 kV system. Connecting new large loads, such as industrial projects or AI/data centres, with a magnitude of 1,000-2,000 MW to the Nanticoke-Middleport corridor or Nanticoke 230 kV TS may not be feasible unless the Norfolk-Bloomsburg Area is offloaded. As such, wire options listed in Table 10 were explored. Additional information is provided in the following sections.

Option 1: Dynamic Voltage Support and CDM

Based on load flow studies, dynamic voltage support devices, e.g. STATCOM, SVC or synchronous condenser, with a total post-contingency capacity of 100 Mvar are required to stabilize the voltage and increase the load meeting capability of the Norfolk-Bloomsburg Area to its thermal limit of 150 MW. Combined with new CDM programs, this option can meet the supply capacity need for the 20-year forecast without enabling any further growth. However, it does not resolve the station capacity needs at Bloomsburg DS and Norfolk TS. In addition, a limitation on the upstream 230 kV system is also present.

Option 2: Upgrading 115 kV System to 230 kV

This option entails replacing 115 kV wires along 45 km of double-circuit lines and adding two sets of stepdown transformers serving loads at the two stations. Implementing this upgrade would require frequent outages to the system including the 500 kV circuit that shares towers with the 115 kV circuits. The cost and lead time of this option are the largest among the wire options without providing any additional benefits comparing to Options 3a and 3b.

Option 3a and 3b: Transferring Load to a New 230 kV DESN Supplied Via New Lines Connecting to the Nanticoke-Middleport 230 kV Corridor or Nanticoke TS

Option 3 has two alternatives, a and b, with similar cost, timeline, and benefits.

Option 3b, constructing a new DESN and connecting to Nanticoke TS, is recommended because it addresses the long-term supply and station capacity needs and enables future growth for the Norfolk-Bloomsburg Area. Option 3b is preferred over 3a, since it can address the needs for multiple areas, including possible growth due to industrial projects or AI/data centers in the vicinity of Nanticoke TS.

To address supply capacity needs, rather than constructing a new DESN, it is possible to convert the existing DESNs at Bloomsburg DS and Norfolk TS from 115 kV to 230 kV supply. However, this will not resolve station capacity needs, and additional measures will be needed.

The choice between constructing a new DESN or converting existing DESNs, the siting of new transmission lines, and the siting of potential new DESNs will be determined in the upcoming Regional Infrastructure Planning (RIP) led by the transmitter.

Depending on the implementation of the medium-term recommendation for a BESS in the Norfolk area, and the pace of load growth and distributed generation connections in the area over the near and medium term, there may be an opportunity to further defer the need for the long-term solution. However, given the interest from large loads in the Nanticoke area and the long lead time of the solution, it is recommended that as the work proceeds on the long-term solution, the TWG continues to monitor interest from load connections in the area. In the next planning cycle, the TWG will review the proposed in-service date and determine if any changes are needed.

Table 11 | Wire Options for Norfolk-Bloomsburg Area

#	Description	Cost (\$M)	Note
1	Add dynamic voltage support + new CDM at Norfolk and Bloomsburg	100-200	Barely meets the 20-year supply capacity need; does not resolve station capacity needs; does not enable future growth; limits upstream 230 kV system
2	Upgrade 115 kV lines and stations to 230 kV	250-350	Resolves supply and station capacity needs and enable future growth at highest cost
3a	Transfer Norfolk and Bloomsburg loads to a new 230 kV DESN supplied via new lines connecting to the Nanticoke-Middleport 230 kV corridor	150-200	Resolves supply and station capacity needs; enable future growth
3b	Transfer Norfolk and Bloomsburg loads to a new 230 kV DESN supplied via new lines connecting to Nanticoke TS*	150-200	Recommended long-term option. Same benefits as Option 3; additionally, can address needs in multiple areas

* Transmitter-led Regional Infrastructure Plan (RIP) assesses and develops a detailed plan for implementation.

For a summary of recommendations with timing and lead responsibility, please refer Table 2, Table 3, and Table 4 in Sections 2.2 to 2.4.

8 Community and Stakeholder Engagement

Engagement is critical in the development of an IRRP. Providing opportunities for input in the regional planning process enables the views and perspectives of the public, which for these purposes, refers to market participants, municipalities, stakeholders, communities, Indigenous communities, customers and the general public, to be considered in the development of the plan, and helps lay the foundation for successful implementation. This section outlines the engagement principles and activities undertaken to date for the Burlington to Nanticoke IRRP.

8.1 Engagement Principles

The IESO's External Relations Engagement [Framework](#) is built on a series of key principles that respond to the needs of the electricity sector, communities and the broader economy. These principles ensure that diverse and unique perspectives are valued in the IESO's processes and decision-making. We are committed to engaging with purpose with external audiences to foster trust and build understanding as the energy transition continues.

Figure 12 | The IESO's Engagement Principles



8.2 Engagement Approach

To ensure that the Plan reflects the needs of market participants, municipalities, stakeholders, communities, Indigenous communities, customers and the general public, engagement involved:

- Leveraging the [Burlington to Nanticoke engagement webpage](#) to post updated information, engagement opportunities, meeting materials, input received and IESO responses to feedback.
- Timely and targeted discussions with transmission-connected loads and municipalities to help inform the engagement approach for this planning cycle;
- Hosted a series of public webinars at major junctions in the plan development to share plan details, understand feedback and answer questions, and
- Communications and other engagement tactics to enable a broad participation through email and IESO's weekly Bulletin updates.

As a result, the engagement plan for this IRRP included:

- A dedicated webpage on the IESO website to post all meeting materials, feedback received and IESO responses to the feedback throughout the engagement process;
- Regular communication with interested communities and stakeholders by email or through the IESO weekly Bulletin;
- Public webinars; and
- Targeted one-on-one outreach with specific communities and stakeholders to ensure that their identified needs are addressed (see Section 8.4).

8.3 Engage Early and Often

The IESO held preliminary discussions to help inform the engagement approach for the third round of planning, and to establish new relationships and dialogue in this region where there has been no active engagement previously. This started with the Scoping Assessment Outcome Report for the Burlington to Nanticoke Region. An invitation was sent to targeted municipalities, Indigenous communities, and those with an identified interest in regional issues, to announce the commencement of a new planning cycle and invite interested parties to provide input on the Burlington to Nanticoke Region Scoping Assessment Report finalization. A public webinar was held in November 2022 to provide an overview of the regional electricity planning process and seek input on the high-level needs identified and proposed approach. The final Scoping Assessment was posted later in December 2022, identifying the need for a coordinated regional planning approach and an IRRP.

Following finalizing the Scoping Assessment, several targeted outreach meetings then began to involve large customers and municipalities in the region to ensure growth and development plans have been accurately captured in the Technical Working Group's draft demand forecast and solicit early feedback on the IESO's approach to engagement. The launch of a broader engagement initiative followed, with an invitation to IESO subscribers of the Burlington to Nanticoke Region to ensure that all interested parties were made aware of this opportunity for input. Three public webinars were held at major stages during the IRRP development to give interested parties an

opportunity to hear about its progress and provide comments on key components of the plan. These webinars were attended by a cross-representation of community representatives, businesses, and other stakeholders, and written feedback was collected following a comment period after each webinar.

The three stages of engagement at which input was invited:

1. The draft engagement plan, electricity demand forecast, and early identified needs – to set the foundation of this planning work.
2. The defined electricity needs for the region and high-level screening of potential options to meet the identified needs.
3. The analysis of options and draft IRRP recommendations.

Comments received during this engagement primarily focused on:

- Organic growth and economic development projects across the region;
- Interest in leveraging existing and local generation; and
- Interest in ensuring electricity infrastructure can accommodate economic development.

Feedback received during the written comment periods for these webinars helped to guide further discussions throughout the development of this IRRP, as well as add due consideration to the final recommendations.

All interested parties were kept informed throughout this engagement initiative via email to Burlington to Nanticoke's Region subscribers, municipalities, and Indigenous communities.

Based on the discussions through this engagement initiative, a key priority was to ensure the IRRP and recommended actions aligned with strong forecast growth and development both within specific municipalities and the region more broadly (e.g. future urban expansion as shared by Norfolk County, residential growth as shared by Haldimand County, and capacity concerns as shared by Hamilton). These insights have been valuable to the IESO – as they supported an understanding of local growth and an accurate electricity demand forecast, the determination of needs, and the recommendation of solutions to ensure adequate and reliable long-term supply.

Additionally, participants would like to be engaged when there is additional information to share regarding Hamilton's needs, options and draft recommendations as well as progress in-between planning cycles. To that end, ongoing discussions will continue through the Hamilton Addendum to keep interested parties engaged in a two-way dialogue. Additionally, municipalities are encouraged to ensure their local distribution company is aware of any changes and updates to their growth and development plans.

All background information, including engagement presentations, recorded webinars, detailed feedback submissions, and responses to comments received, are available on the IESO's [Burlington to Nanticoke IRRP engagement webpage](#).

8.4 Involving Municipalities in the Plan

The IESO held meetings with municipalities to seek input on their planning and to ensure that key local information about growth and development and energy-related initiatives were taken into consideration in the development of this IRRP. At major milestones in the IRRP process, meetings were held with the upper- and lower-tier municipalities in the region to discuss key issues of concern, including forecast regional electricity needs, options for meeting the region's future needs, and broader community engagement. These meetings helped to inform the municipal/community electricity needs and priorities, establish new relationships, and provided opportunities for ongoing dialogue beyond this IRRP process.

Through these discussions valuable feedback was received around strong anticipated growth in major growth centres in the region and community preferences around solutions:

- Over the next 20 years, significant residential growth in Caledonia with 4,000 to 5,000 residential dwellings, Hagersville with 3,000 to 3,500 residential dwellings and Jarvis and Dunnville with 500.
- There is a potential urban boundary expansion in Norfolk County and a new employment area in Delhi.
- Significant growth is anticipated for St. George (when wastewater treatment plant expansion is completed), Burford (servicing master plan is underway) and Oakland/Scotland areas in the County of Brant.
- Electrification initiatives within City of Brantford are underway such as the construction of a transit hub.
- Capacity concerns for Dundas and Dundas 2 were raised by the City of Hamilton prompting those station capacity needs to be explored in this study rather than the Hamilton Addendum.
- Several municipalities are exploring local energy projects to support their energy needs and would like to have these, or other non-wire alternatives, considered as solutions for the IRRP.

8.5 Engaging with Indigenous Communities

To raise awareness about the regional planning activities underway and invite participation in the engagement process, regular outreach was made to Indigenous communities within the Region throughout the development of the plan. This includes the Mississaugas of the Credit First Nation, Six Nations of the Grand River, and a number of MNO councils located within or near the Region including MNO Clear Waters Métis Council and MNO Grand River Métis Council.

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

9 Conclusions

The Burlington to Nanticoke IRRP identifies electricity needs in the region over the 20-year period from 2023 to 2042, and recommends a plan to address needs from the immediate to long-term. The IESO will continue to participate in the Technical Working Group during the next phase of regional planning, the RIP, to provide input and ensure a coordinated approach.

In the near-to-medium term, the Technical Working Group recommends the pre-contingency opening of bus-tie breakers, and load transfers between nearby stations at the distribution level, where viable and cost-effective. These recommendations are needed at several stations supplied by the 115 kV transmission system and one by the 230 kV transmission system.

In the medium-term, the Technical Working Group recommends the procurement of a BESS in the Norfolk-Bloomsburg Area, and the construction of a new substation⁵ near Dundas TS. These recommendations will respectively address needs in the Norfolk-Bloomsburg Area, and on the Hamilton 115 kV Subsystem and at the Dundas and Dundas 2 stations.

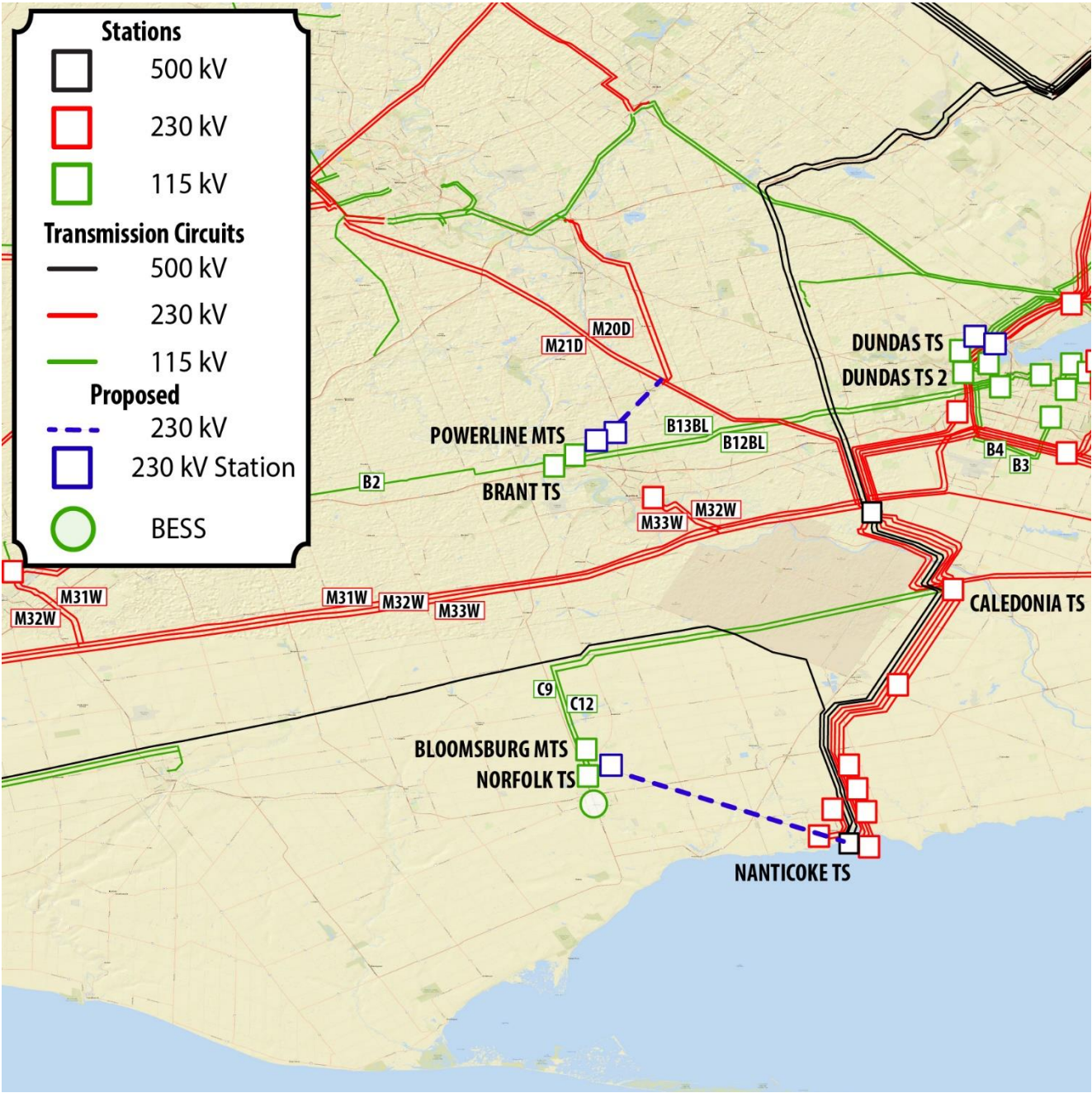
Finally, in the long term, the Technical Working Group recommends constructing two new double-circuit transmission lines and associated substations⁵, separating the Woodstock 115 kV Subsystem from the Brant 115 kV Subsystem, and considering cost-effective CDM at Brantford TS and Caledonia TS closer to needs dates to defer capacity needs at these stations. A map outlining the medium- and long-term recommendations is provided in Figure 13.

The first transmission line is recommended from Nanticoke TS into the Norfolk-Bloomsburg Area, and a new station with an LTR of approximately 200 MVA is recommended at the end of the line. The Technical Working Group then recommends that Norfolk TS and Bloomsburg TS be entirely offloaded onto the new substation⁵. The second transmission line is recommended as an extension from the existing Middleport-Detweiler corridor in the Kitchener/Waterloo/Cambridge/Guelph region into County of Brant, and a new station with an LTR of approximately 400 MVA is recommended at the end of this line. The Technical Working Group then recommends that Brant TS and Powerline MTS be entirely offloaded onto the new substation⁵. Last, the Woodstock 115 kV Subsystem is recommended to be separated from the Brant 115 kV Subsystem by opening the Brant DB2 breaker.

The Technical Working Group will continue to monitor growth at Brantford TS and Caledonia TS and across the region. This includes any future community energy planning, electrification trends, datacentres, or industrial load. Additionally, there are benefits to investigating opportunities to target incremental CDM to the region. The Technical Working Group will meet at regular intervals to complete the Hamilton addendum, monitor developments and track progress toward plan deliverables. In the event that underlying assumptions change significantly, local plans may be revisited through an amendment, or by initiating a new regional planning cycle sooner than the five-year schedule mandated by the Ontario Energy Board.

⁵ Rather than building a new station, the existing DESNs may be converted from a 115 kV supply to a 230 kV supply by replacing all 115 kV station equipment. The subsequent Transmitter-led Regional Infrastructure Plan (RIP) will identify the most cost-effective solution and develop a detailed plan for implementation.

Figure 13 | Medium/Long-Term Recommendations in the Burlington to Nanticoke Region



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