Windsor-Essex Integrated Regional Resource Plan

April 3, 2025

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Acronym	Definition
BESS	Battery Energy Storage System
CHP	Combined Heat and Power
CTS	Customer Transformer Station
DESN	Dual-Element Spot Network
DG	Distributed Generation
DR	Demand Response
DS	Distribution Station
eDSM	electricity Demand Side Management
FIT	Feed-in-Tariff
GHG	Greenhouse Gas
IESO	Independent Electricity System Operator
IRRP	Integrated Regional Resource Plan
km	kilometre
kV	kilovolt
LDC	Local Distribution Company
LED	Light Emitting Diode
LMC	Load Meeting Capability
LTR	Limited Time Rating
MTS	Municipal Transformer Station
MVA	Megavolt ampere

Acronym	Definition
MW	Megawatt
MWh	Megawatt-hour
NERC	North American Electric Reliability Corporation
NPCC	Northeast Power Coordinating Council
NWA	Non-Wires Alternative
OGVG	Ontario Greenhouse Vegetable Growers
ORTAC	Ontario Resource and Transmission Assessment Criteria
RAS	Remedial Action Scheme
RIP	Regional Infrastructure Plan
SS	Switching Station
TS	Transformer Station
UVLS	Under Voltage Load Shedding

Executive Summary

The Windsor-Essex Integrated Regional Resource Plan (IRRP) addresses electricity needs in the region over the twenty-year period from 2024 to 2043. The Windsor-Essex region is located in southwest Ontario, east of the Chatham-Kent/Lambton/Sarnia region. It includes the City of Windsor, Town of Amherstburg, Town of Essex, Town of Kingsville, Town of Lakeshore, Town of LaSalle, Municipality of Leamington, Town of Tecumseh, Township of Pelee Island, and the western portion of the Municipality of Chatham-Kent.

Due to the rapidly growing agricultural sector and more recent economic developments, regional electricity planning in southwestern Ontario has been occurring on a continuum since 2019 rather than the typical five-year cycle, with no signs of slowing down. From 2018 to 2022, winter net electricity demand in the region has increased by approximately 370 megawatts (MW) and the region is projected to be winter peaking going forward. Successful electricity resources implemented in the region include 857 MW of generation procurements since 2020, the construction of a new double-circuit transmission line into the region, the completion of Lakeshore Transmission Station (TS), and the completion of South Middle Road Dual-Element Spot Network (DESN) #1, with construction of South Middle Road DESN #2 underway to be completed in 2025. In 2023 there were 3 MW of verified electricity Demand-Side Management (eDSM) savings in the region. This IRRP builds upon those previous regional and bulk plans to continue to ensure reliable electricity supply across the region.

The IESO conducted extensive engagement and outreach throughout the planning process through targeted discussions, webinars and communications to seek input and ensure that key local information about growth and development and energy-related initiatives were taken into consideration in the development of this IRRP. In response to sustained growth driven by municipal and housing developments, greenhouse development, industrial development, and electrification initiatives in the West Essex and Windsor sub-system as well as Lakeshore/Tilbury sub-system, the Technical Working Group recommends:

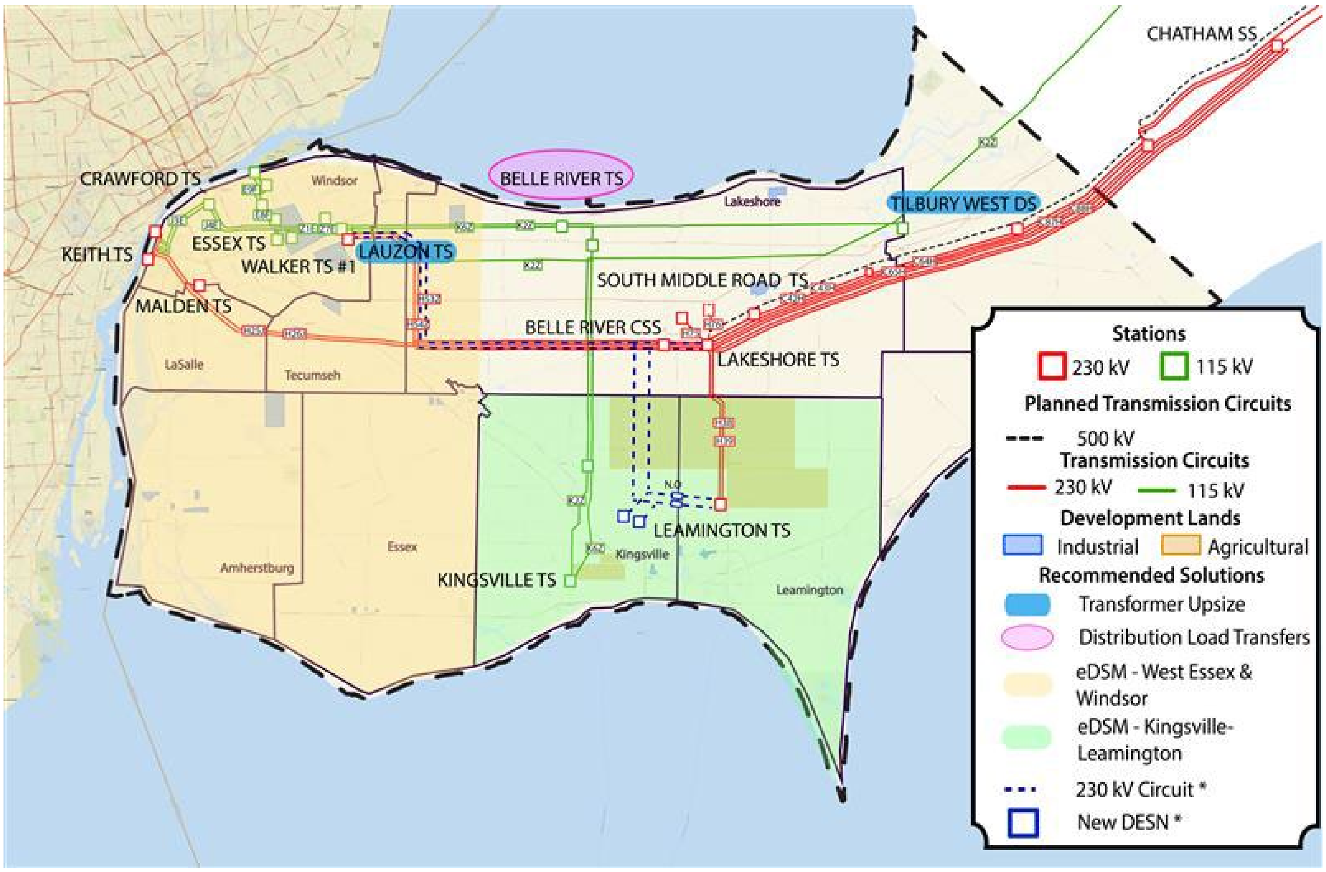
- Considering potential targeted eDSM programs for the West Essex and Windsor sub-system;
- Constructing a new double-circuit 230 kV transmission line from Lakeshore TS to Lauzon TS, to increase the supply capacity into the area, as well as enable potential electricity supply resource connections;
- Exploring the potential scope and value of a corridor study to identify future transmission paths into the West Essex and Windsor sub-system;
- Upsizing the transformers at Lauzon TS DESN 2, to address multiple station capacity needs and enable the forecast load growth at Lauzon TS and load from Belle River TS, after load transfers; and
- Upsizing the transformers at Tilbury West DS, to address the local station capacity need.

To address continued growth in the agriculture sector, the Technical Working Group reinforces the recommendations from the 2022 Windsor-Essex Addendum for:

- Continuing targeted eDSM programs for the Kingsville-Leamington sub-system (e.g., continuing the targeted greenhouse sector incentives supporting Light Emitting Diode – or LED – conversions and advanced lighting controls).
- Constructing two new DESNs with a connecting double-circuit 230 kV transmission line from Lakeshore TS, to increase the station and supply capacity in Kingsville-Leamington; and
- Constructing a double-circuit 230 kV transmission line connecting the new lines to H38/H39 with normally open breakers to provide load restoration capability.

Figure 1 visually depicts the IRRP recommendations across the Windsor-Essex region.

Figure 1 | Overview of Recommended Solutions for Windsor-Essex IRRP



The Technical Working Group will continue to monitor growth across the region to determine if or when further reinforcements will be needed. This includes monitoring any future community energy plans, electrification trends, customer connection queues, and changes to local generation. In the interim, operational measures can be used to support growth in the region through use of operating ratings and improving the redundancy of the Lakeshore Remedial Action Scheme (RAS).[1]

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[1] A Remedial Action Scheme – or RAS – is a set of pre-planned operating actions that are initiated under select contingencies to ensure the reliability and stability of the electricity grid. In particular, the Lakeshore RAS monitors the 230 kV circuits in the region and may reject load or generation depending on the contingency observed.

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

The Technical Working Group will continue to meet to develop the Regional Infrastructure Plan (RIP) and annually thereafter to monitor developments and track progress toward plan deliverables. If 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.

1. Introduction

This IRRP addresses the electricity needs of the Windsor-Essex region over the 20-year period from 2024 to 2043. The Windsor-Essex region is located in southwest Ontario, east of the Chatham-Kent/Lambton/Sarnia region. It includes the City of Windsor, Town of Amherstburg, Town of Essex, Town of Kingsville, Town of Lakeshore, Town of LaSalle, Municipality of Leamington, Town of Tecumseh, Township of Pelee Island, and the western portion of the Municipality of Chatham-Kent.

Several Indigenous communities are located in or near the region, including: Aamjiwnaang First Nation, Caldwell First Nation, Chippewas of Kettle and Stony Point First Nation, Chippewas of the Thames First Nation, Eelŭnaapéewi Lahkéewiit Delaware Nation, Munsee-Delaware Nation, Oneida Nation of the Thames, and Walpole Island First Nation.

The region's electricity is delivered by five Local Distribution Companies (LDCs): ENWIN Utilities Ltd. ("ENWIN"), Essex Powerlines Corporation ("Essex Powerlines"), E.L.K Energy Inc. ("E.L.K."), Entegrus Powerlines Inc. ("Entegrus"), and Hydro One Networks Inc. ("Hydro One Distribution"). Hydro One Networks Inc. ("Hydro One 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 Transmission, and the IESO.

Figure 2 depicts the electrical transmission infrastructure for the Windsor-Essex region. Power is transmitted into the region via 230 kV transmission lines from Chatham Switching Station (SS) east of the region to Lakeshore TS, which supplies Leamington TS and South Middle Rd TS. The 230 kV corridor continues west with two circuits toward Lauzon TS and two circuits toward Keith TS via Malden TS. Keith TS provides an interconnection with the Michigan system via 230 kV circuit J5D.

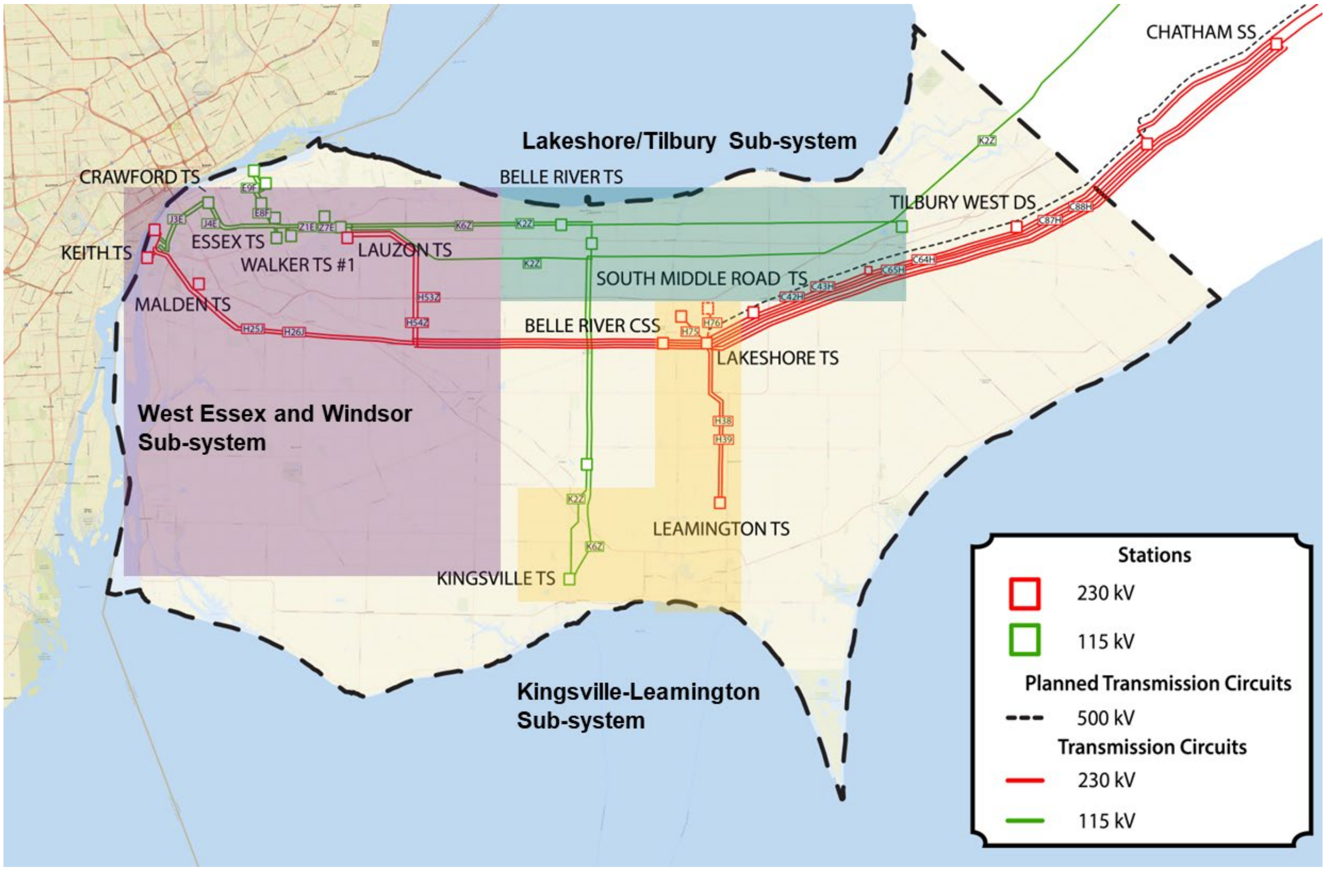
Historically, the region was supplied by four 230 kV circuits along with local generation resources; however, as of December 2024, two additional 230 kV circuits from Chatham SS to Lakeshore TS were completed.

For the purposes of regional planning, the Windsor-Essex region has been divided into three sub-systems, as shown in Figure 2:

- The **West Essex and Windsor sub-system** in the west of the region, electrically defined by the load and generation connected to and downstream of the H53Z, H54Z, H25J, and H26J 230 kV circuits west of Lakeshore TS. In Windsor, Keith TS and Lauzon TS connect the region's 115 kV network to the 230 kV transmission system via two autotransformers at each station. These supply the 115 kV transmission lines that connect to Belle River TS, Crawford TS, Essex TS, Kingsville TS, Lauzon TS, Tilbury West DS, Walker Municipal Transformer Station (MTS) #2, and Walker TS #1. Keith TS has one DESN and Lauzon TS has two DESNs (in addition to the autotransformers). Malden TS and NextStar TS are also connected to the 230 kV lines in this sub-system.
- The **Kingsville-Leamington sub-system** in the south-east of the region, electrically defined by the load and generation connected to Kingsville TS, the H38 and H39 230 kV radial circuits south of Lakeshore TS, and the H75 and H76 radial circuits north of Lakeshore TS.

- The **Lakeshore/Tilbury sub-system** in the north-east of the region, electrically defined by the load and generation connected to the K2Z and K6Z 115 kV circuits downstream of Lauzon TS, inclusive of Belle River TS and Tilbury West DS but excluding Kingsville TS.

Figure 2 | Map of the Windsor-Essex Region and Defined Sub-systems



There are seven transmission-connected customers in the region served by Customer Transformer Stations (CTSs). There are also several transmission-connected generation resources in the region, primarily gas and wind generation, some solar generation, as well as some battery storage facilities under development. The distribution-connected resources or distributed generation (DG) in the region includes natural gas combined heat and power (CHP), solar and wind resources, and a small amount of biogas.

This report describes the culmination of the Windsor-Essex IRRP, which was initiated in May 2023 following the publication of the Needs Assessment Report in February 2023 by Hydro One and the Scoping Assessment Outcome Report in May 2023 by the IESO. The Scoping Assessment identified needs requiring further assessment 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, eDSM contributions, and DG 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 Windsor-Essex region over the twenty-year period from 2024 to 2043. 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, considering reliability, cost, technical feasibility, maximizing the use of the existing electricity system (where economic), and feedback from stakeholders.

The Windsor-Essex electricity demand forecast, provided by the LDCs, anticipates sustained growth driven by municipal and housing developments, industrial development, expansion of the agriculture industry, and electrification initiatives. The decreased reliance on emitting generation and resources coming off contract in the region are also major drivers of the electricity supply needs into and within the region.

The IRRP recommendations below are organized under near-term, medium-term, and other ongoing or long-term initiatives to address needs in the three sub-systems identified: West Essex and Windsor, Kingsville-Leamington, and Lakeshore/Tilbury. This distinction reflects the different levels of forecast certainty, lead time for development, and planning commitment required over these time horizons. This approach ensures that the IRRP provides clear direction on investments needed in the near and medium term, while retaining flexibility over the long term as electrification, energy efficiency, and development plans evolve.

2.1. Status of Ongoing Work

Following the previous cycle of region planning and various bulk plans, several projects were recommended which have now been completed or are presently underway. The plans implemented a multi-pronged approach of both wires and non-wires solutions to address electricity needs across the region. The status of these projects is summarized in Table 1.

Table 1 | Summary of Ongoing and Recently Completed Projects

Project	Expected In-Service Date
Conduct IESO Grid Innovation Fund targeted call for indoor agriculture projects	Complete
Upsize Keith TS end-of-life 230/115 kV autotransformers T11/T12	Complete
Decommission Keith TS end-of-life T1 (115 kV/27.6 kV) transformer	Complete

Project	Expected In-Service Date
Build a new switching station at the Leamington Junction[2]	Complete
Acquire 550 MW of new or existing local resources[3]	Complete
Begin bilateral negotiations for Brighton Beach Generating Station	Complete[4]
Build a new supply station, South Middle Road DESN 1	Complete
Build a new 230 kV double-circuit transmission line from Chatham SS to Lakeshore TS	Complete
Carry out Greenhouse-specific Light Emitting Diode (LED) Incentive, Save On Energy incentives in the Southwest zone, and Advanced Lighting Controls	Ongoing
Build a second new supply station, South Middle Road DESN 2	2025
Upsize Lauzon TS DESN 1 end-of-life step-down transformers	2026
Replace the phase-shifting transformer at Keith TS ("PSR5")[5]	2028
Build a new 230 kV double-circuit transmission line from Lambton TS southwards to Chatham SS (the "St. Clair line")	2028
Build a single-circuit 500 kV transmission line from Longwood TS to Lakeshore TS	2030
Build two new 230 kV DESNs and double-circuit connection lines from Lakeshore TS, including the option for a new 230 kV line between Leamington TS and the new DESNs, and transfer Kingsville TS load to the new DESNs	On hold – recommended again in this IRRP

[2] This was ultimately put into service as Lakeshore TS.
[3] Approximately 857 MW of generation was procured in Windsor-Essex since 2020.
[4] The negotiations for Brighton Beach Generating Station are also complete, with a contract term from July 16, 2024 to July 15, 2034.
[5] This recommendation is a result of a joint intertie study completed by the IESO and the Midcontinent Independent System Operator, rather than a regional planning or bulk planning initiative. The purpose of this project is to address end-of-life concerns and increase the capability of the device to improve control of scheduled intertie flows between the two jurisdictions.

2.2. Near- to Medium-Term Plan

The Technical Working Group recommends the near- to medium-term plans, including several recommendations to accommodate load growth, maintain reliability, and optimize asset replacement. Where possible, needs are grouped to align with integrated sets of solutions. The following subsections discuss these near- to medium-term plans.

2.2.1. Targeted Electricity Demand Side Management

The Kingsville-Leamington and West Essex and Windsor areas are experiencing sustained growth, driven by greenhouse lighting, industrial development, municipal and housing growth, and electrification initiatives. For this reason, a combination of non-wires alternatives (NWAs) and wires options is required to address the needs in these two sub-systems. The Technical Working Group recommends the continuation of energy efficiency programs targeted to the greenhouse sector, as well as exploring opportunities to leverage provincial eDSM programs for the local area.

2.2.2. Supply Stations and Connection Lines in Kingsville-Leamington

An integrated solution is recommended to address the capacity needs and load restoration needs in Kingsville-Leamington. The Technical Working Group recommends two new 230 kV load supply stations in the Kingsville-Leamington area to address the forecast capacity requirements starting in 2027. The new supply stations also have the potential to offload a portion of Kingsville TS. These stations are to be supplied via a new 230 kV double-circuit line from Lakeshore TS. A new 230 kV double-circuit line between the new supply stations and Leamington TS should also be built to address the sub-system's load restoration needs. The new DESNs and supply lines will enable the connection of both new load and generation resources, and the load restoration lines will improve reliability in the area.

Depending on the subsequent design and environmental assessment phases, there may be an opportunity to integrate the recommended double-circuit 230 kV transmission line from Lakeshore TS to the new Kingsville-Leamington supply stations with the transmission pathway for the new double-circuit 230 kV transmission line recommended from Lakeshore TS to Lauzon TS (see Section 2.2.5). There could be a portion of transmission line shared between these two recommendations west of Lakeshore TS, which would split into two separate paths– one toward Kingsville-Leamington and one toward Lauzon TS. The combined solution would optimize the use of the transmission infrastructure and provide further integration in the Windsor-Essex region.

2.2.3. Load Transfer from Belle River TS

Belle River TS is forecast to immediately exceed its station capacity by 1 MW, with the need increasing slowly over the 20-year study period to 17 MW in 2043. Given the magnitude of this need and the available capacity on the nearby Lauzon TS once DESN 1 and DESN 2 are both upsized in 2025 and 2029 respectively, the Technical Working Group recommends load transfers from Belle River TS to Lauzon TS DESNs 1 and 2 (see Section 2.2.4). In the interim, operational measures, such as using operational ratings, can be used to manage this need until the wires solution is in place.

2.2.4. Upsize Lauzon TS DESN 2

Lauzon TS DESN 2 has an asset replacement need in 2029, as well as a station capacity need starting in 2032. The Technical Working Group recommends upsizing the transformers at Lauzon TS DESN 2 to address these two needs, and to help address the Belle River TS capacity need.

2.2.5. New Transmission into West Essex and Windsor

To ensure continued supply to the West Essex and Windsor sub-system, the Technical Working Group recommends a new 230 kV double-circuit line from Lakeshore TS to Lauzon TS to meet the supply capacity need in 2032. This will increase the transfer capability into the sub-system, allow for additional connections, and improve the resource deliverability along this transmission path. As noted in Section 2.2.2, there is potential for this solution to integrate with the recommendation for Kingsville-Leamington capacity need.

2.2.6. Summary of Near- to Medium-Term Plans

Table 2 summarizes these near- to medium-term plans for Windsor-Essex.

Table 2 | Summary of the Near- to Medium-Term Plans for the Windsor-Essex IRRP

Need(s)	Technical Working Group Recommendation	Lead Responsibility	Expected In-Service Date
West Essex and Windsor supply capacity need	Leverage targeted eDSM programs to support growth in West Essex and Windsor[6]	IESO	N/A
Kingsville-Leamington load security and operational concerns	Explore options to make the design of the Lakeshore Remedial Action Scheme (RAS)[7] redundant	Hydro One Transmission	N/A
Kingsville-Leamington station and supply capacity needs	Continue existing eDSM programs to manage demand across and the sub-system[6]	IESO	N/A

[6] Whereas eDSM programs are recommended in the near-term, they are also expected to contribute to the long-term growth and reliable electricity supply in the region.

[7] A Remedial Action Scheme – or RAS – is a set of pre-planned operating actions that are initiated under select contingencies to ensure the reliability and stability of the electricity grid. In particular, the Lakeshore RAS monitors the 230 kV circuits in the region and may reject load or generation depending on the contingency observed.

Need(s)	Technical Working Group Recommendation	Lead Responsibility	Expected In-Service Date
Kingsville-Leamington station capacity, supply capacity, and load restoration needs	Construct two new supply stations in the Kingsville-Leamington area with two 230 kV circuits from Lakeshore TS Connect the two new 230 kV circuits to Leamington TS via two additional 230 kV circuits	Hydro One Transmission	2027–2029
Belle River TS station capacity need	Transfer load from Belle River TS to the upsized Lauzon TS DESN 1 and 2	Hydro One Distribution	2026–2031
Lauzon TS DESN2 station capacity need	Upsize transformers	Hydro One Transmission	2029
West Essex and Windsor supply capacity need	Build a new 230 kV double-circuit line from Lakeshore TS to Lauzon TS	Hydro One Transmission	2032

2.3. Long-Term Plan and Ongoing Initiatives

In the long term, the Windsor-Essex region's electricity demand is projected to continue to grow. This IRRP sets out recommended actions required to ensure that options remain available to address future needs in the most efficient and cost-effective way, if and when they ultimately arise.

2.3.1. Upsize Tilbury West DS

Tilbury West DS is forecast to exceed its peak station capacity in 2036. The recommendation to upsize the transformers at Tilbury West DS can be implemented in three to five years. Given the timing of this need, the Technical Working Group recommends monitoring growth and triggering the upsizing of transformers at Tilbury West DS as needed, or revisiting this need in the next cycle of regional planning.

2.3.2. West Essex and Windsor Corridor Study

The High Forecast for West Essex and Windsor indicates the need for further supply in this sub-system; however, there are land restrictions due to conservation areas, an airport, and flooding risks. Thus, the Technical Working Group recommends the scope and value of a corridor study be explored to identify additional paths for transmission supply into West Essex and Windsor, to prepare for a quicker response when higher growth materializes.

2.3.3. Monitor Load Growth

Load in this region is projected to increase and is expected to advance under the High Forecast. Given the uncertainty of the High Forecast, a firm recommendation addressing this level of growth is not required at this time. The Technical Working Group will continue to monitor load growth across the region – in particular, the agricultural sector in Kingsville-Leamington and industrial sector in West Essex and Windsor – and revisit these needs in the next cycle of regional planning. As part of broader monitoring, the Technical Working Group should also monitor and participate in any future community energy plans developed by municipalities in the Windsor-Essex region, as well as the status of bulk system transmission and resource developments.

2.3.4. Summary of Long-Term Plan

Table 3 summarizes the long-term recommendations beyond the ten-year horizon and ongoing initiatives.

Table 3 | Summary of Long-Term Plan for the Windsor-Essex IRRP

Need(s)	Technical Working Group Recommendation	Lead Responsibility	Expected In-Service Date
Tilbury West DS station capacity	Upsize transformers	Hydro One Distribution	2036
West Essex and Windsor High Forecast supply capacity	Conduct a corridor study to identify additional paths for transmission supply west of Lakeshore TS	IESO	N/A
Windsor-Essex region growth	Monitor load growth across the region, transmission projects, and changes in generation across the region	IESO	N/A

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. Windsor-Essex and IRRP Development

The process to develop the Windsor-Essex IRRP was initiated in May 2023, following the publication of the Needs Assessment report in February 2023 by Hydro One and the Scoping Assessment Outcome Report in May 2023 by the IESO. The Scoping Assessment recommended that the needs identified for the Windsor-Essex 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 Windsor-Essex region. Electricity planning in Ontario typically occurs on a cyclical basis. However, due to the rapidly growing agricultural sector and more recent economic developments, planning in southwestern Ontario has been occurring on a continuum over the last five years, with no signs of slowing down. The 2019 Windsor-Essex bulk study occurred in parallel with the 2019 Windsor-Essex IRRP, followed by the 2020 Windsor-Essex Regional Infrastructure Plan and the 2021 West of London bulk plan that considered a broader area that encompassed this region[8]. In tandem, the 2022 Windsor-Essex Addendum was undertaken to address remaining local needs in Kingsville and Leamington.

The previous regional and bulk recommendations and subsequent plans are summarized in the sections below.

4.1. Previous Regional Planning Cycle

The previous cycle of regional planning for the Windsor-Essex region was completed in 2019, which implemented a multi-pronged approach of both wires and non-wires solutions to address electricity needs across the region. Subsequently, an Addendum was completed in 2021 to assess remaining local reliability issues in the Kingsville and Leamington areas: capacity needs to enable new distribution-level customers to connect, as well as load restoration needs. Recommendations from this planning cycle are summarized below.

2019 Windsor-Essex IRRP

- IESO Grid Innovation Fund targeted call for indoor agriculture projects – two projects contracted within Kingsville-Leamington, with support provided between 2020 and 2023.
- Greenhouse-specific LED Incentive, Save On Energy incentives in the Southwest zone, and Advanced Lighting Controls – implemented under the 2021–2024 Conservation and Demand Management Framework and continuing under the 2025–2036 eDSM Framework. In 2023, there were 3 MW of verified eDSM savings in the region.
- Upsize Keith TS end-of-life 230/115 kV autotransformers T11/T12 from 125 MVA to 250 MVA– completed in 2023.
- Upsize Lauzon TS DESN 1 end-of-life step-down transformers T5/T6 – expected to be in-service by 2026.
- Decommission Keith TS end-of-life T1 (115 kV/27.6 kV) transformer – completed.

[8] The West of London bulk plan considered the area from outside the western edge of the City of London, to the City of Sarnia in the northwest, and to the City of Windsor in the west.

2020 Windsor-Essex Regional Infrastructure Plan

- Build a new supply station, South Middle Road DESN 1, connected to Lakeshore TS – completed in 2022.
- Build a second new supply station, South Middle Road DESN 2, connected to Lakeshore TS – work underway, expected to be in-service in 2025.

2022 Windsor-Essex Addendum

- Build two new 230 kV DESNs and double-circuit connection lines from Lakeshore TS, including a new 230 kV line between Leamington TS and the new DESNs – on hold pending customer commitment and is being recommended again in this IRRP.
- Transfer load in excess of the Kingsville TS station load meeting capability to the new DESNs once in-service – on hold until DESNs proceed and is being recommended again in this IRRP.
- Initiate engagement with customers to determine cost-justified measures to mitigate the load restoration need – on hold until DESNs proceed.

4.2. Bulk Planning and Other Developments

In addition to historical regional planning activities, the Windsor-Essex region has been the subject of bulk planning initiatives and other developments. The 2019 Windsor-Essex bulk plan focused on increasing the overall transfer capability of the bulk transmission system west of Chatham to reliably supply the forecast load growth in the Kingsville-Leamington area and Windsor-Essex region. The 2021 West of London bulk plan. This plan looked to address remaining bulk transmission system constraints east of Chatham and ensure adequate supply to the West of London area. In addition, given the expiry of generation contracts in the area, it intended to identify any transmission constraints limiting the ability of supply resources and imports within West of London to meet provincial needs.

2019 Windsor-Essex Bulk Plan

- Build a new switching station at the Leamington Junction (Lakeshore TS) – completed in 2022.
- Build a new 230 kV double-circuit transmission line from the existing Chatham SS to the new switching station at the Leamington Junction (Lakeshore TS) – completed in 2024 (one year earlier than planned).

2021 West of London Bulk Plan

- Build a new 230 kV double-circuit transmission line from Lambton TS southward to Chatham SS (the "St. Clair line") and associated station facility expansions or upgrades required at the terminal stations – development underway and regulatory approval received, expected to be in-service in 2028.

- Begin bilateral negotiations for Brighton Beach Generating Station, to support the area's needs in the near-term until the Lambton-to-Chatham transmission line is in-service – completed.[9]
- Build a single-circuit 500 kV transmission line from Longwood TS to Lakeshore TS – development underway, expected to be in-service in 2030.
- Acquire 550 MW of new or existing local resources – secured through completed procurements, expected to be in-service earlier than the 2030 to 2035 need.

2024 Central-West Bulk Plan

- Reconstruct the M31W circuit between Buchanan TS and the tap line for the planned Centennial TS with higher capacity double-circuit towers, strung with one circuit but capable of accommodating a second circuit in the future – development underway, expected to be in-service in 2027.
- Monitor load growth across the Central-West area and be prepared to implement dynamic voltage devices as demand grows, including Ingersoll TS.

Ongoing South and Central Bulk Planning

A new South and Central Bulk Plan is underway to address known bottlenecks in the transmission system, including between northern and southern Ontario, within the Greater Toronto Area, and along the Windsor-to-Hamilton corridor. The objectives of the study are to unlock opportunities for generation connections, enable phase-out of emitting resources, and support future growth and economic development. The study will determine the transmission reinforcements and/or network expansion required to enable reliable:

- Reliable supply under scenarios for decommissioning greenhouse gas (GHG) emitting resources; and
- Long-term, high-growth scenarios within key areas of the South-Central system, such as the Windsor-to-Hamilton corridor.

Other Developments

In 2022, a governmental directive declared that three of the transmission lines recommended in the regional and bulk plans above are priority projects, specifically:

- The Chatham-to-Lakeshore double-circuit 230 kV line (completed in 2024);
- The double-circuit 230 kV St. Clair line; and
- One single-circuit 500 kV line from Longwood TS to Lakeshore TS.

This would streamline the Ontario Energy Board's regulatory approval process and designate Hydro One Transmission as the transmitter for the priority projects. In the Order in Council the government also asked Hydro One Transmission to undertake development work and seek approvals for two future projects:

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[9] The negotiations for Brighton Beach Generating Station are also complete, with a contract term from July 16, 2024 to July 15, 2034.

This had the effect of streamlining the Ontario Energy Board's leave to construct process for these projects. Further, in 2020 and 2022, the Minister of Energy issued Directives requiring Hydro One Transmission to develop these projects, including their associated station facility upgrades, along with two new projects:

- A new 230 kV line that would run from Lakeshore TS to the Windsor area; and
- A second 500 kV transmission line from Longwood TS to Lakeshore TS

4.3. Current Cycle of Regional Planning

The current cycle of regional planning began in 2023, with the publication of the Needs Assessment, in which several needs requiring further regional coordination were identified. The 2023 Scoping Assessment recommended an IRRP for the entire region to address needs in a coordinated manner. This report presents an integrated regional electricity plan over a 20-year period from 2024 to 2043.

This IRRP develops and recommends options to meet the electricity needs of the Windsor-Essex 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, eDSM, DG, transmission and distribution system capability, relevant community plans, condition of transmission assets, and developments on the bulk transmission system.

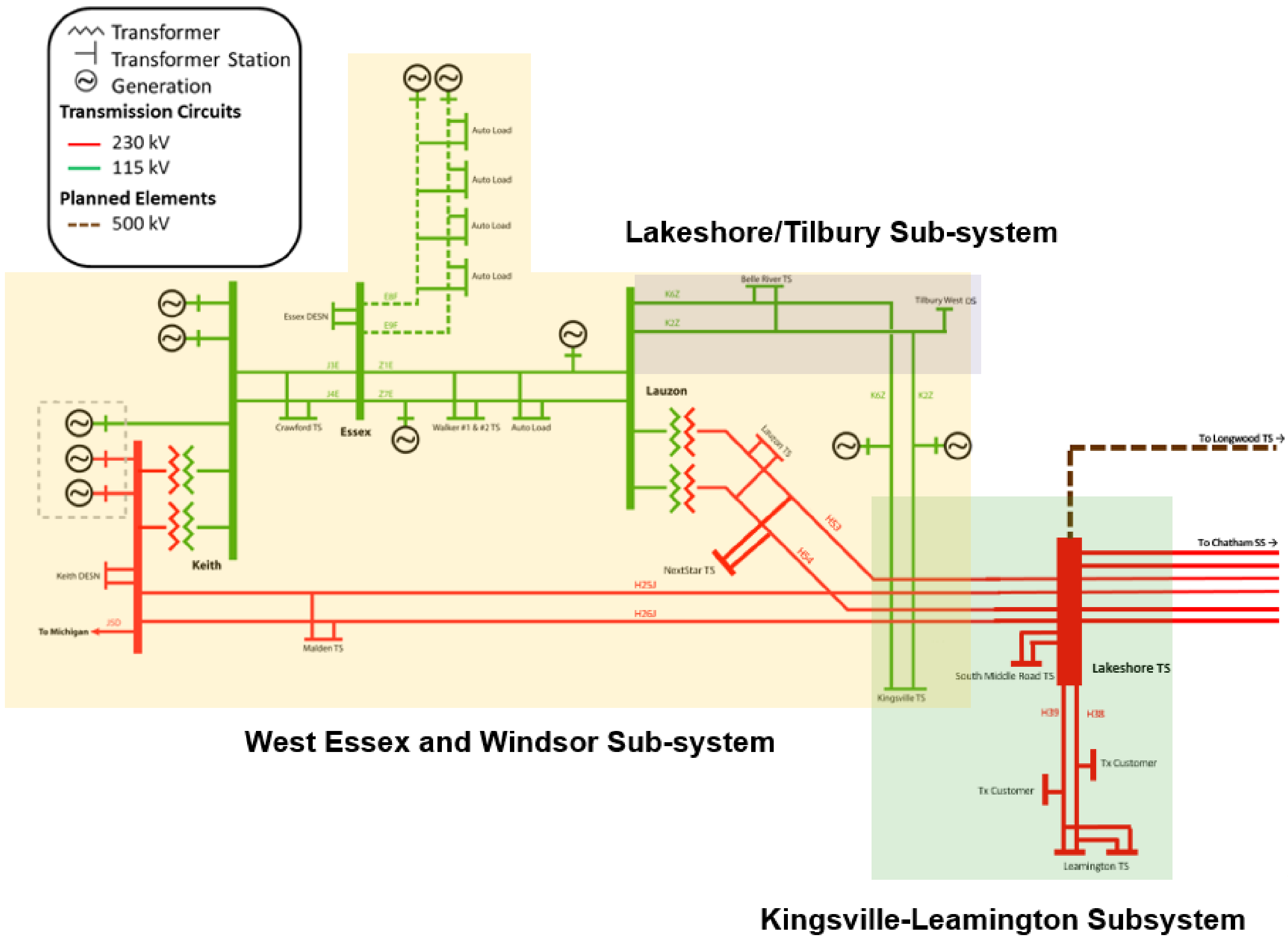
The following transmission facilities were included in the scope of this study:

- Transformer stations: Belle River TS, Crawford TS, Essex TS, Keith TS, Kingsville TS, Lauzon TS, Leamington TS, Malden TS, South Middle Road TS, Tilbury West DS, Walker MTS #2, Walker TS #1, and eight CTS.
- 115 kV transmission circuits: J3E, J4E, E8F, E9F, Z1E, Z7E, K6Z, and K2Z.
- 230 kV transmission circuits: H25J, H26J, H53Z, H54Z, H38, H39, H75, and H76.

The single line diagram of the Windsor-Essex region is shown in Figure 3. Note that the bulk system transfer capabilities into the region[10] are not within the scope of the IRRP, but are encompassed in the ongoing South and Central Bulk study. The schedule of bulk planning activities is identified through the IESO's Annual Planning Outlook.

[10] Includes flow into Lakeshore from the six 230 kV circuits from Chatham SS and the recommended 500 kV circuit from Longwood TS under development.

Figure 3 | Single Line Diagram of the Windsor-Essex Region



The Windsor-Essex IRRP was developed by completing the following steps:

- Establishing alternatives to address system needs, including, where feasible and applicable, generation, transmission and/or distribution, and other approaches such as non-wires alternatives, including eDSM.
- Engaging with the community on needs and possible alternatives.
- Evaluating alternatives to address near- and long-term needs.
- Considering the impact of the High Forecast as a sensitivity of the flexibility and optionality of the potential alternatives.
- 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 Windsor-Essex region. It highlights the assumptions made for peak demand forecasts, including weather correction, the contribution of eDSM and DG, and the development of a High Forecast scenario. The "Planning Scenario" was derived based on firm loads (current and planned), organic growth, residential, electrification, community energy plans, greenhouse growth, and industrial growth as described in more detail in Appendix B. The "Planning Forecast" is the result of "Planning Forecast" presented net of existing DG and eDSM, and corrected for extreme weather. The Planning Forecast is used in assessing the electricity needs of the area over the planning horizon.

The "High Scenario" incorporates potential demand growth that is less certain, in terms of timelines, magnitude and location, into the Planning Scenario. The "High Forecast" is also the result of the High Scenario adjusted to be net of existing DG and eDSM, and corrected for extreme weather. The High Forecast used as the basis for a sensitivity analysis as described further in Section 5.7.2.

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. This differs from a non-coincident peak, which refers to each station's individual peak, regardless of whether these peaks occur at different times. In the past, the Windsor-Essex region peak loading has historically occurred in the summer. However, with the recent and projected growth of the greenhouse sector, the region is now winter peaking.

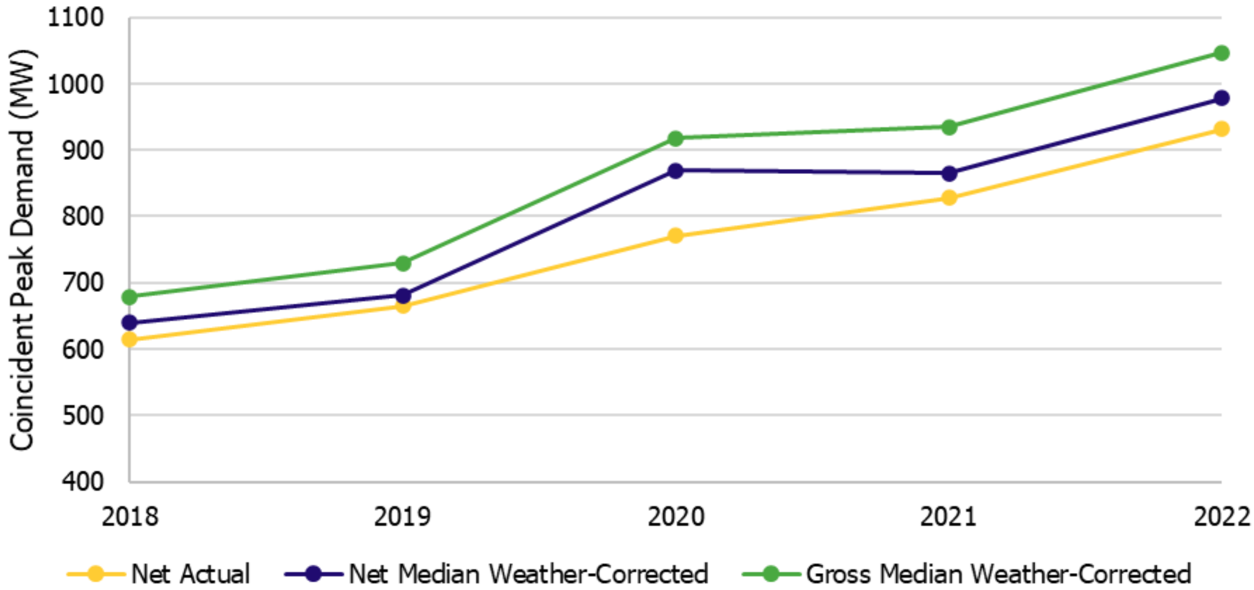
5.1. Historical Demand

The Windsor-Essex region is winter peaking mainly due to increased greenhouse load for lighting during winter months. From 2018 to 2022, electrical demand[11] grew by nearly 370 MW, peaking between approximately 9 AM to 6 PM. Figure 4 shows the historical winter peak demand as measured three different ways:

1. Coincident net actual, as observed at the metering point;
2. Net median weather-corrected (adjusted to reflect median weather conditions); and
3. Gross median weather-corrected historical demand with contributions of DG removed.

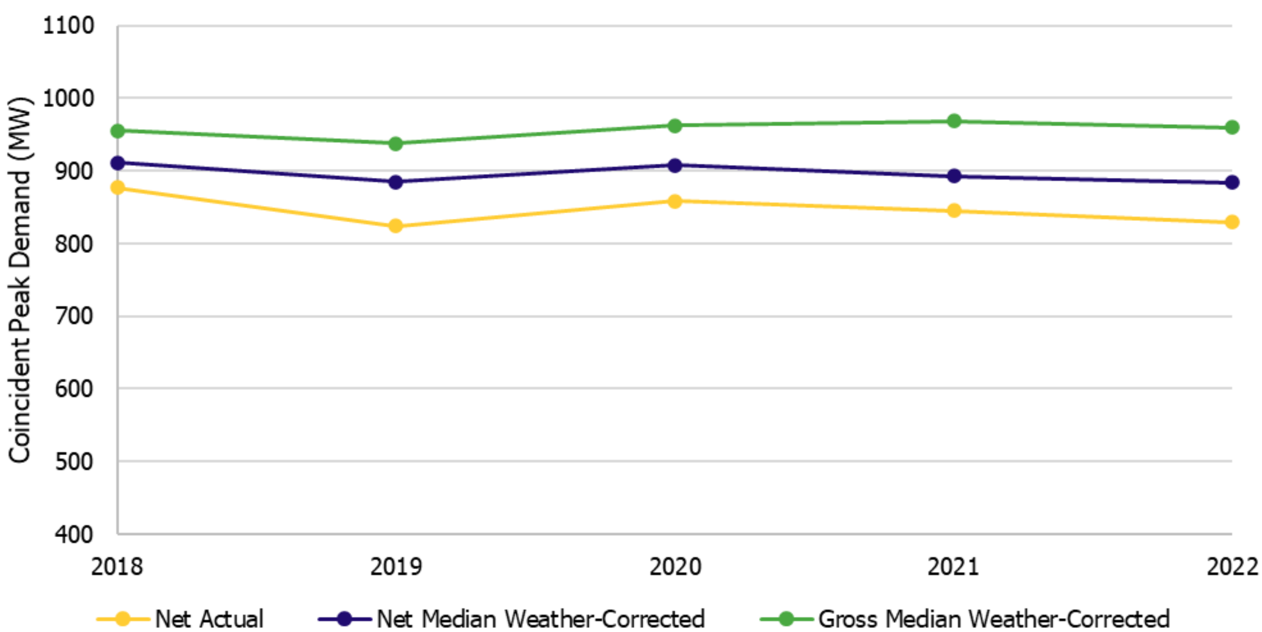
[11] Gross median weather-corrected demand.

Figure 4 | Historical Winter Peak Demand in the Windsor-Essex Region



Summer peak electricity demand within the Windsor-Essex region has remained stable in the five years prior to this planning cycle. Figure 5 shows the summer coincident net actual, net median weather-corrected, and gross median weather-corrected historical demand. The summer gross median weather-corrected demand has averaged 960 MW over the past five years, with the peak demand hour for each year occurring between approximately 2 PM to 5 PM.

Figure 5 | Historical Summer Peak Demand in the Windsor-Essex Region



Since the forecast was developed in 2023, the 2022 summer and winter gross median weather-corrected peaks at each station in the Windsor-Essex region were used as the starting points for the forecast.

5.2. Current Drivers of Load Growth

Electricity demand in the Windsor-Essex region is growing at a rapid pace due to residential and commercial growth, continued expansion of the agricultural and industrial sectors, and electrification. Agriculture has been driving electricity demand growth and needs in the region over the last several years, especially in winter, and continues to be an important driver going forward. Broader economic development across the region, electrification, and local climate action plans are also expected to be key factors for future electricity needs. These factors identified as drivers of growth are used to inform the forecasts developed for the region and are discussed in more detail in the following subsections.

5.2.1. Community Load Growth

The population of the Windsor-Essex region is approximately 420,000 people, with close to 10,000 new residents welcomed between 2021 and 2022, according to the latest census. The Provincial Housing Commitment is anticipated to result in the development of 13,000 new homes over the next ten years in the Windsor-Essex region. This residential development will be accompanied by population growth, and Windsor expects a need will arise to expand its infrastructure to support this growth. The region also anticipates that new residences will employ electric heating and that existing residences will convert to electric heating, with the lowest expected conversion rate being 60 per cent. In addition to electric heating, electric vehicle uptake is expected to increase in the area, in accordance with forward looking projections from Statistics Canada and the regulated targets for zero-emission vehicles within the Electric Vehicle Availability Standard implemented by the Government of Canada in 2023. Electric vehicle uptake is expected by both municipal fleets and more broadly by community members.

Further, the region anticipates climate change and resulting extreme weather will have an impact on electricity demand. Windsor-Essex experiences hotter summers than other areas of Ontario because of its southern geography, which results in more days requiring electric cooling. The City of Windsor and County of Essex are surrounded on three of four sides by large bodies of water, and there are a number of shoreline and low-lying areas in the region that are vulnerable to flooding.[12]

The communities of the Windsor-Essex region anticipate steady population growth accompanied by necessary residential development. The City of Windsor, Municipality of Leamington, Town of LaSalle, Town of Tecumseh, and Municipality of Chatham-Kent each expect a population increase near to or greater than 6,000 individuals over a ten-year period, as informed by their Development Charges Background Studies.

Communities have identified large development projects that will increase electricity demand; these include the Howard-Bouffard Secondary Plan in the Town of LaSalle, the Tecumseh Hamlet Secondary Plan, Oldcastle Hamlet Development plan and Manning Road Secondary Plan in Tecumseh, the Settlements Areas for Employment Lands plan in the Town of Essex, and the Sewage Treatment Facility expansion in the Town of Kingsville. Moreover, some communities have identified objectives for reducing electricity demand through Energy Management plans like the City of Windsor and the Town of Lakeshore.

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[12] Based on the City of Windsor East Riverside Flood Risk Assessment and Essex Region Conservation Authority website.

5.2.2. Agricultural Sector

The Kingsville-Leamington area within the Windsor-Essex region is home to North America's largest concentration of greenhouse vegetable production. Growth in the agricultural sector has been driven by strong indoor agricultural growth, mainly vegetable greenhouses, as well as, in part, cannabis, specifically through existing greenhouses switching to lit indoor facilities, expansion of greenhouse facilities, and supplemental load to support the sector. There are also early indications of expansion to include berries and propagation.

Indoor agriculture loads are significantly different from other industrial, commercial, and residential loads in the province. The concentration of indoor agriculture in Windsor-Essex owes much to the region's natural advantages. Its proximity to the Windsor-Detroit border crossing is ideal for supplying both the Canadian and U.S. markets, and its southern latitude and climate provide optimal conditions for agricultural activities. Windsor-Essex also hosts an established ecosystem of support industries and partners, including agriculture research and greenhouse fabrication facilities, which further encourage greenhouse growth in the area.

Since the last cycle of regional planning, the greenhouse sector continues to grow. Both transmission-connected greenhouse loads, and the recommended supply stations (South Middle Rd DESNs 1 and 2) have connected or are under development. In the future, agricultural growth may concentrate in the southern portion of Chatham-Kent, between Wheatly and Port Alma.

5.2.3. Industrial Sector

Windsor-Essex remains the country's manufacturing and automotive powerhouse, with significant recent investments in electric vehicle battery manufacturing. Windsor-Essex is home to more than 1,000 manufacturers, with more than 90 parts manufacturers, including two original equipment manufacturers, over 250 machine, tool, die and mould manufacturers, and more than 500 automation-related firms.[13]

In April 2024, the Ontario government announced that it will offer support to four companies in the automotive and food processing industries (DS Actimo Canada, Kautex Textron, Integrity Tool & Mold Inc. and Highbury Canco Corp.) to expand their manufacturing capacity in the area. The government anticipates that these companies will invest around $215 million, and create around 153 new local jobs.[14] In October 2024, NextStar Energy (a joint venture between Stellantis and LG Energy Solution) started production in their new electric vehicle battery plant in Windsor. At full production, the plant is expected to employ 2,500 workers and produce enough battery cells to power 450,000 vehicles annually. In addition, the Ontario government announced that it would invest over $9 million to train approximately 2,300 manufacturing and construction sector workers in Windsor.[15]

5.3. Demand Forecast Methodology

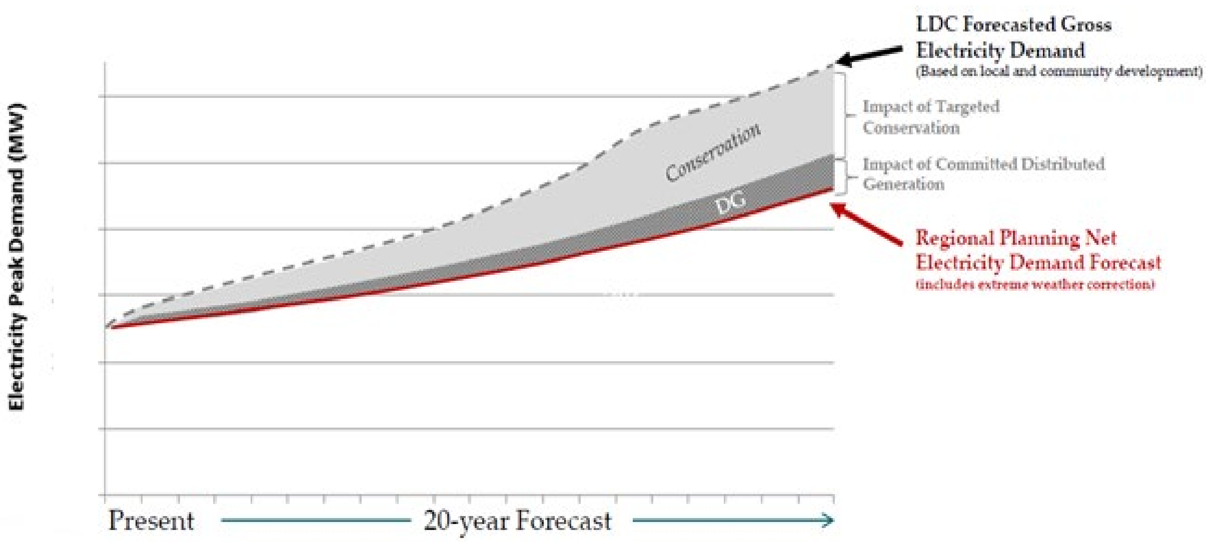
The steps taken to develop a 20-year IRRP peak demand forecast are depicted in Figure 6. Gross demand forecasts, which assume the weather conditions of an average year based on historical

[13] https://www.investwindsoressex.com/industries/advanced-manufacturing/#:~:text=Industry%20profile,Automate%20Canada
[14] https://news.ontario.ca/en/release/1004431/ontario-welcomes-125-million-manufacturing-boost-in-southwestern-ontario
[15] https://news.ontario.ca/en/release/1005049/ontario-investing-over-9-million-to-train-2300-workers-in-windsor

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 Planning 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 has also published a [Load Forecast Guideline] for regional planning, through the [Regional Planning Process Advisory Group].

Figure 6 | Illustrative Development of Demand Forecast



5.4. Gross LDC Forecasts

Each participating LDC in the Windsor-Essex 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. The LDCs cited alignment with municipal and regional official 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 in 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 eDSM programs), which are accounted for by the IESO (discussed in Section 5.5). The gross LDC forecasts assume median on-peak weather conditions and loading that is coincident to each station.

Figure 7 and Figure 8 show the gross non-coincident demand forecasts provided by the LDCs for the Windsor-Essex region under the Planning Scenario and High Scenario for summer and winter peak demand.

Figure 7 | Total Summer Gross Non-Coincident Demand Forecasts Provided by LDCs (Median Weather)[16]

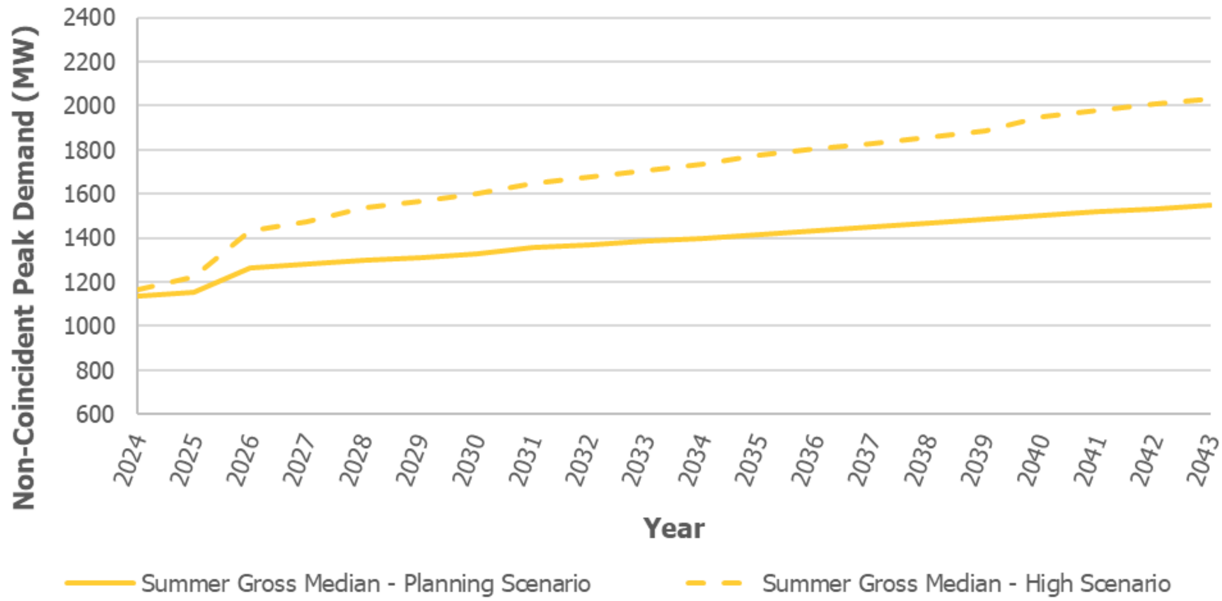
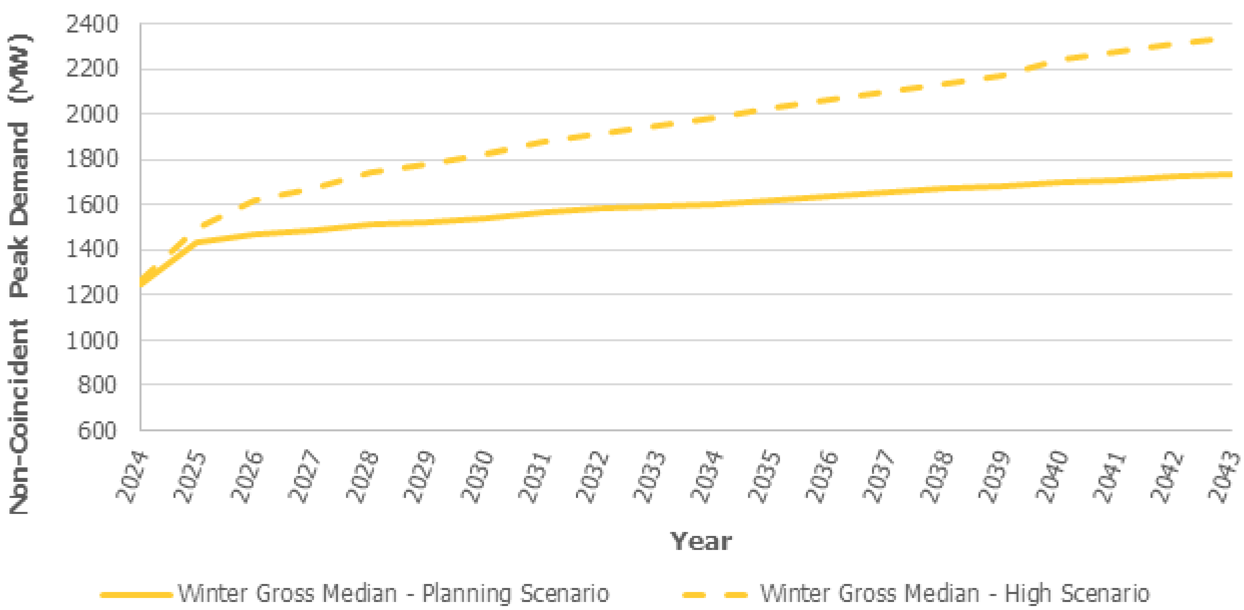


Figure 8 | Total Winter Gross Non-Coincident Demand Forecasts Provided by LDCs (Median Weather)[17]



[16] Excludes existing transmission-connected industrial customers in the Windsor-Essex region (historically contributing an average of 75 MW to the summer non-coincident peak demand), as well as forecasted greenhouse and industrial sector growth not assigned to specific LDCs.

[17] Excludes existing transmission-connected industrial customers in the Windsor-Essex region (historically contributing an average of 63 MW to the winter non-coincident peak demand), as well as forecasted greenhouse and industrial sector growth not assigned to specific LDCs.

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, and the municipalities and communities that they serve. The IESO typically carries out demand forecasting at the provincial level. More details on LDC load forecast assumptions can be found in Appendix B.2 to B.6.

5.5. Contribution of Energy Efficiency to the Forecast

Energy efficiency is a clean and cost-effective resource that helps meet Ontario's electricity needs and has been an integral component of provincial and regional planning. Energy efficiency is achieved through a mix of codes and standards amendments, as well as eDSM program-related activities. These approaches complement each other to maximize conservation results.

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

The estimates of demand reduction due to eDSM program-related activities account for the 2021–2024 Conservation and Demand Framework, federal programs that result in electricity savings in Ontario, and forecasted long-term energy efficiency programs. Under the 2021–2024 Conservation and Demand Management Framework, the IESO centrally delivered programs on a province-wide basis to serve business and residential customers, as well as Indigenous communities.

The demand forecast was finalized before approval of the new 2025–2036 eDSM framework and its savings targets, and assumes that programs continue at 2021–2024 Conservation and Demand Framework levels, with adjustments for gross demand growth. The increased targets under the new framework may impact the exact scale and timing of needs.

Figure 9 and Figure 10 show the estimated total yearly reduction to the demand forecast due to energy efficiency (from codes, standards, and eDSM programs) for each of the residential, commercial, and industrial consumers. Additional details are provided in Appendix B.8 and Appendix E.

Figure 9 | Total Summer Forecast Peak Demand Reduction (Codes, Standards, and eDSM Programs)

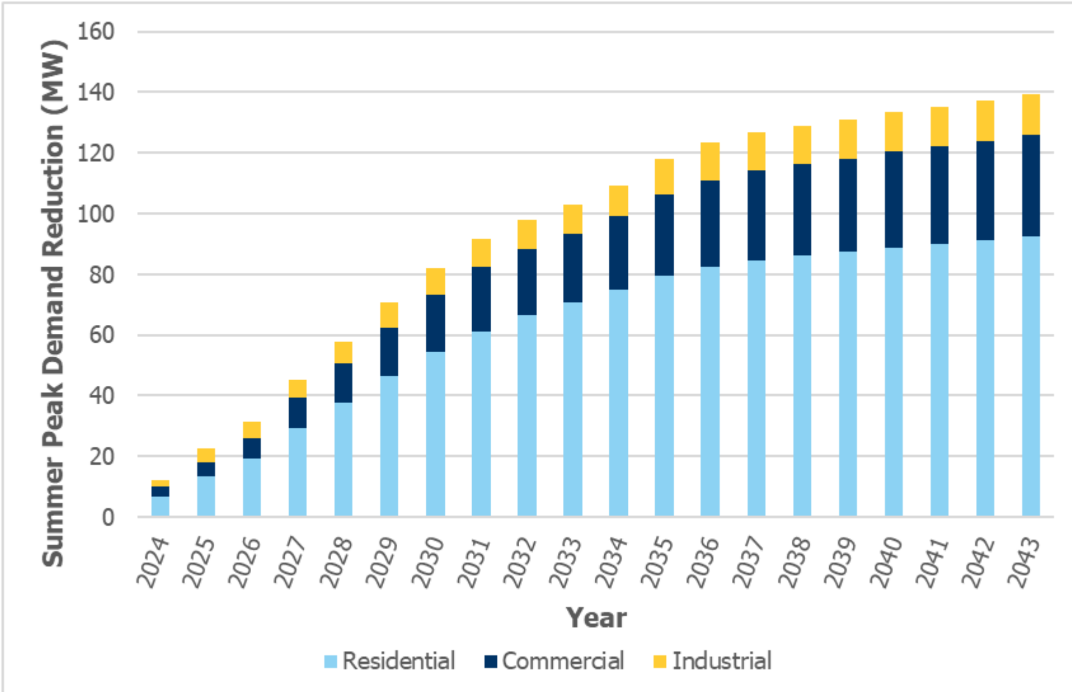
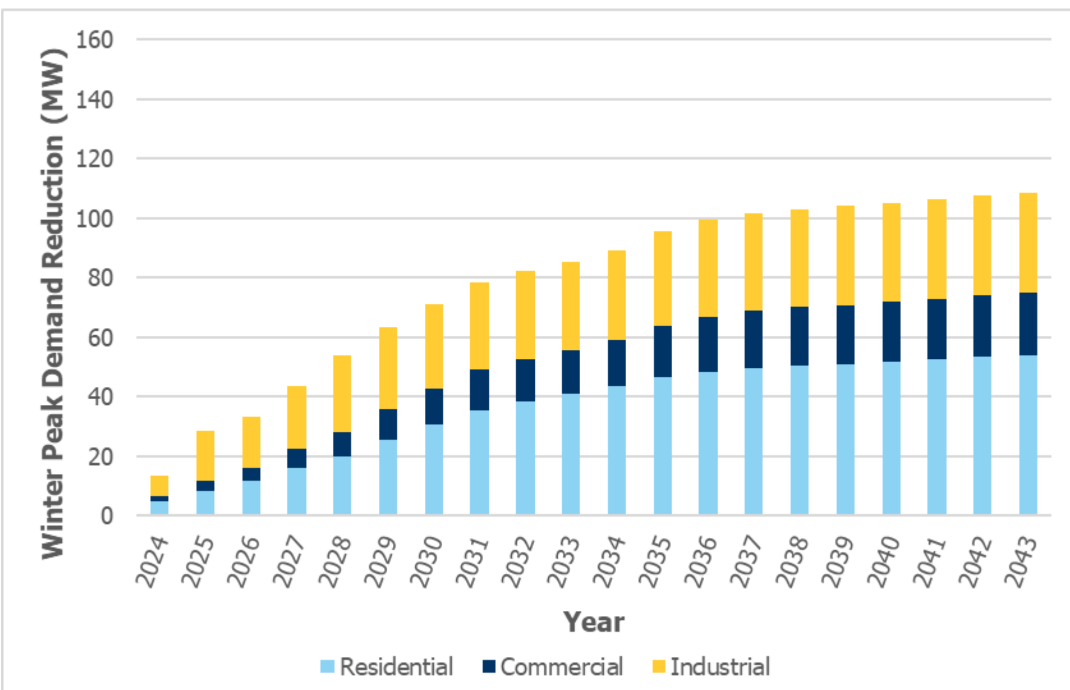


Figure 10 | Total Winter Forecast Peak Demand Reduction (Codes, Standards, and eDSM Programs)

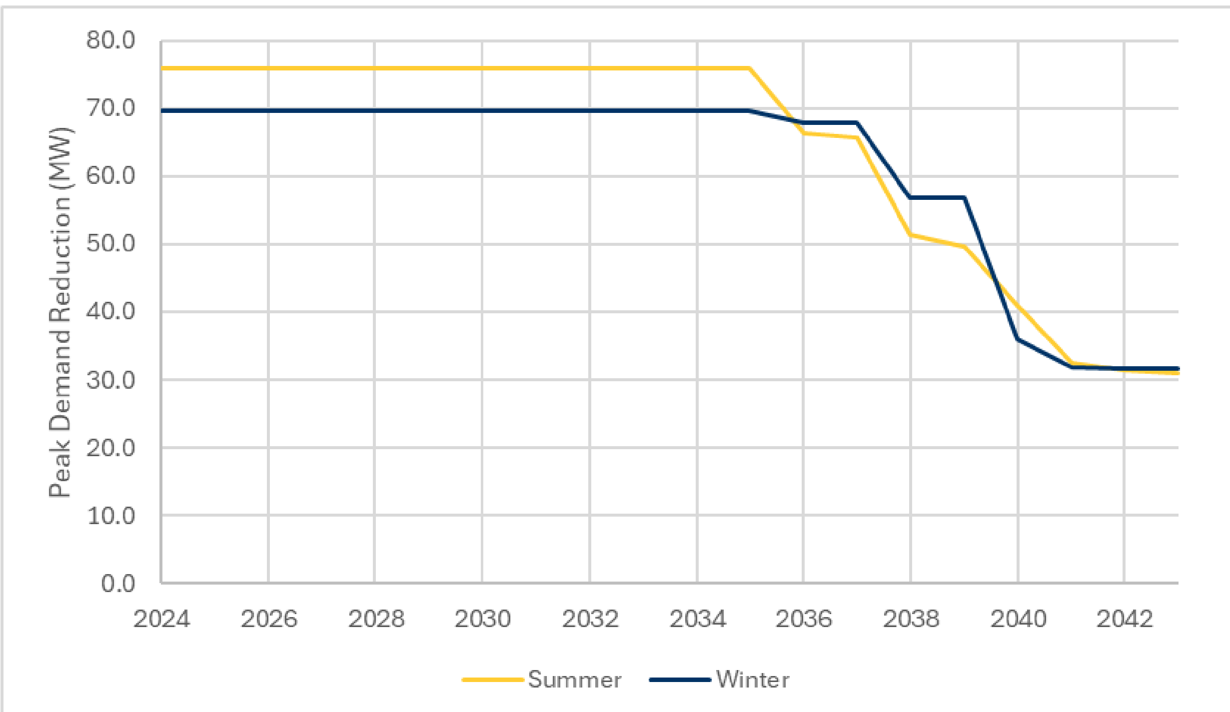


5.6. Contribution of Distributed Generation to the Forecast

In addition to energy efficiency, DG in the Windsor-Essex region is also forecast to offset peak demand requirements. The introduction of Ontario's FIT Program 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 contribution factor assumptions can be found in Tables 3 and 4 of the accompanying IRRP data tables (provided as a separate Excel file). Most of the total installed DG capacity in the Windsor-Essex region is wind and solar, with the remainder being natural gas (CHP) and biogas facilities.

After reducing the demand forecast due to energy efficiency (as described in Section 5.5) the forecast is further reduced by the expected contribution from contracted DG. Figure 11 shows the impact of DG on reducing the Windsor-Essex region demand forecasts. Note that facilities without a contract with the IESO were not included in the DG peak demand reduction forecast, except for DG facility information provided directly by the LDCs.

Figure 11 | Peak Demand Reduction Due to DG



A decision was made within the Technical Working Group to consider the expected lifespan of each DG facility based on resource type, rather than assuming that facilities will not be re-contracted past their current contract end date. In alignment with the IESO 2024 Annual Planning Outlook, the assumption for resource expected lifespans was 25 years for solar, and 30 years for wind, natural gas and biogas. A total of 76 MW of summer peak contribution is identified for the Windsor-Essex region in 2024, reducing to 30 MW by 2044. This reduction is reflected in the planning forecasts as discussed in the next section.

5.7. Planning Forecasts

After taking into consideration the combined impacts of energy efficiency and DG, a 20-year net demand forecast was produced for the Windsor-Essex region considering the Planning Scenario and High Scenario. The following subsections describe the implementation of weather correction to create the Planning Forecast and High Forecast, the total demand outlook for the region, and the specific demand outlooks for the agricultural and industrial forecasts (which represent significant and unique portions of the overall load growth).

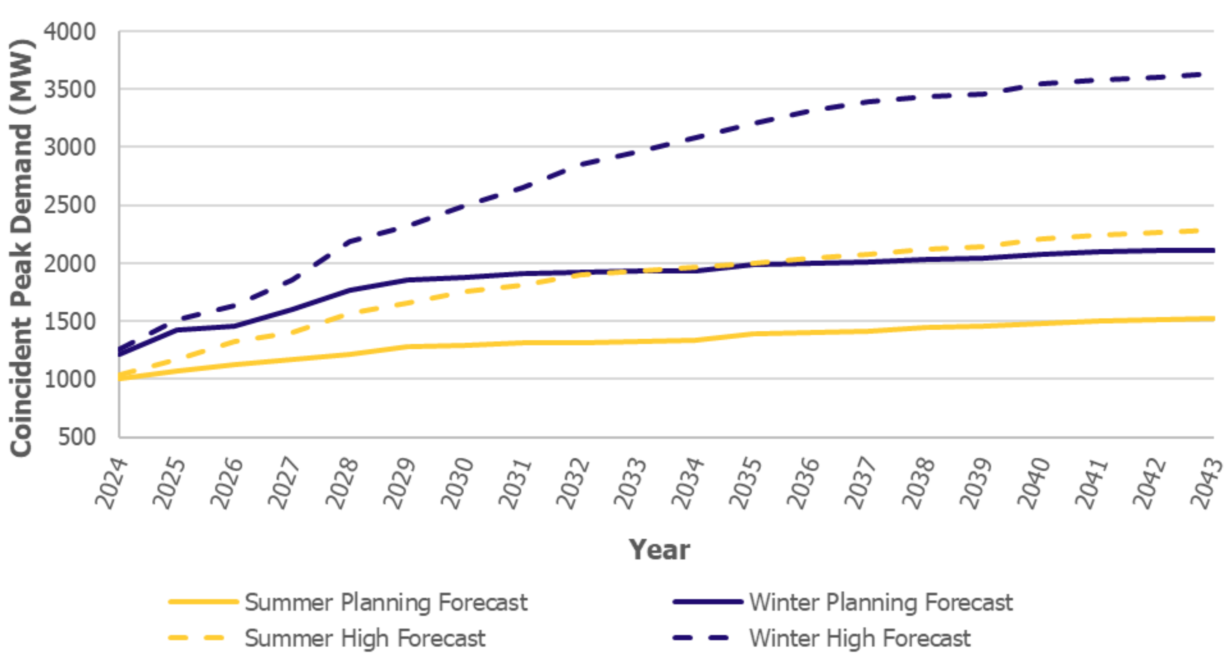
5.7.1. Net Extreme Weather Planning Forecast

The net extreme weather forecast is created by adjusting the net median weather forecast (the gross demand forecast including the forecast DG and eDSM impacts) for extreme weather conditions. The weather correction methodology is described in Appendix B.1. The Planning Forecast results from the net extreme-weather forecast applied to the Planning Scenario.

Note that this Planning Forecast is coincident, meaning that each station forecast reflects its expected contribution to the regional peak demand level. This supports the identification of need dates for regional needs that are driven by more than one station. For station-specific needs, the non-coincident forecast is calculated by applying a non-coincidence factor. The factor is based on the historical non-coincident peaks of each station compared to the station's contribution to the region's coincident peaks over the past five years.

The coincident net extreme weather forecast for the Windsor-Essex region is shown in Figure 12 Figure 12: both the Planning Forecast and High Forecast representing peak summer and winter demand.

Figure 12 | Net Extreme Weather Planning Forecast and High Forecast for the Windsor-Essex Region



5.7.2. High Forecast Scenario

The Technical Working Group developed a High Forecast sensitivity scenario for the Windsor-Essex region, which is also shown in Figure 12. The High Forecast is meant to quantify prospective development in the Windsor-Essex region that is not yet committed. This higher demand scenario is driven by significant growth potential in the agricultural and industrial sectors, as described in detail in Sections 5.7.3 and 5.7.4.

The High Forecast can be used as a proxy for a variety of factors that could drive demand higher over the next 20 years, including, but not limited to:

- Electric vehicle charging;
- Electrified space and water heating;
- A faster pace of residential development;
- Unanticipated new industrial customers of growth among existing industrial customers; and
- Higher growth in the agricultural sector.

The higher demand scenario was not used to drive any firm recommendations for this IRRP; however, it was used to help the Technical Working Group identify where the future electricity concerns may be and when they could materialize. This information can also be useful for communities conducting community energy plans, for the Technical Working Group in determining areas to monitor in future planning cycles, and for communities and stakeholders to consider when planning various projects in the region. Moreover, while developing this IRRP, the Technical Working Group also considered the flexibility of evaluated options to accommodate greater long-term growth. This is later described in Section 7.

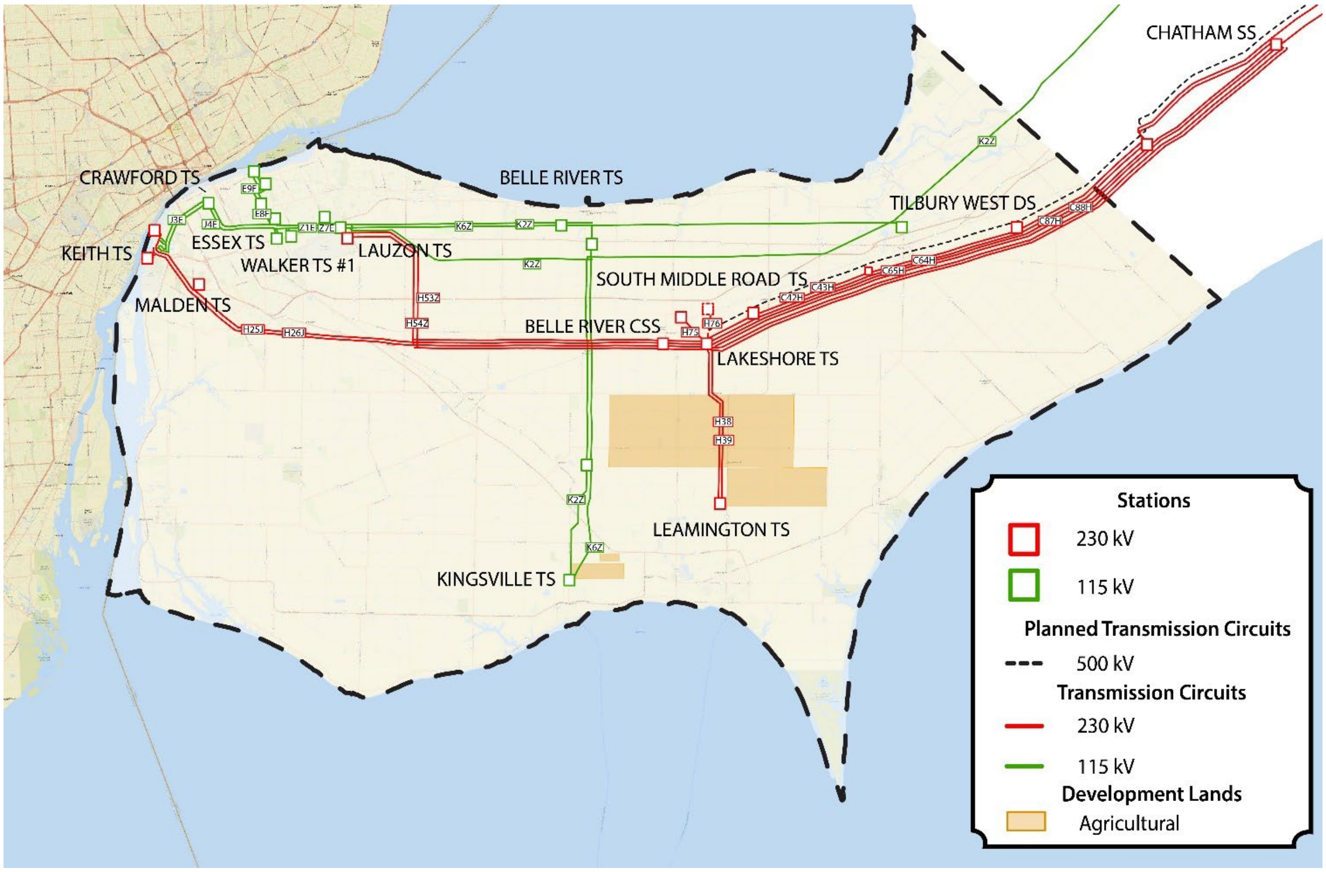
5.7.3. Agricultural Forecast

The agricultural forecast was developed to capture the future growth of the agricultural sector, including greenhouses, in both the Planning Forecast and High Forecast scenarios. The forecast incorporates the anticipated greenhouse developments that were known at the time it was produced. The greenhouse sector continues to expand – the previous IRRP projected a five per cent annual growth rate, which has been realized in the near term. Future growth in the Planning Forecast is expected to be four per cent for the sector, with High Forecast growth of seven per cent. Increasing construction and operational costs contribute to growth levels projected to be slower than the 2019 IRRP forecast.

The Ontario agricultural market is increasingly looking for local greenhouse food as a reliable and secure alternative to importing from traditional suppliers. As a result, Ontario greenhouse growers are expanding their operations, changing their propagation practices, and modifying the items they grow. The sector is shifting from propagating plants in fields to propagation within the greenhouse, to reduce insect contamination and other impurities. Vegetable growers are also starting to expand into berry production, which requires chilled warehouses and more packing space.

To develop the agricultural forecast, engagement was conducted with Indigenous communities, market participants, municipalities, stakeholders, communities, customers and the general public. Public webinars allowed stakeholders to provide their inputs into the planning process and issue public comments on the load forecast, needs, and recommendations. In particular, information on the geographic locations of agricultural growth in Windsor-Essex was provided by municipalities in the region and Ontario Greenhouse Vegetable Growers (OGVG). Greenhouse development remains concentrated in the Leamington and Kingsville areas of Windsor-Essex. This geographic information was used as an approximation to map the agricultural forecast load for the purpose of conducting the needs and options studies, as shown in Figure 13.

Figure 13 | Geographic Locations of Agricultural Growth in the Windsor-Essex Region

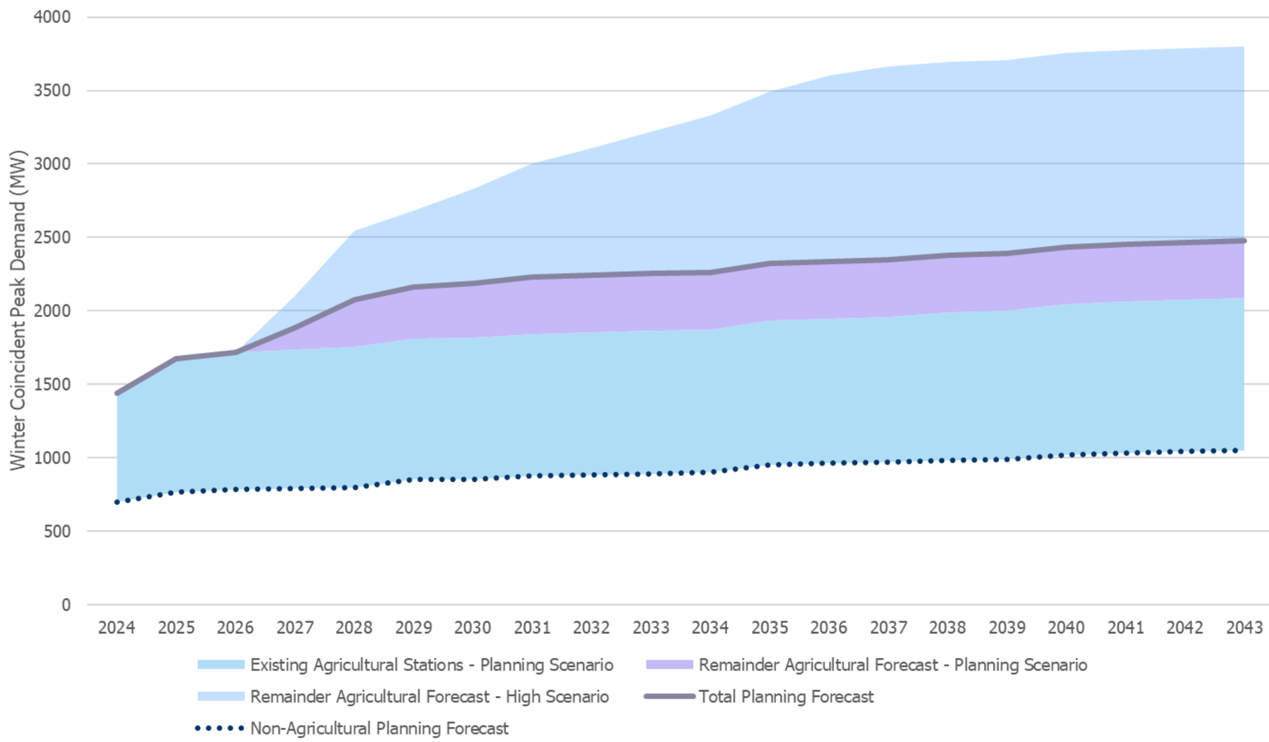


After the forecast was finalized, there were early indications of greenhouse load potential in the area between Wheatly toward Chatham-Kent, along Lake Erie. This pocket of growth is likely to be located in the Chatham-Kent/Lambton/Sarnia planning region outside of the geographic/electrical boundaries shown in Figure 13. It is not expected that this growth will detract from the forecast growth in Windsor-Essex.

Greenhouse developments are subject to a variety of factors, including land availability, municipal support, and water supply. The availability of water supply is a key constraint, with some growers digging their own wells and capturing rainwater to be processed and used to overcome the limitations of municipal/county water supplies.

Peak demand for the agricultural forecast is seen in the winter when greenhouses use grow lights to support their crop production. As greenhouses shift to LED lights (including under an IESO-administered eDSM program), peak demand per acre drops, allowing greenhouses to produce more for the same electricity usage. Grow lights tend to be used between October to April, but growers consider September, October, March, and April to be shoulder months. Electricity demand for greenhouses persists year-round as production continues; however, grow lights are not typically required during summer months. Figure 14 depicts the winter agricultural peak demand forecasts for the Planning and High scenarios.

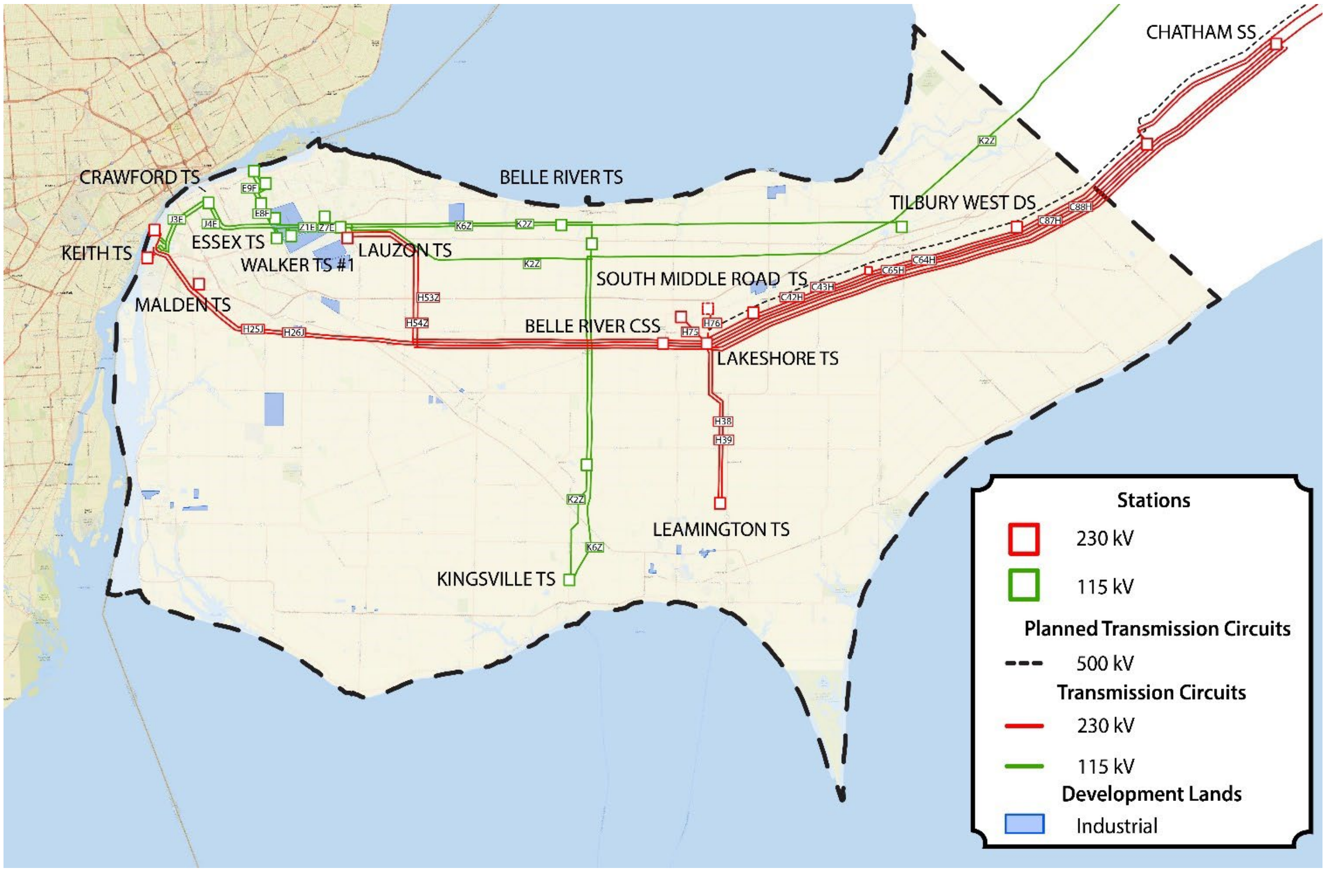
Figure 14 | Agricultural Winter Forecast



5.7.4. Industrial Forecast

Information on potential industrial development lands in the Windsor-Essex region was provided from the County of Essex and Invest WindsorEssex – the not-for-profit organization supported by the City of Windsor and County of Essex responsible for advancing economic development in the region. As shown in Figure 15, industrial development lands are primarily concentrated in the West Essex and Windsor area. The municipalities supplied information on potential industrial land developments, and in some cases, industrial expansion forecasts used in the Planning Scenario and High Scenario. Across the Windsor-Essex region, approximately 800 new acres have been allocated for industrial development, with construction started in 2024.

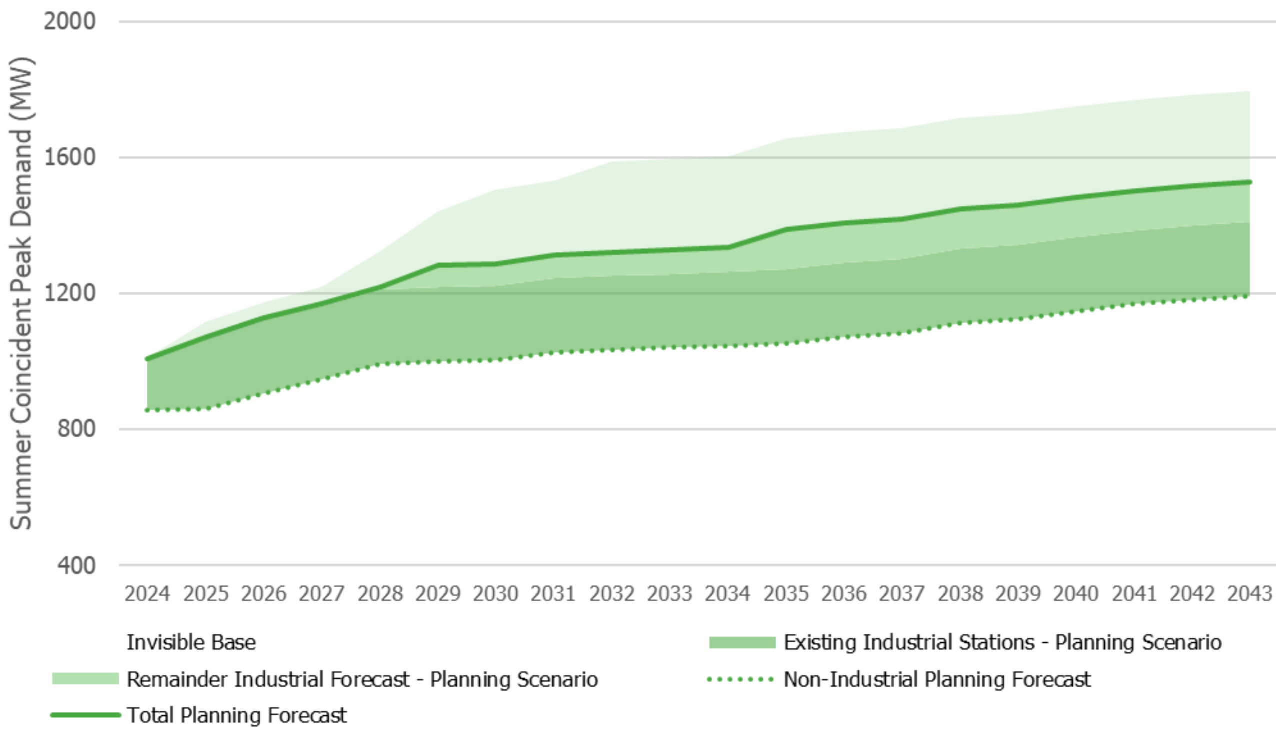
Figure 15 | Geographic Locations of Industrial Growth in the Windsor-Essex Region



The information provided by Invest WindsorEssex identifies approximately 20 new projects in the area requiring significant electrical supply. In addition, anticipated development in the Town of LaSalle could require approximately three gigawatts of power to service business parks and natural environment developments.

The Planning Forecast considered firm and reasonably expected industrial loads, while the High Forecast also incorporated less certain industrial load potential based on municipal and stakeholder input. Figure 16 shows the contributions of the industrial loads to the forecast under the Planning and High Forecasts, relative to the loads at existing stations, and particularly the existing industrial loads in the region. The demand captured in the industrial forecast is relatively constant throughout the year, as industrial loads generally have no relationship with weather conditions.

Figure 16 | Industrial Contribution to Summer Forecast



5.8. Hourly Forecast Profiles

In addition to the annual peak forecast, hourly load profiles (8,760 hours per year over the 20-year forecast horizon) for station(s) included in identified needs were developed to characterize the needs with finer granularity. The profiles were based on historical load 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. As described later in Section 7, these profiles were used to quantify the magnitude, frequency, and duration of needs to better evaluate the suitability of generation and distributed energy resource options.

Additional load profile details, including hourly heat maps for needs where non-wires alternatives other than eDSM were assessed, 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 the 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-001-5.1, 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 downstream or upstream equipment (i.e., breakers, disconnect switches, low-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 referred to as the load meeting capability (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-001-5.1, 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 medium-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 Windsor-Essex IRRP can be found in Appendix G. The needs identified are discussed in Sections 6.2 to 6.7.1 for the most limiting season for each of the three sub-systems.

6.2. West Essex and Windsor Sub-system Needs

There is an asset replacement need at Lauzon TS DESN 2 that, when combined with the station capacity need under the Planning Forecast, was assessed for the opportunity to consider an integrated solution. There is also a supply capacity need on transmission path into the West Essex and Windsor sub-system, which consists of the four 230 kV supply circuits going west from Lakeshore TS: two circuits to Lauzon TS (H53Z and H54Z) and two circuits to Keith TS (H25J and H26J). Table 4 summarizes the needs for the West Essex and Windsor sub-system under the Planning Forecast.

Table 4 | Summary of West Essex and Windsor Sub-system Planning Needs

Need	Need Date	Need by 2043 (MW)
Lauzon DESN 2 (T7/T8) end-of-life	2029	n/a
Lauzon DESN 2 (T7/T8) station capacity	2032	37
West Essex and Windsor supply capacity	2032	230

6.2.1. Asset Replacement Needs

The asset replacement need for Lauzon TS DESN 2 was included within the scope of the Windsor-Essex IRRP for its potential integration with the station's capacity need.

6.2.1.1. Lauzon DESN 2 End-of-Life Needs

Lauzon TS DESN 2 transformers were identified as requiring replacement based on asset condition and were originally scheduled to be replaced with like-for-like 115/27.6 kV 83 megavolt ampere (MVA) units by 2032. The IRRP 20-year demand forecast identified station capacity needs at Lauzon TS DESN 2, necessitating the need to reconsider the like-for-like replacement plan.

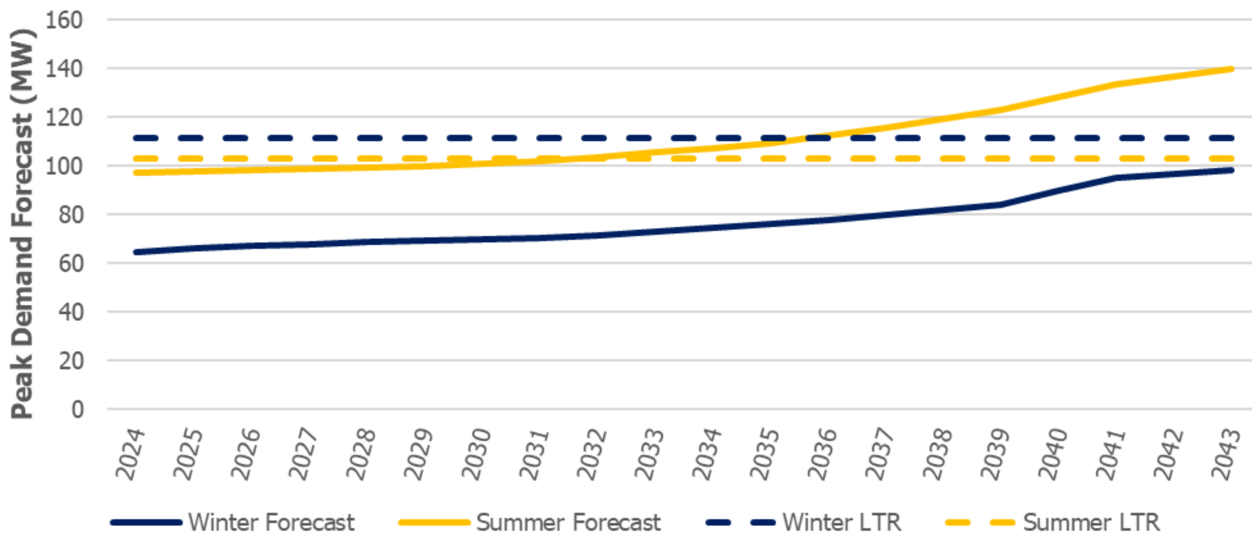
6.2.2. Station and Supply Capacity Needs

The station capacity needs are driven by industrial loads that cannot be accommodated at the existing supply stations due to the magnitude and uncertainty of their location, as well as load growth at Lauzon TS.

6.2.2.1. Lauzon DESN 2 Station Capacity Needs

Supplying customers in West Essex and Windsor, Lauzon TS DESN 2 is forecast to reach its summer station capacity limit in 2032 and grow to a 37 MW need by 2043. The station consists of two 115 kV/27.6 kV transformers with an LTR of 103 MW.

Figure 17 | Lauzon TS DESN 2 Station Capacity Need



6.2.3. West Essex and Windsor Supply Capacity Need

The load in the West Essex and Windsor sub-system is supplied through 230 kV transmission lines from Lakeshore TS (near Comber) to Lauzon TS and to Keith TS (both in Windsor). The 230/115 kV autotransformers at Lauzon TS and Keith TS supply the 115 kV network in West Essex and Windsor. The area is also served by local generation in the Windsor area. The LMC of the sub-system is limited to 840 MW based on the thermal capability of the circuits going to Lauzon TS under the various planning scenarios and applicable contingencies to the circuits along the Lakeshore to Lauzon TS/Keith TS corridor. Considering the forecast growth in the sub-system – including the industrial forecast presented in Section 5.7.4 – this sub-system has a supply capacity need starting in 2032 with 65 MW, which increases to 230 MW in 2043.

6.2.4. High Forecast Needs

Considering the High Forecast, the West Essex and Windsor supply capacity need increases to 840 MW and is advanced by seven years – to 2025 from 2032 under the Planning Forecast. This illustrates the potential impact on the need year, if a portion of the High Forecast materializes. Considering station capacity needs, the Lauzon TS DESN 2 need is advanced to the near-term and two new station capacity needs are identified at Malden TS and Keith TS, as summarized in Table 5.

Table 5 | Summary of New/Updated West Essex and Windsor Sub-system High Forecast Needs

Need	Need Date[18]	2043 Need (MW)
Lauzon DESN 2 (T7/T8) station capacity	2025	120
West Essex and Windsor supply capacity	2025	790
Keith TS station capacity	2033	42
Malden TS station capacity	2040	45

6.3. Kingsville-Leamington Sub-system Needs

The Kingsville-Leamington sub-system continues to experience rapid electricity demand growth from greenhouse loads. Due to the nature of the load growth, the sub-system is expected to be winter peaking and has a unique load profile relative to the rest of the region. Thus, all loading and capacity values in this section refer to the non-coincident winter peak. There are restoration needs, as well as station and supply capacity needs that have been identified, which will be discussed in the following subsections. Table 6 summarizes the Kingsville-Leamington sub-system needs.

Table 6 | Summary of Kingsville-Leamington Sub-system Needs

Need	Need Date[19]	2043 Need (MW)
Leamington TS load restoration	Immediate	320
Kingsville-Leamington Greenhouse station and supply capacity	2027	390

6.3.1. Planning Load Security and Restoration Needs

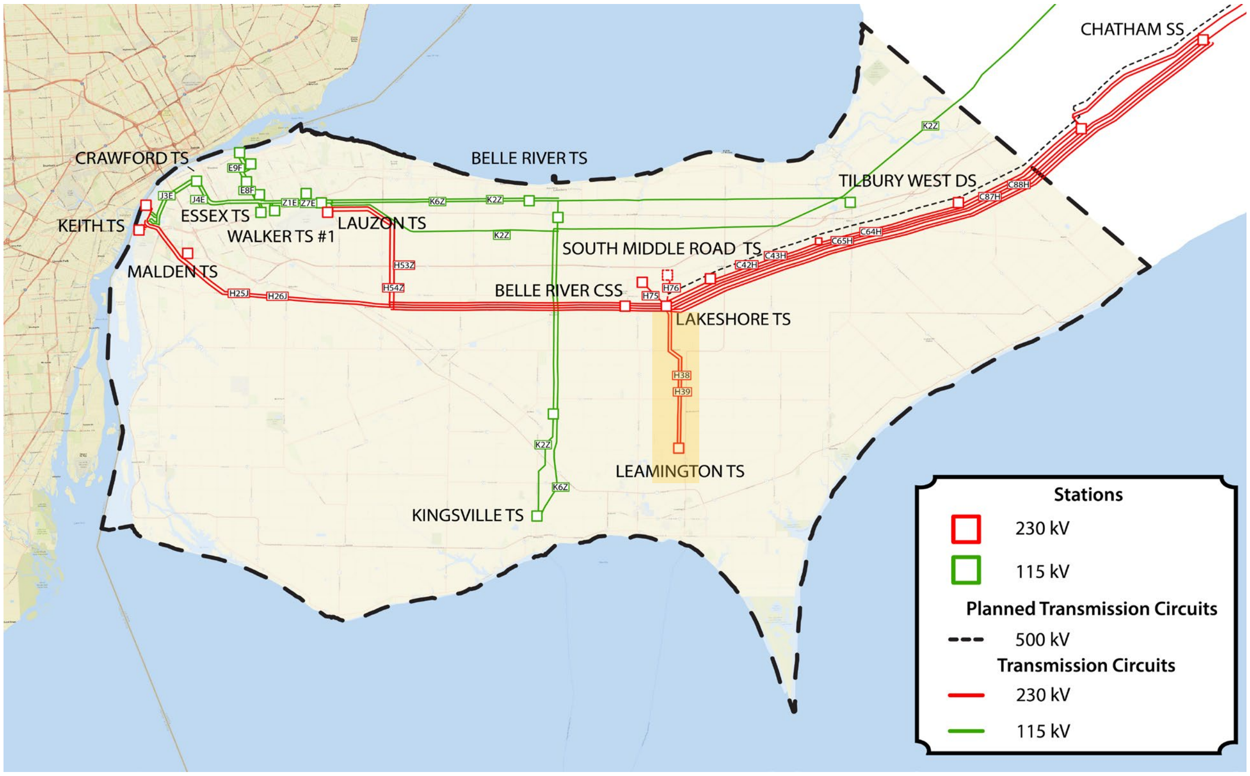
6.3.1.1. Leamington TS Supply (H38/H39 circuits)

The load restoration need on the twelve kilometre, 230 kV double-circuit line from Lakeshore TS to Leamington TS was identified in the 2022 Windsor-Essex Addendum. Leamington TS DESN 1 and DESN 2, as well as two transmission-connected customers south of Lakeshore TS, are supplied radially through these circuits. Figure 18 depicts this portion of the transmission system in the Windsor-Essex region.

[18] Based on non-coincident station forecasts for station capacity needs and coincident station forecasts for supply capacity needs, as explained in Section 0.

[19] Based on non-coincident station forecasts.

Figure 18 | Map of Leamington TS Transmission (Highlighted Yellow)



As per ORTAC Section 7.1, no more than 150 MW is allowed to be interrupted by configuration following a single-element contingency, and a total of 600 MW (by configuration, load curtailment or load rejection) following a two-element contingency. The current system has a RAS, whereby up to 170 MW would be lost following the loss of either radial supply circuit. With all recommended bulk reinforcements in-service, it is expected that the RAS will no longer be needed, such that the load security need is addressed.

By the end of the study period, approximately 490 MW would be interrupted following an outage to both circuits, H38 and H39, by configuration. Of this 490 MW, Hydro One Transmission has indicated that only 30 MW of the load could be restored within four hours through a load transfer to Kingsville TS. Thus, the restoration targets of load in excess of 250 MW cannot be restored within 30 minutes, nor can load in excess of 150 MW be restored within four hours. This is in violation of load restoration planning requirements (ORTAC Section 7.2), and is summarized in Table 7.

Table 7 | Load Restoration Planning Requirements on the Leamington Supply Lines

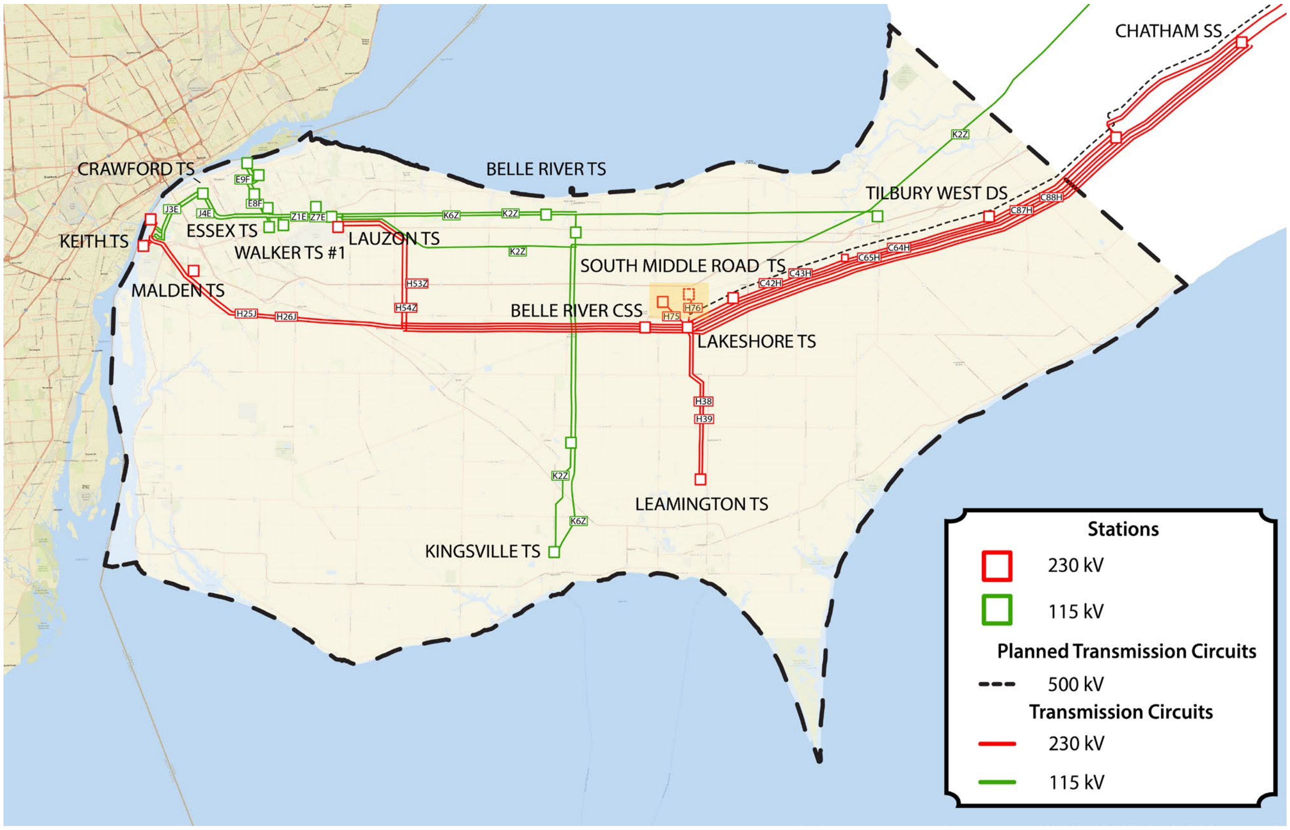
Time Post-Contingency	ORTAC Requirement: Restoration Target	Peak Load to be Restored	Achievable Based on the Current and Planned Transmission System?
Within 30 minutes	Load in excess of 250 MW	240 MW	No
Within four hours	Load in excess of 150 MW	340 MW	No, 30 MW is achievable
Within eight hours	All load	490 MW	Yes – the circuits are assumed to be restored by the transmitter within eight hours

6.3.1.2. South Middle Rd Supply (H75/H76)

A load restoration need on the one kilometre, 230 kV double-circuit line from Lakeshore TS to South Middle Rd TS (H75 and H76) was identified in the Needs Assessment. South Middle Rd TS DESN 1 and DESN 2 are supplied radially through these circuits. Figure 19 provides an overview of this portion of the transmission system in the Windsor-Essex region. Since these circuits are one kilometre or less in length, the loss of H75 and H76 is not a respected double contingency per planning criteria. Thus, there are no load restoration violations identified.

As per ORTAC criteria, no more than 150 MW is allowed to be interrupted by configuration following a single contingency. Under the current configuration and RAS, 120 MW of load would be lost following the loss of H75 or H76, which falls within the load security criteria. Thus, no load security concerns have been identified.

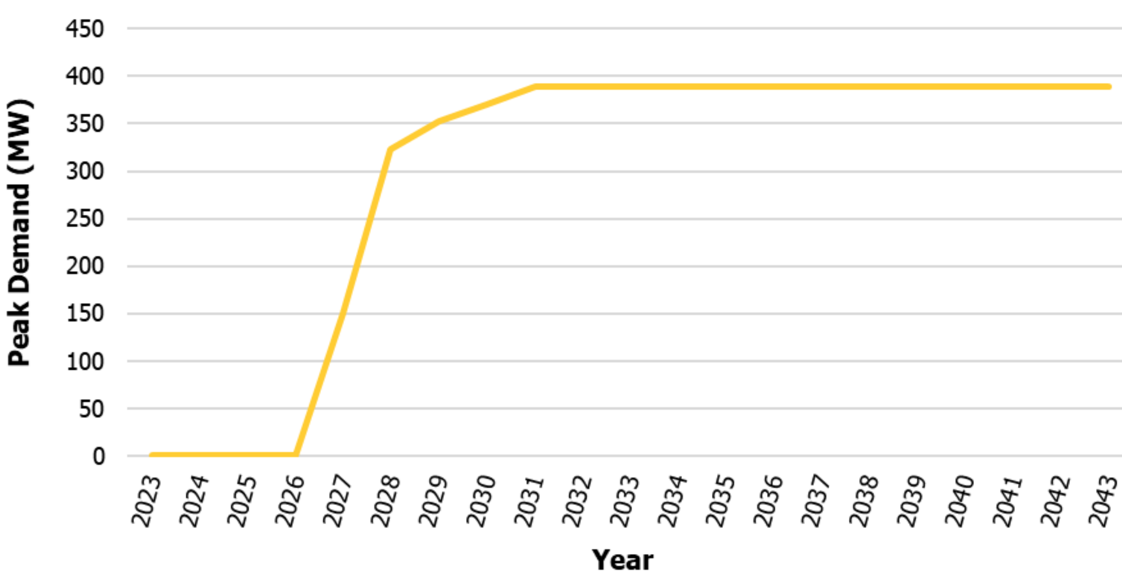
Figure 19 | Map of South Middle Rd Transmission Supply (Highlighted Yellow)



6.3.2. Station and Supply Capacity Needs

The Kingsville-Leamington capacity need is driven by load growth and new greenhouse developments that cannot be accommodated at the existing supply stations. The capacity need starts at 150 MW in 2027 and quickly reaches 390 MW by 2031.

Figure 20 | Kingsville-Leamington Greenhouse Developments Capacity Need



The supply capacity in the Leamington area is measured by the LMC on the Leamington tap – the 230 kV circuits identified as H38 and H39. The current system is limited to 380 MW due to the maximum allowable voltage drop.[20] There is sufficient capacity to supply the existing loads on these circuits, but it is unable to accommodate the 390 MW in additional greenhouse demand.

The supply capacity in the South Middle Rd area, measured by the LMC on the South Middle Rd tap, is limited to 455 MW, also based on maximum allowable voltage drop, assuming the voltage dependent load model. This is limited to 417 MW, based on the station capacity. This is sufficient to supply the two DESN stations at South Middle Rd TS, approximately 410 MW combined for the 2043 winter peak.

6.3.3. High Forecast Needs

Under the High Forecast, the magnitude of the load increases significantly among the total loads in the Kingsville-Leamington area – consisting of Kingsville TS, Leamington TS, South Middle Rd TS, and the new greenhouse developments. Considering the non-coincident peaks of theses loads, the electricity demand forecast increases from 1,400 MW in the Planning Forecast to 2,400 MW.

6.4. Lakeshore/Tilbury Sub-system Needs

There are immediate summer station capacity needs at Belle River TS. In the longer term, there are station capacity needs at Tilbury West DS, which emerge in 2036 due to a summer need, but the magnitude of need in 2043 is driven by a winter need. Table 8 summarizes needs for the Lakeshore/Tilbury sub-system.

Table 8 | Summary of Lakeshore/Tilbury Sub-system Needs

Need	Need Date	2043 Need (MW)
Belle River TS station capacity	Immediate	16
Tilbury West DS station capacity[21]	2036	13

6.4.1. Station Capacity Needs

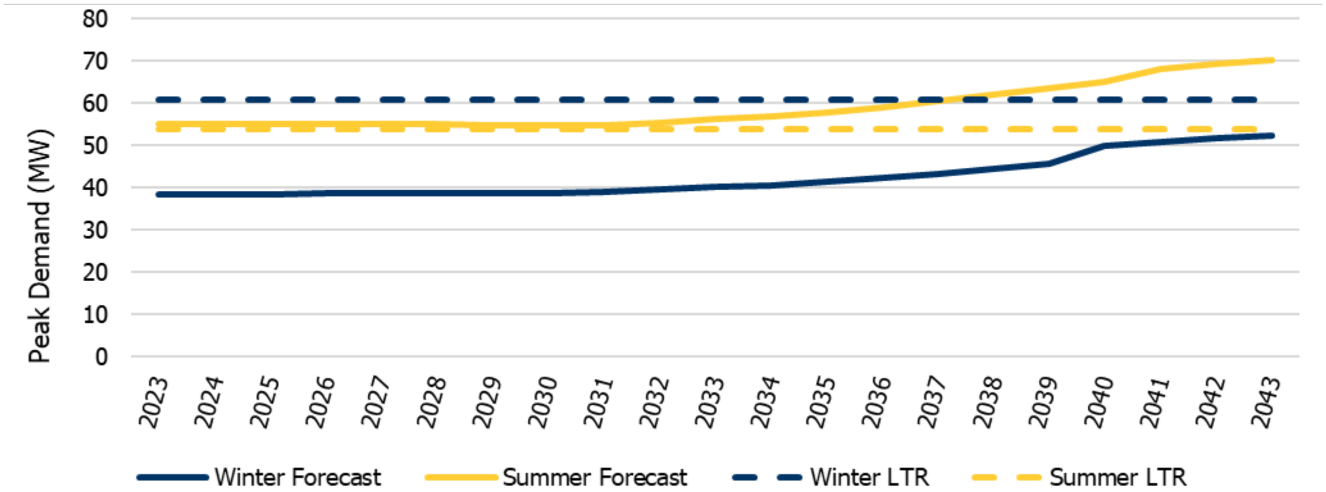
6.4.1.1. Belle River TS Station Capacity Needs

Belle River TS has an immediate summer station capacity need of one megawatt in 2024. Over the forecast period, the summer need increases to 16 MW by 2043. There is no winter need over the forecast period. Figure 21 shows the peak demand forecast relative to the summer and winter LTR values for Belle River TS.

[20] With all elements in service, ORTAC Section 4.3 limits the percentage voltage drop change following a contingency on the transmission system to 10 per cent before tap changer action and 10 per cent after tap changer action.

[21] Need date is driven by summer need but size of need is driven by winter need.

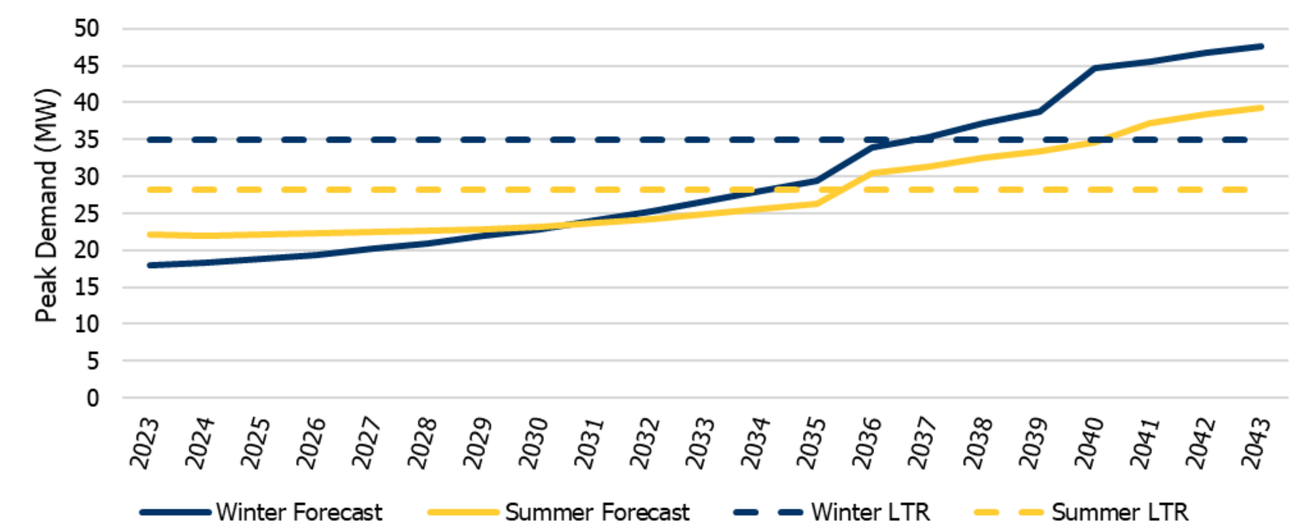
Figure 21 | Belle River TS Station Capacity Need



6.4.1.2. Tilbury West DS Station Capacity Needs

Tilbury West DS has a station capacity need of three megawatts in summer 2036, which increases to 13 MW by winter 2043. Figure 22 shows the Tilbury West DS demand forecast in relation to the summer and winter LTR values.

Figure 22 | Tilbury West DS Demand Forecast



6.5. Operational Issues

Operational issues are not defined as planning needs; however, they affect the reliability and operability of the region. As a result, the Technical Working Group investigates the potential for addressing operational issues using solutions already being considered to meet planning needs, where opportunity for overlap exists. The following operational issues were identified by the Technical Working Group:

- **Kingsville-Leamington Sub-system Load Security:** There is a temporary RAS in place for the Kingsville-Leamington sub-system, known as the Lakeshore RAS. This scheme allows for load connections in advance of the recommended transmission reinforcements coming into service, to continue to enable growth in the interim. However, the RAS impacts reliability in the Kingsville-Leamington sub-system. It is also operationally complex, due to the lack of redundancy and interaction with the Windsor RAS.
- **Lakeshore TS Station Configuration:** There is an operational concern at Lakeshore TS, where a contingency can that introduce low voltage concerns on the downstream circuits. in
- **Lauzon TS Station Configuration:** There is an operational concern at Lauzon TS., where a contingency can result in low voltage concerns, in the area.
- **Lakeshore/Tilbury sub-system Load Security:** There is an under voltage load shedding (UVLS) scheme in place for the Lakeshore/Tilbury sub-system. This sub-system is radially supplied from Lauzon TS, resulting in post-contingency voltage concerns., which is mitigated through the UVLS. As load increases in this sub-system, the reliance on this scheme may increase.

6.6. Supply into Windsor-Essex

The focus of regional planning is to ensure reliable supply within a region. While supply into the region is out of scope of this IRRP, the High Forecast indicates a potential need for additional transmission reinforcement into the Windsor-Essex region in the mid-2030s. The ongoing South and Central Bulk Plan will assess this potential need, while considering the transmission reinforcements and/or network expansion required to support economic development, reduce reliance on emitting resources and enable reliable long-term supply.

6.7. Summary of Identified Needs

6.7.1. Planning Needs

Table 9 provides an overview of all the Planning needs identified in this IRRP.

Table 9 | Summary of Planning Needs in the Windsor-Essex Region

Sub-System	Need	Need Date	2043 Need (MW)
West Essex and Windsor	Lauzon DESN 2 end-of-life	2029	n/a
West Essex and Windsor	Lauzon DESN 2 (T7/T8) station capacity	2032	37
West Essex and Windsor	West Essex and Windsor supply capacity	2032	230
Kingsville-Leamington	Leamington TS load restoration	Immediate	320
Kingsville-Leamington	Kingsville-Leamington Greenhouse Development station and supply capacity	2027	390
Lakeshore/Tilbury	Belle River TS station capacity	Immediate	16
Lakeshore/Tilbury	Tilbury West DS station capacity	2036	13

7. Plan Options and Recommendations

This section describes the options considered and recommendations to address the needs in the Windsor-Essex region. In developing the plan, the Technical Working Group considered a range of integrated options. Considerations in assessing alternatives included maximizing use of existing infrastructure, provincial electricity policy, federal regulations, technical feasibility, cost effectiveness, lead time, local preferences, and consistency with longer-term needs in the area.

Generally speaking, there are two approaches for addressing regional needs:

- 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 capability. These are commonly referred to as "Non-Wire" Alternatives (NWAs) and can include things like local utility-scale generation or storage, distributed energy resources (including distribution-connected generation and demand response), or eDSM.

Section 7.1 provides 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-wires options. Subsequently, Section 7.3 to Section 7.5 present the options that were ultimately developed and evaluated (including a cost comparison) before the Technical Working Group made a recommendation.

7.1. Non-Wires Analysis Process in IRRPs

Wires options are always considered in regional planning, and while they are always viable options for regional needs, NWAs may be more suitable for specific need types and characteristics. To select and appropriately size non-wire options like generation or battery storage, additional work is required – including the creation of an hourly load profile, as described in Section 5.8. The most suitable technology type and capacity is chosen by examining the "unserved energy" profile, which is the hourly demand above the existing station or system capability The profile indicates the duration, frequency, magnitude, and total energy associated with each need. More details on the NWA process and analysis are provided in Appendix C.

7.1.1. Needs Screening

While traditional wires infrastructure is always a viable option for regional needs, NWAs are suitable for specific types of needs, as described in the Integrated Regional Resource Plans: Guide to Assessing Non-Wires Alternatives. An initial screening step is performed to identify which NWAs may be suitable for the type of need addressed.

High-level cost estimates for wire options are based on input provided by the transmitter and transmission benchmark costs. Similarly, cost estimates for non-wire options are based on benchmark capital and operating cost characteristics for each resource type and size. The complete list of assumptions used in the needs screening and options analysis is provided in Appendix F.

New eDSM measures can also help decrease the net electricity demand. Centrally delivered energy efficiency measures under the 2021–2024 Conservation and Demand Management Framework and Save on Energy brand are already included in the load forecast, as discussed in Section 5.5. As part of this 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 eDSM 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 to leverage distribution rates to help address distribution and transmission system needs using NWAs. Generally, incremental eDSM 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 per cent per year). These considerations are discussed further in Section 7.2, as part of the screening of options that was conducted.

Where NWAs are screened in and determined to be feasible, the upfront capital and operating costs for both wire options and NWAs are compiled to generate levelized annual capacity costs (measured in dollars per kW per year). In this scenario, the cash flow of the levelized costs for the options are compared over the lifespan of the wire option and the net present value of these levelized costs is the primary basis through which feasible options are compared. Where NWAs are screened out or determined to be infeasible for meeting the need, overnight capital costs for wire options are used instead.

NWAs are subject to uncertainties in the procurement in terms of both the resource costs bid my proponents and the overall success of the procurement. 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.

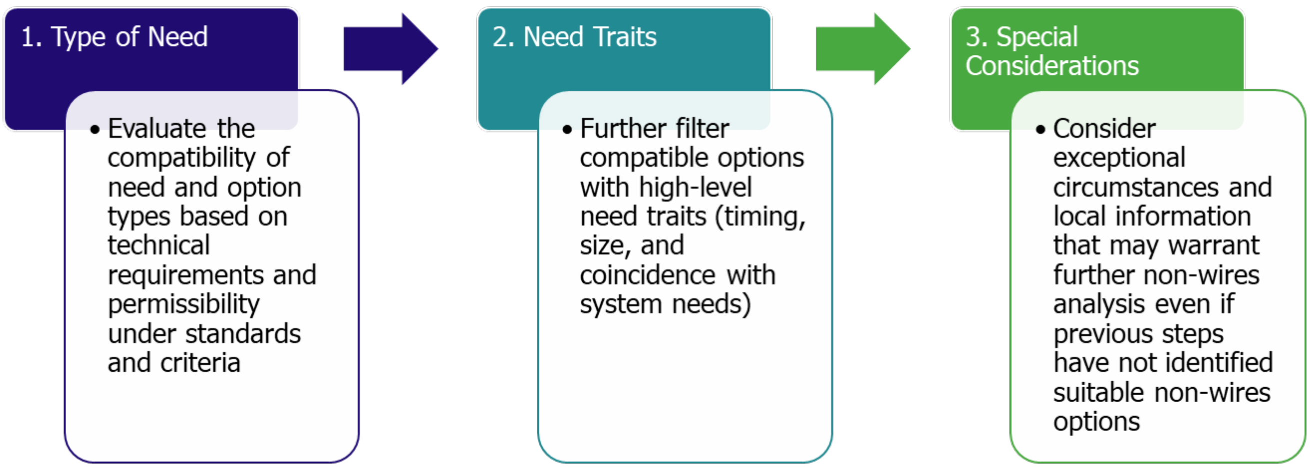
It is important to recognize that there is a significant error margin around cost estimates at the planning stage (from minus 50 per cent on the low side to plus 100 per cent on the high side), as they are only intended to enable comparison between options during the IRRP. The transmitter-led RIP (which 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 cost estimates differ significantly.

7.2. NWA Screening Results

As explained in Section 7.1, an array of options can be developed to meet local needs during an IRRP, but options are ultimately evaluated to recommend the most cost-effective and technically feasible solution that aligns with stakeholder needs and preferences.

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 NWA analysis (hourly need characterization, options development, financial analysis, and engagement) toward the most promising options. The three-step, high-level approach is shown in Figure 23.

Figure 23 | IRRP Screening Mechanism



The results of the application of the screening mechanism to the Windsor-Essex IRRP needs are summarized in Table 10 and then further described in the sections below. More details on the steps and inputs used in the screening mechanism can be found in Appendix C. The list of assumptions made in the needs screening and option analysis can be found in Appendix F.

Table 10 | Results of the Windsor-Essex IRRP Screening

Sub-system	Need	Options Screened In	Options Screened Out[22]
West Essex and Windsor	Lauzon TS DESN 2 end-of-life and station capacity	Wires options	All NWA options
West Essex and Windsor	West Essex and Windsor supply capacity	Wires options Energy efficiency Transmission-connected generation	Distributed generation Demand response

[22] Since the IESO is mandated to centrally deliver provincial eDSM programs, the incremental eDSM potential is estimated for each need regardless of its ability to meet the need.

Sub-system	Need	Options Screened In	Options Screened Out[22]
Kingsville-Leamington	Kingsville-Leamington Greenhouse Developments station and supply capacity	Wires options Demand response Energy efficiency	Distributed generation Transmission-connected generation
Kingsville-Leamington	Kingsville-Leamington load restoration	Wires options	All NWA Options
Lakeshore/ Tilbury	Belle River TS station capacity	Wires options Energy efficiency Distributed generation	Transmission-connected generation Demand response
Lakeshore/ Tilbury	Tilbury West DS station capacity	Wires options Energy efficiency Distributed generation	Transmission-connected generation Demand response

7.3. West Essex and Windsor Sub-system Evaluation

This section evaluates options to address the asset replacement need and station capacity need at Lauzon DESN 2, and the supply capacity need into the sub-system.

7.3.1. Lauzon TS Asset Replacement and Supply Capacity Needs

As described in Section 6.2, an asset replacement and station capacity need were identified at Lauzon TS DESN 2. These needs at Lauzon TS are evaluated together in this section to consider integrated solutions.

Wires Options

The wires options assessed were:

1. Upsizing the existing transformers at Lauzon TS DESN 2; and
2. Constructing a new DESN at Lauzon TS or connected to the circuits between Lauzon TS and Lakeshore TS.

Out of the two wires options, only option one – upsizing the existing transformers at Lauzon TS DESN 2 – addresses both the asset replacement and station capacity needs at Lauzon TS. In addition, upsizing the DESN from its current LTR of 100 MW to 180 MW would supply the need at Lauzon TS DESN 2 while also facilitating up to 15 MW of load transfers from Belle River TS (see Section 7.5.1). The remainder of the incremental capacity could be used to supply a portion of additional West Essex and Windsor load, depending on where the future loads materialize. The incremental cost of upsizing the transformers at Lauzon DESN 2, relative to a like-for-like replacement, is estimated to be between $15–30M.

Option two could address the Lauzon TS DESN 2 station capacity need by providing 180 MW of additional capacity but would not address the asset replacement need. The estimated cost of option two is $60M, which is substantially higher than option one, since it does not take advantage of the end-of-life sustainment.

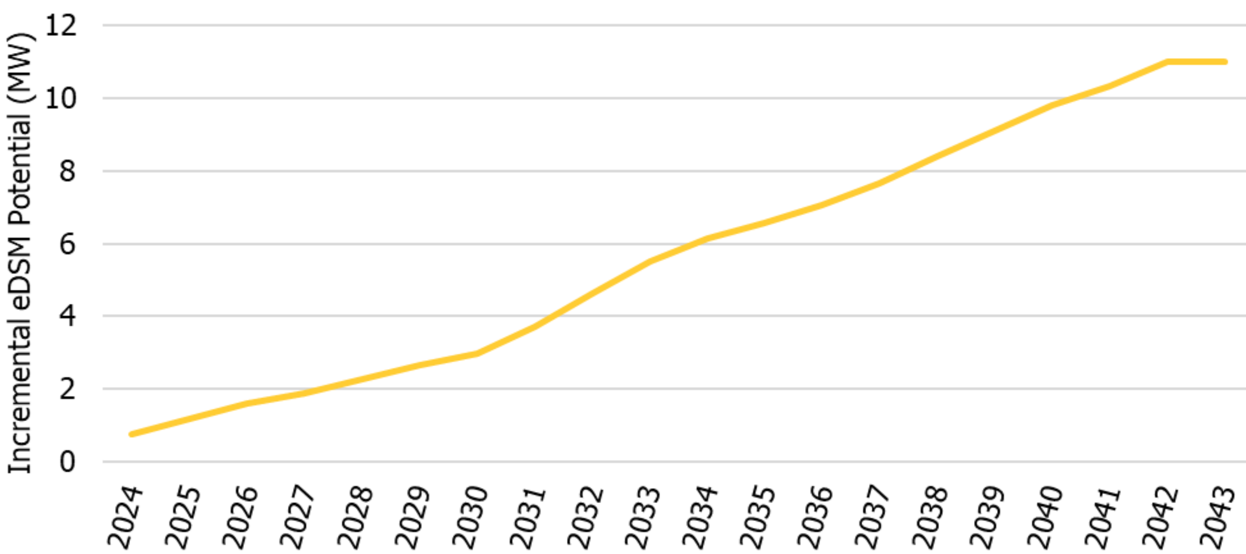
Non-wires Options

Since a cost-effective, integrated solution to address both needs is possible, all NWAs were screened out. However, since energy efficiency is important in managing demand in Ontario, the incremental eDSM potential for Lauzon TS DESN 2 was estimated. EDSM plays a key role in maximizing the useful life of existing infrastructure and maintaining reliable supply. The IESO is mandated to centrally deliver province-wide eDSM programs for Ontario that target businesses, residential customers, and First Nations communities. The IESO offers incentives and rebates to electricity customers through a suite of Save On Energy programs, which provide a valuable and cost-effective system resource that helps customers better manage their energy costs.

While eDSM does not address the asset replacement need, it could be used to meet approximately 11 MW of the 40 MW need at Lauzon TS, as shown in Figure 24. The eDSM can be targeted to Lauzon TS DESN 2 customers using regional adders to encourage uptake in areas where transmission constraints exist, as well as targeted local programming, both of which are delivered by the IESO through the Save On Energy brand. The cost of eDSM is estimated to be $50M; however, this was assumed to be cost-effective to the system, meaning that there is a net benefit when comparing the program investment (cost) against the provincial average avoided costs of providing electricity (benefit).

There are other potential benefits to NWAs, such as customer cost savings, maximizing the utilization of the existing electricity system, and reducing GHG emissions. As some of these other objectives may align with municipal energy plans in the region, this may be useful input for identifying the potential for projects and strategies at the local level, while identifying where electrical system benefits and infrastructure deferral value may also exist.

Figure 24 | Estimated Incremental eDSM Potential for Lauzon TS DESN 2



Long-term Considerations

Going forward, the need for additional transformation at Lauzon TS should be monitored. Under the High Forecast, other stations in the West Essex and Windsor sub-system – namely Keith TS and Malden TS – are forecast to develop station capacity needs. Monitoring load growth and implementing eDSM programs across the West Essex and Windsor sub-system will help to ensure that the electricity system is able to reliably meet future needs.

Recommendations

> Based on the Technical Working Group's analysis of the options to address the Planning Forecast, it is recommended to upsize the transformers at Lauzon TS DESN 2 to 180 MW LTR to meet both the asset replacement need and station capacity need at Lauzon TS.

This solution also facilitates load transfers from Belle River TS and can be used to serve new industrial developments in the area. The Technical Working Group should also monitor load growth across other stations in the sub-system.

7.3.2. West Essex and Windsor Supply Capacity Need

As presented in Section 6.2, there is a supply capacity need to the West Essex and Windsor sub-system.

Wires Options

To address the supply capacity needs of the West Essex and Windsor sub-system, transmission expansion options were evaluated. Two electrical pathways for additional transmission into the sub-system were considered: Lakeshore TS to Lauzon TS and Lakeshore TS to Keith TS. Transmission options focused on the path from Lakeshore TS to Lauzon TS, based on the location of the thermal limitation identified. The length of this transmission path is 32 km. This path is also identified in the non-wires options analysis as limiting the ability to connect large amounts of generation. Thus, options to reinforce this path would address the supply capacity need and improve deliverability at the same time. The option of reinforcing the existing transmission line to Lauzon TS, instead of constructing a new line, was also considered, but this option was ultimately rejected, since it would not provide sufficient capacity to meet the need.

The following wires options were evaluated:

1. A single-circuit 230 kV line from Lakeshore TS to Lauzon TS;
2. A double-circuit 230 kV line from Lakeshore TS to Lauzon TS; and
3. A single-circuit 500 kV line from Lakeshore TS to Lauzon TS.

For option one, the single-circuit 230 kV transmission line would increase the transfer capability by 360 MW, which can address the Planning Forecast need and account for changes in generation supply. Based on preliminary estimates, this option is expected to cost $120M. This option falls within the scope of the Minister of Energy's existing direction that Hydro One Transmission (Order in Council 875/2022) develop and seek approvals for "a new 230 kV transmission line that connects the

Windsor area to the Lakeshore Transformer Station, including associated station facility expansions or upgrades required at the terminal stations.”. In addition, it can facilitate more connections at Lauzon TS and along the entire transmission corridor from Lakeshore TS.

For option two, the double-circuit 230 kV line increases the transfer capability by 510 MW, which addresses the Planning Forecast need and would help to serve additional loads beyond the Planning Forecast (e.g., if the High Forecast were to materialize). This option would also fall under the scope of existing direction to Hydro One Transmission (Order in Council 875/2022). This option is expected to cost between $235M but has additional benefits on top of the higher supply capability. The double-circuit option has the added benefit of providing improved redundancy and reliability, by allowing for outages to occur while still having one of the two circuits in-service to maintain supply. In addition, the connection of a double-circuit line at Lauzon TS would provide the opportunity to strategically locate the two termination points at the station to address some of the existing operational concerns at Lauzon TS identified in Section 6.5.

For option three, the 500 kV transmission line provides a comparable amount of transfer capability as option two, but is more expensive – estimated to cost between $350M. This is driven by the cost of higher voltage equipment, as well as the need to build a new 500 kV station with new autotransformers. Option three also limits new load connections to Lauzon TS instead of facilitating the growth along the entire corridor. Since the 500 kV transmission network is the backbone of the electricity system, the ability to connect directly to it is restricted. In addition, this option would essentially lock-in further load growth as needing to connect to Lauzon TS, limiting the location of economic development across the West Essex and Windsor sub-system. This option would also be beyond the scope of Order in Council 875/2022, potentially compounding the longer lead times assumed for a 500 kV transmission project.

Non-wires Options

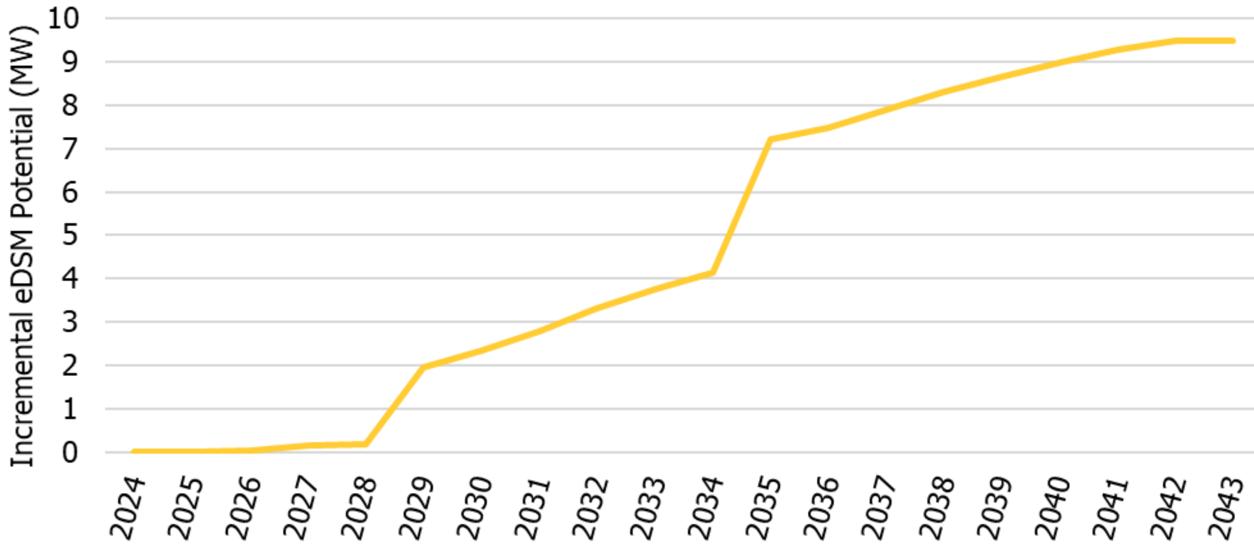
Due to the large magnitude of the West Essex and Windsor supply capacity, eDSM, demand response, and DG were not found to be adequate to resolve the needs. However, eDSM was considered as a cost-effective way to address near-term load growth. Thus, for the West Essex and Windsor supply capacity need, the following non-wires options were assessed:

1. eDSM; and
2. Transmission-connected generation at Lauzon TS.

As shown in Figure 25, eDSM can only provide 9 MW of the 230 MW need but can be used to support growth across the West Essex and Windsor sub-system at a cost of $35M, which is cost effective relative to system benefits. The IESO recently received an increased level of funding to support industrial energy efficiency.[23] The eDSM can be targeted to West Essex and Windsor customers using regional adders to encourage uptake in areas where transmission constraints exist, as well as targeted local programming delivered by the IESO through the Save On Energy brand.

[23] IESO Receives Natural Resources Canada Funding for Industrial Energy Efficiency

Figure 25 | Estimated Incremental eDSM Potential for West Essex and Windsor Industrial Developments



Transmission-connected generation options were sized to meet the need profile of 230 MW peak demand, 20 hours of maximum continuous energy, and 100,000 megawatt-hours (MWh) of maximum continuous energy. The following generation options were identified as meeting the need profile:

- 1,000 MW of wind with 270 MW / 2,700 MWh of Battery Energy Storage System (BESS); and
- 400 MW of solar with 220 MW / 1200 MWh of BESS.

A solar-only option was considered but did not meet the adequacy criteria to be able to meet the duration of the need from 2040 onwards. A wind-only solution was screened out due to the size of the summer need, a BESS-only solution was screened out due to the duration of the need, and implementation of a small modular reactor was screened out based on the size of the need and load characteristics. The combination of wind, solar, and BESS was considered, but this combination did not require any wind generation to meet the need.

Given the size of the resources needed to meet the need profile, all three transmission-connected generation options exceeded the connection capacity of the H53Z and H54Z circuits, and were, therefore, technically infeasible. They also require significant land-use in an urban area (ranging from 1,400 to 34,000 hectares), which would also limit space for economic development.

Long-term Considerations

The High Forecast indicates the need for additional supply into the West Essex and Windsor sub-region. If additional transmission is required, the termination of the transmission supply would depend on the location of economic development in the area. Options include expanding to existing stations in the area (Lauzon TS or Keith TS), or building a new station optimally located to supply multiple pockets of growth.

Options were considered to adapt the 230 kV wires options (options one or two), so that additional supply capacity could be available along the same infrastructure. One way would be to construct the option with 500 kV towers, so that the circuit(s) could be converted to the higher voltage in future, by replacing the conductors and insulators. However, this would restrict where load growth in West Essex and Windsor could occur, by concentrating supply transfer at Lauzon TS. Another possibility would be to construct half of the 230 kV wires option with 500 kV equipment, but operate it at the lower voltage until the optimal termination of the 500 kV circuit within West Essex and Windsor could be determined. However, these variations are cost prohibitive. In addition, it will be difficult to convert the line from 230 kV to 500 kV after it is in-service. The conversion would take an extended period of time, which would interrupt supply to a significant portion of existing loads in West Essex and Windsor for an unacceptable amount of time. This introduces the risk of increasing the upfront cost, overbuilding, and stranding assets in the future.

Future growth in the area beyond the Planning Forecast could be supported by additional transmission supply, but would need to consider any potential land limitations. The West Essex and Windsor sub-system – and the City of Windsor in particular – is prone to flooding and severe weather events. Surrounded by three bodies of water – Lake Erie, Lake St. Clair, and the Detroit River – the City of Windsor is known as one of Ontario's most flood-prone areas. Over the past decade, the city's low flood plain, along with an increase in the frequency of severe weather events, has contributed to a spike in major water damage for the region. These issues are expected to exacerbate further due to climate change. There is value in conducting a corridor study to consider diversification of supply, enable load and generation resources in the region, and provide redundancy between transmission pathways and station locations.

Recommendations

To meet the supply capacity need and support future growth in the area, it is recommended to build a new double-circuit 230 kV line from Lakeshore TS to Lauzon TS. Depending on the design and environmental assessment process, there may be an opportunity to integrate this solution with the recommendation for the Kingsville-Leamington sub-system. Furthermore, additional eDSM programs targeting the West Essex and Windsor sub-system are recommended.

According to the High Forecast, further transmission line reinforcements or local generation in West Essex and Windsor may be needed to enable additional industrial load growth. Due to land restrictions and uncertainty of load growth locations, a corridor study could help identify potential paths for transmission supply into the West Essex and Windsor area that best supply growth across the sub-system.

The Technical Working Group also recommends that a corridor study should be conducted to identify potential transmission paths into the sub-system to position the system to more quickly respond when higher growth materializes.

7.4. Kingsville-Leamington Sub-system Evaluation

This section evaluates options to address the station capacity, supply capacity and load restoration needs in the sub-system.

7.4.1. Kingsville-Leamington Greenhouse Development Station and Supply Capacity Needs

As described in Section 6.3, station and supply capacity needs were identified for the Kingsville-Leamington greenhouse loads. Options to address these needs are evaluated together in this section.

Interim Solution – Operational Measures

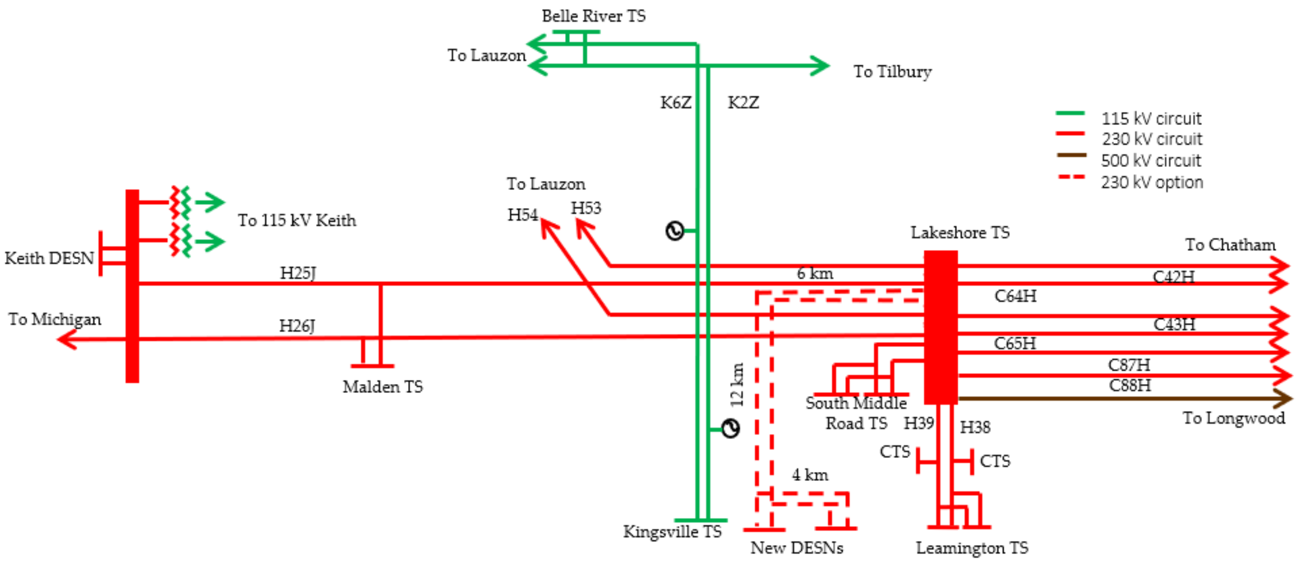
As discussed in Section 6.3.1.1, capacity needs are being addressed using the Lakeshore RAS in the interim, until the previously recommended bulk transmission reinforcements come in-service. Once the transmission reinforcements come into service over the 2028 to 2030 period, the Lakeshore RAS will no longer be needed to address the load security needs. By making the Lakeshore RAS redundant in the interim, the magnitude of loads potentially subject to the lower level of reliability is reduced.

As an interim solution, it is recommended that Hydro One Transmission explore options to modify the design of the Lakeshore RAS to make this operational measure more redundant and improve the near-term reliability in the Kingsville-Leamington sub-system.

Wires Options

The Technical Working Group evaluated the transmission wire option, which was previously recommended in the 2022 Windsor-Essex Addendum – to construct a new radial double-circuit 230 kV line from Lakeshore TS, connecting to two new DESNs. The locations of the DESNs have been estimated based on best available information from Hydro One Distribution, which may be updated during the RIP or subsequent design and environmental assessment work. Thus, the assumed length of the radial line is 22 km, comprising 18 km to the first DESN and 4 km to the second DESN. Figure 26 depicts the single line diagram of this option.

Figure 26 | Configuration of Option for New 230 kV TS and Connection Lines



This option fully addresses the sub-system's station capacity and supply capacity needs. It is expected to cost $210M, with an estimated implementation time between four and five years. This option facilitates both load and generation connections in the Kingsville-Leamington sub-system and allows offloading of the existing Kingsville TS.

This option also provides integration with other needs across the region. It will allow for Kingsville TS to be offloaded via distribution transfers, relieving the 115 kV network limitation discussed in Section 7.5. It provides additional connection capacity for greenhouse load, broader growth in the area and DG, which is otherwise limited in the sub-system. The wires option also enables the load restoration solution, as described in Section 7.4.2. Finally, it is possible that a portion of the transmission pathway for this option can be integrated with the recommended solution for addressing the West Essex and Windsor supply capacity (see Section 7.3.2). Depending on the subsequent design and environmental assessment process, there could be a portion of transmission line shared between these two recommendations west of Lakeshore TS, which would split into two separate paths– one toward Kingsville-Leamington and one toward Lauzon TS. The combined solution would optimize the use of the transmission infrastructure and provide further integration in the Windsor-Essex region.

The Technical Working Group also evaluated the possibility of using the existing radial supply lines to serve the load. However, the remaining capacity on these circuits is insufficient to meet the Planning Forecast. This approach would also exacerbate the existing load restoration concerns and would be limited by the length of the H75/H76 tap, as well as the physical constraints for expansion on the H38/H39 tap.

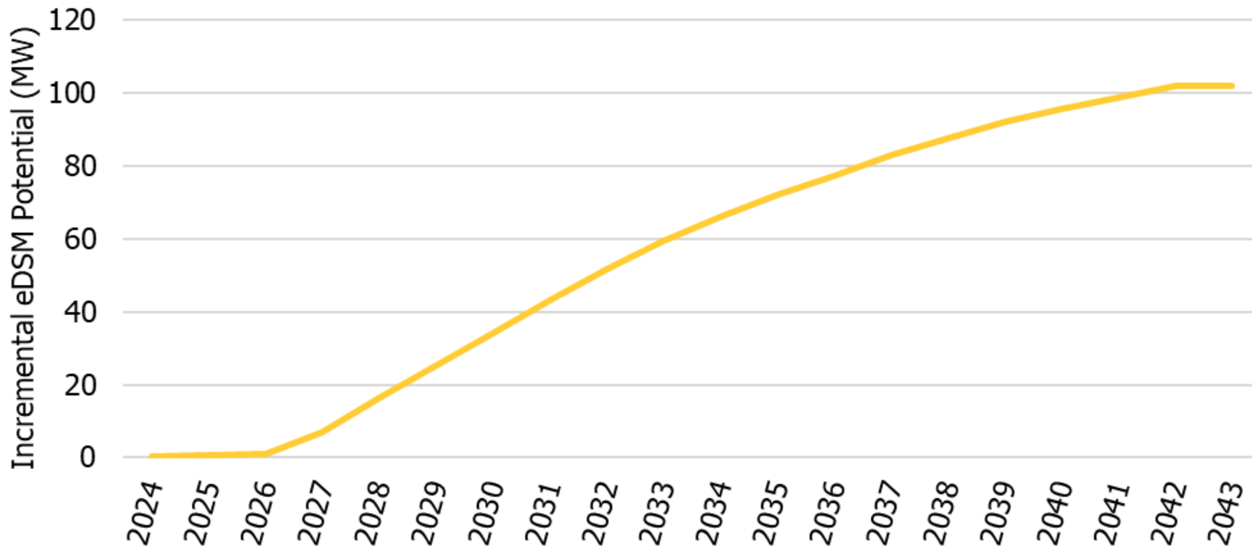
Non-wires Options

As presented in Section 7.2, the following non-wires options were screened in:

1. Energy efficiency (eDSM); and
2. Demand response.

Under the existing eDSM framework and programs primarily targeting greenhouses, up to 100 MW of the total 390 MW winter need can be addressed. The expected cost of achieving the full 100 MW of peak demand savings is $330M. As covered in Section 7.3, eDSM is important for managing demand in Ontario and plays a key role in maximizing the useful life of existing infrastructure and maintaining reliable supply. In the Kingsville-Leamington area, eDSM savings are primarily achieved through programs targeting greenhouse grow lights and greenhouse envelope improvements, which have a substantial impact in winter months (see Appendix E for more details).

Figure 27 | Estimated Incremental eDSM Potential of Kingsville-Leamington Greenhouse Loads



Demand response is an option to address the Kingsville-Leamington station capacity and supply capacity needs. However, a new local program would be required, since the local need profile is not aligned with the design of the provincial procurement. This would require its own procurement process and a unique, local activation system. It is expected that such a program would take two to three years to implement. While there are no cost benchmarks for this type of solution, it is expected that a demand response solution would be more expensive than leveraging the existing eDSM framework and programs in the area.

Demand response among the greenhouse loads in the Kingsville-Leamington sub-system would be feasible through use of a third-party aggregator to allow participation of all the loads in the area. Greenhouses could participate in demand response by reducing the use of grow lights during the daytime in winter months. Based on information provided by OGVG, the potential greenhouse peak demand reduction is in the order of tens of megawatts during winter daytime periods. Figure 28 shows the heat map of the hourly winter need for December 2043, overlaid with the expected magnitude and timing of demand response (“DR Potential”). Figure 29 shows the 2043 hourly summer need, represented by July. No greenhouse demand response was indicated to be possible in the summer.

Figure 28 | Heat Map of Kingsville-Leamington Need in December 2043

MW of Need	Percentage of Winter Days Exceeding Need at Specified Hour																						
500	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
444	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
389	0%	0%	0%	0%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
333	0%	0%	0%	13%	42%	48%	52%	52%	52%	19%	19%	19%	19%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
278	0%	52%	52%	58%	74%	87%	100%	100%	100%	77%	45%	45%	45%	42%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
222	32%	97%	100%	100%	100%	100%	100%	100%	100%	100%	55%	48%	52%	58%	48%	0%	0%	0%	0%	0%	0%	0%	0%	0%
167	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	42%	0%	0%	0%	0%	0%	0%	39%	52%
111	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	48%	0%	0%	0%	0%	52%	100%	100%
56	100%	100%	100%	100%	100%	100%	100%	100%	DR Potential								100%	100%	100%	100%	100%	100%	100%	100%
0	100%	100%	100%	100%	100%	100%	100%	100%	DR Potential								100%	100%	100%	100%	100%	100%	100%	100%
HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
								Sunrise									Sunset							

Figure 29 | Heat Map of Kingsville-Leamington Need in July 2043

MW of Need	Percentage of Summer Days Exceeding Need at Specified Hour																						
500	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
444	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
389	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
333	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
278	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
222	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
167	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
111	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
56	0%	0%	0%	0%	1%	2%	3%	4%	4%	4%	4%	4%	4%	4%	4%	3%	2%	1%	0%	0%	0%	0%	0%	0%
0	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

As shown in these heat maps, the winter need peaks between 5 AM and 6 AM, whereas the demand response potential is available between 8 AM and 4 PM. Furthermore, the winter need persists 24 hours per day, which does not align with a demand response program's ability to deliver short-term capacity relief. Finally, while the magnitude of need in the Kingsville-Leamington sub-system is greatest in winter, a summer need persists which would not be addressed by the demand response option.

Long-term Considerations

The High Forecast indicates additional station capacity needs in the Kingsville-Leamington sub-system, if agricultural load growth in the region accelerates. Up to six additional supply stations would be required to meet the 930 MW of additional greenhouse growth in the High Forecast. The placement of these supply stations would be sited depending on the location of the growth. It is also possible that some of the growth materializes within southwestern Ontario but would be situated outside of the Windsor-Essex region. Should higher growth occur within the Windsor-Essex region, supply connection lines to the upstream 230 kV corridor, as well as connections between the existing supply stations, will be required to enable this capacity. The Technical Working Group will continue to monitor growth to enable the required supply stations and connections as required.

Recommendations

> The recommended option to address the station capacity, supply capacity, and load restoration is the integrated wires option of a 22 km double-circuit 230 kV transmission line from Lakeshore TS serving two new transformer stations in the Kingsville-Leamington area.

This solution is depicted in Figure 26. Depending on the design and environmental assessment process, there may be an opportunity to integrate this solution with the recommendation for the West Essex and Windsor sub-system.

It is recommended to continue the existing eDSM programs in the Kingsville-Leamington area to increase capacity in the sub-system and provide broader system benefits.

Considering the uncertainty among the forecast drivers in the region and the potential for increased eDSM targets under the new 2025-2036 eDSM Framework, the Technical Working Group will continue to monitor growth in the region to determine whether sector trends and connection requests indicate a need for development beyond the Planning Forecast.

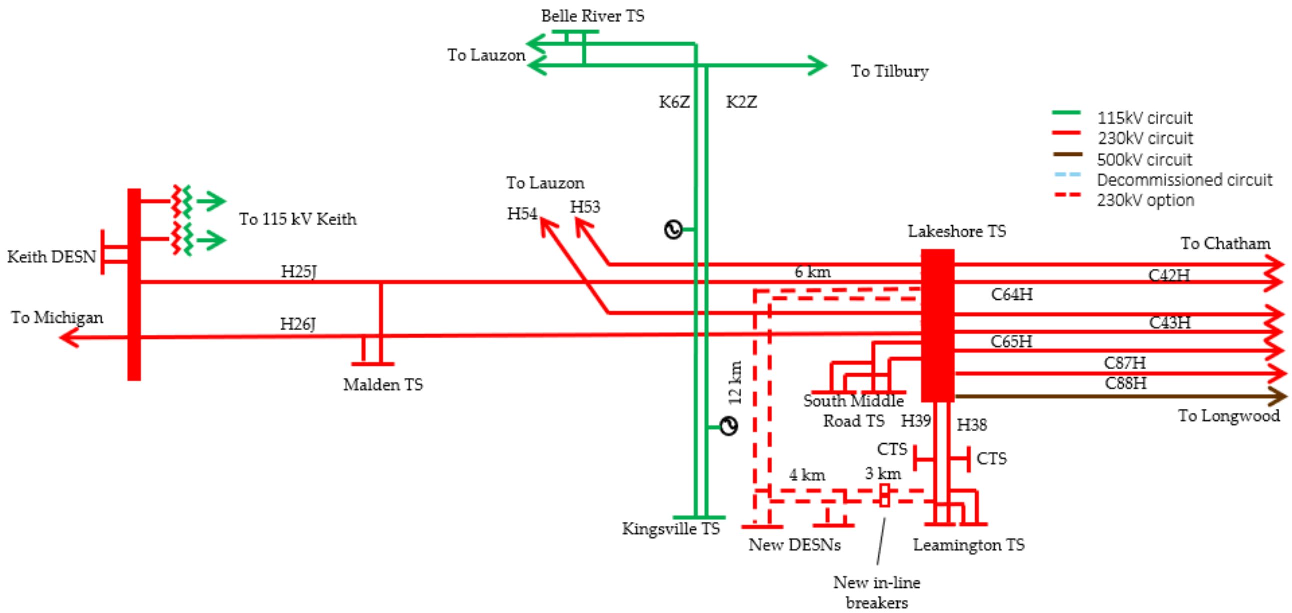
7.4.2. Leamington TS Load Restoration and Security Needs

The load restoration need for the supply circuits toward Leamington TS is evaluated in this section. As discussed in Section 6.3.1.1, load security will be addressed by ongoing transmission reinforcements in the area; thus, no load security needs are identified in this sub-system.

Wires Options

Figure 30 shows the integrated wires option to address the load restoration need – a double-circuit 230 kV transmission line connecting the existing H39/H39 circuits with the wires solution to address the station capacity and supply capacity needs in the sub-system. Under the Planning Forecast scenario, in-line breakers would be required in a normally open position to operate the load restoration lines. This provides a benefit to the broader Kingsville-Leamington sub-system, since the solution provides improved flexibility to restore supply to loads under a variety of outages and contingencies. However, under specific outage scenarios (e.g., peak winter load), not all customers will be restored. Since the specific loads that can be restored cannot be guaranteed, there is a broader benefit to this option for all load in the sub-system.

Figure 30 | Integrated Solution to Address Kingsville-Leamington Station Capacity, Supply Capacity, and Load Restoration Needs



The pathway and length of the load restoration lines are subject to future design work and the environmental assessment process. Based on best available information from Hydro One Distribution regarding the expected location of new DESNs, the load restoration lines are estimated to be three kilometres long. The portion of the integrated solution addressing the load restoration needs in the Kingsville-Leamington sub-system is expected to cost $30M.

Non-wires Options

Due to the nature of planning criteria outlined in ORTAC 7.2, non-wires options such as eDSM, demand response, and DG cannot be applied to load restoration needs because they do not restore the connection of loads to the bulk transmission system. Thus, non-wires options are infeasible for load restoration needs. However, as noted in the 2022 Windsor-Essex IRRP Addendum study, there may be value in pilot projects or other demonstration projects to help meet the sub-systems load restoration needs using NWAs – in addition to constructing the load restoration line.

Long-term Considerations

The projected load flows under the Planning Forecast require that the load restoration lines are operated with normally open in-line breakers. However, the High Forecast indicates the potential need for additional supply stations and lines in the Kingsville-Leamington sub-system. In this scenario, the optimal configuration would be to convert the radial supply lines into a transmission loop. This would require unique connections to the upstream transmission system on either end of the supply lines (i.e., at Lakeshore TS and another supply station west or east of Lakeshore TS, depending on the location of additional growth in this area). This would support new supply stations, allow for redundant supply, and address the load restoration needs. There may be opportunities to integrate this with the High Forecast transmission options for the West Essex and Windsor sub-system, if both paths are aligned.

Recommendations

The recommended option to address the load restoration need is the integrated wires option: the 3 km double-circuit 230 kV transmission line connecting the existing H39/H39 circuits to the new supply stations and connection lines recommended in the previous section, as shown in Figure 30.

7.5. Lakeshore/Tilbury Sub-system Evaluation

The station capacity needs at Belle River TS and Tilbury West DS are evaluated in this section.

7.5.1. Belle River TS Station Capacity Need

As described in Section 6.4.1, a station capacity need was identified at Belle River TS. This section evaluates the wires and non-wires options to address that need.

Wires Options

For the Belle River TS station capacity need, the following wires options were evaluated:

1. Load transfers on the distribution system;
2. Upsize transformers at Belle River TS; and
3. New DESN at Belle River TS.

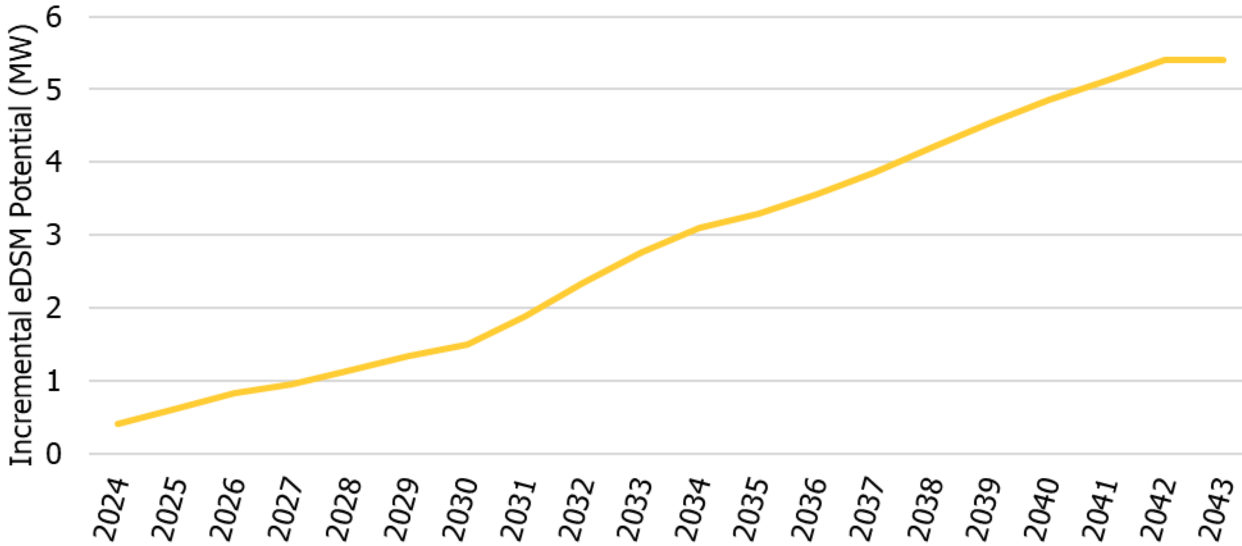
Option one is to leverage capacity on the existing transmission system to transfer load from Belle River TS to nearby stations, namely Lauzon TS DESN 1 and DESN 2. The planned upsizing of Lauzon TS DESN 1 from 100 MW to 180 MW LTR in 2025 will enable load transfers on the distribution system from Belle River TS to Lauzon DESN 1 to meet some of the station capacity need. Similarly, the recommended solution to address the end-of-life and station capacity need of Lauzon TS DESN 2 will also result in upsized transformers, which will enable additional load transfers on the distribution system to fully meet the Belle River TS station capacity need. This solution is expected to cost between $10M and $15M to implement. The load transfers are expected to take place between 2026 and 2031, considering the timing of upsizing Lauzon DESN 1 in 2025 and Lauzon DESN 2 in 2029.

Option two is to upsize the DESN at Belle River TS from 53 MW LTR to 100 MW LTR, which is estimated to cost between $15M and $30M. Option three is to construct a new 100 MW LTR DESN at Belle River TS, which is estimated to cost $60M. Both options two and three are expected to take between three and five years. These options also provide additional capacity beyond the Belle River TS need; however, this capacity cannot be utilized due to upstream capacity limitations.

Non-wires Options

New eDSM programs in the area could meet 5 MW of the 17 MW need over the 20-year period, as illustrated in Figure 31. The estimated cost of achieving these eDSM savings is $18M, which is considered cost effective to the system. However, previous eDSM programs targeting loads at Belle River TS have had less than expected impact, reflecting challenges targeting programs to relatively small areas and predominantly residential load composition. Consequently, there is a higher level of uncertainty with this option.

Figure 31 | Estimated Incremental eDSM Potential for Belle River TS



Long-term Considerations

Load growth beyond the Planning Forecast may require additional supply to the Lakeshore/Tilbury 115 kV sub-system. Options for increasing future supply in the region include new 115 kV circuits, a 230 kV conversion, or new 230 kV supply, depending on the level of growth anticipated and the cost effectiveness of these solutions to meet the projected need. Long-term considerations in the Lakeshore/Tilbury sub-system are also interrelated with options to supply the Kingsville-Leamington sub-system, since options to offload Kingsville TS loads onto the 230 kV system could alleviate supply concerns on the 115 kV system.

Recommendations

In the interim, operational measures, such as loading the transformer beyond its LTR, can be used to manage this need until the wires solution is in place.

In the near term, the recommendation to address the Belle River TS station capacity need is to transfer load through the distribution system to the upsized Lauzon TS DESN1 and DESN2 by 2031. This work may commence after Lauzon TS DESN1 has been upsized in 2025, but is expected to take an additional one to two years to complete after Lauzon TS DESN2 has been upsized in 2029.

7.5.2. Tilbury West DS Station Capacity Need

As described in Section 6.4.1, a station capacity need was identified at Tilbury West DS. This section evaluates the wires and non-wires options to address that need.

Wires Options

To meet the Tilbury West DS station capacity need, load transfers are not feasible since load could only be transferred to Belle River TS, which already has a capacity need. The remaining wires options assessed are:

1. Upsize transformers at Tilbury West DS; and
2. New DESN at Tilbury West DS.

For option one, upsizing the transformers at Tilbury West DS would increase the summer LTR from 28 MW to 53 MW. This is estimated to cost between $15M and $30M and take three to five years to implement. This option also improves reliability and resiliency in the area by increasing the capability to transfer load on the distribution system in the event of an outage.

Option two is a new 100 MW LTR DESN. This is more expensive than option one. It is estimated to cost $60M and would take the same amount of time as option one to implement. This option was determined to be infeasible, since upstream limitations would mean that this capacity cannot be fully utilized and would be a stranded asset.

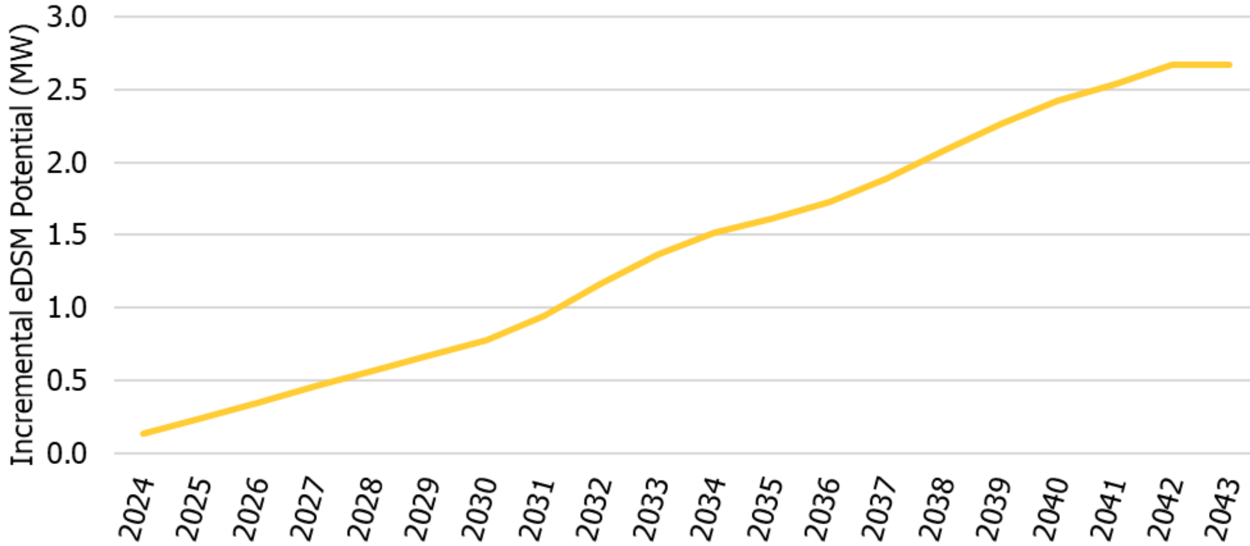
Non-wires Options

For Tilbury West DS, the following non-wires options were assessed:

1. eDSM; and
2. DG.

eDSM programs targeting load supplied by Tilbury West DS could meet 3 MW of the 13 MW need over the 20-year period, as illustrated in Figure 32. The eDSM can be targeted to Tilbury West DS customers using regional adders to encourage uptake in areas where transmission constraints exist, as well as targeted local programming delivered by the IESO through the Save On Energy brand. The estimated cost of achieving these eDSM savings is $8M, which is considered cost effective to the system.

Figure 32 | Estimated Incremental eDSM Potential for Tilbury West DS



By 2043, the need profile for Tilbury West DS peaks at 13 MW, requires 91 hours of maximum continuous demand, and approximately 600 MWh of maximum continuous energy supplied. Based on the characterization of the need, the following DG solutions were screened in:

- Combined wind and BESS solution;
- Combined solar and BESS solution; and
- Combined solar, wind, and BESS solution.

Wind as a standalone option was screened out due to the land requirements combined with the maximum continuous hours of need. Solar as a standalone option was screened out since it could not meet the winter and overnight needs. BESS as a standalone solution was screened out based on the continuous hours of the need and magnitude of energy for these hours. Small modular reactors were screened out, since the need size does not warrant this type of technology.

Among the screened-in generation options, the following solutions were sized to meet the need:

- 22 MW of wind and 26 MW / 250 MWh of BESS;
- 60 MW of solar and 26 MW / 250 MWh of BESS; and
- 20 MW of wind, 8 MW of solar, and 24 MW / 230 MWh of BESS.

All three DG options exceed the DG connection capacity at Tilbury West DS, which currently has a thermal capacity limit of 19 MW. Furthermore, there are connection restrictions downstream of the 115 kV K2Z circuit due to inverter-based resource limitations, as well as the fact that this circuit has a limited ability to deliver resources to the rest of the province. In particular, Tilbury West DS has a low short-circuit ratio, which limits its capability to connect new inverter-based resources. In addition, these options have a large land requirement of between 200 and 770 hectares. If these solutions were feasible, they would be expected to take between four to six years to implement.

Long-term Considerations

Long-term considerations for this need are discussed in Section 7.5.1.

Recommendations

The recommendation to address the Tilbury West DS station capacity need is to upsize transformers at Tilbury West DS to 25/41.7 MVA (rated for 53 MW LTR) to meet the need by 2036.

Given that this option would take three to five years to implement, while the need emerges in 2036, the Technical Working Group recommends load monitoring. This way, upsizing the transformer can be triggered when needed, or revisited in the next cycle of regional planning.

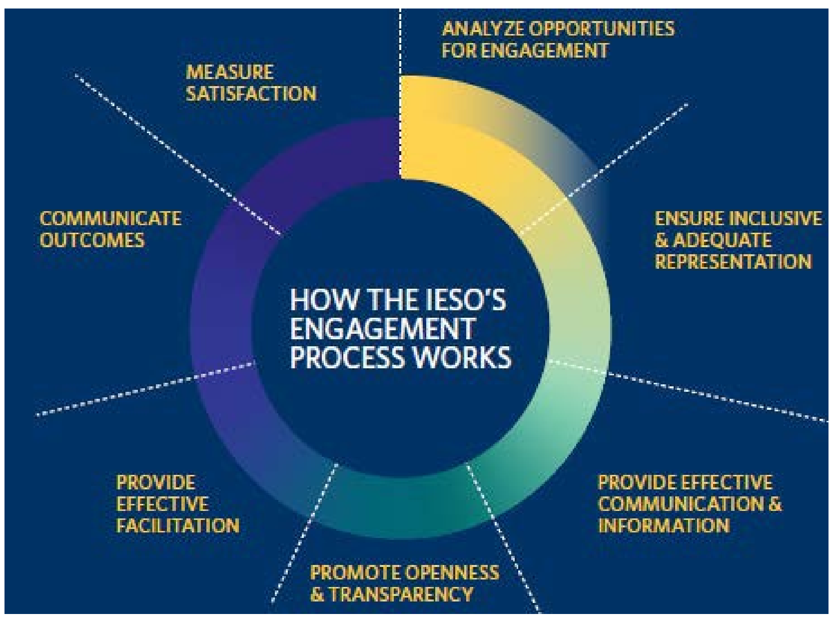
8. Community and Stakeholder Engagement

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 Indigenous communities, market participants, municipalities, stakeholders, 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 as well as the activities undertaken to date for the Windsor-Essex IRRP.

8.1. Engagement Principles

The IESO's External Relations Engagement Framework and the Indigenous 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 33 | The IESO's Engagement Principles



8.2. Engagement Approach

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

- Leveraging the Windsor-Essex engagement webpage to post updated information, engagement opportunities, meeting materials, input received and IESO responses to feedback,
- Targeted discussions with municipalities and associations to help inform the engagement approach for this planning cycle and to understand feedback and perspectives at key milestones,
- 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 this round of planning, and to continue to build relationships and dialogue in this region from past engagements. This started with the Scoping Assessment Outcome Report for the Windsor-Essex region. An invitation was sent to targeted Indigenous communities, municipalities, 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 Windsor-Essex region Scoping Assessment Report finalization. A public webinar was held in April 2023 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 May 2023, identifying the need for a coordinated regional planning approach and an IRRP.

Following finalizing the Scoping Assessment, several targeted outreach meetings began with municipalities and associations in the region to inform early discussions for development of the IRRP, including the IESO's approach to engagement and to ensure growth, electrification, and development plans have been accurately captured in the Technical Working Group's draft demand forecast scenarios. The launch of a broader engagement initiative followed, with an invitation to IESO subscribers of the Windsor-Essex 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, municipalities, associations, businesses, and other stakeholders, and written feedback was collected over an approximately three-week comment period after each webinar.

The three stages of engagement at which input was invited:

1. The draft engagement plan, and electricity demand forecast scenarios – 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 were primarily focused on:

- Ensuring key areas of growth in specific pockets in the Windsor-Essex region (including lands designated for industrial developments and planned agricultural developments) have been considered and accounted for in the IRRP work;
- Ensuring infrastructure development matches future potential growth; and
- Keeping lines of communication following the plan completion to share information and updates.

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 Windsor-Essex 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 and employment areas as outlined in the updated Windsor-Essex region Official Plan). This insight has been valuable to the IESO – it supported an understanding of local growth and accurate electricity demand forecast scenarios, the determination of needs, and the recommendation of solutions to ensure adequate and reliable long-term supply. To that end, ongoing discussions will continue to keep interested parties engaged in a two-way dialogue on local developments, priorities, and initiatives to prepare for the next planning cycle.

All background information, including engagement presentations, recorded webinars, detailed feedback submissions, and responses to comments received, are available on the IESO's Windsor-Essex IRRP engagement webpage.

8.4. Bringing Municipalities and Associations to the Table

The IESO held meetings with municipalities and association 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, and associations in the region to discuss key issues of concern, including ensuring infrastructure development matches growth, options for meeting the region's future needs, and broader community engagement. These meetings helped to inform the development of the forecast scenarios, 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, including, but not limited to the following feedback:

- Strong population growth across the Windsor-Essex region based on 2051 growth projections and in some areas above and beyond the regional forecast.
- The County of Essex zoning plans for residential and employment lands.
- Residential growth in the Town of LaSalle due to new residential development.
- The City of Windsor plans for residential development, energy conservation, and industrial expansion.
- The Municipality of Leamington's expected residential growth and indications of greenhouse developments in the region.
- The Town of Amherstburg's residential growth forecasts and industrial development lands.

- The Town of Essex's residential growth forecast and employment lands for industrial development.
- The Town of Kingsville's planning applications for residential units, municipal infrastructure plans, greenhouse development expectations, and expected trend for electricity demand.
- The Town of Lakeshore's residential growth forecast, industrial developments, and agricultural development lands.
- The Town of Tecumseh's residential development plans.
- New development and growth projects identified by Invest WindsorEssex.
- Expected growth rate in the greenhouse sector based on Ontario Greenhouse Vegetable Growers.

8.5. Engaging with Indigenous Communities

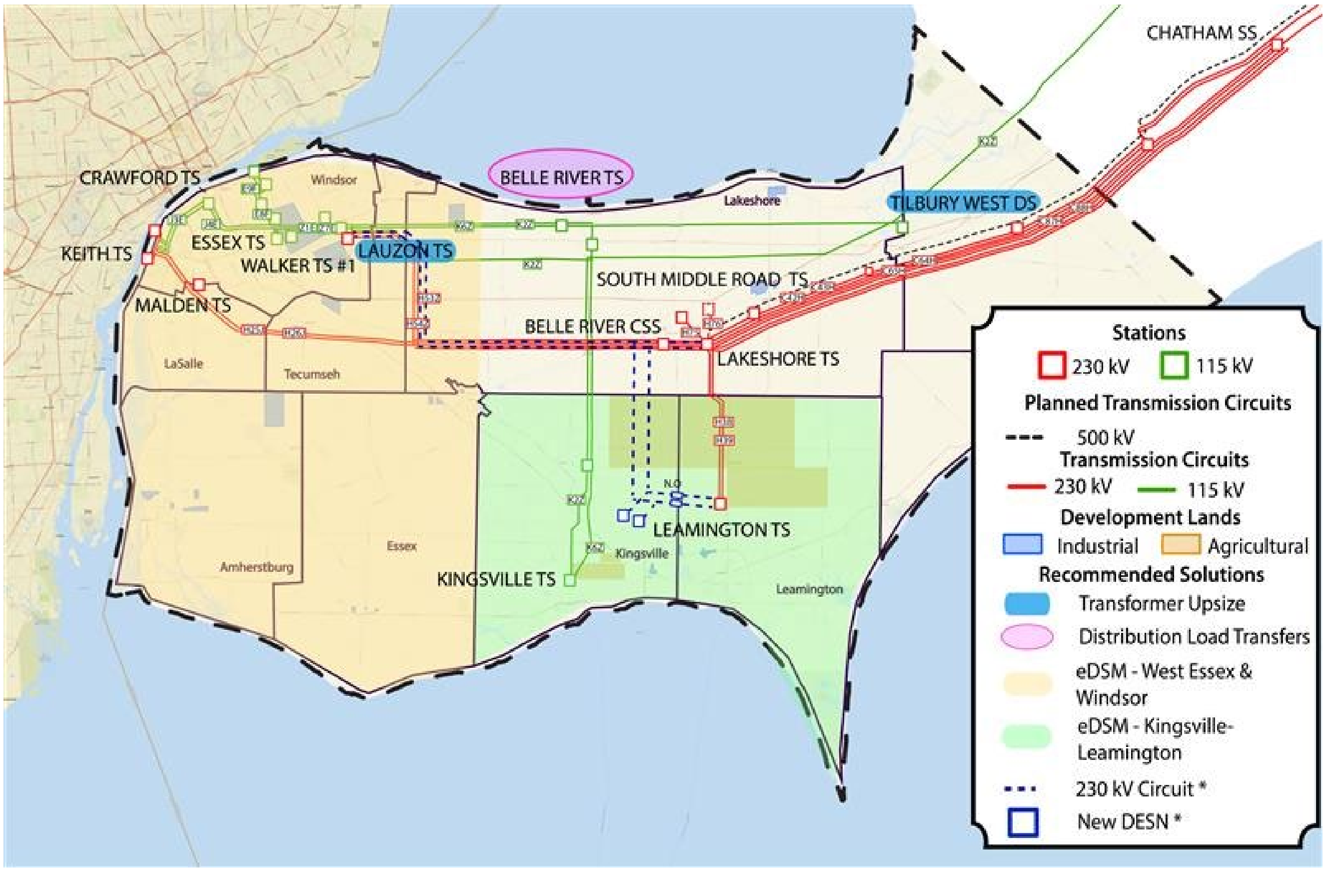
To raise awareness and share information about the regional planning activities underway and invite participation in the engagement process, regular outreach including extending the opportunity to meet one-on-one was made to Indigenous communities within the Windsor-Essex region throughout the development of the plan. This includes the communities of the Aamjiwnaang First Nation, Caldwell First Nation, Chippewas of Kettle and Stony Point First Nation, Chippewas of the Thames First Nation, Eelŭnaapéewi Lahkéewiit Delaware Nation, Munsee-Delaware Nation, Oneida Nation of the Thames, Walpole Island First Nation.

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

9. Conclusion

The Windsor-Essex IRRP identifies electricity needs in the region over the 20-year period from 2024 to 2043, recommends a plan to address immediate and near-term needs, and lays out actions to monitor long-term needs. Figure 34 visually depicts these recommendations across the region.

Figure 34 | Overview of Recommended Solutions for the Windsor-Essex IRRP



In the interim, operational measures can be used to support growth in the region through the use of operating ratings and improving the redundancy of the Lakeshore RAS. The Technical Working Group also recommends targeting eDSM programs in the Kingsville-Leamington and West Essex and Windsor sub-systems to support both near-term and long-term growth.

In the near term, the Technical Working Group recommends upsizing the transformers at Lauzon TS DESN 2 and transferring loads on the distribution system from Belle River TS to Lauzon TS. The Technical Working Group also recommends constructing two new transformer stations in the Kingsville-Leamington sub-system with a double-circuit 230 kV transmission line connection from Lakeshore TS, along with a double-circuit 230 kV transmission line linking the new connection lines to H38/H39 with normally open breakers for load restoration.

In the medium-term, a new double-circuit 230 kV transmission line from Lakeshore TS to Lauzon TS is recommended to support growth in the West Essex and Windsor sub-system. Depending on the subsequent design and environmental assessment process, there may be an opportunity to integrate this recommendation with the 230 kV double-circuit line into Kingsville-Leamington recommended in the near term.

In the long term, the Technical Working Group recommends upsizing the transformers at Tilbury West DS. Finally, the Technical Working Group recommends exploring the scope and value of a corridor study to identify future transmission paths into the West Essex and Windsor sub-system.

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. The Technical Working Group will continue to monitor growth across the region to determine if or when further reinforcements will be needed. This includes any future community energy plans, electrification trends, customer connection queues, changes to local generation, and changes to eDSM programs. The Technical Working Group will meet at regular intervals to monitor developments and track progress toward plan deliverables. If 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.