Need for Bulk System Reinforcements West of London

September 2021

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List of Abbreviations

AAR	Annual Acquistion Report
APO	Annual Planning Outlook
CAD	Canadian
CDM	Conservation Demand Management
CEATI	Centre for Energy Advancement through Technological Innovation
CEP	Community Energy Plan
CHP	Combined Heat and Power
CONE	Cost of the Marginal New Resource
DE-HPS	Double-Ended High-Pressure Sodium
DESN	Dual Element Spot Network
DG	Distributed Generation
DS	Distribution Station
FIC	Flow into Chatham
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GS	Generating Station
HCCC	Haundenosaunee Confederacy Chiefs Council (HCCC),
HDI	Haundenosaunee Development Institute (HDI)
IESO	Independent Electricity System Operator
IRRP	Integrated Regional Resource Plan
kV	Kilovolt
LDC	Local Distribution Company
LED	Light Emitting Diode
MECP	Ministry of Environment, Conservation and Parks
MTS	Municipal Transformer Station
MW	Megawatt
NERC	North American Electric Reliability Corporation
NPCC	Northeast Power Coordinating Council
NPV	Net Present Value
OEB	Ontario Energy Board
OGVG	Ontario Greenhouse Vegetable Growers Association
OR	Operating Reserve
ORTAC	Ontario Resource and Transmission Assessment Criteria
RAS	Remedial Action System
SCGT	Simple Cycle Gas Turbine
SECTR	Supply to Essex County Transmission Reinforcement
SIA	System Impact Assessment
SS	Switching Station
TS	Transformer Station
UCAP	Unforced Capacity
USD	United States dollars
WOC	West of Chatham
WOL	West of London

1. Executive Summary

This report documents the results of a planning study the IESO has undertaken to assess the reliability of the bulk transmission system in the West of London (WOL) area. The WOL area encompasses a 230 kV and 115 kV high voltage network in southwest Ontario, stretching 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. This system interconnects large generators in the Lambton-Sarnia and Windsor areas, with existing load centres and encompasses the growing Kingsville-Leamington and Chatham-Kent areas. It provides four interconnection points with Michigan's power system via Windsor and Lambton-Sarnia. The area is also connected to the 500 kV system at Longwood TS, within the Municipality of Strathroy-Catadoc near the City of London, providing a strong path between the WOL area and the rest of the province.

Electricity demand in Windsor-Essex and the Chatham-Kent area (referred to as the "Focus Area") within WOL is growing at a rapid pace. This growth 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 agricultural sector. The agricultural sector demand in the Focus Area is expected to increase from a winter peak of roughly 500 MW today to 2,300 MW in 2035 – this is the electrical equivalent of adding a city the size of Ottawa. Due to this rapid growth, planning in southwestern Ontario has been occurring on a continuum over the last five years. In 2019, the IESO released the 2019 Windsor-Essex bulk study, which made recommendations for supplying this growing demand. This report is the latest in a line of ongoing analysis at the bulk system and regional level.

Based on the reference forecast, and assuming the transmission recommendations from the 2019 Windsor-Essex bulk study come into service as planned, there will still be a winter need for additional supply to the Focus Area starting in 2024 that reaches 2,050 MW by 2035. This supply need assumes that when generation contracts expire, the resources are not reacquired, and export capability on the Ontario-Michigan intertie, J5D, is maintained with all transmission elements in-service. Typically, the system is planned to maintain export capability when all transmission elements are in service, not when transmission elements are out of service. The supply need is specified assuming resources are not reacquired since reacquisition is a decision that should be made as per the IESO's Resource Adequacy Framework and should not be presupposed. Hence, the statement of supply need should not assume resources are reacquired.

In response to this growing need, the IESO has adopted a multi-pronged approach using a combination of transmission reinforcements, resources, and targeted energy efficiency programs.

Due to the lead time required to implement solutions to provide the additional supply required and support the economic growth in the near-term (2021-2027) and mid-term (2028-2029), the IESO recommended actions ahead of the publication of this report. This report will provide the need and rationale for the actions taken by the IESO, which were:

- On March 26, 2021, the IESO sent a letter to the lead transmitter in the region, Hydro One Networks Inc. ("Hydro One"), in order to inform them of the need for a new 230 kV double circuit line from Lambton TS southwards to Chatham SS (Lambton South line) and associated station facility expansions or upgrades required at the terminal stations. While Hydro One will initiate the work, engagement and related activities, it will be subject to all required Environmental Assessment, regulatory (e.g., Leave-to-Construct), and other approvals and permits; and
- On July 19, 2021, the IESO indicated, through the Annual Acquisition Report (AAR), an intention to begin bilateral negotiations for Brighton Beach Generating Station. This is an existing facility supporting the area's needs today, that has been identified as required to continue supporting this immediate localized need in the near-term until the transmission line recommended in the March 26, 2021 letter is in-service.

These actions will provide the required supply to the domestic load up to the year 2030. With these actions taken, the winter supply requirement for the Focus Area reduces from 2,050 to 1,100 MW in the year 2035.

To deliver the 1,100 MW of required supply, this plan recommends a single circuit 500 kV transmission line from Longwood TS to Lakeshore TS, as well as 550 MW of local resources. The transmission line is required to be in service by 2030. The 550 MW of local resources is the total amount required by 2035, where the requirement progressively increases up to this level starting in 2030. It can be met by reacquiring resources that exist today whose contracts have expired between now and 2035, and/or by acquiring new resources.

The IESO is committed to transitioning to the long-term use of competitive resource acquisition mechanisms to meet Ontario's reliability needs. As such, the long-term resource requirement for 550 MW will be met by using the mechanisms outlined in the IESO's Resource Adequacy Framework, which will be outlined in future AARs.

The IESO will work with entities applying to the Ontario Energy Board (OEB) to become the transmitter for this project as well as stakeholders and communities, to implement the recommended 500 kV transmission line.

This planning report also identifies interdependencies between this provincial/bulk level plan and the regional electricity plan being developed in parallel with local distribution companies (LDCs) in the area – through the on-going Windsor-Essex Regional Addendum study and Chatham-Kent/Lambton/Sarnia regional planning cycle. In particular, depending on where the 550 MW of recommended capacity is located within the Focus Area, a double circuit 230 kV transmission line between Windsor and Lakeshore may be needed to address local reliability issues and maintain interchange capability with Michigan under all elements in-service. Furthermore, the IESO will continue to monitor and explore opportunities for conservation efforts targeted to the Focus Area, including cost-effective energy efficiency measures and pilot projects that help mitigate needs and manage reliability issues until bulk reinforcements are in-service.

Finally, in addition to the reliability of the supply to the Focus Area, this report also explores the reliability of the supply to the larger WOL area, which encompasses the Focus Area. A review of the supply to WOL area was necessary not only because of the forecast load growth in the Focus Area, but also because 85% of the nearly 5,000 MW of supply resources within WOL have contracts expiring by the end of the decade.

The study of the supply to the broader WOL area concluded, that 1,425 MW of local resources must be acquired in the WOL area to reliably supply the region in 2035, where the requirement progressively increases up to that level starting in 2030. This is in addition to what was recommended in this report to supply the Focus Area. Similar to the recommendations made for the Focus Area, the need for 1,425 MW in WOL will be included in future AARs, can be met by reacquiring resources that exist today whose contracts have expired between now and 2035 and/or by acquiring new resources, and will be addressed using the IESO's Resource Adequacy Framework.

2. Introduction

Electricity planning in Ontario typically occurs on a cyclical basis. However, due to the rapidly growing agricultural sector, planning in southwestern Ontario has been occurring on a continuum over the last five years, with no signs of slowing down. Over the course of that time, the IESO has recommended supply lines to Leamington, two load stations at Leamington (Leamington TS DESN 1 and 2) with two more under development in Lakeshore (South Middle Road TS DESN 1 and 2), a new switching station at Leamington Junction (Lakeshore TS[1]) and a new 230 kV double circuit line from Chatham SS to the new Lakeshore TS.

The 2019 Windsor-Essex bulk study recommended Lakeshore TS and the new line from Chatham SS to Lakeshore TS to address bulk transmission system limitations west of Chatham, between Chatham SS and the Kingsville-Leamington area. These recommendations would increase the overall transfer capability of the bulk transmission system west of Chatham in order to reliably supply the forecast load growth in the Kingsville-Leamington area and Windsor-Essex region. At that time, transmission system constraints east of Chatham were also identified but additional assessments (this study) were required before further bulk recommendations could be made.

Agricultural electricity demand primarily concentrated in the Windsor-Essex region and in the community of Dresden within Chatham-Kent (referred to as the "Focus Area" for the purposes of this report) is expected to grow from a winter peak of roughly 500 MW to 2,300 MW between now and 2035 – the electrical equivalent of adding a city the size of Ottawa. Further, there is a significant amount of resources within the broader West of London area, 85% of which have contracts expiring by the end of the decade. As such, a review of the bulk transmission system in WOL is necessary at this time, primarily to ensure adequate supply to the Focus Area, which is experiencing the rapid agricultural load growth. But also to ensure adequate supply to the larger WOL area, given the expiry of generation contracts in the area, and to identify any transmission constraints limiting the ability of supply resources and imports within WOL to meet provincial needs.

The WOL area encompasses a 230 kV and 115 kV high voltage network in southwest Ontario, stretching from the western edge of the City of London, to the City of Sarnia in the northwest, and the City of Windsor in the west. This system interconnects large generators in the Lambton-Sarnia and Windsor areas with existing load centres, and encompasses the growing Kingsville-Leamington and Chatham-Kent areas. It provides four interconnection points with Michigan's power system via Windsor and Lambton-Sarnia. The area is also connected to the 500 kV system at Longwood TS, within the Municipality of Strathroy-Catadoc near the City of London, providing a strong path between the WOL area and the rest of the province.

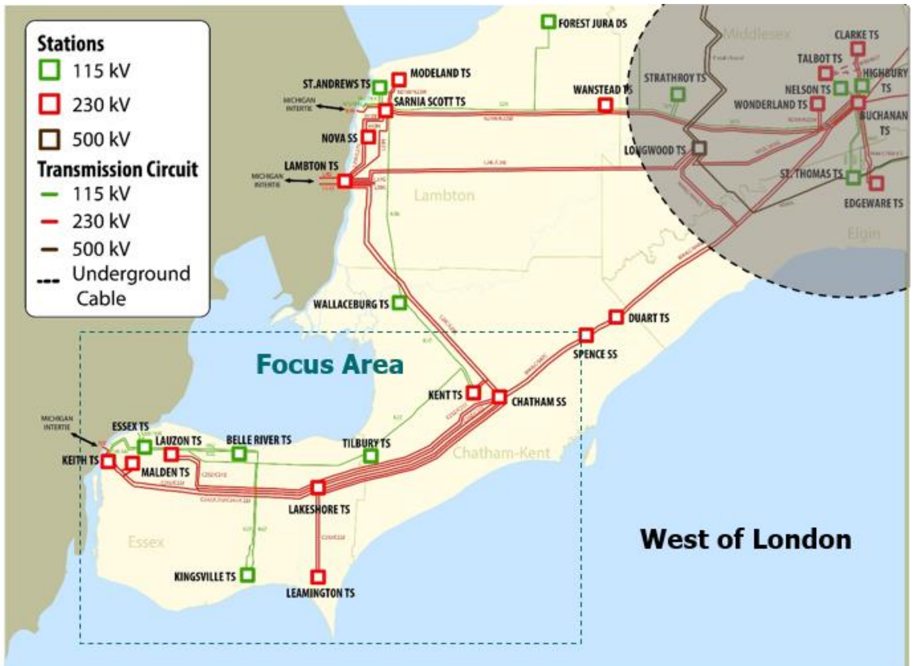
The Windsor-Essex region has historically been characterized by manufacturing loads, large gas generation and interconnection supply with Michigan in the Windsor area, as well as numerous wind generators across the region. More recently, agricultural development and the adoption of indoor

[1] Note that while a switching station was recommended, with the connection of South Middle Road TS DESN 1 and 2 to the station this was designated a transformer station by Hydro One and will subsequently be referred to as a transformer station in this report.

grow lights in Kingsville-Leamington have expanded and is forecast to increase significantly, spreading east towards Chatham proper and surrounding areas. Within the Chatham-Kent/Lambton/ Sarnia region, there is a significant amount of supply resources in Lambton-Sarnia, strategically located near the Dawn gas supply hub, as well as interconnection supply with Michigan. This area also includes large petro-chemical industrial loads in Lambton-Sarnia, much of which are interdependent with the combined heat and power generators.

The relevant parts of the WOL bulk system, consisting of 230 kV and 115 kV transmission circuits, as well the demarcation of the Focus Area, is shown in Figure 1.

Figure 1 | Map of West of London, Highlighting Focus Area



The bulk of the electrical supply is transmitted into WOL through 230 kV circuits from Buchanan TS to Scott TS, Lambton TS, and Chatham SS. Additional supply is transmitted within WOL through the 230 kV circuits between Chatham SS and Lambton TS, and the four existing circuits supplying the Windsor-Essex region from Chatham SS. These four existing circuits will be connected to the new station in Lakeshore, which was recommended in 2019, along with the two new 230 kV circuits from Lakeshore to Chatham. Over the last decade, prevailing power flows on the bulk system have been from the gas generation located in the WOL area east towards Toronto. However, with load changes in the Focus Area, bi-directional flow is expected going forward as new load connects.

This report is organized into the following sections:

- Section 3 provides background on the areas of interest within WOL, specifically the Kingsville-Leamington, Chatham-Kent, and Lambton-Sarnia pockets;
- Section 4 details the relevant electricity demand and load forecast scenarios, as well as overall forecast considerations;
- Section 5 provides an overview of the internal and external resources supplying the Focus Area and the broader WOL area;

- Section 6 discusses the need for additional capacity and energy supply in the Focus Area and WOL area;
- Section 7 outlines the transmission and resource recommendations required to meet the near- to mid-term needs;
- Section 8 analyzes the transmission and resource alternatives considered to meet the long-term needs;
- Section 9 summarizes the implications of the WOL bulk recommendations on the broader area and regional planning;
- Section 10 goes over the engagement activities to date and moving forward for WOL;
- Appendix A outlines the IESO's transmission planning objectives and assessment criteria;
- Appendix B provides a detailed breakdown of the load forecasts used in this study;
- Appendix C presents hourly supply need data determined through the need assessments;
- Appendix D breaks down the capacity and energy assessment assumptions; and
- Appendix E details the options and assumptions associated with the cost comparison for the alternatives.

3. Background and Planning Considerations

3.1 Areas of Interest

The majority of the identified load growth and economic development in WOL is within the Windsor-Essex region and Municipality of Chatham-Kent. This is driven by strong growth in the indoor agricultural sector, mainly in 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 agricultural sector.

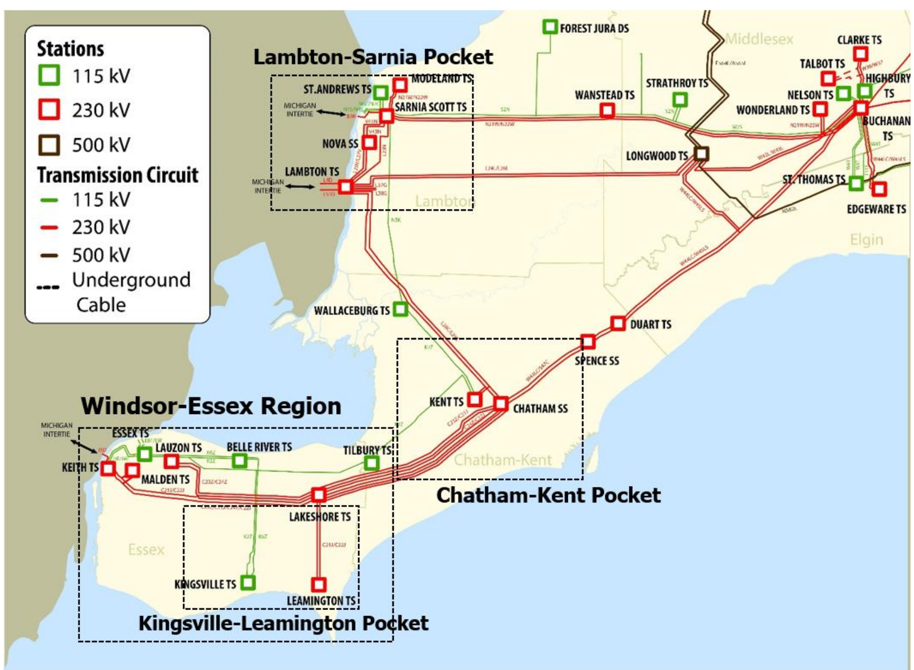
Aside from the points of interconnection with Michigan – one in Windsor and three in Lambton-Sarnia – Lambton-Sarnia contains the largest concentration of generation resources in WOL.

Thus, within WOL there are three areas of interest based on load growth, economic development and/or resources, as follows:

- Windsor-Essex;
- Chatham-Kent; and
- Lambton-Sarnia.

Each of these areas, as illustrated in Figure 2 will be described in the following sections. The considerations highlighted in this section regarding load growth, economic development and Community Energy Plans are incorporated in the load forecasts in Section 4 to the extent known, while local preferences were considered when developing options.

Figure 2 | Map of West of London, Highlighting Areas of Interest



3.1.1 Windsor-Essex

The Windsor-Essex region is the southernmost portion of Ontario, extending southwest from the Municipality of Chatham-Kent to the City of Windsor. The electricity demand of the region has historically been defined by its tourism and manufacturing, in particular automotive manufacturing near the City of Windsor. More recently, agricultural development and adoption of indoor grow lights in the Town of Kingsville and Municipality of Leamington (the Kingsville-Leamington pocket), has expanded and is forecast to increase significantly. The Kingsville-Leamington pocket is considered North America's largest concentration of greenhouse vegetable production, and accounts for all greenhouse and supplemental load that is supplied or will be supplied between Lakeshore TS and Kingsville TS.

Bulk and regional plans for the area are informed by the community's priorities and energy plans. In 2019, the County of Essex, City of Windsor, and other local municipalities declared a climate emergency and called for cooperation in reducing greenhouse gas (GHG) emissions in the region. The County of Essex and City of Windsor each established energy plans that support local economic development while taking climate change action and improving energy performance. The City of Windsor's community energy plan targets a 40% GHG reduction by 2041 from 2014 levels. The City of Windsor also recently requested that the government of Ontario place an interim cap of 2.5 megatons per year on the GHG pollution from Ontario's gas-fired power plants, and develop and implement a plan to phase-out all gas-fired electricity generation by 2030 to help Ontario and the City of Windsor meet their climate targets.

In the Essex Regional Energy Plan, specific targets were identified under seven total strategic directions:

- Efficient homes and buildings;
- Efficient greenhouses;
- Efficient industry;
- Efficient transportation;
- Efficient local supply and distribution;
- Efficient community planning; and
- Data-driven insights and reporting.

These strategic directions will be advanced through a variety of initiatives, including 16 priority projects between 2021-2025. These projects range from developing municipal policies and incentives (such as aligning the Regional Energy Plan with the County Economic Transportation Master Plan, or the County Economic and Employment Land Strategy), to forming governance groups to oversee implementation. Some of these governance groups include a County of Essex Retrofit Entity that would be established to offer standardized energy retrofits to homes and commercial and institutional buildings, as well as a Greenhouse Growers Energy Services Co-operative to consolidate expertise as it relates to energy efficiency and supply needs in the greenhouse sector. Other near-term endeavours involve scale projects, such as a neighbourhood-scale Integrated Energy Master Plan for both a manufacturing cluster and a net-zero community, and more broadly, raising energy and climate literacy. To the extent known, these community priorities have informed the demand forecast in the area and have been taken into consideration in the evaluation of options and the IESO will continue to consider community-led energy plans in future demand forecasts as they are implemented.

3.1.2 Chatham-Kent

The Municipality of Chatham-Kent is about 2,500 square kilometers, located adjacent to the Windsor-Essex region. Based on feedback received from the greenhouse sector, municipalities and local utilities, there are potential constraints regarding the availability of land, water, electricity and natural gas in the Windsor-Essex region.[2] As a result, agricultural load is shifting eastward, concentrated in the community of Dresden and areas surrounding Chatham proper (referred to here as "Chatham-Kent").

In November 2019, Enbridge completed the construction of a new gas pipeline in the area; the Chatham-Kent Rural Pipeline Expansion. This pipeline, which runs from Dover Centre east through the communities of Tupperville and Dresden, provides 30,000 m^3/hr of natural gas capacity, or the equivalent of 350 acres of greenhouses. The Municipality of Chatham-Kent indicated that there are no water or wastewater supply concerns that would delay the development of this area.

The Municipality of Chatham-Kent was an early adopter and is a large supporter of renewable energy in Ontario. Chatham-Kent's 2016 Community Energy Plan builds on its leadership in renewable energy and promotes further energy efficiency, aiming to reduce energy consumption in 2036 by 15% over the 2013 baseline, leading to associated reductions in greenhouse gas emissions.[3] The Environmental Sustainability Section of Council's 2018-2022 Term Priorities calls for reducing the cost and environmental impact of energy use, among other priorities. In addition, on July 15, 2019, Council unanimously approved a motion to declare a climate emergency in Chatham-Kent.[4]

3.1.3 Lambton-Sarnia

The County of Lambton and City of Sarnia (referred to here as Lambton-Sarnia) form part of the Ontario-Michigan interconnection across from Port Huron, Michigan. Together they are home to over 190,000 people, with electricity demand largely driven by the hub of traditional petro-chemical industrial loads and the emerging bio-industrial and clean energy economy.

Based on Ontario's Low-Carbon Hydrogen Strategy discussion paper[5], depending on the production method, hydrogen can help decarbonize the economy and reduce reliance on fuels that have a larger carbon footprint. Key principles of that strategy include reducing greenhouse gas emissions, stimulating economic development, and promoting energy resilience. Since Lambton-Sarnia houses a large concentration of refineries and chemical producers that could switch from using high- to low-carbon hydrogen, the municipality is positioning itself to play a key role in Ontario's hydrogen strategy. This is one way that the County of Lambton is pursuing its mission statement of the "promotion of economic growth, environmental stewardship, and an enhanced quality of life through

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[2] Refer to Section 4 for further details on factors influencing greenhouse load.

[3] As described in the 2016 Chatham-Kent council meeting.

[4] Refer to the Municipality of Chatham-Kent Climate Change Action Plan Terms of Reference for further details.

[5] Issued by the Ontario government in November 2020.

the provision of responsive and efficient services".[6] Similarly, Sarnia city councillors unanimously passed a resolution in support of Enbridge Line 5 as critical infrastructure for the safe, efficient delivery of energy to residents, commerce, and industry in Western Ontario. This pipeline delivers crude oil to be processed by Ontario refineries to produce a cost-effective supply of gasoline, diesel, jet fuel, and natural gas liquids to make petrochemical products.

Over the study period, there is a relatively small amount of industrial load growth projected in the pocket. However, there is approximately 2,300 MW of gas generation in the area, strategically located near the Dawn gas supply hub. It also forms the majority of the Ontario-Michigan interconnection which currently has a capability of approximately 1,600 MW for imports and/or exports.

3.2 Ongoing Conservation and Demand Management Activities

The main driver for electricity growth in the Focus Area is the adoption of indoor grow lights – a vegetable greenhouse with lighting consumes 10 times as much electricity as an unlit vegetable greenhouse. To date, the use of high-intensity discharge lighting, with double-ended high-pressure sodium (DE-HPS) grow lights, continues to be the primary technology in Ontario's greenhouse sector. The 2019 Greenhouse Profile Study issued by the IESO indicated that switching to more energy-efficient light emitting diodes (LED) could save as much as 550 GWh/yr. The study suggests significant potential for energy-efficiency strategies to help greenhouses and indoor facilities improve their operations and save on energy, while reducing the need for new supply infrastructure and enabling new businesses to connect.

Energy efficiency is a low cost resource that offers benefits for individuals, businesses, and the power system as a whole. The efforts made through the participation in energy efficiency programs help reduce the need for new investments in generation resources and transmission lines. The IESO has directed increased efforts and investment to the Windsor-Essex region over the past several years, to encourage the adoption of energy efficiency processes and technologies in businesses and communities.

The IESO's Save on Energy conservation and demand management programs provide incentives for grow lights (both retrofit and new construction) to help defray the increased capital costs of LEDs, as well as deliver longer term operational savings. In 2020, the Save on Energy Regional LED Incentive for Greenhouses received 17 applications – greatly exceeding the expected number of applications and budget. In 2020, the program committed 200 GWh of energy savings and 5 MW of demand savings. In 2021, applications for LED grow lights continue to be high, even with a lower incentive than the original 3x adder that was available in 2020 to spur up-take.[7]

In addition, a Local Initiatives Program will be developed to cost-effectively meet system needs, drive cost competitiveness, and promote consumer-driven solutions in targeted areas of the province, as identified through the IESO's regional planning process.

Energy efficiency combined with innovation can provide an immediate and lasting impact on system reliability, help address province-wide and regional electricity needs, and support business and

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[6] Refer to the County of Lambton Strategic Plan for further details.

[7] Refer to IESO's CEATI's "Energy Management Best Practices for Cannabis Greenhouses and Warehouses".

community growth. The IESO's Grid Innovation Fund has invested in innovative greenhouse pilot projects in the Windsor-Essex region to reduce peak demand while alleviating load growth. Pilot projects include smart LED lighting strategies, and using artificial intelligence to improve energy efficiency. Learnings from these projects will help inform and build capacity within the community for future demand side solutions as load continues to connect.

Section 4 illustrates the net demand growth that remains to be addressed through a bulk transmission and/or resources solution, after accounting for current energy efficiency measures implemented under existing frameworks.

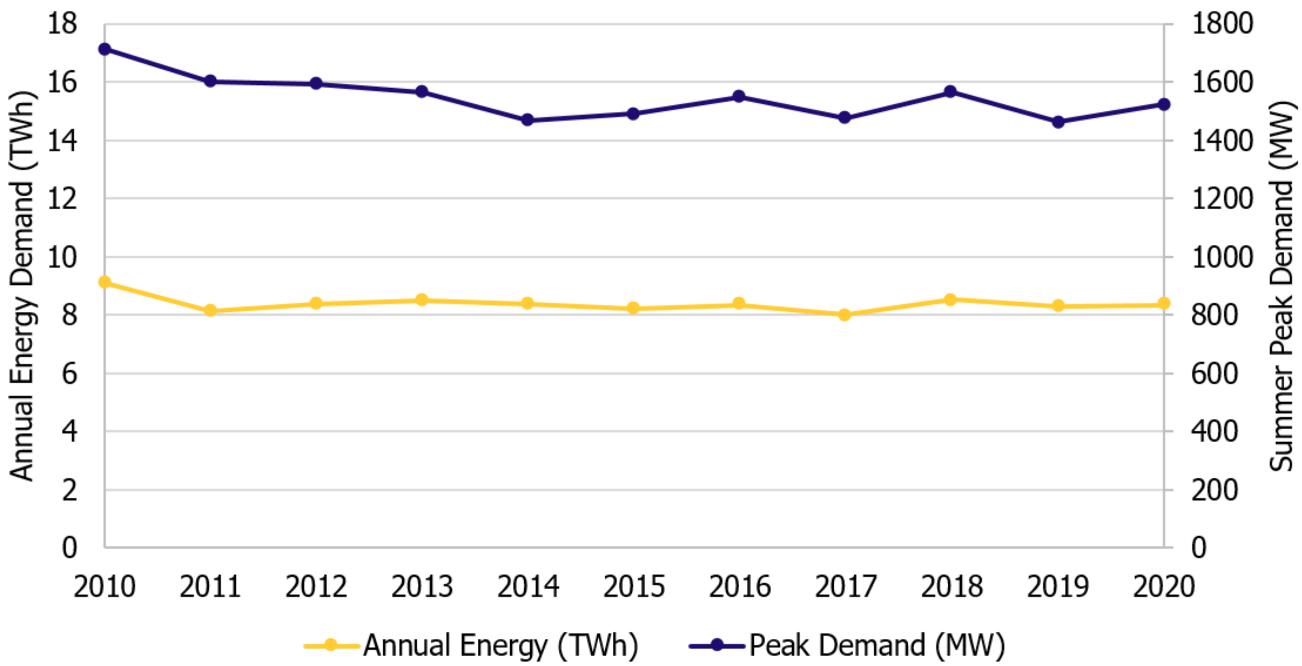
4. Demand Forecasts

This section describes the forecast demand for WOL and the Focus Area, and details of the greenhouse load forecast that is the primary driver for demand growth.

4.1 Overall West of London Demand

As described in Section 3.1, WOL is home to a diverse mixture of residential, commercial, and industrial loads, spanning two regional planning regions: Windsor-Essex, and Chatham-Kent/ Lambton/Sarnia. Together, loads in this summer-peaking area have historically reached approximately 1,600 MW, with annual energy requirements of around 8 TWh. Historical demand and energy consumption in WOL are shown in Figure 3.

Figure 3 | Historical Peak Demand and Energy Consumption for West of London



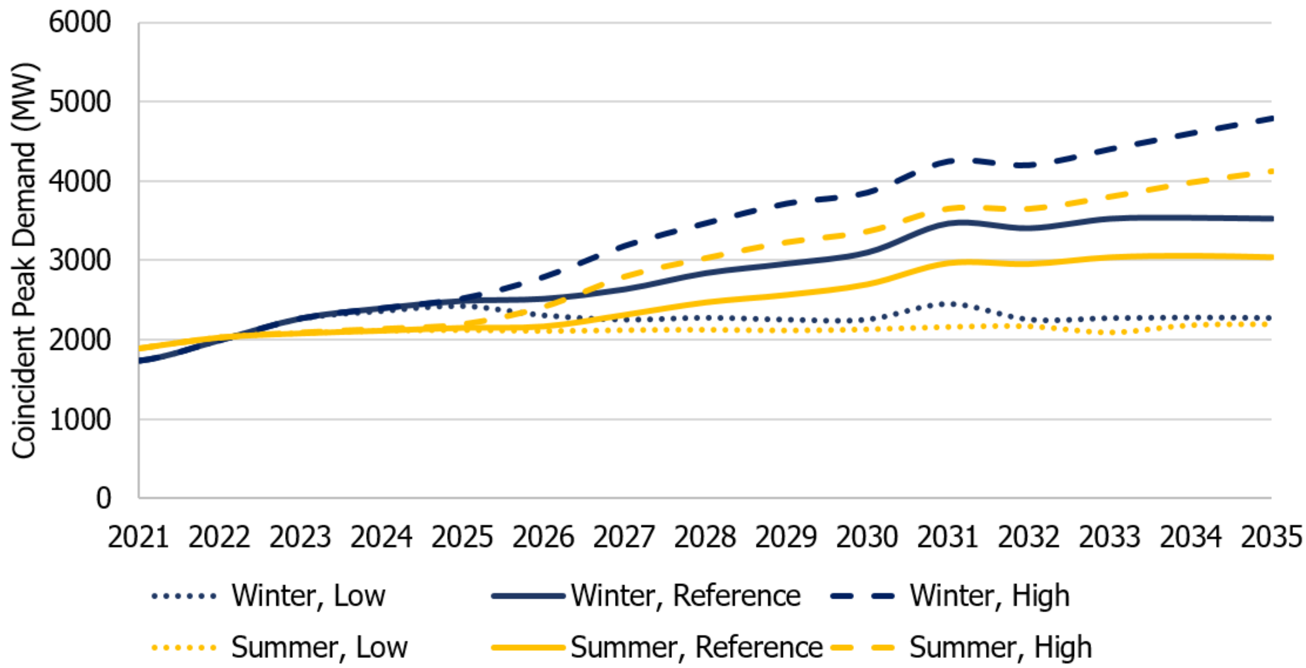
To construct the forecast for the WOL area, a number of data sets were compiled and leveraged. The 2019 Windsor-Essex IRRP planning forecast was used for non-agricultural loads in the Windsor-Essex region, combined with forecast data solicited from distributors, industrial customers, and municipalities in the Chatham-Kent/Lambton/Sarnia region in 2020. The West Zone[8] forecast information from the Annual Planning Outlook (APO) was then used for the remaining stations

[8] Visit the IESO's zonal map illustrating the 10 electrical zones.

defined as WOL.[9] The regional planning forecasts were adjusted to reflect extreme weather conditions,[10] and accounted for the peak capacity contribution of contracted distributed generation. The agricultural load forecast was then developed as described in Section 4.3. Given the significance of the growth in the agriculture sector, three demand scenarios (low, reference and high) were developed for greenhouse load in order to test the robustness of the plan. Together with hourly load information (see Section 4.4), these inputs allowed for three coincident peak forecasts to be estimated for all of WOL; the differences driven by the three greenhouse load forecasts.

By 2035 in the reference scenario, the peak demand in WOL is forecast to increase to about 3,500 MW in the winter and around 3,000 MW in the summer. This magnitude of load growth, in addition to the switch to a winter peak, is largely driven by the indoor agriculture expansions. Figure 4 presents the forecasts for the overall WOL area.

Figure 4 | Total West of London Forecast Scenarios[11]



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[9] Chatham-Kent/Lambton/Sarnia is undergoing a new regional planning cycle in Q3 2021, through which the forecast may be updated. Refer to Appendix B.

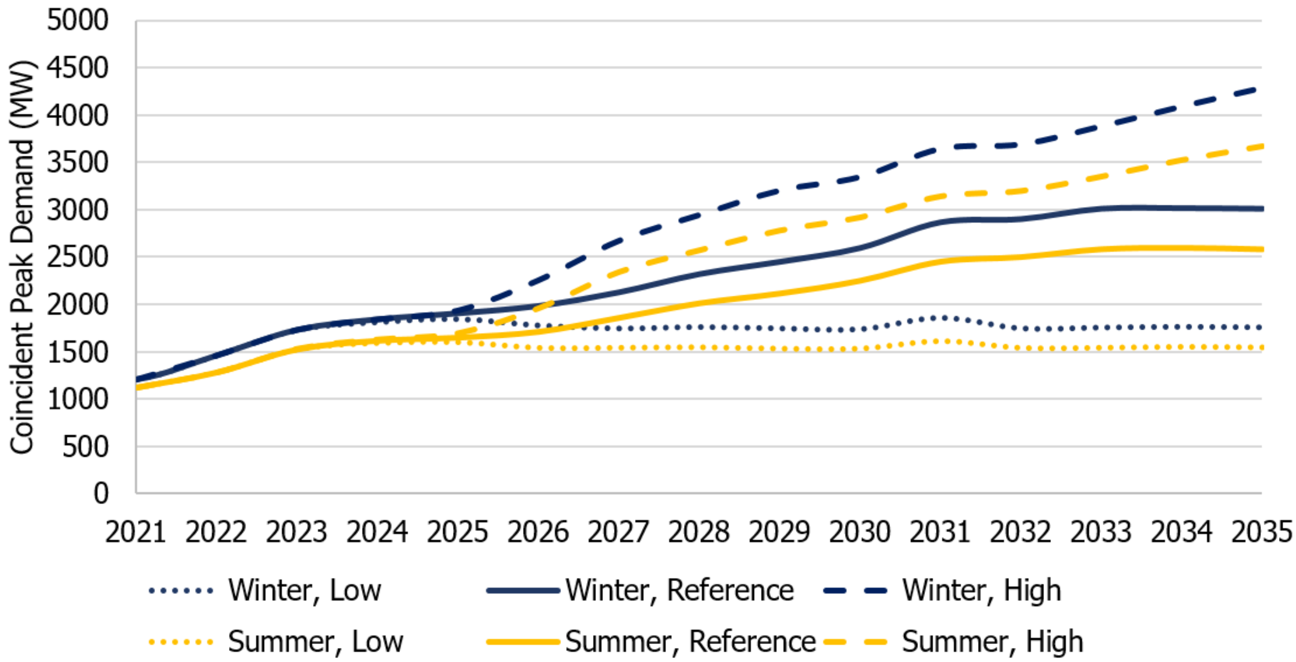
[10] Regional forecasts provided by LDCs are for median weather, which are then corrected for extreme weather by adjusting the forecast to reflect how loads historically react to extreme temperatures.

[11] Overall West of London peak will be subject to actual coincidence as loads materialize and customer segmentation in the region shifts. Higher coincidence between agricultural and non-agricultural loads can lead to greater peak demand. The non-agricultural load shape for this bulk study is based on the APO's West Zone load shape, which is more coincident with the 2031 agricultural load than in the adjacent years, resulting in what appears to be an increased demand. Refer to Section 4.4 and Appendix B for more detailed load information.

4.2 Focus Area Demand

Forecast demand in the Focus Area is a subset of WOL load. As shown in Figure 5, in the reference scenario, coincident peak demand in the Focus Area is anticipated to reach approximately 3,000 MW and 2,600 MW in the winter and summer of 2035, respectively. Similar to WOL, three forecast scenarios are presented, reflecting the three greenhouse load forecasts.

Figure 5 | Focus Area Forecast Scenarios



4.3 Greenhouse Forecast Scenarios

The greenhouse load growth in WOL is concentrated in two areas where the indoor agricultural sector is expanding: Kingsville and Leamington, and Chatham-Kent (specifically, the community of Dresden). The greenhouse load in Kingsville and Leamington includes:

- Loads supplied by the existing Leamington tap lines which will be connected to the future Lakeshore TS;
- South Middle Road TS loads to be connected to Lakeshore TS;
- Gradual connection of an AgriPark[12]; and
- Future distribution-connected load growth in the Kingsville and Leamington geographic area.

Additionally, the greenhouse load in Chatham-Kent is comprised of two parts:

[12] AgriPark refers to an agricultural park which will act as a turn-key solution, providing facilities, equipment, and services to independent end-users/growers.

- Connection requests received by the distributor for the community of Dresden, looking to connect by 2021/2022; and
- Additional 130-230 MW of projected load growth based on the local natural gas capacity, assuming its utilization is for greenhouse facilities.[13]

Demand growth in these areas was combined with different assumptions to create three greenhouse load forecast scenarios. Inputs to these scenarios encompass:

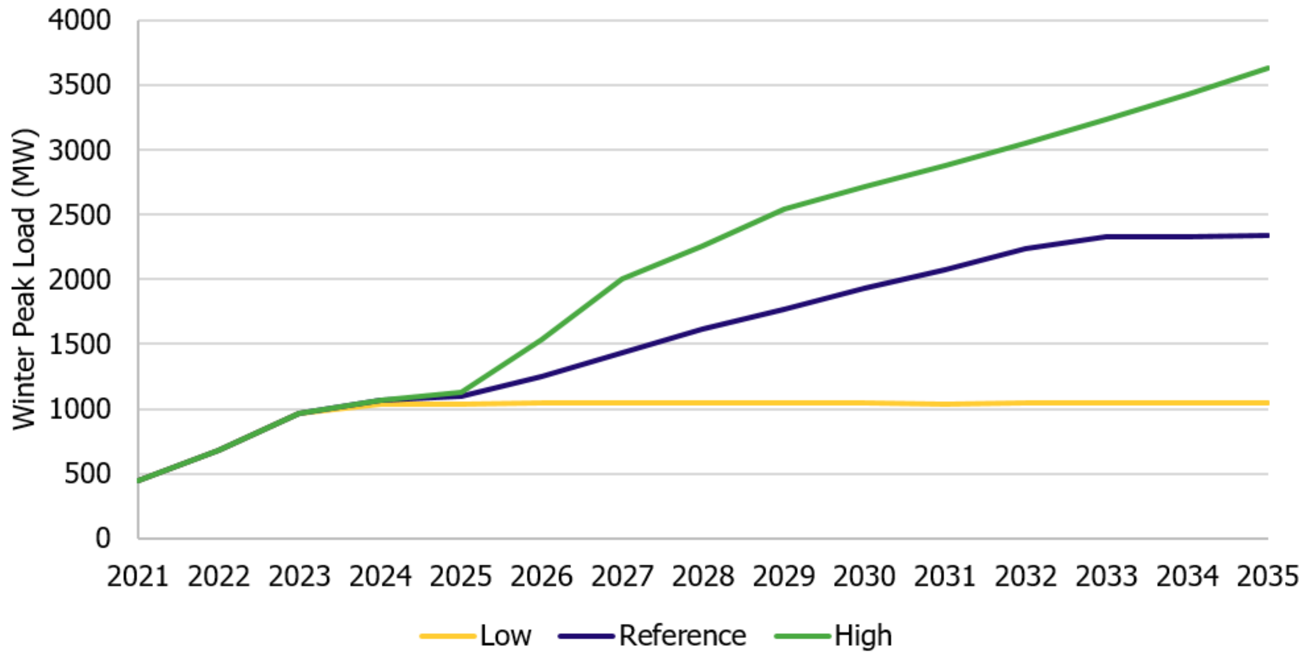
- Greenhouse load growth information received from the LDCs – primarily Hydro One, as most of the new load is in its service territory – including:
  - Customer connection requests, with details of their location, their requested capacity, and crop type (vegetable or cannabis);
  - Customer connection inquiries, with similar details mentioned above;
  - Projections of greenhouse expansions based on the available gas supply capability from Enbridge's Chatham Pipeline expansion in the community of Dresden;
- Information received from those who have applied for an IESO System Impact Assessment (SIA) in WOL;
- Information received by the IESO from potential connection applicants who have inquired about SIAs or other feasibility assessments in WOL; and
- Historical acreage expansion rates for vegetable greenhouse growers, obtained from the Ontario Greenhouse Vegetable Growers (OGVG) Association; and
- Development time of both Windsor-Essex bulk system reinforcements,[14] and new local transformer stations and supply lines required to connect new loads.

As shown in Figure 6, the forecast scenarios differ in both magnitude of total long-term greenhouse load, and the rate at which load materializes.

[13] During the Windsor-Essex IRRP, a near-term capacity need was identified in Chatham-Kent that exceeded the existing local capacity and was driven by greenhouse customers located south of the municipality of Chatham proper. Due to the urgency and proximity of the load to the Windsor-Essex region, this need was incorporated into the 2019 Windsor-Essex IRRP. However, as a result of economic influences on demand for the proposed load, the recommended station build was not implemented by the customer.

[14] Specifically, the Lakeshore transformer station and 230 kV double circuit lines from Chatham SS to Lakeshore TS.

Figure 6 | West of London Greenhouse-Only Load Forecast Scenarios, Winter



The low load scenario incorporates only the already-existing loads, facilities for which SIAs have been received,[15] and confirmed load for which a preferred connection option has been studied (such as in the community of Dresden). The rate of load growth assumed for these facilities aligns directly with the forecasts from the distributor or transmission-connected customer.

The reference scenario builds upon the low scenario's assumptions and reflects additional customer connection requests received by the distributor that have not been assigned a connection point. It assumes additional vegetable greenhouse load growth near the community of Dresden using the projected rate of growth indicated by Hydro One. Subsequently, starting in 2026 (after the Chatham-Lakeshore 230 kV circuits are in-service), the remaining Kingsville and Leamington customer queue (distribution-level connection requests) is assumed to be connected in 50 MW annual increments. Simultaneously, the AgriPark load is anticipated to ramp up by 100 MW per year.

The high load scenario assumes a more aggressive and faster buildout of transformer stations and distribution lines, also starting in 2026 – possible if transmission and distribution facilities are developed in parallel. In this scenario, the magnitude of long-term greenhouse load near the community of Dresden is larger, assuming that a greater portion of projected growth is driven by more load-intensive cannabis grow lights rather than vegetable. The Kingsville and Leamington customer queue and AgriPark are still accounted for, but ramp up at a faster rate: both at 200 MW per year. The high load scenario also applies a long-term growth rate of 6% starting in 2029, after the known customer requests and distributor forecasts are met. This 6% factor is based on the historical rate of under-glass greenhouse acreage expansion in the Leamington area according to OGVG, and implies that the ratio of lit to unlit acreage in 2029 will persist in the long-term.

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[15] Information valid as of December 2020.

4.4 Hourly Demand Forecasts

In addition to establishing peak demand forecasts to identify bulk capacity needs, hourly forecasts were developed to inform the energy analysis (see Section 6). While real-time demand is subject to a myriad of factors – including hourly weather changes and individual customer or facility behaviour – the WOL load shape is expected to be impacted most significantly by indoor agriculture load shapes as more greenhouse customers connect over the planning horizon, until 2035 for the purposes of this study. Specifically, a key characteristic of greenhouse demand is a winter morning peak sustained over multiple hours, as growers seek to compensate for lower solar insolation with artificial lighting. This differs from non-agricultural demand in WOL, which is typically summer-peaking and highest during weekday afternoons/early evenings.

The IESO created the hourly forecasts leveraging three load shapes:

- Non-agricultural – consistent with the 2019 APO West Zone load profile;
- Vegetable, greenhouse – from load profiles developed through the 2019 Windsor-Essex IRRP and bulk study; and
- Cannabis, greenhouse – also from load profiles developed through the 2019 Windsor-Essex IRRP and bulk study.

These load shapes were aggregated according to segmentation information and location, and then scaled to reach estimated peak demand levels. The result was load profiles combined as appropriate to represent different scenarios (i.e., low, reference, or high) and different areas (i.e., West of London, Focus Area, or West of Chatham).[16]

4.5 Consideration of Forecast Scenarios and Sensitivities

As the indoor agriculture sector evolves and load materializes over the long-term planning horizon, it is expected that the forecast will also evolve. Uncertainties around core assumptions in the forecast give cause to study more than one scenario. Each load connection scenario developed for the West of London bulk study incorporates the most up-to-date information known at the time (2020). Each scenario also indicates a large amount of electricity demand growth concentrated in the Kingsville, Leamington, and Chatham-Kent areas, requiring further transmission reinforcements. No major impact to demand has been identified in WOL from the COVID-19 pandemic other than to further support consumer demand for local produce.

Recommendations made through this bulk study prioritize the reference scenario, but by exploring critical assumptions such as rate of growth and total magnitude of the connection queue, the needs and options analyses were also subjected to low and high load growth scenarios.

Moreover, consistent with information gathered throughout the 2019 Windsor-Essex IRRP and bulk study, stakeholders have continued to flag key sensitivities that can impact the load growth's overall magnitude and rate:

- Crop type segmentation;

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[16] Detailed load information can be found in Appendix B

- Location and access to other services and infrastructure that support the indoor agriculture sector's growth (including land, labour, markets, natural gas supply, waste treatment facilities, local policies, permitting, and water supply);
- Rate of LED grow light adoption;
- Potential long-term impacts of applicable community and regional energy plans;
- Uptake of behind-the-meter generation;
- Costs (i.e., of the required services or carbon emissions); and
- Other broader trends driving greenhouse expansion (such as the desire for food security and/or year-round production, or new product/crop type categories).

These sensitivities can not only influence the amount and timing of the forecast load growth – they can also impact the seasonal and hourly assumptions. For instance, differences in lighting strategies between crop types and growers could alter forecast load profiles. While the majority of existing lit facilities use traditional high pressure sodium lighting, the advancement in the technology combined with interest in incentives mentioned in Section 3.2, indicate that adoption of LED grow light can potentially increase substantially. There is, however, still work needed to increase LED uptake in the sector. Stakeholders have indicated that the main barrier to LEDs is cost, as up-front costs are much larger for LEDs than DE-HPS and the increase in efficiency may not be as high as expected. However, costs are partially offset by the fact DE-HPS has a much shorter lifespan than LEDs. If the ratio between grow light type were to shift to a 50/50 split, as opposed to the currently-assumed majority of DE-HPS, it could defer the need dates identified in Section 6 by 1-2 years. Thus, highlighting the role conservation measures targeted to the sector could play in mitigating this need.

Stakeholders have also indicated that stalled expansion for some crop types (such as cannabis) could be offset by a switch to others (such as vegetable). As stated in Section 4.2, assumptions regarding crop type were based on information provided by the LDCs and customers. However, if the ratio of vegetable to cannabis greenhouses were to change, this would primarily impact the summer energy profile, as cannabis facilities are currently assumed to have an equal ratio between summer and winter demand, while vegetable facilities are assumed to have greater demand in the winter. Since the capacity and energy needs in this area are driven by the winter profiles, this would have a minimal impact on the needs identified.

Note that for this West of London bulk study, the greenhouse forecast scenarios (as described in Section 4.2) are not developed with a top-down approach, such as using greenhouse acreage expansion rates and estimated grow light intensity (i.e., MW/acre according to crop type). Rather, the key inputs to the forecast are the queue of load connection requests (in total MW), crop type (percentage vegetable or cannabis) according to the distributor, and information from known large, directly-connected transmission customers. These inputs were then constrained by timelines of transmission reinforcements (either already under development or assuming typical lead times). Currently, the distribution capacity in the Focus Area is fully allocated – at the existing Leamington TS DESN 1 and 2, and planned South Middle Road TS DESN 1 and 2, with expected in-service dates of Q2 2022 and Q3 2025 respectively. Therefore, all three demand forecast scenarios for greenhouse customers account for the development time of previously recommended Windsor-Essex bulk system reinforcements, and new local transformer stations and supply lines.

Beyond the factors described above (i.e., crop type segmentation, lighting technology, seasonal behaviour), the IESO notes that changes related to the amount or use of behind-the-meter generation can also influence the forecast growth. Known contracted distributed generation and transmission-connected market resources are accounted for, in either the forecast or modelled in the power flow and energy assessments. No assumptions are made regarding customers relying on already-existing behind-the-meter generation and whether they would be seeking to meet their load requirements with a grid connection instead – if this is the case, it would be expected that the customer requested a load connection with the distributor and would be included in the overall queue information. Stakeholders have indicated that these facilities could be used by customers in various ways, such as for peak-shaving, back-up supply, electricity supply until transmission reinforcements are in-service, or to help meet thermal or carbon dioxide requirements. At the time of this bulk study, no planned new behind-the-meter generation projects have been confirmed, so no impact from future activity is reflected in the load forecast.

As more greenhouses connect over the next several years, continued monitoring and conversations with customers can improve future planning forecasts.

5. Existing Supply to the Focus Area and West of London Area

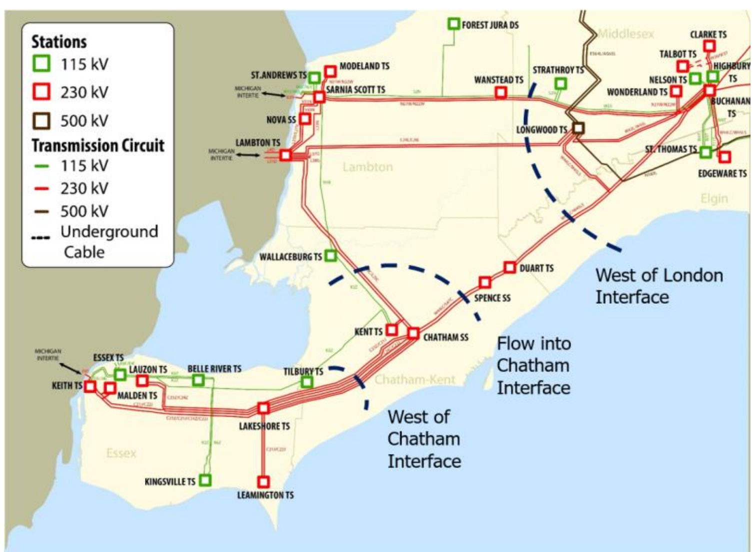
WOL is supplied by a number of internal wind and gas generation resources, as well as external resources accessed through the existing 230 kV network (connecting the area to the rest of Ontario).[17] The area also encompasses the entire Michigan interconnection, which allows for imports and exports to flow through Lambton-Sarnia and Windsor to the rest of the province.

As illustrated in Figure 7, there are three main interfaces of interest:

- The Flow into Chatham (FIC) interface consisting of the 230 kV circuits, which supply the Focus Area;
- The West of Chatham (WOC) interface consisting of the existing and planned 230 kV circuits west of Chatham SS, which supply the Windsor-Essex portion of the Focus Area; and
- The WOL interface consisting of the 230 kV circuits west from London (Buchanan TS/ Longwood TS), which supply the broader WOL area.

The capability of the transmission system to deliver external resources to meet the area's needs reflects limits for all elements in-service conditions, opposed to under outage conditions, since all elements in-service conditions are more limiting in the determination of the area's need.[18]

Figure 7 | Map of West of London Area with Relevant Interfaces



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[17] The mixture of resources used to supply the region's and the province's energy needs at any given time is determined by the real-time energy market.

[18] Planning standards require the deterministic assessment of the system's ability to withstand certain contingencies when all elements are in-service and when a system element is under outage. All elements in-service limits were most limiting to the area's supply in this case because under outage conditions load rejection can be armed and the need to maintain export capability is relaxed.

The following sections describe how the Focus Area and the broader WOL area are supplied.

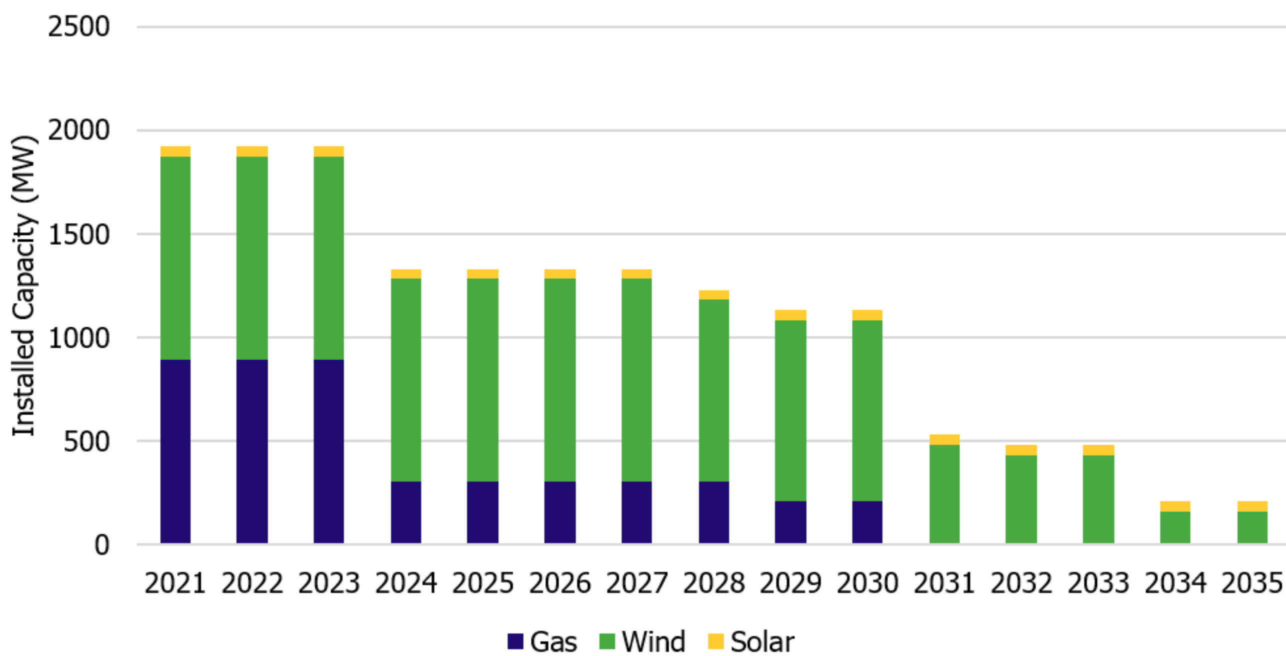
5.1 Existing Supply to the Focus Area

5.1.1 Resources Internal to the Focus Area

Transmission-connected resources in the Focus Area are currently a mixture of gas generation in Windsor, a number of wind generators in Windsor-Essex and Chatham-Kent, and a large solar installation in Windsor. These resources represent a combined total of approximately 1,900 MW of installed generation capacity, split relatively evenly between gas facilities and renewable resources, approximately 900 MW and 1,000 MW respectively.

Figure 8 shows the installed transmission-connected resource mix in the Focus Area per year, reflecting the contracted capacity as existing contracts expire through the study period.[19] Over the next two decades, the majority of contracts with natural gas-fired and renewable generation are expected to expire, which was considered when identifying local supply needs. By the end of the study period in 2035, contracts for almost 1,700 MW of resources will have expired, including all natural gas-fired resources in the Focus Area.

Figure 8 | Contracted Transmission-Connected Generation Capacity in the Focus Area



[19] The region also has a significant number of distribution connected resources, mainly wind and solar. The area also benefits from a number of smaller distribution connected combined heat and power generators. The impact of these distributed resources was also modelled in the study.

5.1.2 External Supply from Ontario Resources

Assuming the recommendations in the 2019 Windsor-Essex bulk study are implemented, the transfer capability of the FIC transmission interface is what limits the delivery of power into the Focus Area and is dependent on the output of generation and Ontario-Michigan imports in the Lambton-Sarnia area. The transfer capability of the FIC interface is 1,350 MW and 1,200 MW, in the winter and summer respectively, when Lambton-Sarnia generation and Ontario-Michigan imports are between 0-1,500 MW. This interface is generally limited by the Lambton-to-Chatham path. When Lambton-Sarnia generation and imports are less than 0 MW (i.e., exporting with no Lambton-Sarnia resources generating) the capability to transfer power into the area is lower due to thermal limitations on the Longwood-to-Chatham path. When the Lambton-Sarnia generation and imports are greater than 1,500 MW, the capability to transfer power into the area is lower due to thermal limitations on the Lambton-to-Chatham path.

Table 1 | Summary of Limitations on the FIC Interface, Relative to the Total Lambton-Sarnia Generation and Total Winter West of London Greenhouse Demand Forecast (MW)

Lambton-Sarnia generation and Ontario-Michigan interchange[20]	FIC Limitation
Less than 0 MW	Limit lower due to thermal limitations on the Longwood-to-Chatham path
0 – 1,500 MW	Limited by the Lambton-to-Chatham path
Greater than 1,500 MW	Limit lower due to thermal limitations on the Lambton-to-Chatham path

For the purpose of identifying supply needs in the Focus Area, the transfer capability of the FIC interface is assumed to be 1,350 MW and 1,200 MW, in the summer and winter respectively.

5.1.3 External Supply from Neighbouring Jurisdictions

The Focus Area is also interconnected with Michigan through a 230 kV interconnection, circuit J5D at Keith TS (Windsor to Detroit). The flow on this intertie typically represents 20% of the flow across the entire Ontario-Michigan interconnection, with the other three connection points located in the Lambton-Sarnia. Imports on this intertie could help supply load in the Focus Area, while exports on this intertie would increase the supply required to the Focus Area. However, since flow on the Ontario-Michigan interties are scheduled as a whole, limitations to imports on the Sarnia-Port Huron interties, for example, affect the ability for imports on the Windsor-Detroit intertie to help supply the Focus Area. In addition, the Midcontinent Independent System Operator's 2020 Planning Resource Auction for the Michigan zone cleared at the cost of new entry of $250/MW-day. While this constraint was not reflected in the 2021 auction, it indicates that there may be limited resources that would subsequently be available to provide imports from Michigan to Ontario to meet Ontario provincial or local supply needs.

[20] Negative values represent exports; positive values represent generation and/or imports.

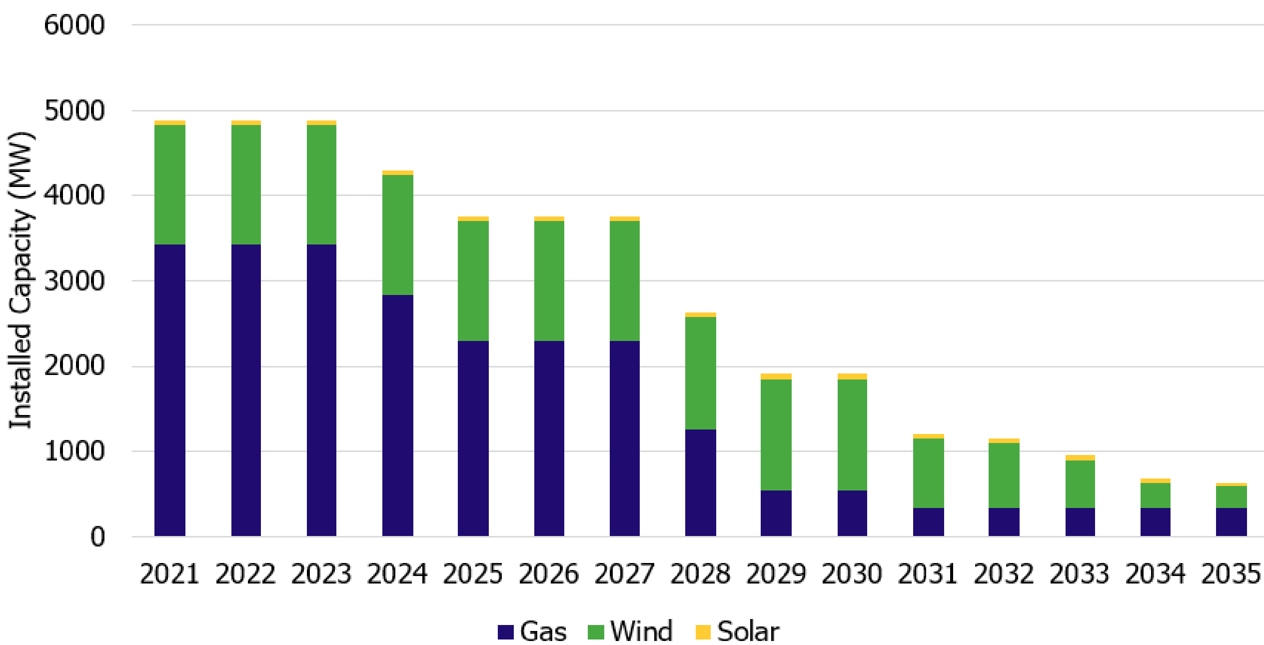
5.2 Existing Supply to the WOL Area

Supply to WOL is provided by generation located within WOL, flow west from the rest of Ontario, and flow east from the United States through the Ontario-Michigan interconnection, as outlined in the following sections.

5.2.1 Resources Internal to WOL

In addition to the transmission-connected resources in the Focus Area, the WOL area is also comprised of a significant amount of installed gas generation in Lambton-Sarnia, over 2,500 MW, and approximately 440 MW of renewable resources. In combination, these resources represent a total of nearly 5,000 MW of installed generation capacity. Figure 9 shows the installed transmission-connected resource mix in the WOL area in 2021.[21] Over the next two decades, the majority of contracts with natural gas-fired and renewable generation are expected to expire. By the end of the study period in 2035, contracts with approximately 4,250 MW of generation will have expired.

Figure 9 | Contracted Transmission-Connected Generation Capacity in West of London



[21] The region also has a significant number of distribution connected resources, mainly wind and solar. The area also benefits from a number of smaller distribution connected combined heat and power generators. The impact of these distributed resources was also modelled in the study.

5.2.2 External Supply from Ontario Resources

Supply to WOL from the rest of the province is provided through the WOL transmission interface comprising, the existing 230 kV transmission circuits that connect Lambton TS, Scott TS, and Chatham SS in the area to Longwood TS and Buchanan TS in the east. The current planning limit of the WOL interface (westbound) is approximately 2,350 MW and 2,100 MW in the winter and summer, respectively. Under low levels of generation in Lambton-Sarnia and high exports, the WOL interface is restricted by either the Longwood TS to Lambton TS path or the Longwood TS to Chatham SS path, for the loss of two circuits along the other path (i.e., restricted by Longwood-to-Lambton for the loss of two circuits along Longwood-to-Chatham, or vise versa).

Limitations on the supply to the Focus Area (i.e. the FIC interface) currently impact the capability of the WOL interface.

5.2.3 External Supply from Neighbouring Jurisdictions

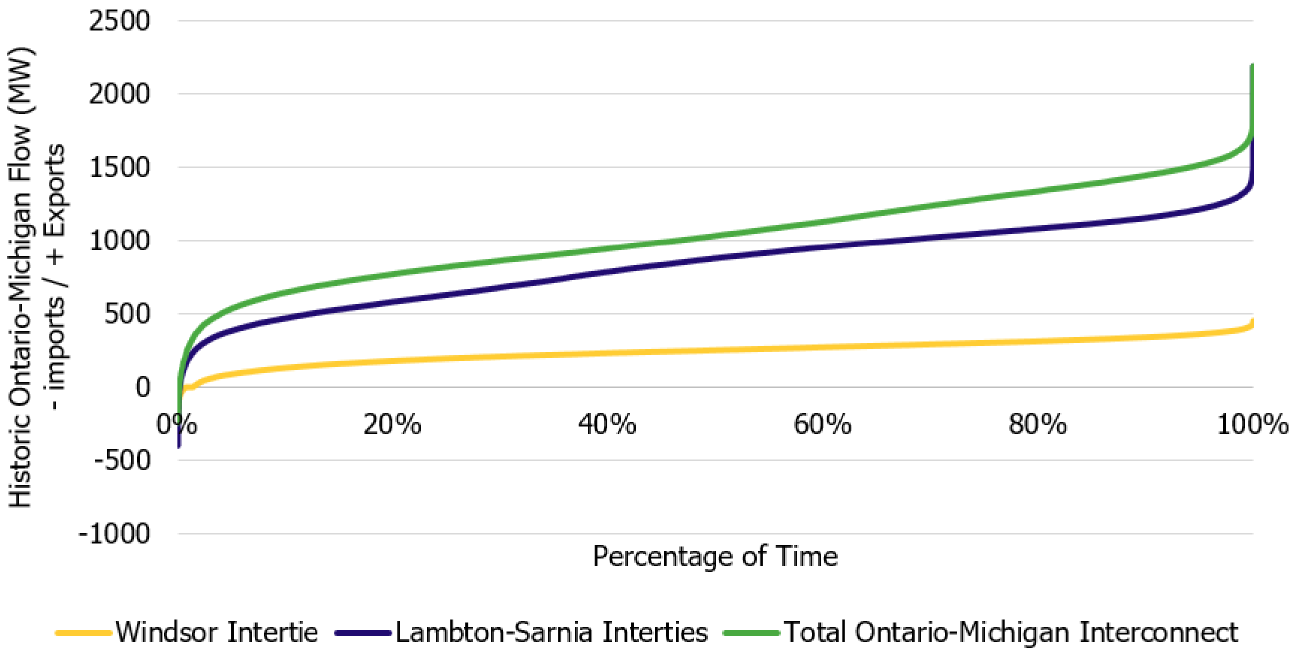
WOL is also interconnected with Michigan through four interconnection ties – a circuit J5D at Keith TS (Windsor to Detroit), as well as circuits L4D and L51D at Lambton TS and B3N at Scott TS (Sarnia to Port Huron). The interconnection between Ontario and Michigan supports import and export trade via the Ontario and Michigan real-time energy markets. Trading electricity across different markets provides operational and planning flexibility, as well as enhances the reliability, resiliency and cost-effectiveness of the electricity system.

Real-time trading provides a significant economic benefit to ratepayers, through savings when imports are scheduled instead of an Ontario asset with higher production costs, or through savings when exports are scheduled during times of surplus energy to avoid costly shutdowns or curtailments. In addition to cost savings, competitive trading also delivers an additional revenue stream for ratepayers, through intertie congestion rent.

From an operational and reliability perspective, trading electricity provides a significant amount of flexibility to address needs that emerge close to real-time and without much notice, such as unexpected generation or transmission line outages as well as changes in demand. It can act as cost-effective insurance, by relying on our neighbours to make up any potential shortfall. This was most recently illustrated by the Texas blackout event, which may have been exacerbated by the lack of interconnections with other jurisdictions if they had available capacity to provide.

The Ontario-Michigan interconnect has a combined capability of 1,650 MW for exports in the winter and summer, and 1,700/1,550 MW for imports in the winter and summer respectively, roughly split evenly among the four ties – 20% on the J5D Windsor intertie, and 80% on the Lambton-Sarnia interties. Figure 6 shows the recent historical flows on the interconnection as a whole, and the split between the Windsor-Detroit and Sarnia-Port Huron ties.

Figure 10 | Historic Ontario-Michigan Flows (All hours 2018-2020)



The Ontario-Michigan interface is subject to "loop-flows," which represent unscheduled flows that naturally occur, influenced by the dispatch of generation (within and external to Ontario), load levels and the configuration of the interconnected network. The IESO operates to control this to within +/- 200 MW of the scheduled flow for the entire interface, but at times a portion of these loop-flows cannot be controlled. This means that the intertie circuit is likely subject to some amount of loop flow at any given time.

The current Ontario resource mix and loop flows drive a substantial amount of export flow on this intertie – export flow exceeds 1,200 MW from Ontario to Michigan 31% of peak hours,[22] compared to the 1,650 MW export capability. Looking at the Windsor-Detroit intertie specifically, export flow exceeds 300 MW for 25% of peak hours, compared to the approximately 400 MW capability.

[22] Peak hours are defined as 7 AM – 8 PM weekdays, not including holidays or long-term outages.

6. Need for Additional Supply

This section describes the assessment of whether or not additional supply is required to the Focus Area and, more broadly, to the WOL area. Planning criteria were applied in accordance with North American Electric Reliability Corporation (NERC) standards and the Northeast Power Coordinating Council (NPCC) reliability directories to determine system capacity needs.[23] In the context of the bulk system, adequacy is defined as the ability to supply demand, while respecting transfer capability limits across the bulk system and interconnections.[24]

This assessment assumed that the recommendations of the 2019 Windsor-Essex bulk study were implemented – i.e. a transformer station in Lakeshore (Lakeshore TS) and a new double circuit 230 kV line between Lakeshore and Chatham (the Chatham west lines) are in place to facilitate further load supply. The capacity and energy assessments considered both the contribution of existing internal resources and resources external to the area. Distributed generation resources are accounted for in the net demand forecast presented in Section 4.[25]

A number of key sensitivities were considered to determine the magnitude and timing of the need for additional supply capability, including considerations for three demand forecasts (low, reference, high), whether existing resources continue to operate once their contract expires, and the interchange capability between Ontario and Michigan.

As the base case for determining supply needs for the purpose of identifying options, the study assumed that resources would not be reacquired at the end of their contracts and the interchange path between Ontario and Michigan would be maintained through the ultimate solution. Typically, the system is planned to maintain export capability when all transmission elements are in service, not when transmission elements are out of service. The supply need is specified assuming resources are not reacquired because reacquiring a resource is a decision that should be made as per the IESO's Resource Adequacy Framework and should not be presupposed. These assumptions were applied to the three demand forecast scenarios, to define a Low Need, Reference Need and High Need.

Supply needs were also specified under the following sensitivities to help identify interim and near-term actions that could be taken to expedite customer connections until the mid- and long-term solutions can be determined and implemented. Each sensitivity was also applied to the three demand forecast scenarios.

- Sensitivity A: Considering resources in the study area (i.e. the Focus Area or WOL) coming off contract continue to operate, without maintaining interchange capability; and

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[23] Refer to Appendix A for details on the planning assessment criteria.

[24] In comparison, resource adequacy, as defined in the APO and AAR also takes into account the effective capacity of each resource, reflecting allowances for allowances for resource outages.

[25] Refer to Appendix D for further details on the capacity and energy assessments.

- Sensitivity B: Considering resources in the study area would not be reacquired at the end of their contracts, without maintaining interchange capability.

The ability for available resources to meet system needs was evaluated based on the supply assessments presented in the following sections for the Focus Area and for WOL as a whole.

6.1 Supply Need for the Focus Area

Since demand forecasts in the Focus Area are winter-peaking, the capacity and energy requirements are defined by the winter needs. However, when analyzing needs and alternatives, checks were completed to ensure solutions also meet summer needs. In terms of locational constraints, as mentioned in Section 5, supply to the Focus Area is limited by the FIC interface.

6.1.1 Capacity Need in the Focus Area

Based on the Reference Need, to supply the Focus Area until the end of the study period (2035) there is a 2,050 MW winter capacity need, which begins to emerge in 2024 as local resources reach contract expiry. The summer capacity need is generally lower than the winter capacity need, reaching approximately 1,800 MW by 2035 (Reference Need).

However, if resources are considered to be reacquired and interchange capability is not maintained, Reference Sensitivity A, a supply capacity need does not emerge until 2028, which grows to 860 MW by 2035. This indicates that utilizing existing resources and/or limiting interchange capability could address the supply capacity needs in the interim years (2024-2028) until future system reinforcements can come into service.[26]

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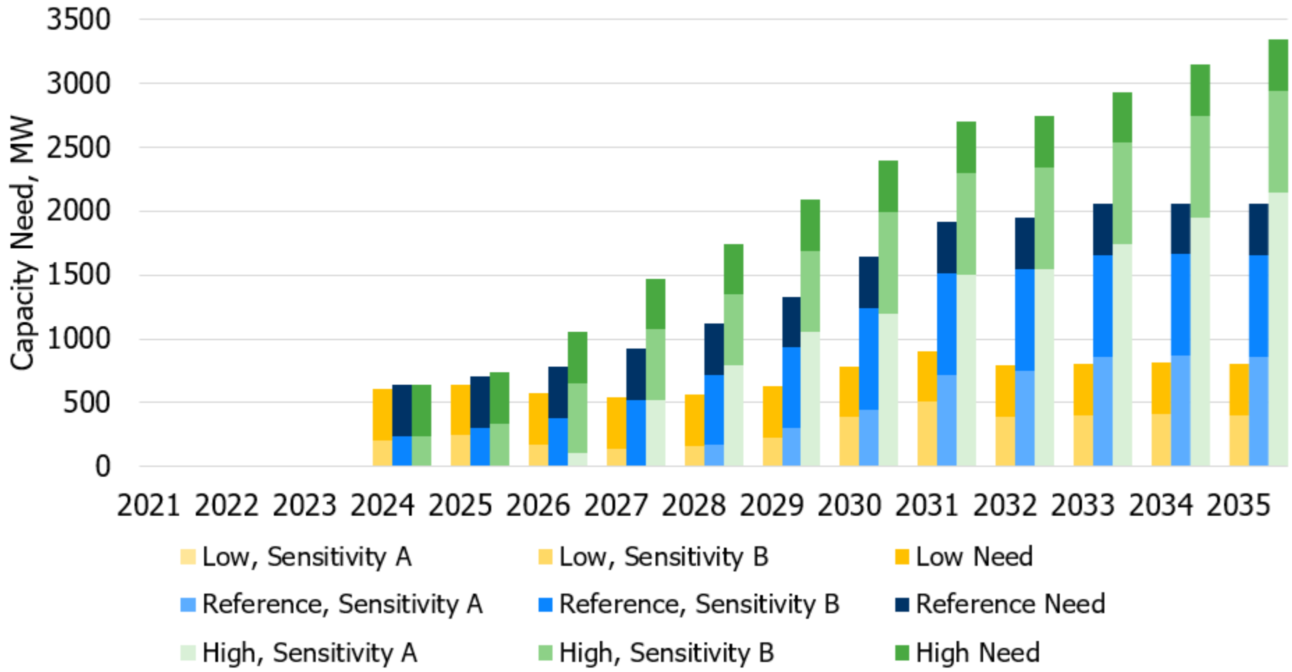
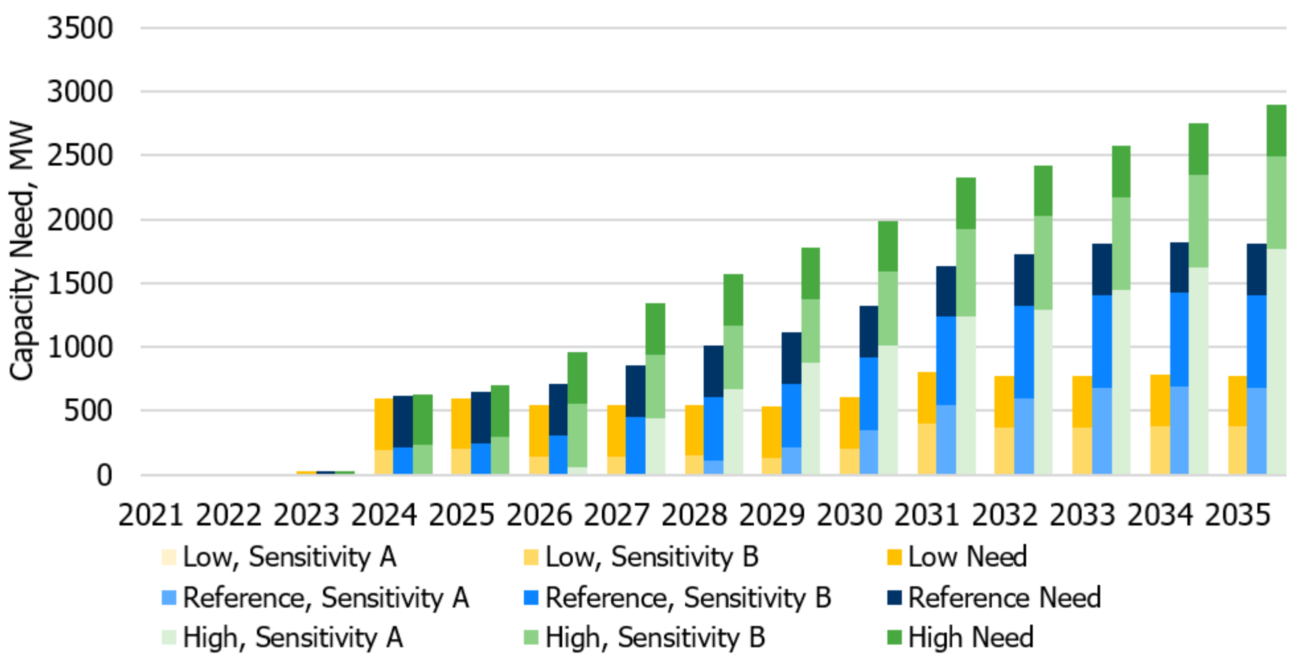
[26] Until West of Chatham reinforcements are implemented, the WOC interface may be more restrictive, however this is being managed by operational measures.

Figure 11 | Focus Area Capacity Need, Winter



The Focus Area capacity Reference Need in the summer is lower than the winter beyond 2023, thus actions taken to address the mid- and long-term winter needs will address the summer needs.

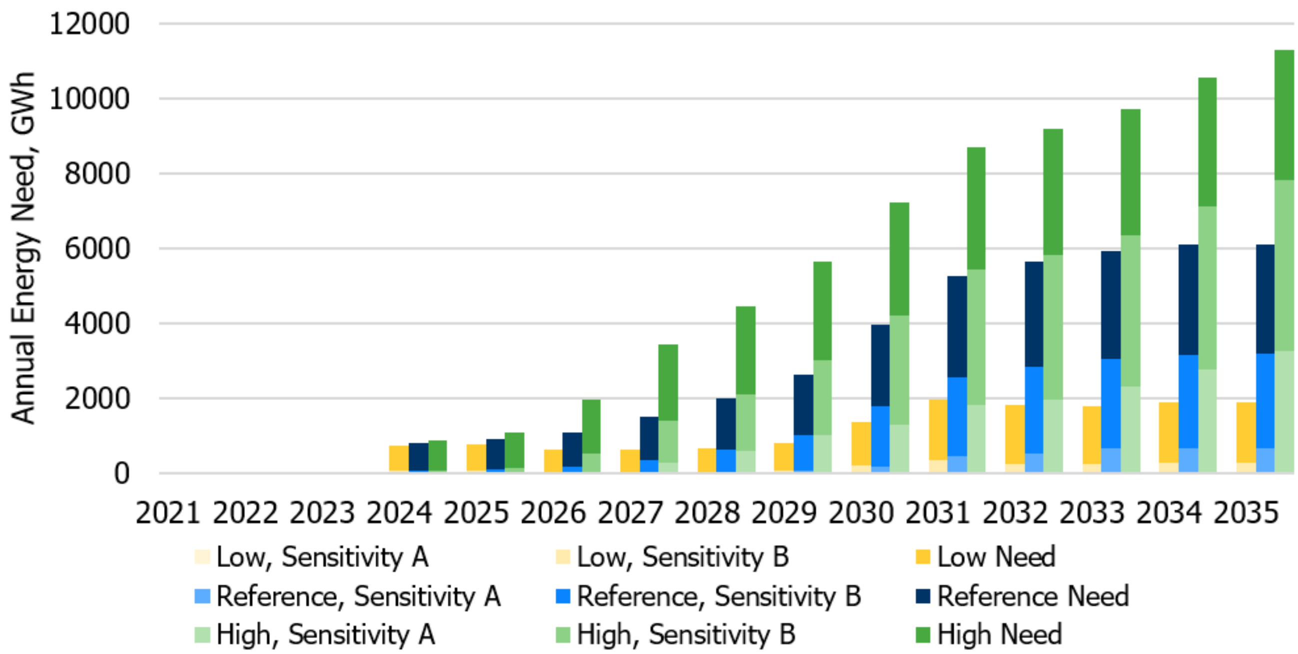
Figure 12 | Focus Area Capacity Need, Summer



6.1.2 Energy Need in the Focus Area

Figure 13 demonstrates that for the Reference Need there is a 6,100 GWh energy need by 2035, which begins to emerge in 2024. Considering resources reaching contract expiry without maintaining interchange capability (Reference, Sensitivity B) by 2035 there is a 3,200 GWh energy need, also emerging in 2024. This indicates there is a significant energy requirement in addition to the capacity requirement outlined in the previous section. This is largely driven by the almost 900 MW of natural gas-fired resources reaching contract expiry in the Focus Area between 2024-2031, that would otherwise be able to contribute to the energy requirements.

Figure 13 | Annual Unserved Energy for the Focus Area for Each Forecast Scenario, Under Different Generation and Export Assumptions



In addition to the annual total energy shortfall, the estimated frequency, duration, and magnitude of unserved energy events were investigated and used to inform options development. Figure 14 contains heat maps to visually demonstrate these characteristics, which were developed using the same assumptions as energy assessment presented in this section.

Figure 14 | Heat Maps Showing Possible Reference Need Energy Events for the Focus Area in 2035

MW Range	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000+	0.1%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1778-2000	1.3%	1.6%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%
1556-1778	2.3%	2.4%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%	0.8%	2.1%
1333-1556	3.5%	3.6%	1.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.3%	2.0%	3.0%
1111-1333	4.2%	4.2%	2.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	3.3%	2.7%	3.9%
889-1111	5.3%	5.2%	3.6%	0.0%	0.0%	0.0%	0.1%	0.0%	1.2%	5.1%	4.3%	5.0%
667-889	6.4%	5.6%	4.7%	0.2%	0.4%	0.7%	2.0%	1.8%	3.5%	5.7%	5.2%	6.0%
444-667	7.0%	6.3%	5.9%	1.5%	3.7%	3.9%	4.6%	4.4%	5.0%	6.6%	6.1%	6.7%
222-444	8.5%	7.4%	7.3%	4.4%	5.8%	5.9%	6.6%	6.6%	7.6%	8.5%	7.7%	8.2%
0-222	8.6%	7.7%	8.5%	7.3%	8.6%	8.3%	8.6%	8.6%	8.3%	8.6%	8.3%	8.6%

Month

MW Range	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
2000+	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1778-2000	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.4%	0.7%	1.0%	0.8%	0.4%	0.2%	0.2%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1556-1778	0.0%	0.0%	0.0%	0.0%	0.2%	0.6%	1.0%	1.6%	1.8%	1.5%	0.8%	0.6%	0.5%	0.5%	0.3%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1333-1556	0.0%	0.0%	0.4%	0.7%	0.9%	1.3%	1.7%	2.0%	2.1%	1.9%	1.4%	0.9%	0.8%	0.9%	0.7%	0.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1111-1333	0.0%	0.3%	1.0%	1.1%	1.3%	1.8%	2.1%	2.2%	2.2%	2.0%	1.8%	1.2%	1.0%	1.1%	1.1%	0.8%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
889-1111	0.4%	0.8%	1.5%	1.7%	2.1%	2.1%	2.2%	2.3%	2.3%	2.2%	2.0%	2.0%	1.6%	1.6%	1.7%	1.7%	1.2%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
667-889	0.9%	1.4%	1.9%	2.1%	2.2%	2.3%	2.5%	2.6%	2.6%	2.7%	2.7%	2.8%	2.8%	2.8%	2.9%	2.9%	2.5%	1.2%	0.2%	0.0%	0.0%	0.0%	0.0%	0.4%
444-667	1.6%	1.9%	2.2%	2.3%	2.4%	2.7%	3.2%	3.8%	4.1%	4.0%	3.9%	3.9%	3.9%	3.8%	3.8%	3.9%	3.6%	2.6%	1.5%	0.5%	0.5%	0.2%	0.2%	1.5%
222-444	2.5%	2.5%	2.5%	2.5%	3.0%	3.6%	3.9%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.1%	3.9%	3.6%	3.3%	3.0%	3.0%	2.8%	2.7%
0-222	4.0%	4.0%	4.1%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.1%	3.9%

Hour Ending

Each cell in the heat map indicates the expected frequency, of all hours of unserved energy, that may occur in that specific hour or month. By 2035, some level of unserved energy is expected to occur each month, with the largest impact in winter. For instance, it is estimated that of all need events in 2035, nearly a tenth is under 222 MW in size and occur in January. The heat maps illustrate that unserved energy in an hour can be as large as + 2000 MW, but that these events are estimated to be infrequent and occurring primarily in winter mornings – such as January or February, between 8-10 AM. From an hourly perspective, a sustained need of approximately 450-650 MW is concentrated from 8 AM – 5 PM, peaking at 8-11 AM. However, the unserved energy profile shifts depending on the season. On a peak summer day, the need could be greater than 400 MW for 11 hours of the day, whereas on a peak winter day there could be only 6 hours when the need is less than 400 MW and 9 hours when the need is greater than 1,200 MW. This indicates that in addition to the capacity need, there is a need for significant and sustained energy production, particularly in the winter, which may limit the resource technologies capable of meeting these needs.

These estimated need characteristics are largely driven by hourly forecast and resource assumptions, and will be subject to real-time conditions, market dispatch, renewable generation output and customer behaviour. The heat maps provide some insight to when, how often, and how large supply needs might be, and supplement analyses completed for peak demand capacity requirements (as described previously in Section 6). Utilization of the hourly need information is further explained in Appendix D, in the context of sizing and evaluating resource options such as gas or storage facilities.

6.2 Supply Requirements for West of London

6.2.1 Capacity Requirements in WOL

Looking at WOL as a whole, there is a winter Reference Need that emerges in 2028. This WOL capacity need continues to grow throughout the study period, and is largely driven by resources reaching contract expiry by 2035, with approximately 4,250 MW coming off contract within the study period (3,100 MW of gas generation). This reflects the fact that resources WOL are critical to supply the area's current demand and to provide reliable supply to forecast growth in winter demand.

If resources are considered to be reacquired and interchange capability is not maintained, Reference Sensitivity A, a supply capacity need does not emerge for the study period – hence this sensitivity cannot be seen in Figure 15 or Figure 16 below. When considering generation coming off contract (but still not maintaining interchange capability), by 2035 there is a capacity need of 880 MW in the winter and 650 MW in the summer, which begins to emerge in 2029 (Reference Sensitivity B). The capacity need is approximately 2,500 MW in the winter and over 2,300 MW in the summer by 2035 if full interchange capability between Ontario-Michigan is maintained, which starts to emerge in 2028 (Reference Need).

Figure 15 | West of London Capacity Need, Winter

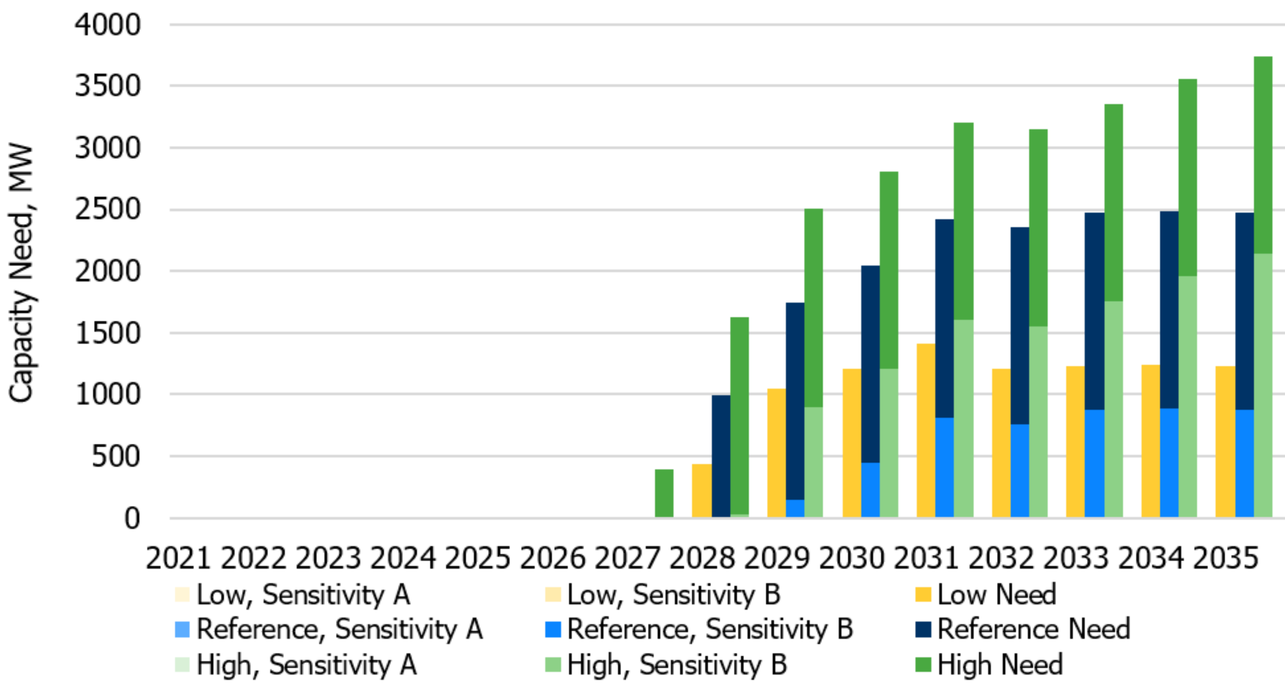
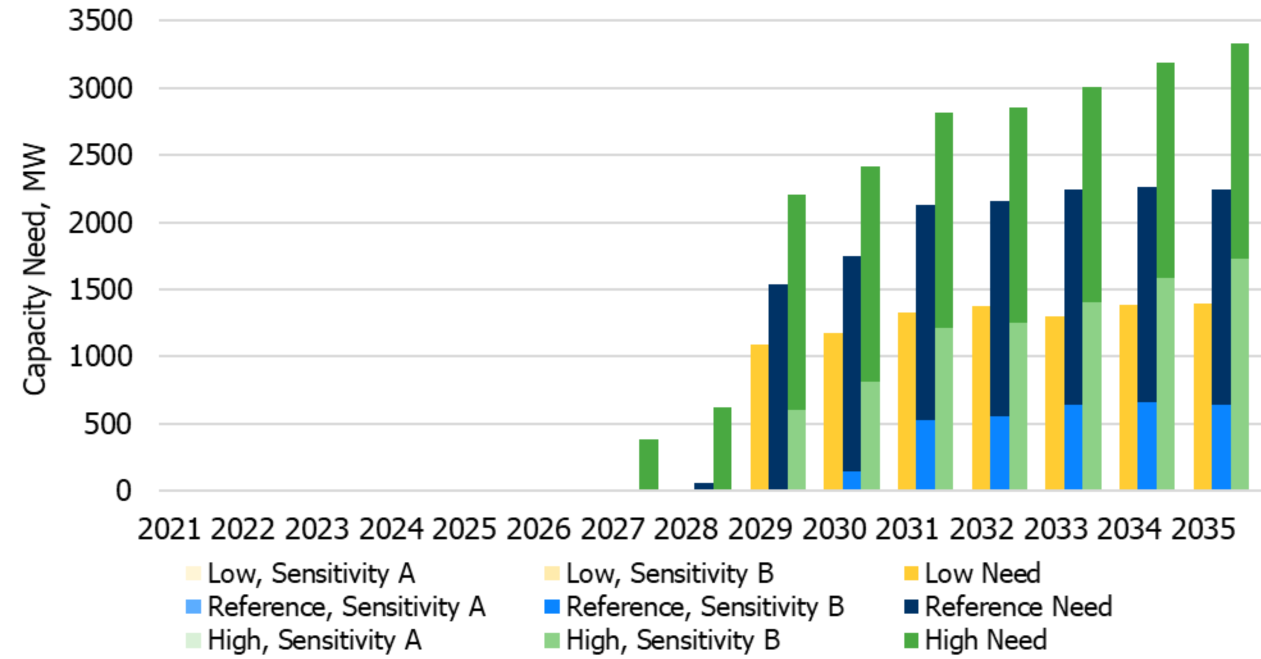


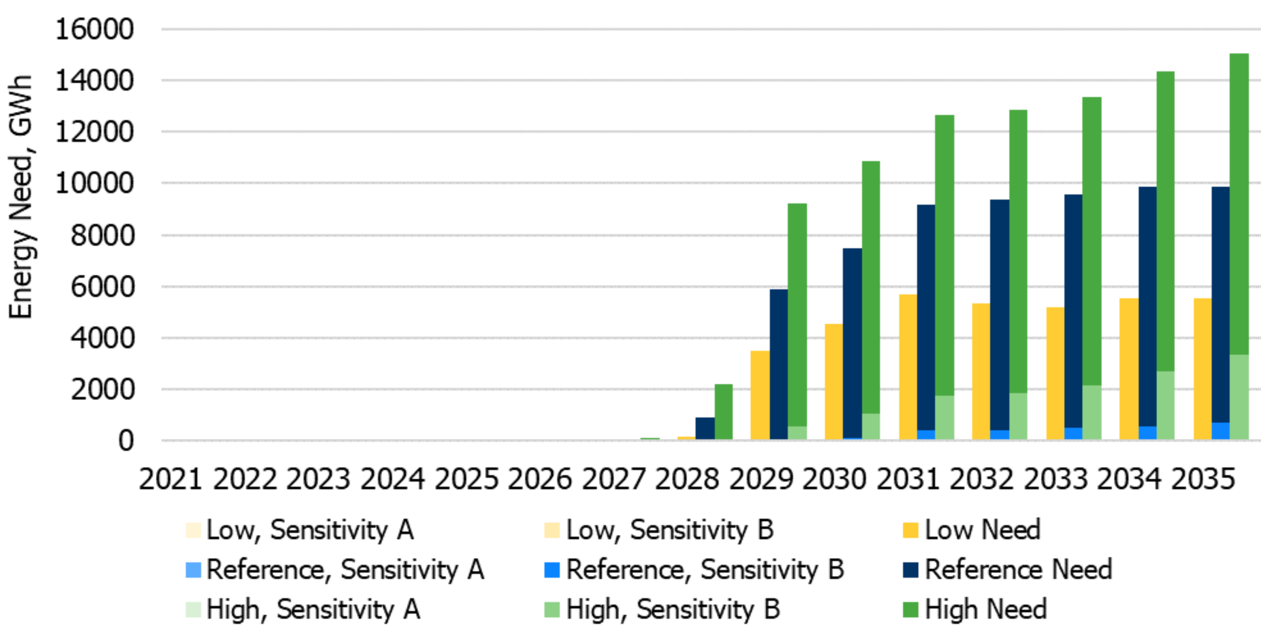
Figure 16 | West of London Capacity Need, Summer



6.2.2 Energy Requirements in WOL

Figure 17 shows that there is a 9,850 GWh Reference Need by 2035, which begins to emerge in 2028. Considering resources reaching contract expiry without maintaining interchange capability (Reference Sensitivity B) there is a 700 GWh energy need by 2035, which emerges in 2030. As expected based on the significant capacity need, there is a large energy requirement, which may impact exports while Ontario loads are peaking.

Figure 17 | Annual Unserved Energy Behind the WOL Interface for Each Forecast Scenario, Under Different Generation and Export Assumptions



7. Near- to Mid-Term Solutions

Section 6 indicated that additional supply to the Focus Area was needed to supply the forecast electricity demand from the agricultural sector. Section 6 also indicated that there is sufficient supply to the larger WOL area, if some the existing resources were reacquired and interchange capability is not maintained. Hence, this Section and Section 8 recommends the most effective solution to supplying the load in the Focus Area and then given that solution, Section 9 presents the amount of resources (existing resources that must be reacquired or new equivalent capacity) that is needed) to ensure adequate supply to the broader WOL area.

Due to the lead time required to implement solutions to meet the Focus Area's supply requirements in the near-term (2021-2027) and mid-term (2028-2029), the IESO recommended actions ahead of the publication of this report. This section provides the rationale for the actions taken by the IESO, which were:

- **Mid-Term Recommendation:** On March 26, 2021, the IESO sent a letter to the lead transmitter in the region, Hydro One, in order to inform them of the need for a new 230 kV double circuit line from Lambton TS southwards to Chatham SS (Lambton South line) and associated station facility expansions or upgrades required at the terminal stations. While Hydro One will initiate the work, engagement and related activities, it will be subject to all required Environmental Assessment, regulatory (e.g., Leave-to-Construct), and other approvals and permits; and
- **Near-Term Recommendation:** On July 19, 2021, the IESO indicated through the AAR an intention to begin bilateral negotiations for Brighton Beach Generating Station. This is an existing facility supporting the area's needs today, that has been identified as required to continue supporting this immediate localized need in the near-term until the transmission line recommended in the March 26, 2021 letter is in-service.

7.1 Near-term Options Analysis

As outlined in Section 6.1.1, a 640 MW supply need into the Focus Area emerges in 2024 based on the Reference Need – which considered resources reaching contract expiry and maintaining full interchange capability. Even if the need to maintain interchange capability is relaxed (Reference, Sensitivity B), and remedial action schemes continued to be relied on, a 240 MW supply need still emerges in 2024.

The need is immediate, triggered by a single contract expiry, and is large in magnitude due to the ongoing and forecast load connections in the Focus Area. The lead time would significantly limit potential cost-effective options (i.e. insufficient time for large transmission reinforcement or for initiating a competitive procurement). The initial magnitude of the need when it emerges and impacts of forecast growth in the area, limit the pool of technically feasible options, even if lead time were not an issue.

Reference, Sensitivity B (considering resources reaching contract expiry but not maintaining full interchange capability) illustrates the minimum capacity and energy requirements in order to defer the need from 2024 to early 2028, when transmission enhancements or other long lead time solutions could be implemented, is 525 MW of capacity and 340 GWh of energy.

In order to determine the most cost-effective way to defer the need, the following options were considered:

1. **Load transfer** – This option considers the ability to transfer load outside the Focus Area.
2. **Local resources** – In this option, the identified capacity and energy needs are met through local resources, either through existing resources whose contracts are expiring between 2024-2027 and/or an equivalent amount of new capacity located within the Focus Area.

As discussed, new transmission would not be implemented in time to meet the 2024 need date. However, load transfers would be a low cost option that could be implemented by 2024. Typically load transfers occur between adjacent or proximate supply stations via the local distribution system, or in some cases by reconfiguring the transmission system (i.e. creation or removal of normally open points (switches) on the lines which could transfer load between pockets of the transmission system). In this case, the supply need extends across the entire Focus Area (Windsor-Essex and Chatham-Kent). Currently, there is the ability to transfer up to 50 MW of the 115 kV load in the Focus Area to an existing 115 kV circuit connected to Scott TS in the Lambton-Sarnia area. However, this creates operability and low voltage concerns connecting load radially along this distance. It is preferable to retain the capability to transfer load during outage conditions for the purpose of load supply. Load transfer of any significant amount of capacity is not technically feasible, based on the lack of available transmission infrastructure to support such a long-distance transfer.

For a resource to meet the need, it must be located in the Focus Area, ideally close to the greenhouse loads and directly connected to an integrated transmission station. They must also be capable of providing a significant energy component along with the required capacity since, until further transmission reinforcements are in place, energy availability within the Focus Area will be limited and worsen as resource contracts expire. Combined with insufficient lead time to carry out a competitive procurement, reacquiring existing resources with expiring contracts presents a cost-effective and least risk solution to ensuring the area's existing and growing needs will continue to be met in 2024.

Considering existing resources supporting the Focus Area's needs today that would be coming off contract between 2024-2027, it was identified that Brighton Beach GS could address the local need while system reinforcements are being constructed to meet the identified deferred 2028 need date. Like Lennox GS, it represents the only supplier in the local area with requisite scale to address this immediate need, offering 588 MW of capacity (approximately 500 MW of unforced capacity[27]) to support the growing loads in the Focus Area. This is an existing facility supporting the area's needs today, which will come to the end of its contract in 2024, but has been identified as being needed to ensure the reliability of the area as an interim solution to address the near-term needs.

[27] Unforced capacity, or UCAP is defined in the AAR as a resource's installed capacity that accounts for seasonal and ambient weather conditions, further reduced by forced outages.

As a result, it is recommended that the IESO plan to begin bilateral negotiations for Brighton Beach GS, until the mid-term recommendation is in-place. By this time, it is likely that competitive mechanisms will help address this growth, offering an opportunity for a wider range of suppliers to contribute through a medium-term or long-term mechanism to meet the mid- to long-term needs.

7.2 Mid-term Option Analysis

Similar to the near-term, the options identified to meet the mid-term needs prioritized the supply of Ontario loads, given known resource constraints – i.e., considering resources reaching contract expiry, but not maintaining interchange capability (Reference, Sensitivity B). As per the near-term options analysis, it was then assumed that resources reaching contract expiry (i.e. Brighton Beach GS) continue to operate until 2028. Thus as outlined in Section 6.1, a supply need into the Focus Area re-emerges in 2028 and grows to approximately 930 MW by 2029. This need is driven by the limitation of the FIC interface.

Thus options considered to address the mid-term needs involve improving the FIC interface limit by addressing the most restrictive path – Lambton to Chatham, or new local generation within the FIC boundary. These options are described below:

1. **Reinforce the existing Flow into Chatham interface (the Lambton South Line)** – In this option, a new 230 kV double circuit transmission line from Lambton TS to Chatham SS forms the next stage of transmission development in the area. The approximately 60-km transmission line would increase the FIC transfer capability to 2,300 MW (a 950 MW increase from 1,350 MW) and increase the deliverability of Lambton-Sarnia resources.
2. **No transmission expansion** – In this option, the identified capacity and energy needs are met through the addition of the least-cost resource alternative, located between Chatham SS and Lakeshore TS. This analysis included 950 MW of additional resources staged in as needs grow, corresponding to the increased capability achieved by the transmission reinforcement in option 1.

Both options increase the supply capability in the Focus Area by 950 MW, which more than addresses the 2029 Reference Need, Sensitivity B.

Note that in option 1, the Lambton South line addresses the upstream FIC constraint and enables the full transfer capability of the previously recommended Chatham west lines and Lakeshore TS, resulting in a WOC limit of 1,950 MW (winter capability).

Note that option 2 was evaluated considering two cost benchmarks based on resource types capable of supplying the magnitude of energy and capacity required - a new natural gas-fired simple cycle gas turbine (SCGT), and an energy storage facility.[28] However, the ultimate resource type could be a combination of various generation and/or storage technologies, depending on a variety of factors including the profile of energy required to meet this need, impact of demand response on greenhouse crop growth cycles, and ratepayer value.

Other options, including wind, solar, and renewables in combination with storage were considered as potential cost benchmarks for the analysis but would be more expensive than the resource options

[28] Refer to Appendix D for details on the resource cost assumptions.

presented.[29] The planned energy efficiency and use of existing distributed energy resources were incorporated into the demand forecasts. Note, as part of the addendum study for the Windsor-Essex IRRP, the IESO is working with distributors to better understand how existing distributed generation connected to their system can be better leveraged to address needs. This work, along with input from stakeholders helps to inform the ongoing regional and future bulk studies. Since there is no firm import agreement impacting the Ontario-Michigan interconnection at this time and the ability for the neighbouring jurisdiction to accommodate full imports is unknown, this was not considered as a potential solution. In addition, flow on the Ontario-Michigan interconnection is scheduled as a whole and so it can help and hinder at the same time. Imports cannot be directed to flow only onto the Windsor-Detroit tie, which would help the capacity need, but proportionally flows across the Sarnia-Port Huron ties as well, which further exacerbate the Lambton-Sarnia deliverability issues.

Due to the sustained periods of energy need (as described in Section 6), a reservoir size of over 11 times the capacity need was needed for the option 2 storage alternative, making it prohibitively expensive. As such, results of the near- to mid-term analysis presented here focused on the transmission and SCGT options comparison only.

Comparing the required near- to mid-term transmission reinforcement to the generation alternative, the Lambton South line results in a net present cost savings of approximately $1.2B for supplying load under the reference scenario and continued use of current local resources.

These results indicate that the Lambton South line is the most economical next stage of bulk system reinforcement. Various sensitivity analyses were conducted to verify these results, yielding the same preferred solution.[30] Under the base cost assumptions, the resource option only starts to become a viable economic alternative when the value of system capacity is greater than $190k/MW-year and more than 95% of the generator's capacity is considered deliverable to contribute to the overall provincial capacity need.

A reinforcement of the transmission system from Lambton TS to Chatham SS would provide additional benefits, unique to a transmission solution, beyond meeting the identified reliability requirements. While both options could help improve the deliverability of resources in the Lambton-Sarnia area, the transmission option decreases congestion of resources in Lambton-Sarnia. Analysis showed that constraints on the dispatch of resources in Lambton-Sarnia are practically eliminated with the transmission reinforcement, however the full potential to import/export across the Ontario-Michigan interconnection is still constrained. While the resource option would reduce the flow on circuits east of Chatham, which could help offset the reduced deliverability of Lambton-Sarnia resources, this would come at the expense of dispatching resources within the Focus Area to allow deliverability of Lambton-Sarnia resources (or in lieu of Lambton-Sarnia resources) at a greater cost in those hours where it would otherwise be constrained.

The Lambton South line also enables the west of Chatham reinforcements previously recommended to operate to their full capability, maximizing the benefit of these assets.[31]

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[29] Refer to Appendix D for further details on the economic assessment methodology.

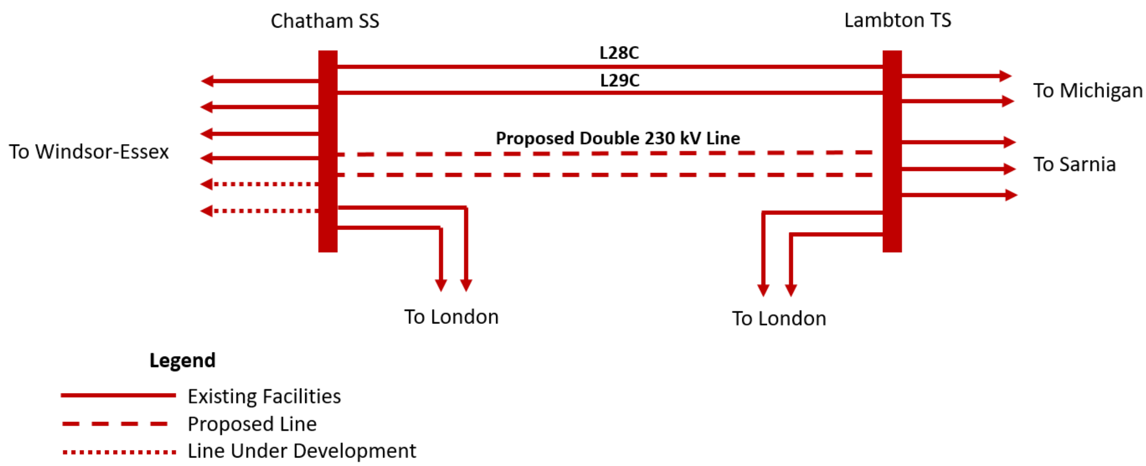
[30] No short circuit limitations were identified at Lambton TS, however if station upgrades are required to maintain the current solid bus operation at Lambton TS the associated cost would be within the bounds of the sensitivity analysis.

[31] As identified in the 2019 Windsor-Essex bulk study, the full capability of the recommended Chatham West lines is currently limited by upstream constraints.

7.3 Near- to Mid-term Recommendations

Based on the analysis presented in this section, to address the near-term needs the IESO plans to begin bilateral negotiations for Brighton Beach GS in the near-term until a new 230 kV double circuit line between Lambton-Sarnia and the municipality of Chatham-Kent is constructed. This line would improve the deliverability of resources in Lambton-Sarnia, and enable up to 900 MW of supply capacity into the Focus Area. On March 29, 2021 the IESO issued a handoff letter to Hydro One, the lead transmitter in the region. The letter recommended that they initiate the work, engagement and activities, subject to seeking Environmental Assessment and Leave to Construct approvals, required to develop and construct a new 230 kV double circuit line from Lambton TS southwards to Chatham SS and associated station facility expansions or upgrades required at the terminal stations.

Figure 18 | Single line diagram of Proposed Near- to Mid-term Facilities



These recommendations address the bulk needs (Reference, Sensitivity B) in the area up to the year 2030. Loads in the Dresden area will require a new supply station connected to the recommended Lambton South line, however local considerations for load supply connections such as these will be addressed through the ongoing regional planning for Windsor-Essex and Chatham-Kent/Lambton/ Sarnia.

8. Long-Term Solutions

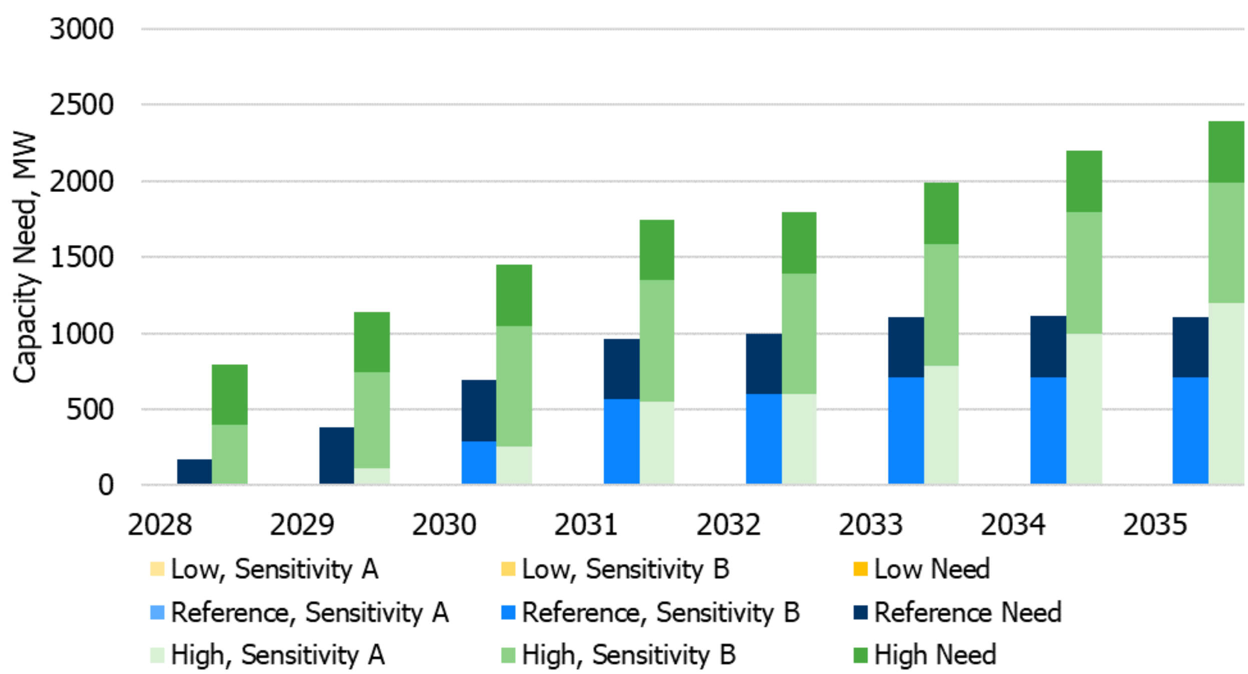
The recommendations outlined in the previous section address the supply capacity need for Reference, Sensitivity B in the area up to the year 2030. This section presents the options considered and analysis conducted to determine the recommendations to address the Reference Need for supply capacity in the Focus Area in the long-term (2030-2035).

8.1 Long-term Objectives

With the Lambton South line, for moderate levels of generation and Ontario-Michigan imports in the Lambton-Sarnia area, supply to the Focus Area is limited by the WOC interface (i.e. exceeding thermal ratings of the interface following the loss of two circuits between Chatham SS and Lakeshore TS). Under higher levels of generation and Ontario-Michigan imports in the Lambton-Sarnia area, the supply to the Focus Area is limited by the Lambton-to-Chatham path and under lower levels of generation in the Lambton-Sarnia area the supply is limited by the Longwood-to-Chatham path. These constraints correspond to a winter capability of 1,950 MW for the WOC interface and 2,350 MW for WOL.

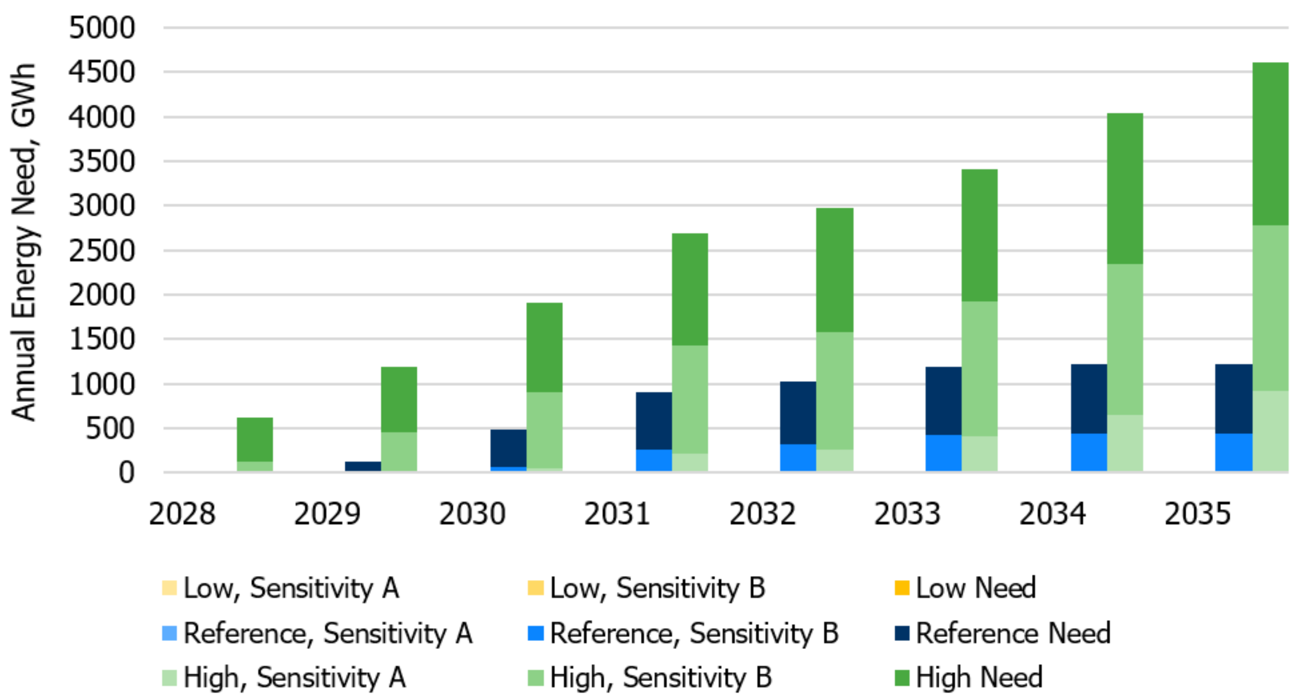
After accounting for the near- to mid-term recommendations, a 1,100 MW supply need remains by the end of the study period, as illustrated in the following figure.

Figure 19 | Winter Capacity Need for the Focus Area with the Near- and Mid-term Recommendations for Each Forecast Scenario, Under Different Generation and Export Assumptions



Correspondingly, by 2035, there remains a 1,200 GWh Reference Need, compared to the 6,100 GWh energy need without the mid-term recommendation. The reduction is due to the improved transfer capability into the area provided by the Lambton-South Line.

Figure 20 | Annual Unserved Energy for the Focus Area with the Near- and Mid-term Recommendations for Each Forecast Scenario, Under Different Generation and Export Assumptions



Two options were considered to address this long-term need for capacity in the Focus Area:

1. **Transmission expansion and local resources** – In this option, the transmission lines along the London[32] to Lakeshore path are reinforced either through:
   a. A new 230 kV double circuit transmission line from Longwood TS to Chatham SS and from Chatham SS to Lakeshore TS, with 400 MW of local resources, or
   b. A new 500 kV single circuit transmission line from Longwood TS to Lakeshore TS, with 550 MW of local resources.

[32] This refers to connection to the existing 500 kV Longwood TS situated south of Glen Oak, within Middlesex County.

For option 1a, the approximately 135-km 230 kV transmission line would increase the transfer capability into the Focus Area by 700 MW.[33] The limiting phenomena with option 1a does not change, however the corresponding limits are significantly improved.

For option 1b, the 500 kV transmission line would increase the transfer capability into the Focus Area by 550 MW (the winter transfer capability of the FIC interface increases from 2,300 MW to 2,850 MW and the WOC interface increases from 1,950 MW to 2,500 MW). The limiting phenomena with option 1b is voltage collapse for supply into WOC for the loss of the 500 kV circuit. As a result, the WOC winter transfer capability is only increased to 2,500 MW (compared to 2,750 MW with option 1a).

Since neither of these transmission options resolve the full 1,100 MW need, additional least-cost resources are needed to address the remaining capacity and energy Reference Needs. The differences in WOC limits for these two variations result in different resource requirements – 400 MW and 550 MW for option 1a and 1b respectively.[34]

2. **No transmission expansion** – In this option, the remaining capacity and energy needs are met through the addition of the least-cost resource alternative, ideally located between Chatham SS and Lakeshore TS. This stage considered 1,100 MW of resources staged in as needs grow, corresponding to the remaining capability and energy needs under the reference scenario.

Note, when determining the long-term needs, it was assumed that existing generators coming off contract did not continue to operate. However, when costing the resource alternative for both options, reacquisition costs were used where appropriate. Long-term use of resources west of Lakeshore would require additional regional transmission reinforcements, as described in Section 9.3. Where appropriate, these costs were included in the following assessment. Refer to Appendix E for further details on the cost assumptions.

A transmission-only option was also considered in the preliminary analysis, which would require a single 500 kV circuit from Longwood to Lakeshore in addition to either of the transmission portions of options 1a and 1b. The second 500 kV circuit would help to serve additional loads beyond the reference forecast. Based on preliminary cost estimates, the transmission-only options were significantly more expensive than the options presented. To accommodate further load growth beyond the Reference Need, it was determined that there is minimal cost advantage to building both single circuits at the same time. However, constructing the single 500 kV line in option 1b to accommodate a future 500 kV circuit does warrant further consideration, as this may impact the operability and capability to address further load growth beyond the Reference Need.

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[33] Note, the winter transfer capability of the WOC interface increases from 1,950 MW to 2,750 MW – an 800 MW improvement. However, depending on the wind output and connection of Dresden loads there may not be a one-to-one increase in the transfer capacity into the Focus Area. Hence, the most restrictive limits were considered.

[34] The exact amount of resources required for option 1 will depend on the connection arrangement of the Dresden loads, within Chatham-Kent. Optimal connection of these loads would be through a station supplied by the new Lambton South lines, which may result in lower resource requirements. However, analysis was completed assuming the worst case scenario, that loads would connect to the existing system ahead of the mid-term reinforcement. The IESO will continue to work with the applicable transmitter(s) and distributors to finalize the load configuration and long-term recommendations, to optimize value for the ratepayer. This would not impact the option 2 resource amount.

8.2 Long-term Options Analysis

Cost Considerations

This analysis uses the near- to mid-term recommendations as part of the base assumptions. Comparing the two combined transmission and resource options to the resource-only alternative, the 230 kV option (option 1a) results in a net present cost savings of approximately $650-1,000M, while the 500 kV option (option 1b) results in a net present cost savings of approximately $450-750M for supplying load under the reference load forecast and continued use of current local resources.

Table 2 | Summary of Long-term Options

Option	Description of Option	Cost ($M)
1a	New double circuit 230 kV line from Longwood to Chatham to Lakeshore, and 400 MW of local resources	500 – 1,000
1b	New single circuit 500 kV line from Longwood to Lakeshore, and 550 MW of local resources	800 – 1,150
2	1,100 MW of local resources (no transmission enhancement)	1,500 – 1,600

These results indicate a combination of transmission and resources is the most cost-effective option. The differential between the 230 kV and 500 kV variations of the combined option is approximately $200-250M.

Although Option 1a is the lower cost option, Option 1b better enables expansion if the demand for electricity in the Focus Area is higher than the Reference load growth scenario. Option 1b leaves more space at Lakeshore TS for an additional 500 kV circuit, if needed to continue to supply the area.

Resource Considerations

Acquired supply resources under these options would provide additional benefits to the system through reliability services (e.g., operating reserve) and capacity to supply provincial needs. While a gas-fired turbine has historically been the pricing benchmark for new resources in Ontario, changes to carbon pricing and community support limit the viability of this assumption. Current carbon pricing has negligible impact on costing of electricity resources in Ontario, but proposed federal policy changes could result in significant costs being passed to ratepayers. This is especially true for new resources, as they are classified differently than existing resources and as such are significantly impacted by carbon pricing. These proposed changes have been accounted for in the operating costs of the resource option. In addition, an increasing number of entities in the area (municipalities, non-governmental organizations, industry associations etc.) are calling for a phase-out of gas-fired electricity and promotion of renewable energy.

Storage, on the other hand, must rely on other energy resources to charge during low-price hours in order to provide energy when needed, behaving as a net load. Thus, storage has a higher dependence on local market signals to determine when to charge and discharge to meet the area's needs. Even with changes to the market to provide stronger signals and more information, there is an inherent uncertainty in the forecast and system conditions, which may increase the costs of this option relative to the study assumptions.

Through various engagement activities undertaken to inform plan development including public webinars and targeted discussions with communities and stakeholders, the IESO has been made aware of various opportunities for alternative resource technologies, e.g., storage, biomass, waste-to-energy, etc., which could help meet these needs and create local jobs at the same time. In addition to this strong interest in alternative energy solutions, another key theme of the community feedback received is the impact that plan recommendations may have on economic development lands and property in the area. The combination of transmission and resources in option 1 is cost-effective, but also helps balance between the land-use impacts of new transmission corridors and local resources, the opportunities they provide to communities, and building a diverse supply within and to the region.

Despite the uncertainty regarding which resource type is the most appropriate benchmark to use, the analysis shows lower costs for the combined transmission and resource option compared to the resource or transmission-only alternatives.

8.3 Long-term Recommendations

Based on the analysis presented in this section, the IESO determined that a new single circuit 500 kV transmission line between London and the municipality of Lakeshore, along with 550 MW of local resources, is the most effective way to address the long-term capacity needs in the area. The transmission line is required to be in service by 2030. The 550 MW of local resources is the total amount required by 2035, where the requirement progressively increases up to this level starting in 2030. It can be met by reacquiring resources that exist today whose contracts have expired between now and 2035, or by acquiring new resources. This combined solution would reinforce the transfer of power towards the Focus Area and enable approximately 1,100 MW of additional capacity within the Focus Area. This preserves the option for a future additional single circuit 500 kV line to continue to supply the area if the load grows beyond the reference scenario. Similar to the near- to mid-term period, advancing either the resource or transmission portion of the long-term recommendation would allow load to connect ahead of the reference scenario and improve the deliverability of existing resources in Lambton-Sarnia earlier.

Figure 21 | Map of Proposed Long-term Transmission Path and New Local Resources

Preserving the capability for the recommended single circuit 500 kV line to accommodate a future additional circuit warrants further consideration and study, which would need to be confirmed before the Environmental Assessment is initiated. While the double circuit line would not offer an improvement in transfer capability with all elements in-service, there is potential value from a land-use and operability standpoint under a scenario where load levels remain relatively stable post 2035, or alternatively, it could help address a scenario where load grows beyond the level that two single circuit 500 kV lines could accommodate.[35]

The Appendices of this report provide data on the forecast load, interface data and assumptions used for resource sizing. This data is provided for interested parties to better understand the long-term profile for the 550 MW of resources required and help develop solution proposals independent of, or in preparation for, upcoming IESO resource acquisition mechanisms.

Ultimately, the IESO's Market Renewal Program will provide more transparent price signals (e.g., locational marginal prices reflecting transmission congestion) that can help further drive market activities in the area which can contribute to addressing the growing needs. Furthermore, the IESO remains committed to transitioning to the long-term use of competitive resource acquisition mechanisms to meet Ontario's resource reliability needs and has developed a Resource Adequacy Framework. Details of the resource need, energy profile, locational considerations and other requirements will inform future AARs and subsequent resource acquistion strategies.

[35] A double circuit 500 kV line does not meet any additional capacity needs relative to the single circuit 500 kV line since transfer capability is most limited by all in-service conditions, where the loss of both a single and a double circuit line need to be respected according to NERC and NPCC standards, so would result in similar limits.

9. Implications on the Broader WOL Area and Linkages with Regional Planning

Section 7 and 8 recommend transmission enhancements and identify the amount of capacity required in the Focus Area to supply the growing demand for electricity. However, as mentioned earlier, in addition to determining the adequacy of the supply to the Focus Area, a review of the supply to larger WOL area, which encompasses the Focus Area, is necessary not only because of the load growth expected in the Focus Area, but also because there is a significant amount of supply resources within WOL and 85% have contracts expiring by the end of the decade. This section identifies the amount of capacity needed to supply the larger WOL area if the recommendations in this report are implemented and assuming that when the generation contracts expire the generation is not reacquired. To address the need for capacity, resources would be acquired as per the IESO's Resource Adequacy Framework – either through existing resources whose contracts have expired and/or an equivalent amount of new capacity located in the WOL area.

This section also identifies any remaining constraints on the capacity resources located in the WOL area to meet provincial capacity needs assuming the recommendations in Section 7 and 8 are implemented.

Finally this Section also discusses the interdependencies between this bulk plan (provincial-level) and the regional plan (local-level) being developed in parallel with LDCs in the region – through the on-going Windsor-Essex IRRP Addendum study and Chatham-Kent/Lambton/Sarnia regional planning cycle.

9.1 Reliability of Supply to the WOL Area

If the recommendations in Section 7 and 8 are implemented, minimum generation levels within the WOL area are driven by the need to maintain export capability on the Ontario-Michigan interconnection under peak loading conditions.

With the transmission component of long-term recommendation option 1b in place, starting in 2030 new or reacquired WOL resources would be required meet the WOL need, including maintaining export capability, growing to a 1,975 MW requirement by 2035. By locating approximately 550 MW of those resources within the Focus Area the supply needs in the Focus area are also addressed. This leaves a need of 1,425 MW to be addressed in the WOL area.

These minimum resource amounts for the Focus Area, along with the remainder needed in the broader WOL area, would be new or reacquired resources and represent what would be required to meet the need out to 2035, where the requirement progressively increases up to that level starting in 2030. These WOL resource requirements would be acquired as per the IESO's Resource Adequacy Framework and can be met by reacquiring resources that exist today whose contracts will expire between now and 2035 and/or by acquiring new resources.

9.2 Deliverability of Supply in the Focus Area and WOL area to the rest of Ontario

As described in the Annual Planning Outlook (APO), there is a growing need for additional capacity in Ontario emerging in 2022, exceeding 6,000 MW in 2026 as demand increases and available capacity decreases. Generation in the Focus Area and WOL area could contribute to meeting that need and this revenue stream has been incorporated into the cost assessment of the near- to mid-term and long-term options.

9.3 Interdependency with Regional Planning

In parallel with this bulk study, transmission planning continues at the regional level through the on-going Windsor-Essex IRRP Addendum and the Chatham-Kent/Lambton/Sarnia regional planning cycle which recently began (Q3 2021) to address remaining local customer supply needs. While the focus of this bulk study is to address bulk transfer limitations and broader energy needs in the WOL area, customer supply needs persist on the regional level and will be addressed in regional plans.

The 2019 Windsor-Essex IRRP triggered an addendum study to address remaining local needs in Kingsville and Leamington. Given the rapid growth and multiple reinforcements in development, an addendum allowed integrated regional planning at the local level to continue in tandem with the WOL bulk study. The addendum is focused on enabling further distribution load connections in Kingsville and Leamington, along with addressing the remaining load restoration and security needs in Leamington. The final recommendations for the addendum are expected by Fall 2021, and will outline next steps for local supply stations and connection facilities.

The recommendations from bulk and regional planning are linked, as the outcomes of one influences the other. Depending on where the 550 MW of capacity recommended in Section 8 is located within the Focus Area, a double circuit 230 kV transmission line between Windsor and Lakeshore may be needed to address local reliability issues. Concentrating the 550 MW resource requirement entirely in Windsor or entirely in Lakeshore may necessitate a transmission reinforcement between Windsor and Lakeshore. While the ideal location for new resources to serve the growing loads would be connected to Lakeshore TS, locating approximately 100-150 MW of those resources in the Windsor area would maintain the Ontario-Michigan interconnection capability and offset the need for reinforcement between Windsor and Lakeshore. This report only points out this interdependency and has included the associated costs in the assessment of long-term options discussed in Section 8, however the Windsor-Essex IRRP Addendum will provide the details of the limitations and need.

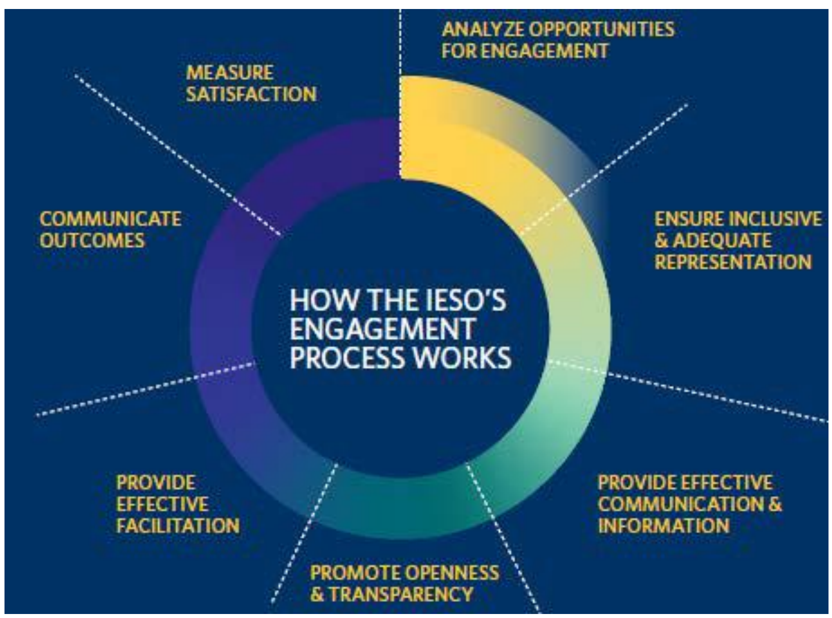
10. Engagement

The IESO is currently developing a formalized process for bulk system planning to enhance transparency and opportunities for stakeholder input. As part of that initiative, defining how stakeholders can participate in the electricity planning process and be kept informed has been identified as a critical component of the process design. Providing opportunities for input in the transmission planning process enables the views and preferences of communities and stakeholders to be considered in the development of the plan, and helps lay the foundation for successful implementation. The IESO has endeavored to encompass those principles throughout the WOL bulk work. This section outlines the engagement principles as well as the activities undertaken to date for WOL.

10.1 Engagement Principles

The IESO's engagement principles help ensure that all interested parties kept informed and enable opportunities for purposeful engagement to contribute to electricity planning initiatives such as the development of this WOL bulk plan. The IESO adheres to these principles to ensure inclusiveness, sincerity, respect and fairness in its engagements, striving to build trusting relationships as a result.

Figure 22 | The IESO's Engagement Principles



10.2 Engagement Approach

To ensure that the bulk plan reflects the needs of Indigenous communities, community members and interested stakeholders, engagement involved:

- Leveraging the Southwest Bulk Planning Initiatives webpage and Windsor-Essex Regional Planning engagement webpage on the IESO website to post updated information, engagement opportunities, meeting materials, input received and IESO responses to the feedback;

- Regular communication with communities, stakeholders and interested parties through email, Southwest Regional Electricity Network updates, and IESO weekly Bulletin;
- Public webinars; and
- Targeted outreach throughout plan development with municipalities, customers, Indigenous communities and rights-holders, and those with an identified interest in southwest Ontario electricity issues. These discussions were instrumental in garnering feedback about increased expected economic development being driven by high greenhouse growth in Kingsville, Leamington and Dresden, as well as increased growth in residential and industrial developments.

Two public webinars were held at major junctures during bulk plan development to give interested parties an opportunity to hear about its progress and provide comments on key components including:

- Electricity demand forecast;
- Identified needs;
- Options evaluation for mid-term and long-term needs; and
- Draft long-term recommendations.

Both webinars received strong participation with cross-representation of stakeholders and municipal and Indigenous community representatives in attendance, and submitting written feedback during a 21-day comment period.

Comments received during this engagement focused on the following major themes:

- Alignment and coordination is needed with other community planning, local developments and growth plans. Future infrastructure and/or electricity supply should consider the priorities of energy and climate action plans and, in particular, alternative energy systems, renewable generation and electrification
- Consideration should be given to non-wires alternatives as part of the recommended solutions;
- Concern around potential delays in needed electricity infrastructure to enable investments and economic development;
- Consideration should be given to the land impact and minimizing the footprint of options;
- Integrated options that provide both local and broader provincial system benefit should be considered;
- Incorporate shifting economies, in particular for different resource technologies, into planning assumptions and cost benefit analysis; and
- Access to additional data used to inform the plan including to provide details on historic demand and future demand assumptions, existing and future system capabilities, and solution

assessment methodology and assumptions used to establish the need and evaluate potential solutions.

In addition to the public webinars and written comment windows, a virtual Southwest Network meeting was held to provide an overview and address questions on the new Lambton-to-Chatham transmission line that was announced in advance of this final WOL bulk plan.

Based on the discussions both on the WOL bulk plan and parallel Windsor-Essex regional planning initiative, it is clear that there is broad interest in several Southwestern Ontario communities to further discuss the potential for solutions that fully utilize existing transmission infrastructure and minimize the footprint of solutions.

Feedback received helped to guide further discussion throughout the development of this bulk plan as well as add due consideration to the final recommendations.

In response to feedback received requesting open access to data, information was provided following the second public webinar on the detail and format of data to be made available to support this bulk plan. Interested parties were able to comment on the proposed data sharing to ensure information provided is in an accessible format. Feedback informed the data that has been made available within the body of this report, the appendices, and supplemental excel files. This information will allow communities, stakeholders and interested parties to make more informed choices and plan strategically.

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

10.3 Bringing Communities to the Table

The IESO held meetings with communities to seek input on local planning priorities and initiatives that should be taken into consideration in the development of this bulk plan. At major milestones in the bulk plan development process, targeted discussions were held with the upper- and lower-tier municipalities in the planning area to discuss identify and address any key issues of concern, including forecast electricity needs, and options for meeting those future needs. These meetings helped to inform electricity needs at the municipal/community-level, develop options and recommended solutions, and further build and strengthen local relationships for ongoing dialogue beyond this bulk process.

10.4 Engaging with Indigenous Communities

To raise awareness about the bulk planning activities underway and invite participation in the engagement process, outreach was made to Indigenous communities and rights-holders within the WOL electricity planning area throughout the development of the plan. Those invited to participate include the communities of Saugeen Ojibway First Nation, Nawash First Nation, Chippewas of the Thames First Nation, Mississaugas of the New Credit, Six Nations of the Grand River, Haundenosaunee Confederacy Chiefs Council (HCCC), Haundenosaunee Development Institute (HDI), Aamjiwnaang First Nation, Bkejwanong (Walpole Island First Nation), and Métis Nation of Ontario.

Indigenous communities and rights-holders were invited to attend a general meeting along with stakeholders in July 2021, and an Indigenous-specific meeting was held the next day in order to provide another opportunity to ask questions and obtain their input to this final bulk plan.

Without limiting general and ongoing issues that community representatives/rights-holders raise, we did not receive specific feedback on WOL. However from other engagements dating back to 2017 with community representatives, the IESO is aware of growing interest from Indigenous communities and rights holders around new electricity infrastructure, including economic participation, relationships with government and industry that help facilitate participation and protection of Aboriginal and treaty rights and the environment.

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

10.4.1 Indigenous Participation and Engagement in Transmission Development

The IESO determines the most reliable and cost-effective option after it has engaged with stakeholders, rights-holders Indigenous communities, and publishes those recommendations in the applicable regional or bulk planning report. Where the IESO determines that the lead time required to implement those solutions require immediate action, the IESO may provide those recommendations ahead of the publication of a planning report, such as through a handoff letter to the lead local transmitter in the region, for example.

As part of the overall transmission development process, a proponent applies for applicable regulatory approvals, including an Environmental Assessment that is overseen by the Ministry of Environment, Conservation and Parks (MECP). This process includes, where applicable, consultation regarding Aboriginal and treaty rights, with any approval including steps to avoid or mitigate impacts to said rights. MECP may delegate the procedural aspects of consultation to the proponent while overseeing those delegated aspects and the consultation process generally. Following development work, the proponent will then need to apply to the OEB for approval through a Leave to Construct hearing, and only if approval is granted, can it proceed with the project.

In consultation with MECP, project proponents are encouraged to engage with Indigenous communities and rights-holders on ways to enable participation in these projects.

11. Conclusions and Recommendations

This report documents the bulk plan that has been developed for the West of London area, and recommends a multi-pronged approach to address the near- to long-term supply capacity needs using a combination of transmission reinforcements, resources, and targeted energy efficiency programs.

The Chatham-to-Lakeshore line, recommended in the Windsor-Essex bulk plan, would increase the overall transfer capability of the bulk transmission system west of Chatham and allow the connection of approximately 400 MW of additional load in Kingsville-Leamington. The Lambton South line would improve the deliverability of resources in Lambton-Sarnia and enable up to 950 MW of supply capacity into the Focus Area (450 MW in Windsor-Essex). The subsequent Longwood-to-Lakeshore line would reinforce the transfer of power towards the Focus Area and enable approximately 550 MW of additional capacity within the Focus Area, or 1,100 MW of capacity in combination with the recommended 550 MW of local resources.

To supply the broader WOL area while maintaining full export capability with all elements in-service, 1,425 MW of additional capacity is needed in the WOL area by 2035, where the requirement progressively increases up to that level starting in 2030, in addition to what is recommended to supply the Focus Area.

This bulk plan has been coordinated with regional plans, with the Windsor-Essex IRRP Addendum set to be completed by fall 2021 and the planning cycle for the Chatham-Kent/Lambton/Sarnia region recently began (Q3 2021). In particular, depending on where the 550 MW of recommended local resources is located within the Focus Area a double circuit 230 kV transmission line between Windsor and Lakeshore may be needed to address local reliability issues and maintain interchange capability under all elements in-service.

For the associated long-term resource requirements, the IESO's Market Renewal Program will provide more transparent price signals (e.g., locational marginal prices reflecting transmission congestion) that can help further drive market activities in the area which can contribute to addressing the area's growing needs. As that is being implemented, the IESO remains committed to transitioning to the long-term use of competitive resource acquisition mechanisms to meet Ontario's resource reliability needs using the Resource Adequacy Framework. Details of the Focus Area and WOL resource need, energy profile, locational considerations and other requirements will inform subsequent resource acquistion strategies, and those strategies will be stated in the corresponding AARs.

For the recommended transmission solutions, the transmitter(s) seeking leave to construct will proceed with development work, including the Environmental Assessment process that is overseen by the MECP. This process includes engagement with Indigenous communities and rights-holders, community members and interested stakeholders and, where applicable, consultation regarding Aboriginal and treaty rights, with any approval including steps to avoid or mitigate impacts to said rights. The MECP may delegate the procedural aspects of consultation to the proponent while overseeing those delegated aspects and the consultation process generally. The OEB will then assess the projects and provide final approval through the Leave to Construct process, following which the transmitter will proceed with implementation and construction.

The IESO, along with the relevant distributors and transmitters, will continue to monitor the load growth, progress of developments toward plan deliverables, conservation measures, and pace of new connections in the Focus Area and the WOL area as a whole to identify any impacts on completed or future bulk and regional plans and recommendations for the areas.

Appendix A – Planning Assessment Criteria

In developing this bulk plan, the IESO followed a number of steps including:

- Data gathering, including development of electricity demand forecasts;
- Conducting technical studies to determine electricity needs and the timing of these needs;
- Developing potential options; and
- Preparing a recommended plan including actions for the near and longer term.

Throughout this process, engagement was carried out with stakeholders interested in the area, in the form of public webinars and targeted discussions with the affected communities, local distribution companies and transmitters.

This bulk report documents the inputs, findings and recommendations developed through the process described above and provides recommended actions for the various entities responsible for plan implementation. The report helps ensure that recommendations to address near-term needs are implemented, while maintaining the flexibility to accommodate changing long-term conditions.

The overall objectives of planning are consistent among both regional and bulk planning, which are the following:

- Ensure reliability and service quality;
- Enable economic efficiency; and
- Support sector policy and decision making.

There are various reliability standards which, as the electricity system planner and operator, the IESO is obliged to meet. NERC and NPCC membership requires the bulk system be planned to consider specific operating conditions, such as peak and light load, and a set of contingencies to ensure the bulk system is planned reliably and meets standards. Additionally, the IESO is required to demonstrate its adherence to these standards through compliance reporting.

Reliability standards require the IESO to define its own performance criteria to meet under the conditions and contingencies specified. The Ontario Resource and Transmission Assessment Criteria (ORTAC) define the planning performance criteria for Ontario which are more specific and/or more stringent standards than NERC/NPCC. The IESO also considers operational issues and solutions that simultaneously consider bulk system reliability needs, regional needs, and assets reaching end of life, as appropriate.

The study used the planning criteria in accordance with events and performance as detailed by:

- NERC TPL-001 "Transmission System Planning Performance Requirements" (TPL-001),
- NPCC Regional Reliability Reference Directory #1 "Design and Operation of the Bulk Power System" (Directory #1), and
- IESO Ontario Resource and Transmission Assessment Criteria (ORTAC).

In addition to meeting established criteria and standards, the IESO also seeks to enable economic efficiency and support sector policy. Bulk system planning has a role in ensuring policy objectives can be incorporated with maximum benefit to ratepayers, and in identifying opportunities for improving overall system economics, especially in a competitive environment. This includes seeking economic opportunities, such as reducing losses, congestion, or other service costs, facilitate intertie/trade requirements, and providing timely and relevant information to market participants to enhance their participation and decision making leading to greater market efficiency and competition. It also includes supporting policy implementation affecting the power grid, such as sensitivity analysis of the economic impact of carbon pricing policies on congestion costs, as well as considering community energy plans and goals.

Appendix B – Load Forecast Data

The following datasets are included in this section and are also available in the excel file provided:

- Overall annual West of London peak forecasts
  - Table 3 & 4: Total coincident low, reference, and high scenarios for summer (May through October) and winter (January through April, November, December)
- Focus Area peak forecasts
  - Table 5 & 6: Total coincident low, reference, and high scenarios for summer (May through October) and winter (January through April, November, December)
- Annual station (those without greenhouse loads) peak forecasts, by region
  - Table 7 & 8: Summer and winter peak planning forecast in the Windsor-Essex region
  - Table 9 & 10: Summer and winter peak planning forecast in the Chatham-Kent/Lambton/Sarnia region
- Annual greenhouse peak forecasts
  - Table 11 & 12: Total West of London coincident low, reference, and high scenarios for summer and winter
  - Table 13 & 14: Peak demand forecast for West of London stations with greenhouse load for summer and winter
  - Table 15: Peak segmentation assumptions for West of London stations with greenhouse load

Refer to the excel file provided for the following datasets:

- Table 16: Forecast West of London greenhouse hourly load profiles (2021, 2035)
- Table 17: Forecast West of London total hourly load profiles (2021, 2035)
- Table 18: Historical hourly Leamington DESN 1 and DESN 2 station load profiles (2020)

Overall West of London Forecasts

Table 3 | Total Coincident Winter West of London Peak Demand Forecast (MW)

Forecast Scenario	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Low	1730	1989	2264	2362	2426	2307	2253	2277	2253	2254	2454	2254	2273	2281	2275
Reference	1730	1989	2264	2391	2484	2511	2630	2834	2953	3095	3461	3400	3520	3532	3521
High	1730	1989	2265	2393	2517	2787	3179	3464	3713	3852	4245	4198	4399	4599	4786

Table 4 | Total Coincident Summer West of London Peak Demand Forecast (MW)

Forecast Scenario	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Low	1893	2030	2081	2111	2120	2108	2119	2124	2115	2128	2158	2166	2090	2181	2192
Reference	1893	2030	2081	2115	2151	2168	2313	2470	2564	2697	2963	2952	3036	3056	3037
High	1893	2030	2093	2139	2198	2417	2796	3028	3228	3364	3651	3648	3801	3980	4121

Focus Area Forecasts

Table 5 | Total Coincident Winter Focus Area Peak Demand Forecast (MW)

Forecast Scenario	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Low	1204	1458	1728	1810	1843	1775	1744	1759	1744	1736	1857	1744	1754	1762	1755

Forecast Scenario	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Reference	1204	1458	1728	1838	1901	1979	2123	2316	2446	2592	2863	2897	3007	3013	3007
High	1204	1458	1729	1840	1935	2255	2673	2946	3206	3349	3648	3694	3886	4096	4293

Table 6 | Total Coincident Summer Focus Area Peak Demand Forecast (MW)

Forecast Scenario	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Low	1124	1284	1526	1593	1601	1542	1543	1549	1534	1535	1613	1542	1544	1553	1547
Reference	1124	1284	1526	1617	1650	1711	1858	2011	2114	2249	2449	2498	2580	2595	2580
High	1124	1284	1533	1631	1697	1960	2341	2570	2777	2916	3137	3194	3345	3519	3665

Annual Station Peak Forecasts, by Region

Table 7 | Winter Planning Peak Demand Forecast for Windsor-Essex Region Stations with No Greenhouse Load (MW)[36]

Station	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Belle River TS	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Crawford TS	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Essex TS	36	36	34	33	33	32	32	32	32	32	32	33	33	33	33

[36] No changes to these forecasts (net and coincident) have been made since the 2019 Windsor-Essex IRRP.

Station	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Industrial Customer #1	36	36	34	33	33	32	32	32	32	32	32	32	32	32	33
Industrial Customer #2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Industrial Customer #3	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Industrial Customer #4	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Industrial Customer #5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Keith TS	66	65	64	62	61	61	61	60	60	60	60	60	60	60	60
Lauzon DESN 1	80	79	77	75	74	73	73	73	73	73	73	73	73	74	74
Lauzon DESN 2	70	70	70	70	69	69	69	69	68	68	68	68	68	68	68
Malden TS	104	104	101	100	99	98	98	98	98	98	98	98	98	98	99
Tilbury TS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tilbury West DS	14	14	14	14	14	14	14	15	15	15	15	15	15	15	16
Walker MTS #2	39	39	38	37	36	36	36	36	36	36	36	36	36	37	37
Walker TS #1	37	37	35	34	33	33	33	33	33	33	33	33	33	33	34

Table 8 | Summer Planning Peak Demand Forecast for Windsor-Essex Region Stations with No Greenhouse Load (MW) [37]

Station	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Belle River TS	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
Crawford TS	62	61	60	60	59	59	59	59	59	59	59	59	59	60	60
Essex TS	47	46	46	46	45	45	45	45	45	45	45	46	46	46	46
Industrial Customer #1	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29
Industrial Customer #2	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Industrial Customer #3	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Industrial Customer #4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Industrial Customer #5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Keith TS	58	57	57	57	57	56	56	56	56	56	56	56	57	57	57
Lauzon DESN 1	126	124	123	122	121	121	120	120	120	121	121	121	122	122	122
Lauzon DESN 2	88	88	87	87	87	87	86	86	86	86	86	86	86	86	86
Malden TS	143	141	141	140	139	139	139	139	139	139	139	140	140	140	141
Tilbury TS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

[37] No changes to these forecasts (net, coincident, and corrected for extreme weather) have been made since the 2019 Windsor-Essex IRRP.

Station	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Tilbury West DS	17	17	17	17	18	18	18	18	18	18	18	19	19	19	19
Walker MTS #2	49	48	48	47	47	47	47	47	47	47	47	47	48	48	48
Walker TS #1	47	47	46	46	45	45	45	45	45	45	46	46	46	46	46

Table 9 | Winter Planning Peak Demand Forecast for Chatham-Kent/Lambton/Sarnia Region Stations with No Greenhouse Load (MW) [38]

Station	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Industrial Customer #1	43	43	43	35	35	35	35	35	35	35	35	35	35	35	35
Duart TS	7	7	7	7	7	7	7	7	7	7	8	8	8	8	8
Forest Jura DS	5	5	5	5	5	5	5	5	5	5	5	5	5	6	6
Industrial Customer #2	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Industrial Customer #3	0	0	0	12	12	12	12	12	12	12	12	12	12	12	12
Kent TS	135	136	138	139	140	141	143	144	145	146	148	149	150	151	153
Lambton TS	58	58	58	59	59	59	59	60	60	60	60	60	61	61	61
Modeland TS	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72

[38] These forecasts account for the expected peak contribution of distributed generation, and are coincident for the Chatham-Kent/Lambton/Sarnia region.

Station	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Industrial Customer #4	17	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Industrial Customer #5	16	31	31	31	31	31	31	31	31	31	31	31	31	31	31
Industrial Customer #6	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Industrial Customer #7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Industrial Customer #8	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
St. Andrews TS	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
Industrial Customer #9	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
Wallaceburg TS	29	30	30	30	31	31	31	31	32	32	32	33	33	33	34
Wanstead TS	40	41	42	42	43	43	44	44	45	46	46	47	47	48	48
Wonderland TS	59	60	61	62	63	64	64	65	66	67	68	69	70	71	72
Industrial Customer #10	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Table 10 | Summer Planning Peak Demand Forecast for Chatham-Kent/Lambton/Sarnia Region Stations with No Greenhouse Load (MW) [39]

Station	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Industrial Customer #1	45	45	45	38	38	38	38	38	38	38	38	38	38	38	38
Duart TS	14	14	14	14	14	14	15	15	15	15	15	15	15	15	16
Forest Jura DS	19	20	20	20	21	21	21	22	22	22	23	23	23	23	24
Industrial Customer #2	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57
Industrial Customer #3	0	0	0	12	12	12	12	12	12	12	12	12	12	12	12
Kent TS	156	158	160	161	162	164	165	167	168	170	171	173	174	176	177
Lambton TS	66	66	67	67	67	67	68	68	68	68	69	69	69	69	70
Modeland TS	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97
Industrial Customer #4	18	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Industrial Customer #5	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33
Industrial Customer #6	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
Industrial Customer #7	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9

[39] These forecasts account for the expected peak contribution of distributed generation and extreme weather, and are coincident for the Chatham-Kent/Lambton/Sarnia region.

Station	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Industrial Customer #8	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
St. Andrews TS	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56
Industrial Customer #9	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56
Wallaceburg TS	38	39	39	40	40	40	41	41	42	42	43	43	43	44	44
Wanstead TS	47	47	48	49	49	50	51	51	52	52	53	54	54	55	55
Wonderland TS	97	98	100	101	102	104	105	106	108	109	111	112	113	115	116
Industrial Customer #10	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Annual Greenhouse Forecasts

Table 11 | Total Winter West of London Greenhouse Demand Forecast (MW)

Forecast Scenario	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Low	443	685	964	1038	1035	1042	1045	1044	1046	1047	1035	1047	1045	1045	1046
Reference	443	685	964	1068	1095	1252	1436	1615	1767	1935	2073	2234	2333	2333	2334
High	443	685	964	1068	1126	1533	1997	2258	2543	2711	2874	3046	3229	3423	3628

Table 12 | Total Summer West of London Greenhouse Demand Forecast (MW)

Forecast Scenario	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Low	366	590	833	892	890	895	898	897	899	900	890	900	899	898	899
Reference	366	590	833	916	938	1065	1214	1359	1483	1618	1729	1860	1941	1940	1941
High	366	590	839	930	985	1315	1699	1918	2149	2288	2419	2559	2708	2865	3031

Table 13 | Gross Winter Peak Demand Forecast for West of London Stations with Greenhouse Load (MW)

Station	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Kingsville TS*	123	123	124	124	124	124	124	125	125	125	125	125	125	125	125
Leamington DESN 1*	202	205	205	205	205	205	205	205	205	205	205	205	205	205	205
Leamington DESN 2	203	206	206	206	206	206	206	206	206	206	206	206	206	206	206
South Middle Road DESN 1	-	157	206	206	206	206	206	206	206	206	206	206	206	206	206
South Middle Road DESN 2	-	-	181	206	206	206	206	206	206	206	206	206	206	206	206
Remainder of greenhouse forecast, reference (not yet assigned to a station)	-	80	130	210	240	390	571	752	902	1067	1217	1367	1467	1467	1467
Remainder of greenhouse forecast, high (not yet assigned to a station)	-	80	130	210	271	671	1132	1394	1677	1844	2018	2180	2364	2557	2762

*Station load contains both agricultural and non-agriculture load

Table 14 | Gross Summer Peak Demand Forecast for West of London Stations with Greenhouse Load (MW)

Station	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Kingsville TS*	89	93	93	93	93	93	94	94	94	94	94	94	94	94	94
Leamington DESN 1*	143	143	143	143	143	143	143	143	143	143	143	143	143	143	143
Leamington DESN 2	59	59	60	61	61	61	61	61	61	61	61	61	61	61	61
South Middle Road DESN 1	-	73	86	106	106	106	106	106	106	106	106	106	106	106	106
South Middle Road DESN 2	-	-	65	66	88	94	94	94	94	94	94	94	94	94	94
Remainder of greenhouse forecast. reference (not yet assigned to a station)	106	256	420	482	484	600	746	892	1014	1148	1269	1390	1472	1472	1472
Remainder of greenhouse forecast, high (not yet assigned to a station)	106	256	426	496	531	850	1231	1451	1680	1818	1959	2089	2239	2397	2562

*Station load contains both agricultural and non-agriculture load

Table 15 | Peak Segmentation Assumptions for West of London Stations with Greenhouse Load

Station	Non-Agriculture	Vegetable	Cannabis
Kingsville TS	30%	36%	34%
Leamington DESN 1	30%	52%	18%
Leamington DESN 2	-	74%	26%

Station	Non-Agriculture	Vegetable	Cannabis
South Middle Road DESN 1	-	29%	71%
South Middle Road DESN 2	-	53%	47%
Remainder of greenhouse forecast (not yet assigned to a station)	-	76%	24%

Appendix C – Supply Need Data

Refer to the excel file provided for the forecasted hourly supply need for the following scenarios:

- Table 19: Near-term Supply Need: Flow into Chatham Reference, Sensitivity B Need (2024, 2027)
- Table 20: Mid-term Supply Need: Flow into Chatham Reference, Sensitivity B Need (2028, 2029)
- Table 21: Long-term Supply Need: Flow into Chatham Reference Need with mid-term recommendations; Lambton South line (2030, 2035)

Reference Need refers to the base case for determining supply needs for the purpose of identifying options, which assumes that to supply the reference demand forecast, resources would not be reacquired at the end of their contracts and the interchange path between Ontario and Michigan would be maintained. Sensitivity B considers resources in the study area would not be reacquired at the end of their contracts, without maintaining interchange capability.

Appendix D - Assessment of Supply

The IESO assessed supply to the Focus Area and WOL based on two assessments, capacity and energy. This will be detailed further in the following sections.

Capacity Assessment

A deterministic approach was used to evaluate the need for additional capacity behind the FIC, WOC, and WOL interfaces. A need was identified where the annual coincident load forecast exceeded the total installed capacity of transmission-connected gas generation in winter or summer (discounted by seasonal derates) and the internal and Ontario-Michigan interface transfer limits.

For example, in the Focus Area a Reference capacity supply need is identified when the Focus Area demand plus exports on the Windsor-Detroit intertie, is larger than the Focus Area generation resources (900 MW, less derates and contract expiry) plus the transmission capacity into the Focus Area (i.e., on the FIC interface).

Similarly, a WOL Reference capacity supply need is identified when the WOL demand plus exports on the entire Ontario-Michigan interconnection, is larger than the WOL generation resources plus the transmission capacity into WOL from the rest of the province. When resolving the WOL needs, the location of resources within the Focus Area impacts their effectiveness at meeting the need due to internal constraints within the WOL area. Where impactful, these locational constraints are identified.

The assessment considered the installed capacity of transmission-connected gas generation in winter or summer (discounted by seasonal derates). To be conservative, needs were not discounted by contributions from wind or solar, since these resources cannot be dispatched up, and the output is variable. This variability cannot be accounted for through the deterministic calculations. Most critically, wind generation is higher during off peak periods and therefore not well correlated with gas generation.

Energy Assessment

A deterministic approach was taken to evaluate the need for energy behind the FIC, WOC, and WOL interfaces. A need was identified when the hourly coincident load forecast (plus exports, as appropriate based on the study scenario) exceeded the total installed capacity of transmission-connected gas generation in winter or summer (discounted by seasonal derates) and the transmission interface transfer limits. This unserved energy is another indication of the magnitude of a need behind a transmission interface and also informative of its duration. Similar to the capacity assessment, needs were not discounted by contributions from wind or solar.

Appendix E – Economic Assessment Assumptions

The following is a list of the assumptions made in the economic analysis:

- The net present value (NPV) of the cash flows is expressed in 2020 CAD.
- The USD/CAD exchange rate was assumed to be 0.78 for the study period.
- The NPV analysis was conducted using a 4% real social discount rate. Sensitivities at 2% and 8% were performed.
- An annual inflation rate of 2% is assumed.
- The assessment was performed from an electricity consumer perspective and included all costs incurred by project developers, which were assumed to be passed on to consumers.
- The existing supply resources described in Section 5 were reflected in the analysis. Mid-term analysis assumed that the near-term recommendation is in-place until 2028. Beyond 2028, the mid- and long-term analysis assumed all existing resources in the Focus Area and WOL coming off contract do not continue to operate to better assess the full scope of options required.
- The NPV study period for the mid-term extended from the start of 2028, the year that the solution would need to be in service, to the end of 2097, when a transmission asset replacement decision would be required. Similarly, the NPV study period for the long-term was from 2030 to 2099. For the long-term generation-only alternative, capital injection was estimated as a percentage of overnight capital costs (12%) to extend resource life a further 10 years.
- Reacquisition costs were assumed to be 80% of the facilities' net revenue requirement as the baseline assumption. A sensitivity of 80-20% of the facilities' net revenue requirement was assessed for reacquisition costs. Actual reacquisition costs would be determined through subsequent resource acquisition mechanisms.
- The life of the station upgrades was assumed to be 45 years; the life of the line was assumed to be 70 years; and the life of the SCGT generation and storage assets was assumed to be 30 years and 10 years respectively. The life of the storage asset was based on a capacity of 3,600 cycles, which is assumed to be used to serve the local need first, and then global energy and ancillary services for the rest of the year. Cost of asset replacement were included where necessary to ensure the same NPV study period.
- Development timelines for transmission was assumed to be 6-8 years; development timelines for generation and storage were assumed to be 3 years following a procurement.
- Capital costs for the transmission options were determined based on $2-3M/km estimates for a new double circuit 230 kV line, $2-4.5M/km estimates for a new single circuit 500 kV line, and a $30-35M/station estimate for station upgrade costs required to terminate the new

circuits or add an autotransformer. This was informed by the 2015 SECTR and Bruce-by-Milton cost estimates in the Leave to Construct application evidence on file with the Ontario Energy Board, as well as the input received from Hydro One. A 50% contingency was assumed for the purpose of this analysis.

- Capital cost for the transmission reinforcement between Windsor and Lakeshore required to maintain resources west of Lakeshore (as described in Section 9.3) was included for resource alternatives exceeding 600 MW. A sensitivity of +/- 20% was assessed on the capital and ongoing fixed costs for generation.
- All long-term solutions will require voltage control devices, preferably in the form of small capacitors and reactors throughout the area and/or automatic regulation in the form of a static var compensator. Since this was common to all options, these costs were not factored into this analysis.
- Costs for additional transformation in the 500 kV yard at Longwood TS were included in the long-term option 1a assessment to enable sufficient voltage support and power transfer from the 500 kV bus to the 230 kV bus. Note, this could alternatively be resolved through additional reactive capacity or reconfiguration of the existing transformers in the 500 kV switchyard at Longwood TS.
- The size of the resource option was determined by the capacity needs presented in Section 6. This showed a 2,050 MW capacity need over the 15-year assessment period. Based on the capability of the mid-term transmission option, this was split into 950 MW and 1,100 MW requirements for the mid-term and long-term respectively. Within each assessment, this was staggered into multiple separate units to align with the need growth, and optimize the resource option, so as not to overbuild capacity before it is needed.
- A SCGT was identified as one of the lowest-cost resource alternatives. The estimated overnight cost of capital assumed is about $800-900/kW (2020 CAD) depending on the unit size, based on escalating values from a previous study independently conducted for the IESO.
- Natural gas prices were assumed to be an average of $4/MMBtu throughout the study period
- An energy storage facility was identified as another low-cost resource alternative. Total energy storage system costs are composed of capacity and energy costs (i.e. energy storage devices are constrained by their energy reservoir). The estimated overnight cost of capital assumed is about $1000-1300/kW (2020 CAD) depending on the storage capacity to energy requirement, based on escalating Ontario-specific values from a previous study independently conducted for a collection of entities including the IESO.
- Sizing of the storage solution was based on meeting the peak capacity and peak energy requirements for the local reliability need, such that the reservoir size is capable of using existing gas resources to sufficiently charge to meet the hours of unserved energy.
- Sizing of the storage option for the purposes of this analysis was conducted assuming perfect foresight, i.e. demand is predictable and so the facility knows exactly when and how much energy is needed and charges ahead of time, sometimes requiring multiple days to charge, in order to supply that need.

- Resources were assumed to be sited at the preferred location, at Lakeshore TS or between Lakeshore TS and Chatham TS, up to the capability of the existing system. Costs to address existing short circuit limitations at Leamington TS and Lakeshore TS which limit the amount of resources that can be added at the preferred location were included in the assessments, as appropriate.
- The reference demand forecast is presented in Section 4.3. Sensitivities to test the impacts of the low and high growth scenarios on the NPV were performed. Once the need in each scenario surpassed the capability of the transmission solutions being evaluated (i.e., 950 MW in the mid-term and 1,100 MW in the long-term), the demand was flat lined for the purposes of the production cost analysis. While NPVs were calculated based on the life of the longest asset (70 years), holding demand at the respective mid-term and long-term values ensures an equal comparison of options to continue to meet the reference scenario load.
- The magnitude of demand growth in this area exceeds the capability of energy efficiency or demand response to cost-effectively reduce the needs, and were therefore not considered as alternatives, but is considered further through ongoing regional planning in the area.
- System capacity value was $128k/MW-year (2020 CAD) based on an estimate for the cost of the marginal new resource (Net CONE), a new SCGT in southwestern Ontario, with a sensitivity of +/- 25% assessed.
- Production costs were determined based on energy requirements to serve the local reliability need, assuming fixed operating and maintenance costs of $22-32/kW-year for gas-fired resources and $14/kW-year for storage, variable operating and maintenance costs of $3-6/MWh and a heat rate of 7-10 MWh/MMBtu for gas-fired resources.
- Carbon pricing assumptions are based on the proposed federal carbon price increase, from $50/tonne in 2022 to $170/tonne by 2030, and applied to a facility's production. Existing generators emitting above their carbon allowance pay the federal carbon price on those emissions. A sensitivity of up to +225% was assessed on the carbon costs for the gas-fired generation option to assess the risk of potential policy changes to the current carbon pricing strategy.
- The cost of constraining the generation alternative to produce energy for a local need versus the cost of system supply was considered.
- Reduction of the system cost of an ancillary service, such as operating reserve (OR), was also considered.
- A resource's potential contribution to system needs, outside of serving the local needs, was assessed based on the deliverability of that resource's remaining capacity to province's load center. A sensitivity of +/- 16% was assessed on the system benefit of a resource.