Windsor-Essex Integrated Regional Resource Plan Addendum

February 10, 2022

ieso
Connecting Today.
Powering Tomorrow.

Table of Contents

1. Executive Summary

This report documents the results of the addendum study conducted by the Windsor-Essex Integrated Regional Resource Plan ("IRRP") Technical Working Group, consisting of the five local distribution companies, the lead transmitter, and the IESO. Encompassing both 230 kV and 115 kV high voltage networks in Southwest Ontario, the Windsor-Essex electricity planning region is defined from the City of Windsor to the western portion of the Municipality of Chatham-Kent. It includes large generators in the Windsor areas, diverse growing load centres, and an interconnection point with Michigan's power system.

Strong indoor agricultural growth – primarily due to expanding vegetable greenhouses switching to indoor grow lights and year-round production – has driven significant and fast-growing electricity demand; the agricultural sector demand in this region is expected to grow from an approximately 500 MW winter peak today to around 2,100 MW in 2035. Due to this rapid growth, planning in southwestern Ontario has been occurring continuously over the last few years. In 2019, the IESO released both the 2019 Windsor-Essex IRRP and the 2019 Windsor-Essex Bulk Plan, which made recommendations for supplying this growing load. Subsequently, and developed in parallel with this addendum study, the IESO made further recommendations through the 2021 West of London Bulk Plan.

To conduct this addendum with updated information was first proposed in the 2019 IRRP, specifically to assess remaining local reliability issues in the Kingsville and Leamington areas: capacity needs to enable new distribution-level customers to connect, as well as load restoration needs. After consideration for both wires and non-wires options, the Technical Working Group recommends two new 230 kV load supply stations in the Kingsville and Leamington areas to address the forecast capacity requirements. These stations are to be supplied from new 230 kV double-circuit lines from Lakeshore Switching Station ("SS"), and accompanied by the offloading of the existing Kingsville transformer station ("TS"). Furthermore, it is recommended that Hydro One and its customers determine cost-justified measures (new 230 kV line between Leamington TS and the new stations, distributed energy resources, and/or opportunities for distribution load transfer capability) that can mitigate the load restoration needs.

This planning report also identifies broader interdependencies and longer-term considerations for the local electricity system. Recommendations made in this addendum must be aligned with the timing of the multiple bulk reinforcements that address transfer limitations and energy needs impacting overall supply to Windsor-Essex – including the new 230 kV and 500 kV transmission reinforcements and 550 MW of local resources identified in the 2021 West of London bulk plan. While a recommendation for further transmission reinforcements between the Leamington area and Windsor is not made at this time, this report notes that the long-term location of generation resources and load levels in this region can impact future needs and the requirement for such reinforcement.

With the next cycle of regional planning for Windsor-Essex scheduled to begin in Q3 2022, energy-related developments will continue to be monitored. Multiple pilot projects that are either already underway or could participate in future programs or funding sources outside of regional planning will

help inform the viability of demand-side solutions as greenhouse loads connect. Similarly, there continues to be opportunities for energy efficiency to help manage needs, and industry best practices (i.e., adoption of LEDs) should be monitored alongside the community-led energy plans developed by the County of Essex and City of Windsor as they are implemented.

2. Background

In 2019, as part of the regional planning process formalized by the Ontario Energy Board ("OEB"), the IESO led and published an IRRP for the Windsor-Essex region. The IRRP identified local electricity system needs over a 20-year time horizon, as well as recommendations to address them. It was developed on behalf of the Technical Working Group ("Working Group"), consisting of the following distributors and transmitter that supply the region:

- E.L.K. Energy Inc. ("E.L.K. Energy")
- Entegrus Powerlines Inc. ("Entegrus")
- Enwin Utilities Ltd. ("ENWIN")
- Essex Powerlines Corporation ("Essex Powerlines")
- Hydro One Networks Inc. Distribution ("Hydro One Distribution")
- Hydro One Networks Inc. Transmission ("Hydro One Transmission")

Figure 1 | Map of the Windsor-Essex Region and Kingsville-Leamington Area

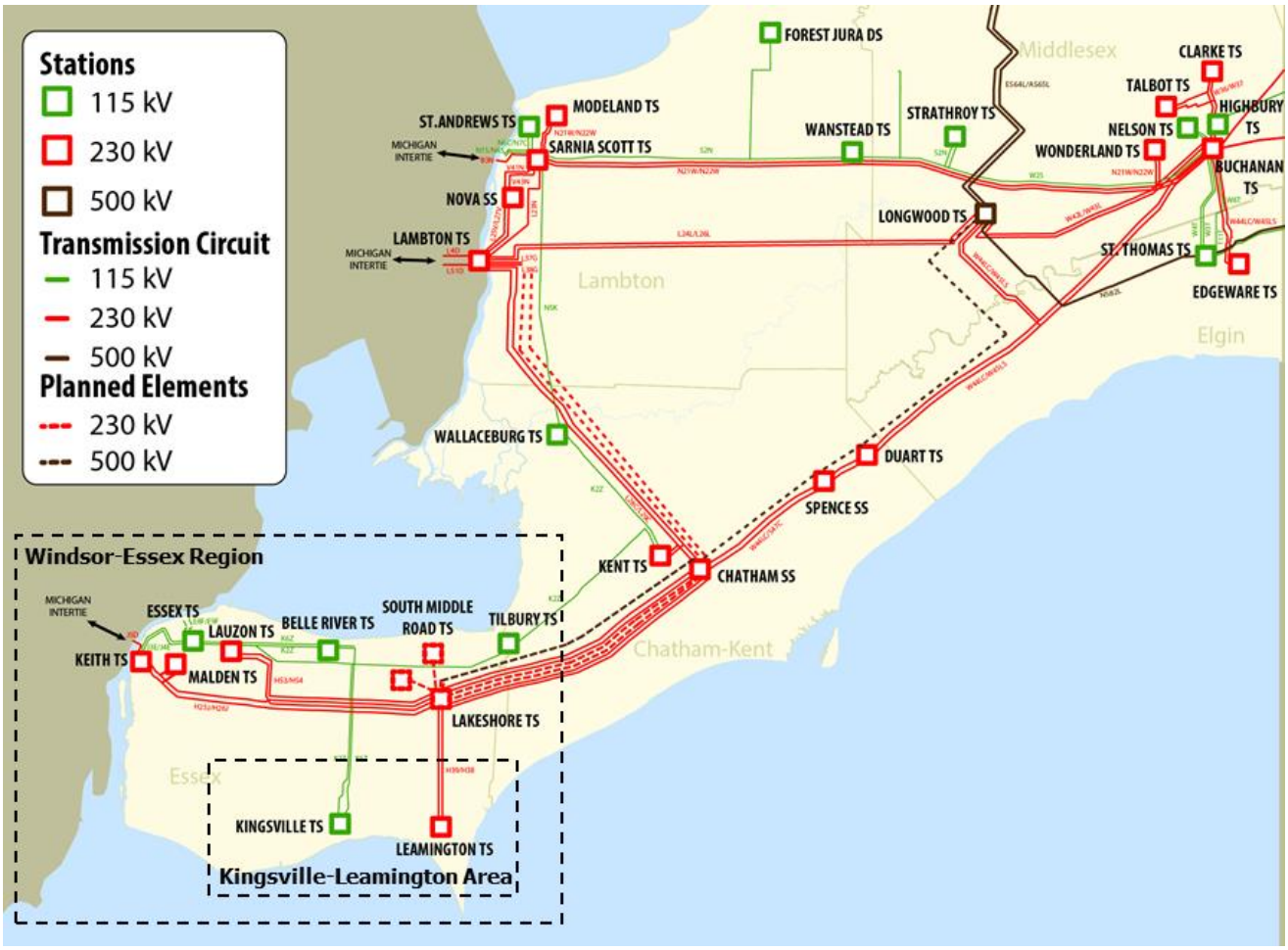
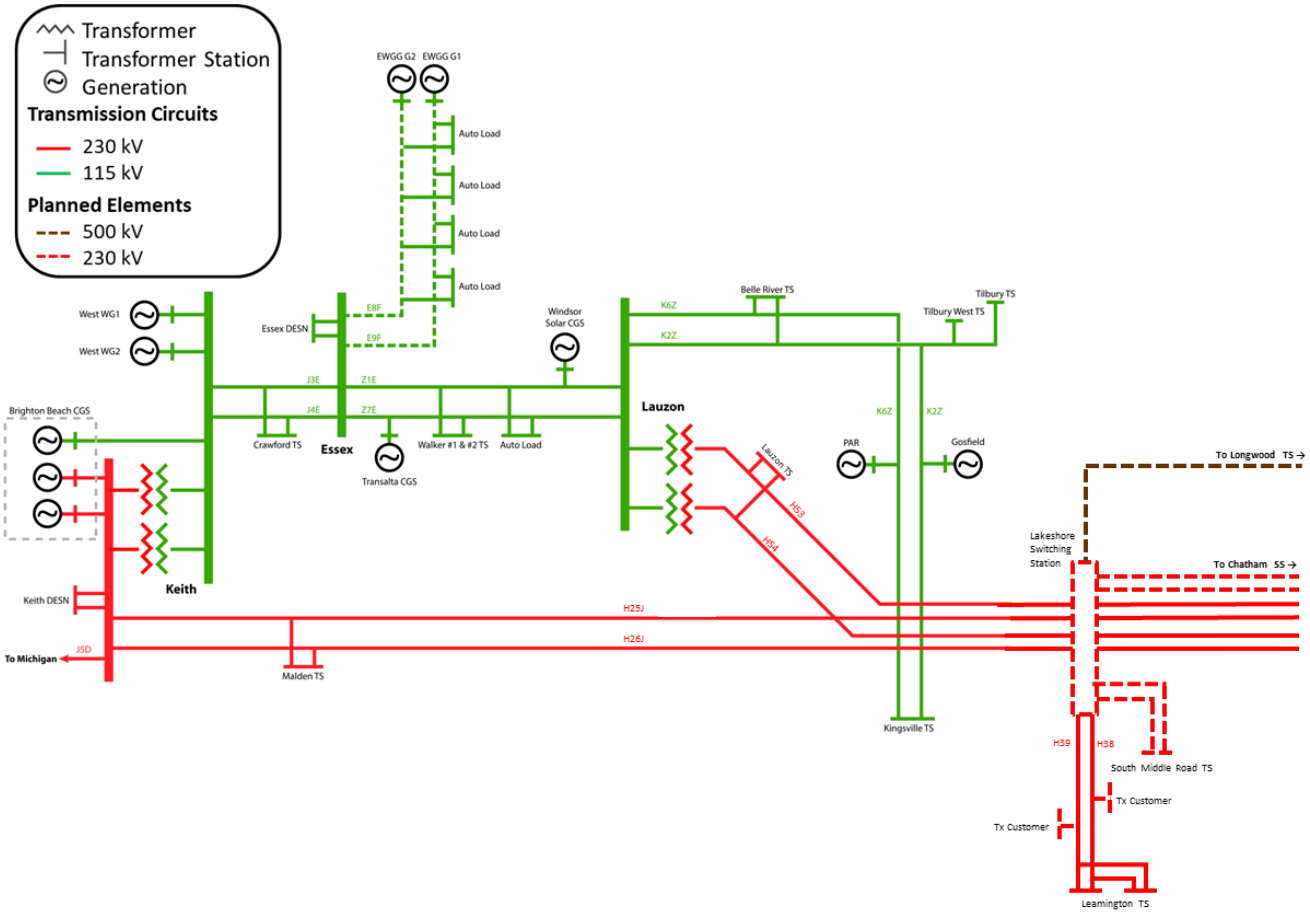


Figure 2 | Windsor-Essex Region Electrical Single Line Diagram



High load growth, driven by the rapidly expanding indoor agriculture sector concentrated in the Kingsville and Leamington area ("Kingsville-Leamington"), necessitated multiple stages of reinforcements to ensure adequate electricity supply to the Windsor-Essex region. A 2019 Windsor-Essex Bulk Plan was completed in tandem with the IRRP, then followed by the 2021 West of London Bulk Plan. A summary of both regional and bulk recommendations stemming from these plans is contained in Table 1.

Table 1 | Summary of Recommended Actions

Plan	Recommendation	Expected In-Service Date
2019 Windsor-Essex IRRP	IESO Grid Innovation Fund targeted call for indoor agriculture projects	Ongoing
	Light-Emitting Diode ("LED") Incentive for greenhouses	Ongoing
	Upsized replacement of end-of-life Keith TS autotransformers T11/T12	2024

Plan	Recommendation	Expected In-Service Date
	Upsized replacement of end-of-life Lauzon TS stepdown transformers T5/T6	2025
2019 Windsor-Essex Bulk Plan	Lakeshore SS[1]	2022
	230 kV double-circuit Chatham-to-Lakeshore line	2025
2020 Windsor-Essex Regional Infrastructure Plan[2]	South Middle Road DESN 1	2022
	South Middle Road DESN 2	2025
2021 West of London Bulk Plan	Bilateral negotiations for continued operation of Brighton Beach Generating Station ("GS") until 2028	2024-2028
	230 kV double-circuit Chatham-to-Lambton line	2028
	500 kV single Longwood-to-Lakeshore line	2030
	550 MW of local generation	2030

At the conclusion of the 2019 Windsor-Essex IRRP ("2019 IRRP"), the Working Group recommended an addendum study ("the Addendum") to address remaining local capacity and load restoration needs concentrated in Kingsville-Leamington. Given the magnitude of the load growth, amount of transmission system changes, and quickly-evolving greenhouse sector in this region, conducting this study enabled remaining local issues to be resolved with the most up-to-date information obtained from the Working Group and through further public engagement. Moreover, by conducting the Addendum in advance of the next Windsor-Essex regional planning cycle starting in Q3 2022 and in parallel with the 2021 West of London Bulk Plan, it facilitated better coordination with bulk recommendations and enabled a continuous dialogue with all stakeholders.

[1] Enables the connection of Leamington DESN 2 (dual-element spot network) in 2020, transmission-connected customers on the Leamington tap in 2022, and South Middle Road DESN 1 and 2.

[2] Led by Hydro One.

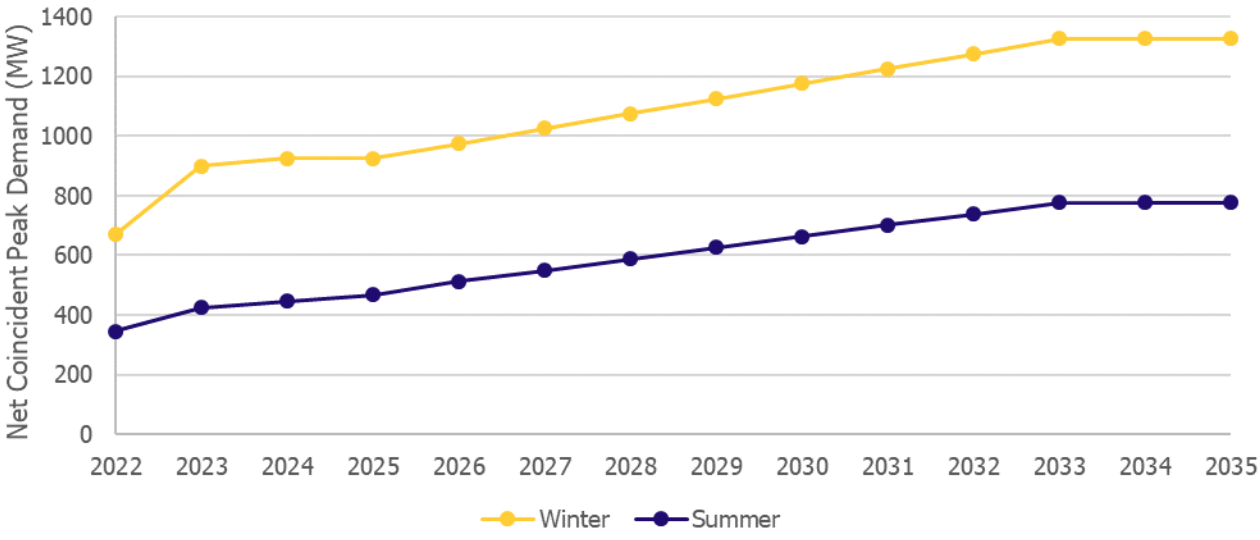
3. Updated Electricity Demand Forecast

The Addendum leveraged the summer and winter peak planning forecasts created for the 2019 IRRP, but updated information regarding the greenhouse load growth located in Kingsville-Leamington. This includes over 150 MW of incremental winter capacity connection requests that were received by Hydro One Distribution after the completion of the 2019 IRRP. These connection requests continue to be driven by lit greenhouse expansions concentrated in Kingsville-Leamington – especially south of Highway 8, between Division Rd in Kingsville and Highway 77 in Leamington. Throughout the Addendum, the Working Group and public stakeholders continued to emphasize the preference for this geographic area; Kingsville-Leamington attracts greenhouse expansions due to the local industry expertise, access to labour, access to both Canadian and U.S. markets, and the availability of supporting services and infrastructure in nearby town centres. Growth with the indoor agriculture sector is also more broadly driven by an interest in increased food security, large contracts for greenhouse produce, winter or year-round production, and new product categories.

The updated Kingsville-Leamington forecast, as shown in Figure 3, accounts for the:

- Existing non-agricultural electricity demand in the area;
- Timing of customer connections supplied by the existing Leamington tap lines, which will be connected to the future Lakeshore SS;
- Timing and capacity allocated to South Middle Road TS, also to be connected to Lakeshore SS; and
- Future distribution-connected customers in the area who are still waiting for capacity.

Figure 3 | Updated Kingsville-Leamington Planning Forecast



The forecast in Figure 3 is consistent with the reference forecast scenario used in the West of London Bulk Plan and assumes the same annual growth rate, but shows only the distribution-connected customers in Kingsville-Leamington and excludes the existing or expected directly-connected transmission customers.[3] Greenhouse load information is primarily provided by Hydro One Distribution, as most of the new growth is in its service territory. This information includes customer connection requests, with details of their location, requested capacity (winter and summer), and crop type (vegetable or cannabis). Figure 3 also reflects the latest status of System Impact Assessment applications, as well as the development time of both Windsor-Essex bulk system reinforcements and new local transformer stations (i.e., South Middle Road TS).

[3] More forecast details can be found in the bulk report and appendices.

4. Study Scope and Needs

By applying the Ontario Resource and Transmission Assessment Criteria ("ORTAC"), multiple types of needs were identified during the development of the 2019 IRRP. These include station and supply capacity needs, as well as load security and restoration needs. These categories of needs are summarized below.

Station capacity: the electricity system's ability to deliver power to the local distribution network through regional step-down transformer stations. The capacity rating of a transformer station is the maximum demand that can be supplied by the station and is limited by the station equipment. Station ratings are often determined based on the 10-day limited time rating ("LTR") of a station's smallest transformer(s), under the assumption that the largest transformer is out of service.

Supply capacity: the electricity system's ability to provide continuous supply to a local area.[4] This is limited by the load meeting capability of the transmission supply to the area. The load meeting capability is determined by evaluating the maximum demand that can be supplied to an area accounting for limitations of the transmission element(s) (e.g., a transmission line, group of lines, or autotransformer), when subjected to contingencies and criteria prescribed by ORTAC. Load meeting capability studies are conducted using power system simulations analysis. Supply capacity needs are identified when the peak demand for the area exceeds the load meeting capability.

Load security and restoration: the electricity system's ability to minimize the impact of potential supply interruptions to customers in the event of a major transmission outage, such as the double contingency loss of two adjacent circuits on a common structure. Load security describes the total amount of electricity supply that would be interrupted in the event of a major transmission outage. Load restoration describes the electricity system's ability to restore power to those affected by a major transmission outage within reasonable timeframes.

The following needs were scoped into the Addendum for further analysis and options evaluation:

- Capacity needs at Kingsville TS;
- Capacity needs in the general Kingsville-Leamington geographic area; and
- Load restoration need on the Leamington tap lines.

These needs are described in detail in Sections 4.1 and 4.2.

[4] Local areas, in the context of IRRPs, are electrically-confined or radial portions of the system within the region or sub-region.

4.1 Capacity Needs

4.1.1 Kingsville TS

Kingsville TS comprises two 115 kV/27.6 kV transformers supplying low-voltage switchgear at a distribution voltage of 27.6 kV. Assuming a 0.95 power factor, it has summer and winter LTRs of 117 MW and 125 MW, respectively. Kingsville TS also has a load meeting capability of 95 MW, limited by voltage change violations for the loss of the K2Z circuit. According to the winter planning forecast, this supply capability is exceeded today by approximately 30 MW, and is currently managed by operational measures outlined in a Remedial Action Scheme.[5]

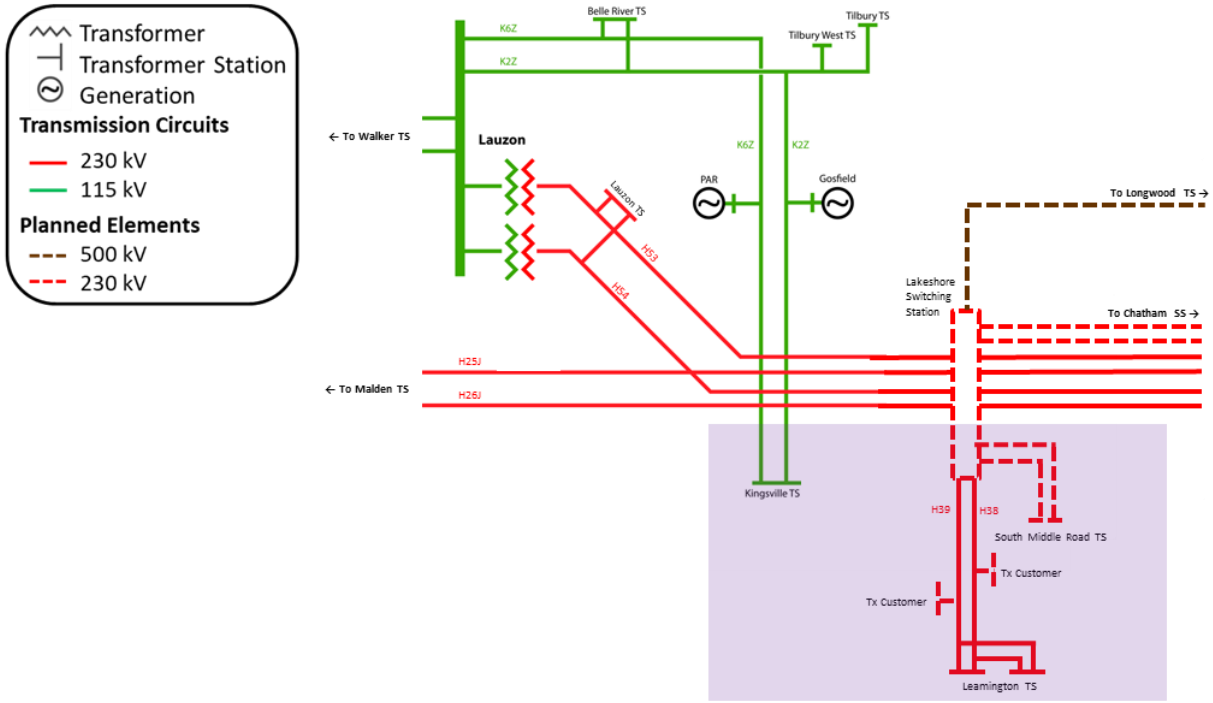
4.1.2 Kingsville-Leamington

Supply to customers located in Kingsville-Leamington is provided through both current and planned transformer stations:

- Existing Kingsville TS on the 115 kV sub-system;
- Existing Leamington DESN 1 & 2 supplied by 230 kV circuits (referred to as the Leamington tap lines) from Lakeshore SS (in-service 2022); and
- South Middle Road DESN 1 & 2 (in-service 2022 and 2025), also supplied at 230 kV from Lakeshore SS.

There are also directly-connected transmission customers who will be supplied from the 230 kV Leamington tap lines starting in 2022. These facilities are shown in a single line diagram in Figure 4.

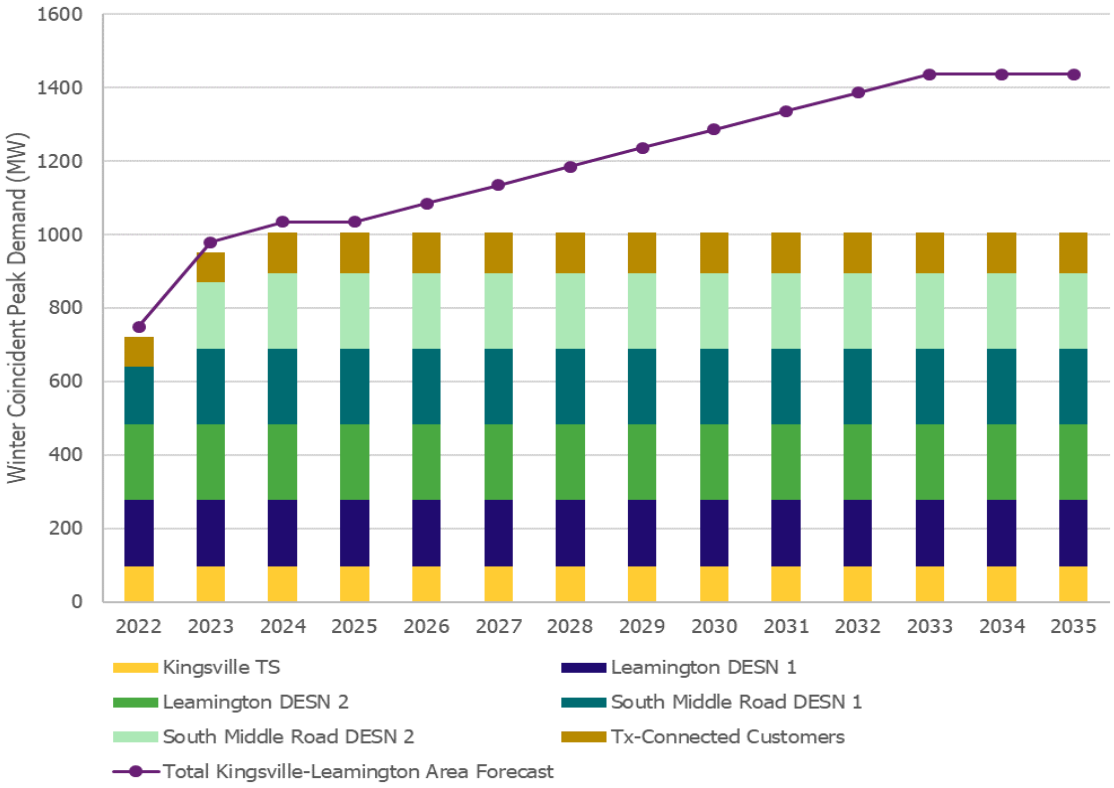
Figure 4 | Electricity Supply in Kingsville-Leamington



[5] Remedial Action Schemes are designed to detect abnormal system conditions and take corrective actions that may include changes in load, generation, or system configuration to maintain system stability, acceptable voltages, or power flows.

With adequate bulk transfer capability into Lakeshore SS, the total load meeting capability of the transformer stations in Kingsville-Leamington is limited by each station's LTR – with the exception of Kingsville TS, which is first limited by voltage change violations as mentioned in Section 4.1.1. Assuming a 0.95 power factor, each 230 kV DESN in this area therefore provides approximately 205 MW and 190 MW of capacity for the winter and summer, respectively. An additional 110 MW of winter capacity is allocated to the transmission-connected customers on the Leamington tap lines.

Figure 5 | Kingsville-Leamington Capacity Need[6]



When comparing the capacity that can be allocated to each station against the demand forecast for Kingsville-Leamington (as shown in Figure 5), a local capacity need arises in 2026.[7] This need is expected to be approximately 440 MW by 2035 – of which 410 MW is forecast based on distribution-level greenhouse customers awaiting connection, and the remaining 30 MW is attributed to the already overloaded Kingsville TS.

4.2 Load Restoration Needs

Once Lakeshore SS is in-service, a load restoration need remains on the Leamington tap lines; two directly-connected transmission customers and Leamington DESN 1 and 2 are currently supplied radially through a 12 km double-circuit line (H38 and H39). Subsequent to an outage of both H38 and H39, supply on the tap would be interrupted by configuration. At winter peak times, this

[6] Demand is shown vertically stacked according to in-service dates of the transformer stations. This total Kingsville-Leamington area forecast line omits anticipated directly-connected transmission customers, other than those known to be connected on the Leamington tap and have completed System Impact Assessments.

[7] This timing and the forecast accounts for the development timelines required for already-planned bulk and regional reinforcements that will enable new customers to connect.

interruption would total approximately 500 MW. Of this 500 MW, Hydro One Transmission has indicated that the restoration targets of load in excess of 250 MW cannot be restored within 30 minutes, nor can load in excess of 150 MW be restored within four hours. This is in violation of load restoration planning requirements (ORTAC Section 7.2) and is summarized in Table 2 below.

Table 2 | Load Restoration Planning Requirements on the Leamington Tap Lines

Time Post-Contingency	ORTAC Requirement: Peak Load to be Restored	Achievable Based on the Current and Planned Transmission System?
Within 30 minutes	250 MW	No
Within four hours	100 MW	No
Within eight hours	150 MW	Yes – the circuits are assumed to be restored by the transmitter within eight hours

While these restoration needs were ultimately identified according to the peak demand forecast for the Leamington tap lines, hourly forecasts helped characterize the needs further. Using load profile data consistent with the 2019 IRRP and the 2019 Windsor-Essex and 2021 West of London bulk plans, an hourly forecast was created for Leamington DESN 1 and 2 and the two directly-connected transmission customers. It leveraged the following load shapes:

- Non-agricultural – consistent with the 2019 Annual Planning Outlook West Zone load profile, and applied to the known existing residential, commercial, and industrial customers at Leamington DESN 1; and
- Greenhouse (vegetable and cannabis) – from load profiles developed through the 2019 IRRP and bulk plan, and applied to the remaining forecast on the Leamington tap.[8]

While hourly load levels depend on real-time factors such as weather, market conditions, and the individual customer or facility behaviour, these forecast profiles helped illustrate the potential impact of a double contingency event across the different months and hours of the year. The figures below contain heat maps that show some load characteristics.

[8] For additional details on load type and crop segmentation, refer to Appendix A.

Figure 6 | Heat Map Showing Possible Frequency of Load on the Leamington Tap Lines in 2035, by MW and Month

MW Range	1	2	3	4	5	6	7	8	9	10	11	12
500+	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
444	2%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
389	3%	3%	1%	0%	0%	0%	0%	0%	0%	1%	2%	3%
333	4%	4%	3%	0%	0%	0%	0%	0%	0%	3%	3%	4%
278	5%	5%	4%	0%	0%	0%	0%	0%	0%	5%	4%	5%
222	7%	6%	5%	0%	0%	0%	0%	0%	0%	6%	6%	6%
167	7%	6%	7%	0%	0%	0%	0%	0%	2%	7%	7%	7%
111	8%	8%	8%	5%	4%	4%	4%	4%	5%	8%	8%	8%
56	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
0	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
Month												

Figure 7 | Heat Map Showing Possible Frequency of Load on the Leamington Tap Lines in 2035, by MW During Winter Hours (January-April, November-December)

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
500+	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
444	0%	0%	0%	0%	0%	1%	1%	2%	2%	2%	1%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
389	0%	0%	0%	1%	2%	2%	3%	3%	3%	3%	2%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
333	0%	1%	2%	2%	3%	3%	3%	3%	3%	3%	3%	2%	2%	2%	2%	1%	0%	0%	0%	0%	0%	0%	0%	0%
278	1%	2%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	2%	2%	2%	2%	2%	0%	0%	0%	0%	0%	0%	0%
222	2%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	1%	0%	0%	0%	0%	0%	2%
167	3%	3%	3%	3%	3%	4%	4%	4%	4%	4%	4%	3%	3%	3%	3%	3%	3%	3%	1%	0%	0%	0%	2%	3%
111	3%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	3%	3%	3%	3%	3%
56	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
0	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Hour																								

Figure 8 | Heat Map Showing Possible Frequency of Load on the Leamington Tap Lines in 2035, by MW During Summer Hours (May-October)

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
500+	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
444	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
389	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
333	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
278	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%
222	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%
167	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	1%
111	1%	1%	1%	1%	1%	2%	3%	4%	4%	4%	4%	4%	4%	4%	4%	4%	3%	3%	2%	1%	1%	1%	1%	1%
56	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
0	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Hour																								

Each cell in the heat map indicates the expected frequency of a load level on the Leamington tap, according to the month or hour of the year or season. For instance, it is estimated that in 2% of total hours in 2035, loading on the Leamington tap exceeds 444 MW and occurs in January. Conversely, load levels are estimated to infrequently exceed 167 MW in summer months such as May to August. From an hourly perspective, a sustained loading of at least 56 MW is estimated across all hours of the day. High load levels greater than for instance, 444 MW, will likely occur during early morning hours like 8 AM – 10 AM during the winter.

While it is difficult to predict the frequency and timing of N-2 contingencies that occur on the 13 km, 230 kV circuits between Leamington TS and Lakeshore SS, this load information helps describe the potential impact of such an event if it were to happen. In general, load levels on the Leamington tap will likely exceed the 150 MW and 250 MW thresholds outlined in the restoration planning criteria. Moreover, it is likely that these load levels will normally persist for periods greater than the 30-minute and four-hour timeframes in the criteria – potentially ~78% of the time in the winter, when electricity demand is driven in large part by the greenhouse customers relying on indoor grow lights for multiple consecutive hours each day. Table 3 summarizes the estimated load behaviour specifically according to the load restoration targets.

Table 3 | Forecast Leamington Tap Load Levels in 2035, According to Load Restoration Criteria Thresholds

Load (MW)	Summer Hours	Winter Hours	Total Hours
0-149	77%	22%	50%
150-249	12%	24%	18%
250+	10%	54%	32%

5. Options and Recommended Plan to Address Regional Electricity Needs

5.1 Screening Options

During regional planning, an array of options can be considered to meet local needs. Wires options include transmission assets such as switching stations, transformer stations, and transmission lines. There are also non-wires options, which encompass both dispatchable and non-dispatchable technologies. Demand response, energy efficiency, distributed energy resources like distributed generation ("DG") or storage, and larger transmission-connected generation can all be considered non-wires options. Operational measures, such as Remedial Action Schemes and control actions like load rejection, can also be leveraged to manage needs.

During an IRRP, options are developed and evaluated to enable the recommendation for the most cost-effective and technically feasible solution to address the identified needs. This process is complemented by considerations for stakeholder preferences and feedback. While traditional wires infrastructure is always a viable option for regional needs, some non-wires options are more suitable for specific need types and characteristics. Therefore, wires options often act as a benchmark for cost effectiveness or a signal for "local value", assuming other options are deemed technically feasible and can meet the need as well. In cases where other barriers downstream of regional planning (i.e., regulatory frameworks for cost-sharing and recovery, or operationalization to meet local reliability constraints) impede the adoption of some of these cost-effective options, pilot or demonstration projects can be explored.[9]

Considerations when identifying the potential for non-wires options in the Addendum are described below.

5.1.1 Non-Wires Options for the Capacity Needs

In general, non-wires options can resolve supply and station capacity needs by reducing net load in the affected area. For station capacity needs specifically, these options cannot be transmission-connected resources that are connected upstream of the limiting step-down transformer.

Given the magnitude of the Kingsville TS and Kingsville-Leamington capacity needs, however, non-wires options are not well-suited to entirely defer or replace wires reinforcements. For instance, the connection of DG is subject to equipment limitations such as minimum loading, feeder capacity, station thermal capacity, and short circuit requirements. As described in Section 4.1, over 400 MW of new station capacity is required in Kingsville-Leamington in the near-term. This amount of incremental DG, regardless of fuel type, is unlikely to be able to connect to the existing and planned transformer stations in the area due to short circuit limitations.[10] The intended operation and reliance on these facilities are also factors for consideration. DG applicants accepted by Hydro One that are

[9] Barriers to non-wires alternatives and recommendations to address them were a part of the Regional Planning Process Review.

[10] At the time of this report, Hydro One has indicated that DG connection space at South Middle Road TS would be known after station completion. For existing station DG connection availability, consider Hydro One's capacity evaluation tool for generation applicants.

intended for "load displacement", for example, are not currently assumed to enable an equivalent amount (MW) of capacity because their operations would be subject to the facility owners' individual strategies (i.e., used for peak-shaving but not generating enough to completely displace the customer's load).[11] In IRRPs, contracted DG output at peak is accounted for during the development of the net demand forecast.

Other non-wires options such as energy efficiency measures and demand response are also unlikely to mitigate the full capacity needs in the Addendum, though they can still provide system and local capacity benefits and there is value in continuing to explore their capabilities. Due to the majority of the greenhouse load being driven by grow lights, the potential for energy efficiency achieved through LEDs – to be used in place of the more traditional high pressure sodium lighting – has been of particular interest. It is expected that the rate of adoption of LEDs will increase over the next 5-10 years, but as of now, the technology is still considered relatively new and factors such as its impact on crop yield, its life span, and the amount of efficiency savings are uncertain.[12] Adjusting the ratio between high pressure sodium lights and LEDs from 75/25 to 50/50, for instance, is only expected to result in about a 9% decrease to the winter peak load forecast by the end of the forecast period. So while the adoption of LED grow lights and other energy efficiency measures in the greenhouse industry are expected to continue and will need to be monitored, there is no confirmation at the time of this report that uptake of these measures can yield winter capacity savings in the range of 400+ MW.

Similarly, demand response can be considered as a potential option for local capacity needs, to the extent that loads in the area are able to curtail lighting during peak hours. Yet many of the challenges first identified in the 2019 IRRP continue to persist:

- The Capacity Auction acquires resources designed to meet global adequacy rather than specific local or regional needs;
- Misalignment between the winter morning peaks expected in Kingsville-Leamington and the provincial peak times that the Capacity Auction resources are required to be available; and
- Uncertainty around the impact of lighting curtailment (depending on duration and frequency) on the growers' crop production.

The amount of demand response that has historically been acquired for system capacity needs can also indicate this option's feasibility for the Addendum. In the latest capacity auction, 63 MW and 59 MW of total capacity cleared for the winter 2020 and summer 2021 obligation periods, respectively. These past auction results provide context as to the scale of demand response that would be required to address the Kingsville-Leamington capacity needs; 60 MW is approximately 2% of the entire West zone peak demand of around 2,700 MW. Displacing the full 400+ MW capacity need requires meeting approximately 80% of existing load in Kingsville-Leamington (i.e., Kingsville TS and Leamington TS) with demand response measures. This is unlikely to be achievable in the near-term.

[11] List of DG applicants can be found on the Hydro One webpage.

[12] Refer to the IESO's collaboration with the Centre for Energy Advancement through Technological Innovation on the "Energy Management Best Practices for Cannabis Greenhouses and Warehouses" report.

Consequently, the Addendum focuses on evaluating wires options to meet the capacity needs of the magnitude that have been forecast for Kingsville-Leamington. To manage and mitigate needs ahead of wires implementation, and to evolve in step with both the broader electricity and greenhouse sectors, there is value in continuing to explore new technologies and demand-side strategies. More on existing initiatives that the IESO is undertaking in this space can be found in Sections 6.2 and 6.3.

5.1.2 Non-Wires Options for the Load Restoration Needs

Due to the nature of planning criteria outlined in ORTAC 7.2, non-wires options such as energy efficiency and demand response cannot be applied to restoration needs because they do not restore supply to transmission customers after a contingency. However, generation options (transmission-connected or distribution-connected) may be suitable depending on technical feasibility and cost-effectiveness. More details on this matter, specific to the Leamington tap load restoration needs, are described in Section 5.3.

5.1.3 Screening Outcomes

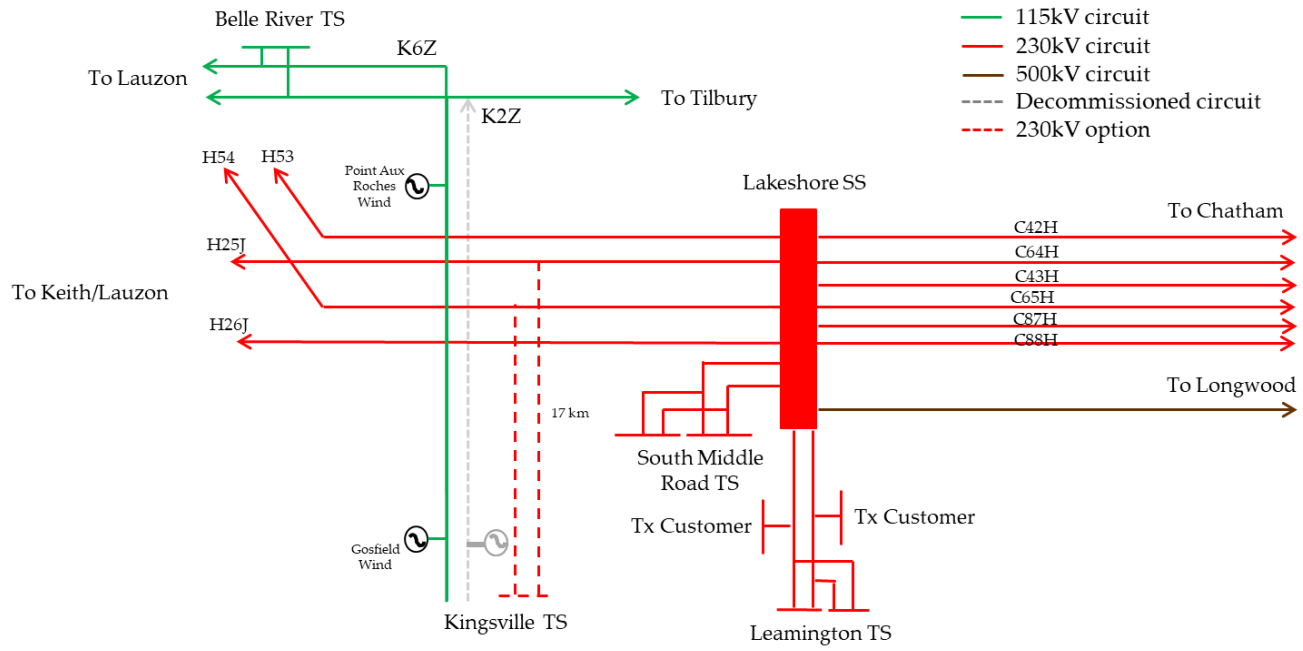
In conclusion, after the considerations described above, the Working Group developed and evaluated wires options to meet the urgent capacity needs at Kingsville TS and forecast for the broader Kingsville-Leamington area. For the load restoration needs scoped into the Addendum, wires options (including new transmission reinforcements or distribution-level transfer capabilities) were considered alongside some non-wires options – specifically, transmission-connected or distribution-connected generation.

5.2 Options for Addressing Supply Capacity Needs

5.2.1 Reconfiguration of Kingsville TS

The conversion of the existing 115 kV Kingsville TS to a new 2 x 75/123 MVA, 230/27.6 kV Bermondsey type DESN was one option considered to address the capacity needs at Kingsville TS and in the broader Kingsville-Leamington area. A reconfigured Kingsville TS could be supplied by new 230 kV double-circuit lines - either approximately 17 km long if building to the H53/54 or H25/26J circuits at Woodslee Junction, or about 26 km if building to Lakeshore SS and following existing transmission corridors. This option was estimated to cost $88-118M (depending on the length of the new line preferred), take 4-5 years, and would require Class Environmental Assessment and Leave to Construct approvals from the OEB.

Figure 9 | Configuration of Option for Reconfiguration of Kingsville TS to 230 kV, Supplied from Woodslee Junction



There are some benefits to the higher voltage supply to Kingsville TS: it would expand capacity in the area (particularly at the already overloaded Kingsville TS), as well as relieve supply capacity constraints on the 115 kV sub-system in Windsor-Essex (see Section 6.1.1). However, this option is still insufficient to meet the forecast growth without two other new DESNs, and has the additional cost of stranding existing assets: the existing 2 x 50/83 MVA stepdown transformers, as well as the 24 km, 115 kV K2Z circuit.

5.2.2 New Transformer Stations and Connection Lines

Another option to increase capacity in the area is the addition of new 230 kV transformer stations and double-circuit 230 kV connection lines. There are a few variations to this option, including the number and general location of the required station(s), as well as the preferred connection point for the new lines.

As described in Section 3, updated information on the distribution customer queue for Kingsville-Leamington was incorporated into the Addendum during its development. At the time of this study, the local forecast capacity need is approximately 430 MW – enough to warrant consideration not for one new 230/27.6 kV DESN station, but two.

New 230 kV connection lines would be required to supply these DESNs for two key reasons: the majority of the customer connection requests are located around Kingsville TS and Leamington TS, but both the existing 115 kV KxZ circuits and the 230 kV Leamington tap are unable to accommodate the incremental 410 MW that the DESNs would add. Moreover, given the density of load customers already supplied from the stations in the area, Hydro One Distribution indicated technical challenges (i.e., lack of spacing for feeder egress and/or lengthy feeders) by continuing new feeder buildout from the existing stations. Transmission-level savings from a shorter 230 kV line to a single site with

both new DESNs would result in additional distribution-level costs and increased difficulty for the feeder buildout.

Consequently, three options (shown in the figures below) were considered for building the new radial 230 kV line to connect the two proposed DESNs:

1. ~13 km from H53 and H25J at Woodslee Junction
2. ~22 km from Lakeshore SS
3. ~45 km from Keith TS

Figure 10 | Configuration of Option 1 for New 230 kV Transformer Stations and Connection Lines

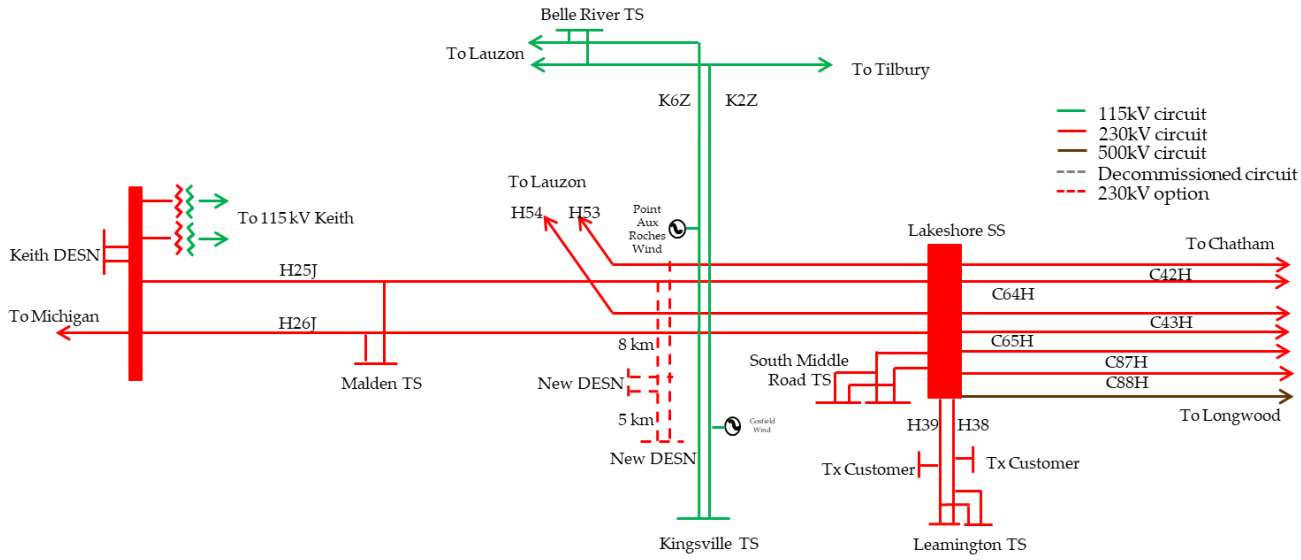


Figure 11 | Configuration of Option 2 for New 230 kV Transformer Stations and Connection Lines

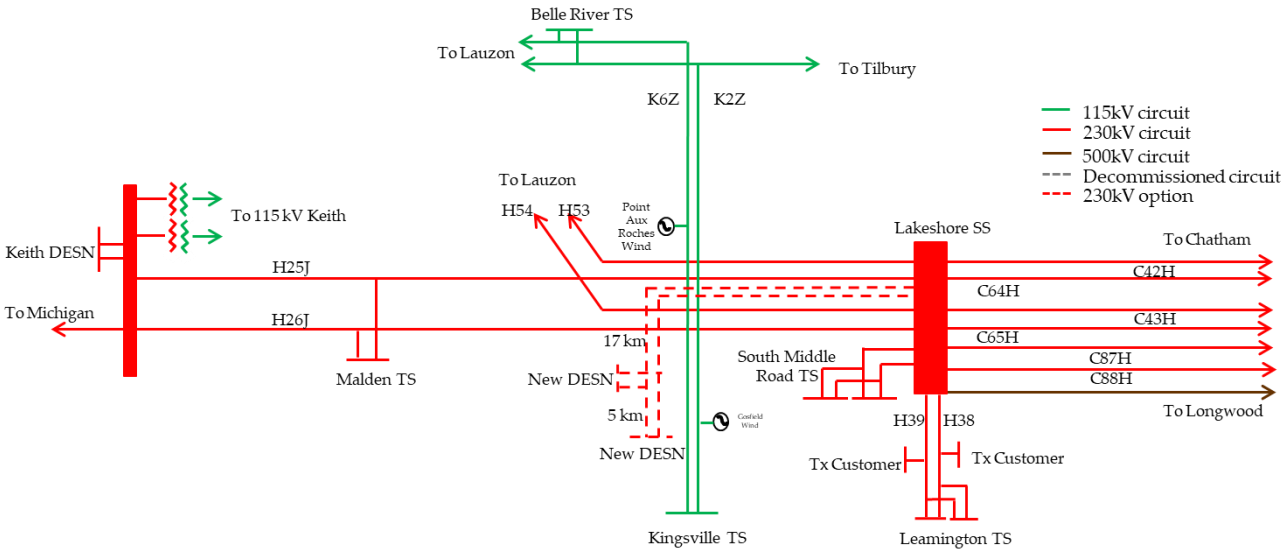
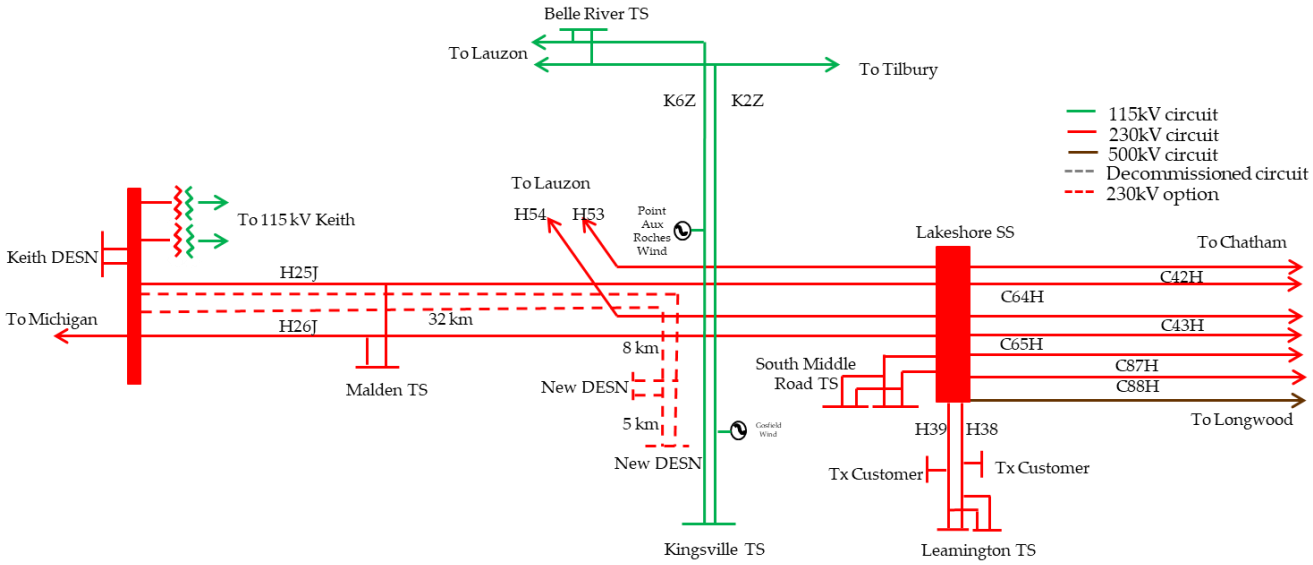


Figure 12 | Configuration of Option 3 for New 230 kV Transformer Stations and Connection Lines



All of these options would provide some incremental capacity to the area, but to varying extents. Option 1, with the shortest new connection lines, is the most inexpensive of the three configurations but enables less capacity than the full LTRs of the DESNs due to voltage limitations. It also provides less flexibility for the wires option proposed in Section 5.3.1. Options 2 and 3 are similar in that the proposed connection lines would extend to a station (rather than tapping the existing 230 kV circuits in the area), but Option 2 would be less expensive due to the shorter circuit length. Option 2 enables approximately 410 MW of station capacity with the two new DESNs, at a total estimated cost of $140M. It too would require 4-5 years, a Class Environmental Assessment, and Leave to Construct approval. Furthermore, it still preserves flexibility for a long-term reinforcement to Keith TS to increase supply to Windsor (see the interdependencies with the J3E/J4E sub-system supply capability in Section 6.1.2).

5.2.3 Recommendation

At the conclusion of the 2019 IRRP, options to address the overload at Kingsville TS and the remaining capacity needs in Kingsville-Leamington were primarily centred on the conversion of Kingsville TS from its 115 kV supply to a 230 kV supply. In particular, consideration was given to the timing of such reconfiguration relative to the in-service dates of the planned new transformer stations, South Middle Road DESN 1 and 2 (previously referred to as Lakeshore DESN 1 and 2 in the 2019 IRRP), as well as the location of the new customers and the optimal distribution network buildout.

The customer connection queue, however, continued to increase during the development of the Addendum. Not only would the reconfiguration of Kingsville TS be insufficient to accommodate the updated forecast, the cost for conversion is estimated to be the same as an entirely new and separate 230 kV DESN nearby. Moreover, the transmission line components along K2Z and K6Z are in good condition – Hydro One had indicated that shieldwire, wood poles, and conductors along these

circuits do not require replacement. The 2 x 50/83 MVA transformers at Kingsville TS were also recently installed (2018-2021) due to the original transformers reaching their end of life. From this perspective, there is no further end-of-life value that reduces the cost of stranding assets with the reconfiguration option.

Consequently, the option to build two new DESN stations supplied from 230 kV double-circuit lines from Lakeshore SS is preferred for its cost-effectiveness and ability to meet the forecast capacity need. Included in this recommendation is the offloading of Kingsville TS to its 95 MW load meeting capability. While exact station siting is subject to the Environmental Assessment and development work undertaken by the transmitter after regional planning, the Technical Working Group has determined that preference is for the new stations to be located close to and northeast of Kingsville TS. Siting either of the stations at the already expanded Leamington TS would not be preferred due to spacing constraints for any further distribution feeder buildout and increased distribution-level costs. The first new DESN is best situated close to Kingsville TS to enable proper offloading, whereas the second DESN, if located farther northeast, could facilitate some distribution-level redundancy between all the stations in Kingsville-Leamington.

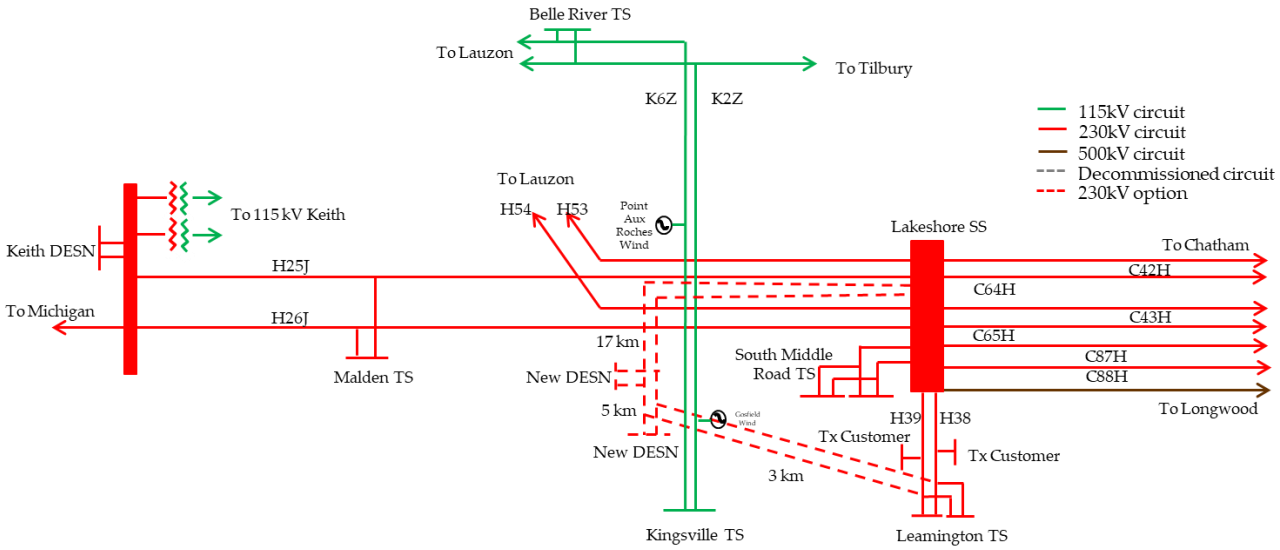
The Working Group notes that with this recommendation, an approximately 20 MW capacity need remains of the 430 MW total capacity need outlined in Section 4.1.2. Further load growth is not expected to impact the need for these recommended reinforcements. An incremental 20 MW or more would require another DESN and possibly more circuits. The cost of these additional reinforcements is not justified at this time; rather, it is recommended that the continued economic development and overall load in the region are monitored, alongside any non-wires initiatives, before triggering further transmission investments in the next cycle of Windsor-Essex regional planning.

5.3 Options for Addressing Load Restoration Needs

5.3.1 New 230 kV Circuits Between Kingsville and Leamington

The option of a new, approximately 3 km, 230 kV double-circuit line between Leamington TS and the new DESN stations was considered for the Leamington load restoration needs. Figure 13 below shows this potential configuration.

Figure 13 | Configuration of Option for New 230 kV Lines



These 230 kV lines are estimated to cost around $15M including the expense of the new 230 kV in-line breaker and switch arrangement, and would also require 4-5 years of development time. Approximately 290 MW of restoration capability to Leamington TS would be added – under double contingency events on H38 and H39, supply to Leamington TS would be restored from Lakeshore SS through the new lines connecting the DESNs that were recommended in Section 5.2. This option and cost estimate includes in-line breakers between the new DESN and Leamington TS, and assumes the in-line breakers would be operated normally open due to short circuit limitations in the area. This means that during normal conditions there would be no flow on the 3 km line; rather, the path would only be used for load restoration following a contingency event.

5.3.2 Distribution System Transfer Capability

Another option considered for the Leamington load restoration needs is emergency distribution-level load transfers. At the time of this report, Hydro One Distribution estimated the following transfer capability between stations in Kingsville-Leamington:

- 50 MW between Kingsville TS and Leamington TS;
- 30 MW between South Middle Road DESN 1 and Leamington TS; and
- 0 MW between South Middle Road DESN 1 and Kingsville TS.

The amount of transfer capability resulting from South Middle Road DESN 2 and the new DESNs identified in Section 5.2 are not known at this point in the planning and development processes. Additionally, the Working Group identified some challenges with relying on distribution-level transfer capability as a post-contingency load restoration measure. Actual transfer capability is likely lower than the amount identified above since it is limited by the real-time loading of the feeders and transformers. Compounding this issue are two considerations: all stations in this local area are already at their load meeting capability (or have been allocated customers to utilize their full capacity), and the majority of load is driven by greenhouse lighting. While individual customer behaviour will vary, the homogeneity and density of the load in response to lighting strategies and weather could reduce the likelihood for room for transfers between nearby stations.

5.3.3 Generation

Generation (both transmission-connected and distribution-connected) was also considered as a potential option to address load restoration needs. There is potential for dispatchable energy resources (including battery storage, gas generation, or storage paired with an intermittent fuel type such as solar) to provide back-up supply to the Leamington tap in the event of outages. However, several challenges were identified with this option.

Stations in Kingsville-Leamington already host a number of distributed energy resources – this is summarized in Table 4, according to Hydro One's list of applications for DG connections.

Table 4 | Existing Distributed Generation by Fuel Type in Kingsville-Leamington

Station	Biomass (MW)	Combined Heat and Power (MW)	Natural Gas/Diesel (MW)	Solar (MW)	Wind (MW)	Other (MW)	Total (MW)
Kingsville TS	0	13	8	3	26	3	53
Leamington DESN 1	2	36	3	4	0	14	58
Leamington DESN 2	0	3	0	1	0	1	5
Total	**2**	**52**	**11**	**8**	**26**	**18**	**116**

During the development the IRRP forecast, the impact of contracted DG was accounted for by using seasonal peak capacity contribution factors in conjunction with the known installed capacity. Since not all DG facilities are contracted, the amount summarized in Table 4 is in excess of what can be relied upon to create a net forecast for the IRRP.

While these resources could provide back-up supply, there are technical and economical issues that must be considered. Under operating scenarios currently allowed on the Hydro One-owned distribution system, customers are permitted to rely on DG for self-supply but are unable to export back to the grid during contingencies. Yet, the ability to operate as an island would be critical for generation to be a viable option for restoring load lost by configuration on the Leamington tap – specifically if wanting to leverage DG through aggregation and/or beyond what is assumed already in the net planning forecast.

Another consideration are the services that would be provided by the generation option and counted upon in its valuation. Resources, whether transmission-connected or distribution-connected, could provide a capacity value by contributing to provincial resource adequacy needs. As described in this section, they could also provide a local value by deferring or replacing a wires alternative that was identified for a regional need. However, there is uncertainty in the overlapping of needs and the feasibility of stacking these services, which impacts the overall cost-effectiveness of the resource option. For instance, a battery storage facility located near Leamington TS could contribute to provincial summer capacity needs and/or help meet bulk winter capacity requirements identified in

the West of London bulk plan, presumably by responding to real-time market signals and discharging during hours of high demand. Since load restoration needs are defined according load levels expected during peak hours, it is uncertain how much back-up supply this same storage facility can provide during a double contingency on the Leamington tap. Note that the contribution from contracted distributed resources was also already accounted for in this need's identification. Moreover, there is currently no market mechanism to signal local load restoration needs to generation resources and compensate for them. Therefore, this hypothetical storage facility cannot necessarily be relied upon for both local restoration needs and provincial capacity needs, depending on their timing.

5.3.4 Recommendation

A combination of wires and non-wires options are required to meet the full load restoration need: a new 230 kV double-circuit line between Leamington TS and the new DESN station to provide approximately 290 MW of load restoration capability, and a further 60 MW provided through distributed energy resources and/or distribution-level transfer capability.

A new 230 kV double-circuit line between Leamington TS and the new DESN station (plus the necessary in-line breakers and switches) is the only technically feasible option to address the scale of the need and provides the most incremental restoration capability. This option's cost-effectiveness is also significantly improved because it adds restoration capability not only to Leamington TS, but to the new DESN stations in the Kingsville area too once they are in-service. For instance, for double contingencies on the new 230 kV connection lines recommended in Section 5.2.3, approximately 290 MW could be restored to the new stations from Lakeshore SS and through the Leamington tap. This benefit would not be provided by generation options that are sited on the Leamington tap for restoration purposes.

However, due to the total restoration capability required for the four-hour and 30-minute timeframes, this new line alone would not be sufficient in meeting the Leamington restoration need. Rather, an additional 60 MW of restoration capability is required according to planning criteria. Thus there is value in exploring the other measures (such as distributed energy resources) to further mitigate and manage this need through pilot or demonstration projects funded through other initiatives. Some of these ongoing projects and programs are specified in Section 6.2. Similarly, local distributors, in conjunction with Hydro One where appropriate, can investigate opportunities to improve distribution load transfer capability between the stations in Kingsville-Leamington to maximize restoration potential.

As an alternative, there is the opportunity for the transmitter and transmission customer(s) (in this case, the distributors supplied from the Leamington tap) to consider load restoration cases on an individual basis. Per ORTAC 7.4, "the transmitter and its customer(s) may agree to higher or lower levels of reliability for technical, economic, safety, and environmental reasons provided the bulk power system adheres to North American Electric Reliability Corporation and Northeast Power Coordinating Council standards". Hydro One may seek agreement from the impacted customers to determine if the risks are acceptable and not proceeding with infrastructure reinforcements is supported.

5.4 Recommended Plan and Implementation

The Working Group recommends the actions described below to meet identified needs in the Addendum.

Table 5 | Summary of Needs and Recommended Actions

Need	Item #	Working Group Recommendation	Lead Responsibility	Timeframe for Recommendation
Kingsville TS capacity need	1	Transfer load in excess of the station load meeting capability to the new DESNs once in-service	Hydro One	2026[13]
Kingsville-Leamington capacity need	2	Initiate engagement and approvals for two new 230 kV DESNs and double-circuit connection lines from Lakeshore SS	Hydro One	2022
	3	Monitor load growth, regional and bulk transmission projects, DERs, and energy efficiency; continue gathering information on developments in the indoor agriculture industry and emerging technologies as required to inform the next planning cycle	IESO	Ongoing
Leamington tap load restoration need	4	Initiate engagement with customers to determine cost-justified measures (new 230 kV line, distributed energy resources, and/or distribution load transfer capability) that can mitigate this need	Hydro One	2022
	5	Include the option for a new 230 kV line between Leamington TS and the new DESNs in the Environmental Assessment for Item #2	Hydro One	2022

[13] Estimated in-service date of the first new DESN. However, offloading Kingsville TS earlier if there is available local capacity would be beneficial.

6. Interdependencies

While the Addendum focuses on electricity system needs and investments that are concentrated in Kingsville-Leamington, they should be integrated with other planning-related activities in the region. The sections below discuss some of these interdependencies, including how these recommendations relate to other Windsor-Essex needs, non-wires projects, and community-led plans.

6.1 Broader Windsor-Essex Regional Issues

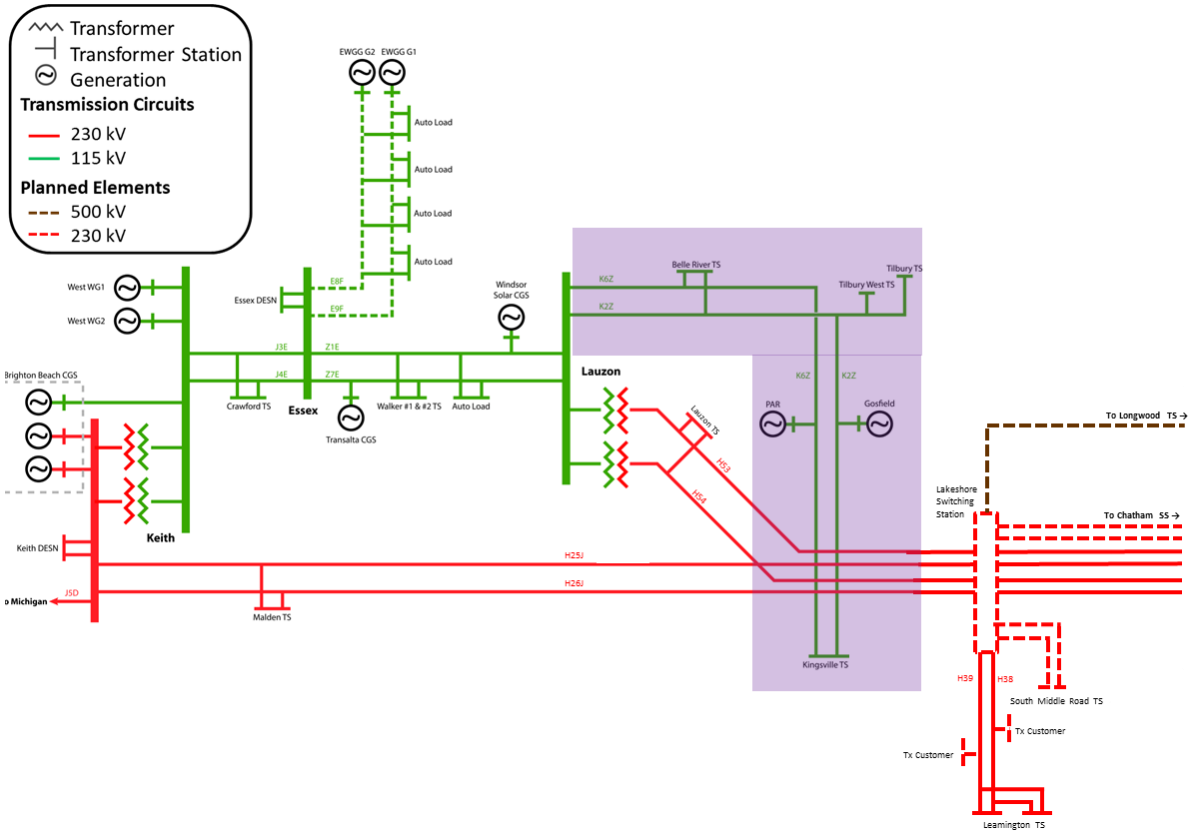
6.1.1 Lauzon TS and the Lauzon 115 kV Sub-System

During the development of the 2019 IRRP, a number of needs were identified for the Lauzon 115 kV sub-system, as well as the nearby 230 kV Lauzon TS:

- Supply capacity need for the 115 kV sub-system (includes total load between Kingsville TS, Belle River TS, and Tilbury West DS);
- Station capacity need at Lauzon DESN 1;
- Supply capacity need at Lauzon TS (includes total load supplied by DESN 1 and 2); and
- End-of-life needs at Lauzon TS: step-down transformers T6 and T8 in 2024, step-down transformers T5 and T7, and 230/115 kV autotransformers T1 and T2 in 2029.

This sub-system includes the transformer stations and generators supplied through the 115 kV circuits K2Z and K6Z, as shown in Figure 14.

Figure 14 | Windsor-Essex Region Electrical Single Line Diagram: Lauzon 115 kV Sub-System



Due to the Lauzon DESN 1 capacity need, the Working Group recommended that T5/T6 be upsized to accommodate the station forecast. Subsequently, since the 2019 IRRP, Hydro One has proceeded with replacement plans for the existing 50/66.6/83.3 MVA two-winding T5/T6 with new 75/100/125 MVA three-winding transformers by December 2025.

By transferring load from Kingsville TS to the recommended new 230 kV transformer stations, the Lauzon 115 kV sub-system is also offloaded, helping to alleviate the supply capacity need. No new information obtained during the Addendum has indicated a capacity need at Lauzon DESN 2 or justification for a similar upsizing. For this reason, it is recommended that T7/T8 are replaced like-for-like, and that the T1/T2 autotransformer end-of-life needs are re-evaluated in the next Windsor-Essex Planning cycle.

6.1.2 Coordination with the West of London Bulk Plan

Similar to the 2019 IRRP, the Addendum was conducted in parallel with a separate bulk study: the West of London bulk plan. This plan assessed the bulk transmission supply across the West of London area, including the concentration of loads in Lambton-Sarnia, Windsor, Kingsville-Leamington, and Chatham-Kent, large generators in Lambton-Sarnia and Windsor, and four interconnection points with Michigan's power system. It covers both the 230 kV and 115 kV high voltage network in southwestern Ontario and the 500 kV connection to the rest of the province at Longwood TS, near the city of London.

While the Addendum, consistent with the scope of regional planning, focuses on local capacity and restoration needs, its recommendations must be aligned with the timing of the multiple bulk reinforcements that address bulk transfer limitations and energy needs impacting overall supply to Windsor-Essex. Both regional and bulk recommendations (made prior to the completion of the Addendum) are listed chronologically in Table 6.

Table 6 | Planned Regional and Bulk Transmission Reinforcements (Prior to the Addendum)

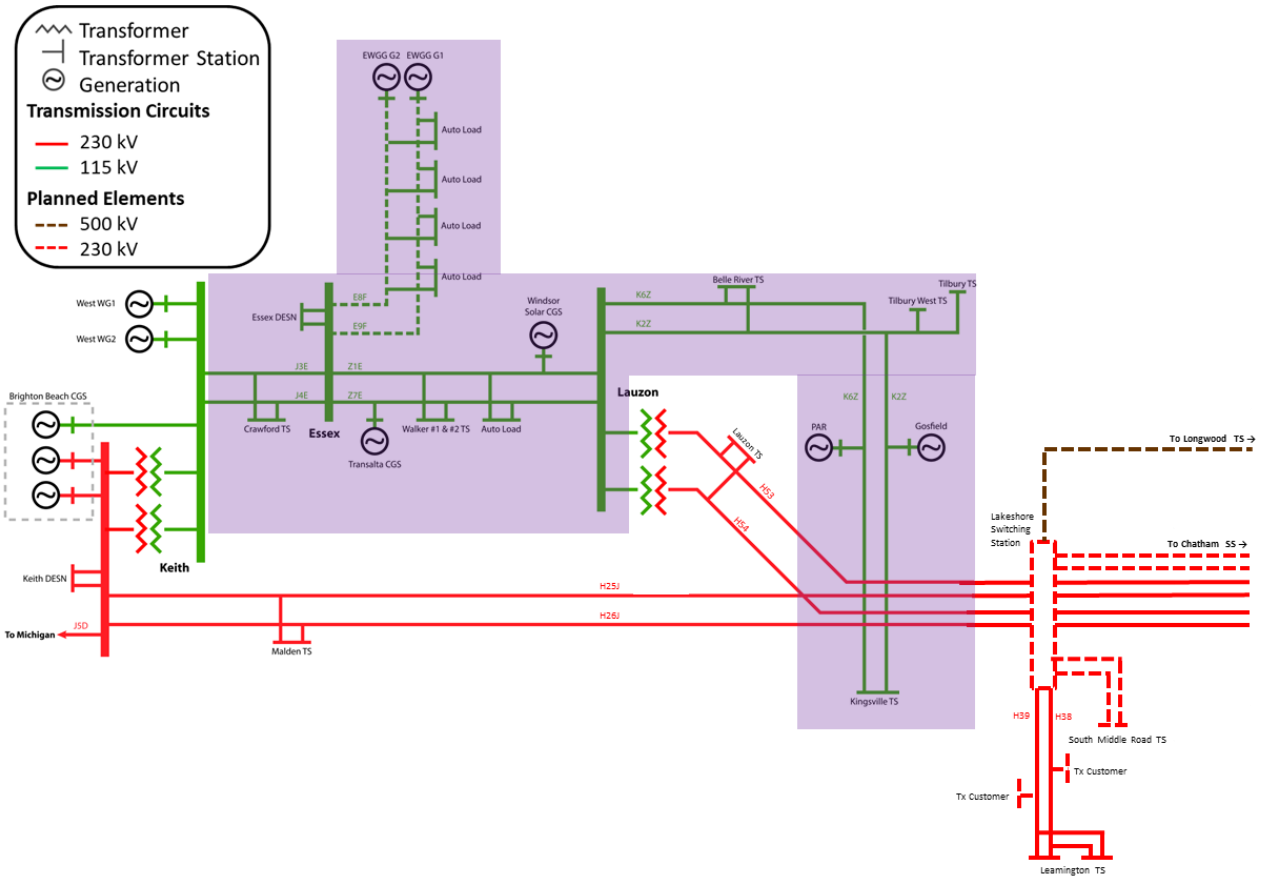
Reinforcement	In-Service Date
Lakeshore Switching Station	2022
South Middle Road DESN 1	2022
South Middle Road DESN 2	2025
Bilateral negotiations for continued operation of Brighton Beach GS	2024-2028
230 kV double-circuit Chatham-to-Lakeshore line	2025
230 kV double-circuit Chatham-to-Lambton line	2028
500 kV single Longwood-to-Lakeshore line	2030
550 MW of local generation	2030

Given the typical lead times for new transmission infrastructure, the Addendum's recommendations for two additional DESNs and 230 kV lines in Kingsville-Leamington are expected to take at least four to five years. The first new DESN is estimated to be in service in 2026, with the following DESN in service in the late 2020s.

J3E/J4E Sub-System

The location of the local resources proposed in the West of London bulk plan has further implications on long-term Windsor-Essex needs. In the 2019 IRRP, the J3E/J4E sub-system was defined and assessed. Shown in Figure 15, this includes all loads supplied on the 115 kV network from the J3E/J4E circuits and the Lauzon 230/115 kV autotransformers.

Figure 15 | Windsor-Essex Region Electrical Single Line Diagram: J3E/J4E Sub-System



Reliability in this sub-system is thermally limited by the 115 kV circuits between Keith and Essex, J3E and J4E. This phenomenon depends on assumptions for the load level of the 115 kV network, the output of generation facilities in Windsor, and imports/exports at J5D, but is particularly relevant for three contingencies:

1. Loss of J3E, for which the companion circuit with a lower long-term emergency rating, J4E, may be overloaded;
2. Loss of both H53 and H54, for which the entire sub-system must be supplied through the J3E/J4E circuits; or
3. Loss of both H25J and H26J, for which J3E and J4E become the only path of supply eastwards from Keith, and H53 and H54 become the only path of supply westwards from Lakeshore SS.

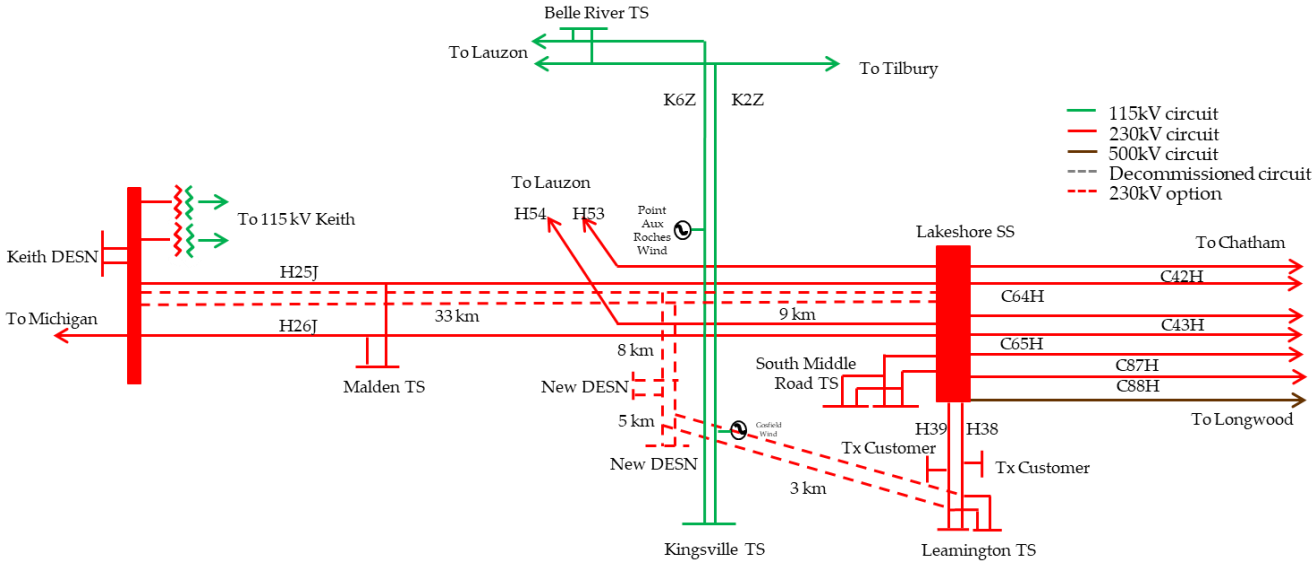
At the time of the 2019 IRRP, no need was identified for the J3E/J4E sub-system due to the forecast load being lower than the load meeting capability, which was most limited under the first two contingencies listed above. However, with growing load that is concentrated in Kingsville-Leamington and supplied from Lakeshore SS, and given the West of London bulk study recommendations, increasing the flow capability eastwards from Keith may be necessary in the long-term.

The West of London bulk plan identified that starting in 2030, 550 MW of local resources will be required in the Windsor-Essex region and/or the community of Dresden within Chatham-Kent. This recommendation can be met by reacquiring resources that already exist (such as current generation

facilities sited in Windsor) or by acquiring new resources.[14] Siting the 550 MW resource requirement entirely in Windsor – specifically at Keith TS – could exacerbate thermal overloads on the JxE circuits. This phenomenon also depends on the level of imports (up to 400 MW) into Windsor-Essex on the J5D intertie. Simultaneously, having some of these resources (approximately 100-150 MW) sited in the Windsor area is also necessary to maintain supply west of Lakeshore SS for the same double contingency on H25J and H26J.

These reliability issues are currently managed by control actions specified in the Windsor Area Remedial Action Scheme – for instance, events that result in the loss of one or two of select 115 kV or 230 kV circuits from Keith TS lead to the rejection of Windsor area generation, Keith autotransformers T11/T12, load, and/or capacitors. As loads near or at Lakeshore SS increase, however, dependence on these operational measures may no longer be feasible and instead may need to be alleviated by transmission reinforcements, such as the upgrading of the J3E and J4E circuits or the addition of circuits between Lakeshore and Keith.[15] The latter option is shown in Figure 16 as an extension of the Addendum's recommendations for new stations and 230 kV lines in Kingsville-Leamington. This additional reinforcement to Keith TS is estimated to cost approximately $155M-$170M and includes about another 33 km of new 230 kV double-circuit lines, station development at Keith TS, and underground Keith TS line egress to Ojibway Junction.

Figure 16 | Potential Long-Term 230 kV Reinforcement Between Keith and Lakeshore



[14] Long-term competitive resource acquisition mechanisms will be outlined through the Resource Adequacy Framework, with signals for acquisition targets in the Annual Acquisition Report.

[15] The typing and design criteria of Remedial Action Schemes are defined in the Northeast Power Coordinating Council's Directory #7. As load grows in this area, the impact of these Remedial Action Schemes failing to operate as intended will change, which impacts the situations in which the scheme can continue to be relied upon on an enduring basis according to ORTAC 3.4.1.

Since the need for further reinforcements to maintain supply to the J3E/J4E sub-system depends on the location of generation resources and load levels in the long-term, a recommendation is not being made at this time and options to address the issue are not limited to what is shown in Figure 16. These needs will be re-assessed in future Windsor-Essex planning cycles once there is sufficient certainty in the generation outlook for the region.

6.2 Novel Projects

Pilot projects – either those that are already underway or could participate in future programs or funding sources outside of regional planning – continue to help inform and build capacity within the community for future demand-side solutions as greenhouse loads connect.

For instance, the 2019 IRRP, through the IESO's Grid Innovation Fund, recommended a targeted call for projects to reduce electricity demand in the indoor agriculture sector. This call was intended to help explore new technologies, practices, and services that could accelerate the adoption of cost-effective demand-side solutions by greenhouse growers. At the time of this report, the IESO's Grid Innovation Fund has provided over $2.2M in financial support to four greenhouse pilot projects in the Windsor-Essex region to reduce peak demand while alleviating load growth:

- Allegro Acres Inc.: To evaluate the performance of low-intensity LED lighting and controls used over a 24-hour period against the current practice of using high-intensity high pressure sodium lighting over a 16 to 17-hour period. This lighting strategy has the potential to reduce electricity up to 30 percent, based on a previous study.
- Great Lakes Greenhouses Inc.: To develop an artificial intelligence-powered program that uses data and a learning algorithm to increase energy efficiency without reducing crop yield in large-scale commercial greenhouses.

Another active project, led by the University of Windsor with support from the Grid Innovation Fund, is aimed at enabling rapid economic expansion of Ontario's greenhouse sector through the delivery of innovative distributed energy resource project options.

Opportunities for novel projects whose learnings can be leveraged in future regional planning in Windsor-Essex continue to arise. In 2021, the Grid Innovation Fund and the OEB's Innovation Sandbox launched a Joint Targeted call for research and demonstration projects that can provide value to consumers. Objectives of this call include testing the effectiveness of distributed energy resources and their ability to defer or eliminate the need for traditional electricity infrastructure, and supporting innovative activities or business models that are currently impeded by regulatory requirements.

6.3 Energy Efficiency

As indoor grow lights continue to be the largest driver for the greenhouse electricity demand, new information regarding industry best practices (i.e., adoption of LEDs instead of high-pressure sodium lights) will need to be monitored to inform future regional planning. In the meantime, energy efficiency is a low cost resource that can help manage and mitigate needs until the recommended reinforcements are in-service.

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. In 2020, the Save on Energy Regional LED Incentive for Greenhouses received 17 applications and 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.

The Local Initiatives Program was also developed to cost-effectively meet system needs, drive cost competitiveness, and promote consumer-driven solutions in targeted areas of the province where local needs were identified through the regional planning process. Included in the areas selected for the first cycle of local initiatives is the service territory supplied by Belle River TS.

Moving forward, the IESO will continue to explore strategies for expanding energy efficiency program opportunities for the long-term and targeting them to regions with local needs.

6.4 Community 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 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% greenhouse gas 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 greenhouse gas 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 County Regional Energy Plan, specific targets were identified under seven 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.

At the minimum, these local plans indicate community priorities and preferences that help inform IRRP recommendations. As the community energy targets and plans are implemented, their implications will need to be captured in future IRRPs in Windsor-Essex. Forecasts should reflect changing load behaviour and customer segmentation, and consider increased electricity demand that results from the electrification of different sectors, or decreased demand due to energy efficiency measures and retrofits. Any new energy projects or resources should be accounted for as well, either modelled in the load forecast or as part of the needs or options identification. Table 7 summarizes the regional and community energy plans' estimated resource requirement to support their recommendations and targets.

Table 7 | Preliminary Estimate of Implementation Impacts by 2041

Element	Windsor Community Energy Plan, Nominal Capacity	Essex Regional Energy Plan, Nomina Capacity
Solar photovoltaics	+90 MW	+225 MW
District energy combined heat and power	+50 MW	+40 MW
Greenhouse combined heat and power	---	+260 MW
Energy efficiency retrofits (homes and buildings), net impact[16]	---	-60 MW
Transportation	To be determined based on charging profile	To be determined based on charging profile

The forecast developed for the 2019 IRRP and this Addendum utilizes the latest and confirmed information at the time of the report, but there is the opportunity for them to be updated and for other scenarios to be developed in future planning cycles. Moreover, the recommendations outlined in the Addendum will complement energy use in the area as it evolves over the long-term. Transmission infrastructure such as new transformer stations and lines add electricity capacity to support local electricity demand, irrespective of the specific end use in the community. Once in service, these investments also can provide more connection capability for future generation projects that are specified in the Windsor Community Energy Plan and Essex County Regional Energy Plan.

[16] Estimated retrofit efficiency peak capacity avoidance after accounting for increased demand from new construction under future efficiency standards.

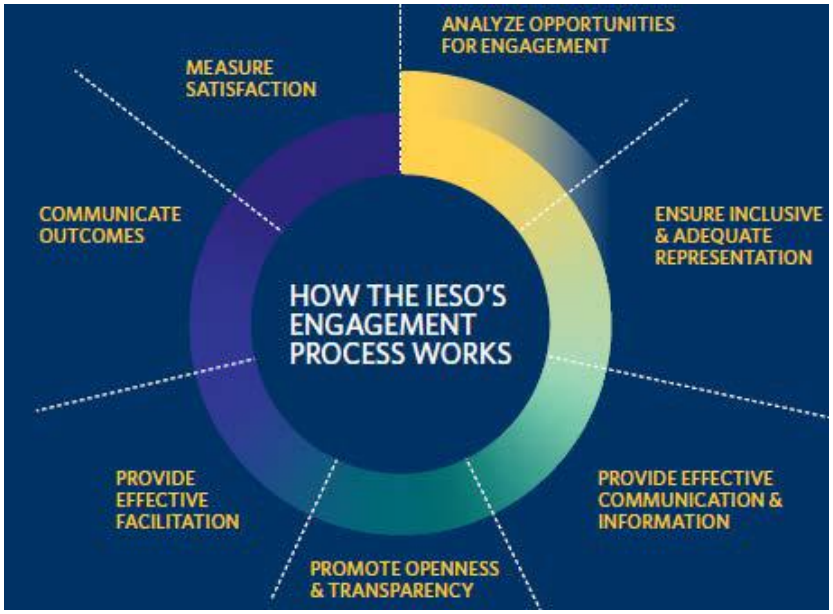
7. Community and Stakeholder Engagement

Engagement is critical in the development of an IRRP. Providing opportunities for input in the regional planning process enables the views and preferences of communities to be considered in the development of the plan, and helps lay the foundation for successful implementation. This section outlines the engagement principles as well as the activities undertaken for the Addendum.

7.1 Engagement Principles

The IESO's engagement principles help ensure that all interested parties are aware of and can contribute to the development of this Addendum. 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 17 | The IESO's Engagement Principles



7.2 Engagement Approach

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

- Leveraging the Windsor-Essex Regional Planning engagement webpage and Southwest Bulk Planning Initiatives 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 Windsor-Essex electricity issues. These discussions were instrumental in garnering feedback about increased expected economic development being driven by high greenhouse growth in Kingsville-Leamington, as well as increased growth in residential, commercial, and industrial developments.

Two public webinars were held at major junctures during Addendum development (in tandem with the West of London bulk study) to give interested parties an opportunity to hear about its progress and provide comments on key components including:

- Updated electricity demand forecast;
- IRRP-identified needs that were scoped into the Addendum;
- Options evaluation; and
- Recommendations.

Both webinars received strong participation with cross-representation of stakeholders and municipal and Indigenous community representatives in attendance, and submissions of 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.

Based on the discussions both on the Addendum and the parallel WOL bulk plan, 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 Addendum, 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. 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 file. 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.

7.3 Bringing Municipalities to the Table

The IESO held several meetings with local municipalities in the Windsor-Essex region at major milestones throughout the development of this Addendum. These targeted discussions focused on the study area to identify any key issues, including with the forecast electricity needs and proposed options for meeting those future needs. Key feedback received during these targeted discussions were related to the continued amplification of growth in Kingsville-Leamington and their preferred option to provide the greatest amount of capacity to support growth over the long-term. Other feedback included, the urgency for capacity in the interim while new infrastructure is being developed and constructed, and the importance of the coordination between municipal infrastructure planning with the implementation of these recommendations in future years. In addition, continued engagement with municipalities in between planning cycles should be conducted to stay apprised of rapidly evolving priorities and developments within these communities.

7.4 Engaging with Indigenous Communities

To raise awareness about the regional planning activities underway and invite participation in the engagement process, outreach was made to Indigenous communities and rights-holders within the Windsor-Essex electricity planning area throughout the development of the Addendum, in tandem with the West of London bulk study. Those invited to participate include the communities of Saugeen 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, Haundenosaunee Development Institute, Aamjiwnaang First Nation, Bkejwanong (Walpole Island First Nation), Caldwell 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.

Without limiting general and ongoing issues that community representatives/rights-holders raise, the IESO did not receive specific feedback on Windsor-Essex. 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.

7.4.1 Indigenous Participation and Engagement in Transmission Development

The IESO determines the most reliable and cost-effective option after it has engaged with stakeholders, Indigenous communities/rights-holders, 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.

8. Conclusion

The Windsor-Essex IRRP Addendum re-evaluates capacity and load restoration needs in Kingsville-Leamington that were first identified in the 2019 IRRP, and recommends a plan to address them.

In the near term, the Addendum recommends the implementation of two additional 230 kV transformer stations in Kingsville-Leamington, supplied through new double-circuit lines from Lakeshore SS, as well as the offloading of Kingsville TS. Responsibility for these actions will be undertaken by the appropriate members of the Working Group.

In the long term, the Addendum recommends further analysis between Hydro One and its customers in Kingsville-Leamington to determine when additional 230 kV lines between Leamington TS and the new transformer stations will be implemented for load restoration purposes. There is also value in exploring further non-wires alternatives projects or programs that help mitigate the local restoration needs.

The Technical Working Group will reconvene when a new regional planning cycle for Windsor-Essex is initiated in Q3 2022, per the minimum five-year schedule mandated by the OEB. The IESO will continue to participate in this Working Group. This includes providing input and ensuring a coordinated approach with future bulk system plans or local pilot projects, if such linkages are identified during the regional planning activities. In the next cycle, the Working Group will consider updated forecast information for the entire region, continue to monitor community energy planning activities, and account for the multiple regional and bulk transmission reinforcements planned for the next decade.

Appendix A – Updated Forecasts and Load Data

Refer to the Excel file provided for the following datasets:

- Historical load:
  - Table 8: Leamington TS, DESN 1 and 2, Hourly Historical Load (2021)
  - Table 9: Kingsville TS, Hourly Historical Load (2020, 2021)
- Peak forecasts:
  - Table 10: Winter Planning Peak Demand Forecast for Windsor-Essex Region Stations with No Greenhouse Load
  - Table 11: Summer Planning Peak Demand Forecast for Windsor-Essex Region Stations with No Greenhouse Load
  - Table 12: Gross Winter Peak Demand Forecast for West of London Stations with Greenhouse Load
  - Table 13: Gross Summer Peak Demand Forecast for West of London Stations with Greenhouse Load
- Hourly forecasts:
  - Table 14: Forecast Total Windsor-Essex Hourly Load Profiles (2022, 2035)
  - Table 15: Forecast Total Kingsville-Leamington Hourly Load Profiles (2022, 2035)
  - Table 16: Forecast Total Leamington Tap Hourly Load Profiles, Restoration Need, and Need with Transmission Reinforcement Option (2022, 2035)
- Table 17: Peak Segmentation Assumptions for Windsor-Essex Stations with Greenhouse Load

Appendix B – Updated Study Results

Study assumptions (including facility ratings and generation output) used for the Addendum are consistent with those documented in the 2019 IRRP Planning Study Report. Only updated power system assessment results that are relevant to the Addendum needs and recommendations are documented below.

Kingsville-Leamington Capacity Needs

Following the completion of Lakeshore SS, the new tap will be supplied from the 230 kV bus at Lakeshore. Each 2 x 75/125 MVA Bermondsey type DESN is assumed to have LTRs of 205 MW and 190 MW for the winter and summer, respectively.[17] Consistent with the Leamington TS expansion and South Middle Road TS, four additional 21.6 MVar capacitor banks were also assumed at the new low-voltage buses as part of this reinforcement. No station-to-station or intra-station (bus-to-bus) load transfers were assumed in this assessment, and a load power factor corrected to 0.95 lagging was used.

Table 18 | New Kingsville Tap Load Meeting Capability Results

Connection Point	Limiting Contingency	Violation	Load Meeting Capability (MW)
Two new supply stations from Lakeshore SS	N-1, single contingency on the tap circuit	Exceed LTR ratings (205 MW, winter) at each DESN	410 (winter)

Leamington Tap Load Restoration Needs

A new double-circuit 230 kV line between Leamington TS and the new DESNs was proposed, with in-line breakers and operated normally open due to short circuit limitations. The Leamington tap load restoration was evaluated as outlined below. For the loss of both H38 and H39, 290 MW can be restored through the new 230 kV line within the 30-minute and four-hour requirement. 60 MW remains unrestored for the four-hour restoration target. The remainder of the load (150 MW) is assumed to be restored within eight hours, according to the transmitter's circuit restoration time estimates.

[17] The LTR of each DESN is defined by the most restrictive step-down transformer 10-day LTR rating. Since the LTR cannot be known until the units have been built and treated, an assumption is made on the capabilities of recently commissioned similar units.

Table 19 | Leamington Tap Load Restoration Requirements – Post New 230 kV Double-Circuit Line

Affected Stations	Contingency	Load Lost by Configuration and Rejection or Curtailment	30-min Restoration Requirement	4-hour Restoration Requirement	8-hour Restoration Requirement
Leamington DESN 1&2, two transmission-connected load customers	N-2, H38 and H39	500 MW	0 MW	60 MW	0 MW

Table 20 | Leamington Load Restoration Capability Results – Post New 230 kV Double-Circuit Line

Affected Stations	Limiting Contingency	Violation	Post-Contingency Load Meeting Capability
Leamington DESN 1&2, two transmission-connected load customers	N-2, H38 and H39	Voltage change >10% post-contingency pre-under-load tap changer ("pre-ULTC") voltage change on 27.6 kV Leamington TS buses	690 MW (200 MW per new DESN & 290 MW Leamington TS)