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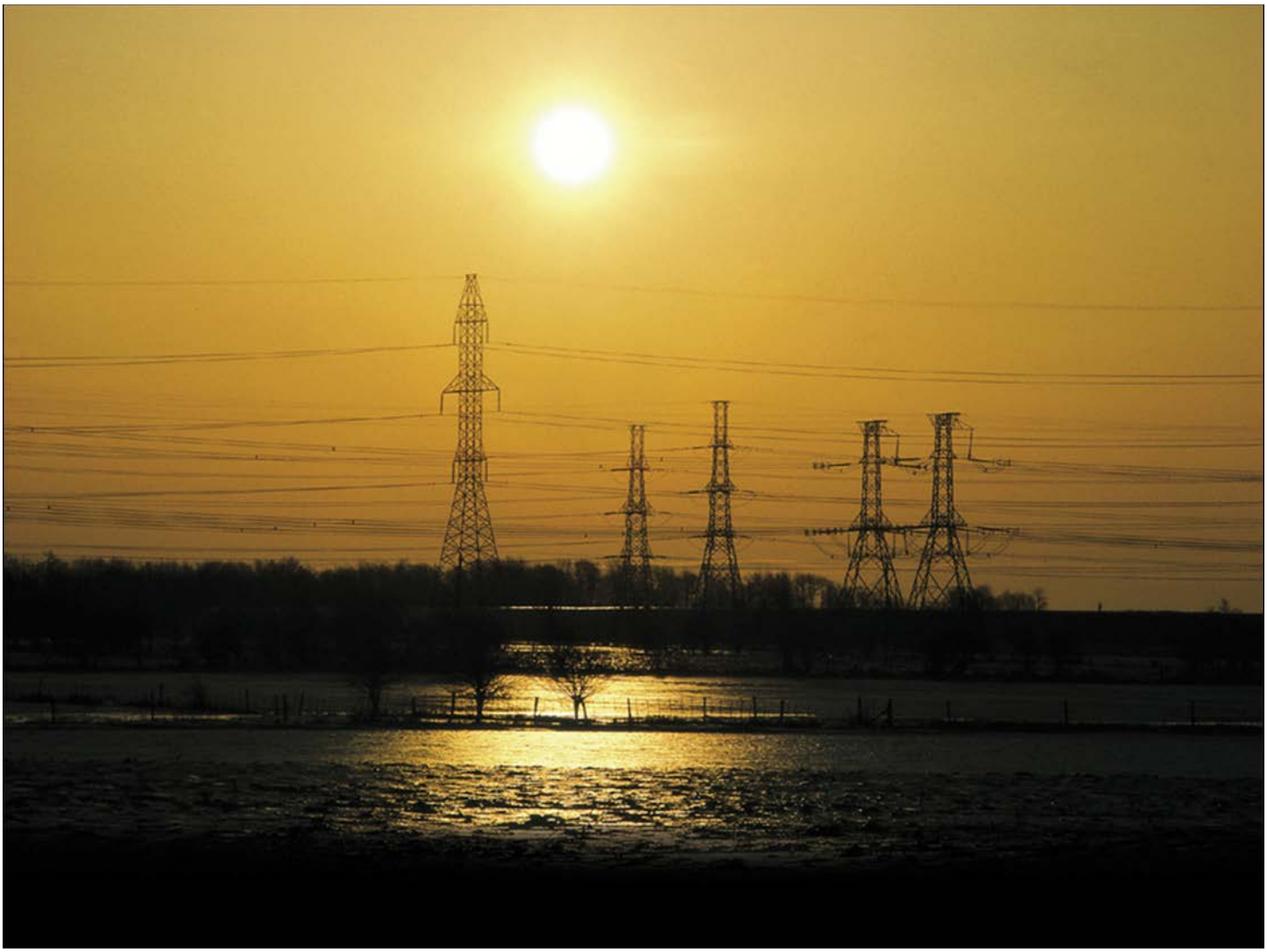

Windsor-Essex

REGIONAL INFRASTRUCTURE PLAN

March 18, 2020

hydro one

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Prepared and supported by:

Company
E.L.K. Energy Inc.
Entegrus Powerlines Inc.
EnWin Utilities Ltd.
Essex Powerlines Corporation
Hydro One Networks Inc. (Distribution)
Independent Electricity System Operator (IESO)
Hydro One Networks Inc. (Lead Transmitter)

DISCLAIMER

This Regional Infrastructure Plan ("RIP") report was prepared for the purpose of developing an electricity infrastructure plan to address all near and mid-term needs identified in previous planning phases and any additional needs identified based on new and/or updated information provided by the RIP Study Team.

The preferred solution(s) that have been identified in this report may be reevaluated based on the findings of further analysis. The load forecast and results reported in this RIP report are based on the information provided and assumptions made by the participants of the RIP Study Team.

Study Team participants, their respective affiliated organizations, and Hydro One Networks Inc. (collectively, "the Authors") make no representations or warranties (express, implied, statutory or otherwise) as to the RIP report or its contents, including, without limitation, the accuracy or completeness of the information therein and shall not, under any circumstances whatsoever, be liable to each other, or to any third party for whom the RIP report was prepared ("the Intended Third Parties"), or to any other third party reading or receiving the RIP report ("the Other Third Parties"), for any direct, indirect or consequential loss or damages or for any punitive, incidental or special damages or any loss of profit, loss of contract, loss of opportunity or loss of goodwill resulting from or in any way related to the reliance on, acceptance or use of the RIP report or its contents by any person or entity, including, but not limited to, the aforementioned persons and entities.

EXECUTIVE SUMMARY

THIS REGIONAL INFRASTRUCTURE PLAN ("RIP") WAS PREPARED BY HYDRO ONE WITH SUPPORT FROM THE RIP STUDY TEAM IN ACCORDANCE TO THE ONTARIO TRANSMISSION SYSTEM CODE REQUIREMENTS. IT IDENTIFIES INVESTMENTS IN TRANSMISSION FACILITIES, DISTRIBUTION FACILITIES, OR BOTH, THAT SHOULD BE DEVELOPED AND IMPLEMENTED TO MEET THE ELECTRICITY INFRASTRUCTURE NEEDS WITHIN THE WINDSOR-ESSEX REGION.

The participants of the Regional Infrastructure Plan ("RIP") Study Team included members from the following organizations:

- E.L.K. Energy Inc.
- Entegrus Powerlines Inc.
- EnWin Utilities Ltd.
- Essex Powerlines Corporation
- Hydro One Networks Inc. (Distribution)
- Independent Electricity System Operator ("IESO")
- Hydro One Networks Inc. (Transmission)

This RIP is the final phase of the second cycle of Windsor-Essex regional planning process, which follows the completion of the Windsor-Essex Integrated Regional Resource Plan ("IRRP") in September 2019 and the Windsor-Essex Region Needs Assessment ("NA") in October 2017. This RIP provides a consolidated summary of the needs and recommended plans for Windsor-Essex Region in the near-term (up to 5 years) and the mid-term (5-10 years).

This RIP discusses needs identified in the previous regional planning cycle, the Needs Assessment and IRRP reports for this cycle, and the solutions recommended to address these needs. Implementation plans to address some of these needs are already completed or are underway. Since the previous regional planning cycle, the following projects have been completed and underway:

- Crawford TS transformer T3 replacement and neutral grounding reactors installation on T3 and T4 (I/S 2017)
- Malden TS breakers replacement (I/S 2018): two 27.6 kV feeder breakers have been replaced.
- Supply to Essex County Transmission Reinforcement (I/S 2017): Build new 13 km double-circuit 230 kV transmission lines to Leamington area tapped to existing C21J/C22J circuits, and new 75/100/125 MVA Leamington TS and its distribution feeders.
- Reconfiguration of 230 kV and 115 kV circuits and 27.6 kV feeders at Keith TS to accommodate the construction of Gordie Howe International Bridge (I/S 2019)
- Leamington TS expansion: Build the second 75/100/125 MVA DESN at Leamington TS (I/S 2019)

- Kingsville TS transformers replacement (in progress, I/S 2022): Transformers T2 and T4 have been replaced with 50/83 MVA T6 in 2018. Transformers T1 and T3 replacement is underway.
- Keith TS autotransformers replacement (in progress, I/S 2023): 125 MVA autotransformers T11 and T12 will be replaced by 250 MVA units.
- Tilbury TS decommissioning (in progress, I/S 2024): Decommissioning of station due to end-of-life and transfer serviced load to Tilbury West DS supply.
- Keith TS transformer T1 decommissioning (expected I/S 2024).

The major infrastructure investments recommended by the Study Team in the near and mid-term planning horizon are provided in the Table 1 below, along with their planned in-service date and budgetary estimates for planning purpose.

Table 1: Recommended Plans in Windsor-Essex Region over the Next 10 Years

No.	Need	Recommended Action Plan	Planned I/S Date	Budgetary Estimate ($M)
1	Supply capacity need to Kingsville- Leamington area	• Build new switching station at Leamington Junction (Lakeshore TS), and new DESN station (South Middle Road TS) • Build 230 kV double-circuit transmission line from Chatham SS to the new Lakeshore TS	2022-2025	$295M
2	Lauzon TS T5/T6 transformers end-of-life and station capacity	• Replace Lauzon TS T5 & T6 transformers replacement with larger 75/125 MVA units	2024	$34M
3	Kent TS station capacity	• Install new feeder positions to supply load growth at Kent TS • Further evaluate the plan for a new DESN south of Chatham as part of the Chatham-Lambton-Sarnia regional planning process	-	-
4	Belle River TS station capacity	• Monitor load growth and re-evaluate the need in the next regional planning cycle	-	-

The Study Team recommends that Hydro One to continue with the implementation of infrastructure investments listed in Table 1 while keeping the Study Team apprised of project status.

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1 INTRODUCTION

THIS REPORT PRESENTS THE REGIONAL INFRASTRUCTURE PLAN ("RIP") TO ADDRESS THE ELECTRICITY NEEDS OF THE WINDSOR-ESSEX REGION BETWEEN 2020 AND 2030.

The report was prepared by Hydro One Networks Inc. (Transmission) ("Hydro One") on behalf of the Study Team that consists of Hydro One, E.L.K. Energy Inc., Entegrus Powerlines Inc., EnWin Utilities Ltd., Essex Powerlines Corporation, Hydro One Networks Inc. (Distribution), and the Independent Electricity System Operator ("IESO") in accordance with the new Regional Planning process established by the Ontario Energy Board in 2013.

The Windsor-Essex Region is comprised of the area southwest of the Municipality of Chatham-Kent. It includes the City of Windsor, Town of LaSalle, Town of Amherstburg, Town of Tecumseh, Town of Essex, Town of Lakeshore, Town of Kingsville, Municipality of Leamington, Township of Pelee, and the western portion of the Municipality of Chatham-Kent.

Electrical supply to the region is provided by seventeen 230 kV and 115 kV step-down transformer stations ("TS"). The map of the region is shown in Figure 1-1 below.

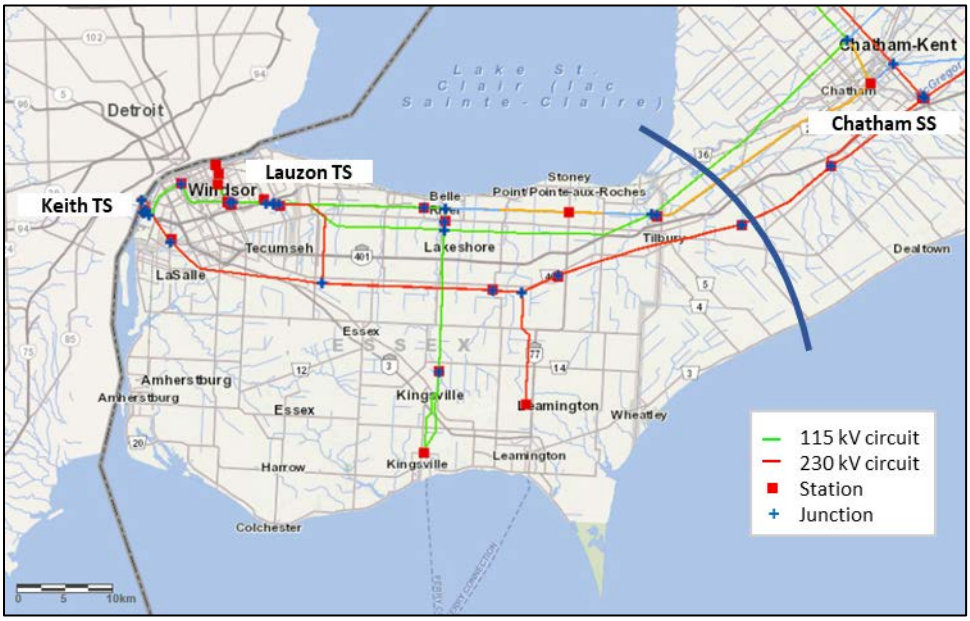

Figure 1-1: Windsor-Essex Region Map

1.1 Objectives and Scope

The RIP report examines the needs in the Windsor-Essex Region. Its objectives are to:

- Provide a comprehensive summary of needs and wires plans to address the needs;

- Identify any new needs that may have emerged since previous planning phases e.g., Needs Assessment ("NA"), Scoping Assessment ("SA"), and/or Integrated Regional Resource Plan ("IRRP");
- Assess and develop a wires plan to address these needs; and
- Identify investments in transmission and/or distribution facilities that should be developed and implemented on a coordinated basis to meet the electricity infrastructure needs within the region.

The RIP reviewed factors such as the load forecast, major high voltage sustainment issues emerging over the near, mid- and long-term horizon, transmission and distribution system capability along with any updates to local plans, conservation and demand management ("CDM") forecasts, renewable and non-renewable generation development, and other electricity system and local drivers that may impact the need and alternatives under consideration.

The scope of this RIP is as follows:

- A consolidated report of the relevant wires plans to address near and medium-term needs identified in previous planning phases (Needs Assessment, Scoping Assessment, and/or Integrated Regional Resource Plan);
- Discussion of any other major transmission infrastructure investment plans over the near to mid-term planning horizon (i.e., within the next 10 year period);
- Identification of any new needs and a wires plan to address these needs based on new and/or updated information;
- Develop a plan to address any longer term needs identified by the Study Team.

1.2 Structure

The rest of the report is organized as follows:

- Section 2 provides an overview of the regional planning process.
- Section 3 describes the regional characteristics.
- Section 4 describes the transmission work completed over the last ten years.
- Section 5 describes the load forecast and study assumptions used in this assessment.
- Section 6 discusses the needs and provides the alternatives and preferred solutions.
- Section 7 provides the conclusion and next steps.

2 REGIONAL PLANNING PROCESS

2.1 Overview

Planning for the electricity system in Ontario is done at three levels: bulk system planning, regional system planning, and distribution system planning. These levels differ in the facilities that are considered and the scope of impact on the electricity system. Planning at the bulk system level typically looks at issues that impact the system on a provincial level, while planning at the regional and distribution levels looks at issues on a more regional or localized level.

Regional planning looks at supply and reliability issues at a regional or local area level. Therefore, it largely considers the 115 kV and 230 kV portions of the power system that supply various parts of the province.

2.2 Regional Planning Process

A structured regional planning process was established by the Ontario Energy Board ("OEB") in 2013 through amendments to the Transmission System Code ("TSC") and Distribution System Code ("DSC"). The process consists of four phases: the Needs Assessment [1] ("NA"), the Scoping Assessment ("SA"), the Integrated Regional Resource Plan ("IRRP"), and the Regional Infrastructure Plan ("RIP").

The regional planning process begins with the NA phase, which is led by the transmitter to determine if there are regional needs. The NA phase identifies the needs and the Study Team determines whether further regional coordination is necessary to address them. If no further regional coordination is required, further planning is undertaken by the transmitter and the impacted local distribution company ("LDC") or customer and develops a Local Plan ("LP") to address them.

In situations where identified needs require coordination at the regional or sub-regional levels, the IESO initiates the SA phase. During this phase, the IESO, in collaboration with the transmitter and impacted LDCs, reviews the information collected as part of the NA phase, along with additional information on potential non-wires alternatives, and makes a decision on the most appropriate regional planning approach. The approach is either a RIP, which is led by the transmitter, or an IRRP, which is led by the IESO. If more than one sub-region was identified in the NA phase, it is possible that a different approach could be taken for different sub-regions.

The IRRP phase will generally assess infrastructure (wires) versus resource (CDM and Distributed Generation) options at a higher or more macro level, but sufficient to permit a comparison of options. If the IRRP phase identifies that infrastructure options may be most appropriate to meet a need, the RIP phase will conduct detailed planning to identify and assess the specific wires alternatives and recommend a preferred wires solution. Similarly, resource options that the IRRP identifies as best suited to meet a need are then further planned in greater detail by the IESO. The IRRP phase also includes IESO led stakeholder engagement with municipalities, Indigenous communities, business sectors and other interested stakeholders in the region.

[1] Also referred to as Needs Screening

The RIP phase is the fourth and final phase of the regional planning process and involves: discussion of previously identified needs and plans; identification of any new needs that may have emerged since the start of the planning cycle; and development of a wires plan to address the needs where a wires solution would be the best overall approach. This phase is led and coordinated by the transmitter and the deliverable is a comprehensive report of a wires plan for the region. Once completed, this report is also referenced in transmitter's rate filing submissions and as part of LDC rate applications with a planning status letter provided by the transmitter.

To efficiently manage the regional planning process, Hydro One has been undertaking wires planning activities in collaboration with the IESO and/or LDCs for the region as part of and/or in parallel with:

- Planning activities that were already underway in the region prior to the new regional planning process taking effect;
- The NA, SA, and LP phases of regional planning;
- Participating in and conducting wires planning as part of the IRRP for the region or sub-region;
- Working and planning for connection capacity requirements with the LDCs and transmission connected customers.

Figure 2-1 illustrates the various phases of the regional planning process (NA, SA, IRRP, and RIP) and their respective phase trigger, lead, and outcome.

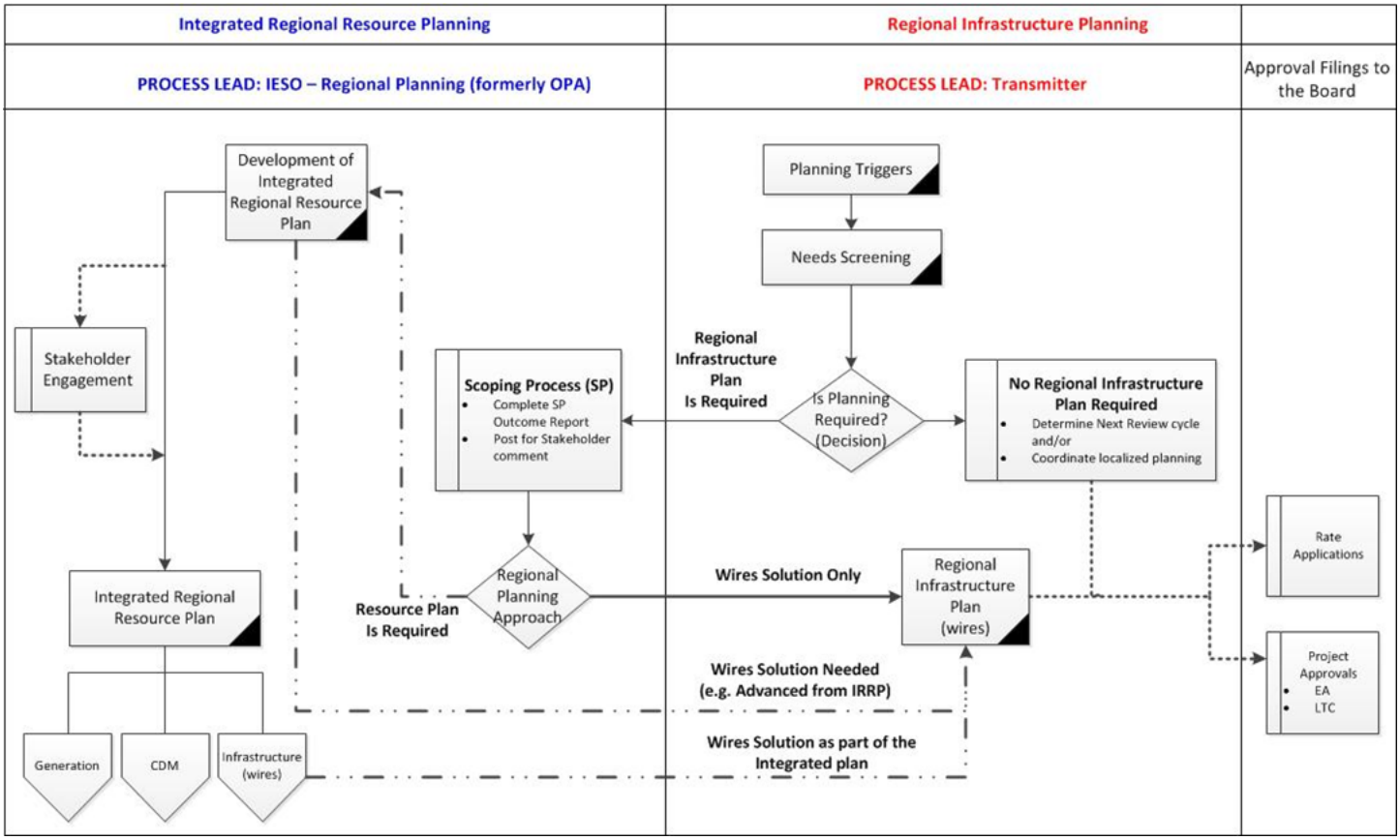

Figure 2-1: Regional Planning Process Flowchart

2.3 RIP Methodology

The RIP phase consists of a four step process (see Figure 2-2) as follows:

1) Data Gathering: The first step of the process is the review of planning assessment data collected in the previous phase of the regional planning process. Hydro One collects this information and reviews it with the Study Team to reconfirm or update the information as required. The data collected includes:
   - Net peak demand forecast at the transformer station level. This includes the effect of any distributed generation or conservation and demand management programs.
   - Existing area network and capabilities including any bulk system power flow assumptions.
   - Other data and assumptions as applicable such as asset conditions; load transfer capabilities, and previously committed transmission and distribution system plans.
2) Technical Assessment: The second step is a technical assessment to review the adequacy of the regional system including any previously identified needs. Depending upon the changes to load forecast or other relevant information, regional technical assessment may or may not be required

or be limited to specific issue only. Additional near and mid-term needs may be identified in this phase.

3) Alternative Development: The third step is the development of wires options to address the needs and to come up with a preferred alternative based on an assessment of technical considerations, feasibility, environmental impact and costs.
4) Implementation Plan: The fourth and last step is the development of the implementation plan for the preferred alternative.

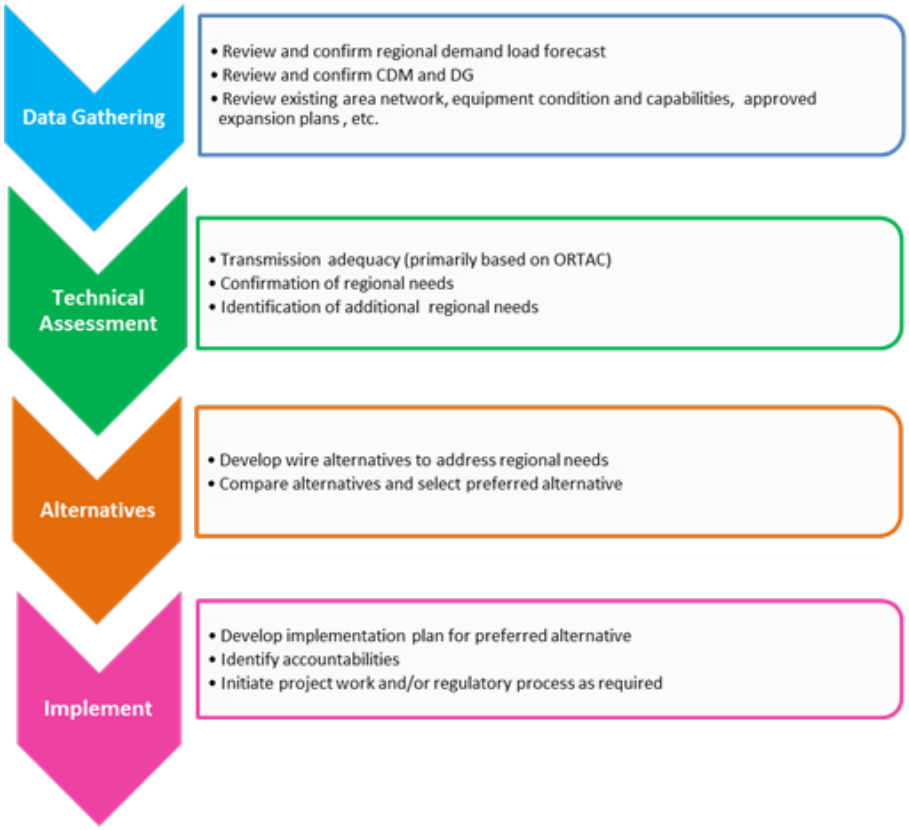

Figure 2-2: RIP Methodology

3 REGIONAL CHARACTERISTICS

THE WINDSOR-ESSEX REGION INCLUDES THE AREA ROUGHLY BORDERED GEOGRAPHICALLY BY CANADA-UNITED STATES (MICHIGAN) BORDER TO THE WEST AND THE MUNICIPALITY OF CHATHAM-KENT TO THE EAST. IT IS THE SOUTHERNMOST REGION OF ONTARIO.

The main transmission corridor in the region connects with the rest of the Hydro One system at Chatham Switching Station ("SS") and connects the Ontario transmission system with the Michigan transmission system at Keith TS.

The region's 115 kV network connects to the 230 kV transmission system at Keith TS and Lauzon TS via two autotransformers in each station. Fourteen 115 kV step-down transformer stations ("TS") and three 230 kV TS's serve the electrical load in the region through the 115 kV and 230 kV transmission network, as shown in Figure 3-1. Leamington TS is a new transformer station serving demand in the Kingsville-Leamington area, and came into service in 2017. Installation of a new second DESN at Leamington TS was completed in 2019.

There are 13 customer-owned generating plants in the region, connecting at the 230 kV and 115 kV levels with a combined contract capacity of 1,574 MW. Table 3-1 lists the region's transmission connected generations.

Table 3-1: Transmission Connected Generations

Station Name	Technology	Connection Point	Contract Capacity (MW)
Brighton Beach Power Station	Combined Cycle	Keith TS	541.25
West Windsor Power	Combined Cycle	J2N (Keith TS)	122.78
TransAlta Windsor Essex Cogeneration	CHP	Z1E	72.28
East Windsor Cogeneration	CHP	E8F/E9F	84
Gosfield Wind Project	Wind	K2Z	50.6
Pointe Aux Roches Wind	Wind	K6Z	48.6
Comber East (C24Z) Wind Project	Wind	C24Z	82.8
Comber West (C23Z) Wind Project	Wind	C23Z	82.8
KEPA Port Alma Wind Farm (I and II)	Wind	C24Z	200.6
RWEC Dillon Wind Farm	Wind	C23Z	78
Belle River Wind	Wind	C23Z	99.8
Romney Wind Farm	Wind	C21J	60
Windsor Solar	Solar	Z1E	50

The Windsor-Essex Region summer coincident peak demand in 2019 was about 1032 MW, adjusted to extreme weather. The region is served by five Local Distribution Companies ("LDC"): E.L.K. Energy Inc., Entegrus Powerlines Inc., EnWin Utilities Ltd., Essex Powerlines Corporation, and Hydro One Distribution. EnWin and Hydro One Distribution are directly connected to the transmission system, while three other LDCs have low voltage connections.

A single line diagram showing the electrical facilities in Windsor-Essex Region is provided in Figure 3-1.

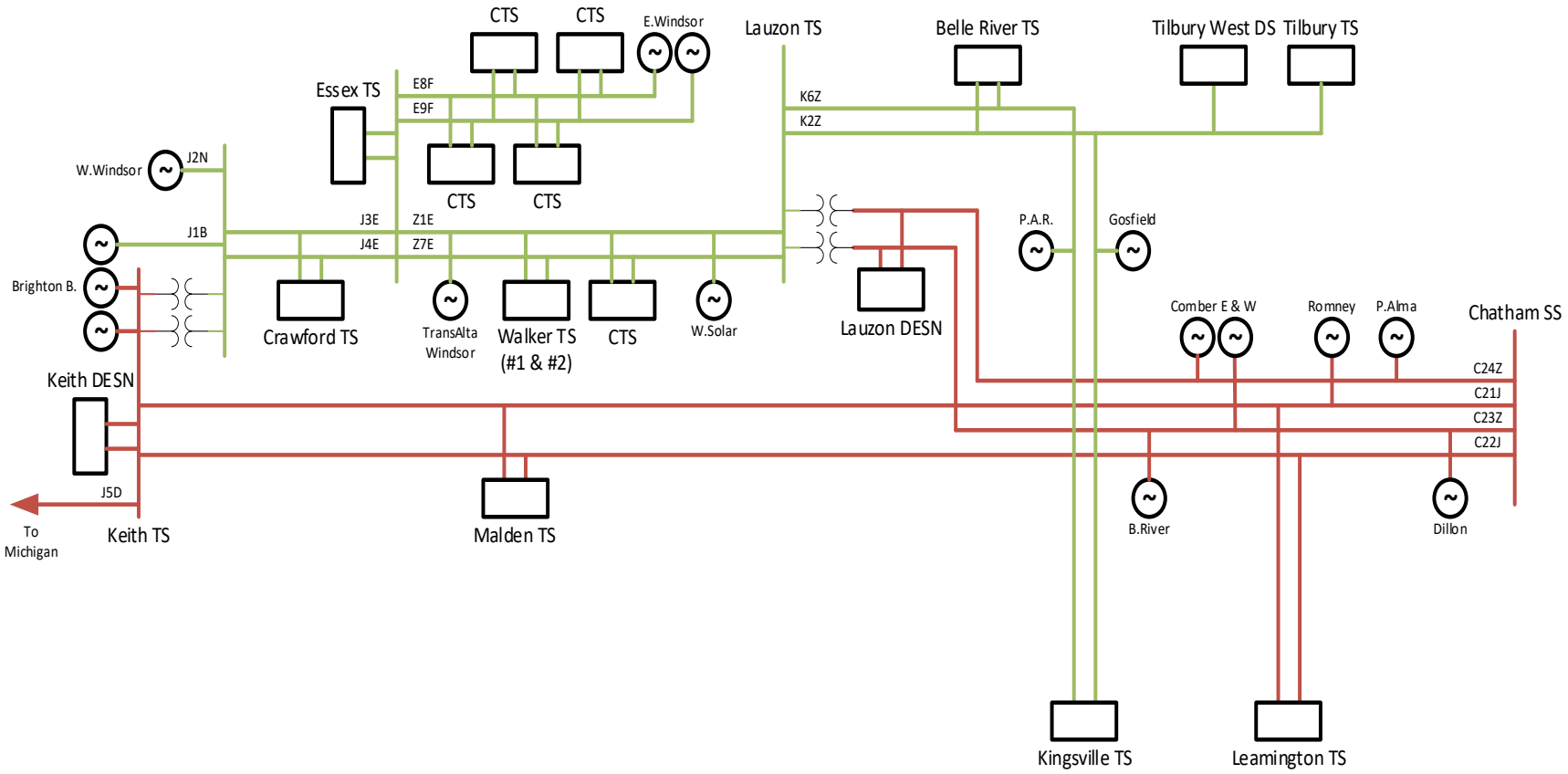

Figure 3-1: Single Line Diagram of Windsor-Essex Region's Existing Transmission System

4 TRANSMISSION FACILITIES COMPLETED AND/OR UNDERWAY OVER THE LAST TEN YEARS

OVER THE LAST TEN YEARS, A NUMBER OF TRANSMISSION PROJECTS HAVE BEEN PLANNED AND UNDERTAKEN BY HYDRO ONE AIMED TO MAINTAIN THE RELIABILITY AND ADEQUACY OF ELECTRICITY SUPPLY TO THE WINDSOR-ESSEX REGION.

A summary and description of the major projects completed and/or currently underway over the last ten years is provided below.

- Malden TS transformers replacement (I/S 2011): T1 and T2 were replaced in 2010 and 2011, respectively.
- Walker TS #1: Reactor installation for short circuit mitigation (I/S 2011).
- Kingsville TS: Reactor installation for short circuit mitigation (I/S 2011).
- Keith TS: Reactor installation for short circuit mitigation (I/S 2012).
- Lauzon TS breakers replacement (I/S 2012): Three breakers were replaced (SC2Q, SC3E, and SC4J).
- Keith TS DESN transformers replacement (I/S 2013): T23 and T22 were replaced in 2008 and 2013, respectively.
- Keith TS breakers replacement (I/S 2015): Six breakers were replaced (SC11K, SC11SC, SC1B, T11P, T12P, and SC2Y).
- Crawford TS transformer T3 replacement and neutral grounding reactors installation on T3 and T4 (I/S 2017)
- Malden TS breakers replacement (I/S 2018): two 27.6 kV feeder breakers have been replaced.
- Supply to Essex County Transmission Reinforcement (I/S 2017): Build new 13 km double-circuit 230 kV transmission lines to Leamington area tapped to existing C21J/C22J circuits, and new 75/100/125 MVA Leamington TS and its distribution feeders.
- Reconfiguration of 230 kV and 115 kV circuits and 27.6 kV feeders at Keith TS to accommodate the construction of Gordie Howe International Bridge (I/S 2019)
- Leamington TS expansion: Build the second 75/100/125 MVA DESN at Leamington TS (I/S 2019)
- Kingsville TS transformers replacement (in progress, I/S 2022): Transformers T2 and T4 have been replaced with 50/83 MVA T6 in 2018. Transformers T1 and T3 replacement is underway.
- Keith TS autotransformers replacement (in progress, I/S 2023): 125 MVA autotransformers T11 and T12 will be replaced by 250 MVA units.
- Tilbury TS decommissioning (in progress, I/S 2024): Decommissioning of station due to end-of-life and transfer serviced load to Tilbury West DS supply.
- Keith TS transformer T1 decommissioning (planned I/S 2024)

5 LOAD FORECAST AND STUDY ASSUMPTIONS

5.1 Load Forecast

The electricity demand in the Windsor-Essex Region is anticipated to grow at an average rate of 1.5% over the next ten years. The Windsor-Essex Region has been historically a summer-peaking region. With the new development in the greenhouse sector particularly in the Kingsville-Leamington area, the region peak demand has gradually shifted to the winter season. Figure 5-1 shows the updated Windsor-Essex Region's summer non-coincident and coincident peak load forecast for the 2020-2030 study period.

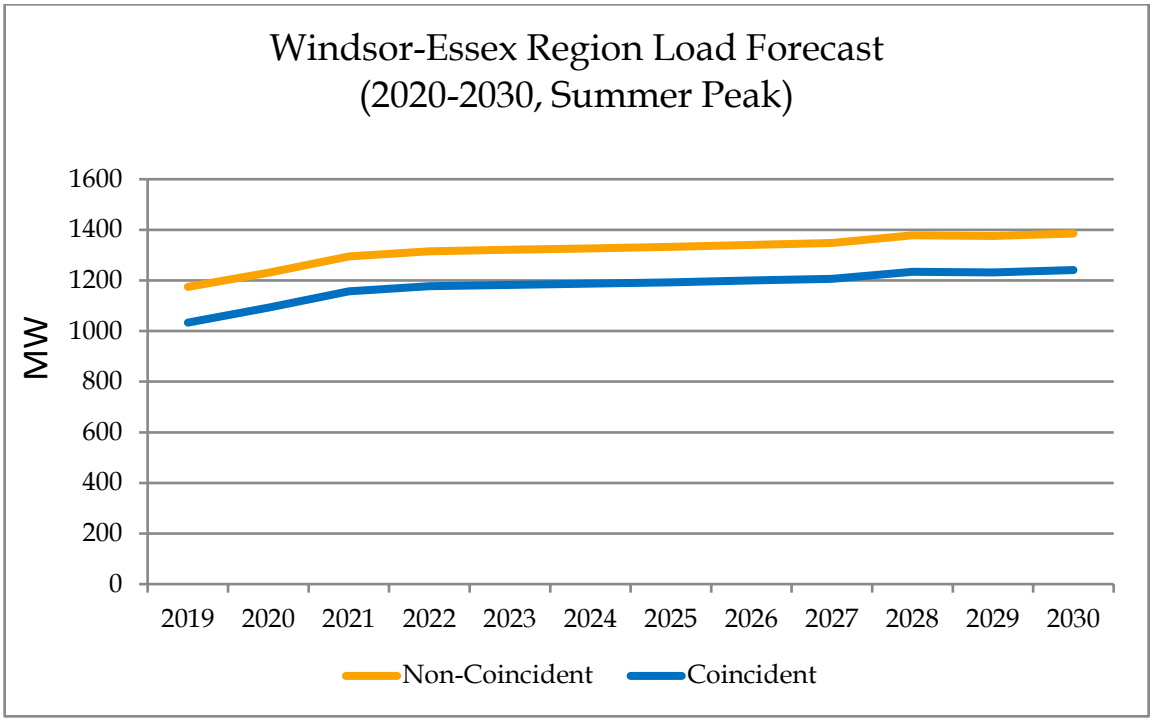

Figure 5-1: Windsor-Essex Region Load Forecast (Summer Peak)

The load forecast shows that the Region peak summer load increases from 1093 MW in 2020 to 1241 MW by 2030. The corresponding non-coincident summer peak loads increase from 1230 MW to about 1385 MW over the same period. The non-coincident and coincident net load forecasts for the individual stations in the Windsor-Essex Region are given in Appendix D, Table D-1 and Table E-1. Specifically for Kingsville TS and Leamington TS, based on their load characteristics, the annual peak of the stations occurs in the winter, thus for the two stations, the winter load forecast is also provided in Table D-2 and E-2 (for non-coincident and coincident forecast, respectively).

5.2 Study Assumptions

The following other assumptions are made in this report.

- The study period for the RIP assessments is 2020-2030.

- Load forecast includes the contribution from the distributed generation (DG) and conservation, and demand management (CDM) program, as provided by the 2019 Windsor-Essex IRRP (i.e., net load forecast).
- All facilities identified in Section 4 and that are planned to be placed in-service within the study period are assumed in-service.
- Normal planning supply capacity for transformer stations is determined by the summer 10-day Limited Time Rating (LTR), assuming a 90% lagging power factor.

6 REGIONAL NEEDS AND PLANS

THIS SECTION DISCUSSES ELECTRICAL INFRASTRUCTURE NEEDS IN THE WINDSOR-ESSEX REGION AND SUMMARIZES THE PLANS DEVELOPED TO ADDRESS THESE NEEDS.

This section outlines and discusses electrical infrastructure needs in the Windsor-Essex Region and plans to address these needs for the study period of 2020-2030. Table 6.1 provides a summary of the needs and the corresponding sub-sections where recommendation and plans are discussed.

Table 6-1: Identified Near and Mid-Term Needs in Windsor-Essex Region

Section	Facilities	Need	Timing
6.1	• New Switching Station ("Lakeshore TS") • DESNs ("South Middle Road TS") • New 2-circuit 230 kV transmission line (Chatham SS x Lakeshore TS)	Supply capacity to Kingsville-Leamington area load	2023
6.2	Lauzon TS	Step-down transformers T6/T8 end-of-life and T5/T6 station capacity	2024
		Step-down transformers T5/T7 and autotransformers T1/T2 end-of-life	2029
	Lauzon 115 kV Subsystem (i.e., stations radially supplied from Lauzon TS via K2Z/K6Z)	Load meeting capability due to voltage change violations	Today
6.3	Kent TS	Station capacity	2025
6.4	Belle River TS	Station capacity	2028

6.1 Supply Capacity to Kingsville-Leamington Area Load

6.1.1 Description

In the first cycle of regional planning for the Windsor-Essex Region, the Study Team recommended the Supply to Essex County Transmission Reinforcement (SECTR) project to supply the unprecedented load growth in the Kingsville-Leamington area driven by greenhouse development. The SECTR project included 13 km extension of existing 230 kV double-circuits C21J/C22J south to Leamington, and a new Leamington TS DESN, adding 200 MW of supply capacity in the Kingsville-Leamington area. The SECTR project was placed in service late 2017.

The added supply was fully allocated by the time SECTR project was in-service. The continuing significant load growth in the Kingsville – Leamington and the associated load forecast indicated that changes would be required in the recommended plan as set out in the first cycle RIP of December 2015. This situation

triggered the second cycle of regional planning for the Windsor – Essex region, with the Needs Assessment completed in October 2017.

To meet the growing electricity demand in the area, Hydro One proceeded to build the second DESN at Leamington TS. This expansion of Leamington TS, placed in service in late 2019, doubles the station capacity to 400 MW. Again, the rapidly growing demand in Kingsville-Leamington area exceeded the expanded station capacity – the existing connection applications in total are about 100 MW over the expanded station capacity. The magnitude of the electricity demand in this area not only exceeded station capacity, but also exceeded load meeting capacity of the transmission system. As consequences of this increasing demand, station capacity need, upstream transmission need, and load security need in this area have been identified by the Study Team. Until the transmission system is sufficiently upgraded, the system inadequacy would be managed with Special Protection Systems.

6.1.2 Alternatives and Recommendation

During the IRRP process, the Study Team has assessed the potential of non-wires alternatives including demand response, energy efficiency, and local generation to meet the supply capacity need in the Kingsville-Leamington area.

The Study Team recommends building a new switching station at Leamington JCT and new DESNs to meet the requirements of forecast load growth in the Kingsville – Leamington area. The team also recommends building a new 2 – circuit 230 kV line between Chatham SS and the new station at Leamington Junction.

Recommended Stations Project and Current Status

Hydro One has commenced a project to build a switching station in the vicinity of the existing Leamington Junction in the Town of Lakeshore in Essex County. All the 230 kV circuits C21J, C22J, C23Z and C24Z at this junction will be terminated at this station with full switching. The new station, to be known as Lakeshore Transformer Station, will have provision for additional development in the future. A second station will be built in close proximity to Lakeshore TS for the establishment of two new DESNs. This new station will be known as South Middle Road Transformer Station. Both stations will be located in the same Hydro One property in the Town of Lakeshore (Figure 6-1).

Each of the two DESNs at South Middle Road TS will consist of 2 x 75/100/125 MVA, 230/27.6 – 27.6 kV power transformers, twelve LV feeder positions and 2 LV capacitor banks, plus required switchgear.

Hydro One has completed necessary engagement activities and Class Environmental Assessment work for the establishment of the two stations. Hydro One obtained EA approval for the stations with the submission of the final Environmental Study Report to the Ministry of the Environment, Conservation and Parks, in January 2020. Construction is planned to commence in Q3 2020 for both Lakeshore TS and the first of the two DESNs at South Middle Road TS, and both facilities are planned to be in service in Q2 2022.

The second DESN at South Middle Road TS is planned to be in service in Q3 2025.

Recommended Line Project and Current Status

Hydro One is in the planning stages of the project to build a 2 x 230 kV line, about 49 km, between Chatham SS and Lakeshore TS. Engagement activities and Class Environmental Assessment studies are planned to commence in January 2020. EA approval and the OEB "Leave to construct" approval for the new line are expected in 2021 and 2022, respectively. The line is planned to be placed in service in Q4 2025.

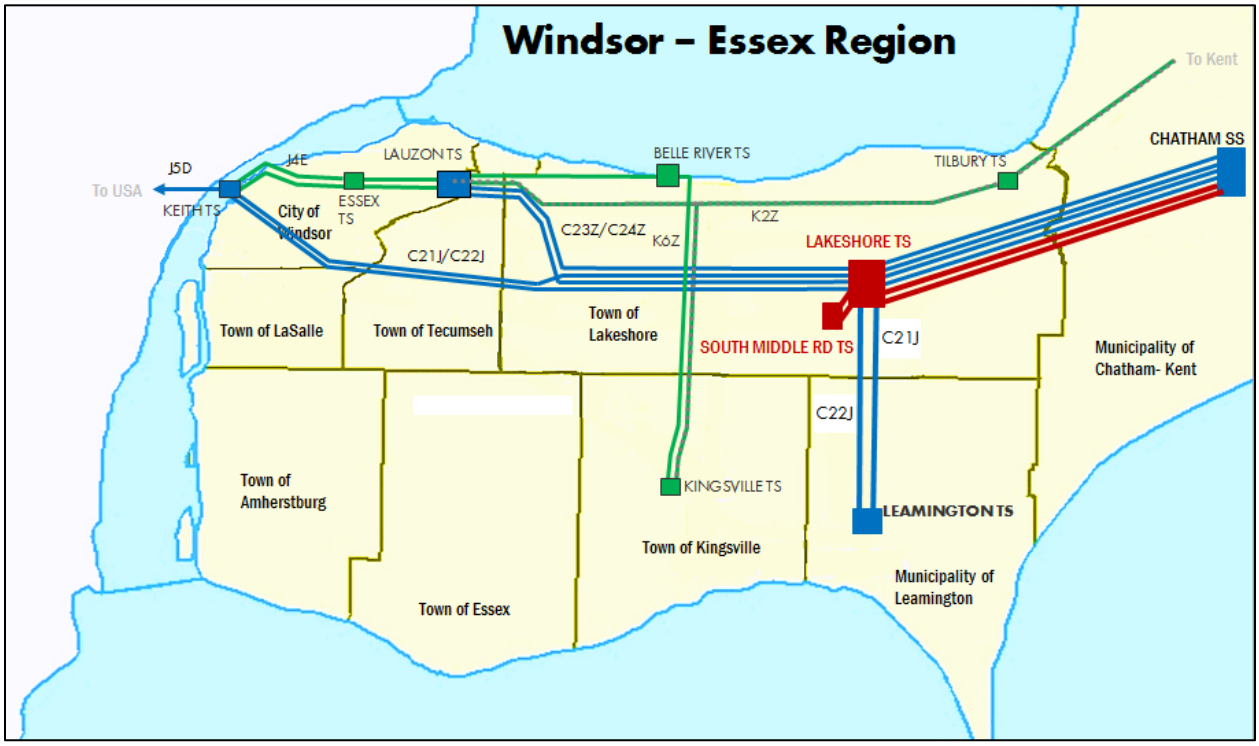

Figure 6-1: Planned Lakeshore TS, South Middle Road TS and Chatham SS x Lakeshore TS Line

6.2 Lauzon TS Transformers End-of-Life & Lauzon 115 kV Subsystem Supply Capacity Need

6.2.1 Description

Lauzon TS is located in the eastern part of the City of Windsor, and includes 230/115 kV autotransformation facility (T1, T2), as well as two 230/27.6 kV DESNs (T5/T6 and T7/T8). Lauzon TS is connected to the 230 kV circuits C23Z/C24Z, and 115 kV circuits Z1E/Z7E and K2Z/K6Z.

All of the Lauzon TS autotransformers and step-down transformers are reaching their end-of-life within the next 10 years. The T6 and T8 transformers are expected to reach their end-of-life by 2024, while the rest of the units (T1, T2, T5, and T7) are expected to reach their end-of-life by 2029. Figure 6-2 shows the overview of the station and the surrounding area.

Figure 6-2: Lauzon TS

Over the next 10 years, the combined station summer peak load is expected to remain fairly constant at approximately 220 MW. The T5/T6 DESN supplies approximately 130 MW of load, and the T7/T8 DESN supplies 90 MW of load. Considering each DESN is rated approximately 100 MW, a station capacity need has also been identified at the T5/T6 DESN level as well at the combined station level.

In addition, there is an existing supply capacity need in the Lauzon 115 kV subsystem, as shown in Figure 6-3, which includes stations supplied by the 115 kV K2Z/K6Z (i.e., Kingsville TS, Belle River TS, and Tilbury West DS). This need arises due to voltage change violations of ORTAC following certain contingencies. This need is being evaluated in-detail through a separate study, to be provided as an addendum to the 2019 Windsor-Essex IRRP, expected for completion in Q3 2020.

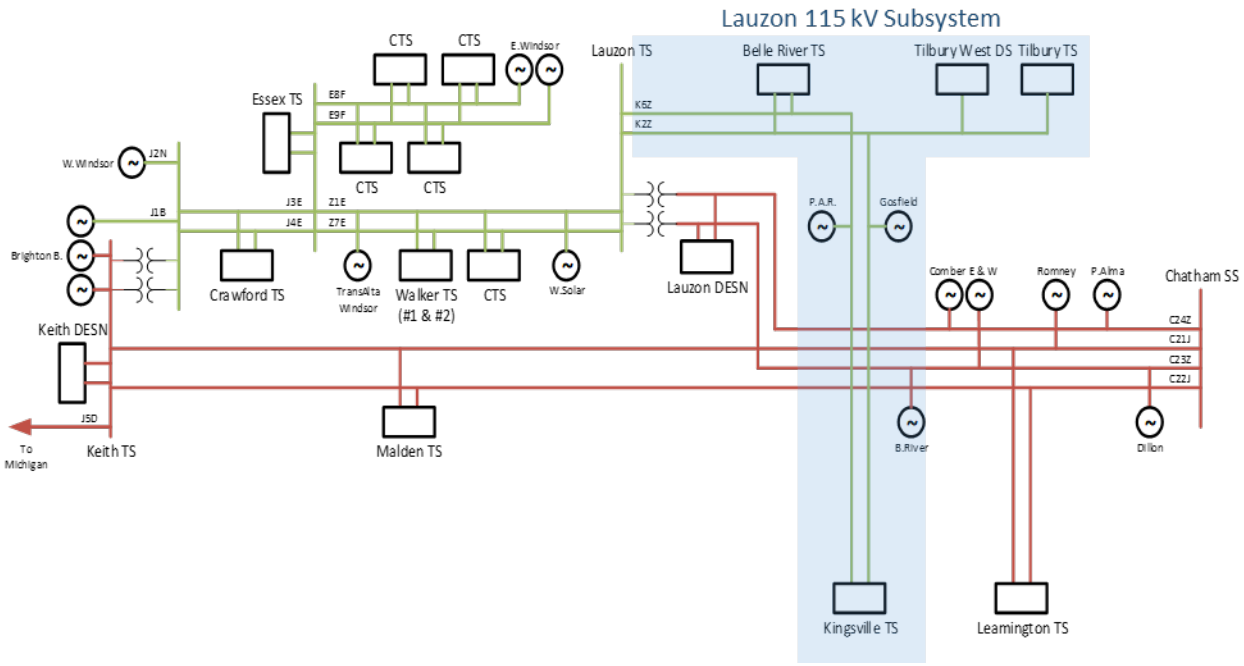

Figure 6-3: Lauzon 115 kV Subsystem

6.2.2 Alternatives and Recommendation

The following alternatives are considered to address the above end-of-life and station capacity needs:

1. **Maintain Status Quo:** This alternative was considered and rejected as it does not address the station capacity and risk of failure due to asset condition and would result in increased maintenance cost and reduce supply reliability for customers.
2. **Like-for-Like Replacement:** This alternative was considered and rejected as it does not address the station capacity need.
3. **Load Balancing between two DESNs:** Load balancing between two DESNs can be achieved through distribution feeders' re-configuration. This alternative was considered and rejected as the load forecast shows demand at Lauzon TS exceeds 200 MW in the whole study period.
4. **Distribution Load Transfer to Nearby Stations:** This alternative is not feasible as there are no sufficient capability to transfer the excess load to nearby stations.
5. **Replace and Upgrade the End-of-Life Transformers T5/T6:** This option will address the station capacity need and the T5/T6 end-of-life need.

The Study Team recommends Hydro One proceed with Alternative 5 – to replace the 50/83 MVA T5/T6 with 75/125 MVA units, with expected in-service date of 2024. The strategy of T1/T2 and T7/T8 replacement will be determined after the Lauzon 115 kV subsystem study is completed (expected Q3 2020).

6.3 Kent TS Station Capacity Need

6.3.1 Description

Kent TS is part of the Chatham-Lambton-Sarnia Region, and at the inter-regional boundary with the Windsor-Essex Region. Kent TS is located approximately 6 km to the northwest of Chatham SS, and is electrically connected to 230 kV double circuits L28C/L29C between Chatham SS and Lambton TS. Kent TS consists of two 230 kV/27.6 kV DESNs (T1/T2 and T3/T4). The T1/T2 DESN is rated 153 MVA of capacity in summer; while the T3/T4 DESN is rated 58.7 MVA. Based on historical peak loading, and a request for load allocation, Entegrus was allocated 38 MW of incremental load at the T1/T2 DESN. Hydro One is currently coordinating with Entegrus to connect two new feeder positions at the T1/T2 DESN.

Figure 6-4 below shows the map and transmission system around Kent TS.

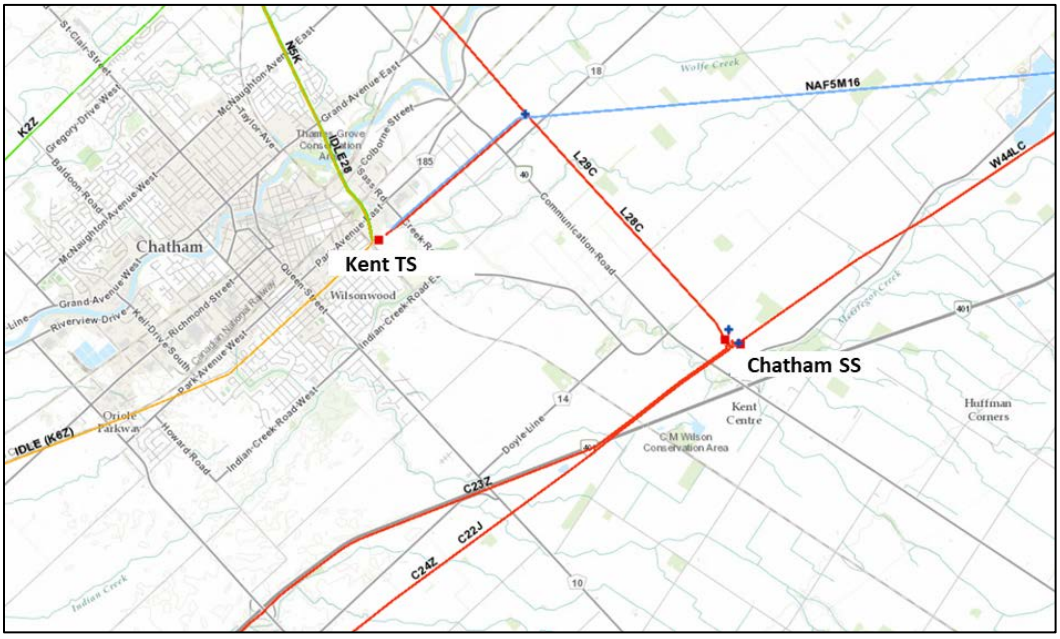

Figure 6-4: Kent TS Map

While Kent TS is part of the Chatham-Lambton-Sarnia Region, and not in the Windsor-Essex Region, there was an urgent capacity need identified by the LDCs in the region. There is a 55 MW load connection anticipated at Kent TS, and in addition, the load forecast predicts that the existing load will increase by 12.5 MW in the next five years. In 2020, the station capacity at Kent TS is expected to be fully utilized; and there will be an incremental capacity need of 30-40 MW over the next ten years.

6.3.2 Alternatives and Recommendation

The Study Team has evaluated the potential of upsizing Kent TS transformers and/or adding new DESN transformers at the station to provide the additional station capacity. Assessments concluded that those options were not feasible because long feeders would be required to connect the new load (located South of Chatham) to Kent TS, which would incur significant costs, higher losses along with challenges with station egress and feeder routing. Accordingly, the Study Team has determined that the recommended location for a new DESN is south of Chatham.

However, several transmission planning assessments are currently underway, including the Dresden area study which will be followed by regional planning for the Chatham-Kent-Lambton-Sarnia Region to be triggered in Q1/Q2 2020. In light of the fact that load forecasts for Chatham have shifted out the capacity need, the Study Team recommends that the plan for the new DESN South of Chatham to be further evaluated as part of the upcoming Chatham-Kent-Lambton-Sarnia regional planning process.

6.4 Belle River TS Station Capacity Need

6.4.1 Description

The existing Belle River TS comprises a 115 kV/27.6 kV DESN (T1/T2). It is supplied by two 115 kV circuits K2Z and K6Z. The station capacity is approximately 54 MW. The summer peak of its serving area is currently 45 MW. According to the load forecast in the study period, Belle River TS is expected to have moderate load growth. The station capacity is expected to be exceeded as early as in 2028.

6.4.2 Alternatives and Recommendation

1. **Maintain Status Quo:** Do nothing, and monitor if the forecasted load growth materializes.
2. **Non-wires Alternatives:** The provincial energy-efficiency initiatives could relieve the future capacity need at Belle River TS and keep the station loading below the station capacity.
3. **Wires Alternatives:** The wire alternatives to this need include upgrading the existing transformers to higher rating units, or transferring some of Belle River TS load to nearby stations through distribution load transfer.

The Study Team recommends Alternative 1, that no further investment is required at this time due to the amount of lead time available. Hydro One and relevant LDCs will continue monitoring the load growth at Belle River TS and re-evaluate the station capacity need in the next planning cycle.

7 CONCLUSIONS AND NEXT STEPS

THIS REGIONAL INFRASTRUCTURE PLAN CONCLUDES THE REGIONAL PLANNING PROCESS FOR THE WINDSOR-ESSEX REGION.

The major infrastructure investments recommended by the Study Team in the near and mid-term planning horizon are provided in Table 7-1 below, along with their planned in-service date and budgetary estimates for planning purpose.

Table 7-1: Recommended Plans in Windsor-Essex Region over the Next 10 Years

No.	Need	Recommended Action Plan	Planned I/S Date	Budgetary Estimate ($M)
1	Supply capacity need to Kingsville- Leamington area	• Build new switching station at Leamington Junction (Lakeshore TS), and new DESN station (South Middle Road TS) • Build 230 kV double-circuit transmission line from Chatham SS to the new Lakeshore TS	2022-2025	$295M
2	Lauzon TS T5/T6 transformers end-of-life and station capacity	Replace Lauzon TS T5 & T6 transformers replacement with larger 75/125 MVA units	2024	$34M
3	Kent TS station capacity	• Install new feeder positions to supply load growth at Kent TS • Further evaluate plan for the new DESN south of Chatham as part of the Chatham-Lambton-Sarnia regional planning process	-	-
4	Belle River TS station capacity	Monitor load growth and re-evaluate the need in the next regional planning cycle	-	-

The Study Team recommends that Hydro One to continue with the implementation of infrastructure investments listed in Table 7-1 while keeping the Study Team apprised of project status.

8 REFERENCES

[1] **Windsor-Essex Regional Infrastructure Plan (2015)**
https://www.hydroone.com/abouthydroone/CorporateInformation/regionalplans/windsoressex/Documents/RIP%20Report%20Windsor-Essex.pdf

[2] **Windsor-Essex Needs Assessment (2017)**
https://www.hydroone.com/abouthydroone/CorporateInformation/regionalplans/windsoressex/Documents/Needs%20Assessment_Windsor-Essex_Final.pdf

[3] **Windsor-Essex Scoping Assessment Outcome Report (2018)**
http://www.ieso.ca/-/media/Files/IESO/Document-Library/regional-planning/Windsor-Essex/2018-Windsor-Essex-Scoping-Assessment-Outcome-Report.pdf?la=en

[4] **Windsor-Essex Integrated Regional Resource Plan (2019)**
http://www.ieso.ca/-/media/Files/IESO/Document-Library/regional-planning/Windsor-Essex/Windsor_Essex_IRRP_Report_20190903.pdf?la=en

[5] **Windsor-Essex Integrated Regional Resource Plan – Appendices (2019)**
http://www.ieso.ca/-/media/Files/IESO/Document-Library/regional-planning/Windsor-Essex/Windsor_Essex_IRRP_Appendices_20190903.pdf?la=en

APPENDIX A. STATIONS IN THE WINDSOR-ESSEX REGION

Station (DESN)	Voltage (kV)	Supply Circuits
Keith TS T1	115/27.6	Keith TS 115 kV Bus
Keith TS T22/T23	230/27.6	Keith TS 230 kV Bus
Leamington TS T1/T2	230/27.6	C21J/C22J
Leamington TS T3/T4	230/27.6	C21J/C22J
Malden TS T1/T2	230/27.6	C21J/C22J
Lauzon TS T5/T6	230/27.6	C23Z/C24Z
Lauzon TS T7/T8	230/27.6	C23Z/C24Z
Belle River TS T1/T2	115/27.6	K2Z/K6Z
Kingsville TS T1//T3/T6	115/27.6	K2Z/K6Z
Tilbury West DS	115/27.6	K2Z
Tilbury TS T1	115/27.6	K2Z
Crawford TS T3/T4	115/27.6	J3E/J4E
Essex TS T5/T6	115/27.6	Essex TS 115 kV Bus
Walker TS #1 T3/T4	115/27.6	Z1E/Z7E
Walker MTS #2	115/27.6	Z1E/Z7E
Ford Essex CTS	115/13.8	Z1E/Z7E
Chrysler WAP MTS	115/27.6	E8F/E9F
Ford Annex MTS	115/13.8	E8F/E9F
Ford Windsor MTS	115/27.6	E8F/E9F
G.M. Windsor MTS	115/27.6	E8F/E9F

APPENDIX B. TRANSMISSION LINES IN THE WINDSOR-ESSEX REGION

Location	Circuit Designations	Voltage (kV)
Chatham x Keith	C21J, C22J	230
Chatham x Lauzon	C23Z, C24Z	230
Keith x Essex	J3E, J4E	115
Lauzon x Essex	Z1E, Z7E	115
Essex x East Windsor CGS	E8F, E9F	115
Lauzon x Kingsville	K2Z, K6Z	115
Keith x Michigan Tie	J5D	115

APPENDIX C. DISTRIBUTORS IN THE WINDSOR-ESSEX REGION

Distributor Name	Station Name	Connection Type
E.L.K. Energy Inc.	Belle River TS	Dx
	Kingsville TS	Dx
	Lauzon TS	Dx
Entegrus Powerlines Inc.	Kingsville TS	Dx
	Leamington TS	Dx
	Tilbury West DS	Dx
EnWin Utilities Ltd.	Crawford TS	Tx
	Essex TS	Tx
	Keith TS	Tx
	Lauzon TS	Tx
	Malden TS	Tx
	Walker TS #1	Tx
	Walker MTS #2	Tx
	Chrysler WAP MTS	Tx
	Ford Annex MTS	Tx
	Ford Essex CTS	Tx
	Ford Windsor MTS	Tx
	G.M. Windsor MTS	Tx
Essex Powerlines Corp.	Keith TS	Dx
	Lauzon TS	Dx
	Leamington TS	Dx
	Malden TS	Dx
Hydro One Networks Inc. (Distribution)	Belle River TS	Tx
	Kingsville TS	Tx
	Lauzon TS	Tx
	Tilbury West DS	Tx
	Tilbury TS	Tx
	Keith TS	Tx
	Malden TS	Tx
	Leamington TS	Tx

APPENDIX D. WINDSOR-ESSEX REGION NON-COINCIDENT LOAD FORECAST

Table D-1: Windsor-Essex Non-Coincident (Summer) Net Load Forecast

Station	LTR* (MW)	2019**	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
230 kV													
Keith TS	142	104	88	87	87	86	86	85	85	85	85	85	85
Lauzon T5/T6	101	124	128	130	131	132	133	134	135	136	138	139	140
Lauzon T7/T8	103	87	88	87	88	88	89	89	89	89	90	90	90
Leamington T3/T4	183	121	120	122	123	123	123	124	125	126	127	127	128
Leamington T1/T2	183	4	68	125	139	139	139	139	140	140	140	144	145
Malden TS	183	134	134	134	135	135	135	134	135	136	137	137	137
115 kV													
Belle River TS	54	47	48	49	49	50	51	52	53	54	55	56	57
Crawford TS	92	81	82	82	83	84	85	86	87	88	88	89	90
Essex TS	107	89	90	90	91	92	93	93	94	95	95	96	97
Industrial Customer #1	59	34	34	35	35	35	35	35	35	35	35	35	35
Industrial Customer #2	39	8	8	8	8	8	8	8	8	8	8	8	8
Industrial Customer #3	39	10	10	10	10	10	10	10	10	10	10	10	10
Industrial Customer #4	59	16	16	16	16	17	17	17	17	17	17	17	17
Industrial Customer #5	39	24	24	24	24	24	24	25	25	25	25	25	26
Kingsville TS	104	87	86	85	85	85	85	85	84	84	105	92	93
Tilbury TS	7	0	0	0	0	0	0	0	0	0	0	0	0
Tilbury West DS	31	19	19	20	20	20	20	20	20	21	21	21	22
Walker MTS #2	89	115	116	117	118	119	119	120	121	122	123	124	125
Walker TS #1	90	71	72	73	74	74	75	76	77	77	78	79	80

* Station LTR is based on 90% power factor

** Non-coincident station peak, adjusted to extreme weather

Table D-2: Kingsville TS and Leamington TS Non-Coincident (Winter) Net Load Forecast

Station	LTR* (MW)	2019**	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
230 kV													
Leamington T3/T4	195	109	166	181	181	181	180	180	181	180	181	217	226
Leamington T1/T2	195	3	61	114	127	127	127	127	127	128	128	146	152
115 kV													
Kingsville TS	116	102	116	116	116	116	116	116	116	115	115	128	131

APPENDIX E. WINDSOR-ESSEX REGION COINCIDENT LOAD FORECAST

Table E-1: Windsor-Essex Coincident (Summer) Net Load Forecast

Station	LTR* (MW)	2019**	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
230 kV													
Keith TS	142	69	59	58	58	58	57	57	57	57	57	57	57
Lauzon T5/T6	101	121	125	126	127	128	129	130	131	133	134	135	136
Lauzon T7/T8	103	84	85	85	85	86	86	86	87	87	87	87	88
Leamington T3/T4	183	121	120	122	123	123	123	124	125	126	127	127	128
Leamington T1/T2	183	4	68	125	139	139	139	139	140	140	140	144	145
Malden TS	183	128	128	128	129	129	129	129	129	130	131	131	131
115 kV													
Belle River TS	54	44	45	46	47	48	49	49	50	51	52	53	54
Crawford TS	92	72	73	74	75	75	76	77	78	78	79	80	81
Essex TS	107	86	86	87	88	88	89	90	90	91	92	93	93
Industrial Customer #1	59	32	33	33	33	33	33	33	33	33	33	33	34
Industrial Customer #2	39	7	7	7	7	7	7	7	7	7	7	7	7
Industrial Customer #3	39	8	8	8	8	8	8	8	8	8	8	8	8
Industrial Customer #4	59	4	4	4	4	4	4	4	4	4	4	4	4
Industrial Customer #5	39	15	15	15	15	15	15	15	16	16	16	16	16
Kingsville TS	104	82	81	80	80	80	80	80	79	79	99	87	87
Tilbury TS	7	0	0	0	0	0	0	0	0	0	0	0	0
Tilbury West DS	31	18	19	19	19	19	19	19	20	20	20	20	21
Walker MTS #2	89	76	77	77	78	79	79	80	81	81	82	82	83
Walker TS #1	90	61	61	62	62	63	64	64	65	66	66	67	68

* Station LTR is based on 90% power factor

** Coincident station peak, adjusted to extreme weather

Table E-2: Kingsville TS and Leamington TS Coincident (Winter) Net Load Forecast

Station	LTR* (MW)	2019**	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
230 kV													
Leamington T3/T4	195	109	166	181	181	181	180	180	181	180	181	217	226
Leamington T1/T2	195	3	61	114	127	127	127	127	127	128	128	146	152
115 kV													
Kingsville TS	116	87	99	99	99	99	99	99	98	98	98	109	112