NEEDS ASSESSMENT REPORT

London Area

November 26, 2024

Needs Assessment Report

London Area

- November 26, 2024 -

Lead Transmitter:

Hydro One Networks Inc.

Prepared by: London Area Technical Working Group

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Disclaimer

This Needs Assessment (NA) Report was prepared for the purpose of identifying potential needs in the London Area and to recommend which needs a) do not require further regional coordination and can be directly addressed by developing a preferred plan as part of the NA phase and b) require further assessment and regional coordination. The results reported in this NA are based on the input and information provided by the Technical Working Group (TWG) for this region at the time. Updates may be made based on best available information throughout the planning process.

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Executive Summary

REGION	London Area Region (the "Region")
LEAD	Hydro One Networks Inc. ("HONI")
START DATE: July 29, 2024	**END DATE:** November 26, 2024

1. INTRODUCTION

The 2nd Regional Planning cycle for the London Area Region was completed in August 2022 with the publication of the Regional Infrastructure Plan ("RIP") report. This is the 3rd cycle of Regional Planning for the region.

The purpose of this Needs Assessment ("NA") is to:

a) Identify any new needs and reaffirm needs identified in the previous regional planning cycle; and,
b) Recommend which needs:
   i) require further assessment and regional coordination (and hence, proceed to the next phases of regional planning); and,
   ii) do not require further regional coordination (i.e., can be addressed directly between Hydro One and the impacted LDC(s) to develop a preferred plan and/or no regional investment is required at this time and the need may be reviewed during the next regional planning cycle).

The planning horizon for this NA assessment is ten (10) years.

2. REGIONAL ISSUE/TRIGGER

In accordance with the Regional Planning process, the Regional Planning cycle should be triggered at least once every five years. Considering these timelines, the 3rd Regional Planning cycle was triggered in July 2024 for the London Area Region. Due to significant load growth in the region, the Technical Working Group ("TWG") decided that the 3rd Regional Planning cycle be triggered one year in advance of the five-year period.

3. SCOPE OF NEEDS ASSESSMENT

The scope of the London Area Region NA and includes:

a) Review and reaffirm needs/plans identified in the previous regional planning cycle RIP (as applicable),
b) Identify any new needs resulting from this assessment,
c) Recommend which need(s) require further assessment and regional coordination in the next phases of the regional planning cycle; and,
d) Recommend which needs do not require further regional coordination (i.e., can be addressed directly between Hydro One and the impacted LDC(s) to develop a preferred plan and/or no regional investment is required at this time and the need may be reviewed during the next regional planning cycle).

The TWG may also identify additional needs during the next phases of the planning process, namely Scoping Assessment ("SA"), Integrated Regional Resource Plan ("IRRP"), and RIP, based on updated information available at that time. The planning horizon for this NA is ten (10) years.

4. REGIONAL DESCRIPTION AND CONNECTION CONFIGURATION

The London Region includes the municipalities of Oxford County (comprising Township of Blandford-Blenheim, Township of East Zorra-Tavistock, Town of Ingersoll, Township of Norwich, Township of South-West Oxford, Town of Tillsonburg, Township of Zorra), City of Woodstock, Middlesex County (comprising Municipality of Adelaide Metcalfe , Municipality of Lucan Biddulph, Municipality of Middlesex Centre, Municipality of North Middlesex, Municipality of Southwest Middlesex, Municipality of Strathroy-Caradoc, Municipality of Thames Centre, Village of Newbury), City of London, Elgin County (comprising Municipality of Town of Aylmer, Municipality of Bayham, Municipality of Central Elgin, Municipality of West Elgin, Municipality of Dutton/Dunwich, Township of Malahide, Township of Southwold), and City of St. Thomas. In addition, the transmission facilities in this region also supply part of Norfolk County.

5. INPUTS/DATA

The TWG comprises of representatives from Local Distribution Companies ("LDC"), the Independent Electricity System Operator ("IESO"), and Hydro One and provides input and relevant information for the London Area Region regarding capacity needs, reliability needs, operational issues, and major high-voltage (HV) transmission assets requiring replacement over the planning horizon. The LDCs also capture input from municipalities in the development of their ten-year load forecast.

In accordance with the regional planning process, stakeholder engagement takes place during the SA and IRRP phase.

6. ASSESSMENT METHODOLOGY

The assessment's primary objective is to identify the electrical infrastructure needs in the Region over the ten-year planning horizon. The assessment methodology includes a review of planning information such as load forecast (which factors various demand drivers and consideration of MEPs and/or CEPs where available), conservation and demand management ("CDM") forecast, distributed generation ("DG") forecast, system reliability and operation, and major HV transmission assets requiring replacement.

A technical assessment of needs is undertaken based on:

a) Current and future station capacity and transmission adequacy;

b) System reliability needs and operational concerns;

c) Major HV transmission equipment requiring replacement with consideration to "right-sizing"; and,

d) Sensitivity analysis to capture uncertainty in the load forecast as well as variability of demand drivers such as electrification.

7. NEEDS

I. Updates on needs identified during the previous regional planning cycle

The following needs and projects have been recently completed:

- Edgeware TS PCT and component replacement (completed in 2024)
- Reversing of the normally open point at Cranberry Junction, per the Aylmer-Tillsonburg Reinforcement project (completed in 2024)
- Tillsonburg TS component replacement (completed in 2023)
- Nelson TS station refurbishment (completed in 2022)
- Tillsonburg TS low voltage capacitor banks installation (completed in 2021)
- Sarnia Scott TS x Buchanan TS 230 kV N21W/N22W circuits tower structures refurbishment (completed in 2021)
- St. Thomas TS decommissioning and 115 kV W14 circuit re-termination work (completed in 2020)
- Strathroy TS T1 and component replacement (completed in 2019)
- Wonderland TS T6 replacement (completed in 2019)

The needs and projects discussed in the London Area 2nd cycle RIP report for the London Area Region are as follows:

- Talbot TS Station Capacity: According to the net load forecast in the study period, Talbot TS T1/T2 DESN and Talbot T3/T4 DESN was expected to exceed its station capacity throughout the study period
- Talbot TS transformers T3 and T4, associated disconnect switches, and low-voltage switchyard components replacement need: Replacement that will allow for maintaining reliability (2032)
- Greater London Sub-Region Restoration Need: The 230 kV double-circuit line, W36 and W37, emanates from Buchanan TS and supplies Talbot TS (both DESNs) and Clarke TS. Should the simultaneous loss of W36/W37 occur, all loads supplied by the Clarke TS and Talbot TS would be interrupted by configuration. The potential load loss would exceed the ORTAC load restoration criteria.
- Buchanan TS Autotransformer T2 and T3 and associated equipment replacement need: Replacement that will allow for maintaining reliability (beyond planning horizon)
- Clarke TS Transformer T3 and T4, associated disconnect switches, and low-voltage switchyard components replacement need: Replacement that will allow for maintaining reliability (beyond planning horizon)

II. Newly identified needs in the region

The following are new needs that were identified as part of this assessment:

a) Asset Renewal for Major HV Transmission Equipment

- No new Asset Renewal Needs

b) Transformation Capacity

- New Transformation Capacity needs were identified at the following stations:
  - Aylmer TS
  - Clarke TS
  - Edgeware TS
  - Nelson TS
  - Strathroy TS
  - Tillsonburg TS
  - Woodstock TS
  - Wonderland TS

c) Transmission System Capacity

- Thermal limitations were observed on 230 kV W44LC/W45LS for the loss of companion circuit
- Thermal limitations were observed on the 115 kV WT1T to Tillsonburg TS, in pre-contingency

d) System Reliability, Operation and Load restoration

- Load restoration limitations on 230 kV M31W/M32W and 115 kV K7/K12/B2 circuits for a single tower contingency caused by the loss of double-circuit line M31W and M32W or for a double contingency with the loss of both autotransformers at Karn TS
- Load restoration limitations on 230 kV M31W/M33W circuits for a single tower contingency
- Load restoration limitations on 230 kV W44LC/W45LS circuits for a single tower contingency

8. SENSITIVITY ANALYSIS

The objective of a sensitivity analysis is to capture uncertainty in the load forecast as well as variability of electric demand drivers to identify any emerging needs and/or advancement or deferment of recommended investments.

The impact of the sensitivity analysis for the high and low growth scenarios was considered relatively minor to near-term need dates for station and line capacity needs.

9. RECOMMENDATIONS

The TWG recommendations are as follows:

I. Needs that require further assessment and regional coordination

These needs may have broader regional impacts and require further assessment and coordination during the next phases[1] of the regional planning cycle. A list of these needs are as follows:

a. Transmission System Capacity

- Thermal limitations on 230 kV W44LC/W45LS for the loss of companion circuit
- Thermal limitations on the 115 kV WT1T to Tillsonburg TS pre-contingency

b. System Reliability, Operation and Load Restoration

- Load restoration limitations on 230 kV M31W/M32W and 115 kV K7/K12/B2 circuits for a single tower contingency causing the loss of double-circuit line M31W and M32W or for a double contingency with the loss of both autotransformers at Karn TS
- Load restoration limitations on 230 kV M31W/M33W circuits for a single tower contingency
- Load restoration limitations on 230 kV W36/W37 circuits for a single tower contingency
- Load restoration limitations on 230 kV W44LC/W45LS circuits for a single tower contingency

c. Transformation Capacity Needs:

- Aylmer TS
- Edgeware TS
- Clarke TS
- Nelson TS
- Strathroy TS
- Talbot T1/T2
- Talbot T3/T4
- Tillsonburg TS
- Wonderland TS
- Woodstock TS

II. Needs that do not require further regional coordination

The TWG recommends reviewing all needs in the region, identified in this needs assessment, proceed to the next phases of this regional planning cycle for further assessment.

[1] Non-wires options are further considered (i.e. incremental to CDM and DG that is considered in this NA) as potential options in addressing these needs during the IRRP phase.

List of LDC(s) to be involved in further regional planning phases:

- Entegrus Powerlines Inc.
- ERTH Power Inc.
- Hydro One Distribution
- London Hydro Inc.
- Tillsonburg Hydro Inc.

List of LDC(s) which are not required to be involved in further regional planning phases:

- N/A

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1. INTRODUCTION

The second cycle of the Regional Planning process for the London Area Region was completed in August 2022 with the publication of the Regional Infrastructure Plan ("RIP") report. The RIP report included a common discussion of all the options and recommended plans for preferred wire infrastructure investments to address the near- and medium-term needs.

This Needs Assessment initiates the third regional planning cycle for the London Area Region. The purpose of this Needs Assessment ("NA") is to:

a) Identify any new needs and reaffirm needs identified in the previous regional planning cycle; and,
b) Recommend which needs:

i) require further assessment and regional coordination (and hence, proceed to the next phases of regional planning); and,

ii) do not require further regional coordination (i.e., can be addressed directly between Hydro One and the impacted LDC(s) to develop a preferred plan and/or no regional investment is required at this time and the need may be reviewed during the next regional planning cycle).

The planning horizon for this NA assessment is ten years. A flow chart of the Regional Planning Process is shown in Figure 1 below.

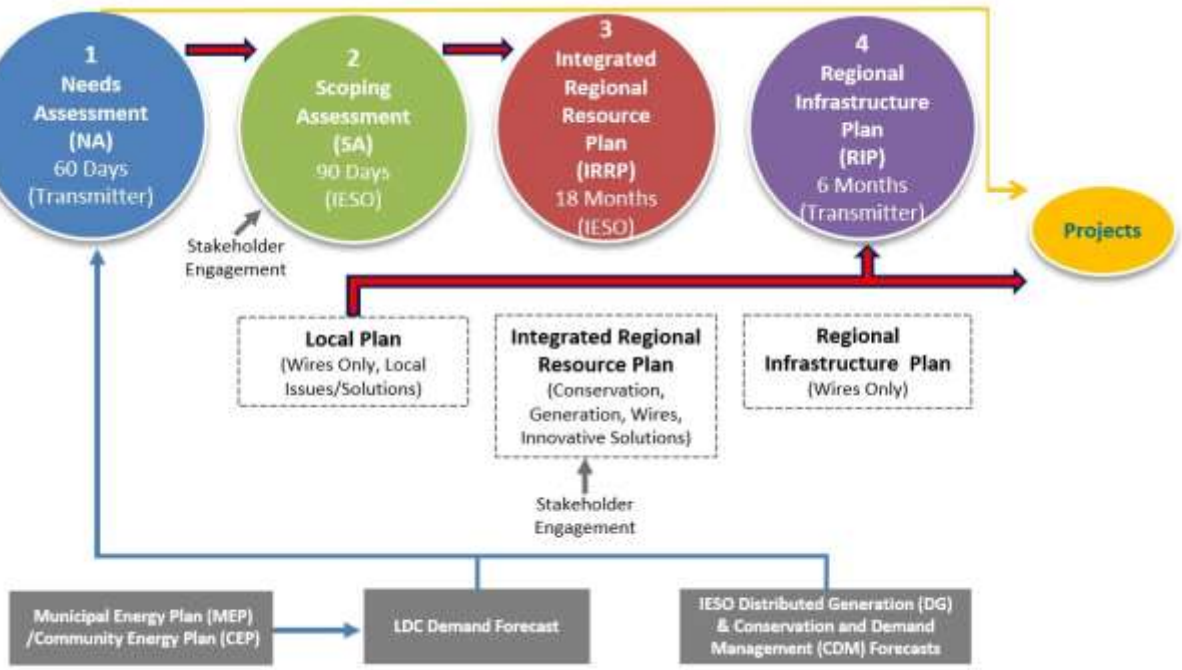


Figure 1: Regional Planning Process

This report was prepared by the London Area Technical Working Group ("TWG"), led by Hydro One Networks Inc. The report presents the results of the assessment based on information provided by the Hydro One, the Local Distribution Companies ("LDC") and the Independent Electricity System Operator ("IESO"). Participants of the TWG are listed below in Table 1.

Table 1: London Area Region TWG Participants

Sr. no.	Name of TWG Participants
1	Hydro One Networks Inc. (Transmission) – Transmitter
2	Independent Electricity System Operator (IESO) – System Operator
3	Entegrus Powerlines Inc. – LDC
4	ERTH Power Inc. – LDC
5	Hydro One Networks Inc. (Distribution) – LDC
6	London Hydro Inc. – LDC
7	Tillsonburg Hydro Inc. – LDC

2. REGIONAL ISSUE/TRIGGER

In accordance with the Regional Planning process, the Regional Planning cycle should be triggered at least once every five years. As such, the 3rd Regional Planning cycle was triggered for the London Area region. Due to significant load growth in the region, the Technical Working Group ("TWG") decided that the 3rd Regional Planning cycle be triggered one year in advance of the five-year requirement.

3. SCOPE OF NEEDS ASSESSMENT

The scope of this NA covers the London Area region and includes:

- Review and reaffirm needs/plans identified in the previous cycle RIP (as applicable),
- Identify any new needs resulting from this assessment,
- Recommend which need(s) require further assessment and regional coordination in the next phases of the regional planning cycle; and,

- Recommend which needs do not require further regional coordination (i.e., can be addressed directly between Hydro One and the impacted LDC(s) to develop a preferred plan and/or no regional investment is required at this time and the need may be reviewed during the next regional planning cycle).

The Technical Working Group TWG may also identify additional needs during the next phases of the planning process, namely Scoping Assessment ("SA"), Integrated Regional Resource Plan ("IRRP"), Local plan (LP) and RIP, based on updated information available at that time.

The planning horizon for this NA assessment is 10 years.

4. REGIONAL DESCRIPTION AND CONNECTION CONFIGURATION

The geographical boundaries of the London Area region are shown in Figure 2 below. The London Region includes the municipalities of Oxford County (comprising Township of Blandford-Blenheim, Township of East Zorra-Tavistock, Town of Ingersoll, Township of Norwich, Township of South-West Oxford, Town of Tillsonburg, Township of Zorra), City of Woodstock, Middlesex County (comprising Municipality of Adelaide Metcalfe , Municipality of Lucan Biddulph, Municipality of Middlesex Centre, Municipality of North Middlesex, Municipality of Southwest Middlesex, Municipality of Strathroy-Caradoc, Municipality of Thames Centre, Village of Newbury), City of London, Elgin County (comprising Municipality of Town of Aylmer, Municipality of Bayham, Municipality of Central Elgin, Municipality of West Elgin, Municipality of Dutton/Dunwich, Township of Malahide, Township of Southwold), City of St. Thomas. In addition, the transmission facilities in this region also supply part of Norfolk County.

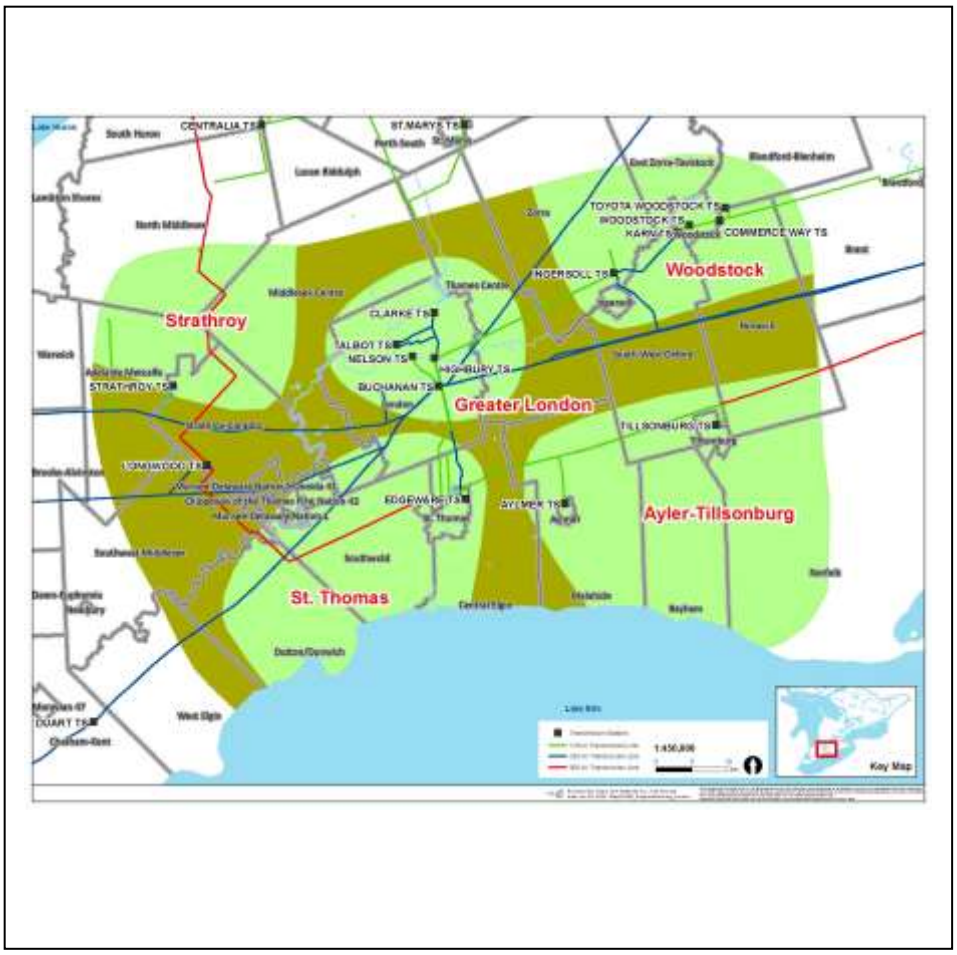


Figure 2: Map of London Area Regional Planning Area

The Bulk Electrical Supply Network in the London Area consists of 500/230kV autotransformers at Longwood TS that supplies a network of 230kV and 115kV circuits. There are 230/115kV autotransformers at Buchanan TS and Karn TS.

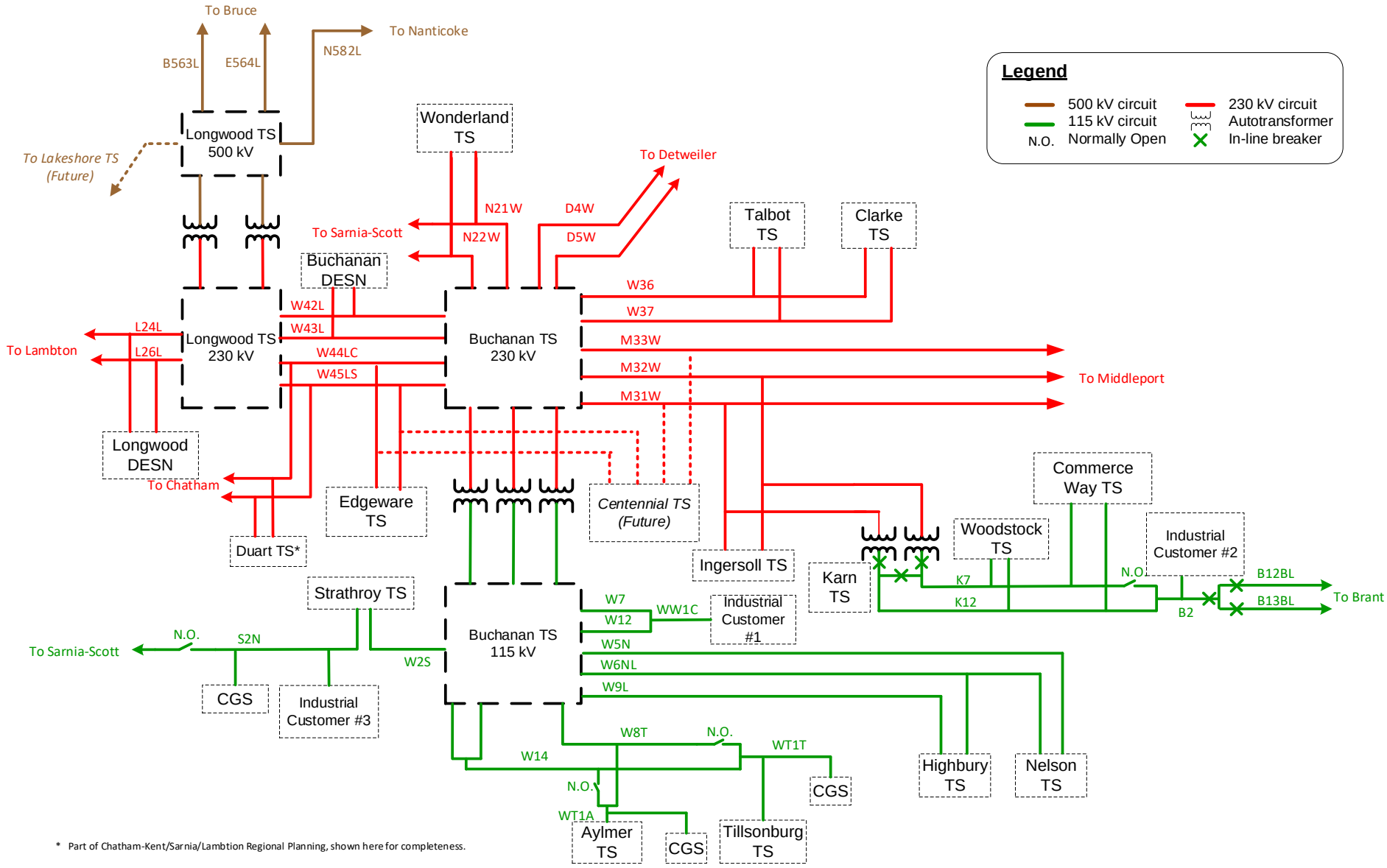
London Area transmission system is a network of 230 kV and 115 kV circuits and is connected to Longwood TS through five 500/230 kV autotransformers. Autotransformers at Buchanan TS and Karn TS provide the necessary 230/115 kV auto-transformation. Step-down transformer stations are connected to both 230 kV and 115 kV systems to bring the power to distribution level of 27.6 kV to serve the area. There are fourteen Hydro One step-down TS's, three transmission connected industrial load customers and three transmission connected generators in the London Area.

The existing facilities in the London Area are summarized below and depicted in the single line diagram shown in Figure 3:

- Fourteen step-down transformer stations currently supply the London Area load: Aylmer TS, Buchanan TS, Clarke TS, Commerce Way TS, Edgeware TS, Highbury TS, Ingersoll TS, Longwood TS, Nelson TS, Strathroy TS, Talbot TS (Dual Element Spot Network or DESN 1 and DESN 2), Tillsonburg TS, Wonderland TS, and Woodstock TS.
- One new step-down transformer station is planned to be in-service in 2026/2027: Centennial TS.
- Three directly connected industrial customer loads are connected in the London Area.
- Three existing transmission-connected generating stations in the London Area.

Although depicted, Duart TS is not included in the London Area study and will be studied as part of the Chatham-Kent/Lambton/Sarnia (CKLS) Area Regional Planning.

The single line diagram of the Transmission Network of London Area region is shown in Figure 3 below.



* Part of Chatham-Kent/Sarnia/Lambton Regional Planning, shown here for completeness.

Figure 3: London Area Transmission Single Line Diagram

Table 2: Transmission Station and Circuits in the London Area Region

115kV circuits	230kV circuits	Hydro One Transformer Stations	Generation Stations
W2S	W42L	Longwood TS*	CGS (total): 150MW
W14	W43L	Wonderland TS**	
W8T	W44LC	Buchanan TS*	
WT1A	W45LS	Edgeware TS	
WT1T	N21W	Talbot TS	
W9L	N22W	Clarke TS**	
W6NL	D4W	Strathroy TS**	
W5N	D5W	Ingersoll TS	
W7	W36	Aylmer TS**	
W12	W37	Tillsonburg TS**	
WW1C	M31W	Karn TS*	
K7	M32W	Highbury TS**	
K12	M33W	Nelson TS	
B2		Woodstock TS**	
		Commerce Way TS	
		Centennial TS (Future)**	
		CTS1	
		CTS2	
		CTS3	

*Stations with Autotransformers installed

**Stations with low-voltage capacitor banks

5. INPUTS AND DATA

TWG participants, including representatives from LDCs, IESO, and Hydro One provided information and input for the London Area NA. With respect to the load forecast information, the OEB Regional Planning Process Advisory Group (RPPAG) recently published a document called "Load Forecast Guideline for Ontario" in October 2022. The objective of this document is to provide guidance to the TWG in the development of the load forecasts used in the various phases of the regional planning process with a focus on the NA and the IRRP. One of the inputs into the LDC's load forecast that is called for in this guideline is information from Municipal Energy Plans ("MEPs") and/or Community Energy Plans ("CEPs"). The list of all the Municipalities falling under the geographical boundaries of the region are given in Appendix E.

The information provided includes the following:

- London Area 10-year Load Forecast for all supply stations inclusive of the inputs provided by the municipalities (e.g. through their MEPs & CEPs).

- Known capacity and reliability needs, operating issues, and/or major assets requiring replacement/ refurbishment; and
- Planned/foreseen transmission and distribution investments that are relevant to Regional Planning for the London Area.
- Captured uncertainty in the load forecast as well as variability of electric demand drivers to identify any emerging needs and/or advancement or deferment of recommended investments.

6. ASSESSMENT METHODOLOGY

The following methodology and assumptions are made in development of this Needs Assessment:

6.1 Technical Assessments and Study Assumptions

The technical assessment of needs was undertaken based on:

- Current and future station capacity and transmission adequacy;
- System reliability and operational considerations;
- Asset renewal for major high voltage transmission equipment requiring replacement with consideration to "right-sizing"; and,
- Load forecast data was requested from industrial customers in the region, and
- This assessment is based on summer peak loads. Three load forecasts were developed i.e. Normal Growth scenario, High & low Growth scenario. The High and low Growth scenario load forecast was developed to conduct a sensitivity analysis to cover unforeseen developments such as, fuel switching, Government policies, higher than expected EV charging trend during peak load conditions, etc.

The following other assumptions are made in this report.

- The study period for this Needs Assessment is 2024-2033.
- The Region is summer peaking, so this assessment is based on summer peak loads.
- Line capacity adequacy is assessed by using coincident peak loads in the area.
- Station capacity adequacy is assessed by comparing the non-coincident peak load with the station's normal planning supply capacity, assuming a 90% lagging power factor for stations having no low-voltage capacitor banks and 95% lagging power factor for stations having low-voltage capacitor banks.
- Normal planning supply capacity for transformer stations is determined by the Hydro One summer 10-Day Limited Time Rating (LTR) of a single transformer at that station.
- Adequacy assessment is conducted as per Ontario Resource Transmission Assessment Criteria (ORTAC).

6.2 Information Gathering process

6.2.1. Load forecast:

The LDCs provided their historical peaks, starting points with considerations for load transfers, and load forecasts without weather normalization, for all the stations supplying their loads in the London Area region for the 10-year study period including the inputs from the Municipalities such as MEPs and CEPs. The IESO provided a Conservation and Demand Management ("CDM") and Distributed Generation ("DG") forecast for the London Area region. The region's extreme summer non-coincident peak gross load forecasts for each station were prepared by applying the LDC load forecast growth rates to the actual 2023 summer peak corrected for load transfers and extreme weather. The extreme summer weather correction factor for 2023 was provided by Hydro One. The net extreme summer weather load forecasts were produced by reducing the gross load forecasts for each station by the percentage CDM and then by the amount of effective DG capacity provided by the IESO for that station. It is to be noted that as contracts for existing DG resources in the region begin to expire, at which point the load forecast has a decreasing contribution from local DG resources, and an increase in net demand. This extreme summer weather corrected net load forecast for the individual stations in the London Area region is given in Appendix A.

The CDM savings is estimated based on existing and planned CDM programs, as well as Building Codes & Equipment Standards. The estimated CDM forecasts will be further refined in the next phases of Regional Planning.

Distributed generation is accounted for through values provided by the IESO, based on the known contracted resources.

6.2.2. Sensitivity Analysis:

A sensitivity analysis was undertaken by the TWG to capture uncertainty in the load forecast as well as variability of drivers such as electrification. Hence, the NA recommendations are not necessarily linked to sensitivity scenarios; but rather are used to identify any emerging needs for consideration in developing recommendations. The impact of sensitivity analysis for the high and low growth scenarios are provided in section 8 of this report.

6.2.3. Asset renewal Needs for Major HV Equipment:

List of major HV transmission equipment planned and/or identified to be refurbished and/or replaced based on asset condition assessment, relevant for Regional Planning purposes**.** This includes HV transformers, autotransformers, HV Breakers, HV underground cables and overhead lines. The scope of equipment considered is given in section 7.1.

6.2.4. System Reliability and Operational Issues:

The IESO will identify any known system reliability and operational issues for the London Area region.

7. NEEDS

This section describes emerging new needs identified in the London Area Region and/or updates on previously identified needs since the completion of Previous Regional Planning cycle.

Needs that were identified and discussed in the previous regional planning cycle with associated projects that were recently completed and reaffirmed needs that are underway and are briefly described below with relevant updates. These projects include:

1. W36/W37 Load Restoration: This need was reported in the previous Regional Planning cycles and the impacted LDC, London Hydro, and Hydro One undertook further planning and analysis as part of Local Planning process. A detailed historical equipment performance review was performed to assess the probability of common-mode failure that would lead to simultaneous loss of W36 and W37. It was concluded that the only common-mode failure that may result in the simultaneous loss of both W36/W37 is the failure of the steel poles that carry the two circuits and probability of this event is very low.

All near, and mid-term needs that are discussed as a part of this report are summarized in Table 3 below.

Table 3: Near/Mid-term Needs Identified in Previous RIP and/or this NA

Need Description	Recommended Plan/Update	Previous RIP Report Section	NA Report Section
Asset Renewal Needs			
Talbot TS	Talbot TS Transformers T3 and T4 and associated switchyard equipment replacement	6.1.1	7.1.1
Buchanan TS	Buchanan TS Autotransformers T2 and T3 and associated switchyard equipment replacement	6.3.1	N/A*
Clarke TS	Clarke TS Transformer T3 and T4 and associated switchyard equipment replacement	6.3.2	N/A*
Station Capacity Needs			
Aylmer TS	The load forecast exceeds the station supply capacity in the near term	N/A	7.2.1
Clarke TS	The load forecast exceeds the station supply capacity in the near term	N/A	7.2.2
Edgeware TS	The load forecast exceeds the station supply capacity in the near term	N/A	7.2.3
Strathroy TS	The load forecast exceeds the station supply capacity in the near term	N/A	7.2.4
Nelson TS	The load forecast exceeds the station supply capacity in the medium term	N/A	7.2.5

Talbot T1/T2	The load forecast exceeds the station supply capacity in the near term	6.1.2	7.2.6
Talbot T3/T4	The load forecast exceeds the station supply capacity in the near term	6.1.2	7.2.7
Tillsonburg TS	The load forecast exceeds the station supply capacity in the near term	N/A	7.2.8
Wonderland TS	The load forecast exceeds the station supply capacity in the near term	N/A	7.2.9
Woodstock TS	The load forecast exceeds the station supply capacity in the near term	N/A	7.2.10
Transmission Line Capacity Needs			
W44LC/W45LS	Transmission Line Capacity limitation on 230 kV W44LC/W45LS for the loss of companion circuit in the medium term	N/A	7.3.1
WT1T/W14	Transmission Line Capacity limitation on the 115 kV WT1T to Tillsonburg TS pre-contingency in the near term	N/A	7.3.2
System Reliability, Operation and Load restoration Needs			
M31W/M32W K7/K12/B2	Load restoration limitation on 230 kV M31W/M32W and 115 kV K7/K12/B2 circuits for a single tower contingency causing the loss of double-circuit line M31W and M32W or for a double contingency with the loss of both autotransformers at Karn TS	N/A	7.4.1
M31W/M33W	Load restoration limitation on 230 kV M31W/M33W circuits for a single tower contingency	N/A	7.4.2
W36/W37	Load restoration limitation on 230 kV W36/W37 circuits for a single tower contingency	6.2	7.4.3
W44LC/W45LS	Load restoration limitation on 230 kV W44LC/W45LS circuits for a single tower contingency.	N/A	7.4.4
Voltage Performance			
N/A	N/A		

*Current planned date of replacement beyond the planning horizon of this Needs Assessment

7.1 Asset Renewal Needs for Major HV Transmission Equipment

In addition to the previously identified asset renewal needs from the second regional planning cycle, Hydro One and TWG has also identified new asset renewal needs for major high voltage transmission equipment that are expected to be replaced over the next 10 years in the London Area Region. The complete list of major HV transmission equipment requiring replacement in the London Area Region is provided in table 4 in this section. Hydro One is the only Transmission Asset Owner (TAO) in the Region.

Asset Replacement needs are determined by asset condition assessment. Asset condition assessment is based on a range of considerations such as:

- Equipment deterioration due to aging infrastructure or other factors,
- Technical obsolescence due to outdated design,
- Lack of spare parts availability or manufacturer support, and/or
- Potential health and safety hazards, etc.

The major high voltage equipment information shared and discussed as part of this process is listed below:

- 230/115kV autotransformers
- 230 and 115kV load serving step down transformers
- 230 and 115kV breakers where:
  replacement of six breakers or more than 50% of station breakers, the lesser of the two
- 230 and 115kV transmission lines requiring refurbishment where:
  Leave to Construct (i.e., section 92) approval is required for any alternative to like-for-like
- 230 and 115kV underground cable requiring replacement where:
  Leave to Construct (i.e., section 92) approval is required for any alternative to like-for-like

The Asset renewal assessment considers the following options for “right sizing” the equipment:

- Maintaining the status quo
- Replacing equipment with similar equipment with *lower* ratings and built to current standards
- Replacing equipment with similar equipment with *lower* ratings and built to current standards by transferring some load to other existing facilities
- Eliminating equipment by transferring all the load to other existing facilities
- Replacing equipment with similar equipment and built to current standards (i.e., “like-for-like” replacement)
- Replacing equipment with higher ratings and built to current standards

From Hydro One’s perspective as a facility owner and operator of its transmission equipment, do nothing is generally not an option for major HV equipment due to safety and reliability risk of equipment failure. This also results in increased maintenance cost and longer duration of customer outages. Hydro One will continue to assess asset priorities based on recent operational performance to determine the appropriate timing for replacement.

Table 4: Major HV Transmission Asset assessed for Replacement in the region

Station/Circuit	Need Description	Planned ISD
Talbot TS	Talbot TS Transformer T3 and T4 and associated switchyard equipment replacement	2032

7.1.1 Talbot TS (T3/T4)

The existing Talbot TS comprises two 230 kV/27.6 kV DESNs (T1/T2 and T3/T4) and supplies electricity to London Hydro customers. It is supplied by two 230 kV circuits W36 and W37. Step-down transformers T3 and T4 have been in-service from 1979 and as per asset condition assessment, are identified for replacement. In recent years, Talbot TS has experienced several failures with the breakers in the medium-voltage switchyard. Hydro One will continue to assess asset priorities based on recent operational performance to determine the appropriate timing for replacement. A station capacity need has also been identified for the Talbot T3/T4 DESN (Section 7.2.7)

7.2 Station Capacity Needs

A Station Capacity assessment was performed over the study period **2024-2033** for the 230kV and 115kV Transforming stations in the **London Area** Region using the summer non-coincident peak load forecasts that were provided by the Technical Working Group. Based on the results, the following Station capacity needs have been identified in the during the study period

7.2.1 Aylmer TS – 115/27.6 kV

Aylmer TS is a DESN station located in Aylmer-Tillsonburg. The station is supplied by the 115 kV circuit W8T and supplies electricity to ERTH Power and Hydro One Distribution customers. The station had a 2023 non-coincident summer peak of 30.2 MW. The station forecast exceeds the station LTR of 43.0 MW within the near term (within 5 years).

7.2.2 Clarke TS – 230/27.6 kV

Clarke TS is a DESN station located in the northern part of London. The station is supplied by two 230 kV circuits W36 and W37 and supplies electricity to London Hydro and Hydro One Distribution customers. The station had a 2023 non-coincident summer peak of 101.7 MW. The station forecast exceeds the station LTR of 109.7 MW within the near term (within 5 years).

7.2.3 Edgeware TS – 230/27.6 kV

Edgeware TS is a DESN station located in the St. Thomas area. The station is supplied by the 230 kV circuits W44LC and W45LS and supplies electricity to Entegrus, Hydro One Distribution, and London Hydro customers. The station had a 2023 non-coincident summer peak of 100.9 MW. The station forecast exceeds the station LTR of 180.9 MW within the near term (within 5 years).

7.2.4 Nelson TS – 115/27.6 kV

Nelson TS is a DESN station located in London. The station is supplied by the 115 kV circuits W5N and W6NL and supplies electricity to London Hydro customers. The station had a 2023 non-coincident summer peak of 57 MW. The station forecast exceeds the station LTR of 107 MW in the medium term (5-10 years).

7.2.5 Strathroy TS – 115/27.6 kV

Strathroy TS is a DESN station located in Strathroy. The station is supplied by the 115 kV circuits S2N and W2S and supplies electricity to Entegrus and Hydro One Distribution customers. The station had a 2023 non-coincident summer peak of 38.1 MW. The station forecast exceeds the station LTR of 61.1 MW within the near term (within 5 years).

7.2.6 Talbot T1/T2 DESN – 230/27.6 kV

Talbot TS comprises of two 230 kV/27.6 kV DESNs (T1/T2 and T3/T4) and supplies electricity to London Hydro customers. The Talbot T1/T2 DESN is supplied by two 230 kV circuits W36 and W37. The station is supplied by the 230 kV circuits S2N and W2S. The station supplies electricity to London Hydro customers. The station had a 2023 non-coincident summer peak of 115.5 MW. The station forecast exceeds the station LTR of 113.5 MW within the near term (within 5 years).

7.2.7 Talbot T3/T4 DESN – 230/27.6 kV

Talbot TS comprises of two 230 kV/27.6 kV DESNs (T1/T2 and T3/T4) and supplies electricity to London Hydro customers. The Talbot T3/T4 DESN is supplied by two 230 kV circuits W36 and W37. The station is supplied by the 230 kV circuits S2N and W2S. The station supplies electricity to London Hydro customers. The station had a 2023 non-coincident summer peak of 163.4 MW. The station forecast exceeds the station LTR of 161.6 MW within the near term (within 5 years).

7.2.8 Tillsonburg TS – 115/27.6 kV

Tillsonburg TS is a DESN station located in Tillsonburg. The station is supplied by the 115 kV WT1T (tapped from W14) and supplies electricity to Hydro One Distribution and Tillsonburg Hydro customers. The station had a 2023 non-coincident summer peak of 93.4 MW. The station forecast exceeds the station LTR of 108.9 MW within the near term (within 5 years).

7.2.9 Wonderland TS – 230/27.6 kV

Wonderland TS is a DESN station located in the southwest part of London. The station is supplied by the 230 kV circuits N21W/N22W and supplies electricity to London Hydro and Hydro One Distribution customers. The station had a 2023 non-coincident summer peak of 115.9 MW. The station forecast exceeds the station LTR of 122.4 MW within the near term (within 5 years).

7.2.10 Woodstock TS – 115/27.6 kV

Woodstock TS is a DESN station located in Tillsonburg. The station is supplied by the 115 kV circuits K7/K12/B2 and supplies electricity to Hydro One Distribution customers. The station had a 2023 non-coincident summer peak of 60.8 MW. The station forecast exceeds the station LTR of 86.3 MW within the near term (within 5 years).

7.3 Transmission Lines Capacity Needs

All line and equipment loads shall be within their continuous ratings with all elements in service and within their long-term emergency ratings with any one element out of service. Immediately following contingencies, lines may be loaded up to their short-term emergency ratings where control actions such as re-dispatch, switching, etc. are available to reduce the loading to the long-term emergency ratings. A Transmission Lines Capacity Assessment was performed over the study period 2024-2033 for the 230kV and 115kV Transmission line circuits in the London Area Region by assessing thermal limits of the circuit and the voltage range as per ORTAC to cater this need. Based on the results, the following line capacity needs have been identified in the during the study period:

7.3.1 W44LC/W45LS – 230 kV – Thermal Limits

The W44LC/W45LS double circuit line, of which the portion from Buchanan JCT to Edgeware TS is about 16 km and supplies Edgeware TS and will supply the future Centennial TS. For the loss of one of the W44LC or W45LS, the loading on the Buchanan JCT to Edgeware TS section exceeds its post-contingency rating in the Medium-Term.

7.3.2 WT1T/W14 – 115 kV – Thermal Limits

The WT1T radial circuit is about 3.5 km tapped from the W14 circuit. The loading on the Cranberry JCT to ESWF JCT and the ESWF JCT to Tillsonburg JCT exceeds its pre-contingency rating in the Near-Term.

7.4 System Reliability, Operation and Restoration Needs

The transmission system must be planned to satisfy demand levels up to the extreme weather, median-economic forecast for an extended period with any one transmission element out of service. A study has been performed, considering the net coincident load forecast and the loss of one element over the study period 2024-2033 to cater this need**.** Based on the results, some system reliability, operating and restoring issues have been identified for this Region.

As per the load security criteria (ORTAC Section 7.1), with one element out of service, planned load curtailment or load rejection is permissible only to account for local generation outages; and not more than 150MW of load may be interrupted by configuration, planned load curtailment or rejection. With two elements out of service, not more than 600 MW of load may be interrupted by configuration, planned load curtailment or rejection.

As per the load restoration criteria (ORTAC Section 7.2), interrupted load must be restored within the following timelines:

- Load above 250 MW, within 30 minutes;
- Load above 150 MW, within 4 hours; and
- All load, within 8 hours.

7.4.1 M31W/M32W 230 kV – K7/K12/B2 115 kV – Load Restoration

Based on the net coincident load forecast at Ingersoll TS and stations connected along the 115 kV circuits K7/K12/B2, the load interrupted by configuration may reach up to 267 MW for the loss of double-circuit line M31W and M32W or loss of both autotransformers at Karn TS. Ingersoll TS up to 95 MW, Woodstock TS up to 92 MW, Commerce Way TS up to 68 MW and Toyota Woodstock CTS up to 20 MW.

In accordance with ORTAC, the system is required to restore 17 MW within 30 mins, 100 MW within 4 hours and the remaining 150 MW within 8 hours. This need was identified in previous Regional Planning cycles and remains in this cycle.

Approximately 20 MW of load can be transferred to the B2 circuit from Brant TS.

7.4.2 M31W/M33W– 230 kV – Load Restoration

Based on the load forecast at the new Centennial TS, the load interrupted by configuration will reach approximately 189 MW in 2027 for the loss of double-circuit line M31W and M33W.

In accordance with ORTAC, the system is required to restore 39 MW within 4 hours and the remaining 150 MW within 8 hours.

7.4.3 W36/W37 – 230 kV – Load Restoration

Based on the net coincident load forecast at Clarke TS, Talbot T1/T2 and Talbot T3/T4, the load interrupted by configuration will reach up to 414 MW in 2033 for the loss of double-circuit line W36 and W37. Clarke TS up to 126 MW, Talbot T1/T2 up to 119 MW and Talbot T3/T4 up to 166 MW.

In accordance with ORTAC, the system is required to restore 164 MW within 30 minute, 100 MW within 4 hours and the remaining 150 MW within 8 hours. This need was reported in the previous Regional Planning cycles and the impacted LDC, London Hydro, and Hydro One undertook further planning and analysis as part of Local Planning process. A detailed historical equipment performance review was performed to assess the probability of common-mode failure that would lead to simultaneous loss of W36 and W37. It was concluded that the only common-mode failure that may result in the simultaneous loss of both W36/W37 is the failure of the steel poles that carry the two circuits and probability of this event is very low.

7.4.4 W44LC/W45LS – 230 kV – Load Restoration

Based on the net coincident load forecast at Edgeware TS, Duart TS and the future Centennial TS, the load interrupted by configuration will reach up to 486 MW in 2033 for the loss of double-circuit line W44LC and W45LS. Edgeware TS area up to 247 MW, Duart TS approximately 50 MW, and the future Centennial TS approximately 189 MW.

The simultaneous loss of double-circuit line W44LC and W45LS will interrupt approximately 486 MW of load at Edgeware TS, Duart TS and the new Centennial TS by configuration.

In accordance with ORTAC, the system is required to restore 236 MW within 30 minute, 100 MW within 4 hours and the remaining 150 MW within 8 hours.

Approximately 50 MW of load can be transferred from Duart TS.

8. SENSITIVITY ANALYSIS

The objective of a sensitivity analysis is to capture uncertainty in the load forecast as well as variability of electric demand drivers to identify any emerging needs and/or advancement or deferment of recommended investments. The TWG determined that the key electric demand driver in the London Area region to be considered in this sensitivity analysis is electric vehicle (EV) penetration and unforeseen electrification which would cause the load to increase at a faster rate than shown in the forecast; or the potential delay in some projects which could result in less demand than anticipated.

The TWG reviewed EV scenarios and any unforeseen electrification needs to develop high demand growth forecasts by applying 50% additional growth to the growth rate on the extreme summer corrected Normal Growth net load forecasts. The low growth scenario was obtained by reducing the growth rate by 50%.

The normal and high growth forecasts are shown in Tables A.1, A.2, A.3 and A.4 in Appendix A.

The impact of sensitivity analysis for the high and low growth scenario identified the following updates or new Station/Line capacity needs:

Table 5: Impact of Sensitivity Analysis on Station/Line capacity needs in the region

Sr.no.	Need Identified	Normal Growth Scenario	High Growth Scenario	Low Growth Scenario
1	Aylmer TS Station Capacity	2025	2025	Long Term
2	Clarke TS Station Capacity	2026	2025	2027
3	Edgeware TS Station Capacity	2025	2025	2033
4	Nelson TS Station Capacity	2030	2028	Long Term
5	Strathroy TS Station Capacity	2028	2024	Long Term
6	Talbot T1/T2 DESN Station Capacity	2024	2024	2024
7	Talbot T3/T4 DESN Station Capacity	2024	2024	2024
8	Tillsonburg TS Station Capacity	2024	2024	2027
9	Wonderland TS Station Capacity	2027	2026	Long Term
10	Woodstock TS Station Capacity	2025	2025	Long Term

11	W44LC/W45LS Transmission Line Capacity	2029	2029	2029
12	WT1T Transmission Line Capacity	2025	2025	2025
13	M31W/M32W/K7/K12/B2 Load Restoration	Ongoing	Ongoing	Ongoing
14	M31W/M33W Load Restoration	2027	2027	2027
15	W36/W37 Load Restoration	Ongoing	Ongoing	Ongoing
16	W44LC/W45LS Load Restoration	Ongoing	Ongoing	Ongoing

9. CONCLUSION AND RECOMMENDATION

The Technical Working Group's recommendations to address the needs identified are as follows:

Table 7: Needs which require further regional coordination

Sr.no.	Need	Recommendation
1	Talbot T3/T4 DESN Asset Renewal	To be considered in addition to capacity needs in the next Regional Planning phases.
2	Aylmer TS Station Capacity	To be further assessed in the next Regional Planning phases.
3	Clarke TS Station Capacity	To be further assessed in the next Regional Planning phases.
4	Edgeware TS Station Capacity	To be further assessed in the next Regional Planning phases.
5	Nelson TS Station Capacity	To be further assessed in the next Regional Planning phases.
6	Strathroy TS Station Capacity	To be further assessed in the next Regional Planning phases.
7	Talbot T1/T2 Station Capacity	To be further assessed in the next Regional Planning phases.
8	Talbot T3/T4 Station Capacity	To be further assessed in the next Regional Planning phases.
9	Tillsonburg TS Station Capacity	To be further assessed in the next Regional Planning phases.
10	Wonderland TS Station Capacity	To be further assessed in the next Regional Planning phases.
11	Woodstock TS Station Capacity	To be further assessed in the next Regional Planning phases.
12	W44LC/W45LS post-contingency capacity limitation (Buchanan JCT x Edgeware JCT)	To be further assessed in the next Regional Planning phases.
13	WT1T/W14 pre-contingency capacity limitation (Cranberry JCT x ESWF JCT and ESWF JCT x Tillsonburg JCT)	To be further assessed in the next Regional Planning phases.
14	Load restoration limitation – M31W/M32W / K7/K12/B2 due to	To be further assessed in the next Regional Planning phases.

	the loss of double-circuit line M31W and M32W or for a double contingency with the loss of both autotransformers at Karn TS	
15	Load restoration limitation – M31W/M33W for a single tower contingency	To be further assessed in the next Regional Planning phases.
16	Load restoration limitation – W36/W37 for a single tower contingency	To be reassessed in the next Regional Planning phases.
17	Load restoration limitation – W44LC/W45LS for a single tower contingency	To be further assessed in the next Regional Planning phases.

List of LDC(s) to be involved in further regional planning phases:

- Entegrus Powerlines Inc.
- ERTH Power Inc.
- Hydro One Distribution
- London Hydro Inc.
- Tillsonburg Hydro Inc.

List of LDC(s) which are not required to be involved in further regional planning phases:

- N/A

10. REFERENCES

[1] Independent Electricity System Operator, Ontario Resource and Transmission Assessment Criteria (issue 5.0 August 22, 2007)

[2] Ontario Energy Board, Transmission System Code (issue July 14, 2000 rev. August 2, 2023)

[3] Ontario Energy Board, Distribution system Code (issue July 14, 2000 rev. March 27, 2024)

[4] Ontario Energy Board, Load Forecast Guideline for Ontario (issue October 13, 2022)

Appendix A: Extreme Summer Weather Adjusted Net Load Forecast

Table A.1: London Area Region – Non-Coincident- Normal Growth Net Load Forecast

Station	LTR (MW)	Historical (MW)	Summer Net Forecast (MW)									
		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Aylmer TS	43.0	30.2	38.8	44.6	45.4	41.9	42.7	43.6	44.5	45.6	46.7	47.9
Buchanan TS	173.5	119.5	122.0	126.7	128.0	129.5	130.7	131.8	133.1	134.7	139.4	145.2
Clarke TS	109.7	101.7	107.1	108.8	109.8	128.1	129.2	130.3	131.5	133.0	134.7	136.5
Commerce Way TS	106.0	36.2	51.1	54.0	65.7	67.9	70.1	71.2	72.4	73.7	75.1	76.5
Edgeware TS	180.9	100.9	122.8	187.3	187.8	196.8	204.0	219.4	228.6	232.0	239.9	247.7
Highbury TS	85.0	64.3	64.7	65.5	66.4	67.4	68.2	69.1	70.0	71.0	72.3	73.6
Ingersoll TS	158.6	69.3	75.0	84.8	100.7	103.1	106.6	110.1	113.7	117.6	119.9	122.7
Longwood TS	121.7	36.9	52.6	53.6	64.6	75.1	75.6	76.5	77.2	78.1	79.3	80.4
Nelson TS	107.0	57.0	56.1	57.7	59.4	61.1	91.7	94.1	118.2	121.4	124.7	128.2
Strathroy TS	61.1	38.1	54.4	55.9	59.1	60.6	62.2	64.7	66.6	67.7	69.8	71.4
Talbot T1/T2	113.5	115.5	120.7	122.4	120.1	107.4	109.0	110.3	112.8	114.7	116.9	119.6
Talbot T3/T4	161.6	163.4	166.6	168.2	179.2	174.1	175.9	188.5	174.1	176.1	178.6	181.6
Tillsonburg TS	108.9	93.4	109.1	115.8	122.8	128.6	134.8	139.1	142.8	147.6	152.2	156.8
Wonderland TS	122.4	115.9	95.0	98.1	114.1	124.1	126.2	128.3	130.6	133.1	136.2	139.2
Woodstock TS	86.3	60.8	67.5	86.8	90.7	91.2	91.7	89.1	89.6	90.6	91.6	92.6

Table A.2: London Area Region – Coincident – Normal Growth Net Load Forecast

Station	LTR (MW)	Historical (MW)	Summer Net Forecast (MW)									
		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Aylmer TS	43.0	27.0	34.6	40.3	41.0	37.3	38.1	38.8	39.6	40.5	41.5	42.6
Buchanan TS	173.5	118.0	120.4	125.1	126.4	127.8	129.0	130.1	131.4	132.9	137.6	143.4
Clarke TS	109.7	94.4	99.3	100.9	101.8	118.7	119.7	120.7	121.8	123.1	124.7	126.4
Commerce Way TS	106.0	29.1	43.6	46.6	58.3	60.5	62.7	63.7	64.8	65.9	67.1	68.4
Edgeware TS	180.9	100.9	122.8	187.2	187.7	196.7	203.8	219.2	228.4	231.8	239.7	247.5
Highbury TS	85.0	58.7	58.8	59.6	60.4	61.3	62.0	62.7	63.5	64.5	65.6	66.8
Ingersoll TS	158.6	51.2	54.3	61.8	77.3	79.4	82.5	85.2	88.0	91.0	92.8	95.0
Longwood TS	121.7	36.9	52.6	53.6	64.6	75.1	75.6	76.5	77.2	78.1	79.3	80.4
Nelson TS	107.0	39.6	53.3	54.8	56.3	58.0	87.3	89.5	112.7	115.7	118.9	122.2
Strathroy TS	61.1	32.9	46.5	47.9	50.8	52.1	53.5	55.6	57.2	58.2	60.0	61.4
Talbot T1/T2	113.5	115.5	120.5	122.2	119.8	107.1	108.6	109.8	112.3	114.1	116.3	118.9
Talbot T3/T4	161.6	150.0	151.8	153.3	163.4	158.6	160.2	172.7	159.5	161.3	163.6	166.3
Tillsonburg TS	108.9	93.4	109.1	115.8	122.8	128.7	134.8	139.1	142.8	147.7	152.2	156.9
Wonderland TS	122.4	103.8	95.2	98.4	114.5	124.6	126.8	129.0	131.4	134.0	137.2	140.2
Woodstock TS	86.3	60.8	67.5	86.7	90.6	91.1	91.6	88.9	89.4	90.4	91.4	92.4

Table A.3: London Area Region Non-Coincident – High Growth Net Load Forecast

Station	LTR (MW)	Historical (MW)	Summer Net Forecast (MW)									
		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Aylmer TS	43.0	30.2	39.3	48.1	49.5	46.4	47.8	49.2	50.7	52.3	54.1	55.9
Buchanan TS	173.5	119.5	124.6	132.1	134.5	137.0	139.3	141.5	143.9	146.5	152.4	159.3
Clarke TS	109.7	101.7	108.4	111.3	113.1	140.7	142.8	144.9	147.0	149.4	152.2	155.0
Commerce Way TS	106.0	36.2	59.6	64.2	81.8	85.2	88.5	90.4	92.3	94.3	96.4	98.5
Edgeware TS	180.9	100.9	132.9	229.9	231.0	244.8	256.0	279.5	293.7	299.2	310.9	322.6
Highbury TS	85.0	64.3	65.4	66.9	68.4	70.0	71.5	73.0	74.6	76.3	78.3	80.3
Ingersoll TS	158.6	69.3	78.8	93.7	117.7	122.0	127.4	133.0	138.6	144.6	148.1	152.1
Longwood TS	121.7	36.9	60.1	61.7	78.4	94.3	95.2	96.6	97.8	99.2	101.1	102.7
Nelson TS	107.0	57.0	57.0	59.6	62.2	65.0	110.9	114.7	151.0	155.9	161.0	166.2
Strathroy TS	61.1	38.1	63.6	65.9	70.9	73.3	75.8	79.6	82.6	84.4	87.6	89.7
Talbot T1/T2	113.5	115.5	121.8	124.7	121.7	102.9	105.7	108.1	112.3	115.3	118.8	122.9
Talbot T3/T4	161.6	163.4	167.8	170.8	188.0	180.7	184.0	198.1	177.1	180.5	184.4	189.0
Tillsonburg TS	108.9	93.4	117.1	127.4	138.3	147.3	155.5	162.3	168.2	175.7	182.6	189.6
Wonderland TS	122.4	115.9	96.7	101.6	126.1	141.3	144.9	148.5	152.2	156.3	161.0	165.6
Woodstock TS	86.3	60.8	70.3	99.4	105.5	106.4	107.5	103.8	104.9	106.4	107.9	109.5

Table A.4: London Area Region – Coincident – High Growth Net Load Forecast

Station	LTR (MW)	Historical (MW)	Summer Net Forecast (MW)									
		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Aylmer TS	43.0	27.0	35.0	43.7	44.9	41.7	43.0	44.2	45.5	46.9	48.5	50.1
Buchanan TS	173.5	118.0	123.0	130.5	132.8	135.3	137.5	139.7	142.0	144.6	150.4	157.3
Clarke TS	109.7	94.4	100.5	103.3	104.9	130.6	132.5	134.3	136.3	138.5	141.1	143.7
Commerce Way TS	106.0	29.1	52.2	56.8	74.4	77.8	81.1	82.8	84.5	86.3	88.1	90.0
Edgeware TS	180.9	100.9	132.8	229.9	230.9	244.7	255.9	279.4	293.5	298.9	310.7	322.4
Highbury TS	85.0	58.7	59.5	60.8	62.2	63.7	65.0	66.4	67.8	69.3	71.1	73.0
Ingersoll TS	158.6	51.2	57.3	68.7	92.2	96.0	100.9	105.2	109.6	114.2	117.0	120.2
Longwood TS	121.7	36.9	60.1	61.7	78.4	94.3	95.2	96.6	97.8	99.2	101.1	102.7
Nelson TS	107.0	39.6	54.2	56.6	59.0	61.6	105.9	109.4	144.3	149.0	153.9	158.9
Strathroy TS	61.1	32.9	54.5	56.7	61.2	63.3	65.5	68.8	71.3	72.8	75.6	77.5
Talbot T1/T2	113.5	115.5	121.6	124.5	121.4	102.6	105.3	107.6	111.7	114.7	118.1	122.2
Talbot T3/T4	161.6	150.0	153.0	155.7	171.4	164.7	167.7	181.5	162.2	165.3	168.9	173.1
Tillsonburg TS	108.9	93.4	117.1	127.4	138.3	147.3	155.5	162.4	168.2	175.7	182.7	189.7
Wonderland TS	122.4	103.8	96.9	102.0	126.5	141.8	145.6	149.2	153.1	157.3	162.0	166.6
Woodstock TS	86.3	60.8	70.3	99.4	105.4	106.3	107.3	103.7	104.7	106.2	107.7	109.2

Appendix B: Lists of Step-Down Transformer Stations

No.	Transformer Station	Voltage (kV)	Supply Circuits
1	Longwood TS	500/230	B563L, E564L, N582L, L24L, L26L, W42L, W43L, W44LC, W45LS
2	Wonderland TS*	230	N21W, N22W
3	Buchanan TS	230/115	N21W N22W, D4W, D5W, W36, W37, M31W, M32W, M33W, W2S, W7, W12, W5N, W6NL, W9L, W8T, W14
4	Edgeware TS	230	W44LC, W45LS
5	Talbot TS	230	W36, W37
6	Clarke TS*	230	W36, W37
7	Strathroy TS*	115	W2S, S2N
8	Ingersoll TS	230	M31W, M32W
9	Aylmer TS*	115	W8T, WT1A
10	Tillsonburg TS*	115	W14, WT1T
11	Karn TS	230/115	M31W, M32W, K7, K12
12	Highbury TS*	115	W6NL, W9L
13	Nelson TS	115	W5N, W6NL
14	Woodstock TS*	115	K7, K12
15	Commerce Way TS	115	K7, K12
16	Centennial TS (Future)*	230	W44LC, W45LS, M31W, M33W
17	CTS1	115	WW1C
18	CTS2	115	B2
19	CTS3	115	S2N

* Stations with low-voltage capacitor banks

Appendix C: Lists of Transmission Circuits

No.	Connecting Stations	Circuit ID	Voltage (kV)
1	Longwood TS to Buchanan TS	W42L	230
2	Longwood TS to Buchanan TS	W43L	230
3	Longwood TS to Chatham TS to Buchanan TS	W44LC	230
4	Longwood TS to Spence SS to Buchanan TS	W45LS	230
5	Scott TS to Buchanan TS	N21W	230
6	Scott TS to Buchanan TS	N22W	230
7	Buchanan TS to Detweiler TS	D4W	230
8	Buchanan TS to Detweiler TS	D5W	230
9	Buchanan TS to Talbot TS and Clarke TS	W36	230
10	Buchanan TS to Talbot TS and Clarke TS	W37	230
11	Buchanan TS to Middleport TS	M31W	230
12	Buchanan TS to Middleport TS	M32W	230
13	Buchanan TS to Middleport TS	M33W	230
14	Buchanan TS to Strathroy TS	W2S	115
15	Buchanan TS to Cranberry JCT	W14	115
16	Buchanan TS to Cranberry JCT	W8T	115
17	Lyons JCT to Aylmer TS	WT1A	115
18	Cranberry JCT to Tillsonburg TS	WT1T	115
19	Buchanan TS to Highbury TS	W9L	115
20	Buchanan TS to Highbury TS to Nelson TS	W6NL	115
21	Buchanan TS to Nelson TS	W5N	115
22	Buchanan TS to CTS	W7	115
23	Buchanan TS to CTS	W12	115
24	Buchanan TS to CTS	WW1C	115

25	Karn TS to Commerce Way TS	K7	115
26	Karn TS to Commerce Way TS	K12	115

Appendix D: List of LDC's

No.	Name of LDC
1	Entegrus Powerlines Inc. - LDC
2	ERTH Power Inc. - LDC
3	Hydro One Networks Inc. (Distribution) - LDC
4	London Hydro Inc. - LDC
5	Tillsonburg Hydro Inc. - LDC

Appendix E: List of Municipalities in the London Area Region

No.	Name of Municipality
1	Oxford County (comprising of Township of Blandford-Blenheim, Township of East Zorra-Tavistock, Town of Ingersoll, Township of Norwich, Township of South-West Oxford, Town of Tillsonburg, Township of Zorra)
2	City of Woodstock
3	Middlesex County (comprising of Municipality of Adelaide Metcalfe , Municipality of Lucan Biddulph, Municipality of Middlesex Centre, Municipality of North Middlesex, Municipality of Southwest Middlesex, Municipality of Strathroy-Caradoc, Municipality of Thames Centre, Village of Newbury)
4	City of London
5	Elgin County (comprising Municipality of Town of Aylmer, Municipality of Bayham, Municipality of Central Elgin, Municipality of West Elgin, Municipality of Dutton/Dunwich, Township of Malahide, Township of Southwold)
6	City of St. Thomas
7	Norfolk County

Appendix F: Acronyms

Acronym	Description
A	Ampere
BES	Bulk Electric System
BPS	Bulk Power System
CDM	Conservation and Demand Management
CEP	Community Energy Plan
CIA	Customer Impact Assessment
CGS	Customer Generating Station
CSS	Customer Switching Station
CTS	Customer Transformer Station
DESN	Dual Element Spot Network
DG	Distributed Generation
DS	Distribution Station
GS	Generating Station
HV	High Voltage
IESO	Independent Electricity System Operator
IRRP	Integrated Regional Resource Plan
kV	KiloVolt
LDC	Local Distribution Company
LP	Local Plan
LTE	Long Term Emergency
LTR	Limited Time Rating
LV	Low Voltage
MEP	Municipal Energy Plan
MTS	Municipal Transformer Station
MW	Megawatt
MVA	Mega Volt-Ampere
MVAR	Mega Volt-Ampere Reactive
NA	Needs Assessment
NERC	North American Electric Reliability Corporation
NGS	Nuclear Generating Station
NPCC	Northeast Power Coordinating Council Inc.
NUG	Non-Utility Generator
OEB	Ontario Energy Board

ORTAC	Ontario Resource and Transmission Assessment Criteria
PF	Power Factor
PPWG	Planning Process Working Group
RIP	Regional Infrastructure Plan
SA	Scoping Assessment
SIA	System Impact Assessment
SPS	Special Protection Scheme
SS	Switching Station
STG	Steam Turbine Generator
TS	Transformer Station