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NEEDS ASSESSMENT REPORT

Region: London Area

Date: May 29, 2020

Prepared by: London Area Study Team

Disclaimer

This Needs Assessment Report was prepared for the purpose of identifying potential needs in the London Area Region and to recommend which needs may require further assessment and/or regional coordination to develop a preferred plan. The results reported in this Needs Assessment are based on the input and information provided by the Study Team.

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Executive Summary

REGION London Area Region ("the Region")

LEAD Hydro One Networks Inc.

START DATE: April 1, 2020 **COMPLETION DATE:** May 29, 2020

1. INTRODUCTION

The first cycle of Regional Planning for the London Area Region was completed in August 2017 with the publication of the Regional Infrastructure Plan (RIP) which provided a description of needs and recommendations of preferred wires plans to address near-term needs. This is the second cycle of Regional Planning and the purpose of this Needs Assessment is to identify any new need that emerged since the conclusion of previous London Area Regional Planning cycle.

2. REGIONAL ISSUE/TRIGGER

In accordance with the Regional Planning process as mandated by the Ontario Energy Board, the Regional Planning process should be triggered at least every five years. The first cycle of Regional Planning for the London Area Region began in February 2015 and given five years have elapsed, the second Regional Planning cycle for London Area was officially initiated in April 2020.

3. SCOPE OF NEEDS ASSESSMENT

The assessment's primary objective is to identify the electrical infrastructure needs over the ten-year study period and recommend which needs require further regional coordination.

4. & 5. LONDON AREA TRANSMISSION SYSTEM & INPUTS AND DATA

The Needs Assessment focuses on the adequacy of the 230 kV and 115 kV transmission system supplying the London Area. The Study Team representatives from Local Distribution Companies (LDCs), the Independent Electricity System Operator (IESO), and Hydro One provided input and relevant information for the London Area Region regarding capacity needs, reliability needs and replacement plan of major assets approaching end-of-life.

6. ASSESSMENT METHODOLOGY

The assessment methodology includes the review of planning information such as load forecast, conservation and demand management (CDM) forecast and available distributed generation (DG) information, any system reliability and operation issues, and major high voltage equipment identified to be at or near end of life. A technical assessment of needs was undertaken based on:

- Current and future station capacity and transmission adequacy; and
- Reliability needs and operational concerns.

7. RESULTS

I. Previously identified needs as part of first cycle of Regional Planning

A. Load Restoration: Ensure load interrupted can be restored in a reasonable time following simultaneous loss of M31W/M32W or loss of W36/W37

B. Voltage Constraint: Insufficient voltage at Tillsonburg TS 115 kV

C. Thermal Constraint: Thermal constraint on 115kV line W8T

D. Delivery Point Performance: Poor delivery point performance at Tillsonburg TS

II. Newly identified needs in the region

A. 230/115 kV Autotransformers

The 230/115 kV autotransformers (Buchanan TS and Karn TS) supplying the London Area are adequate over the study period for the loss of a single 230/115 kV autotransformer.

B. 230 kV Transmission Lines

The 230 kV circuits supplying the London Area are adequate over the study period for the loss of a single 230 kV circuit.

C. 115 kV Transmission Lines

The 115 kV circuits supplying the London Area are adequate over the study period for the loss of a single 115 kV circuit.

D. 230 kV and 115 kV Connection Facilities

Loading at Clarke TS will exceed its transformer 10-Day Limited Time Rating (LTR) in 2022 based on the net load forecast. Talbot TS T3/T4 is forecasted to exceed its 10-Day LTR throughout the study period. These needs were primarily driven by load transfer from Nelson TS during the construction period of the station refurbishment and voltage conversion project. London Hydro confirmed the load will be transferred back to Nelson TS over time and no additional transformation capacity is required at this time.

E. System Security and Restoration Review

Based on the latest load forecast, the loss of one element will not result in load interruption greater than 150 MW. The maximum load interrupted by configuration due to the loss of two elements is below the load loss limit of 600 MW by the end of the ten-year study period.

For the loss of two elements M31W/M32W on the 230 kV system, the load interrupted by configuration may exceed 150 MW. Hydro One Distribution estimated there is sufficient distribution transfer capability to address the restoration requirement for loss of M31W/M32W. For the loss of two elements W36/W37, the load interrupted by configuration may exceed 250 MW. As there are a number of projects currently underway which will affect loading at Talbot TS, it was recommended London Hydro and Hydro One to further examine this restoration need in Local Planning and devise an action plan for when all these projects are completed. For the loss of two elements W44LC/W45LS, the load interrupted by configuration may exceed 150 MW. There is sufficient capability on the existing system to restore interrupted within the targeted time period.

F. Aging Infrastructure and Replacement Plan of Major Equipment

During the study period, equipment replacement plans do not affect the needs identified.

8. RECOMMENDATIONS

Based on the findings of the Needs Assessment, the study team recommends that load restoration need following the loss of W36 and W37 should be further assessed as part of Local Planning by Hydro One and relevant LDC and that no further regional coordination is required to address needs in the London area.

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List of Tables and Figures

1 INTRODUCTION

The first cycle of the Regional Planning for the London Area Region began in 2015 and was completed in August 2017 with the publication of the Regional Infrastructure Plan (RIP). The RIP provided a description of needs and recommendations of preferred wires plans to address near- and medium-term needs.

The purpose of this Needs Assessment is to identify any new need that emerges since the completion of the previous London Area Regional Planning cycle.

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

Table 1: London Area Region Study Team Participants

Companies	
Entegrus Power Lines lnc.	London Hydro Inc.
ERTH Power Inc.	Tillsonburg Hydro Inc.
Hydro One Networks Inc. (Distribution)	Independent Electricity System Operator
Hydro One Networks Inc. (Lead Transmitter)	

2 REGIONAL ISSUE/TRIGGER

In accordance with the Regional Planning process as mandated by the Ontario Energy Board, Regional Planning cycle should be take place every five years. The first cycle of Regional Planning for the London Area Region began in February 2015 and given five years have elapsed, the second Regional Planning cycle for London Area was initiated in April 2020.

3 SCOPE OF NEEDS ASSESSMENT

The scope of this Needs Assessment includes a review of needs identified in the previous cycle and assessment to identify any new needs (e.g. system capacity, reliability, security and restoration) that may emerge in the next ten years.

The Study Team may identify additional needs during the subsequent phases of the Regional Planning process shown in Figure 1, namely Scoping Assessment, Local Planning, Integrated Regional Resource Plan (IRRP) and RIP.

Figure 1 – Regional Planning process at a glance

4 LONDON AREA TRANSMISSION SYSTEM

The London Area 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 facilities located in the London Region supply part of Norfolk County. The boundaries of the London Area are shown below in Figure 2.

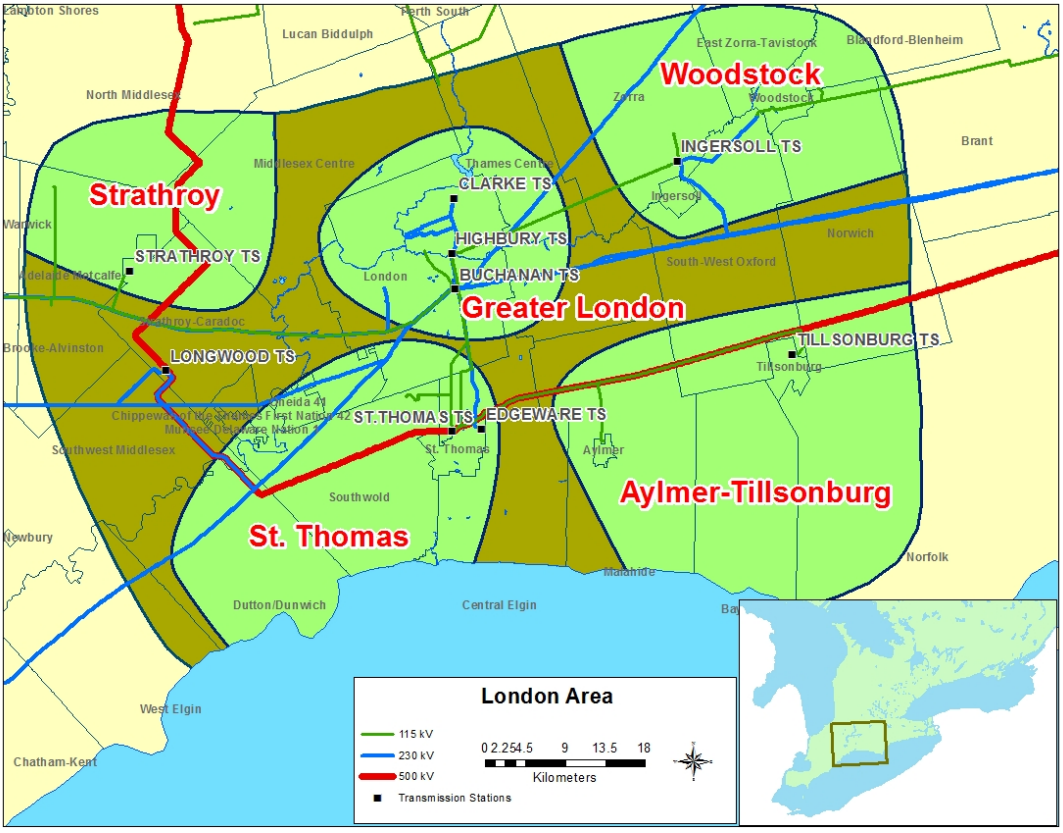

Figure 2: London Area Region

Electrical supply to the London Area is provided through a network of 230 kV and 115 kV circuits supplied by 500/230 kV autotransformers at Longwood Transformer Station (TS) and 230/115 kV autotransformers at Buchanan TS and Karn TS. 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 thirteen 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. The 500 kV system is part of the bulk power system and is not studied as part of this Needs Assessment. Also, although depicted, Duart TS is not included in the London Area study and will be studied as part of the Chatham-Kent/Lambton/Sarnia Area Regional Planning.

- Longwood TS is the major transmission station that connects the 500kV network to the 230 kV system via two 500/230 kV autotransformers.
- Buchanan TS and Karn TS house 230/115 kV autotransformers which provide the necessary transformation from the 230 kV system to the 115 kV system.
- Thirteen step-down transformer stations supply the London Area load: Aylmer TS, Buchanan TS, Clarke TS, Commerce Way TS, Edgeware TS, Highbury TS, Ingersoll TS, Nelson TS, Strathroy TS, Talbot TS (Dual Element Spot Network or DESN 1 and DESN 2), Tillsonburg TS, Wonderland TS, and Woodstock TS.
- Three directly connected industrial customer loads are connected in the London Area: Enbridge Keyser CTS, Lafarge Woodstock CTS and Toyota Woodstock TS.
- There are three existing Transmission-connected generating stations in the London Area as follows:
  - Suncor Adelaide GS is a 40 MW wind farm connected to 115 kV circuit west of Strathroy TS
  - Port Burwell GS is a 99 MW wind farm connected to 115 kV circuit near Tillsonburg TS
  - Silver Creek GS is a 10 MW solar generator connected to 115 kV circuit near Aylmer TS
- There is a network of 230 kV and 115 kV circuits that provides supply to the London Area, as shown in Table 2 below:

Table 2: Transmission Lines in London Area

Voltage	Circuit Designations	Location
230 kV	N21W, N22W	Scott TS to Buchanan TS
	W42L, W43L	Longwood TS to Buchanan TS
	W44LC	Longwood TS to Chatham TS to Buchanan TS
	W45LS	Longwood TS to Spence SS to Buchanan TS
	W36, W37	Buchanan TS to Talbot TS and Clarke TS
	D4W, D5W	Buchanan TS to Detweiler TS
	M31W, M32W, M33W	Buchanan TS to Middleport TS
115 kV	W2S	Buchanan TS to Strathroy TS
	W5N	Buchanan TS to Nelson TS
	W6NL	Buchanan TS to Highbury TS to Nelson TS
	W9L	Buchanan TS to Highbury TS
	W7, W12	Buchanan TS to CTS
	WW1C	Buchanan TS to CTS
	W8T	Buchanan TS to ESWF JCT
	WT1T	ESWF JCT to Tillsonburg TS
	W3T, W4T	Buchanan TS to St. Thomas TS[1]
	WT1A	Aylmer TS to Lyons JCT
	K7, K12	Karn TS to Commerce Way TS

[1] St. Thomas TS will be decommissioned, work is underway but is currently on hold due to COVID-19, retermination work is currently planned to be completed in Q4 2020 subject to resource availability.

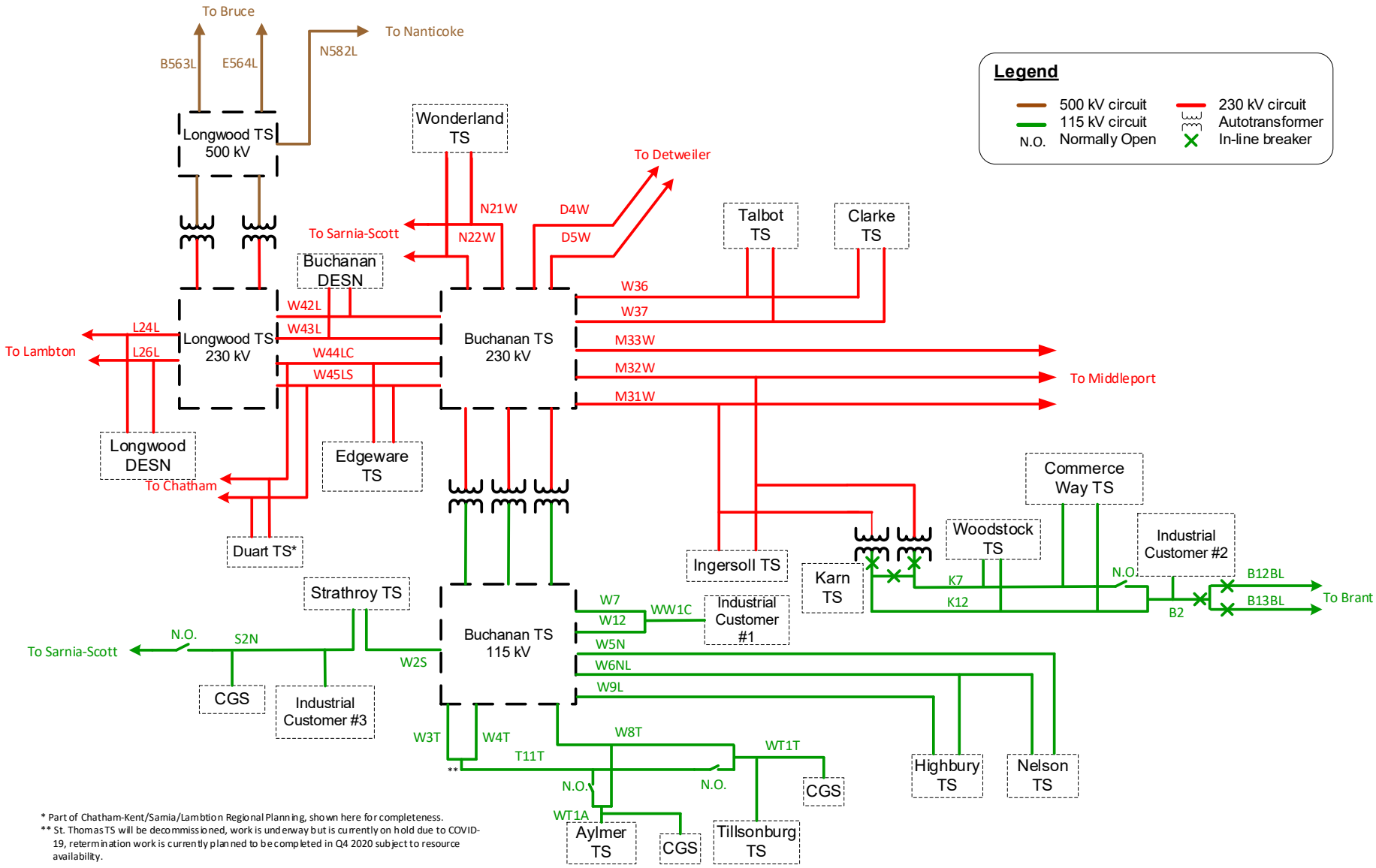

Figure 3: London Area Region Transmission System

5 INPUTS AND DATA

In order to conduct the Needs Assessment, Study Team participants provided the following information and data:

- IESO provided:
  i. List of existing reliability and operational issues
  ii. Forecasted contributions from Conservation and Demand Management (CDM) and Distributed Generation (DG) as well as seasonal capacity factors for different resources
- LDCs provided historical load data (2017 – 2019) and gross load forecast (2020 –2029)
- Hydro One (Transmission) provided transformer and circuit ratings, historical station load data (2017 – 2019), regional extreme weather correction factor and replacement plan for major assets approaching the end of their useful life.
- LDCs and Hydro One (Transmission) provided relevant planning information, including planned transmission and distribution investments.
- The study assumes Aylmer-Tillsonburg transmission reinforcement project as recommended in the previous Regional Planning cycle and St. Thomas decommissioning project will be implemented as planned.

6 ASSESSMENT METHODOLOGY

In general, a forecast of the peak demand to 2029 was developed based on the information listed in Section 5. From the forecast demand, the amount of available distributed generation and conservation & demand management was then deducted, and the remaining demand was compared to the supply capability of the existing system. The determination of need was consistent with the assumptions, consideration and criteria contained in the IESO Ontario Resource and Transmission Assessment Criteria (the "IESO ORTAC"). The section below provides more details about methodology and assumptions made in this Needs Assessment:

1. The assessment is based on summer peak loads.

2. Load data for transmission-connected industrial customers in the region was assumed to be consistent with historical peak loads.

3. The 2019 summer station peak load is considered as a reference point and was adjusted for extreme weather impact (7.34% in 2019). All LDCs' load forecasts are translated into load growth rates and are applied onto to the reference point to develop a gross load forecast.

   Distributed generation (DG) refers to small-scale power generation connected in the distribution system which is located close to where the electricity is consumed. Both conservation & demand management (CDM) as well as DG can reduce the amount of load that needs to be supplied and their contributions are directly net against the gross load forecast from Step (3) to develop a net load station forecast. A non-coincident version of the net load forecast was used to assess the station capacity as stated in Step (6).

As not all of the utility peaks are coincident with the regional peak. A coincident version of the net load forecast was used to assess the 230 kV transmission line needs (Section 7.1.2), 115 kV transmission line needs (Section 7.1.3), system security and restoration needs (Section 7.2).

The demand forecast for transformer stations in London Area are shown in Appendix A. Overall, the London Area is expected to grow at an average rate of approximately 0.9% annually from 2020 – 2029.

4. Review impact of any on-going and/or planned development projects in the London Area during the study period.

5. Review and assess impact of any critical/major elements planned to be replaced at the end of their useful life such as autotransformers, transformers and transmission lines.

6. 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. Normal planning supply capacity for transformer stations in this Region is determined by the summer 10-Day limited time rating (LTR).

7. To identify emerging need in the Region and determine whether or not further coordinated regional planning should be undertaken, the study was performed observing all elements in-service and only one element out of service.

8. Transmission adequacy assessment is consistent with the IESO ORTAC and below is a brief summary:
   - With all elements in service, the system is to be capable of supplying forecast demand with equipment loading within continuous ratings and voltages within normal range.
   - With one element out of service, the system is to be capable of supplying forecast demand with circuit loading within their long-term emergency (LTE) ratings and transformers within their summer 10-Day LTR.
   - All voltages must be within pre and post contingency ranges as per ORTAC Sections 4.2 and 4.3 criterion.
   - With one element out of service, no more than 150 MW of load is lost by configuration. With two elements out of service, no more than 600 MW of load is lost by configuration.
   - With two elements out of service, the system is capable of meeting the load restoration time stated ORTAC Section 7.2 criteria.

7 RESULTS

This section summarizes needs identified in the London Area Region. Status of the previously identified needs is summarized in Table 3 and the newly identified/emerging needs pertaining to this Needs Assessment will be discussed further in the remaining of this section.

Table 3: Needs Identified in the Previous Regional Planning Cycle

Needs identified in the previous Regional Planning cycle	Details	Current Status
Load Restoration for loss of M31W/M32W	Previous assessments indicated in case of simultaneous loss of two transmission elements (M31W/M32W), the load interrupted with current circuit configuration during peak periods will exceed 150 MW.	This need remains as the load interrupted will reach 158 MW in 2029 and is elaborated further in Section 7.2.
Load Restoration for loss of W36/W37	Previous assessments indicated for the simultaneous loss of two transmission elements (W36/W37), the load interrupted with the current circuit configuration during peak periods will exceed 250 MW.	This need remains as the load interrupted will reach over 390 MW in 2029. The last cycle of London Area regional planning recommended installing automated switching as well as extending feeders in the distribution system to improve the load restoration capability. London Hydro confirmed that these capital projects are currently underway. This need is further discussed in Section 7.2.
Voltage Violation at Tillsonburg TS	Pre-contingency voltage on Tillsonburg 115kV side falls below the permissible levels outlined in ORTAC.	The last cycle of London Area Regional Planning recommended Hydro One to proceed with the Aylmer-Tillsonburg project to address these needs, which among other things, will include installing two new 10 MVar capacitor banks at Tillsonburg TS. The additional reactive power support will address the voltage issue at Tillsonburg 115 kV and W8T thermal overload. Together with the impacted LDCs, a number of options were explored to address the delivery point performance need. It was agreed that reversing the existing normal operating points at Cranberry Junction will be the most cost-effective option. Upon the completion of the Aylmer-Tillsonburg project, Tillsonburg TS will be normally supplied by W3T/W4T/T11T while Aylmer TS will remain normally supplied by W8T. This project is currently underway with in-service date of Q2 2022.
Thermal constraint on 115kV line W8T	Thermal constraints are observed on 115 kV circuit W8T between Buchanan TS and Edgeware JCT. Under pre-contingency conditions, the thermal loading on this section line will exceed its planning rating.	
Poor delivery point performance at Tillsonburg TS	Historical data indicated that the frequency of outages to Tillsonburg Hydro and Hydro One Distribution exceed level prescribed in Hydro One's "Customer Delivery Point Performance Standard".	

7.1 Transmission Capacity Needs

Sections 7.1.1 to 7.1.3 summarize the Needs Assessment study results based the London Area region coincident load forecast.

7.1.1 230/115 kV Autotransformers

The 230/115 kV autotransformers (Buchanan TS and Karn TS) supplying the London Area are adequate over the study period for the loss of a single 230/115 kV autotransformer.

7.1.2 230 kV Transmission Lines

Under peak load condition and with standard power factor assumption of 0.9, for (N-1) contingency of W36/W37 and breaker failure contingencies at Buchanan TS that involve loss of either W36 or W37, the companion circuit will be loaded close to its LTE rating (96% to 99%) by the end of study period. The circuit loadings improve when power factor of 0.97 as provided by London Hydro is assumed for the transformer stations connected to W36 and W37, namely Talbot TS and Clarke TS.

The remaining 230 kV circuits supplying the London Area have adequate capacity over the study period for the loss of a single 230 kV circuit in the Region.

7.1.3 115 kV Transmission Lines

The 115 kV circuits supplying the London Area have adequate capacity over the study period for the loss of a single 115 kV circuit in the Region.

7.1.4 230 kV and 115 kV Connection Facilities

A station capacity assessment was performed over the study period for the 230 kV and 115 kV TS's in the London Area using the summer station peak load forecasts (non-coincident) provided by the study team. The results are as follows:

Clarke TS
Clarke TS T3/T4 will exceed its 10-Day LTR in 2022 based on the net load forecast (approximately 101% of Summer 10-Day LTR).

Talbot TS
Talbot TS T3/T4 DESN is forecasted to exceed its 10-Day LTR rating throughout the study period based on the net load forecast (approximately 118% of Summer 10-Day LTR).

Nelson TS recently underwent refurbishment which includes converting the low-voltage supply from 13.8 kV to 27.6 kV. During the construction period, significant portion of the load that was originally supplied by this station was transferred to Clarke TS and Talbot TS. The newly refurbished Nelson TS was placed in-service in December 2018 and as more 27.6 kV distribution feeders becomes available in downtown London, London Hydro confirmed load will be transferred back to Nelson TS and additional transformation capacity is not required at this time.

All the other TSs in the London Area are forecasted to remain within their normal supply capacity during the study period. Therefore, no action is required at this time and the capacity needs will be reviewed in the next planning cycle.

7.2 System Security and Restoration Review

Based on the net coincident load forecast, the loss of one element will not result in load interruption greater than 150 MW. The maximum load interrupted by configuration due to the loss of two elements is below the load loss limit of 600 MW by the end of the 10-year study period.

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 158 MW for the loss of double-circuit line M31W and M32W or loss of both autotransformers at Karn TS. The system is required to restore 8 MW within 4 hours and the remaining 150 MW within 8 hours. This need was first identified in the previous Regional Planning cycle and remains in this cycle. Hydro One Distribution estimated 10 MW of load at Ingersoll TS can be transferred to Highbury TS to restore some load remotely within 4 hours. To restore the remaining 148 MW of interrupted load within 8 hours, field crew from the nearest staffed centre in London area will be dispatched and install temporary fixes on the transmission system such as building emergency by-pass. Therefore, no action is required at this time and this will be reviewed in the next planning cycle.

Based on the net coincident load forecast at Clarke TS and Talbot TS, the load interrupted by configuration will reach beyond 390 MW in 2029 for the loss of double-circuit line W36 and W37. In accordance with ORTAC, the system is required to restore 140 MW within 30 minute, 100 MW within 4 hours and the remaining 150 MW within 8 hours. This need was first reported in the previous Regional Planning cycle and the impacted LDC, London Hydro, and the IESO undertook further planning as part of the Integrated Regional Resource Plan (IRRP). The recommendation was to install automated switches and extend feeders in the distribution system and London Hydro confirmed these projects are currently underway. Further, as discussed in Section 7.1.4, load will continue to be transferred from Clarke TS and Talbot TS to Nelson TS over the study period. The amount of load required to be restored within 30 minutes will continue to be reduced as these projects progress, post-completion of these projects will be a better representation of the steady state load restoration requirement. Therefore, it is recommended that London Hydro and Hydro One Transmission to further examine this need in form of Local Planning to determine the restoration target once all the ongoing projects are completed, identify the restoration capability from the existing transmission and distribution systems and devise an action plan.

The simultaneous loss of double-circuit line W44LC and W45LS will interrupt approximately 165 MW of load at Edgeware TS and Duart TS[2] by configuration and 15 MW of interrupted load needs to be restored within 4 hours. All remaining load must be restored within 8 hours. Hydro One Distribution estimated 10 MW of load at Edgeware TS can be transferred to Aylmer TS. Another 11 MW could be transferred from Duart TS to Kent TS on the feeder level. These measures can be deployed remotely to manage and mitigate the impact of the [N – 2] contingency within the 4 hours timeframe. The remaining 144 MW of interrupted load can be within 8 hours by dispatching field crew from the nearest staffed centre in London area to install

[2] Coincident forecasted load for Duart TS not available as it is part of the Chatham-Kent/Lambton/Sarnia Area Region which is scheduled to begin at a later time. For the purpose of this report, 2019 summer station peak of approximately 50 MW is assumed.

temporary fixes on the transmission system. Therefore, no action is required at this time and this will be reviewed in the next planning cycle.

7.3 Aging Infrastructure and Replacement Plan of Major Equipment

Hydro One reviewed the sustainment initiatives that are currently planned for the replacement of any autotransformers, power transformers and high-voltage lines. During the study period:

- The existing 115 kV switchyard in Buchanan TS will be replaced on a like-for-like basis and is scheduled to be completed in 2025. Project scope will be finalized upon asset condition verification.
- The existing Clarke TS DESN transformers will be replaced on a like-for-like basis and is scheduled to be completed in 2025.
- The existing Wonderland TS 27.6 kV switchyard will be replaced on a like-for-like basis and is scheduled to be completed in 2023.
- Protection equipment replacement projects will take place at Edgeware TS, Longwood TS, and Tillsonburg TS and will not have material impact to this Needs Assessment study.
- There is no significant lines sustainment plan that will affect the results of this Needs Assessment study.

To conclude, equipment replacement plans do not affect the needs identified during the study period.

8 CONCLUSION AND RECOMMENDATIONS

Based on the findings and discussion in Section 7 of the Needs Assessment report, the study team recommends that load restoration need following the loss of W36 and W37 should be further assessed as part of Local Planning by Hydro One and relevant LDC and that no further regional coordination is required to address needs in the London area.

9 REFERENCES

[1] RIP Report – London Area Region – August 2017

[2] IRRP Report – Greater London Area

[3] Planning Process Working Group Report to the Ontario Energy Board - May 2013

[4] Ontario Resource and Transmission Assessment Criteria (ORTAC) – Issue 5.0 -August 2007

Appendix A: London Area Region non-coincident and coincident summer load forecast

Table A.1: London Area Region Summer Non-Coincident Load Forecast

Transformer Station	Quantities	Reference	Near Term Forecast (MW)					Medium Term Forecast (MW)				
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Aylmer TS	Gross	26.67	27.03	27.40	27.77	28.15	28.54	28.93	29.32	29.72	30.12	30.54
	DG		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	CDM		0.22	0.25	0.31	0.39	0.45	0.52	0.57	0.66	0.71	0.73
	Net		26.79	27.14	27.45	27.75	28.07	28.39	28.73	29.05	29.40	29.79
Buchanan TS	Gross	145.86	148.04	150.24	152.48	154.76	157.07	159.41	161.79	164.20	166.65	169.13
	DG		11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23
	CDM		1.22	1.35	1.68	2.14	2.48	2.88	3.16	3.64	3.93	4.04
	Net		135.59	137.66	139.57	141.38	143.36	145.30	147.39	149.33	151.49	153.87
Clarke TS	Gross	104.14	105.76	107.40	109.07	110.77	112.49	114.23	116.01	117.81	119.64	121.50
	DG		2.61	2.61	2.61	2.61	2.61	2.61	2.61	2.61	2.61	2.61
	CDM		0.87	0.97	1.21	1.53	1.77	2.06	2.27	2.61	2.82	2.90
	Net		102.28	103.82	105.25	106.62	108.10	109.56	111.13	112.58	114.21	115.98
Commerce Way TS	Gross	38.39	38.70	39.00	39.32	39.63	39.95	40.27	40.59	40.91	41.24	41.57
	DG		2.95	2.95	2.95	2.95	2.95	2.95	2.95	2.95	2.95	2.95
	CDM		0.32	0.35	0.43	0.55	0.63	0.73	0.79	0.91	0.97	0.99
	Net		35.43	35.71	35.94	36.14	36.37	36.59	36.85	37.06	37.32	37.63
Edgeware TS	Gross	106.29	107.83	109.39	110.97	112.57	114.20	115.85	117.53	119.23	120.95	122.70
	DG		3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16
	CDM		0.89	0.99	1.23	1.56	1.80	2.09	2.30	2.64	2.85	2.93
	Net		103.78	105.24	106.58	107.85	109.24	110.60	112.07	113.42	114.94	116.61
Highbury TS	Gross	72.46	73.36	74.28	75.20	76.14	77.09	78.05	79.02	80.01	81.01	82.01
	DG		3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89
	CDM		0.60	0.67	0.83	1.05	1.22	1.41	1.54	1.77	1.91	1.96
	Net		68.87	69.71	70.48	71.19	71.98	72.75	73.59	74.34	75.20	76.16
Ingersoll TS	Gross	77.78	78.60	79.43	80.27	81.12	81.97	82.84	83.71	84.60	85.49	86.40
	DG		9.36	9.36	9.36	9.36	9.36	9.36	9.36	9.36	9.36	9.36
	CDM		0.65	0.72	0.89	1.12	1.29	1.50	1.64	1.88	2.01	2.06
	Net		68.60	69.36	70.02	70.64	71.32	71.99	72.72	73.37	74.12	74.98
Longwood TS	Gross	38.37	38.77	39.18	39.58	40.00	40.41	40.83	41.26	41.69	42.12	42.56
	DG		0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
	CDM		0.32	0.35	0.44	0.55	0.64	0.74	0.81	0.92	0.99	1.02
	Net		37.64	38.00	38.33	38.62	38.96	39.28	39.63	39.94	40.31	40.72
Nelson TS	Gross	40.56	42.23	43.97	45.78	47.67	49.64	51.69	53.82	56.04	58.35	60.75
	DG		17.55	17.55	17.55	17.55	17.55	17.55	17.55	17.55	17.55	17.55
	CDM		0.35	0.40	0.51	0.66	0.78	0.93	1.05	1.24	1.37	1.45
	Net		24.34	26.03	27.73	29.47	31.31	33.21	35.22	37.25	39.43	41.76
Strathroy TS	Gross	38.37	38.56	38.75	38.95	39.14	39.34	39.54	39.74	39.94	40.14	40.34
	DG		6.29	6.29	6.29	6.29	6.29	6.29	6.29	6.29	6.29	6.29
	CDM		0.32	0.35	0.43	0.54	0.62	0.71	0.78	0.89	0.95	0.96
	Net		31.95	32.11	32.23	32.31	32.43	32.53	32.67	32.76	32.90	33.09
Talbot T1/T2	Gross	112.38	112.34	112.29	112.25	112.21	112.16	112.12	112.08	112.04	111.99	111.95
	DG		-	-	-	-	-	-	-	-	-	-
	CDM		0.92	1.01	1.24	1.55	1.77	2.03	2.19	2.48	2.64	2.67
	Net		111.41	111.28	111.01	110.65	110.40	110.10	109.89	109.55	109.35	109.28
Talbot T3/T4	Gross	204.95	204.05	203.15	202.25	201.36	200.47	199.59	198.71	197.83	196.96	196.09
	DG		12.13	12.13	12.13	12.13	12.13	12.13	12.13	12.13	12.13	0.37
	CDM		1.68	1.83	2.23	2.79	3.16	3.61	3.88	4.39	4.64	4.68
	Net		190.24	189.19	187.89	186.44	185.18	183.85	182.69	181.31	180.19	191.04
Tillsonburg TS	Gross	89.14	90.52	91.92	93.34	94.78	96.25	97.74	99.25	100.78	102.34	103.92
	DG		3.46	3.46	3.46	3.46	3.46	3.46	3.46	3.46	0.68	0.68
	CDM		0.74	0.83	1.03	1.31	1.52	1.77	1.94	2.23	2.41	2.48
	Net		86.32	87.64	88.85	90.01	91.27	92.51	93.85	95.09	99.24	100.76
Wonderland TS	Gross	90.70	91.82	92.95	94.09	95.25	96.42	97.61	98.81	100.03	101.26	102.50
	DG		1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41
	CDM		0.75	0.84	1.04	1.32	1.52	1.76	1.93	2.22	2.39	2.45
	Net		89.65	90.70	91.64	92.52	93.49	94.43	95.47	96.40	97.46	98.65
Woodstock TS	Gross	65.39	65.95	66.51	67.08	67.66	68.24	68.82	69.41	70.00	70.60	71.21
	DG		1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62
	CDM		0.54	0.60	0.74	0.94	1.08	1.24	1.36	1.55	1.66	1.70
	Net		63.79	64.29	64.72	65.10	65.54	65.96	66.43	66.83	67.32	67.89
Industrial Customer #1		12	12	12	12	12	12	12	12	12	12	12
Industrial Customer #2		19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9
Industrial Customer #3		2	2	2	2	2	2	2	2	2	2	2
London Area Total			1211	1222	1232	1241	1251	1261	1272	1282	1297	1322

Note (1) – Edgeware TS 15MW load increase (CAA 2019-658) is included in gross load forecast that increases load in an even annual stream over the next ten to 15 years, as opposed to a sudden step change at a particular point in time.
Note (2) – Buchanan TS 15MW load increase (CAA 2019-670) is included in gross load forecast with the assumption that some existing load will be transferred to nearby stations; hence there is no step change.

Table A.2: London Area Region Summer Coincident Load Forecast

Transformer Station	Quantities	Reference	Near Term Forecast (MW)					Medium Term Forecast (MW)				
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Aylmer TS	Gross	20.64	20.92	21.21	21.50	21.79	22.09	22.39	22.69	23.00	23.32	23.64
	DG		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	CDM		0.17	0.19	0.24	0.30	0.35	0.40	0.44	0.51	0.55	0.56
	Net		20.74	21.00	21.25	21.47	21.72	21.97	22.24	22.48	22.75	23.06
Buchanan TS	Gross	139.77	141.86	143.97	146.12	148.30	150.51	152.76	155.04	157.35	159.69	162.08
	DG		11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23
	CDM		1.17	1.30	1.61	2.05	2.37	2.76	3.03	3.49	3.76	3.87
	Net		129.46	131.45	133.28	135.02	136.91	138.77	140.78	142.63	144.70	146.98
Clarke TS	Gross	114.79	116.57	118.38	120.22	122.09	123.98	125.91	127.86	129.85	131.87	133.92
	DG		2.61	2.61	2.61	2.61	2.61	2.61	2.61	2.61	2.61	2.61
	CDM		0.96	1.07	1.33	1.69	1.96	2.27	2.50	2.88	3.11	3.20
	Net		113.00	114.70	116.28	117.78	119.41	121.02	122.75	124.36	126.15	128.11
Commerce Way TS	Gross	27.27	27.49	27.71	27.93	28.15	28.38	28.61	28.83	29.06	29.30	29.53
	DG		2.95	2.95	2.95	2.95	2.95	2.95	2.95	2.95	2.95	2.95
	CDM		0.23	0.25	0.31	0.39	0.45	0.52	0.56	0.64	0.69	0.70
	Net		24.32	24.51	24.68	24.82	24.99	25.14	25.33	25.47	25.66	25.88
Edgeware TS	Gross	104.38	105.89	107.42	108.98	110.55	112.15	113.77	115.42	117.08	118.78	120.49
	DG		3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16
	CDM		0.87	0.97	1.20	1.53	1.77	2.06	2.25	2.60	2.80	2.88
	Net		101.86	103.30	104.61	105.86	107.22	108.56	110.00	111.33	112.82	114.46
Highbury TS	Gross	58.42	59.15	59.89	60.63	61.39	62.15	62.93	63.71	64.51	65.31	66.12
	DG		3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89	3.89
	CDM		0.49	0.54	0.67	0.85	0.98	1.14	1.24	1.43	1.54	1.58
	Net		54.77	55.45	56.07	56.64	57.28	57.90	58.57	59.18	59.88	60.65
Ingersoll TS	Gross	50.59	51.12	51.66	52.21	52.76	53.31	53.88	54.45	55.02	55.60	56.19
	DG		9.36	9.36	9.36	9.36	9.36	9.36	9.36	9.36	9.36	9.36
	CDM		0.42	0.47	0.58	0.73	0.84	0.97	1.06	1.22	1.31	1.34
	Net		41.34	41.84	42.27	42.67	43.12	43.55	44.03	44.44	44.94	45.49
Longwood TS	Gross	35.60	35.97	36.34	36.72	37.10	37.49	37.88	38.27	38.67	39.07	39.48
	DG		0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
	CDM		0.30	0.33	0.41	0.51	0.59	0.68	0.75	0.86	0.92	0.94
	Net		34.85	35.19	35.49	35.77	36.08	36.37	36.70	36.99	37.33	37.72
Nelson TS	Gross	30.98	32.26	33.59	34.97	36.41	37.92	39.48	41.11	42.80	44.57	46.41
	DG		17.55	17.55	17.55	17.55	17.55	17.55	17.55	17.55	17.55	17.55
	CDM		0.26	0.30	0.39	0.50	0.60	0.71	0.80	0.95	1.05	1.11
	Net		14.45	15.74	17.04	18.36	19.77	21.22	22.76	24.31	25.97	27.75
Strathroy TS	Gross	35.05	35.23	35.40	35.58	35.76	35.94	36.12	36.30	36.48	36.67	36.85
	DG		6.29	6.29	6.29	6.29	6.29	6.29	6.29	6.29	6.29	6.29
	CDM		0.29	0.32	0.39	0.50	0.57	0.65	0.71	0.81	0.86	0.88
	Net		28.65	28.80	28.90	28.98	29.08	29.18	29.30	29.39	29.51	29.68
Talbot T1/T2	Gross	112.00	111.96	111.91	111.87	111.83	111.78	111.74	111.70	111.66	111.61	111.57
	DG		-	-	-	-	-	-	-	-	-	-
	CDM		0.92	1.01	1.24	1.55	1.76	2.02	2.18	2.48	2.63	2.66
	Net		111.04	110.90	110.63	110.28	110.02	109.72	109.52	109.18	108.98	108.91
Talbot T3/T4	Gross	172.58	171.82	171.06	170.31	169.56	168.81	168.06	167.32	166.58	165.85	165.12
	DG		12.13	12.13	12.13	12.13	12.13	12.13	12.13	12.13	12.13	0.37
	CDM		1.41	1.54	1.88	2.35	2.66	3.04	3.27	3.69	3.91	3.94
	Net		158.28	157.39	156.30	155.08	154.02	152.90	151.92	150.76	149.81	160.80
Tillsonburg TS	Gross	80.84	82.09	83.36	84.65	85.96	87.29	88.64	90.01	91.40	92.81	94.25
	DG		3.46	3.46	3.46	3.46	3.46	3.46	3.46	3.46	0.68	0.68
	CDM		0.67	0.75	0.94	1.19	1.38	1.60	1.76	2.03	2.19	2.25
	Net		77.96	79.16	80.26	81.31	82.46	83.58	84.79	85.92	89.94	91.31
Wonderland TS	Gross	97.34	98.53	99.75	100.97	102.22	103.48	104.75	106.04	107.34	108.66	110.00
	DG		1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41
	CDM		0.81	0.90	1.12	1.42	1.63	1.89	2.07	2.38	2.56	2.63
	Net		96.31	97.44	98.45	99.39	100.43	101.44	102.55	103.55	104.69	105.96
Woodstock TS	Gross	64.65	65.20	65.76	66.32	66.89	67.46	68.04	68.62	69.21	69.80	70.40
	DG		1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62
	CDM		0.54	0.59	0.73	0.93	1.06	1.23	1.34	1.53	1.64	1.68
	Net		63.04	63.55	63.97	64.34	64.78	65.19	65.66	66.05	66.53	67.10
Industrial Customer #1		12	12	12	12	12	12	12	12	12	12	12
Industrial Customer #2		19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9
Industrial Customer #3		2	2	2	2	2	2	2	2	2	2	2
London Area Total			1104	1114	1123	1132	1141	1150	1161	1170	1184	1208

Note (1) – Edgeware TS 15MW load increase (CAA 2019-658) is included in gross load forecast that increases load in an even annual stream over the next ten to 15 years, as opposed to a sudden step change at a particular point in time.
Note (2) – Buchanan TS 15MW load increase (CAA 2019-670) is included in gross load forecast with the assumption that some existing load will be transferred to nearby stations; hence there is no step change.

Appendix B: Acronyms

Acronym	Description
CDM	Conservation and Demand Management
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
LTE	Long Term Emergency
LTR	Limited Time Rating
LV	Low Voltage
MW	Megawatt
MVA	Mega Volt-Ampere
MVAR	Mega Volt-Ampere Reactive
OEB	Ontario Energy Board
ORTAC	Ontario Resource and Transmission Assessment Criteria
PPWG	Planning Process Working Group
RIP	Regional Infrastructure Plan
SA	Scoping Assessment
SIA	System Impact Assessment
SS	Switching Station
TS	Transformer Station