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NEEDS ASSESSMENT REPORT

Renfrew Region

Date: May 17th 2021

Prepared by: Renfrew Region Study Team

Disclaimer

This Needs Assessment Report was prepared for the purpose of identifying potential needs in the Renfrew Region and to recommend which need may be a) directly addressed by developing a preferred plan as part of NA phase and b) identify needs requiring further assessment and/or regional coordination. The results reported in this Needs Assessment are based on the input and information provided by the Study Team for this region.

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Executive Summary

REGION Renfrew Region (the "Region")

LEAD Hydro One Networks Inc. ("HONI")

START DATE: MARCH 19, 2021 **END DATE:** May 17, 2021

1. INTRODUCTION

The first cycle of the Regional Planning process for the Region was completed in July 2016 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 starting from Needs Assessment ("NA"). The purpose of this NA is a) to identify any new needs and/or to reaffirm needs identified in the previous Renfrew Regional Planning cycle and b) recommend which need may be a) addressed by developing a preferred plan as part of NA phase and b) identify needs requiring further assessment and/or regional coordination.

2. REGIONAL ISSUE/TRIGGER

In accordance with the Regional Planning process, the regional planning cycle should be triggered at least every five years. In light of these timelines, the 2nd Regional Planning cycle was triggered for the Renfrew Region.

3. SCOPE OF NEEDS ASSESSMENT

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

The scope of this NA includes:

- Review and reaffirm needs/plans identified in the previous RIP; and
- Identification and assessment of system capacity, reliability, operation, and aging infrastructure needs in the region: and
- Develop options for need(s) and/or a preferred plan or recommend which needs require further assessment/regional coordination.

The Study Team may also identify additional needs during the next phases of the planning process, namely Scoping Assessment ("SA"), IRRP and RIP, based on updated information available at that time.

As per the PPWG Regional Planning Report to the Board (May 2013), the planning horizons of regional facilities are typically considered over the 1-20 years; however, in the Needs Assessment the focus is over the first 1 – 10 years.

4. INPUTS/DATA

Study team participants, including representatives from LDCs, the IESO, and Hydro One transmission provided information for the Renfrew Region. The information included: existing information from planning activities

already underway, historical load, load forecast, conservation and demand management (CDM) and distributed energy resources (DER) information, load restoration data, and performance information including major equipment approaching end-of-life.

5. ASSESSMENT METHODOLOGY

The assessment methodology include review of planning information such as load forecast, conservation and demand management ("CDM") forecast and available distributed energy resources ("DER") information, any system reliability and operation issues, and major high voltage equipment identified to be at or near the end of their life.

A technical assessment of needs was undertaken based on:

- Current and future station capacity and transmission adequacy;
- Reliability needs and operational concerns; and
- Any major high voltage equipment reaching the end of its life.

6. NEEDS

I. Update on plan implementation of identified needs from previous cycle

a. No new needs were identified in the previous regional planning cycle. D6 and X1P were monitored as per the recommendation of the previous planning and the performance of the circuit was reliable and not found to be an outlier.

II. Newly identified needs in the region

a. Line / Station Capacity

i. The 2019 summer peak loading on Pembroke TS was 48 MW, which is above its 10 day summer LTR of 47 MW. Based on the submitted load forecast, the Pembroke TS will be loaded 52 MW by year 2029. Load relief is required at the Pembroke TS in the near term.

ii. All other stations in the region have sufficient capacity to supply the loads in studied period under normal and single contingency condition for forecasted load of this study period.

b. Aging Infrastructure Transformer and Line replacements

i. Chenaux TS – T3/T4 Auto transformers and 115 kV switchyard refurbishment (2021)

ii. D6 - Des Joachims TS to Petawawa DS Line refurbishment (2022)

7. RECOMMENDATIONS

The Study Team recommends the following -

a. Hydro One Distribution to undertake load transfer studies to alleviate Pembroke TS overloading concerns in the near term. Alternatively, Hydro One Distribution may also assess the option of building a new distribution transformer station to manage Pembroke TS overloading and to serve future load growth in the area.

b. Replacement of end of life asset with similar equipment does not require further regional coordination (see further details in Section 7.1). The implementation and execution plan for below EOL needs were / will coordinated by Hydro One with affected LDCs.

i. Chenaux T3/T4 Auto transformers and 115 kV switchyard refurbishment
ii. D6 - Des Joachims TS to Petawawa DS Line refurbishment

c. Continue to monitor the reliability performance of D6 and X1P. Should the performance of D6 and X1P fall below adequate levels (as shown by standard OGCC monitoring systems) the Hydro One will undertake to assess and address this issue with the LDCs.

d. Further regional planning coordination is required for Pembroke TS overloading capacity mitigation. A Scoping Assessment should be undertaken for the Renfrew region to determine the appropriate regional planning approach i.e. Integrated Regional Resource Planning (IRRP) and/or Regional Infrastructure Planning (RIP) to address needs identified in this Needs Assessment.

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1 INTRODUCTION

The first cycle of the Regional Planning process for the Renfrew Region was completed in July 2016 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 ("NA") is to identify new needs and to reconfirm needs identified in the previous Renfrew regional planning cycle. Since the previous regional planning cycle, some new needs in the region have been identified.

This report was prepared by the Renfrew Region Study Team ("Study Team"), led by Hydro One Networks Inc. Participants of the Study Team are listed below in Table 1. 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").

Table 1: Renfrew Region Study Team Participants

Company
Hydro One Networks Inc. (Lead Transmitter)
Independent Electricity System Operator (IESO)
Ottawa River Power Corporation
Hydro One Networks Inc. (Distribution)

2 REGIONAL ISSUE/TRIGGER

In accordance with the Regional Planning process, the Regional Planning cycle should be triggered at least every five years. In light of Regional Planning cycle timelines and new needs in the Renfrew region, the 2nd Regional Planning cycle was triggered for the Renfrew region.

3 SCOPE OF NEEDS ASSESSMENT

The scope of this NA covers the Renfrew region and includes:

- Review the status of needs/plans identified in the previous RIP; and
- Identification and assessment of any new needs (e.g. system capacity, reliability, operation, and aging infrastructure)

The Study Team may identify additional needs during the next phases of the regional planning process, namely Scoping Assessment ("SA"), Local Planning ("LP"), IRRP, and/or RIP.

4 REGIONAL DESCRIPTION AND CONNECTION CONFIGURATION

The Renfrew Region includes all of Renfrew County. The boundaries of Renfrew Region is shown below in Fig. 1.

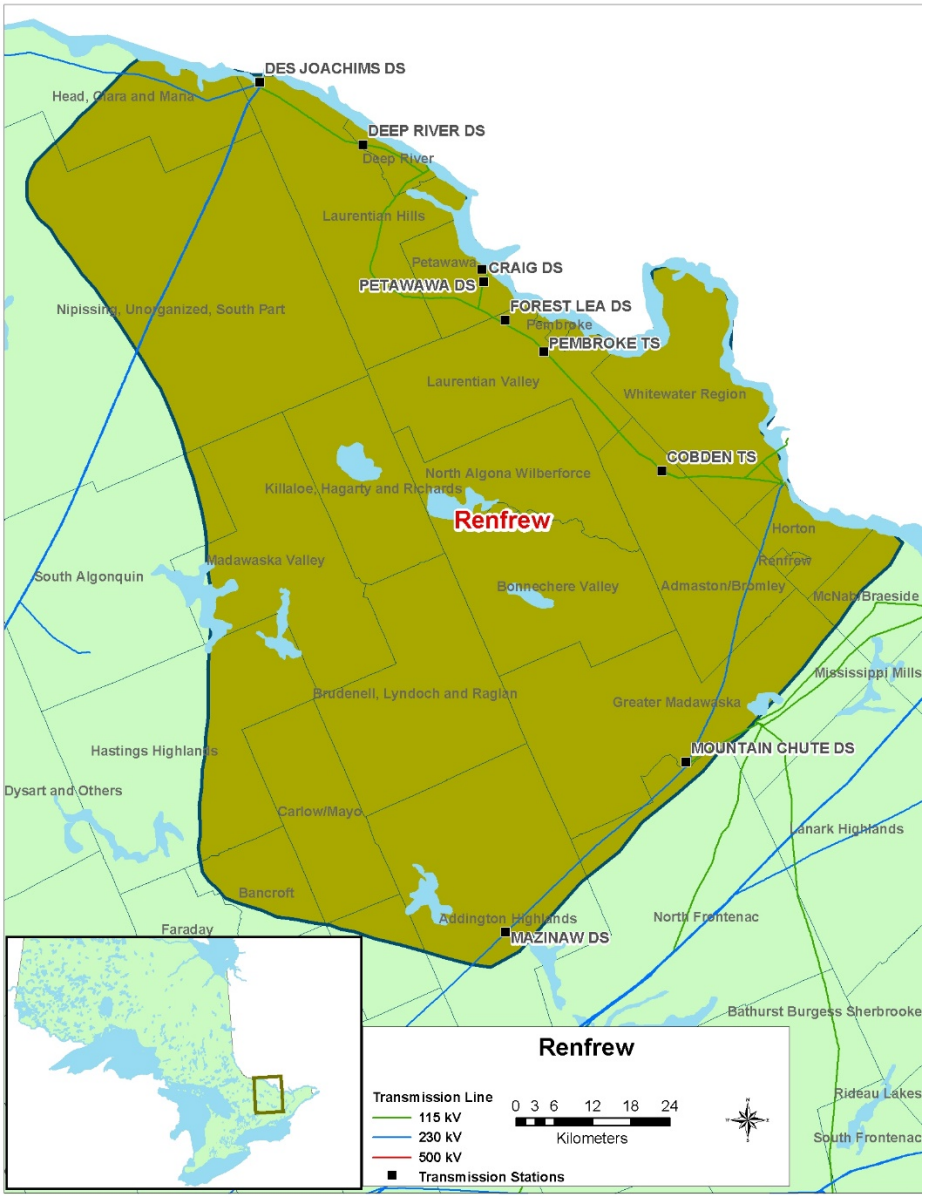

Figure 1: Geographical Area of Renfrew Region with Electrical Layout

The electricity supply to the region is provided through one 230kV circuit X1P and three 115 kV radial circuits: D6, X6 and X2Y (Fig.1). The 115kV circuits are supplied by 230/115 kV autotransformers at Chenaux Transformer Station (TS) from the East and Des Joachims TS from the West. A normally opened 115kV switch at Pembroke TS isolates the East and the West sides of the region.

The Renfrew Region is bounded by the Des Joachims TS on the West and Chenaux TS on the East, and 230kV circuit X1P to the Southeast. The distribution system in this region consists of voltage levels 44 kV and 12.5 kV. The main generation facilities in the Renfrew Region are Chenaux Generation Station (GS) of 143.7 MW, Mountain Chute GS of 170.2 MW and Des Joachims GS of 432.5 MW.

Hydro One Networks Inc. (Distribution) is the main customer in the area. Other Local Distribution Companies (LDC) supplied from electrical facilities in the Renfrew Region include Ottawa River Power Corporation and Renfrew Hydro Inc., both are embedded into Hydro One's distribution system. Renfrew Hydro Inc. customers are being fed from Stewartville TS which is part of the Greater Ottawa Regional Planning. As such Renfrew Hydro Inc. has not been included as part of this NA. Major transmission connected customers in the area include Atomic Energy of Canada Limited and Magellan Aerospace.

The existing facilities in the Region are summarized below and depicted in the single line diagram shown in Fig. 2.

- Chenaux TS is a major 230kV station in the region. The station has 143.7MW of hydraulic generation connected to the 230kV bus. The station connects to the bulk system via a single 230kV circuit X1P. Two autotransformers step down the voltage to 115kV to supply two radial circuits X6 and X2Y.

- The 115kV circuits X6 and X2Y from Chenaux TS supply four stations: Pembroke TS, Cobden TS, Cobden DS and Magellan Aerospace CTS.

- Des Joachim TS is the other major 230kV transformer station in the Region. There are 432.5MW of hydraulic generation connecting to the 230kV bus. The station interconnects to the Bulk Electric System (BES) via five 230kV circuits which are not in the scope of this regional assessment. Two autotransformers (one operates as standby) step down the voltage to 115kV to supply one radial circuit D6.

- The 115kV circuit D6 from Des Joachim TS 115kV bus supplies six stations: Des Joachims Distribution Station (DS), Deep River DS, Craig DS, Forest Lea DS, Petawawa DS, and Chalk River Customer Transformer Station (CTS).

- Bryson GS of Hydro Quebec can be radially connected to Renfrew region via X2Y.

- The 230kV single circuit X1P from Dobbin TS to Chenaux TS connects two stations in Renfrew Region: Mountain Chute GS (with hydraulic generation of 170.2MW) and Mazinaw DS.

- Mountain Chute DS, a 115kV station adjacent to Mountain Chute GS, is supplied by a circuit W3B from outside of the studied region.

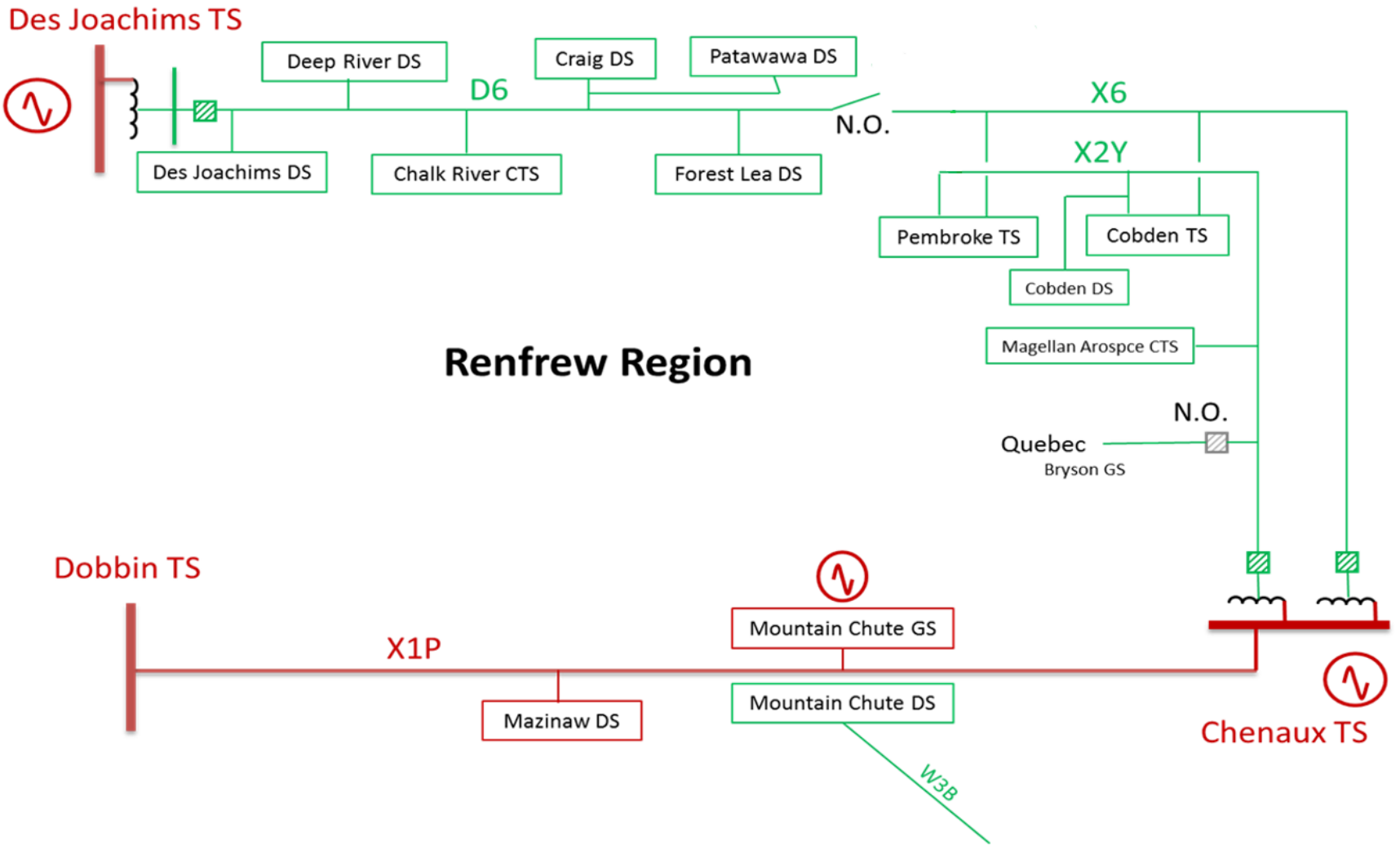

Figure 2: Single Line Diagram of Renfrew Region

5 INPUTS AND DATA

Study Team participants, including representatives from LDCs, IESO, and Hydro One provided information and input for the Renfrew Region NA. The information provided includes the following:

- Renfrew Load Forecast for all supply stations;
- Known capacity and reliability needs, operating issues, and/or major assets approaching the end of life ("EOL"); and
- Planned/foreseen transmission and distribution investments that are relevant to regional planning for the Renfrew Region.

6 ASSESSMENT METHODOLOGY

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

Information gathering included:

i. Load forecast: The LDCs provided load forecasts for all the stations supplying their loads in the Renfrew region for the 10 year study period. The IESO provided a Conservation and Demand Management ("CDM") and Distributed Energy Resources ("DER") forecast for the Renfrew region. The region's extreme summer non-coincident peak gross load forecast for each station were prepared by applying the LDC load forecast load growth rates to the actual 2019 summer and 2019/20 winter peak extreme weather corrected loads. The extreme summer / winter weather correction factors were provided by Hydro One. The net extreme weather summer load forecasts were produced by reducing the gross load forecasts for each station by the % age CDM and then by the amount of effective DER capacity provided by the IESO for that station. It is to be noted that in the mid-term (5 to 10 year) time frame, contracts for existing DER resources in the region begin to expire, at which point the load forecast indicates a decreasing contribution from local DER resources, and an increase in net demand. These extreme weather corrected net summer / winter load forecast for the individual stations in the Renfrew region is given in Appendix A;

ii. Relevant information regarding system reliability and operational issues in the region; and

iii. List of major HV transmission equipment planned and/or identified to be refurbished and/or replaced due to the end of life which is relevant for regional planning purposes. This includes HV transformers, autotransformers, HV Breakers, HV underground cables and overhead lines.

A technical assessment of needs was undertaken based on:

- Current and future station capacity and transmission adequacy;
- System reliability and operational concerns; and
- Any major high voltage equipment reaching the end of life.

Transmission adequacy assessment is primarily based on the following criteria:

- 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. Projected coincidental peak loads are used in such assessment.
- 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 Ontario Resource and Transmission Assessment Criteria (ORTAC). Des Joachims and Chenaux 115kV bus voltages are maintained between 122kV and 127kV according to established operation practice.
- 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.
- The system is capable of meeting the load restoration time limits as per ORTAC criteria.

7 NEEDS

This section describes emerging needs identified in the Renfrew Region, and also reaffirms the near, mid, and long-term needs already identified in the previous regional planning cycle. The previous Regional Planning for this region didn't identify any need that require further regional planning. The recent load forecast prepared for this report is higher than the previous cycle of regional planning. The load at the Pembroke TS is above its 10 day summer LTR. There is minimal or no load growth at other stations in the region in comparison with the previous cycle. There are no known major load increases in the area during this study period. The proposed TransCanada pump station that was expected to tap to X2Y near Pembroke TS from the previous cycle of regional planning have been cancelled and will no longer be proceeding. A contingency analysis was performed for the region and no new system needs were identified.

7.1 End-Of-Life (EOL) Equipment Needs

Hydro One and LDCs have provided high voltage asset information under the following categories that have been identified at this time and are likely to be replaced over the next 10 years:

- Autotransformers
- Power transformers
- HV breakers
- Transmission line requiring refurbishment where an uprating is being considered for planning needs and require Leave to Construct (i.e., Section 92) application and approval
- HV underground cables where an uprating is being considered for planning needs and require EA and Leave to Construct (i.e., Section 92) application and approval

The end-of-life assessment for the above high voltage equipment typically included consideration of the following options:

1. Replacing equipment with similar equipment and built to current standards (i.e., "like-for-like" replacement);
2. Replacing equipment with similar equipment of higher / lower ratings i.e. right sizing opportunity and built to current standards;
3. Replacing equipment with lower ratings and built to current standards by transferring some load to other existing facilities;
4. Eliminating equipment by transferring all of the load to other existing facilities;

In addition, 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.

Accordingly, following major high voltage equipment has been identified as approaching its end of life over the next 10 years and assessed for right sizing opportunity.

a. Chenaux TS – Transformers Replacement

Chenaux Transformer Station (TS) supplies power from Chenaux Generating Station (GS) to Circuit X1P, supplying Dobbin TS and has tap connections to Mountain Chute GS and Mazinaw Distribution Station (DS) via two 230 kV disconnect switches T1-A and T2-A, owned by OPGI. Chenaux TS also supplies DESN T3/T4 that connect to 115 kV Circuits X2Y and X6, where T3 is 36/60/78 MVA in size, constructed in 1948 and T4 is 108/115 MVA in size, constructed in 1951, both of which steps down from 230 kV to 115 kV and have separate voltage regulators. The Chenaux TS auto transformers T3/T4 summer 10 day LTR is 174 MW for T3 and 187 MW for T4. T3 is 73 years old and T4 is 70 years old, both of which have reached their end of life. In addition, regulators TR3 and TR4, 115 kV oil circuit breakers 4X6 and 4X2Y, and protection and control equipment associated with transformers T3/T4 are also at the end of life and need to be replaced.

The scope of this project is to replace transformers T3 and T4, regulators TR3 and TR4, 115 kV oil circuit breakers 4X6 and 4X2Y, and associated protection and control assets with the current standard equipment. The transformers will be replaced with new 75/100/125 MVA, three-phase, 60Hz239/121/13.9 kV, oil-filled, forced-air cooling transformers equipped with an Under Load Tap Changer (ULTC). Moreover, the current LTR rating of the transformers is adequate to serve the forecasted load for the next 20 years and therefore this replacement will not have negative impacts on load serving. Currently, the work is in progress and the targeted in-service for this project is in year 2021.

The Study Team recommended to continue with these end of life asset replacement work as per the plan.

b. Circuit D6 – Line Refurbishment

Circuit D6 is a 98.2 km, 115 kV, single circuit, wood pole transmission line that provides connection between Des Joachims TS and Pembroke TS. Between Des Joachims TS and Pembroke TS, this circuit also provides connecting taps to distribution stations Craig DS, Deep River DS and Petawawa DS.

The 76.8 km line sections between Des Joachims TS and Petawawa/Craig DS contain multiple ACSR conductor segments that have been verified through testing to have reached end-of-life. As the other assets along this line are of original vintage and therefore beyond expected service life, this confirmed sustainment need has triggered the complete line refurbishment of transmission circuit D6 between Des Joachims TS and Petawawa/Craig DS. The 20.4 km section between Petawawa JCT and Pembroke TS was refurbished in 1999 and does not require sustainment at this time. Also, the 1 km section between Chalk River JCT and Chalk River CTS is being ignored at this time, because Chalk River CTS is presently located in a known flood zone and will be moved in the near future. Moving Chalk River CTS may result in decommissioning of line section Chalk River JCT X Chalk River CTS.

This project prescribes the complete line refurbishment of circuit D6 between Des Joachims TS and the two Petawawa distribution stations – Petawawa DS and Craig DS. The goal of this refurbishment project is to completely renew all end-of-life assets along circuit D6. As the majority of the circuit (76.6 km) is the old 4/0 conductors, the refurbishment project will replace it with the standard 411 kcmil conductors. This upgrade resulted in a line loss savings of about $8769 per year using 2020 HOEP. Moving to the next size up to a 477 kcmil would cost an additional $26,810 for the conductor cost alone plus additional cost associated for any tower reinforcement. This without tower reinforcement cost would only save an additional $964 per year in loss savings. The payback period would be over 27 years and therefore not justifiable to have an upgrade. Currently, the work is in progress and the targeted in-service for this project is in year 2022.

The Study Team recommended continuation of these end of life asset replacement as per the plan.

7.2 Station and Transmission Capacity Needs in the Renfrew Region

The following Station and Transmission supply capacities needs have been identified in the Renfrew region during the study period of 2020 to 2030.

7.2.1 230/115 kV Autotransformers

The 230/115 kV autotransformers (Chenaux TS and Des Joachim TS) supplying the Region are within the thermal limits of the circuits and within the voltage range as per Ontario Resource and Transmission Assessment Criteria (ORTAC) over the study period for the loss of a single 230/115 kV autotransformer in the Region.

7.2.2 230 kV Transmission Lines

The 230 kV circuits supplying the Region are within the thermal limits of the circuits and within the voltage range as per ORTAC over the study period for the loss of a single 230 kV circuit in the Region.

7.2.3 115kV Transmission Lines

The 115 kV circuits supplying the Region are within the thermal limits of the circuits and within the voltage range as per ORTAC over the study period adequate over the study period for the loss of a single 115 kV circuit in the Region.

7.2.4 230 kV and 115 kV Connection Facilities

A station capacity assessment was performed over the study period for the 230 kV and 115 kV TSs in the Region using either the summer or winter station peak load forecasts as appropriate that were provided by the study team.

a. Pembroke TS

The 2019 non-coincident summer peak load on Pembroke TS was 48 MW which is above its 10 day summer LTR of 47 MW. Based on the submitted load forecast, the Pembroke TS will be loaded more than 52 MW in the mid term.

Based on the above, the Study Team recommends that in the near term, Hydro One Transmission work with the Hydro One Distribution for load transfer options to nearby distribution stations to provide load relief at Pembroke TS.

Alternatively, a new distribution station can be build to relief the Pembroke TS overloading and serve the future load growth in the area. The work can be coordinated between Hydro One Transmission and Hydro One Distribution.

Non Wires Alternative (NWA) may be considered from the IESO to relief the constraint. This option will be assessed by the IESO as part of the Scoping Assessment stage of this Regional Planning cycle.

All the other TSs and HVDSs in the Region are forecasted to remain within their normal supply capacity during the study period and therefore, the capacity needs for these TSs and HVDSs will be reviewed in the next planning cycle.

7.2.5 Sensitivity Study for Transmission Facility Adequacy Assessment

The projected regional peak loads can be supplied under normal operations even if the local generations at Des Joachims GS and Chenaux GS are out of service. In the X6/X2Y corridor, loss of one circuit

(including breaker failure condition to cause additional loss of Chenaux generation) would not cause overload or under-voltage on the accompanying circuit. The area can be reliably supplied if the load forecast in 2030 was 10% greater than the base case used.

7.3 System Reliability, Operation and Restoration Review

No new significant system reliability and operating issues identified for this Region. Circuit X1P was monitored and during the last 5 years, it has not been an outlier and the performance was adequate to supply the load in the area. Based on the net coincident load forecast, the loss of one element will not result in load interruption greater than 150MW. The maximum load interrupted by configuration due to the loss of two elements is below the load loss limit of 600MW by the end of the 10-year study period.

Since the region is supplied through radial circuits and is prone to high number of weather related events, over 75% of the forced outages were recorded due to extreme weather events. Building additional lines on the same right-of-way will not help materially mitigate weather related outages in the area. In contrast, improved vegetation and effective outage response have reduced sustained outages duration significantly over the years. It is also expected that the completion of the D6 refurbishment project will improve the reliability by addressing the end of asset life related outages.

The most critical contingency in the Region would be loss of 230kV circuit X1P which would produce an island at Chenaux. Stable islanding operation might be achieved depending on pre-contingency flow and generation rejection arming.

When Chenaux GS is in-service and not able to sustain the island on a X1P contingency, the normally open HV switch, D6-X6, is closed at Pembroke TS to supply the loads connected to X6 and X2Y from Des Joachim TS. Studies show that under this scenario, the amount of load that can be radially supply from Des Joachims TS to Pembroke TS and Cobden TS will be highly dependent on the output of Chenaux GS. IESO had noted that on a 85% dependability criteria, Chenaux GS output is 55 MW or higher, which is adequate to support all the load in the area for the study period using the summer coincidental load forecast.

As full load transfers for restoration purposes are not considered as mandatory requirement. Restorations of load between Chenaux TS and Des Joachims TS via D6-X6 load transfers are performed to the extent possible and there are no plans to enhance this discretionary capability. No action is required at this time and this will be reviewed in the next planning cycle.

7.4 Other Planning Considerations in the Renfrew Region

In addition, community energy plans in the region have also been scanned and reviewed (Section 9 for references). Federal, Provincial and Municipal agencies are contemplating to reduce Green House Gas (GHG) emissions and to achieve carbon neutrality by no later than 2050 through renewable resources, energy efficiency and/or electrification of heating and transportation. At this time, there is insufficient data available for input into the load forecast for this Needs Assessment study however, the Study

Team should monitor the evolving climate action plans of federal, provincial and municipal agencies as they are expected to lead climate action in the coming years.

8 CONCLUSION AND RECOMMENDATIONS

In conclusion, no new needs were identified except Pembroke TS overloading concern as the current load forecast for the study period can be adequately supplied by the existing facilities.

The Study Team recommends the following -

a. Hydro One Distribution to undertake load transfer studies to alleviate Pembroke TS overloading concerns in the near term. Alternatively, Hydro One Distribution may also assess the option of building a new distribution transformer station to manage Pembroke TS overloading and to serve future load growth in the area.

b. Replacement of end of life asset with similar equipment does not require further regional coordination (see further details in Section 7.1). The implementation and execution plan for below EOL needs were / will coordinated by Hydro One with affected LDCs.

i. Chenaux T3/T4 Auto transformers and 115 kV switchyard refurbishment
ii. D6 - Des Joachims TS to Petawawa DS Line refurbishment

c. Continue to monitor the reliability performance of D6 and X1P. Should the performance of D6 and X1P fall below adequate levels (as shown by standard OGCC monitoring systems) the Hydro One will undertake to assess and address this issue with the LDCs.

d. Further regional planning coordination is required for Pembroke TS overloading capacity mitigation. A Scoping Assessment should be undertaken for the Renfrew region to determine the appropriate regional planning approach i.e. Integrated Regional Resource Planning (IRRP) and/or Regional Infrastructure Planning (RIP) to address needs identified in this Needs Assessment.

9 REFERENCES

[1] RIP Report – Renfrew Region – July 2016

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

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

[4] 2017 Long Term Energy Plan – Ontario Government

[5] Government of Canada – Excerpts from Greening Government Strategy Website (as of Nov 7, 2019)

APPENDIX A: EXTREME WEATHER ADJUSTED SUMMER / WINTER LOAD FORECAST

Table 2: Renfrew Region Summer Non-Coincident Load Forecast

Transformer Station		Summer 10 Day LTR (MW)	Type	Actual	Forecasted										
Name	DESN ID			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cobden DS	T3	11.3	Gross		7	8	8	8	8	8	8	8	8	8	8
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	7	7	8	8	8	8	8	8	8	8	8	8
Cobden TS	T1/T2	43	Gross		22	23	23	23	24	24	24	24	25	25	25
			DER		0	0	0	0	0	0	0	0	-1	-1	-1
			CDM		0	0	0	1	1	1	1	1	1	1	1
			Net	22	22	23	23	23	23	23	23	23	24	24	25
Craig DS	T1/T2	15.9	Gross		14	14	14	15	15	15	15	15	16	16	16
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	1	1	1	1	1	1	1
			Net	13	14	14	14	14	14	14	14	15	15	15	15
Deep River DS	T1/T2/T3	11.9	Gross		8	9	9	9	9	9	9	9	9	9	9
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	8	8	9	9	9	9	9	9	9	9	9	9
Des Joachims DS	T1	11.3	Gross		2	2	2	2	2	2	2	2	2	2	2
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	2	2	2	2	2	2	2	2	2	2	2	2

Forest Lea DS	T1/T2	10	Gross		10	10	10	10	10	11	11	11	11	11	11
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	1	1	1	1
			Net	10	10	10	10	10	10	10	10	10	10	10	10
Mazinaw DS	T1	5.4	Gross		4	4	4	4	4	4	4	4	4	4	4
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	4	4	4	4	4	4	4	4	4	4	4	4
Mountain Chute DS	T1	11.3	Gross		1	1	1	1	1	1	1	1	1	1	1
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	1	1	1	1	1	1	1	1	1	1	1	1
Pembroke TS	T1/T2	47	Gross		49	50	51	51	52	52	53	54	54	55	55
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	1	2	2	2	2	3	3	3	3
			Net	48	49	49	50	50	50	50	51	51	51	52	52
Petawawa DS	T1/T2	14.8	Gross		11	11	11	12	12	12	12	12	12	12	12
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	1	1	1	1	1	1
			Net	11	11	11	11	11	11	11	11	11	11	12	12
Chalk River CTS			Net	8	8	8	8	8	8	8	8	8	8	8	8
Magellan Aerospace CTS			Net	3	3	4	4	4	4	4	4	4	4	4	4

Table 3: Renfrew Region Winter Non-Coincident Load Forecast

Transformer Station		Winter 10 Day LTR (MW)	Type	Actual	Forecasted										
Name	DESN ID			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cobden DS	T3	11.3	Gross		6	6	6	6	6	6	6	7	7	7	7
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	6	6	6	6	6	6	6	6	6	6	6	6
Cobden TS	T1/T2	49.2	Gross		23	24	24	24	25	25	25	25	26	26	26
			DER		0	0	0	0	0	0	-1	-1	-1	-1	-1
			CDM		0	0	0	1	1	1	1	1	1	1	1
			Net	23	23	24	24	24	24	24	25	25	25	26	26
Craig DS	T1/T2	15.9	Gross		14	14	15	15	15	15	16	16	16	16	16
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	1	1	1	1	1
			Net	14	14	14	14	15	15	15	15	15	15	16	16
Deep River DS	T1/T2/T3	11.9	Gross		9	9	9	9	9	9	10	10	10	10	10
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	9	9	9	9	9	9	9	9	9	9	9	9
Des Joachims DS	T1	11.3	Gross		3	3	3	3	3	3	3	3	3	3	3
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	3	3	3	3	3	3	3	3	3	3	3	3
Forest Lea DS	T1/T2	10	Gross		8	8	8	9	9	9	9	9	9	9	9
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	8	8	8	8	8	8	8	8	8	9	9	9

Mazinaw DS	T1	5.4	Gross		3	3	3	3	3	3	3	3	3	3	3
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	3	3	3	3	3	3	3	3	3	3	3	3
Mountain Chute DS	T1	11.3	Gross		1	1	1	1	1	1	1	1	1	1	1
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	1	1	1	1	1	1	1	1	1	1	1	1
Pembroke TS	T1/T2	54	Gross		47	47	48	49	49	50	50	51	52	52	53
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	1	1	1	2	2	2	2	2	2
			Net	45	47	47	47	48	48	48	49	49	50	50	51
Petawawa DS	T1/T2	18.3	Gross		9	9	10	10	10	10	10	10	10	10	10
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	9	9	9	9	10	10	10	10	10	10	10	10
Chalk River CTS			Net	8	8	8	8	8	8	8	8	8	8	8	8
Magellan Aerospace CTS			Net	3	3	3	3	3	4	4	4	4	4	4	4

Table 4: Renfrew Region Summer Coincident Load Forecast

Transformer Station		Summer 10 Day LTR (MW)	Type	Actual	Forecasted										
Name	DESN ID			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cobden DS	T3	11.3	Gross		7	8	8	8	8	8	8	8	8	8	8
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	7	7	8	8	8	8	8	8	8	8	8	8
Cobden TS	T1/T2	43	Gross		22	22	22	23	23	23	23	24	24	24	24
			DER		0	0	0	0	0	0	0	0	-1	-1	-1
			CDM		0	0	0	1	1	1	1	1	1	1	1
			Net	21	22	22	22	22	22	22	22	22	23	23	24
Craig DS	T1/T2	15.9	Gross		14	14	14	14	15	15	15	15	15	16	16
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	1	1	1	1	1	1	1
			Net	13	13	14	14	14	14	14	14	15	15	15	15
Deep River DS	T1/T2/T3	11.9	Gross		8	9	9	9	9	9	9	9	9	9	9
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	8	8	9	9	9	9	9	9	9	9	9	9
Des Joachims DS	T1	11.3	Gross		2	2	2	2	2	2	2	2	2	2	2
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	2	2	2	2	2	2	2	2	2	2	2	2
Forest Lea DS	T1/T2	10	Gross		9	9	9	9	9	9	9	9	10	10	10
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	9	9	9	9	9	9	9	9	9	9	9	9

Mazinaw DS	T1	5.4	Gross		3	3	4	4	4	4	4	4	4	4	4
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	3	3	3	3	3	3	4	4	4	4	4	4
Mountain Chute DS	T1	11.3	Gross		1	1	1	1	1	1	1	1	1	1	1
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	1	1	1	1	1	1	1	1	1	1	1	1
Pembroke TS	T1/T2	47	Gross		43	44	44	45	46	46	47	47	48	48	49
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	1	1	2	2	2	2	2	2	2
			Net	42	43	43	44	44	44	44	44	45	45	46	46
Petawawa DS	T1/T2	14.8	Gross		7	8	8	8	8	8	8	8	8	8	8
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	7	7	8	8	8	8	8	8	8	8	8	8
Chalk River CTS			Net	7	7	7	7	7	7	7	7	7	7	7	7
Magellan Aerospace CTS			Net	2	2	2	2	2	2	2	2	2	2	2	2

Table 5: Renfrew Region Winter Coincident Load Forecast

Transformer Station		Winter 10 Day LTR (MW)	Type	Actual	Forecasted										
Name	DESN ID			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cobden DS	T3	11.3	Gross		6	6	6	6	6	6	6	6	6	6	6
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	5	5	6	6	6	6	6	6	6	6	6	6
Cobden TS	T1/T2	49.2	Gross		22	23	23	23	23	24	24	24	24	24	25
			DER		0	0	0	0	0	0	-1	-1	-1	-1	-1
			CDM		0	0	0	1	1	1	1	1	1	1	1
			Net	22	22	22	22	23	23	23	24	24	24	25	25
Craig DS	T1/T2	15.9	Gross		10	10	11	11	11	11	11	11	11	12	12
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	10	10	10	10	10	11	11	11	11	11	11	11
Deep River DS	T1/T2/T3	11.9	Gross		9	9	9	9	9	9	9	9	9	9	9
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	8	9	9	9	9	9	9	9	9	9	9	9
Des Joachims DS	T1	11.3	Gross		3	3	3	3	3	3	3	3	3	3	3
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	3	3	3	3	3	3	3	3	3	3	3	3
Forest Lea DS	T1/T2	10	Gross		8	8	8	8	8	8	8	8	8	8	9
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	8	8	8	8	8	8	8	8	8	8	8	8

Mazinaw DS	T1	5.4	Gross		2	2	2	2	3	3	3	3	3	3	3
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	2	2	2	2	2	2	2	2	2	3	3	3
Mountain Chute DS	T1	11.3	Gross		0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5
			DER		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			CDM		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Net	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5
Pembroke TS	T1/T2	54	Gross		46	47	48	49	49	50	50	51	51	52	52
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	1	1	1	2	2	2	2	2	2
			Net	45	46	47	47	47	48	48	48	49	49	50	50
Petawawa DS	T1/T2	18.3	Gross		6	6	6	6	6	6	6	6	6	6	6
			DER		0	0	0	0	0	0	0	0	0	0	0
			CDM		0	0	0	0	0	0	0	0	0	0	0
			Net	5	6	6	6	6	6	6	6	6	6	6	6
Chalk River CTS			Net	7	7	7	7	7	7	7	7	7	7	7	7
Magellan Aerospace CTS			Net	3	3	3	3	3	3	3	3	3	3	3	3

APPENDIX B: LISTS OF STEP-DOWN TRANSFORMER STATIONS

Sr. No.	Transformer Stations	Voltages (kV)
1.	Cobden DS (T3)	115/12.5
2.	Cobden TS (T1/T2)	115/44
3.	Craig DS (T1/T2)	115/12.5
4.	Deep River DS (T1/T2/T3)	115/12.5
5.	Des Joachims DS (T1)	115/12.5
6.	Forest Lea DS (T1/T2)	115/12.5
7.	Mazinaw DS (T1/T2)	230/12.5
8.	Mountain Chute DS (T1)	115/12.5
9.	Pembroke TS (T1/T2)	115/44
10.	Petawawa DS (T1/T2)	115/12.5

APPENDIX C: LISTS OF TRANSMISSION CIRCUITS

Sr. No.	Circuit ID	From Station	To Station	Voltage (kV)
1.	D6	Des Joachims DS	Pembroke TS	115
2.	X1P	Dobbin TS	Chenaux TS	230
3.	X2Y	Chenaux TS	Pembroke TS	115
4.	X6	Chenaux TS	Pembroke TS	115

APPENDIX D: LISTS OF LDCS IN THE RENFREW REGION

Sr. No.	Company	Connection Type (TX/DX)
2.	Ottawa River Power Corporation	DX
3.	Hydro One Distribution	TX

APPENDIX E: ACRONYMS

Acronym	Description
A	Ampere
BES	Bulk Electric System
BPS	Bulk Power System
CDM	Conservation and Demand Management
CIA	Customer Impact Assessment
CGS	Customer Generating Station
CSS	Customer Switching Station
CTS	Customer Transformer Station
DESN	Dual Element Spot Network
DER	Distributed Energy Resource
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
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