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Sudbury/Algoma Region

Regional Infrastructure Plan ("RIP")

June 10th, 2016

Greater Sudbury Hydro Inc.
Hydro One Networks Inc. (Distribution)

The Sudbury to Algoma Region includes Greater Sudbury Area, Manitoulin Island, and townships of Verner, Warren, Elliot Lake, Blind River and Walden.

The Needs Assessment ("NA") for the Sudbury/Algoma region was completed in March, 2015 (see attached) and the report recommends that no further coordinated regional planning is required to address needs in the Sudbury-Algoma Region.

To address local needs, local planning was undertaken by Hydro One Networks Inc. (Transmitter) and Hydro One Networks Inc. (Distribution) to address the "Manitoulin TS Low Voltage Regulation" need. A Local Planning ("LP") report was prepared and published by the Working Group for the Sudbury/Algoma region in September, 2015 (also attached).

The only major project planned for the Sudbury/Algoma Region over the near and mid-term is

- New 230/44kV station at Hanmer Ts to replace Coniston Ts (115/22kV). As part of this project, Coniston loads will be converted from 22kV to 44kV (2019). The approximate cost of this work is $25M. This is a pool funded investment.

Consistent with a process established by an industry working group[1] created by the OEB the Regional Infrastructure Plan ("RIP") is the last phase of the planning process. In view that no further regional coordination was required, the attached NA and LP reports will be deemed to form the ("RIP") for the Sudbury/Algoma Region.

The next planning cycle for the region will take place within five years of the start of this cycle (2013) or earlier, should there be a new need identified in the region.

Sincerely,

Ajay Garg | Manager, Regional Planning Co-ordination
Hydro One Networks

[1] Planning Process Working Group (PPWG) Report to the Ontario Energy Board available at www.ontarioenergyboard.ca

Hydro One Networks Inc.
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LOCAL PLANNING REPORT

Manitoulin TS Low Voltage Regulation
Region: Sudbury-Algoma

Revision: Final
Date: September 30, 2015

Prepared by: Hydro One Networks Inc (Transmission & Distribution)

Study Team	
Organization	Name
Hydro One Networks Inc. (Lead Transmitter)	Kirpal Bahra
Hydro One Networks Inc. (Distribution)	Richard Shannon

Disclaimer

This Local Planning Report was prepared for the purpose of developing wires-only options and recommending a preferred solution(s) to address the local needs identified in the Needs Assessment (NA) report for the Sudbury-Algoma Region that do not require further coordinated regional planning. The preferred solution(s) that have been identified through this Local Planning Report may be reevaluated based on the findings of further analysis. The load forecast and results reported in this Local Planning Report are based on the information and assumptions provided by study team participants.

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

LOCAL PLANNING EXECUTIVE SUMMARY

REGION	Sudbury to Algoma (the "Region")		
LEAD	Hydro One Networks Inc. ("Hydro One")		
START DATE	October 20, 2014	**END DATE**	September 30, 2015

1. INTRODUCTION

The purpose of this Local Planning (LP) report is to develop wires-only options and recommend a preferred solution that will address the local needs identified in the Needs Assessment (NA) report for the Sudbury-Algoma Region dated March 12, 2015. The development of the LP report is in accordance with the regional planning process as set out in the Ontario Energy Board's (OEB) Transmission System Code (TSC) and Distribution System Code (DSC) requirements and the "Planning Process Working Group (PPWG) Report to the Board".

Based on Section 6 of the NA report, the study team recommended that no further coordinated regional planning is required to address the needs in the Sudbury-Algoma region. These needs are local in nature and will be addressed by wires options through local planning led by Hydro One with participation of the impacted LDC.

2. LOCAL NEEDS ADDRESSED IN THIS REPORT

The Manitoulin TS Voltage Regulation is a local need addressed in this report.

3. OPTIONS CONSIDERED

Hydro One (Transmitter) and Hydro One Distribution (LDC) have considered addressing the above need with the following options;

Alternative 0 – Status Quo.
Alternative 1 - Install 44kV Capacitor Bank at Manitoulin TS
Alternative 2 - Install 115kV Capacitor Bank at Manitoulin TS

See Section 3 for further detail.

4. PREFERRED SOLUTION

The preferred solution at this time is Alternative 0 – Status Quo. See Section 4 for details.

5. NEXT STEPS

The next steps are summarized in section 5

TABLE OF CONTENTS

1 INTRODUCTION

The Needs Assessment (NA) for the Sudbury/Algoma ("Region") was triggered in response to the Ontario Energy Board's (OEB) Regional Infrastructure Planning process approved in August 2013. Prior to the new regional planning process coming into effect, planning activities were already underway in the Region to address some specific station capacity needs. The NA report can be found on Hydro One's Regional Planning website. The study team identified needs that are emerging in the Sudbury-Algoma Region over the next ten years (2014 to 2023) and recommended whether they should be further assessed through the transmitter-led Local Planning (LP) process or the IESO-led Scoping Assessment (SA) process.

1.1 Sudbury to Algoma Region Description and Connection Configuration

The Sudbury to Algoma Region includes Greater Sudbury Area, Manitoulin Island, and townships of Verner, Warren, Elliot Lake, Blind River and Walden. The boundaries of the Sudbury to Algoma Region are shown below in Figure 1.

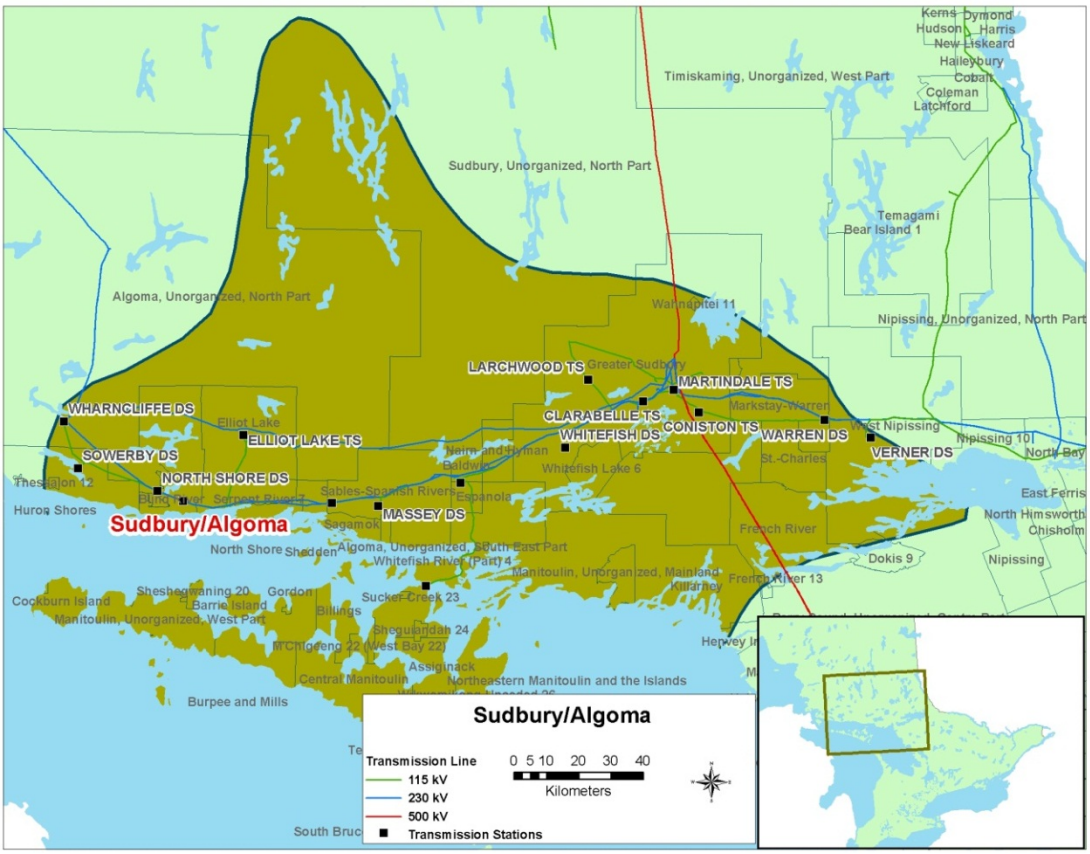

Figure 1: Sudbury to Algoma Region Map

Electrical supply for this region is provided through a network of 230kV and 115kV transmission circuits supplied by autotransformers at Hanmer TS, Algoma TS and Martindale TS. This area is further reinforced through the 500kV circuits (P502X and X504/503E) connecting Hanmer TS (Sudbury) to both Porcupine TS (Timmins) and Essa TS (Barrie). It is also connected to Northwest Ontario through Mississagi TS. Table 2 below lists the major transmission circuits and Hydro One stations in the subject region.

This region has the following two local distribution companies (LDC):

- Greater Sudbury Hydro Inc.
- Hydro One Networks Inc. (Distribution)

Espanola Regional Hydro Distribution is a third LDC in this region embedded into the Hydro One Distribution system. Although invited, this LDC opted not to participate in the Study Team. However, the interests of this LDC were communicated and considered through Hydro One Distribution as a host LDC.

Transmission connected loads in the Sudbury to Algoma region form a large percentage (approximately 50%) of the overall demand. Although these customers are not explicitly participating in the regional planning process, Hydro One considered their impact in this analysis.

115kV circuits	230kV circuits	Hydro One Transformer Stations
S6F,S5M	X74P, X27A	ALGOMA TS
S2B,B4B	A23P, A24P	MARTINDALE TS
T1B, B3E	X23N, S21N	HANMER TS
B4E, L1S	X25S, X26S	CONISTON TS
	S22A	CLARABELLE TS
		ELLIOT LAKE TS
		ESPANOLA TS
		LARCHWOOD TS
		MANITOULIN TS

Table 1: Transmission Lines and Stations in Sudbury to Algoma Region

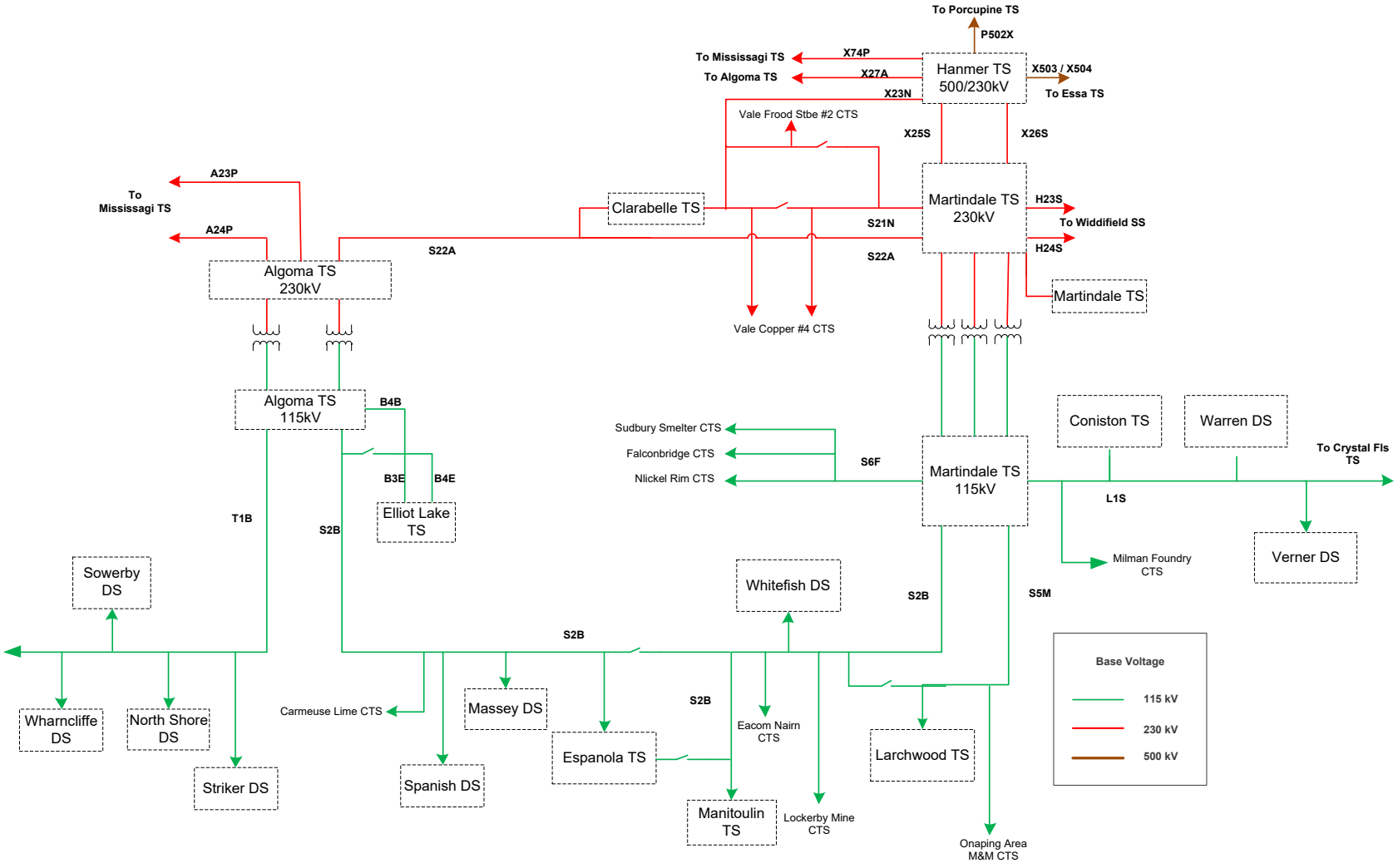

Figure 2: Single Line Diagram – Sudbury to Algoma Region

2 AREA NEEDS

2.1 Sudbury-Algoma Region Needs

As an outcome of the NA process, the study team did not identify any capacity needs based on LDCs load forecast. Only need identified was an issue with potential voltage regulation at Manitoulin TS in the Sudbury-Algoma Region to be addressed by a "localized" wires planning. Where local planning was recommended to address the needs, Hydro One, as transmitter, with the impacted LDC, further undertook planning assessments to address the need.

2.2 Needs Assessed by Hydro One led Local Planning

- Manitoulin TS Voltage Regulation – pre-contingency voltages at Manitoulin TS 115kV can at times fall below the ORTAC criteria of 113kV. Without McLean's mountain wind farm in service, and under peak load conditions, pre-contingency voltage at Manitoulin TS high voltage bus can be as low as 110kV when supplied from Algoma TS, and 112kV when supplied from Martindale TS.

3 ALTERNATIVES CONSIDERED

Hydro One transmission reviewed the above need and determined that the only LDC impacted by a low voltage at Manitoulin TS is Hydro One distribution which is directly supplied at the stations' 44kV bus. Following options were considered to address the needs identified in section 2 above.

Alternative 1 – Status Quo.

No further action is required at this time. Hydro One and LDC will monitor the load and voltages over the next three years. Further review will be undertaken in the next planning cycle or earlier if there is any evidence where load cannot be served or system cannot be operated in a safe, secure and reliable manner.

Alternative 2 – Install 44kV Capacitor Bank at Manitoulin TS

A 7MX low voltage capacitor bank can help improve high voltages regulation at Manitoulin TS. Manitoulin TS has a non-standard low voltage switch yard arrangement whereby each of the two feeders is supplied from a dedicated bus and associated transformer. There is currently no tie breaker between the two 44kV buses and thus, two 5.4MX capacitor banks will be required (for each of the busses). See figure 3.

Alternative 3 – Install 115kV Capacitor Bank at Manitoulin TS

A high voltage capacitor bank would also regulate the high voltage bus at Manitoulin TS. This alternative would require two high voltage breakers, and a motorized disconnect switch. See figure 4. Further investigation into this alternative indicated that 96MX capacitor bank is the smallest size available at this voltage. This large capacitor size would cause large voltage changes during switching and would violate operational criteria. Although this aspect would rule out this alternative it is shown illustration purposes in Table 3.

Table 3 below provides a budgetary cost summary of a cost of all options.

Options Considered	Cost
Alternative 1 – Hydro One to assess voltage performance of 115kV and 44kV bus with no immediate investment.	--
Alternative 2 – Install 44kV Capacitor Bank at Manitoulin TS	$4M
Alternative 3 – Install 115kV Capacitor Bank at Manitoulin TS	$6M

Table 2 – Budgetary Cost for Alternatives

4 PREFERRED SOLUTION AND REASONING

Hydro One Networks and the LDC have reviewed all alternatives and the preferred solution at this time is, Alternative 1 – Status Quo.

The study team acknowledges that the Manitoulin TS HV bus may experience voltages below ORTAC requirements only during limited operating scenarios. These scenarios are infrequent and the impacts of a low voltage at this point does not affect system stability or result in low voltages issues beyond the Manitoulin TS and Hydro One Distribution (LDC)

Manitoulin TS power transformers (T3/T4) are presently equipped with under load tap changers which have the ability to maintain 44kV bus voltages for wide array of voltage variations on the 115kV bus. ULTC ratings for both T3 and T4 are 44kV +/- 20% on 115.5kV at 42MVA load. These ratings are sufficient to maintain a customer delivery point performance within the rules of the Transmission System Code. The 44kV bus voltage will be maintained within 1.06 and 0.98pu for a 110kV (or lower) voltage.

Manitoulin TS voltage is constantly monitored by Hydro One's Ontario Grid Control Centre (OGCC) . OGCC's records will be reviewed regularly to ascertain the system conditions during peak load and its ability to operate the system and supply load to Manitoulin TS at acceptable voltage.

Voltage history will be reviewed with the LDC to determine if 44kV supply voltage remains within acceptable range for all distributed connected customers. The next planning cycle will take place within five years and an investment can be triggered at any time should there be a situation where load cannot be served or system cannot be operated safely and reliably.

5 NEXT STEPS

A summary of the next steps, actions/solutions and timelines required to address the local needs are as follows:

Need	Action / Recommended Solution	Lead Responsibility	Timeframe
Low Voltage at Manitoulin 115kV bus	• Status Quo –standard five year cycle	Hydro One Networks	Maximum five years

Table 3: Solutions and Timeframe

6 DIAGRAMS

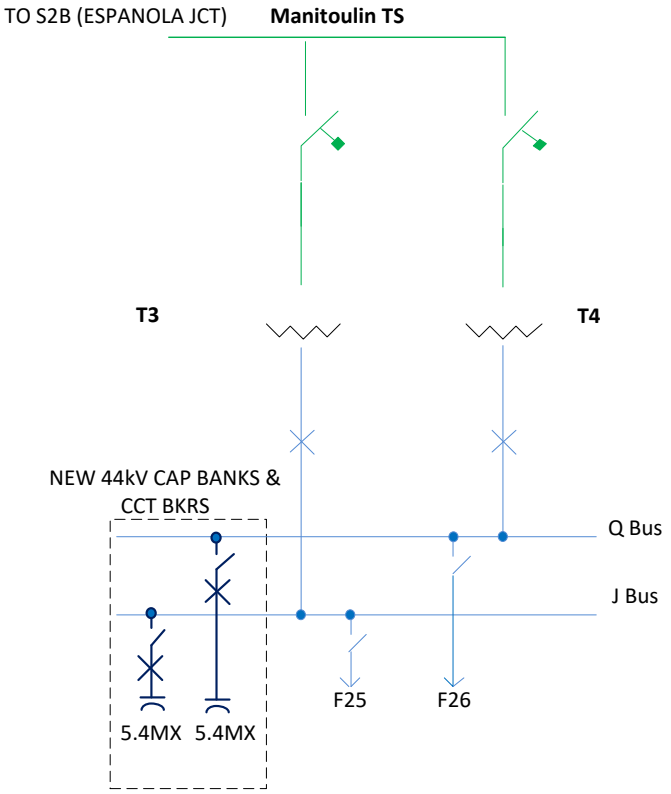

Figure 3 – New 44kV Capacitor Banks

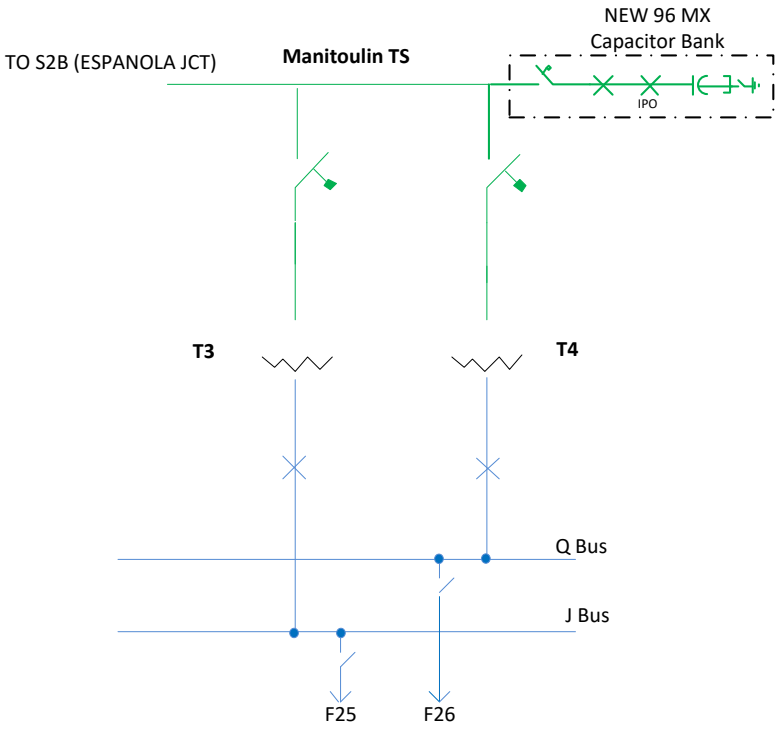

Figure 4 – 115kV Cap bank

7 REFERENCES

[1] Planning Process Working Group (PPWG) Report to the Board: The Process for Regional Infrastructure Planning in Ontario – May 17, 2013

[2] IESO Ontario Resource and Transmission Assessment Criteria (ORTAC)

[3] Sudbury-Algoma Needs Assessment Report

8 ACRONYMS

BES	Bulk Electric System
BPS	Bulk Power System
CDM	Conservation and Demand Management
CIA	Customer Impact Assessment
CGS	Customer Generating Station
CTS	Customer Transformer Station
DESN	Dual Element Spot Network
DG	Distributed Generation
DSC	Distribution System Code
GS	Generating Station
GTA	Greater Toronto Area
IESO	Independent Electricity System Operator
IRRP	Integrated Regional Resource Planning
kV	Kilovolt
LDC	Local Distribution Company
LP	Local Planning
LTE	Long Term Emergency
LTR	Limited Time Rating
LV	Low-voltage
MW	Megawatt
MVA	Mega Volt-Ampere
NA	Needs Assessment
NERC	North American Electric Reliability Corporation
NGS	Nuclear Generating Station
NPCC	Northeast Power Coordinating Council Inc.
OEB	Ontario Energy Board
OPA	Ontario Power Authority
ORTAC	Ontario Resource and Transmission Assessment Criteria
PF	Power Factor
PPWG	Planning Process Working Group
RIP	Regional Infrastructure Planning
SIA	System Impact Assessment
SS	Switching Station
TS	Transformer Station
TSC	Transmission System Code
ULTC	Under Load Tap Changer

APPENDIX A – LOAD FORECAST FOR SUDBURY-ALGOMA STATIONS

Station Name	DESN ID	Customer Data (MW)	Historical Data (MW)			Near Term Forecast (MW)					Medium Term Forecast (MW)				
			2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Clarabelle TS	T1/T2	Gross Peak Load				106.7	105.8	104.9	103.9	103.0	102.1	101.3	100.4	99.5	98.6
		Net Load Forecast	87.4	78.7	114.3										
Coniston TS	T2/T3	Gross Peak Load				3.6	3.6	3.6	3.6	3.7	3.7	3.7	3.8	3.8	3.8
		Net Load Forecast	9.0	10.8	7.1										
Elliot Lake TS	T1/T2/T3	Gross Peak Load				20.3	20.4	20.6	20.7	20.7	20.9	21.1	21.2	21.3	21.4
		Net Load Forecast	43.2	39.3	40.3										
Espanola TS	T1/T2/T3	Gross Peak Load				13.9	14.0	14.0	14.1	14.2	14.3	14.5	14.5	14.6	14.6
		Net Load Forecast	26.7	24.0	26.4										
Larchwood TS	T2	Gross Peak Load				13.2	13.3	13.4	13.5	13.6	13.8	13.9	14.0	14.1	14.2
		Net Load Forecast	25.2	27.1	26.2										
Manitoulin TS	T3/T4	Gross Peak Load				37.8	38.2	38.5	38.8	39.0	39.5	40.0	40.3	40.5	40.8
		Net Load Forecast	73.5	63.5	71.0										
Martindale TS	T25/T26	Gross Peak Load				149.5	151.5	152.3	153.0	153.6	154.5	155.3	155.9	156.5	157.9
		Net Load Forecast	97.7	88.3	95.0										
Massey DS	T1	Gross Peak Load				7.5	7.6	7.6	7.7	7.7	7.8	7.9	8.0	8.0	8.1
		Net Load Forecast	11.7	10.7	14.9										
North Shore DS	T1	Gross Peak Load				5.9	6.0	6.1	6.1	6.2	6.3	6.5	6.5	6.6	6.7
		Net Load Forecast	11.3	11.5	11.5										

LOAD FORECAST FOR SUDBURY-ALGOMA REGION (CONTINUED)

Station Name	DESN ID	Customer Data (MW)	Historical Data (MW)			Near Term Forecast (MW)					Medium Term Forecast (MW)				
			2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Sowerby DS	T1	Gross Peak Load				4.7	4.7	4.8	4.8	4.8	4.8	4.9	4.9	4.9	5.0
		Net Load Forecast	10.3	9.7	9.3										
Spanish DS	T1	Gross Peak Load				4.0	4.1	4.1	4.2	4.3	4.3	4.4	4.5	4.6	4.6
		Net Load Forecast	7.7	6.7	7.9										
Striker DS	T1/T2	Gross Peak Load				10.0	10.1	10.3	10.4	10.5	10.7	10.8	11.0	11.1	11.2
		Net Load Forecast	16.8	14.0	19.6										
Verner DS	T1/T2	Gross Peak Load				6.3	6.4	6.4	6.5	6.5	6.6	6.7	6.7	6.8	6.8
		Net Load Forecast	12.1	10.8	12.5										
Warren DS	T1/T2	Gross Peak Load				8.0	8.1	8.1	8.2	8.2	8.3	8.4	8.5	8.5	8.6
		Net Load Forecast	14.6	13.0	15.5										
Wharncliffe DS	T1/T2	Gross Peak Load				5.3	5.3	5.3	5.4	5.4	5.4	5.5	5.5	5.5	5.6
		Net Load Forecast	9.9	9.1	10.5										
Whitefish DS	T1	Gross Peak Load				6.6	6.7	6.7	6.8	6.8	6.9	7.0	7.0	7.1	7.1
		Net Load Forecast	13.8	12.1	13.1										

1. CDM & DG Not included in this table.
2. Sudbury-Algoma region is winter peaking

DG & CDM Forecast for Sudbury-Algoma Stations

Station Name	DESN ID	BUS ID	Customer Data	Existing	Near Term Forecast					Medium Term Forecast				
				2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Clarabelle TS	T1/T2	M1/M3/M7	DG (MW)	5.93	6.19	6.20	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21
			CDM	-	-	-	-	-	-	-	-	-	-	-
Coniston TS	T2/T3	M1	DG (MW)	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
			CDM	-	-	-	-	-	-	-	-	-	-	-
Elliot Lake TS	T1/T2/T3	M1/M2/M3	DG (MW)	-	0	0	0	0	0	8.46	8.46	8.46	8.46	8.46
			CDM	-	-	-	-	-	-	-	-	-	-	-
Espanola TS	T1/T2/T3	M1	DG (MW)	-	-	-	-	-	-	2.54	2.54	2.54	2.54	2.54
			CDM	-	-	-	-	-	-	-	-	-	-	-
Larchwood TS	T2	M3/M4	DG (MW)	-	-	-	-	-	-	6.28	6.28	6.28	6.28	6.28
			CDM	-	-	-	-	-	-	-	-	-	-	-
Manitoulin TS	T3/T4	M25/M26	DG (MW)	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88
			CDM	-	-	-	-	-	-	-	-	-	-	-
Martindale TS	T25/T26	M5/M6/M7	DG (MW)	5.98	5.98	6.40	6.40	6.40	6.40	8.49	8.49	8.49	8.49	8.49
			CDM	-	-	-	-	-	-	-	-	-	-	-
Massey DS	T1	F1/F3	DG (MW)		-	-	-	-	-					
			CDM	-	-	-	-	-	-	-	-	-	-	-
North Shore DS	T1	F1/F2	DG (MW)	1.71	1.71	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94
			CDM	-	-	-	-	-	-	-	-	-	-	-

DG & CDM Forecast for Sudbury-Algoma Stations (Continued)

Station Name	DESN ID	BUS ID	Customer Data	Existing	Near Term Forecast					Medium Term Forecast				
				2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Sowerby DS	T1	F1/F2	DG (MW)	-	-	-	-	-	-	-	-	-	-	-
			CDM	-	-	-	-	-	-	-	-	-	-	-
Spanish DS	T1	F1/F2	DG (MW)	-	-	-	-	-	-	0.78	0.78	0.78	0.78	0.78
			CDM	-	-	-	-	-	-	-	-	-	-	-
Striker DS	T1/T2	F1/F2	DG (MW)	0.01	0.01	0.01	0.01	0.01	0.08	0.08	0.08	0.08	0.08	0.08
			CDM	-	-	-	-	-	-	-	-	-	-	-
Verner DS	T1/T2	F1/F2/F3	DG (MW)											
			CDM	-	-	-	0	0	0	0	0	0	0	0
Warren DS	T1/T2	F1/F2/F3/F4	DG (MW)	-	-	-	0	0	0.02	0.02	0.02	0.02	0.02	0.02
			CDM	-	-	-	-	-	-	-	-	-	-	-
Wharncliffe DS	T1/T2	F1/F2	DG (MW)	-	-	-	-	-	-	-	0.47	0.47	0.47	0.47
			CDM	-	-	-	-	-	-	-	-	-	-	-
Whitefish DS	T1	F1/F2/F3	DG (MW)	-	-	-	-	0.02	0.02	0.02	0.02	0.02	0.02	0.02
			CDM	-	-	-	-	-	-	-	-	-	-	-

1. DG value (MW) is cumulative
2. DG MW Value is for winter peak
3. '-' indicates CDM or DG value not available

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NEEDS ASSESSMENT REPORT

Region: Sudbury Algoma

Date: March 12, 2015

Prepared by: Sudbury - Algoma Region Study Team

Sudbury to Algoma Region Study Team	
Organization	**Name**
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Greater Sudbury Hydro	Brian McMillan
Hydro One Networks Inc. (Distribution)	Richard Shannon

Disclaimer

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

NEEDS ASSESSMENT EXECUTIVE SUMMARY

REGION	Sudbury to Algoma (the "Region")		
LEAD	Hydro One Networks Inc. ("Hydro One")		
START DATE	October 20, 2014	**END DATE**	March 20, 2015

1. INTRODUCTION

The purpose of this Needs Assessment (NA) report is to undertake an assessment of the Sudbury to Algoma Region and determine if there are regional needs that require coordinated regional planning. Where regional coordination is not required, and a "localized" wires solution is necessary, such needs will be addressed between relevant Local Distribution Companies (LDCs) and Hydro One and other parties as required.

For needs that require further regional planning and coordination, IESO will initiate the Scoping Assessment (SA) process to determine whether an IESO-led Integrated Regional Resource Planning (IRRP) process, or the transmitter-led Regional Infrastructure Plan (RIP) process (wires solution), or whether both are required.

2. REGIONAL ISSUE / TRIGGER

The NA for the Sudbury Algoma Region was triggered in response to the Ontario Energy Board's (OEB) Regional Infrastructure Planning process approved in August 2013. To prioritize and manage the regional planning process, Ontario's 21 regions were assigned to one of three groups. The NA for Group 1 Regions is complete and has been initiated for Group 2 Regions. The Sudbury Algoma Region belongs to Group 2. The NA for this Region was triggered on October 20, 2014 and was completed on March 20, 2015.

3. SCOPE OF NEEDS ASSESSMENT

The scope of the NA study was limited to the next 10 years as per the recommendations of the Planning Process Working Group (PPWG) Report to the Board. As such, relevant data and information was collected up to the year 2023. Needs emerging over the next 10 years and requiring coordinated regional planning may be further assessed as part of the IESO-led SA, which will determine the appropriate regional planning approach: IRRP, RIP, and/or local planning. This NA included a study of transmission system connection facilities capability, which covers station loading, thermal and voltage analysis as well as a review of system reliability, operational issues such as load restoration, and assets approaching end-of-useful-life.

4. INPUTS/DATA

Study team participants, including representatives from LDCs, the Independent Electricity System Operator (IESO), and Hydro One transmission provided information for the Sudbury Algoma Region. The information included: historical load, load forecast, conservation and demand management (CDM) and distributed generation (DG) information, load restoration data, and performance information including major equipment approaching end-of-useful life.

5. NEEDS ASSESSMENT METHODOLOGY

The assessment's primary objective was to identify the electrical infrastructure needs and system performance issues in the Region over the study period (2014 to 2023). The assessment reviewed available information and load forecasts and included single contingency analysis to confirm needs, if and when required. See Section 5 for further details.

6. RESULTS

Transmission Needs

A. 230/115 kV Autotransformers

- The 230/115 kV autotransformers (Algoma TS, Martindale TS, Hanmer TS) supplying the Region are adequate over the study period for the loss of a single 230/115 kV autotransformer in the Region.

B. 230 kV Transmission Lines

- The 230 kV circuits supplying the Region are adequate over the study period for the loss of a single 230 kV circuit in the Region.

C. 115kV Transmission Lines

- The 115 kV circuits supplying the Region are adequate over the study period for the loss of a single 115 kV circuit in the Region.
-

D. 230 kV and 115 kV Connection Facilities

- The 230k and 115kV connection facilities in this region are adequate over the study period.

E. Pre-contingency voltages at Manitoulin TS

- Under peak load conditions, pre-contingency voltages at Manitoulin TS 115kV bus can be below 113 kV.

System Reliability, Operation and Restoration Review

Based on the gross 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. For the loss of one or two elements, the load interrupted by configuration does not exceed 150 MW or 250 MW. In addition,

- As identified by the IESO, under peak load conditions, the loss of two Martindale TS 230/115kV transformers may result in the overload of the third Martindale transformer.
- As identified by the IESO, With either X25S or X26S is out of service, the loss of the companion circuit may result in voltage declines at Martindale 230kV and 115kV buses below acceptable ORTAC limits.

The above issues will be further assessed as part of bulk system planning outside of the regional planning process.

Aging Infrastructure / Replacement Plan

Replacement of the autotransformers at Martindale is currently in Hydro One's 5yr sustainment business plan. As part of this replacement, T21/T23 autotransformer replacement at Martindale TS may result in higher emergency ratings.

7. RECOMMENDATIONS

Based on the findings of the Needs Assessment, the study team recommends that no further regional coordination is required and following needs identified in Section 6 be further assessed as part of Local Planning:

Manitoulin TS Voltage Regulation

- Low pre-contingency voltages at Manitoulin TS 115kV bus.

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1 INTRODUCTION

This Needs Assessment (NA) report provides a summary of needs that are emerging in the Sudbury to Algoma Region ("Region") over the next ten years. The development of the NA report is in accordance with the regional planning process as set out in the Ontario Energy Board's (OEB) Transmission System Code (TSC) and Distribution System Code (DSC) requirements and the "Planning Process Working Group (PPWG) Report to the Board".

The purpose of this NA is to undertake an assessment of the Sudbury to Algoma Region to identify any near term and/or emerging needs in the area and determine if these needs require a "localized" wires only solution(s) in the near-term and/or a coordinated regional planning assessment. Where a local wires only solution is necessary to address the needs, Hydro One, as transmitter, with Local Distribution Companies (LDC) or other connecting customer(s), will further undertake planning assessments to develop options and recommend a solution(s). For needs that require further regional planning and coordination, the Independent Electricity System Operator (IESO) will initiate the Scoping Assessment (SA) process to determine whether an IESO-led Integrated Regional Resource Planning (IRRP) process, or the transmitter-led Regional Infrastructure Plan (RIP) process (wires solution), or both are required. If localized wires only solutions do not require further coordinated regional planning, the SA may also recommend that local planning between the transmitter and affected LDCs be undertaken to address certain needs.

This report was prepared by the Sudbury to Algoma Region NA study team (Table 1) and led by the transmitter, Hydro One Networks Inc. The report captures the results of the assessment based on information provided by LDCs, and the Independent Electricity System Operator (IESO).

Table 1: Study Team Participants for Sudbury to Algoma Region

No.	Company
1.	Hydro One Networks Inc. (Lead Transmitter)
2.	Independent Electricity System Operator
3.	Greater Sudbury Hydro Inc ("Sudbury Hydro")
4.	Hydro One Networks Inc. (Distribution)

2 REGIONAL ISSUE / TRIGGER

The NA for the Sudbury to Algoma Region was triggered in response to the OEB's Regional Infrastructure Planning process approved in August 2013. To prioritize and manage the regional planning process, Ontario's 21 regions were assigned to one of three groups. The NA for Group 1 Regions is complete and has been initiated for Group 2 Regions. The Sudbury to Algoma Region belongs to Group 2. The NA for this Region was triggered on October 20, 2014 and was completed on March 20, 2015

3 SCOPE OF NEEDS ASSESSMENT

This NA covers the Sudbury to Algoma Region over an assessment period of 2014 to 2023. The scope of the NA includes a review of transmission system connection facility capability which covers transformer station capacity, thermal capacity, and voltage performance. System reliability, operational issues such as load restoration, and asset replacement plans were also briefly reviewed as part of this NA.

3.1 Sudbury to Algoma Region Description and Connection Configuration

The Sudbury to Algoma Region includes Greater Sudbury Area, Manitoulin Island, and townships of Verner, Warren, Elliot Lake, Blind River and Walden. The boundaries of the Sudbury to Algoma Region are shown below in Figure 1.

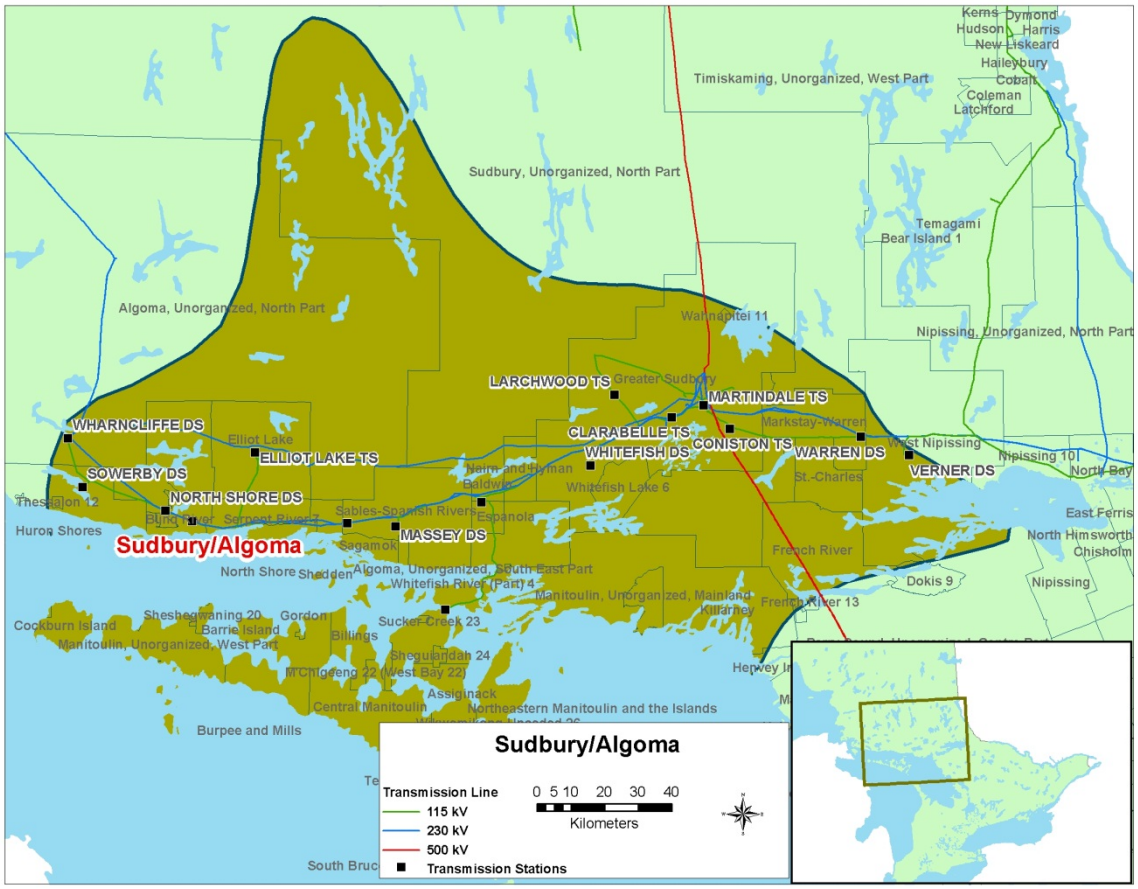

Figure 1: Sudbury to Algoma Region Map

Electrical supply for this region is provided through a network of 230kV and 115kV transmission circuits supplied by autotransformers at Hanmer TS, Algoma TS and Martindale TS. This area is further reinforced through the 500kV circuits (P502X and X504/503E) connecting Hanmer TS (Sudbury) to both Porcupine TS (Timmins) and Essa TS (Barrie). It is also connected to Northwest Ontario through Mississagi TS. Table 2 below lists the major transmission circuits and Hydro One stations in the subject region.

This region has the following two local distribution companies (LDC):

- Greater Sudbury Hydro Inc.
- Hydro One Networks Inc. (Distribution)

Espanola Regional Hydro Distribution is a third LDC in this region embedded into the Hydro One Disribution system. Although invited to participate in the Study Team, the interests of this LDC was communicated through Hydro One Distribution.

Tranmission connected loads in the Sudbury to Algoma region form a large percentage (approximately 50%) of the overall demand. Although these customers are not explicitly participating in the regional planning process, Hydro One will consider their impact in the NA of this region.

115kV circuits	230kV circuits	Hydro One Transformer Stations
S6F,S5M	X74P, X27A	ALGOMA TS
S2B,B4B	A23P, A24P	MARTINDALE TS
T1B, B3E	X23N, S21N	HANMER TS
B4E, L1S	X25S, X26S	CONISTON TS
	S22A	CLARABELLE TS
		ELLIOT LAKE TS
		ESPANOLA TS
		LARCHWOOD TS
		MANITOULIN TS

Table 2: Transmission Lines and Stations in Sudbury to Algoma Region

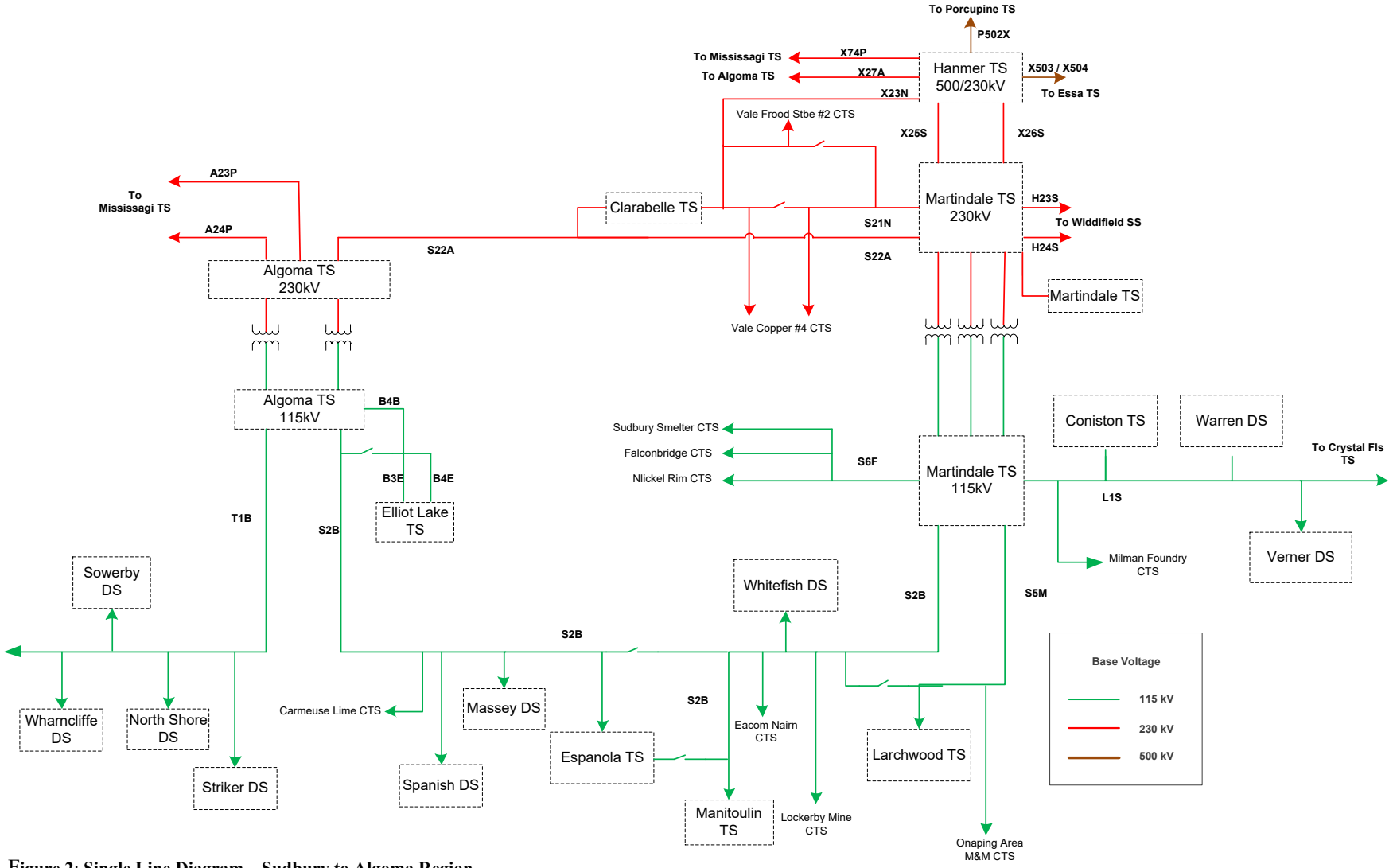

Figure 2: Single Line Diagram – Sudbury to Algoma Region

4 INPUTS AND DATA

In order to conduct this Needs Assessment, study team participants provided the following information and data to Hydro One:

- IESO provided:
  i. Historical 2013 regional coincident peak load and station non-coincident peak load
  ii. List of existing reliability and operational issues
  iii. Conservation and Demand Management (CDM) and Distributed Generation (DG) data
- LDCs provided historical (2011-2013) net load and gross load forecast (2014-2023)
- Hydro One (Transmission) provided transformer, station, and circuit ratings
- Any relevant planning information, including planned transmission and distribution investments provided by the transmitter and LDCs, etc.

4.1 Load Forecast

As per the data provided by the study team, the gross load in region is expected to grow at an average rate of approximately 0.3% annually from 2014-2023.

The net load forecast takes the gross load forecast and applies the planned CDM targets and DG contributions. The net load is expected to decrease at an average rate of approximately 0.2% annually from 2014-2023.

5 NEEDS ASSESSMENT METHODOLOGY

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

1. The Region is winter peaking so this assessment is based on winter peak loads.
2. Forecast loads are provided by the Region's LDCs (Greater Sudbury Hydro Inc, Hydro One Distribution).
3. Load data was provided by industrial customers in the region. Where data was not provided, the load was assumed to be consistent with historical loads.
4. The LDC's load forecast is translated into load growth rates and is applied onto the 2013 winter peak load as a reference point.
5. The 2013 winter peak loads are adjusted for extreme weather conditions according to Hydro One's methodology.

6. Accounting for (2), (3), (4) above, the gross load forecast and a net load forecast were developed. The gross load forecast is used to develop a worst case scenario to identify needs. Where there are issues, the net load forecast which accounts for CDM and DG is analyzed to determine if needs can be deferred. A gross and net non-coincident peak load forecast was used to perform the analysis for Section 6.1.3 of this report.
   A gross and net region-coincident peak load forecast was used to perform the analysis for sections 6.1.1 and 6.1.2.
   Review impact of any on-going and/or planned development projects in the Region during the study period.
7. Review and assess impact of any critical/major elements planned/identified to be replaced at the end of their useful life such as autotransformers, cables, and stations.
8. 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 or the historical low voltage power factor, whichever is more conservative. For stations having low-voltage capacitor banks, a 95% lagging power factor was assumed or the historical low-voltage power factor, whichever is more conservative. Normal planning supply capacity for transformer stations in this Region is determined by the summer or winter 10-Day Limited Time Rating (LTR), as appropriate.
9. To identify emerging needs 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.
10. Transmission adequacy assessment is primarily based on, but is not limited to, 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.
    - With one element out of service, the system is to be capable of supplying forecast demand with circuit loading within their winter long-term emergency (LTE) ratings. Thermal limits for transformers are acceptable using winter loading with winter 10-day LTR.
    - All voltages must be within pre and post contingency ranges as per Ontario Resource and Transmission Assessment Criteria (ORTAC) criteria.
    - 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 limits as per ORTAC criteria.

6 RESULTS

This section summarizes the results of the Needs Assessment in the Sudbury to Algoma Region.

6.1 Transmission Capacity Needs

6.1.1 230/115 kV Autotransformers

The 230/115 kV autotransformers (Algoma TS, Martindale TS, Hanmer TS) supplying the Region are adequate over the study period for the loss of a single 230/115 kV autotransformer in the Region.

6.1.2 Transmission Lines & Ratings

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

The 115 kV circuits supplying the Region are adequate over the study period.

6.1.3 230 kV and 115 kV Connection Facilities

A station capacity assessment was performed over the study period for the 230 kV and 115 kV transformer stations in the Region using the station winter peak load forecast provided by the study team. All stations in the area have adequate supply capacity for the study period (2014-2023).

6.1.4 Pre-contingency voltages at Manitoulin TS 115kV

Pre-contingency voltages at Manitoulin TS 115kV bus can be below the ORTAC criteria of 113 kV. This issue has been also identified by the IESO as part of their System Impact Assessments.

6.2 System Reliability, Operation and Restoration

Based on the gross 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. For the loss of one or two elements, the load interrupted by configuration does not exceed 150 MW or 250 MW. Review of the power network in the area indicates that all loads in the Sudbury-Algoma area can be restored within the 8 hour requirement.

6.2.1 Post contingency voltage declines at Martindale TS

With either X25S or X26S is out of service, the loss of the companion circuit may result in voltage declines at Martindale 230kV and 115kV buses below acceptable ORTAC limits. This issue has been presented in the IESO System Impact Assessment Victoria

Advanced Exploration Project (CAA 2013-512). In this assessment, voltage declines at the Martindale 230kV and 115 kV buses were found to be greater than the 10% limit.

6.2.2 Post Contingency Thermal Overload of Martindale Autotransformers

Under peak load conditions, the loss of two Martindale 230/115kV transformers may result in the overload of the third Martindale transformer. This issue has been presented in the IESO System Impact Assessment Process Gas (CAA 2012-488).

The double element contingency presented here occurs on the premise that all 115kV area loads would be supplied from one remaining autotransformer at Martindale TS. The worst case would be with Martindale T23 transformer remaining as it has the lowest STE (Short Term Emergency) rating.

Replacement of the autotransformers is listed in Hydro Ones 5yr sustainment business plan. T21/T23 autotransformers at Martindale TS may result in higher emergency ratings. In addition, loads connected to S2B (from Martindale) can also be transferred to S2B from Algoma, reducing Martindale 115kV load.

The above issues (6.2.1, 6.2.2) will be further assessed as part of bulk system planning outside of the regional planning process.

6.3 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 cables. During the study period:

- Replace T21/T23 230/115kV autotransformers at Martindale TS
- Build a new 230/44kV station at Hanmer TS to replace Coniston TS (115/22kV). As part of this project, Coniston loads will be converted from 22kV to 44kV
- Replace 115/44kV power transformers at Espanola TS (T1/T2) and Larchwood TS (T2)

7 RECOMMENDATIONS

Based on the findings and discussion in Section 6 of the Needs Assessment report, the study team recommends that no further coordinated regional planning is required. It is further recommended that following needs identified be best addressed by wires options thru local planning led by Hydro One:

Manitoulin TS - Pre-contingency voltages

- Low pre-contingency voltages at 115kV Manitoulin TS.

8 NEXT STEPS

Following the Needs Assessment process, the next regional planning steps, based on the evaluation conducted by this assessment is for Hydro One Transmission and impacted LDCs to carry out the local planning studies identified in Section 7

9 REFERENCES

i) Planning Process Working Group (PPWG) Report to the Board: The Process for Regional Infrastructure Planning in Ontario – May 17, 2013
ii) IESO 18-Month Outlook: March 2014 – August 2015
iii) IESO Ontario Resource and Transmission Assessment Criteria (ORTAC) – Issue 5.0

10 ACRONYMS

BES	Bulk Electric System
BPS	Bulk Power System
CDM	Conservation and Demand Management
CIA	Customer Impact Assessment
CGS	Customer Generating Station
CTS	Customer Transformer Station
DESN	Dual Element Spot Network
DG	Distributed Generation
DSC	Distribution System Code
GS	Generating Station
HVDS	High Voltage Distribution Station
IESO	Independent Electricity System Operator
IRRP	Integrated Regional Resource Planning
kV	Kilovolt
LDC	Local Distribution Company
LTE	Long Term Emergency
LTR	Limited Time Rating
LV	Low-voltage
MW	Megawatt
MVA	Mega Volt-Ampere
NERC	North American Electric Reliability Corporation
NGS	Nuclear Generating Station
NPCC	Northeast Power Coordinating Council Inc.
NA	Needs Assessment
OEB	Ontario Energy Board
ORTAC	Ontario Resource and Transmission Assessment Criteria
PF	Power Factor
PPWG	Planning Process Working Group
RIP	Regional Infrastructure Planning
SIA	System Impact Assessment
SS	Switching Station
TS	Transformer Station
TSC	Transmission System Code
ULTC	Under Load Tap Changer