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NEEDS ASSESSMENT REPORT

Region: Greater Bruce – Huron

Revision: Final

Date: May 6, 2016

Prepared by: Greater Bruce-Huron Study Team

Distribution

Transmission

Greater Bruce-Huron Region Study Team Organization
Entegrus
Erie Thames Power
Festival Hydro Inc.
Goderich Hydro - West Coast Huron Energy Inc.
Hydro One Networks Inc. (Distribution)
Hydro One Networks Inc. (Lead Transmitter)
Independent Electricity System Operator
Wellington North Power Inc.
Westario Power Inc.

Disclaimer

This Needs Assessment Report was prepared for the purpose of identifying potential needs in the Greater Bruce-Huron Region and to assess whether those needs require further coordinated regional planning. The potential needs that have been identified through this Needs Assessment Report may be studied further through subsequent regional planning processes and may be reevaluated based on the findings of further analysis. The load forecast and results reported in this Needs Assessment Report are based on the information and assumptions provided by study team participants.

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NEEDS ASSESSMENT EXECUTIVE SUMMARY

REGION	Greater Bruce-Huron Region (the Region)		
LEAD	Hydro One Networks Inc. (Hydro One)		
START DATE	February 29, 2016	**END DATE**	April 28, 2016

1. INTRODUCTION

The purpose of this Needs Assessment report is to undertake an assessment of the Greater Bruce-Huron 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, the Independent Electricity System Operator (IESO) will initiate the Scoping Assessment 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 Needs Assessment for the Greater Bruce-Huron 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 - Group 1 Regions are being reviewed first. The Greater Bruce-Huron Region belongs to Group 3. The Needs Assessment for this Region was triggered on February 29, 2016 and was completed on April 28, 2016.

3. SCOPE OF NEEDS ASSESSMENT

The scope of this Needs Assessment was limited to the next 10 years as per the recommendations of the Planning Process Working Group Report to the OEB.

The scope of the Needs Assessment includes a review of transmission system capability which covers transformer station capacity, transmission circuit thermal capacity, and voltage performance. System reliability, operational issues and asset replacement plans were also briefly reviewed as part of this Needs Assessment.

Needs emerging over the next 10 years and requiring coordinated regional planning may be further assessed as part of the IESO-led Scoping Assessment and/or IRRP, or in the next planning cycle. If required, an IRRP will develop a 20-year strategic direction for the Region.

4. INPUTS/DATA

Study team participants, including representatives from LDCs, the IESO, and Hydro One transmission provided information for the Greater Bruce-Huron Region. The information included: planning activities already underway, historical load and power factor, load forecast, conservation and demand management (CDM) and distributed generation (DG) information, system reliability performance, operational issues and major equipment approaching end-of-life.

5. ASSESSMENT METHODOLOGY

The assessment's primary objective was to identify the electrical infrastructure needs in the Region over the study period (2016 to 2025). The assessment reviewed available information and load forecasts and included single contingency analysis to identify needs.

6. RESULTS

Transmission System Capacity Needs

A. 230/115 kV Autotransformer Capacity

- Based on the gross regional-coincident load forecast, the 230/115 kV autotransformer capacity (Seaforth TS, Hanover TS) supplying the Region is adequate over the study period for the loss of a single 230/115 kV autotransformer in the Region.

B. 230 kV Transmission Lines

- Based on the gross regional-coincident load forecast, 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. 115 kV Transmission Lines

- Based on the gross regional-coincident load forecast, thermal limits for 115 kV circuit L7S between Seaforth Junction and Kirkton Junction will be exceeded in the near term (summer 2019) for the loss of 115 kV circuit D8S.
- Based on the net regional-coincident load forecast, the need date is expected to be deferred to the end of the study period.
- Due to the limited recorded effectiveness of CDM uptake in this Region, further study is required to identify an action plan.
    - The Need will be managed via Local Planning with the Region's study team.

D. 230 kV and 115 kV Connection Facilities

- Based on the gross non-coincident load forecast, the capacity of the 230 kV and 115 kV connection facilities in the Region are adequate over the study period.

System Reliability, Operation and Restoration Needs

A. Load Security

- Based on the gross regional-coincident load forecast and the existing transmission configuration, load security criteria can be met over the study period.

B. Load Restoration

- Based on the gross regional-coincident load forecasts with the use of existing transmission infrastructure, restoration criteria can be met over the study period.

C. Power Factor at Connection Facilities

- Historically, power factor at Wingham TS and Bruce HWP B TS do not meet Market Rule requirements.
    - The Need at Wingham TS will be managed via Local Planning between the transmitter and the affected LDCs.
    - The Need at Bruce HWP B TS will be managed via Local Planning between the transmitter

and the affected customer.

D. Voltage Performance

- Under gross regional-coincident peak load conditions, post-contingency voltage at the Wingham TS 44 kV bus is below 6% of nominal voltage and may result in poor end-of-feeder voltages (winter 2020/2021).
- Based on the net regional-coincident peak load forecast at Wingham TS, the need date may be deferred by 2 years.
- Due to the synergy between voltage performance and power factor, this voltage deficiency Need will be further studied in coordination with Wingham TS's power factor.
    - The Need will be managed via Local Planning between the transmitters and the affected LDCs

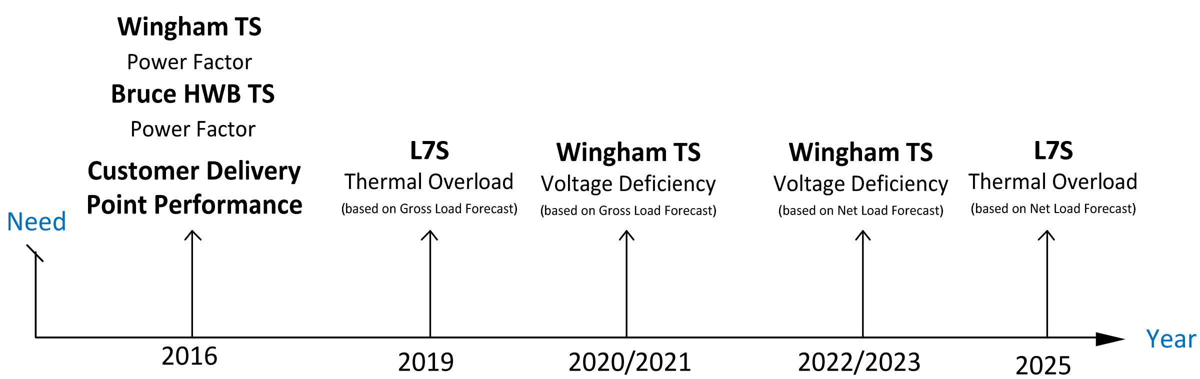
E. Customer Delivery Point Performance

- Based on a review of delivery point performance, several customer delivery points in the Region are below their historical measures.
    - Mitigation measures that align with Hydro One's OEB-approved process for addressing poor performance will be discussed between the transmitter and the affected LDCs and transmission customers.

F. Bulk Power System Performance in the Region

- Based on a limited analysis of the bulk power system in the Region, 230 kV transmission circuit D7V between Detweiler TS and Waterloo North Junction is over its thermal limit near the end of the study period. This result is consistent with the KWCG Regional Infrastructure Plan (RIP) findings.
    - As recommended in the KWCG RIP, this Needs Assessment also recommends further investigation via bulk system planning study.

Needs Timeline Summary



Aging Infrastructure / Replacement Plan

During the study period, plans to replace aged equipment at ten stations and several transmission circuits will take place. The replacement of aged equipment may improve customer delivery point performance. Investigation into customer delivery point performance will take into consideration this replacement work.

Further details of these investments can be found in Section 6.3 of this report.

7. RECOMMENDATIONS

Based on the findings of this Needs Assessment, the study team recommendations:

1. Poor power factor and voltage deficiency at Wingham TS to be managed by Local Planning between Hydro One transmission and Hydro One distribution and may include additional LDC's embedded within Hydro One distribution fed out of Wingham TS

2. Poor power factor at Bruce HWP B TS to be managed by Local Planning between Hydro One transmission and the transmission connected customer.

3. Mitigation of poor delivery point performance to several 115 kV connected customers to be managed according to Hydro One's OEB-approved process between Hydro One transmission, Hydro One distribution, Goderich Hydro and transmission connected customers.

4. Thermal overload on circuit L7S to be managed by Local Planning between Hydro One transmission and the Region's study team.

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

1 INTRODUCTION

This Needs Assessment report provides a description of the analysis to identify needs that may be emerging in the Greater Bruce-Huron Region (the Region) over the next ten years. The development of the Needs Assessment 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 OEB.

The purpose of this Needs Assessment report is to: consider the information from planning activities already underway; undertake an assessment of the Greater Bruce-Huron Region to identify 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 LDCs or other connecting customer(s) will further undertake planning assessments to develop options and recommend solution(s). For needs that require further regional planning and coordination, the Independent Electricity System Operator (the IESO) will initiate the Scoping Assessment 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.

This report was prepared by Hydro One (Lead Transmitter) with input from the Greater Bruce-Huron Region Needs Assessment study team listed in Table 1. The report captures the results of the assessment based on information provided by LDCs and the IESO.

Table 1: Study Team Participants for Greater Bruce-Huron Region

No.	Company
1	Hydro One Networks Inc. (Lead Transmitter)
2	Entegrus
3	Erie Thames Power
4	Festival Hydro Inc.
5	Goderich Hydro - West Coast Huron Energy Inc.
6	Hydro One Networks Inc. (Distribution)
7	Independent Electricity System Operator
8	Wellington North Power Inc.
9	Westario Power Inc.

2 TRIGGER OF NEEDS SCREEN

The Needs Assessment for the Greater Bruce-Huron 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, where Group 1 Regions are being reviewed first. The Region falls into Group 3. The Needs Assessment for this Region was triggered on February 29, 2016 and was completed on April 28, 2016.

3 SCOPE OF NEEDS ASSESSMENT

This Needs Assessment covers the Greater Bruce-Huron Region over an assessment period of 2016 to 2025. The scope of the Needs Assessment includes a review of transmission system connection facility capability which covers transformer station capacity, transmission circuit 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 Needs Assessment.

3.1 Greater Bruce-Huron Region Description and Connection Configuration

The Greater Bruce-Huron Region includes the counties of Bruce, Huron and Perth, as well as portions of Grey, Wellington, Waterloo, Oxford and Middlesex counties. The boundary of the Greater Bruce-Huron Region is shown in Figure 1.

Figure 1: Greater Bruce-Huron Region Map

Electricity supply for the Region is provided through a network of 230 kV and 115 kV transmission lines supplied mainly by generation from the Bruce Nuclear Generating Station and local renewable generation facilities in the Region. The bulk of the electrical supply is transmitted through 230 kV circuits (B4V, B5V, B22D, B23D, B27S and B28S) radiating out from Bruce A TS. These circuits connect the Region to the adjacent South Georgian Bay/Muskoka Region and the adjacent Kitchener-Waterloo-Cambridge-Guelph (KWCG) Region.

Listed in Table 2 and shown in Figure 2, are the transmission and transmission connected assets in the Greater Bruce-Huron Region.

Table 2: Hydro One and Customer Assets Bounded by the Greater Bruce-Huron Region

115 kV Circuits	**230 kV Circuits**	**Hydro One Transformer Stations**	**Customer Transformer Stations**
61M18, D8S, D10H, L7S, S1H	B4V, B5V, B22D, B23D, B20P, B24P, B27S, B28S, B81HW, B82HW	Bruce HWP B TS, Centralia TS, Douglas Point TS, Goderich TS, Hanover TS, Owen Sound TS, Palmerston TS, Seaforth TS, St. Marys TS, Stratford TS, Wingham TS	Constance DS, Festival MTS, Grand Bend East DS, Customer CTS #1, Customer CTS #2, Customer CTS #3, Customer CTS #4

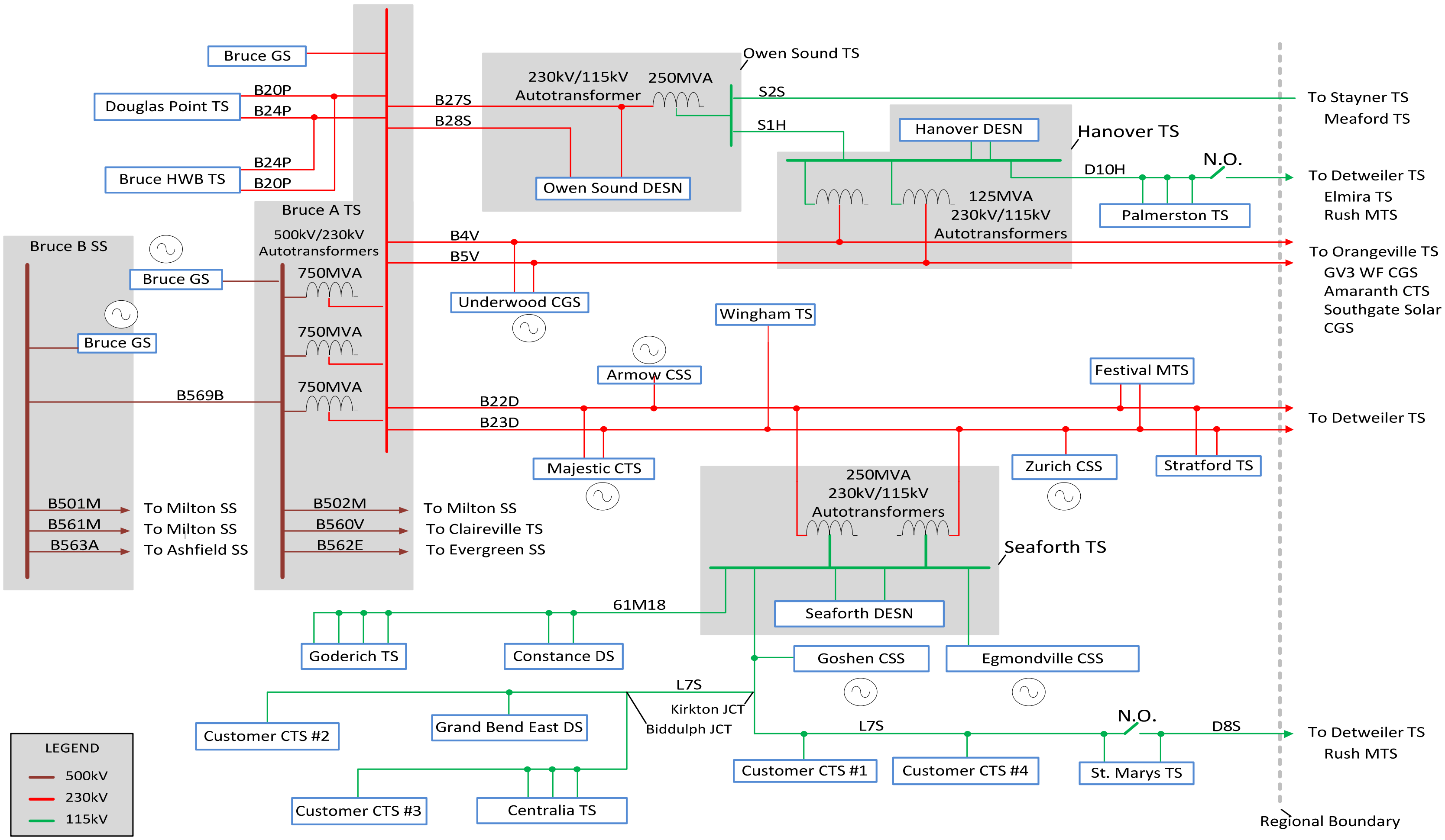


Figure 2: Single Line Diagram – Greater Bruce-Huron Region

4 INPUTS AND DATA

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

- IESO provided:
    i. Historical 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
    iv. Historical power factor data, MW and MVar for each station in the Region
- LDCs provided historical summer and winter net load (2013-2015) as well as summer and winter gross load forecast (2016-2025)
- Hydro One (Transmission) provided transformer, station and circuit ratings
- Hydro One (Transmission) provided existing reliability and operation issues
- Any relevant planning information, including planned transmission and distribution investments are provided by Hydro One (Transmission) and LDCs

4.1 Load Forecast

As per the data provided by the study team, the winter *gross* coincident load in the Region is expected to grow at an average rate of approximately 1.1% annually from 2016-2025 and the summer *gross* coincident load in the Region is expected to grow at an average rate of approximately 1.0% from 2016-2025.

As per the data provided by the study team, the winter *net* coincident load in the Region is expected to grow at an average rate of approximately 0.5% annually from 2016-2025 and the summer *net* coincident load in the Region is expected to grow at an average rate of approximately 0.3% from 2016-2025.

Based on historical load and on the load forecast, the Regions' winter coincident peak load is larger than its summer coincident peak load. As well, the majority of stations within the Region are winter peaking. The load forecasts utilized for this Needs Assessment are found in Appendix A: Load Forecasts.

5 NEEDS ASSESSMENT METHODOLOGY

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

1. The Region contains some stations that are summer peaking and others that are winter peaking. Equipment ratings are normally lower in the summer than winter due to ambient temperature. Based on these factors this assessment is conducted for both summer and winter peak load.
2. Forecast loads are provided by the Region's LDCs using historical 2015 summer and historical 2014/2015 winter peak loads as reference points.
3. Forecast loads are provided by industrial customers in the Region. Where data was not provided, the load is assumed to be consistent with historical loads.
4. The historical peak loads are adjusted for extreme weather conditions according to Hydro One methodology.
5. The LDC's load forecast is translated into load growth rates and is applied onto the historical, extreme weather adjusted, reference points.
6. Accounting for (2), (3), (4), (5) above, a gross load forecast and a net load forecast are developed. The gross load forecast is used to develop a worst case scenario to identify needs. Where there are issues, the net forecast, which accounts for CDM and DG, is analyzed to determine if the needs can be deferred.
    a. A gross and net non-coincident peak load forecast was used to perform the analysis for sections 6.1.4 and 6.2.3
    b. A gross and net regional-coincident peak load forecast was used to perform the analysis for sections 6.1.1 to 6.1.3 and 6.2.1 and 6.2.2 and 6.2.4
7. Review impact of any on-going and planned development projects in the Region during the study period.
8. Review and assess impact of any critical/major elements planned/identified to be replaced at the end of their useful life such as transformers, cables, and stations.
9. Station capacity adequacy is assessed by comparing the non-coincident peak load with the station's normal planning supply capacity by assuming a 90% lagging power factor for stations without low-voltage capacitor banks 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 and winter 10-Day Limited Time Rating (LTR), as appropriate.
10. Transmission adequacy assessment is primarily based on the following criteria:
    - Regional load is set to the forecasted regional-coincident peak load
    - 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 10-Day LTR.
- All voltages must be within pre and post contingency ranges as per the Ontario Resource and Transmission Assessment Criteria (ORTAC).
- The system to meet load security criteria as per the ORTAC, specifically, 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 timeframes as per the ORTAC.

6 RESULTS

This section summarizes the results of the Needs Assessment in the Greater Bruce-Huron Region. The results are based on all 8 Bruce nuclear generating units in-service and no local/renewable generating units in-service in order to verify whether the transmission system has adequate capacity to supply the forecasted regional load.

6.1 Transmission System Capacity Needs

6.1.1 230 kV and 115 kV Autotransformers

The 230/115 kV autotransformers (Seaforth TS, Hanover TS, Detweiler TS, Owen Sound TS) supplying the Region are adequate over the study period for the loss of a single 230/115 kV autotransformer in the Region.

6.1.2 230 kV Transmission Lines

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

6.1.3 115 kV Transmission Lines

The 115 kV lines supplying the Region are radial single circuit lines. These 115 kV circuits have adequate capacity over the study period.

115 kV circuit L7S that runs between Seaforth TS and St. Mary's TS is connected to 115 kV circuit D8S that runs between St. Marys TS and Detweiler TS, through the St. Marys TS low voltage bus-tie breaker. For the loss of D8S, L7S will exceed its short-term emergency (STE) and LTE ratings in the near term (summer 2019), under summer *gross*

peak load conditions. Under summer *net* peak load conditions, the flow on L7S decreases to ~97% of its emergency ratings at the end of the study period (summer 2025).

The sections of circuit explicitly over their ratings are: Seaforth Jct. x Goshen Jct., and Goshen Jct. x Kirkton Jct. The emergency ratings of these sections are limited by substandard clearances due to ground topology and a rural distribution line. Due to the limited recorded effectiveness of CDM uptake in this Region, this thermal overload Need will require further study and will therefore be managed by Local Planning with the Region's study team.

6.1.4 230 kV and 115 kV Connection Facilities

A station capacity assessment was performed over the study period for the 230 kV and 115 kV transformer stations in the Region using the winter and summer station non-coincident peak load forecasts. All stations in the Region have adequate supply capacity for the study period (2016-2025).

6.2 System Reliability, Operation and Restoration Review

6.2.1 Load Security

Based on the gross regional-coincident peak load forecast, with all transmission facilities in-service and coincident with an outage of the largest local generation units, all facilities are within applicable ratings. The largest local generation unit is a 230 kV-connected Bruce nuclear unit on the 230 kV system while on the 115 kV system Goshen wind farm is assumed out of service.

Based on the gross regional-coincident load forecast, the loss of one element will not result in load interruption greater than 150 MW by configuration, by planned load curtailment or by load rejection. In addition, under these conditions, all facilities are within their applicable ratings.

Based on the gross regional-coincident load forecast, the loss of two elements will not results in load interruption greater than 600 MW by configuration, by planned load curtailment or by load rejection. In addition, under these conditions, all facilities are within their applicable ratings.

Therefore, load security criteria for the Region are met.

6.2.2 Load Restoration

Based on the gross regional-coincident peak load forecasts, with the use of existing transmission infrastructure, all load can be restored within approximately 8 hours depending on the severity of the contingency, the prevailing system conditions and the relative distance from the nearest field maintenance centre. Existing transmission infrastructure includes switches that can be operated from the Ontario Grid Control Centre (OGCC), Mid-Span Openers (MSOs) and other isolating devices that require a bucket truck and line crew to open and close.

The largest loss of load in the Region is 325 MW in winter 2024/2025 for the loss of the double circuit line B22D/B23D. By use of existing 61B22D-21 and 61B23D-26 switches at Seaforth TS, the OGCC can quickly resupply, within 30 minutes, approximately 218 MW from Bruce A TS or approximately 268 MW from Detwiler TS. The remaining load can be resupplied in 4-8 hours by opening existing bolted openers along the circuits.

Therefore, load restoration criteria for the Region are met.

6.2.3 Power Factor at Connection Facilities

Based on the analysis of historical power factors at connection facilities under peak load conditions, the power factor at Wingham TS does not meet Market Rule requirements. Based on May 2014 to May 2015 historical data the power factor at Wingham TS does not meet Market Rule requirement of 0.9 lead-lag power factor at the defined meter point at least 60% of the time. This is a Need that will be managed by Local Planning between the transmitter and the affected LDCs.

Based on the analysis of historical power factors at connection facilities under peak load conditions, the power factor at Bruce HWP B TS does not meet Market Rule requirements. Based on January 2014 to December 2015 historical data the power factor at Bruce HWP B TS does not meet Market Rule requirement of 0.9 lead-lag power factor at the defined meter point approximately 80% of the time. This is a Need that will be managed by Local Planning between the transmitter and the affected customer.

6.2.4 Voltage Performance

Under winter 2020/2021 gross regional-coincident peak load conditions, post-contingency voltage at the Wingham TS 44 kV bus is below 6% of nominal voltage and may result is poor end-of-feeder voltages. Under winter *net* regional-coincident peak load conditions, the need is deferred by two years to winter 2022/2023. This is a Need that requires mitigation via Local Planning between the transmitter and the affected LDCs.

6.2.5 Customer Delivery Point Performance

Based on a review of Hydro One's historical delivery point performance statistics, several customer delivery points in the Region are below their historical measures. The delivery points are those fed from the Region's 115 kV system. These statistics are consistent with those provided by IESO. Mitigation measures that align with Hydro One's OEB approved process for addressing poor performance will be discussed between the transmitter and the affected LDCs and transmission customers.

6.2.6 Bulk Power System Performance in the Region

To bridge regional system planning with bulk system planning, a select number of bulk system planning contingencies within the Region are undertaken. With respect to the 230 kV circuits that supply regional load, breaker failure contingencies of these circuit's terminal breakers at BES and BPS station are analyzed to determine their impact. Gross regional-coincident peak load for the Greater Bruce-Huron region was used while a net regional-coincident peak load forecast for the KWCG region was used.

The results showed that 230 kV transmission circuit D7V between Detweiler TS and Waterloo North Junction is at its thermal rating at the end of the study period. This result is consistent with KWCG Regional Infrastructure Plan findings.

As recommended in the KWCG RIP, this Needs Assessment also recommends further investigation via bulk system planning study.

6.3 Aging Infrastructure and Replacement Plan of Major Equipment

Table 3 lists Hydro One transmission sustainment initiatives that are currently planned for aging and End-Of-Life (EOL) infrastructure.

Table 3: Hydro One Transmission Sustainment Initiatives

Station/Circuit	Description of Work	Planning In-Service Date
Bruce A TS	230 kV breaker replacement	2019
	500 kV breaker replacement	2024
Bruce B SS	500 kV breaker replacement	2020
Goderich TS	Station refurbishment: replace existing 3 transformers (T1/T2/T3) with a typical 50/83 MVA 2 transformer DESN arrangement (T4/T5)	2017
Detweiler TS	Replace AC station service	2017
	Replace T2 and T4 autotransformers	2021
Centralia TS	Station refurbishment: replace existing 3 transformers with a typical 25/42 MVA 2	2018

	transformer DESN arrangement	
Palmerston TS	Station refurbishment: replace existing 3 transformers with a typical 50/83 MVA 2 transformer DESN arrangement	2018
Wingham TS	Station refurbishment	2022
Seaforth TS	Station refurbishment: to include autotransformers and DESN	2023
Hanover TS	Station refurbishment: to include DESN	2023
Stratford TS	Station refurbishment	2023
Circuit L7S	Replacement of 4 wood poles	2016
	Insulator replacements	As required
Circuit S1H	Replacement of shield wire	2016
	Replacement of 9 wood poles	2017
Circuits B4V & B5V	Insulator and U-bolt replacement	As required
Circuits B22D & B23D	Insulator replacements	As required
Circuits B27S & B28S	Insulator replacements	As required
Circuits B20P & B24P	Insulator replacements	As required

The replacement and/or refurbishment of equipment may improve the overall reliability performance at customer delivery points. Further investigation is required to verify.

6.4 Planned Transmission and Distribution Investments

Listed in Table 4 are planned transmission and distribution investments in the Region. Note that other than the currently planned refurbishment work in table 3, Hydro One transmission does not have additional planned investments within the Region other than connecting generation upon request.

Table 4: Planned Local Distribution Company Investments

LDC	**Investment Description**	**Planning In-Service Date**
Wellington North Power	Transfer ~50% of LDC's Mount Forest load fed from Hanover TS to Palmerston TS in 2016. A feeder extension (M2) from Palmerston TS will be used for this load transfer. This transfer has been incorporated into the Region's station load forecast.	2016

7 RECOMMENDATIONS

Based on the findings of the Needs Assessment, the study team's recommendations are as follows:

1. To mitigate poor power factor and to prevent against voltage deficiency at Wingham TS, Local Planning between Hydro One transmission and Hydro One distribution (this may include additional LDC's embedded within Hydro One distribution fed out of Wingham TS) is recommended.

2. To mitigate poor power factor at Bruce HWP B TS, Local Planning between Hydro One transmission and the transmission connected customer is recommended.

3. To mitigate poor delivery point performance to several 115 kV connected customers, planning in accordance with Hydro One's OEB-approved process between Hydro One transmission, Hydro One distribution, Goderich Hydro and transmission connected customers is recommended.

4. To prevent against thermal overload on circuit L7S, Local Planning between Hydro One transmission and the Region's study team is recommended.

8 REFERENCES

i) Planning Process Working Group (PPWG) Report to the Board: The Process for Regional Infrastructure Planning in Ontario – May 17, 2013
ii) IESO Ontario Resource and Transmission Assessment Criteria (ORTAC) – Issue 5.0

9 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
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
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

APPENDIX A: LOAD FORECASTS

Table A1: Gross – Winter Regional-Coincident Peak Load Forecast

Station	Historical (MW)	Forecast (MW)									
	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
Centralia TS	32.42	32.87	33.40	33.77	34.25	34.87	35.48	35.93	36.36	36.77	37.19
Constance DS	17.58	17.68	17.76	17.79	17.87	18.01	18.16	18.26	18.35	18.46	18.57
Douglas Point TS	70.95	71.97	72.93	73.75	74.76	75.95	77.17	78.29	79.41	80.58	81.80
Customer CTS #1	0.89*	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Festival MTS #1	19.26	19.41	19.55	19.70	19.85	20.00	20.15	20.30	20.45	20.60	20.76
Goderich TS	36.21	36.35	36.50	36.59	36.73	36.92	37.11	37.25	37.37	37.49	37.61
Grand Bend East DS	14.11	14.22	14.36	14.43	14.55	14.72	14.89	15.00	15.09	15.19	15.28
Hanover TS	101.59	102.37	103.16	103.93	104.95	105.99	107.05	107.73	108.39	109.06	109.72
Customer CTS #2	4.27**	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30
Customer CTS #3	1.93**	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Owen Sound TS	133.69	135.53	137.73	139.21	141.20	143.81	146.38	148.20	149.90	151.56	153.19
Palmerston TS	60.95	61.92	62.92	63.88	65.12	66.22	67.44	68.42	69.41	70.41	71.40
Seaforth TS	33.27	33.44	33.65	33.78	33.97	34.22	34.47	34.64	34.80	34.95	35.10
Customer CTS #4	9.37	9.49	10.07	10.07	10.64	10.64	10.64	10.64	10.64	10.64	10.64
St. Marys TS	23.48	23.74	25.04	25.17	25.31	25.50	25.69	25.84	25.98	26.12	26.25
Stratford TS	79.16	79.78	80.45	81.03	81.67	82.41	83.14	83.76	84.37	84.98	85.59
Wingham TS	48.21	48.99	49.80	50.44	51.23	52.24	53.24	54.07	54.89	55.74	56.62
Bruce HWB TS	10.95	10.96	11.10	11.10	11.10	11.10	11.10	11.10	11.10	11.10	11.10

* Winter 2013/14

** Winter 2012/13

Table A2: Gross – Summer Regional-Coincident Peak Load Forecast

Station	Historical (MW)	Forecast (MW)									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Centralia TS	32.00	32.42	32.73	33.15	33.78	34.40	34.83	35.24	35.65	36.05	36.45
Constance DS	15.47	15.56	15.57	15.63	15.76	15.90	15.98	16.07	16.16	16.26	16.36
Douglas Point TS	45.48	45.81	45.81	46.11	46.56	47.04	47.41	47.78	48.16	48.51	48.90
Customer CTS #1	1.29*	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Festival MTS #1	24.84	25.03	25.22	25.41	25.60	25.79	25.98	26.18	26.37	26.57	26.77
Goderich TS	38.95	39.08	39.15	39.27	39.48	39.68	39.81	39.93	40.06	40.18	40.31
Grand Bend East DS	16.32	16.44	16.50	16.62	16.84	17.05	17.17	17.29	17.39	17.50	17.61
Hanover TS	76.22	76.71	76.94	77.62	78.60	79.25	79.71	80.12	80.53	80.93	81.32
Customer CTS #2	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58
Customer CTS #3	4.17**	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20
Owen Sound TS	96.32	97.58	98.48	99.75	101.70	103.59	104.89	106.11	107.31	108.48	109.63
Palmerston TS	52.00	53.07	53.79	54.90	56.36	57.68	58.81	59.97	61.19	62.43	63.75
Seaforth TS	30.53	30.68	30.77	30.91	31.14	31.35	31.50	31.63	31.14	31.90	32.03
Customer CTS #4	14.42	14.62	15.54	15.54	16.47	16.47	16.47	16.47	16.47	16.47	16.47
St. Marys TS	25.16	25.31	25.42	25.57	25.75	25.94	26.09	26.24	26.38	26.52	26.66
Stratford TS	77.16	77.76	78.26	78.86	79.62	80.38	80.98	81.57	82.16	82.74	83.32
Wingham TS	37.69	37.99	38.11	38.36	38.87	39.37	39.67	39.97	40.26	40.54	40.83
Bruce HWB TS	5.05	5.14	5.24	5.34	5.44	5.54	5.64	5.74	5.84	5.93	6.03

* Summer 2014

** Summer 2013

Table A3: Gross – Winter Non-Coincident Peak Load Forecast

Station	Historical (MW)	Forecast (MW)									
	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
Centralia TS	33.69	34.15	34.70	35.08	35.59	36.23	36.87	37.33	37.77	38.21	38.63
Constance DS	18.63	19.42	19.51	19.54	19.63	19.79	19.95	20.06	20.17	20.28	20.40
Douglas Point TS	70.95	71.97	72.93	73.75	74.76	75.95	77.17	78.29	79.41	80.58	81.80
Customer CTS #1	3.79	3.79	3.79	3.79	3.79	3.79	3.79	3.79	3.79	3.79	3.79
Festival MTS #1	23.79	25.47	25.66	25.85	26.05	26.24	26.44	26.64	26.84	27.04	27.24
Goderich TS	40.95	41.61	41.78	41.88	42.04	42.26	42.48	42.63	42.77	42.91	43.05
Grand Bend East DS	14.63	14.75	14.89	14.97	15.09	15.27	15.45	15.56	15.66	15.75	15.85
Hanover TS	102.64	96.65*	97.40	98.12	99.09	100.07	101.06	101.71	102.33	102.97	103.58
Customer CTS #2	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90
Customer CTS #3	4.63	4.63	4.63	4.63	4.63	4.63	4.63	4.63	4.63	4.63	4.63
Owen Sound TS	133.69	135.53	137.73	139.21	141.20	143.81	146.38	148.20	149.90	151.56	153.19
Palmerston TS	61.48	68.03*	69.12	70.18	71.54	72.76	74.10	75.17	76.26	77.36	78.45
Seaforth TS	33.69	34.75	34.96	35.10	35.29	35.55	35.81	35.99	36.15	36.31	36.47
Customer CTS #4	16.84	17.06	18.10	18.10	19.14	19.14	19.14	19.14	19.14	19.14	19.14
St. Marys TS	24.84	25.13	26.50	26.64	26.79	26.99	27.19	27.35	27.50	27.64	27.78
Stratford TS	83.48	84.52	85.23	85.84	86.52	87.30	88.08	88.74	89.39	90.03	90.68
Wingham TS	57.06	57.98	58.94	59.70	60.63	61.82	63.01	63.98	64.96	65.96	67.00
Bruce HWB TS	11.05	11.07	11.20	11.20	11.20	11.20	11.20	11.20	11.20	11.20	11.20

*Load Transfer from Hanover TS to Palmerston TS

Table A4: Gross – Summer Non-Coincident Peak Load Forecast

Station	Historical (MW)	Forecast (MW)									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Centralia TS	33.79	34.23	34.56	35.01	35.67	36.32	36.78	37.22	37.64	38.07	38.49
Constance DS	17.69	17.78	17.79	17.86	18.01	18.17	18.27	18.36	18.47	18.58	18.70
Douglas Point TS	46.11	46.44	46.45	46.75	47.21	47.69	48.07	48.45	48.83	49.19	49.58
Customer CTS #1	2.53	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Festival MTS #1	27.90	28.11	28.32	28.53	28.74	28.96	29.18	29.39	29.61	29.84	30.06
Goderich TS	39.27	40.71	40.78	40.91	41.12	41.33	41.46	41.59	41.72	41.85	41.98
Grand Bend East DS	18.74	18.88	18.95	19.09	19.34	19.58	19.72	19.85	19.98	20.10	20.22
Hanover TS	76.22	75.61*	75.84	76.50	77.47	78.12	78.57	78.97	79.37	79.77	80.15
Customer CTS #2	5.79	5.79	5.79	5.79	5.79	5.79	5.79	5.79	5.79	5.79	5.79
Customer CTS #3	4.53	4.53	4.53	4.53	4.53	4.53	4.53	4.53	4.53	4.53	4.53
Owen Sound TS	100.01	101.31	102.25	103.57	105.59	107.55	108.90	110.17	111.41	112.63	113.82
Palmerston TS	52.32	54.71*	55.45	56.60	58.10	59.46	60.63	61.82	63.07	64.36	65.72
Seaforth TS	30.53	31.00	31.09	31.24	31.46	31.68	31.83	31.96	31.47	32.24	32.37
Customer CTS #4	16.00	16.22	17.24	17.24	18.27	18.27	18.27	18.27	18.27	18.27	18.27
St. Marys TS	25.90	26.05	26.17	26.31	26.51	26.70	26.86	27.01	27.16	27.30	27.44
Stratford TS	86.43	88.42	88.99	89.68	90.54	91.40	92.09	92.76	93.43	94.09	94.75
Wingham TS	50.74	54.05	54.21	54.58	55.29	56.00	56.43	56.86	57.27	57.67	58.08
Bruce HWB TS	6.42	6.54	6.66	6.79	6.91	7.04	7.16	7.29	7.42	7.54	7.67

*Load Transfer from Hanover TS to Palmerston TS

Table A5: Net – Winter Regional-Coincident Peak Load Forecast

Station	Historical (MW)	Forecast (MW)									
	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
Centralia TS	32.42	32.65	32.92	32.96	33.16	33.52	33.90	34.16	34.45	34.69	34.94
Constance DS	17.58	17.57	17.55	17.41	17.35	17.36	17.40	17.41	17.44	17.46	17.50
Douglas Point TS	70.95	71.54	72.09	72.19	72.59	73.20	73.94	74.64	75.45	76.23	77.08
Customer CTS #1	0.89*	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Festival MTS #1	19.26	19.29	19.33	19.29	19.27	19.28	19.31	19.36	19.43	19.49	19.56
Goderich TS	36.21	36.12	36.07	35.81	35.65	35.58	35.55	35.50	35.49	35.45	35.43
Grand Bend East DS	14.11	14.13	14.19	14.13	14.13	14.19	14.27	14.30	14.34	14.37	14.39
Hanover TS	101.59	101.72	101.94	101.69	101.76	102.01	102.42	102.56	102.84	103.02	103.23
Customer CTS #2	4.27**	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30
Customer CTS #3	1.93**	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Owen Sound TS	133.69	134.70	136.07	136.18	137.02	138.53	140.18	141.21	142.35	143.29	144.25
Palmerston TS	60.95	61.53	62.17	62.50	63.20	63.80	64.60	65.20	65.92	66.58	67.25
Seaforth TS	33.27	33.24	33.26	33.06	32.98	32.98	33.02	33.02	33.06	33.06	33.07
Customer CTS #4	9.37	9.49	10.07	10.07	10.64	10.64	10.64	10.64	10.64	10.64	10.65
St. Marys TS	23.48	23.59	24.75	24.63	24.57	24.58	24.61	24.63	24.68	24.70	24.73
Stratford TS	79.16	79.30	79.52	79.30	79.29	79.42	79.65	79.86	80.16	80.39	80.64
Wingham TS	48.21	48.70	49.23	49.38	49.75	50.36	51.02	51.55	52.16	52.73	53.35
Bruce HWB TS	10.95	10.96	11.10	11.10	11.10	11.10	11.10	11.10	11.10	11.10	11.10

* Winter 2013/14

** Winter 2012/13

Table A6: Net – Summer Regional-Coincident Peak Load Forecast

Station	Historical (MW)	Forecast (MW)									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Centralia TS	32.00	32.04	31.57	31.62	31.89	32.20	32.42	32.61	32.85	33.05	33.25
Constance DS	15.47	15.45	15.35	15.23	15.20	15.20	15.19	15.18	15.20	15.22	15.24
Douglas Point TS	45.48	45.43	45.11	44.89	44.87	44.93	45.02	45.10	45.26	45.35	45.49
Customer CTS #1	1.29*	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Festival MTS #1	24.84	24.85	24.86	24.77	24.69	24.66	24.70	24.74	24.82	24.87	24.93
Goderich TS	38.95	38.70	38.50	38.18	37.98	37.84	37.74	37.63	37.59	37.50	37.43
Grand Bend East DS	16.32	16.32	16.27	16.20	16.24	16.31	16.33	16.33	16.37	16.38	16.40
Hanover TS	76.22	75.82	75.51	75.32	75.37	75.34	75.33	75.25	75.32	75.30	75.29
Customer CTS #2	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58
Customer CTS #3	4.17**	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20
Owen Sound TS	96.32	96.71	96.49	96.54	97.40	98.36	99.01	99.56	100.27	100.83	101.40
Palmerston TS	52.00	52.48	52.81	53.30	54.15	54.94	55.69	56.45	57.35	58.21	59.16
Seaforth TS	30.53	30.39	30.27	30.06	29.96	29.91	29.87	29.82	29.23	29.79	29.76
Customer CTS #4	14.42	14.62	15.54	15.54	16.47	16.47	16.47	16.47	16.47	16.47	16.47
St. Marys TS	25.16	25.07	25.01	24.87	24.79	24.76	24.75	24.74	24.77	24.77	24.78
Stratford TS	77.16	77.10	77.05	76.77	76.70	76.76	76.87	76.97	77.20	77.33	77.49
Wingham TS	37.69	37.72	37.57	37.40	37.49	37.65	37.71	37.76	37.88	37.94	38.03
Bruce HWB TS	5.05	5.06	5.12	5.12	5.12	5.12	5.12	5.12	5.12	5.12	5.12

* Summer 2014

** Summer 2013

Table A7: Net – Winter Non-Coincident Peak Load Forecast

Station	Historical (MW)	Forecast (MW)									
	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
Centralia TS	33.69	33.93	34.20	34.24	34.46	34.82	35.23	35.50	35.79	36.05	36.31
Constance DS	18.63	18.62	18.61	18.45	18.39	18.40	18.44	18.45	18.48	18.51	18.55
Douglas Point TS	70.95	71.54	72.09	72.19	72.59	73.20	73.94	74.64	75.45	76.23	77.08
Customer CTS #1	3.79	3.79	3.79	3.79	3.79	3.79	3.79	3.79	3.79	3.79	3.79
Festival MTS #1	23.79	23.83	23.87	23.82	23.80	23.81	23.84	23.90	24.00	24.07	24.16
Goderich TS	40.95	40.85	40.79	40.49	40.32	40.23	40.20	40.15	40.14	40.09	40.06
Grand Bend East DS	14.63	14.66	14.72	14.65	14.65	14.72	14.81	14.84	14.88	14.90	14.93
Hanover TS	102.64	102.77*	102.99	102.75	102.81	103.07	103.48	103.63	103.90	104.09	104.30
Customer CTS #2	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90
Customer CTS #3	4.63	4.63	4.63	4.63	4.63	4.63	4.63	4.63	4.63	4.63	4.63
Owen Sound TS	133.69	134.70	136.07	136.18	137.02	138.53	140.18	141.21	142.35	143.29	144.25
Palmerston TS	61.48	62.06*	62.70	63.04	63.75	64.36	65.15	65.77	66.49	67.16	67.83
Seaforth TS	33.69	33.66	33.68	33.48	33.39	33.40	33.44	33.44	33.47	33.47	33.49
Customer CTS #4	16.84	17.06	18.10	18.10	19.14	19.14	19.14	19.14	19.14	19.14	19.14
St. Marys TS	24.84	24.97	26.19	26.07	26.01	26.01	26.04	26.07	26.12	26.14	26.17
Stratford TS	83.48	83.62	83.86	83.63	83.62	83.75	84.00	84.21	84.53	84.77	85.04
Wingham TS	57.06	57.64	58.26	58.44	58.87	59.59	60.38	61.01	61.73	62.41	63.14
Bruce HWB TS	11.05	11.07	11.20	11.20	11.20	11.20	11.20	11.20	11.20	11.20	11.20

*Load Transfer from Hanover TS to Palmerston TS

Table A8: Net – Summer Non-Coincident Peak Load Forecast

Station	Historical (MW)	Forecast (MW)									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Centralia TS	33.79	33.84	33.38	33.43	33.72	34.04	34.27	34.47	34.72	34.93	35.15
Constance DS	17.69	17.66	17.54	17.41	17.37	17.38	17.36	17.35	17.38	17.39	17.42
Douglas Point TS	46.11	46.06	45.74	45.52	45.49	45.56	45.65	45.72	45.89	45.98	46.13
Customer CTS #1	2.53	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Festival MTS #1	27.90	27.91	27.92	27.81	27.73	27.69	27.74	27.77	27.87	27.93	28.00
Goderich TS	39.27	39.02	38.81	38.49	38.29	38.15	38.05	37.93	37.89	37.81	37.74
Grand Bend East DS	18.74	18.75	18.68	18.61	18.65	18.73	18.75	18.76	18.80	18.81	18.83
Hanover TS	76.22	75.82*	75.51	75.32	75.37	75.34	75.33	75.25	75.32	75.30	75.29
Customer CTS #2	5.79	5.79	5.79	5.79	5.79	5.79	5.79	5.79	5.79	5.79	5.79
Customer CTS #3	4.53	4.53	4.53	4.53	4.53	4.53	4.53	4.53	4.53	4.53	4.53
Owen Sound TS	100.01	100.41*	100.21	100.26	101.16	102.15	102.82	103.40	104.13	104.72	105.31
Palmerston TS	52.32	52.80	53.13	53.63	54.48	55.27	56.03	56.79	57.70	58.57	59.52
Seaforth TS	30.53	30.39	30.27	30.06	29.96	29.91	29.87	29.82	29.23	29.79	29.76
Customer CTS #4	16.00	16.22	17.24	17.24	18.27	18.27	18.27	18.27	18.27	18.27	18.27
St. Marys TS	25.90	25.81	25.74	25.60	25.52	25.49	25.48	25.47	25.50	25.50	25.50
Stratford TS	86.43	86.36	86.31	86.00	85.92	85.99	86.12	86.22	86.48	86.63	86.81
Wingham TS	50.74	50.79	50.58	50.35	50.48	50.69	50.77	50.84	51.00	51.08	51.20
Bruce HWB TS	6.42	9.83	9.95	9.95	9.95	9.95	9.95	9.95	9.95	9.95	9.95

*Load Transfer from Hanover TS to Palmerston TS