NEEDS ASSESSMENT REPORT

KWCG

[Date: April 09, 2024]

Needs Assessment Report

Final

KWCG

[Date: April 09, 2024]

Lead Transmitter:

Hydro One Networks Inc.

Prepared by: KWCG Technical Working Group

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Disclaimer

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

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Executive Summary

REGION	**KWCG** Region (the "Region")
LEAD	Hydro One Networks Inc. ("HONI")

START DATE: December 11, 2024 **END DATE:** April 09, 2024

1. INTRODUCTION

The 2nd Regional Planning cycle for the KWCG Region was completed in December, 2021 with the publication of the Regional Infrastructure Plan ("RIP") report. This is the 3rd cycle of Regional Planning for the region.

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

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

The planning horizon for this NA assessment is ten years.

2. REGIONAL ISSUE/TRIGGER

In accordance with the Regional Planning process, the Regional Planning cycle should be triggered at least once every five years. Considering these timelines, the 3rd Regional Planning cycle was triggered in December 2023 for the KWCG Region.

3. SCOPE OF NEEDS ASSESSMENT

The scope of the KWCG Region NA and includes:

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

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

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

4. REGIONAL DESCRIPTION AND CONNECTION CONFIGURATION

The KWCG Region covers the cities of Kitchener, Waterloo, Cambridge and Guelph, portions of Oxford and Wellington counties and the townships of North Dumfries, Puslinch, Woolwich, Wellesley and Wilmot. Electrical supply to the Region is provided from eleven 230 kV and thirteen 115 kV step-down transformer stations. The summer 2022 non-coincident regional loads were about 1436 MW.

5. INPUTS/DATA

The TWG comprises of representatives from Local Distribution Companies ("LDC"), the Independent Electricity System Operator ("IESO"), and Hydro One and provides input and relevant information for the KWCG Region regarding capacity needs, reliability needs, operational issues, and major high-voltage (HV) transmission assets requiring replacement over the planning horizon. The LDCs also capture input from municipalities in the development of their 10-year load forecast.

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

6. ASSESSMENT METHODOLOGY

The assessment's primary objective is to identify the electrical infrastructure needs in the Region over the 10-year planning horizon. The assessment methodology includes a review of planning information such as load forecast (which factors various demand drivers and consideration of municipal energy plan(MEPs) and/or Community Energy plans (CEPs) where available), conservation and demand management ("CDM") forecast, distributed generation ("DG") forecast, system reliability and operation, and major HV transmission assets requiring replacement.

A technical assessment of needs is undertaken based on:

a) Current and future station capacity and transmission adequacy;

b) System reliability needs and operational concerns;

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

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

7. NEEDS

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

The following needs and projects discussed in the 2nd cycle RIP report for KWCG region have been completed:

- Hanlon TS Transformers T1/ T2 Replacement (2022).

The following needs and projects discussed in the 2nd cycle RIP report for KWCG region are currently underway:

- **Burlington TS to CTS 1 Line Section:** The refurbishment of 115 kV B6C/ B6C line section from Burlington TS to Harper's Junction was completed in 2019. The refurbishment of line tap section from Harper's Junction to CTS1

is progressing slowly due to outage availability from the customer. This refurbishment work is currently forecasted to be completed in Q3/ Q4 2025 timeframe.

- **Kitchener MTS #5 – T9/T10 Transformers Replacement**: The existing 83 MVA T9/ T10 transformers are planned to be replaced with new 100 MVA units. This work is currently forecasted to be completed by Q1 2025.
- **Preston TS - T3/T4 Transformer Replacement:** Condition assessment of T3/ T4 transformers have identified these units for replacement. These units are currently planned to be replaced by the end of 2027 with similar Hydro One standard units. This replacement will also remove the existing supply capacity constraint due to a technical limitation in the existing units. The new LTR will be 180 MW

The remaining needs and projects discussed in the 2nd cycle RIP report for KWCG region are as follows:

- **Scheifele MTS - T1/T2 and T3/T4 Transformer Replacement**: These four (T1/T2/T3/T4) transformers are expected to approach end of life over the next 10 year horizon and are planned for replacement by Enova Power Corp. Enova Power Corp will continue monitoring the condition of these transformers with its maintenance program. The expected year of replacement is between 2029-2033.
- **Cedar TS - T7/ T8 Transformer Replacement**: Replacing the existing non-standard T7/T8 transformers with Hydro One standard units of higher capacity. Based on latest condition assessment of these units. These units are to be replaced beyond the study period (10 years) of this report. However, this transformer replacement may need to be advanced due to capacity needs.
- **Campbell TS - Breakers and Component replacement:** Replace breakers deemed to be approaching expected service life. This work is planned to be completed by 2032.
- **Fergus TS – T3/T4 Transformer Replacement:** Hydro One will continue monitoring the condition of these T3/T4 transformers and other components at Fergus TS. Hydro One will proceed with the replacement plan, if required. Otherwise, this need will be reassessed in the next regional planning cycle.
- **Galt TS – Breakers and Component Replacement:** Hydro One will continue monitoring the condition of these components at Galt TS and proceed with the replacement plan as required.

II. Newly identified needs in the region

Based on the new and updated information, a summary of the results of this Needs Assessment is provided below:

a. Asset Renewal for Major HV Transmission Equipment

- No new Asset Renewal Needs

b. Transformation Capacity

- The supply capacity needs at Preston TS, Energy + MTS, Cedar T7/T8 and Campbell TS (T3/T4) have been identified in the near term while the needs at Cedar TS T1/T2 DESN, Cedar T7/T8 DESN, Kitchner MTS #7, Waterloo MTS, and Rush MTS have been identified in the middle term.

c. Transmission System Capacity

- During the study period. Post contingency overload violations were observed on 230 kV M20D/M21D and 115 kV D11K/ D12K circuits for the loss of companion circuits.

d. System Reliability, Operation and Load restoration

- During the study period, post contingency voltage violations were observed on 230 kV M20D/M21D for the loss of companion circuits.
- Load restoration violations on 230 kV D6V/D7V circuits in the long term and system security and load restoration violation on the M21D/M20D circuit in the mid term and near term respectively, for a single tower contingency.

8. SENSITIVITY ANALYSIS

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

The impact of the sensitivity analysis for the high and low growth scenarios identified the following updates to need dates and/or new station/line capacity needs: These needs will be assessed again during the next phases of this Regional Planning cycle.

Sr. no	Need Identified	Normal Growth Scenario	High Growth Scenario	Low Growth Scenario
1	Preston TS - Capacity need	2026	2026	2029
2	Galt TS- Capacity need	Reaches capacity in 2032	2030	Long term
3	Energy Inc MTS - Capacity need	2023	2023	2023
4	Rush MTS - Capacity need	2030	2029	Long term
5	Waterloo North MTS #3 - Capacity need	2030	2030	Long term
6	Campbell TS (T3/T4)- Capacity need	2026	2025	2030
7	Cedar TS (T7/T8)- Capacity need	Immediate	Immediate	Immediate
8	Cedar TS (T1/T2)- Capacity need	2031	2029	Long term
9	Kitchener #7	2031	2030	Long term
10	M20D/M21D Transmission Circuit Supply	2026	2024	2026
11	D11K/D12K- Transmission Circuit Supply	2032	2030	Long term

12	D10H - Transmission Circuit Supply	Long term	2030	Long term
13	M20D/M21D Load Security	2032	2028	Long term
14	M20D/M21D Restoration Needs	2025	2023	2025
15	D6V/D7V Restoration Needs	Long term	2030	Long term
16	Voltage change violation on M20D/M21D	2026	2025	2026

9. RECOMMENDATIONS

The TWG recommendations are as follows:

I. Needs that require further assessment and regional coordination

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

a. Transmission System Capacity

- M20D/M21D post contingency violation (Galt Jct x Cambridge #1 Jct)- Near term
- D11K/D12K post contingency violation (Detweiler x Kitchener #1 & 4 Jct) – Mid Term

b. System Reliability, Operation and Load restoration

- System security violation on the M21D/M20D circuit in the Mid term
- Load restoration for M20D/M21D – Near term
- Voltage violations on M20D or M21D due to outage on companion circuit -Near term

c. Transformation Capacity Needs

- Preston TS (T3/T4) – Near term
- Energy Inc MTS (T1/T2) – Near term

Transmission system capacity and restoration needs are likely to trigger system reinforcement needs in the KWCG region.

II. Needs that do not require further regional coordination

These needs are local in nature and do not have a regional impact. They can be addressed by a straightforward transmission and/or distribution wires solution. They do not require investment in any upstream transmission facility or Leave to Construct (i.e., Section 92) approvals. These needs generally impact a limited number of LDCs and can be addressed directly between Hydro One and the LDC(s) to develop a preferred local plan. A list of these needs are as follows:

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

a. Transformation Capacity Needs

- Campbell TS (T3/T4) – Mid term
- Cedar TS (T1/T2) – Mid term
- Kitchener MTS #7 (T14/T13) – Mid term
- Cedar (T7/T8) – Near term
- Rush MTS – Mid term
- Waterloo North MTS #3 - Mid term

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

- Grandbridge Energy
- Enova Power Corp

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

- Hydro One Networks Inc. (Distribution)
- Alectra Inc.
- Center Wellington Hydro
- Halton Hills Hydro Inc.
- Wellington North Power

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1. INTRODUCTION

The second cycle of the Regional Planning process for the KWCG Region was completed in [December 10, 2021] with the publication of the Regional Infrastructure Plan ("RIP") Report The RIP report included a common discussion of all the options and recommended plans and preferred plans for wire infrastructure investments to address the near- and medium-term needs.

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

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

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

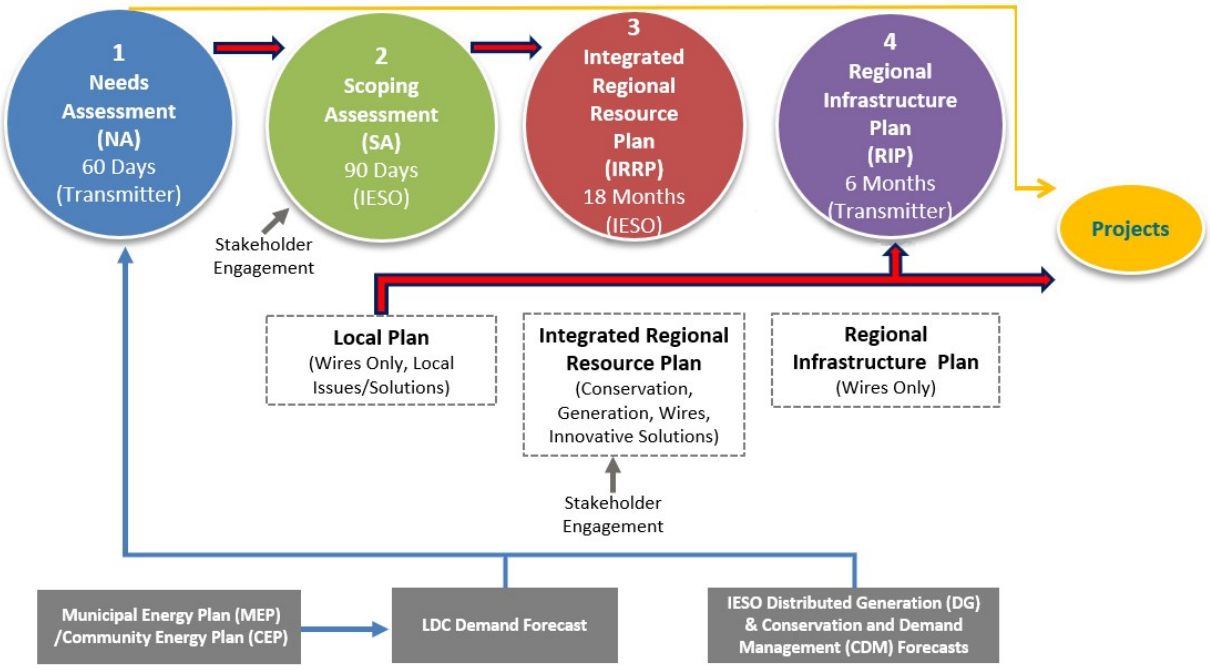

Figure 1: Regional Planning Process

This report was prepared by the KWCG Technical Working Group("TWG"), led by Hydro One Networks Inc. The report presents the results of the assessment based on information provided by the Hydro One,

the Local Distribution Companies ("LDC") and the Independent Electricity System Operator ("IESO"). Participants of the TWG are listed below in Table 1.

Table 1: KWCG Region TWG Participants

Sr. no.	Name of TWG Participants
1	Hydro One Networks Inc. (Lead Transmitter)
2	Independent Electricity System Operator ("IESO")
3	Enova Power Corp.
4	Alectra Inc.
5	Grandbridge energy
6	Centre Wellington
7	Wellington North
8	Halton Hills Hydro Inc.
9	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 once every five years. As such, the 3rd Regional Planning cycle was triggered for the KWCG region.

3. SCOPE OF NEEDS ASSESSMENT

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

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

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

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

The planning horizon for this NA assessment is 10 years.

4. REGIONAL DESCRIPTION AND CONNECTION CONFIGURATION

The KWCG Region covers the cities of Kitchener, Waterloo, Cambridge and Guelph, portions of Oxford and Wellington counties and the townships of North Dumfries, Puslinch, Woolwich, Wellesley and Wilmot. Electrical supply to the Region is provided from eleven 230 kV and thirteen 115 kV step-down transformer stations. The accumulative summer 2022 non-coincident loads were about 1477 MW. The approximate boundaries of the KWCG Region are shown below in Figure 1.

The main sources of electricity into the KWCG Region are from five Hydro One stations: Middleport TS, Buchanan TS, Detweiler TS, Orangeville TS and Burlington TS. At these stations electricity is transformed from 500 kV and 230 kV to 230 kV and 115 kV levels, respectively. Electricity is then delivered to the end users of LDCs and transmission connected industrial customers through 26 (supply transformer stations) step-down transformer stations. Figure 2 illustrates these stations as well as the four major regional sub-systems: Waterloo-Guelph 230 kV sub-system, Cambridge-Kitchener 230 kV sub-system, Kitchener Guelph 115 kV sub-system and South-Central Guelph 115 kV sub-system. The single line diagram of the KWCG region is shown in Figure 3 below.

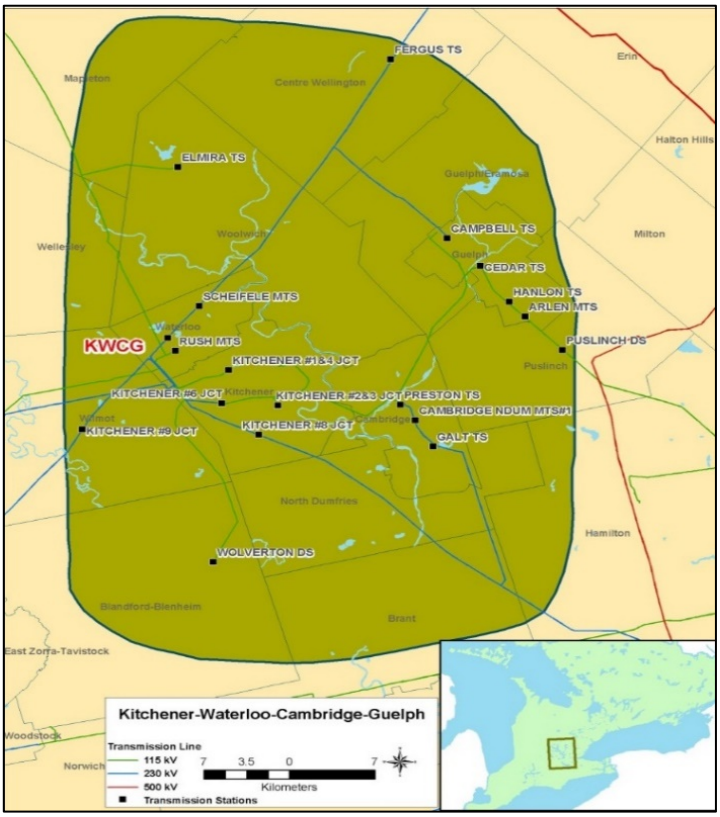

Figure 2: Map of KWCG Regional Planning Area

The circuits and stations of the area are summarized in the Table 2 below:

Table 2: Transmission Station and Circuits in the KWCG Region

115Kv circuits	230Kv circuits	Hydro One Transformer Stations	Generation Stations
B5C/B6C D7F/D9F F12C/F11C D11K/D12K D8S D10K	D4W/D5W D6V/D7V B22D/B23D M20D/M21D	*Detweiler TS , Fergus TS, *Cedar TS, Campbell TS, Galt TS, Elmira TS, Hanlon TS, Scheifele MTS, Waterloo North MTS#3, Energy MTS#1, Kitchener MTS #1, Kitchener MTS#3, Kitchener MTS#4, Kitchener MTS#5, Kitchener MTS#6, Kitchener MTS#7, Kitchener MTS#8, Kitchener MTS#9, Rush MTS, Wolverton DS, Puslinch DS, CTS 1, CTS 2, Preston TS*.	N/A

*Stations with Autotransformers installed

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

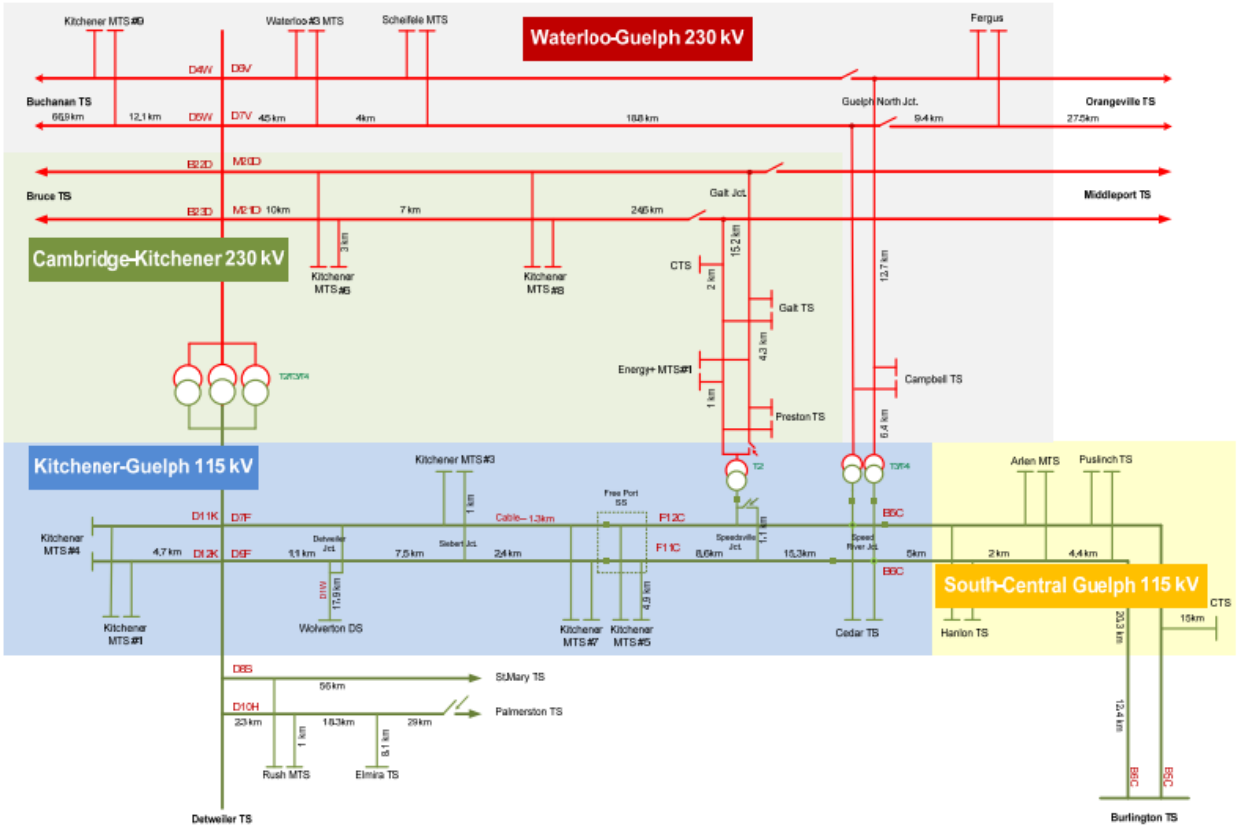

Figure 3: KWCG Transmission Single Line Diagram

5. INPUTS AND DATA

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

The information provided includes the following:

- KWCG 10-year Load Forecast for all supply stations inclusive of the inputs provided by the municipalities (e.g. through their MEPs & CEPs),
- Known capacity and reliability needs, operating issues, and/or major assets requiring replacement/ refurbishment; and
- Planned/foreseen transmission and distribution investments that are relevant to Regional Planning for the KWCG.
- Captured uncertainty in the load forecast as well as variability of electric demand drivers to identify any emerging needs and/or advancement or deferment of recommended investments.

6. ASSESSMENT METHODOLOGY

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

6.1 Technical Assessments and Study Assumptions

The technical assessment of needs was undertaken based on:

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

The following other assumptions are made in this report.

- The study period for this Needs Assessment is 2023-2032.
- The Region is summer peaking, so this assessment is based on summer peak loads.
- Line capacity adequacy is assessed by using coincident peak loads in the area.
- Station capacity adequacy is assessed by comparing the non-coincident peak load with the station’s normal planning supply capacity, assuming a 90% lagging power factor for stations having no low-voltage capacitor banks and 95% lagging power factor for stations having low-voltage capacitor banks.

- Normal planning supply capacity for transformer stations is determined by the Hydro One summer 10-Day Limited Time Rating (LTR) of a single transformer at that station.
- Adequacy assessment is conducted as per Ontario Resource Transmission Assessment Criteria (ORTAC).

6.2 Information Gathering process

6.2.1. Load forecast:

The LDCs provided their load forecast for all the stations supplying their loads in the KWCG region for the 10-year study period including the inputs from the Municipalities such as MEPs and CEPs. The IESO provided a Conservation and Demand Management ("CDM") and Distributed Generation ("DG") forecast for the KWCG region. The region's extreme summer non-coincident peak gross load forecasts for each station were prepared by applying the LDC load forecast growth rates to the actual 2022 summer peak extreme weather corrected loads. The extreme summer weather correction factors were provided by Hydro One. The net extreme summer weather load forecasts were produced by reducing the gross load forecasts for each station by the percentage CDM and then by the amount of effective DG capacity for the contracted projects only provided by the IESO for that station. It is to be noted that as contracts for existing DG resources in the region begin to expire, at which point the load forecast has a decreasing contribution from local DG resources, and an increase in net demand. This extreme summer weather corrected net load forecast for the individual stations in the KWCG region is given in Appendix A.

A very few of the stations have winter peaks marginally higher than summer peaks. The higher winter transformer and line ratings are adequate to accommodate the marginally higher loads. Therefore, only the Summer Assessment was carried out.

Alectra recently advised the TWG that a revised forecast, to better account for their community's decarbonization activities, will soon be available. This updated forecast will be included in later stages of the regional planning process and may impact the area's overall needs and/or may require the creation of a regional winter forecast.

6.2.2. Sensitivity Analysis:

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

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

6.2.3. Asset renewal Needs for Major HV Equipment:

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

6.2.4. System Reliability and Operational Issues:

- Palmerston-to-Detweiler transfer during Hanover bank outages:
  With current load forecast, this issue does not exist.

TWG members identified the following bulk system issues in the KWCG region to be discussed outside of the RP process:

- Detweiler TS configuration and operating instruction asking for multiple equipment to be out of service during contingency
- Detweiler TS Station Service Auto-Transfer Issues
- Palmerston-to-Detweiler transfer during Hanover bank outages.

7. NEEDS

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

Needs that were identified and discussed in the previous regional planning cycle with associated projects that were recently completed and reaffirmed needs that are underway are briefly described below with relevant updates and will not be discussed further in the report. These projects include:

- Hanlon T1/T2 transformer replacement was completed in 2022.
- Kitchener MTS #5 project is currently underway, existing 83MVA transformers to be replaced by 100MVA units. The planned in-service date is Q3 2024 for T10 and Q1 2025 for T9.
- Preston TS: Project for like-for-like replacement of transformers T3/T4 is underway. The planned in-service date is 2027.
- B5C/B6C 115kV line section refurbishment: The Burlington TS to Harper junction line refurbishment was completed in 2019. The refurbishment of line tap from Harper junction to CTS-1 is progressing slowly due to outage availability from customer. Expected completion date is Q3/Q4 2025.
- Galt TS: The asset condition assessment identified breakers and other components needs to be replaced in long-term. Hydro One will continue to monitor the condition of these components and if required, proceed with the replacement plan.
- Campbell TS: Two feeder breakers and a bus tie breaker for T1/T2 DESN were identified for replacement. The planned in-service date is 2032.

- Scheifele MTS T1/T2/T3/T4 Transformer replacement: These four (T1/T2/T3/T4) transformers are expected to approach end of life over the next 10-year horizon and are planned for replacement by Enova Power Corp. The expected year of replacement is between 2029-2033.

Note: The planned in-service year for the above projects is tentative and is subject to change.

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

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

Need Description	Recommended Plan/Update	Previous RIP Report Section	NA Report Section
Asset Renewal Needs			
Cedar TS	T7/T8 Transformers Replacement	7.3.2	7.1.1
Fergus TS	T3/T4 Transformers Replacement	7.3.4	7.1.2
Galt TS	Breakers and Component Replacement	7.3.5	7.1.4
Campbell TS	Breakers and Component Replacement	7.3.6	7.1.3
Station Capacity Needs			
Preston TS	Preston T3/T4 is forecasted to exceed its supply capacity during the study period (beyond the anticipated LTR of the new transformers)	N/A	7.2.1
Energy Inc MTS	The load at Energy Inc MTS is forecasted to exceed its supply capacity in the near term.	N/A	7.2.2
Campbell TS (T3/T4)	The load at Campbell TS (T3/T4) is forecasted to exceed its supply capacity in the near term.	N/A	7.2.3
Cedar TS	Load demand at both Cedar TS T1/T2 and T7/T8 DESNs is forecasted to exceed supply capacities in the mid and near term respectively.	N/A	7.2.4
Kitchener MTS#7	The load at Kitchener MTS#7 is forecasted to exceed its supply capacity in the mid-term.	N/A	7.2.5

Waterloo North MTS #3	The load at Waterloo North MTS#3 is forecasted to exceed its supply capacity in the mid-term.	N/A	7.2.6
Rush MTS	The load at Rush MTS is forecasted to exceed its supply capacity in the mid-term.	N/A	7.2.7
Transmission Line Capacity Needs			
M20D/M21D	The 230 kV M20D/M21D circuits supply transformer stations connected between Detweiler TS and Middleport TS. Loading violations were observed on M20D/ M21D circuits starting 2026 on the sections between Galt Jct. and Cambridge Jct. .	N/A	7.3.1
D11K/D12K	D11K/D12K supplies Enova Power Corp stations, Kitchener MTS#1 and Kitchener MTS#4. Loading violations were observed on these circuits for the loss of companion circuit in the mid-term.	N/A	7.3.2
D10H	The 115 kV D10H circuit between Detweiler TS and Hanover TS supplies loads at Rush MTS, Elmira TS and Palmerston TS with a normally open motorized switch just south of Palmerston TS. During the outage of 115 kV D8S circuit, loading violations were observed on a section of 115 kV D10H circuit in the long term.	N/A	7.3.3
System Reliability, Operation and Load restoration Needs			
M20D/ M21D	For the loss of two elements M20D/M21D on the 230 kV system, the load interrupted by configuration will exceed 600MW based on the peak coincident load, resulting in violation of ORTAC security criteria in the mid-term.	N/A	7.4.1
M20D/M21D	Load restoration violations observed on the M20D/M21D 230 kV circuits	N/A	7.4.1
D6V/ D7V	Marginal load restoration violations were observed for D6V/D7V 230 kV circuits	N/A	7.4.2
Voltage Performance			

M20D/M21D	Several voltage violations were observed in the near term.	N/A	7.4.3

7.1 Asset Renewal Needs for Major HV Transmission Equipment

Hydro One and TWG has identified asset renewal needs for major high voltage transmission equipment that are expected to be replaced over the next 10 years in the **KWCG** Region. The complete list of major HV transmission equipment requiring replacement in the **KWCG** Region is provided in table 4 in this section. Hydro One and Enova Power Corp are the Transmission Asset Owners (TAO) in the Region.

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

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

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

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

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

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

From Hydro One’s perspective as a facility owner and operator of its transmission equipment, do nothing is generally not an option for major HV equipment due to safety and reliability risk of equipment failure. This also results in increased maintenance cost and longer duration of customer outages.

Table 4: Major HV Transmission Asset assessed for Replacement in the region over the next 10 years

Station/Circuit	Need Description	Planned ISD
Kitchener MTS #5	The existing T10 & T9 83 MVA transformers to be replaced by 100 MVA units	T10-2024 T9-2025
Preston TS	Replacement of existing T3 & T4 transformers with similar size units.	2027
B5C/B6C	Refurbishment of B5C/B6C line between Burlington TS to CTS1.	2025
Scheifele MTS	The existing four transformers are expected to approach end of service life over the next 10 years Horizon	2029-2033

7.1.1 Cedar TS (T7/T8)

Cedar TS is located in the city of Guelph supplying Alectra loads. Cedar T7/T8 is a 115/13.8 kV DESN station with an LTR of 44 MVA (40 MW @ 0.9 PF), and 40 MW of peak load in 2022. Hydro One will continue to monitor the condition of these transformers. Based on asset condition assessment, T7/T8 are expected to reach end of life beyond the 10-year planning horizon. The station capacity need at this station is discussed in Section 7.2.4 of this report.

7.1.2 Fergus TS (T3/T4)

Fergus TS is a 230 kV/ 44 kV single DESN station having two 125 MVA transformers located in the township of Fergus having a supply capacity of 154 MW and supplying 94 MW of loads. The supply capacity of this station is forecasted to be sufficient over the study period and beyond. Based on asset condition assessment, T7/T8 are expected to reach end of life beyond the 10-year planning horizon.

The TWG recommended Hydro One to keep monitoring the condition of these transformers. No further regional planning coordination is required at this time.

7.1.3 Campbell TS (T1/T2) Breakers and Components

Campbell TS is located in the city of Guelph supplying Alectra loads. Campbell TS has two 230/13.8 kV DESNs T1/T2 and T3/T4, having supply capacities of 94 MW and 56 MW respectively. The loads on these two DESNs are currently supplying about 86 MW and 47 MW of loads respectively.

In the previous regional planning RIP report, two feeder breakers and a bus tie breaker for T1/T2 DESN were identified for replacement. Based on asset condition assessment, the equipment at this station are

expected to reach end of life within 10 year planning horizon. No further regional coordination is required at this time.

7.1.4 Galt TS Breakers and Components

Galt TS is located in the city of Cambridge supplying Energy + loads in the KWCG region. Galt TS has two 230/ 28-28 kV transformers T7 and T8 of 75/100/125 MVA, currently supplying 115 MW of peak loads. The total supply capacity of Galt TS is 169 MW, expected to be more than adequate over the study period.

The T7/T8 transformers were replaced in 2010 and 2012 respectively due to technical issues with the transformers. The breakers and other component at the station are almost 50 years old. Condition assessment has identified that these older components to be replaced in the long term.

The station cannot be downsized or eliminated because there is no nearby supply station/s having surplus supply capacity for transferring loads. Hydro One will continue monitoring the condition of these components at Galt TS and if required proceed with the replacement plan as required.

7.2 Station Capacity Needs

A 'Station Capacity' assessment was performed over the study period 2023-2032 for the 230kV and 115kV Transforming stations in the KWCG Region using the non-coincident summer peak load forecasts provided by the Technical Working Group. Based on the results, the following Station capacity needs have been identified during the study period:

7.2.1 Preston TS Supply Transformers

Preston TS (DESN) is located in the city of Cambridge supplying Grandbridge energy loads. Preston TS is a single T3/T4 DESN station of 125 MVA transformers with no additional LTR capability available. This station is currently supplying loads to its supply capacity. The non-coincident loads at Preston TS are currently forecasted to reach 242 MW[2] by the end of study period. The replacement of these station supply transformers is underway and forecasted to be completed by Q2 of 2027. Upon completion, the new station LTR is expected to be in the range of 180 MW. The Preston TS loads are currently forecasted to reach this new supply capacity in the in-service timeframe of these new transformers. A near-term solution is required to address this need. The TWG recommends to further review this need in next regional planning phases.

[2] Note: Due to the load limit on M20D/M21D imposed by ORTAC's load security criteria, the coincident peak loading on M20D/M21D is limited to 600 MW forecasted to exceed in 2032.

7.2.2 Energy MTS#1

Energy + MTS#1 is located in the city of Cambridge supplying Grandbridge Energy loads in the KWCG region. This station has an LTR of 102 MW and forecasted to exceed its supply capacity near the end of the study period. The loading at this station will be monitored by Grandbridge Energy and this need will be further assessed in the next regional planning phase. Grandbridge Energy is working on measures to transfer load within the distribution system to Galt TS to address near term loading concerns. Hydro One and Grandbridge will continue to monitor load levels.

7.2.3 Campbell TS Transformer

Campbell TS is located in the city of Guelph supplying Alectra loads. Campbell TS has two 230/13.8 kV DESNs units supplying through T1/T2 and T3/T4 transformers, having supply capacities of 94 MW and 56 MW respectively. These two Campbell TS DESNs are currently supplying about 81 MW and 45 MW of loads respectively and their combined loads at Campbell TS are forecasted to exceed the total station supply capacity close to the end of the study period.

Alectra to propose measures to address capacity needs at this station, if required. Hydro One and Alectra will continue to monitor load levels. The TWG recommends that no further regional coordination is required at this time.

7.2.4 Cedar T1/T2 and T7/T8

Cedar TS is located in the city of Guelph supplying Alectra loads. Cedar TS has two 115/13.8 kV DESN stations T1/T2 and T7/T8 of 75 MVA with a LTR of 115 MVA (103 MW @ 0.9 PF) and 37 MVA with a LTR of 44 MVA (40 MW @ 0.9 PF), currently supplying 82 MW and 40 MW of peak loads respectively. The total load of both DESNs is forecasted to exceed its supply capacity in the near term.

Alectra to propose measures to address this capacity needs, if required. Hydro One and Alectra to continue monitoring load levels. The TWG recommends that no further regional coordination is required at this time.

7.2.5 Kitchener MTS #7

Kitchener MTS #7 is located in the city of Kitchener supplying Enova Power Corp loads. Kitchener MTS #7 is a 115/ 13.8 kV single T13/T14 DESN station having 50 MVA transformers and a LTR of 60 MVA (54 MW @ 0.9 PF). This station is currently supplying 37 MW of peak load. The loads at Kitchener MTS #7 are currently forecasted to grow approaching its supply capacity near the end of the study period.

Enova Power Corp to monitor the loading on this station and manage any overloading through load transfers, if required. The TWG recommends that no further regional coordination is required at this time.

7.2.6 Waterloo North MTS #3

Waterloo North MTS#3 is located in the city of Waterloo supplying Enova Power Corp. Waterloo North MTS#3 is a 230/27.6 kV single T1/T2 DESN station having an LTR of 85MVA. This station is currently supplying 48 MW of peak load. The loads at Waterloo North MTS#3 is currently forecasted to grow approaching its supply capacity near the end of the study period. Enova Power Corp to monitor the loading on this station and manage any overloading in the mid term through load transfers and a new supply station in the long term. The TWG recommends that no further regional coordination is required at this time.

7.2.7 Rush MTS

Rush MTS is located in the city of Waterloo supplying Enova Power Corp loads. Rush MTS is a 115/ 13.8 kV single T1/T2 DESN station having an LTR of 68 MW. This station is currently supplying 50 MW of peak load. The loads at Rush MTS is currently forecasted to grow approaching its supply capacity near the end of the study period. Enova Power Corp to monitor the loading on this station and manage any overloading in the mid term through load transfers and a new supply station in the long term. The TWG recommends that no further regional coordination is required at this time and will be reviewed in next regional planning cycle.

7.3 Transmission Lines Capacity Needs

All line and equipment loads shall be within their continuous ratings with all elements in service and within their long-term emergency ratings with any one element out of service. Immediately following contingencies, lines may be loaded up to their short-term emergency ratings where control actions such as re-dispatch, switching, etc. are available to reduce the loading to the long-term emergency ratings. A Transmission Lines Capacity Assessment was performed over the study period 2023-2032 for the 230kV and 115kV Transmission line circuits in the KWCG Region by assessing thermal limits of the circuit and the voltage range as per ORTAC to cater this need. Based on the results, the following line capacity needs have been identified in the during the study period:

7.3.1 M20D/M21D – 230 kV – Transmission Circuit Supply

The M20D/M21D is a 230kV double circuit line about 58 km long, supplying the following stations:

- Kitchener MTS #6
- Kitchener MTS #8
- Galt TS
- Preston TS
- Energy + Inc.
- A Customer CTS

For the loss of one of the M20D or M21D 230 kV circuits, the loading on the Galt JCT to Cambridge JCT section exceeds its rating starting in 2026 (Summer load forecast). The TWG recommends to further review this need in next regional planning phases.

7.3.2 D11K/D12K

D11K/D12K is a 115 kV line supplying Enova Power Corp stations of Kitchener MTS#1 and Kitchener MTS#4. With the current load forecast on the above stations, these D11K and D12K 115 kV circuits will be experiencing overloading for the loss of companion circuits by the end of the study period (2032). The TWG recommends to further review this need in next regional planning phases.

7.3.3 D10H

The 115 kV D10H circuit between Detweiler TS and Hanover TS supplies loads to Rush MTS and Elmira TS. The D10H circuit has a normally open point just south of Palmerston TS through a motorized disconnect switch for emergency supply to Palmerston TS. The northern section of D10H is supplied from Hanover TS radially supplying Palmerston TS loads. The southern section of D10H is supplied through Detweiler TS radially supplying Enova Power Corp's 34 MW of Elmira TS peak loads. D10H also supplies Rush MTS which has a dual supply through 115 kV D8S circuit from Detweiler TS. For any outage of 115 kV D8S circuit. The D10H line section between Detweiler and Leong Jct is approaching its supply capacity close to the end of the study period.

7.4 System Reliability, Operation and Restoration Needs

The transmission system must be planned to satisfy demand levels up to the extreme weather, median-economic forecast for an extended period with any one transmission element out of service. A study has been performed, considering the net coincident load forecast and the loss of one element over the study period 2023-2032 to cater this need**.** Based on the results, some system reliability, operating and restoring issues have been identified for this Region.

7.4.1 M20D/M21D Load Security and Restoration Needs

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

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

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

For the loss of double 230kV circuits (M20D/M21D), a total peak coincident load of 638 MW will be interrupted in 2032 by configuration which violates ORTAC load security criteria since not more than 600 MW of load may be interrupted by configuration.

With respect to load restoration, a total of 638 MW (2032 forecast) will be interrupted by configuration, of which, 388 MW needs to be restored within 30 mins as per ORTAC criteria. For a double line fault on Galt Jct. to Preston TS section, only 210 MW (out of the 388MW required to be restored) of that load is restorable. Kitchener MTS#6 and MTS#8 load can be restored via Galt Jct in-line switches and approximately 100 MW of load can be restored at Preston TS. This can be accomplished by opening the M20/211D line disconnect switches at Preston TS and back-feed Preston TS T2 230-115 kV autotransformer to supply load at Preston TS only.

Therefore, the existing restoration capability to loads connected to M20/21D does not meet criteria for the duration of the study period. The TWG recommends to further review this need in next regional planning phases.

7.4.2 D6V/D7V Restorations Needs.

By year 2032, the total peak coincident forecasted load connected to D6V/D7V is 517 MW. Loss of this double circuit line (Tower Contingency) would result in the loss of all 517 MW which is below the ORTAC load security limit. To restore load to these stations, the 230 kV in-line switches will be utilized to isolate the problem and return to service the remaining healthy circuit sections. These switches allow for more flexibility to restore load to the affected stations in a timely fashion. Non-restorable load within 30

minutes is estimated to be about 256 MW. Hence, the load restoration criterion is substantially met. Therefore, no additional transmission restoration capability is warranted at this time, and the loading levels will be monitored.

7.4.3 Voltage Performance

M20D or M21D post contingency voltage change exceeds the 10% pre-tap and 5% post-tap limits on the low voltage side at Preston TS and Energy + Inc MTS within the near-term coincident forecast. The post contingency voltages also drop beyond the allowable voltage range. The situation is further worsened in the subsequent years.

In the midterm, the voltage change limits on the high side of Preston TS, Galt TS and Energy + Inc MTS are violated for the post-contingency loss of M20D or M21D circuits. Voltage also drops below the allowable voltage range. The TWG recommends to further review this need in next regional planning phases.

8. SENSITIVITY ANALYSIS

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

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

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

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

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

Sr.no	Need Identified	Normal Growth Scenario	High Growth Scenario	Low Growth Scenario
1	Preston TS- Capacity need	2026	2026	2029
2	Galt TS- Capacity need	Reaches capacity in 2032	2030	Long term
3	Energy Inc MTS - Capacity need	2023	2023	2023
4	Rush MTS - Capacity need	2030	2029	Long term
5	Waterloo North MTS #3 - Capacity need	2030	2030	Long term
6	Campbell TS (T3/T4)- Capacity need	2026	2025	2030
7	Cedar TS (T7/T8)- Capacity need	2024	2024	2024
8	Cedar TS (T1/T2)- 115kV- Capacity need	2031	2029	Long term
9	Kitchener MTS#7	2031	2030	Long term
10	M20D/M21D Transmission Circuit Supply	2026	2024	2026
11	D11K/D12K- Transmission Circuit Supply	2032	2030	Long term
12	D10H - Transmission Circuit Supply	Long term	2030	Long term
13	M20D/M21D Load Security	2032	2028	Long term
14	M20D/M21D Restoration Needs	2025	2023	2025
15	D6V/D7V Restoration Needs	Long term	2030	Long term
16	Voltage change violation on M20D/M21D	2026	2025	2026

The sensitivity analysis identified the additional capacity needs towards the end of the study period and advanced the triggering date of all the needs. These needs will be assessed again during the next phases of this Regional Planning cycle.

The 2022 forecast from last year's RIP aligns with the actual 2022 loading. Therefore, the high growth scenario can be discounted for now, and monitoring the load growth is recommended.

9. CONCLUSION AND RECOMMENDATION

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

Table 7: Needs which do not require regional coordination

Sr.no.	Need	Recommendation
1	Campbell TS (T3/T4) Station Capacity	LDC to propose measures to address capacity needs, if required, Hydro One and Alectra to continue to monitor load levels.
2	Cedar TS (T1/T2) Station Capacity	LDC to propose measures to address capacity needs, if required, Hydro One and Alectra to continue to monitor load levels.
3	Kitchener MTS #7 Station Capacity	LDC to monitor load levels and manage any overloading through load transfers.
4	Cedar TS (T7/T8) Station Capacity	LDC to propose measures to address capacity needs, if required. Hydro One and Alectra to continue to monitor load levels. Advancing and upsizing Cedar transformers is also being considered as an option
5	Waterloo North MTS #3 Station Capacity	LDC to monitor the loading on this station and manage any overloading in the mid term through load transfers and a new supply station in the long term.
6	Rush MTS Station Capacity	LDC to monitor the loading on this station and manage any overloading in the mid term through load transfers and a new supply station in the long term.

Table 8: Needs which require further regional coordination

Sr.no.	Need	Recommendation
1	Preston TS Station Capacity	To be further assessed in the next RP phases. Hydro One and Grandbridge Energy to keep monitoring load levels
2	Energy Inc MTS Station Capacity	To be further assessed in the next RP phases. Grandbridge Energy to monitor load levels

3	Overload - M20D/M21D post contingency capacity violation (Galt Jct x Cambridge #1 Jct)-	To be further assessed in the next RP phases.
4	System security violation - M21D/M20D 230 kV circuits	To be further assessed in the next RP phases.
5	Voltage violations – On 230 kV M20D or M21D circuit for loss of companion circuit.	To be further assessed in the next RP phases.
6	Load restorations -M20D or M21D due to single tower outage	To be further assessed in the next RP phases.
7	Overload - D11K/D12K 115 kV circuits experience post contingency violation (Detweiler TS x Kitchener MTS#1 & #4 Jct.)	To be further assessed in the next phases. Enova Power Corp to explore load transfers between their stations. H1 and Enova Power Corp to monitor load levels.

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

- Grandbridge Energy
- Enova Power Corp.

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

- Hydro One Networks Inc. (Distribution)
- Alectra Inc.
- Center Wellington Hydro
- Halton Hills Hydro Inc.
- Wellington North Power

10. REFERENCES

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

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

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

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

Appendix A: Extreme Summer Weather Adjusted Net Load Forecast

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

Station/DESN	LTR (MW)	Historical (MW)	Summer Net Forecast (MW)									
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Arlen MTS	45.0	35.1	34.2	17.8	20.1	21.8	22.6	23.8	24.6	26.0	27.3	28.6
Campbell TS (T1/T2)	94.1	81.2	86.1	87.3	88.3	89.1	88.8	89.2	89.2	89.5	90.0	91.0
Campbell TS (T3/T4)	56.3	45.7	46.9	54.2	56.2	56.7	56.8	57.3	57.6	58.1	58.7	59.3
Cedar TS (T1/T2)	103.3	82.5	89.0	90.7	92.0	94.8	95.8	97.6	99.1	101.3	103.5	105.4
Cedar TS (T7/T8)	39.9	40.7	45.0	46.8	48.3	50.6	51.2	52.1	52.9	54.0	55.1	56.0
Elmira TS	55.0	36.7	33.8	33.9	34.0	34.2	34.2	36.4	36.5	36.7	37.0	37.3
Energy Inc(Cam) MTS#1	101.7	115.2	125.5	130.5	135.6	141.3	146.3	152.5	158.5	164.9	172.4	179.7
Fergus TS	153.5	91.0	93.9	95.9	98.6	101.9	104.9	108.3	110.7	113.5	117.7	120.0
Galt TS	169.4	113.6	117.0	121.9	126.7	132.1	136.7	142.5	148.1	154.6	161.5	168.4
Hanlon TS	42.9	25.7	27.9	28.7	29.2	30.1	30.8	31.7	32.4	33.6	34.7	36.2
Kitchener MTS # 1	54.0	26.1	27.5	28.9	30.2	31.7	34.2	36.9	39.6	42.2	45.1	47.9
Kitchener MTS # 3	108.0	55.1	48.2	59.1	60.1	61.3	63.0	65.2	67.2	85.0	95.9	98.2
Kitchener MTS # 4	90.0	58.6	71.8	63.1	64.4	65.9	68.2	71.0	73.6	76.3	79.3	82.2
Kitchener MTS#5	79.7	72.0	58.1	77.2	78.4	80.0	91.4	94.8	97.7	100.6	98.5	102.5
Kitchener MTS#6	90.0	57.0	64.7	61.1	62.3	63.6	65.7	68.1	70.4	72.7	75.4	78.0
Kitchener MTS#7	54.0	37.4	39.8	40.6	41.7	43.0	44.9	47.2	49.4	51.6	54.1	56.5
Kitchener MTS#8	54.0	36.2	36.5	40.0	41.6	43.3	46.5	50.1	53.5	41.1	44.7	48.3
Kitchener MTS#9	90.0	32.3	20.3	28.7	29.5	30.3	37.5	38.9	40.3	41.7	43.2	44.7
Preston TS[3]	112.5	102.4	109.8	135.5	144.5	190.1	198.0	206.4	214.4	223.0	233.0	242.8
Puslinch DS	56.3	32.7	39.6	40.3	41.0	41.8	42.3	43.0	43.7	44.4	45.4	46.2
Rush MTS	67.5	50.6	54.7	55.6	56.6	57.8	58.6	62.0	65.3	69.4	73.7	78.0
Scheifele MTS (T3/T4)	99.0	83.6	89.7	91.3	92.9	94.9	96.1	101.9	107.3	114.0	113.7	110.1
Scheifele MTS (T1/T2)	62.1	50.5	54.0	55.0	56.0	57.1	57.9	61.4	64.7	58.0	54.8	58.8
Waterloo North MTS#3	76.5	48.4	52.6	53.5	54.5	55.6	56.3	59.7	62.9	77.4	86.0	90.3
Wolverton DS	54.4	18.2	18.2	18.7	19.1	19.7	20.0	20.6	21.0	21.6	22.2	22.8
CTS 1		4.2	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
CTS 2		5.6	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Snyder MTS	85.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	20.6

[3] Upon completion of an on-going project, the new station LTR is expected to be in the range of 180 MW.

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

Station/DESN	LTR (MW)	Historical (MW)	Summer Net Forecast (MW)									
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Arlen MTS	45.0	30.0	34.2	17.8	20.1	21.8	22.6	23.8	24.6	26.0	27.3	28.6
Campbell TS (T1/T2)	94.1	81.2	86.1	87.3	88.3	89.1	88.8	89.2	89.2	89.5	90.0	91.0
Campbell TS (T3/T4)	56.3	43.0	44.0	50.8	52.8	53.3	53.3	53.8	54.1	54.5	55.2	55.7
Cedar TS (T1/T2)	103.3	57.1	61.6	62.7	63.6	65.6	66.2	67.5	68.6	70.0	71.6	73.0
Cedar TS (T7/T8)	39.9	40.4	44.6	46.3	47.9	50.1	50.7	51.7	52.4	53.5	54.6	55.5
Elmira TS	55.0	36.7	33.6	33.7	33.8	34.0	34.0	36.2	36.3	36.5	36.8	37.1
EnergyInc(Cam) MTS#1	101.7	95.8	105.0	109.2	113.5	118.3	122.4	127.6	132.6	138.0	144.3	150.5
Fergus TS	153.5	86.2	88.1	89.9	92.5	95.6	98.5	101.6	103.9	106.5	110.6	112.9
Galt TS	169.4	83.8	91.5	95.4	99.2	103.4	107.0	111.6	116.0	121.2	126.6	132.1
Hanlon TS	42.9	24.3	26.4	27.1	27.6	28.5	29.1	30.0	30.6	31.8	32.8	34.2
Kitchener MTS # 1	54.0	25.1	26.4	27.8	29.1	30.5	32.9	35.5	38.1	40.6	43.4	46.1
Kitchener MTS # 3	108.0	51.8	45.3	55.5	56.4	57.6	59.2	61.2	63.1	79.8	90.1	92.2
Kitchener MTS # 4	90.0	53.9	66.1	58.1	59.3	60.7	62.8	65.4	67.8	70.3	73.0	75.7
Kitchener MTS#5	79.7	65.8	53.0	70.4	71.6	73.0	83.5	86.6	89.2	91.8	90.0	93.6
Kitchener MTS#6	90.0	49.5	56.2	53.0	54.0	55.2	57.0	59.1	61.1	63.2	65.5	67.7
Kitchener MTS#7	54.0	34.4	36.6	37.3	38.4	39.5	41.4	43.5	45.5	47.5	49.8	52.0
Kitchener MTS#8	54.0	32.7	32.8	36.0	37.4	39.0	41.9	45.1	48.2	37.0	40.3	43.5
Kitchener MTS#9	90.0	29.2	17.7	25.3	26.0	26.7	33.7	35.1	36.3	37.5	39.0	40.3
Preston TS[3]	112.5	98.8	108.3	133.7	142.6	187.6	195.4	203.7	211.6	220.1	229.9	239.6
Puslinch DS	56.3	32.1	38.9	39.5	40.2	41.0	41.5	42.2	42.9	43.6	44.5	45.4
Rush MTS	67.5	46.3	50.0	50.9	51.8	52.9	53.6	56.8	59.8	63.5	67.5	71.4
Scheifele MTS (T3/T4)	99.0	75.2	80.6	82.0	83.5	85.2	86.4	91.5	96.4	102.4	102.2	98.9
Scheifele MTS (T1/T2)	62.1	49.6	53.0	54.0	54.9	56.1	56.8	60.2	63.5	57.0	53.8	57.7
Waterloo North MTS#3	76.5	43.0	46.4	47.3	48.1	49.1	49.8	52.7	55.5	68.3	75.9	79.7
Wolverton DS	54.4	13.2	14.4	14.8	15.1	15.5	15.8	16.3	16.6	17.1	17.6	18.1
CTS 1		2.1	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
CTS 2		2.9	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Snyder MTS	85.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	20.6

[3]Upon completion of an on-going project, the new station LTR is expected to be in the range of 180 MW.

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

Station/DESN	LTR (MW)	Historical (MW)	Summer Net Forecast (MW)									
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Arlen MTS	45	35.1	34.2	17.8	21.2	23.8	25.0	26.8	28.1	30.1	32.0	34.0
Campbell TS (T1/T2)	94.1	81.2	86.1	87.3	88.7	90.0	89.6	90.1	90.2	90.5	91.3	92.9
Campbell TS (T3/T4)	56.3	45.7	46.9	54.2	57.1	58.0	58.1	58.8	59.3	60.0	61.0	61.8
Cedar TS (T1/T2)	103.3	82.5	89.0	90.7	92.7	96.8	98.3	101.1	103.3	106.6	109.9	112.8
Cedar TS (T7/T8)	39.9	40.7	45.0	46.8	49.1	52.5	53.4	54.8	55.9	57.6	59.3	60.7
Elmira TS	55	36.7	33.8	33.9	34.1	34.4	34.3	37.7	37.9	38.1	38.6	39.0
EnergyInc(Cam) MTS#1	101.7	115.2	125.5	130.5	138.2	146.8	154.2	163.5	172.5	182.1	193.3	204.4
Fergus TS	153.5	91.0	93.9	95.9	100.0	105.0	109.5	114.5	118.1	122.3	128.6	132.1
Galt TS	169.4	113.6	117.0	121.9	129.1	137.2	144.1	152.9	161.3	171.0	181.4	191.7
Hanlon TS	42.9	25.7	27.9	28.7	29.4	30.8	31.8	33.3	34.2	36.1	37.6	39.9
Kitchener MTS # 1	54	26.1	27.5	28.9	30.9	33.0	36.8	40.9	44.9	48.9	53.2	57.4
Kitchener MTS # 3	108	55.1	48.2	59.1	60.6	62.4	65.0	68.3	71.2	98.0	114.4	117.8
Kitchener MTS # 4	90	58.6	71.8	63.1	65.0	67.3	70.8	75.0	78.9	83.0	87.5	91.8
Kitchener MTS#5	79.7	72.0	58.1	77.2	79.1	81.4	98.6	103.7	107.9	112.3	109.2	115.1
Kitchener MTS#6	90	57.0	64.7	61.1	62.9	64.9	67.9	71.7	75.1	78.6	82.5	86.4
Kitchener MTS#7	54	37.4	39.8	40.6	42.3	44.2	47.1	50.6	53.8	57.2	60.9	64.4
Kitchener MTS#8	54	36.2	36.5	40.0	42.4	45.0	49.8	55.1	60.2	41.7	47.1	52.5
Kitchener MTS#9	90	32.3	20.3	28.7	29.9	31.2	41.8	44.1	46.1	48.2	50.5	52.7
Preston TS[3]	112.5	102.4	109.8	135.5	149.0	217.3	229.3	241.8	253.9	266.8	281.7	296.5
Puslinch DS	56.3	32.7	39.6	40.3	41.3	42.5	43.2	44.4	45.4	46.5	47.9	49.2
Rush MTS	67.5	50.6	54.7	55.6	57.1	58.9	60.0	65.2	70.2	76.2	82.8	89.2
Scheifele MTS (T3/T4)	99	83.6	89.7	91.3	93.7	96.7	98.6	107.1	115.3	125.3	124.9	119.5
Scheifele MTS (T1/T2)	62.1	50.5	54.0	55.0	56.5	58.2	59.4	64.5	69.5	59.6	54.7	60.7
Waterloo North MTS#3	76.5	48.4	52.6	53.5	54.9	56.6	57.8	62.8	67.6	89.3	102.2	108.7
Wolverton DS	54.4	18.2	18.2	18.7	19.4	20.2	20.7	21.5	22.2	23.0	24.0	24.9
CTS 1		4.2	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
CTS 2		5.6	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Snyder MTS	85.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10	20.6

[3] Upon completion of an on-going project, the new station LTR is expected to be in the range of 180 MW.

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

Station/DESN	LTR (MW)	Historical (MW)	Summer Net Forecast (MW)									
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Arlen MTS	45.0	30.0	34.2	17.8	21.2	23.8	25.0	26.8	28.1	30.1	32.0	34.0
Campbell TS (T1/T2)	94.1	81.2	86.1	87.3	88.7	90.0	89.6	90.1	90.2	90.5	91.3	92.9
Campbell TS (T3/T4)	56.3	43.0	44.0	50.8	53.7	54.5	54.6	55.3	55.7	56.4	57.4	58.1
Cedar TS (T1/T2)	103.3	57.1	61.6	62.7	64.1	67.0	68.0	69.9	71.5	73.7	76.0	78.1
Cedar TS (T7/T8)	39.9	40.4	44.6	46.3	48.6	52.0	52.9	54.3	55.4	57.1	58.7	60.1
Elmira TS	55.0	36.7	33.6	33.7	33.9	34.2	34.1	37.5	37.6	37.9	38.4	38.8
EnergyInc(Cam) MTS#1	101.7	95.8	105.0	109.2	115.6	122.8	129.1	136.9	144.4	152.5	161.9	171.2
Fergus TS	153.5	86.2	88.1	89.9	93.8	98.5	102.7	107.5	110.9	114.9	121.0	124.3
Galt TS	169.4	83.8	91.5	95.4	101.0	107.4	112.9	119.7	126.3	134.1	142.3	150.4
Hanlon TS	42.9	24.3	26.4	27.1	27.8	29.2	30.1	31.4	32.3	34.1	35.6	37.7
Kitchener MTS # 1	54.0	25.1	26.4	27.8	29.7	31.8	35.4	39.4	43.2	47.1	51.2	55.2
Kitchener MTS # 3	108.0	51.8	45.3	55.5	56.9	58.6	61.0	64.1	66.9	92.0	107.4	110.6
Kitchener MTS # 4	90.0	53.9	66.1	58.1	59.9	61.9	65.2	69.1	72.7	76.4	80.5	84.5
Kitchener MTS#5	79.7	65.8	53.0	70.4	72.2	74.3	90.0	94.7	98.6	102.5	99.7	105.1
Kitchener MTS#6	90.0	49.5	56.2	53.0	54.6	56.4	59.0	62.2	65.2	68.2	71.7	75.0
Kitchener MTS#7	54.0	34.4	36.6	37.3	38.9	40.6	43.4	46.6	49.6	52.6	56.1	59.3
Kitchener MTS#8	54.0	32.7	32.8	36.0	38.2	40.5	44.9	49.7	54.3	37.5	42.5	47.3
Kitchener MTS#9	90.0	29.2	17.7	25.3	26.3	27.5	38.0	40.0	41.8	43.7	45.8	47.8
Preston TS[3]	112.5	98.8	108.3	133.7	147.0	214.5	226.3	238.6	250.6	263.3	278.0	292.6
Puslinch DS	56.3	32.1	38.9	39.5	40.5	41.7	42.4	43.6	44.6	45.6	47.0	48.3
Rush MTS	67.5	46.3	50.0	50.9	52.3	53.9	55.0	59.7	64.3	69.8	75.8	81.6
Scheifele MTS (T3/T4)	99.0	75.2	80.6	82.0	84.2	86.9	88.6	96.3	103.6	112.6	112.3	107.4
Scheifele MTS (T1/T2)	62.1	49.6	53.0	54.0	55.4	57.2	58.3	63.4	68.2	58.5	53.7	59.6
Waterloo North MTS#3	76.5	43.0	46.4	47.3	48.5	50.0	51.0	55.4	59.7	78.9	90.3	96.0
Wolverton DS	54.4	13.2	14.4	14.8	15.3	15.9	16.4	17.0	17.6	18.2	19.0	19.7
CTS 1		2.1	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
CTS 2		2.9	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Snyder MTS	85.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	20.6

[3]Upon completion of an on-going project, the new station LTR is expected to be in the range of 180 MW.

Appendix B: Lists of Step-Down Transformer Stations

Sr. No.	Transformer Station	Voltage (kV)	Supply Circuits
1.	Arlen MTS	115	B5C/B6C
2.	Campbell TS (T1/T2)	230	D6V/D7V
3.	Campbell TS (T3/T4)	230	D6V/D7V
4.	Cedar TS (T1/T2)	115	B5C/B6C
5.	Cedar TS (T7/T8)	115	B5C/B6C
6.	Elmira TS	115	D10H
7.	Energy+ MTS #1	230	M20D/M21D
8.	Fergus TS	230	D6V/D7V
9.	Galt TS	230	M20D/M21D
10.	Hanlon TS	115	B5C/B6C
11.	Kitchener MTS # 1	115	D11K/D12K
12.	Kitchener MTS # 3	115	D7F/D9F
13.	Kitchener MTS # 4	115	D11K/D12K
14.	Kitchener MTS #5	115	F11C/F12C
15.	Kitchener MTS #6	230	M20D/M21D
16.	Kitchener MTS #7	115	D7F/D9F
17.	Kitchener MTS #8	230	M20D/M21D
18.	Kitchener MTS #9	230	D4W/D5W
19.	Preston TS	230	M20D/M21D
20.	Puslinch DS	115	B5C/B6C
21.	Rush MTS	115	D10H/D8S
22.	Scheifele MTS	230	D6V/D7V
23.	Waterloo North MTS#3	230	D6V/D7V
24.	Wolverton DS	115	D7F/D9F
25.	CTS - 1	230	M20D/M21D
26.	CTS - 2	115	B5C/B6C

Appendix C: Lists of Transmission Circuits

Sr. No.	Connecting Stations	Circuit ID	Voltage (kV)
1.	D6V/ D7V	Detweiler TS	Orangeville TS
2.	M20D/ M21D	Detweiler TS	Middleport TS
3.	D4W/ D5W	Detweiler TS	Buchanan TS
4.	B22D/ B23D	Detweiler TS	Bruce TS
5.	D7F/ D9F	Detweiler TS	Free Port SS
6.	F11C/ F12C	Free Port SS	Cedar TS
7.	B5C/ B6C	Cedar TS	Burlington TS
8.	D11K/ D12K	Detweiler TS	Kitchener MTS #4
9.	D8S	Detweiler TS	St. Mary TS
10.	D10H	Detweiler TS	Hanover TS

Appendix D: List of LDC's

Sr. no.	Name of LDC
1	Energy + Inc
2	Alectra
3	H1 Distribution
4	Enova Power Corp
5	Centre Wellington Hydro
6	Halton Hills Hydro
7	Milton Hydro
8	Wellington North Power Inc

Appendix E: List of Municipalities in the region

Sr. no.	Name of Municipality
1	Township of Blandford-Blenheim
2	City of Cambridge
3	City of Kitchener
4	City of Waterloo
5	Regional Municipality of Waterloo
6	Township of North Dumfries
7	Township of Wellesley
8	Township of Wilmot
9	Township of Woolwich
10	Region of Waterloo
11	City of Guelph
12	County of Wellington
13	Township of Centre Wellington
14	Township of Puslinch
15	County of Perth
16	Town of St. Marys

Appendix F: Acronyms

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

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