Kitchener-Waterloo-Cambridge-Guelph Region

Integrated Regional Resource Plan

May 2021

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List of Abbreviations

Alectra	Alectra Utilities Corp.
CDM	Conservation Demand Management
Centre Wellington Hydro	Centre Wellington Hydro Ltd.
DER	Distributed Energy Resources
DG	Distributed Generation
DSC	Distribution System Code
Energy+	Energy+ Inc.
FIT	Feed-in Tariff
GATR	Guelph Area Transmission Refurbishment
Halton Hills Hydro	Halton Hills Hydro Inc.
Hydro One	Hydro One Networks Inc.
IESO	Independent Electricity System Operator
IRRP	Integrated Regional Resource Plan
kV	Kilovolt
KWCG Region	Kitchener, Waterloo, Cambridge and Guelph
LAC	Local Advisory Committee
LDC	Local Distribution Company
LMC	Load Meeting Capability
LRT	Light Rail Transit
LTR	Limited Time Rating
LV	Low-voltage
Milton Hydro	Milton Hydro Distribution Inc.
MTS	Municipal Transformer Station
MW	Megawatt
NERC	North American Electric Reliability Corporation
OEB	Ontario Energy Board
OPA	Ontario Power Authority
ORTAC	Ontario Resource and Transmission Assessment Criteria
PPWG	Planning Process Working Group
RIP	Regional Infrastructure Plan
TOU	Time-of-Use
TS	Transformer Station
TSC	Transmission System Code
Wellington North Power	Wellington North Power Inc.
WNH	Waterloo North Hydro Inc.
Working Group	Technical Working Group of the KWCG Region

This Integrated Regional Resource Plan (IRRP) was prepared by the Independent Electricity System Operator (IESO) pursuant to the terms of its Ontario Energy Board licence, EI-2013-0066.

This IRRP was prepared on behalf of the Technical Working Group (Working Group) of the Kitchener-Waterloo-Cambridge-Guelph (KWCG) region which included the following members:

- Independent Electricity System Operator
- Alectra Utilities Corporation
- Centre Wellington Hydro Ltd.
- Waterloo North Hydro Inc.
- Energy+ Inc.
- Kitchener-Wilmot Hydro Inc.
- Wellington North Power Inc.
- Halton Hills Hydro Inc.
- Milton Hydro Distribution Inc.
- Hydro One Networks Inc. (Distribution)
- Hydro One Networks Inc. (Transmission)

The Working Group assessed the adequacy of electricity supply to customers in the KWCG Region over a 20-year period beginning in 2019; developed a plan that considers opportunities for coordination in anticipation of potential demand growth and varying supply conditions in the region; and developed an implementation plan for the recommended options, while maintaining flexibility in order to accommodate changes in key conditions over time.

The Working Group developed a plan that considers the potential for long-term electricity demand growth and varying supply conditions in the region and maintains the flexibility to accommodate changes to key conditions over time.

The KWCG Working Group members agree with the IRRP's recommendations and support implementation of the plan, subject to obtaining necessary regulatory approvals and appropriate community consultations.

The KWCG Working Group members do not commit to any capital expenditures and must still obtain all necessary regulatory and other approvals to implement recommended actions.

1 Introduction

This Integrated Regional Resource Plan (IRRP) for the Kitchener-Waterloo-Cambridge-Guelph (KWCG) region addresses the regional electricity needs for the next 20 years (the "study period"). This region is located in southwestern Ontario and, as shown in Figure 1.1, encompasses the Region of Waterloo and the cities of Kitchener, Waterloo, Cambridge and Guelph, and the townships of Wellesley, Woolwich, Wilmot, North Dumfries, and portions of Perth, and Oxford. Wellington County and the municipalities of Blandford-Blenheim, Centre Wellington, Guelph/Eramosa, and Puslinch are also included in the region.

The KWCG Region is summer peaking and is served via 230 kV and 115 kV circuits originating from Detweiler TS and Burlington TS, and by load stations which tap double-circuit 230 kV lines connecting to Detweiler from Orangeville (D6V & D7V), from Middleport (M20D & M21D) and from Buchanan (D4W & D5W) as shown in Figure 1.2 and Figure 1.3. There are no transmission connected resources in this area. The area does include distribution connected resources, including contracted energy storage facilities at Arlen MTS, Kitchener MTS #5, and Elmira TS.

Figure 1.1| Map of KWCG Region

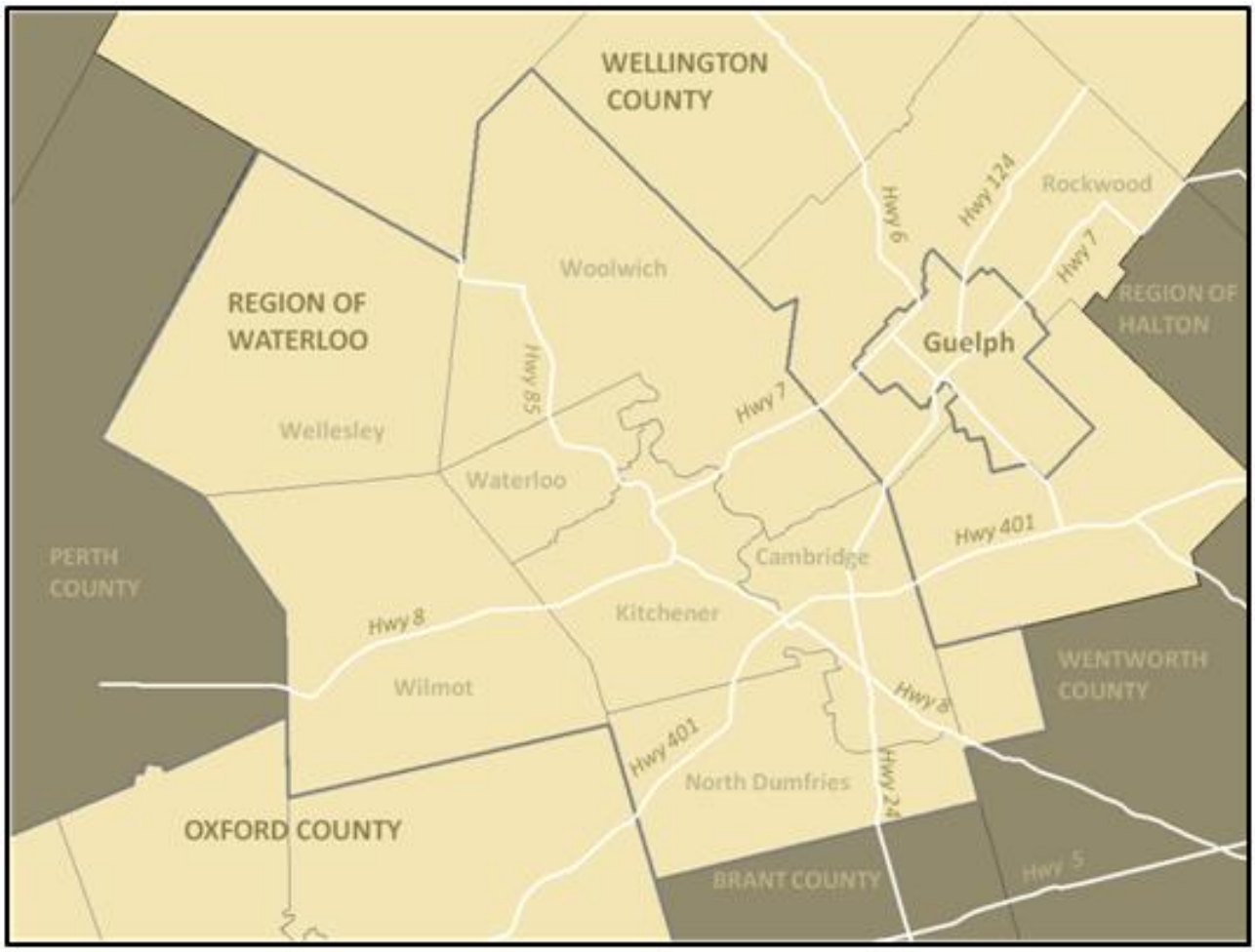


Figure 1.2| Overview of the KWCG Region

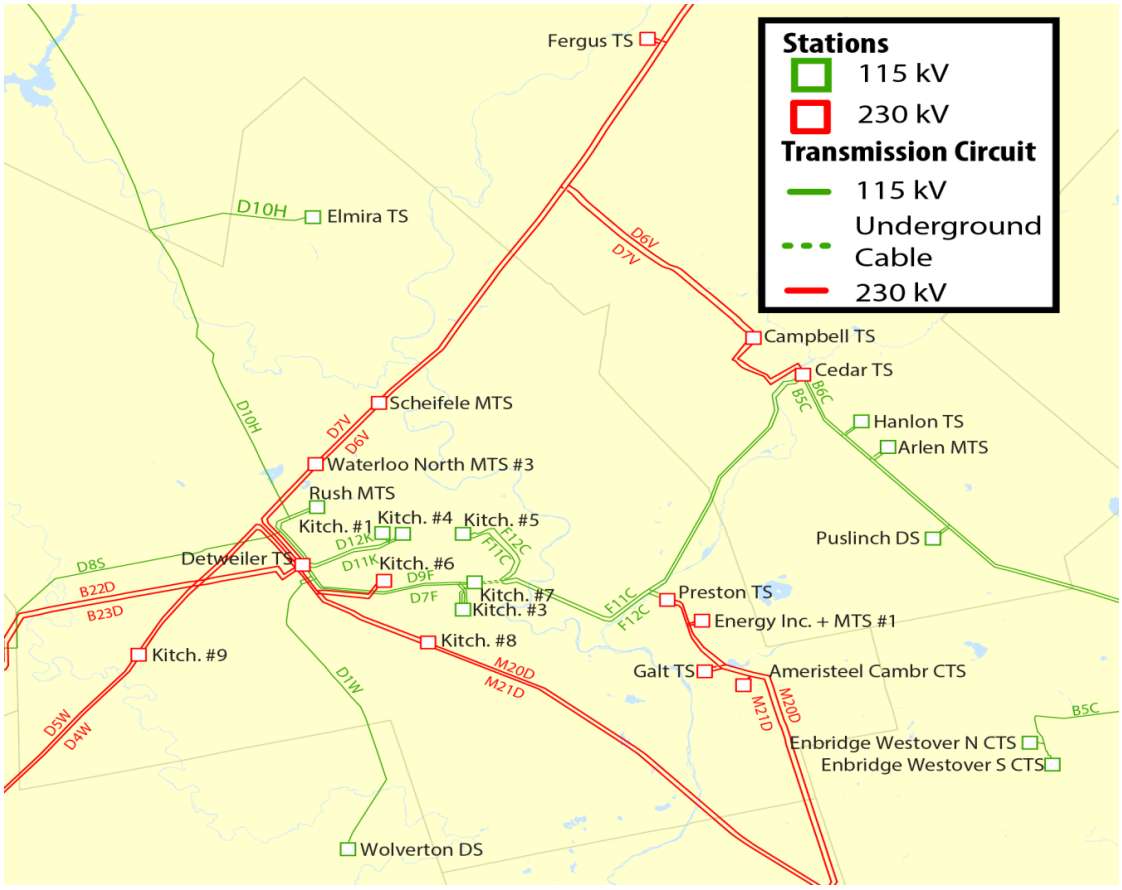
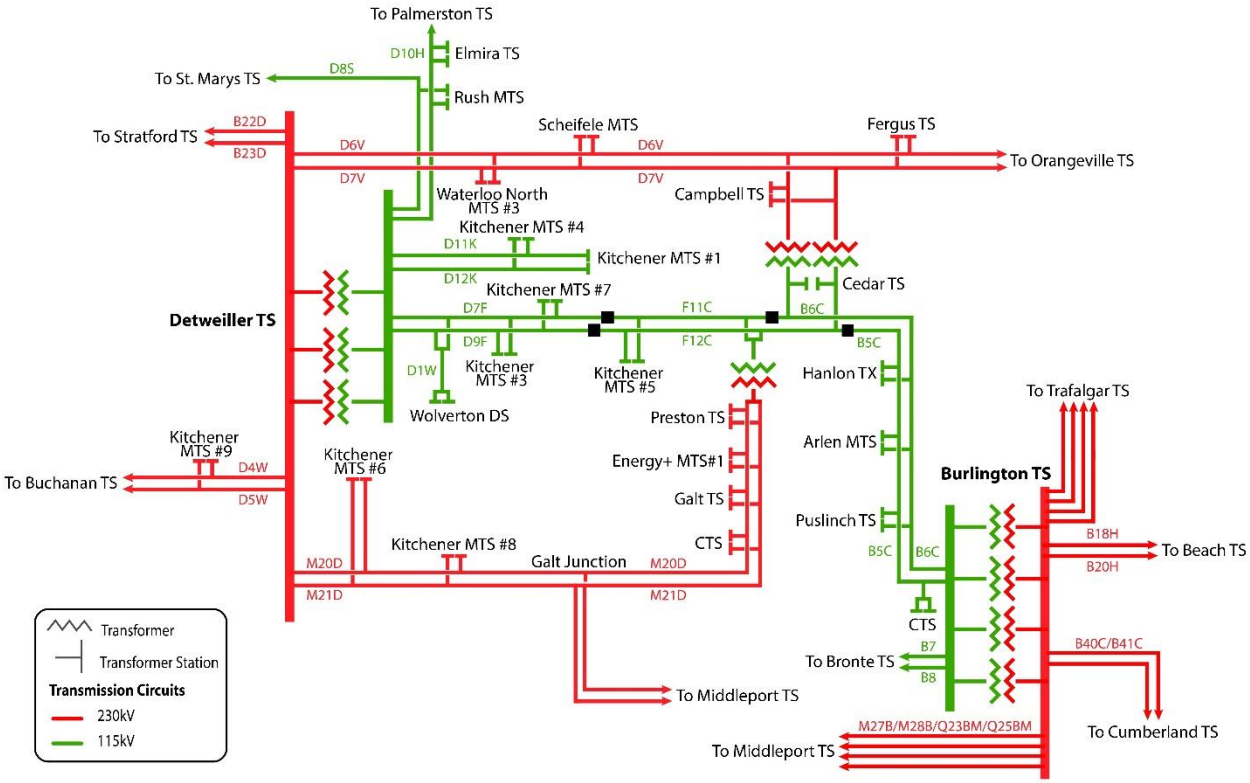


Figure 1.3| Single Line Diagram of the KWCG Region



The region's electricity is delivered by 10 local distribution companies (LDCs): Alectra Utilities (Guelph), Centre Wellington Hydro, Waterloo North Hydro, Energy+, Kitchener-Wilmot Hydro, Wellington North Power, Halton Hills Hydro, Milton Hydro and Hydro One. Hydro One is also the primary transmission asset owner. This IRRP report was prepared by the Independent Electricity System Operator (IESO) on behalf of a Working Group composed of the aforementioned LDCs and transmitter.

Development of the KWCG IRRP was initiated in May 2019 following the publication of the Needs Assessment report in December 2018 by Hydro One after which the IESO's Scoping Assessment Outcome Report and Terms of Reference identified needs that should be further assessed through an IRRP. The Working Group was then formed to gather data, identify near- to long-term needs in the region and develop the recommended actions included in this IRRP.

In Ontario, planning to meet the electrical supply and reliability needs of a large area or region is carried out through regional electricity planning, a process that was formalized by the Ontario Energy Board (OEB) in 2013. In accordance with this process, transmitters, distributors and the IESO are required to carry out regional planning activities for 21 electricity planning regions across Ontario, including the KWCG Region, at least once every five years. The process allows a regional planning cycle to be triggered before the five-year mark due to material changes such as demand or resource changes. The active part of this cycle is made up of Needs Assessment, Scoping Assessment, IRRP, and Regional Infrastructure Plan (RIP) stages, which take up approximately half of the typical five-year timeframe. In many regions, this period of active planning is followed by a period when plan implementation begins, and the Working Group monitors demand trends until the next cycle begins. The complexity of issues requires the Working Group to continue to be engaged in integrated planning throughout the regional planning cycle, after the completion of the IRRP.

Further information on the process can be found in Appendix C. The IESO has also recently completed a review of the regional planning process following the completion of the first cycle of regional planning for all 21 regions. Additional information on the Regional Planning Process Review along with the final report is posted on the IESO's website.

The last IRRP for the KWCG Region was concluded in 2015 with two major recommendations which have since been completed. Those recommendations were: i) installing a circuit switcher on each of M20D and M21D at Galt junction and ii) implementing the Guelph Area Transmission Refurbishment (GATR) which included the installation of two 115 kV/230 kV auto-transformers, switching facilities, and the upgrade of an existing transmission line in Guelph.

The circuit switchers at Galt junction have substantially improved load restoration in the Cambridge and Kitchener areas following a major transmission contingency. The GATR project has addressed supply needs in the South-Central Guelph and Kitchener areas and minimized the impact of potential supply interruptions to customers in Waterloo, Guelph and surrounding areas.

This report is organized as follows:

- A summary of the recommended plan for the region is provided in Section 2;
- The process and methodology used to develop the plan are discussed in Section 3;
- The context for electricity planning in the region and the study scope are discussed in Section 4;

- Demand forecast scenarios, and conservation and demand management and distributed generation assumptions, are described in Section 5;
- Electricity needs in the region are presented in Section 6;
- Alternatives and recommendations for meeting needs are addressed in Section 7;
- A summary of engagement to date and moving forward is provided in Section 8; and
- A conclusion is provided in Section 9.

2 The Integrated Regional Resource Plan

The KWCG IRRP provides recommendations to address the electricity needs for the region over the next 20 years based on application of the IESO's Ontario Resource and Transmission Assessment Criteria (ORTAC). The needs were identified over three main planning horizons, i) up to five years as near-term, ii) six to 10 years as medium-term and iii) 11 to 20 years as long-term. These planning horizons are distinguished in the IRRP to reflect the different levels of forecast certainty, lead time for development, and planning commitment required over these time horizons. The recommendations have been developed in consideration of a number of factors including reliability, cost, technical feasibility, environmental and social factors, and maximization of the use of the existing electricity system, where it is economic to do so.

In the near- to medium-term planning horizon, this IRRP identified capacity and end-of-life needs at a number of stations plus a marginal supply capacity need on 115 kV circuit B5C, when multiple elements are out-of-service. In the long-term planning horizon, additional station capacity needs and a marginal supply capacity need on 115 kV circuit D10H were identified. The potential for future developments in the Cambridge area to contribute to a long-term load restoration need was also identified. Supply capacity needs were also observed for the 230 kV double-circuit line M20D and M21D and the Detweiler TS 230/115 kV autotransformers.

The following sections provide details of the needs and recommendations to address these needs except for the supply capacity needs on M20D, M21D and the Detweiler TS autotransformers, which are deferred to the bulk planning activity for the broader Middleport area scheduled to start by the end of the year.

2.1 End-of-Life Replacement Optimization

Table 2.1 lists the elements that are approaching the end of their life with recommendations for replacement as confirmed by the Working Group.

Table 2.1 | Elements Reaching End-of-Life

Element	Year to Replace	Resposible	Replacement Recommendation
Kitchener #5 T9 & T10	2023-2024	Kitchener Wilmot Hydro	Like-for-like or closest available standard
Hanlon T1 & T2	2023-2024	Hydro One	
Cedar T7 & T8	2025-2026	Hydro One	
Preston T3 & T4	2025-2026	Hydro One	
Scheifele T1 & T2	2025-2026	Waterloo North Hydro	

During the IRRP scoping, possible further optimization was also flagged for the end-of-life replacement of the transformers at Cedar TS and Hanlon TS because of their proximity to each other and to Campbell TS and Arlen MTS. Assessments conducted by the Working Group determined that there was no opportunity to consolidate these assets since the stations are optimized for the configuration of distribution systems and as per the specific needs of customers.

2.2 Needs in Near- to Medium-Term Horizon

2.2.1 Station Capcity Needs and Recommended Solutions

The near- to medium-term station capacity needs and their recommended solutions are listed in Table 2.2. The needs were identified via two distinct approaches: i) exceedance of the non-coincident peak demand forecast at individual stations beyond the capability of each transformer and ii) post-contingency overloading of the transformers in the load flow studies using the coincident peak demand forecast.

Table 2.2 | Near/Medium-Term Station Capacity Needs and Recommended Solutions

Transformer	Estimated Need Year	Recommended Solution*	Responsible
Energy+ #1 T1/T2	2023	Load transfer to Galt TS and Preston TS	Energy+
Preston T3/T4	2021	Load transfer to Galt TS and Energy+ MTS #1 before end-of-life replacement** by 2025-2026	Hydro One, Energy+ & Waterloo North Hydro
Scheifele (T1+T3)/(T2+T4)	2023	Load transfer to Waterloo North Hydro MTS #3, Rush MTS and Elmira TS	Waterloo North Hydro
Campbell T3/T4	2023	Permanent load transfer of 4 MW to Cedar TS by 2023 plus load transfer to Campbell T1/T2 whose LTR capacity is estimated to increase by 6 MVA by 2028-2029 after replacement of minor components	Hydro One & Alectra
Cedar T7/T8	2026	End-of-life replacement** by 2025-2026; if delayed, load transfer to Cedar T1/T2	Hydro One & Alectra
Kitchener #5 T9/T10	2028	End-of-life replacement** by 2023-2024	Kitchener Wilmot Hydro
Kitchener #7 T13/T14	2028	Load transfer to Kitchener MTS #3 or #5	Kitchener Wilmot Hydro
Kitchener #8 T15/T16	2028	Load transfer to Kitchener MTS #3	Kitchener Wilmot Hydro

* Unless otherwise noted, load may be transferred on permanet or temporary basis at the discretion of LDCs.

** End-of-life replacements are like-for-like. However, available standard transformers may have higher ratings.

As indicated in Table 2.2, many of the needs can be managed by transferring the load to other stations with spare capacity on a permanent or temporary basis. A few stations are due for replacing their transformers as they reach their end-of-life. Although the replacements are like-for-like, the available standard transformers may have higher limited time ratings (LTR) which can also alleviate the station capacity needs.

2.2.2 Supply Capacity Need and Recommended Solution

While no near- or medium-term supply capacity needs were identified in the region for the loss of a single element, a marginal post-contingency supply capacity need was identified on B5C, the 115 kV circuit from Burlington to Cedar TS under outage conditions. This circuit can become slightly overloaded during peak demand following the loss of F12C, the circuit in series with B5C, under an outage on B6C, the circuit in parallel to B5C. This combination of outage and contingency results in B5C radially supplying all the loads at Hanlon TS, Arlen MTS, Puslinch TS and a customer owned transformer station.

Since the supply capacity need on B5C is marginal and under specific rare conditions (including multiple contingencies), it is recommended to manage the need into the medium term with operational measures, e.g. rescheduling outages on B6C. Meanwhile, the IESO will monitor the situation and explore long-term solutions with the Working Group and communities as appropriate if the need can no longer be managed without reliability impacts.

2.3 Needs in Long-Term Horizon and Recommendations

Minor station capacity needs are identified at Arlen MTS, Hanlon TS, Rush MTS, Elmira TS, Kitchener MTS #1, and Waterloo North MTS #3 in the long-term horizon.

A long-term marginal supply capacity need was also identified on D10H, the 115 kV circuit from Detweiler towards Hanover TS. This circuit may slightly be overloaded as a result of radially serving all of the loads at Rush MTS and Elmira TS following the loss of D8S, the circuit partially in parallel to D10H.

At this time, none of the station and supply capacity needs identified over the long term require early development work for major infrastructure projects in the KWCG Region. There may be opportunities for communities and local utilities to manage their future electricity demand through the development of community-based solutions under the IESO's Conservation and Demand Management (CDM) Framework or other mechanisms or opportunities that may evolve between planning cycles.

The IESO will re-evaluate these needs periodically including in the next regional planning cycle and explore non-wire solutions with the Working Group and communities as appropriate.

2.4 Load Restoration Needs and Recommendations

After the 2015 KWCG IRRP recommendation regarding the circuit switchers on M20D and M21D at Galt junction was implemented, the load restoration in the Cambridge and Kitchener areas following contingencies on these circuits has substantially been improved. The circuit switchers now allow for the quick isolation of any section with a permanent fault and the ability to place the other sections back into service for restoring load.

By 2040, faults on M20D and M21D will result in the loss of up to 400 MW of load in the Cambridge area. Up to 150 MW of this load must be restored within 30 minutes as required by ORTAC. This is within the capability of the system and, so, no load restoration concern has been identified in this IRRP. However, potential future developments in the area not currently considered in the load forecast may result in a load restoration concern before 2040 and, as such, the Working Group will continue to monitor this need.

Appendix B includes options to alleviate these future restoration needs. However, the appropriate solution for this need is highly dependent on the electricity demand growth, including possible new developments. It is recommended to continue monitoring the situation until the demand growth, and the location and timing of supply to any new developments, is sufficiently certain to inform a recommended solution.

2.5 Short Circuit Capability Needs

The IRRP Scoping Assessment identified a need to assess short circuit levels as they pertain to LDC equipment ratings as well as to challenges regarding the connection of generation or storage resources. The particular concerns raised at the time of the scoping assessment have since been satisfactorily resolved. However, the Working Group recognizes the importance of a holistic system planning approach, which includes analysis related to short circuit levels.

Short circuit levels are informative when assessing feasibility and potential location for non-wires alternatives. As non-wires alternatives will be evaluated for meeting the area's long-term needs, the Working Group examined and will continue to assess short circuit levels and other system constraints when evaluating long-term options in subsequent planning cycles. Further details are provided in Appendix D.

2.6 Conservation and Demand Management

Conservation is important in managing demand in Ontario and plays a key role in maximizing the utilization of existing infrastructure and maintaining a reliable supply of electricity. On September 30, 2020 the IESO received a Ministerial directive to implement a new 2021-2024 CDM Framework, which follows the conclusion of the 2019-2020 Interim Framework.

The new 2012-2024 CDM Framework will focus on cost-effectively meeting the needs of Ontario's electricity system, including by focusing on the achievement of provincial peak demand reductions, as well as targeted approaches to address regional and/or local electricity system needs.

It is recommended that the Working Group monitor the progress of the 2021-2024 CDM Framework and the contribution of savings from its programs to reducing net demand in the region, and to explore the opportunity for participation in the Local Initiatives Program as an option to help address needs in the long term.

3 Development of the Plan

3.1 The Regional Planning Process

In Ontario, preparing to meet the electricity needs of customers at a regional level is achieved through regional planning. Regional planning assesses the interrelated needs of a region—defined by common electricity supply infrastructure—over the near, medium, and long term and results in a plan to ensure cost-effective, reliable electricity supply. A regional plan considers the existing electricity infrastructure in an area, forecast growth and customer reliability, evaluates options for addressing needs, and recommends actions.

The current regional planning process was formalized by the OEB in 2013 and is performed on a five-year planning cycle for each of the 21 planning regions in the province. The process is carried out by the IESO, in collaboration with the transmitters and LDCs in each planning region.

The process consists of four main components:

1. A Needs Assessment, led by the transmitter, which completes an initial screening of a region's electricity needs and determines if there are electricity needs requiring regional coordination;
2. A Scoping Assessment, led by the IESO, which identifies the appropriate planning approach for the identified needs and the scope of any recommended planning activities;
3. An IRRP, led by the IESO, which proposes recommendations to meet the identified needs requiring coordinated planning; and/or
4. A RIP, led by the transmitter, which provides further details on recommended wires solutions.

Further details on the regional planning process and the IESO's approach to regional planning can be found in Appendix C.

Regional planning is not the only type of electricity planning in Ontario. Other types include bulk system planning and distribution system planning. There are inherent overlaps in all three levels of electricity infrastructure planning.

The IESO has recently completed a review of the regional planning process following the completion of the first cycle of regional planning for all 21 regions. Additional information on the Regional Planning Process Review along with the final report is posted on the IESO's website.

3.2 KWCG and IRRP Development

The process to develop the KWCG IRRP was initiated in May 2019 following the release of the needs assessment report for the region by Hydro One and the subsequent scoping assessment report produced by the IESO, which recommended needs identified for the KWCG Region be further pursued through an IRRP. This was due to the potential for coordinated solutions and due to the number of end-of-life assets. Shortly after, the Working Group was formed to develop terms of reference for the IRRP, gather data, identify near- to long-term needs in the area, and recommend near- to long-term solutions.

4 Background and Study Scope

This is the second cycle of regional planning for the KWCG Region. The first cycle of regional planning was concluded in 2015 with two major recommendations which have since been completed. Those recommendations were:

- Installing a circuit switcher on each of M20D and M21D at Galt junction.
- Implementing the GATR project which included the installation of two 115 kV/230 kV auto-transformers, switching facilities, and the upgrade of an existing transmission line in Guelph.

The circuit switchers at Galt junction have substantially improved load restoration in the Cambridge and Kitchener areas following a major transmission contingency. The GATR project has addressed supply needs in South-Central Guelph and the Kitchener area and minimized the impact of potential supply interruptions to customers in Waterloo, Guelph and surrounding areas.

This cycle of regional planning identified a number of needs requiring further regional coordination and recommended an IRRP be initiated. This report presents an integrated regional electricity plan for the next 20-year period starting from 2019.

4.1 Study Scope

This IRRP develops and recommends options to meet the supply needs of the KWCG Region in the near, medium, and long term. The plan was prepared by the IESO on behalf of the Working Group. The plan includes consideration of forecast electricity demand growth, CDM, DG, transmission and distribution system capability, relevant community plans, condition of transmission assets and developments on the bulk transmission system. The needs addressed in this IRRP include adequacy, security, and relevant end-of-life asset considerations.

The following transmission facilities were included in the scope of this study:

- **230 kV connected stations:** Campbell TS, Energy+ MTS #1, Fergus TS, Galt TS, Kitchener MTS #6, Kitchener MTS #8, Kitchener MTS #9, Preston TS, Scheifele MTS, Waterloo North MTS #3 and a customer owned station
- **115 kV connected stations:** Arlen MTS, Cedar TS, Elmira TS, Hanlon TS, Kitchener MTS #1, Kitchener MTS #3, Kitchener MTS #4, Kitchener MTS #5, Kitchener MTS #7, Puslinch TS, Rush MTS, Wolverton DS and a customer owned station
- **230 kV transmission lines:** B22D, B23D, D4W, D5W, D6V, D7V, M20D and M21D
- **115 kV transmission lines:** B5C, B6C, D1W, D7F, D9F, D10H, D8S, D11K, D12K, F11C, F12C
- **230/115 kV autotransformers:** Burlington T4, T6, T9, & T12, Cedar T3 & T4, Detweiler T2, T3 & T4 and Preston T2

Supply to the KWCG Region is mainly provided from Detweiler TS and Burlington TS and to a lesser extent from Middleport TS and Orangeville TS. Any needs related to the 230/115 kV autotransformers and 230 kV circuits at these stations will be assessed by the IESO through a separate bulk planning study for the broader Middleport area starting by the end of the year.

The KWCG IRRP was developed by completing the following steps:

- Preparing a 20-year electricity demand forecast and establishing needs over this timeframe;
- Examining the load meeting capability (LMC) and reliability of the existing transmission system, taking into account facility ratings and performance of transmission elements, transformers, local generation, and other facilities such as reactive power devices. Needs were established by applying ORTAC;
- Assessing system needs by applying a contingency-based assessment and reliability performance standards for transmission supply in the IESO-controlled grid as described in Section 7 of ORTAC;
- Confirming identified end-of-life asset replacement needs and timing with LDCs;
- Establishing alternatives to address system needs, including, where feasible and applicable, possible energy efficiency, generation, transmission and/or distribution, and other approaches such as non-wires alternatives;
- Engaging with the community on needs, findings, and possible alternatives;
- Evaluating alternatives to address near- and long-term needs; and
- Communicating findings, conclusions, and recommendations within a detailed plan.

5 Electricity Demand Forecast

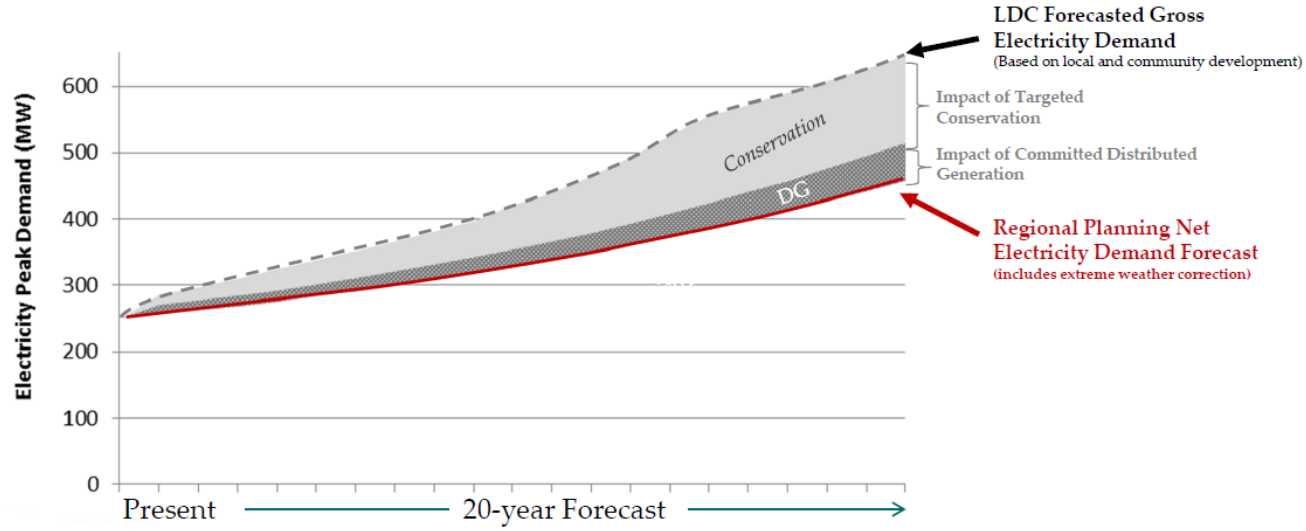
Regional planning in Ontario is driven by the need to meet peak electricity demand requirements in the region. This section describes the specific details of the development of the demand forecast for the KWCG Region. It highlights the assumptions made for peak demand forecasts, including the contribution of conservation and distributed generation (DG) to reducing peak demand. The resulting net demand forecast is used in assessing the electricity needs of the area over the planning horizon as explained in the next section.

To evaluate the adequacy of the electric system, the regional planning process involves measuring the demand observed at each station for the hour of the year when overall demand in the study area is at a maximum, also called the coincident peak demand. This differs from a non-coincident peak, which refers to each station's individual peak, regardless of whether the stations' peaks occur at different times. Within the KWCG Region, the peak loading hour for each year occurs in the summer.

5.1 Demand Forecast Methodology

For the purpose of this IRRP, a 20-year regional peak demand forecast was developed to assess supply and reliability needs for the KWCG area. The steps taken to perform this are depicted in Figure 5.1. Gross demand forecasts, which assume the weather conditions of an average year based on historical weather conditions and referred to normal weather, were developed by the LDCs. These forecasts were then modified to reflect the peak demand impacts of provincial conservation targets and DG contracted through provincial programs such as FIT and microFIT, and then adjusted to reflect extreme weather conditions in order to produce a reference forecast for planning assessments. This forecast was then used to assess the electricity needs in the region. Additional details related to the development of the demand forecast are provided in Appendix A.

Figure 5.1 | Development of Demand Forecast

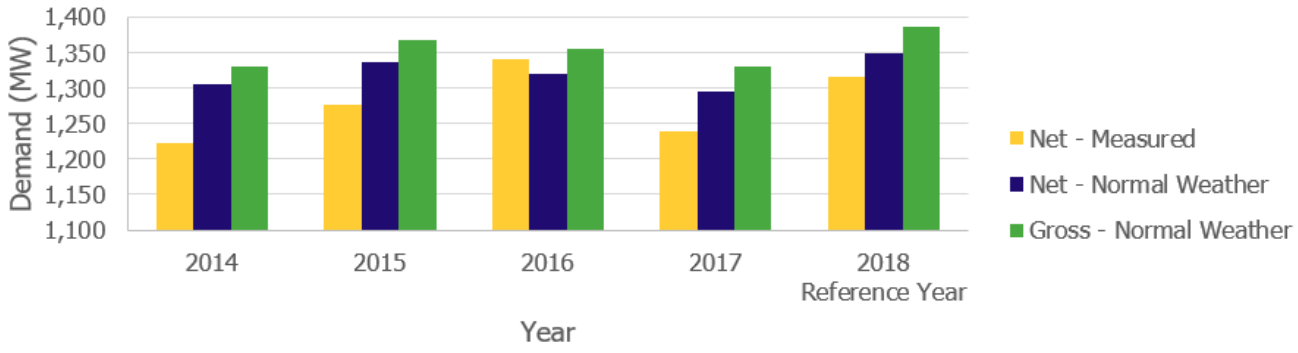


5.2 Historical Electricity Demand

The KWCG Region electricity demand is a mix of residential, commercial and industrial loads, encompassing diverse economic activities ranging from educational institutions to automobile manufacturing. While the industrial and commercial sector is the largest consumer of electricity, high-energy-consuming end uses such as air conditioning also play a significant role in contributing to peak electricity demand. During the summer months, peak demand can also be influenced by extreme weather conditions, with peaks in demand typically occurring after several days of high temperatures. In addition to temperature, factors affecting commercial and industrial energy demand, such as economy, improvements in energy efficiency, and on-site generation development have impact on the peak demand.

As shown in Figure 5.2, the historical summer peak demand has fluctuated between 1,200 MW to 1,350 MW in the recent years. This figure also shows the weather corrected net and gross coincident peak demand for normal weather. The gross demands on the station level in 2018 were the reference values for LDCs to forecast their 20-year gross demand as discussed in the next section.

Figure 5.2 | Measured & Weather Corrected Coincident Net and Gross Historical Peak Demand in the KWCG Region



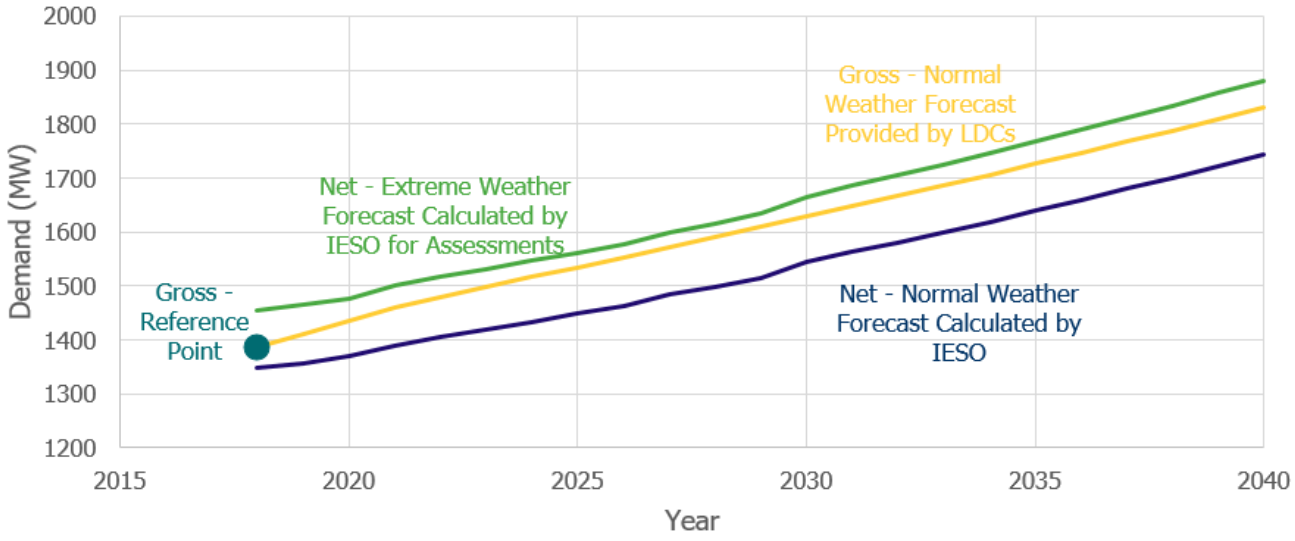
5.3 Gross and Net Demand Forecast

Each participating LDC in the KWCG Region prepared gross demand forecasts at the station level, or at the station bus level for multi-bus stations. Gross demand forecasts account for increases in demand from new or intensified development. LDCs are expected to account for changes in consumer demand resulting from typical efficiency improvements and response to increasing electricity prices, or "natural conservation", but not for the impact of future DG or new conservation measures, such as codes and standards and demand response programs, which will be accounted for by the IESO as discussed in Section 5.1.

LDCs have the best information on customer and regional growth expectations in the near and medium term, since they have the most direct involvement with their customers. Most LDCs cited alignment with municipal and regional official plans as a primary source for input data. Other common considerations included known connection applications and typical electrical demand for similar customer types. More details on the LDCs' load forecast assumptions can be found in Appendix A.

Figure 5.3 shows the total gross demand forecast in the next 20 years as provided by LDCs, based on the IESO's reference point for normal weather. Figure 5.3 also shows the net normal weather forecast compiled by the IESO, which accounts for the impacts of conservation and DG on peak demand, along with the IESO's net demand forecasts corrected to extreme weather, referred to as the planning demand forecast, used for the assessments in the IRRP. The contribution of conservation and DG to the planning demand forecast is discussed in the following sections.

Figure 5.3 | Normal/Extreme Weather Corrected Coincident Net and Gross Peak Demand in the KWCG Region



5.4 Contribution of Conservation to the Forecast

Conservation, including energy efficiency and demand management, is a clean and cost effective resource for helping to meet Ontario's electricity needs and have been an integral part of reliable and sustainable electricity system in provincial and regional planning. Conservation is achieved through a mix of program-related activities, rate structures, and mandated efficiencies from building codes and equipment standards. These approaches complement each other to maximize conservation results.

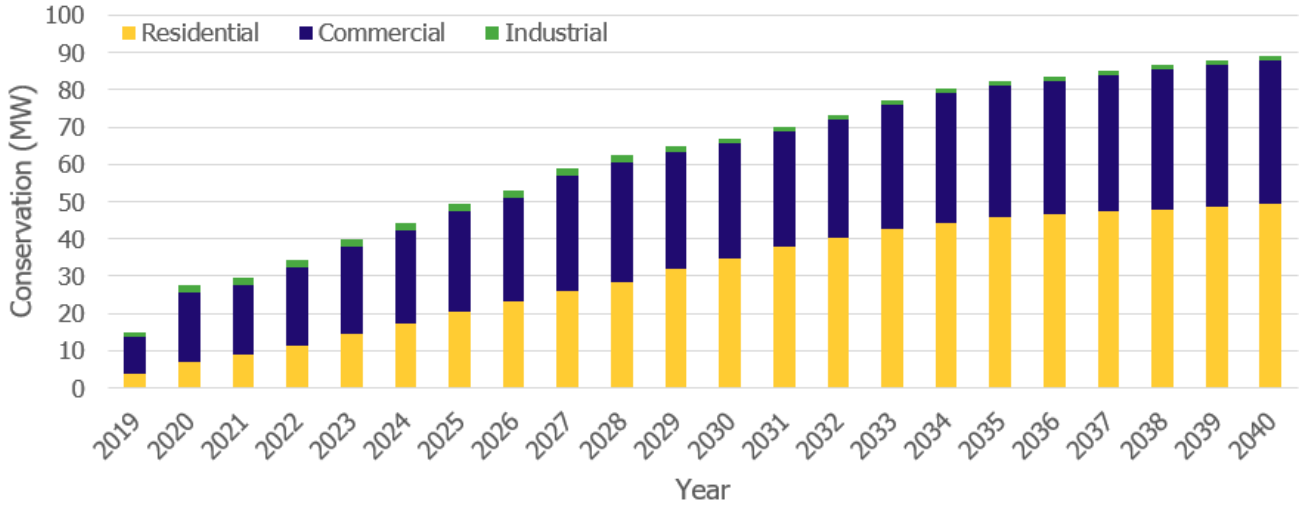
The estimates of demand reduction due to the codes and standards regulations are based on the expected improvement in the codes for new and renovated buildings and for specified categories of consumers, i.e. residential, commercial and industrial, through the regulation of minimum efficiency standards for equipment.

Save on Energy programs will result in new savings, reducing energy and peak demand in the region. The forecast included savings achieved through the wind-down of 2015-2020 Conservation First Framework and the 2019-2020 Interim Framework. The IESO centrally delivers programs on a province wide basis to serve business and low-income customers, as well as Indigenous communities.

On September 30, 2020 the IESO received a Ministerial directive to implement a new 2021-2024 CDM Framework starting in January 2021. As this directive was received after the KWCG Region's load forecast was finalized its impact is not included in the forecast.

Figure 5.4 shows the yearly estimate of the reduction to the demand forecast due to conservation for each of the residential, commercial and industrial consumers. Additional details are provided in Appendix A.

Figure 5.4 | Reduction to Demand Forecast due to Conservation

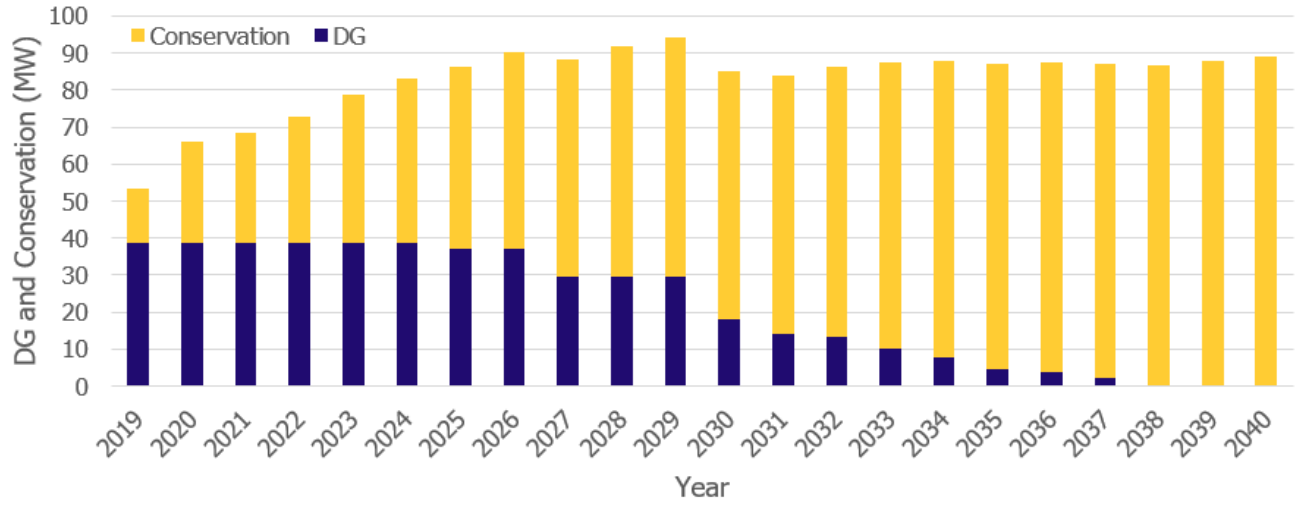


5.5 Contribution of Distributed Generation to the Forecast

In addition to conservation resources, DG in the KWCG Region is also forecast to offset peak-demand requirements. The introduction of the *Green Energy and Green Economy Act, 2009*, and the associated development of Ontario's FIT Program, has increased the significance of distributed renewable generation which, while intermittent, contributes to meeting the province's electricity demands.

After reducing the demand forecast due to conservation as described above, the forecast is further reduced by the expected contribution from contracted DG in the region. Figure 5.5 shows the combined impact of the conservation and DG on reducing the demand forecast. In the long term, as the DG contribution diminishes due to contract expiry, conservation further contributes to reducing the demand and as a result the combined impact remains relatively constant.

Figure 5.5 | Reduction to Demand Forecast due to DG and Conservation



Note that the KWCG Region also contains contracted energy storage facilities, namely 5 MW at Arlen MTS, 2 MW at Kitchener MTS #5 and 2 MW at Elmira TS. The Working Group has decided not to rely on these resources for providing any capacity relief because of uncertainties in their behavior at the time of peak demand as they provide grid services other than capacity.

Additionally, any facilities without a contract are not currently included in the DG forecast.

5.6 Projects to Consider for Next Cycle or Addendum

The following projects were not accounted for in the load forecast during this IRRP cycle because they did not have a confirmed status or connection point. The Working Group will continue to monitor the situation and if required, a new IRRP cycle or addendum will be launched.

- Metrolinx electrification project;
- East Side Lands: as discussed in Appendix E with a connection point in the Cambridge area in vicinity of Preston TS and potentially advancing the Cambridge area load restoration need;
- West Side Employment Lands; and
- Light rail transit project from Kitchener to Cambridge.

6 Needs

6.1 Needs Assessment Methodology

Based on the planning demand forecast (extreme weather, net demand), system capability, the transmitter's identified end-of-life asset replacement plans, and the application of ORTAC[1] and North American Electric Reliability Corporation (NERC) TPL 001-4 Standard[2], the Working Group identified electricity needs in the near-, medium- and long-term timeframe for the following categories:

- **Station Capacity Needs** describe the electricity system's inability to deliver power to the local distribution network through the regional step-down transformer stations at peak demand. The capacity rating of a transformer station is the maximum demand that can be supplied by the station and is limited by station equipment. Station ratings are often determined based on the 10-day LTR of a station's smallest transformer under the assumption that the largest transformer is out of service. A transformer station can also be limited when downstream or upstream equipment, e.g., breakers, disconnect switches, low-voltage bus or high voltage circuits, is undersized relative to the transformer rating.
- **Supply Capacity Needs** describe the electricity system's inability to provide continuous supply to a local area at peak demand. This is limited by the LMC of the transmission supply to an area. The LMC is determined by evaluating the maximum demand that can be supplied to an area accounting for limitations of the transmission elements, e.g., a transmission line, group of lines, or autotransformer, when subjected to contingencies and criteria prescribed by ORTAC and TPL 001-4. LMC studies are conducted using power system simulations analysis.
- **Load Security and Restoration Needs** describe the electricity system's inability to minimize the impact of potential supply interruptions to customers in the event of a major transmission outage, such as an outage on a double-circuit tower line resulting in the loss of both circuits. Load security describes the total amount of electricity supply that would be interrupted in the event of a major transmission outage. Load restoration describes the electricity system's ability to restore power to those affected by a major transmission outage within reasonable timeframes. The specific load security and restoration requirements are prescribed by Section 7 of ORTAC.
- **End-of-life Asset Replacement Needs** are identified by the transmitter with consideration to a variety of factors such as asset age, the asset's expected service life, risk associated with the failure of the asset, and its condition. Replacement needs identified in the near- and early mid-term timeframe would typically reflect more condition-based information, while replacement needs identified in the medium to long term are often based on the equipment's expected service life. As such, any recommendations for medium- to long-term needs should reflect the potential for the need date to change as condition information is routinely updated.

[1] https://www.ieso.ca/-/media/Files/IESO/Document-Library/Market-Rules-and-Manuals-Library/market-manuals/connecting/IMO-REQ-0041-TransmissionAssessmentCriteria.pdf

[2] https://www.nerc.com/files/TPL-001-4.pdf

6.2 Needs Identified

Figure 6.1 shows a summary of needs that were identified for the KWCG Region as listed below:

- Near/medium-term end-of-life replacement needs at Cedar TS, Hanlon TS, Kitchener MTS #5, Preston TS and Scheifele MTS;
- Near/medium-term station capacity needs at Campbell TS, Cedar TS, Energy+ MTS #1, Preston TS, Scheifele MTS, Kitchener MTS #5, #7 and #8;
- Medium-term marginal supply capacity need on B5C, 115 kV circuit from Burlington TS and Cedar TS following the loss of B6C with a prior outage on F12C (i.e. loss of multiple elements);
- Long-term station capacity needs at Arlen MTS, Hanlon TS, Rush MTS, Elmira TS, Kitchener MTS #1, and Waterloo North MTS #3;
- Post-contingency long-term marginal supply capacity need on D10H, 115 kV circuit from Detweiler TS towards Hanover TS following the loss of D8S; and
- Possible long-term restoration need in the Cambridge area after the addition of new but uncertain developments beyond what is included in the confirmed planning forecast. No restoration need was identified in this IRRP based on the confirmed planning forecast.

The aforementioned supply capacity needs were observed for the conditions shown in Table 6.1. The system was analyzed for both single and multiple element contingencies, according to planning standards. Only long-term supply capacity needs were identified for the loss of a single element. Figure 6.2 shows the ORTAC load restoration requirement in the Cambridge area for the extreme weather demand forecast. If new developments materialize (e.g. those in section 5.6) the load restoration requirements may be violated and solutions may be needed.

Figure 6.1 | Needs Identified for the KWCG Region

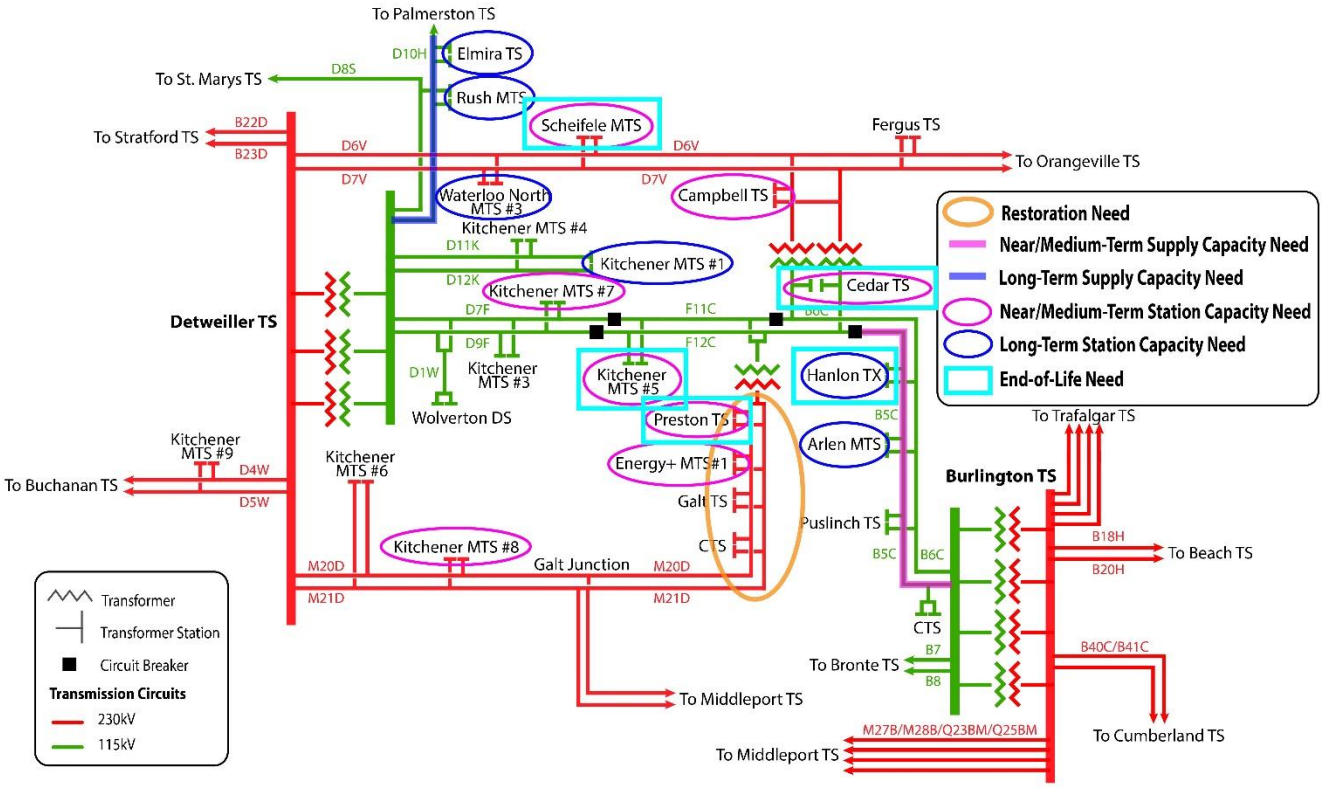


Figure 6.2 | ORTAC Load Restoration Requirement in the Cambridge Area

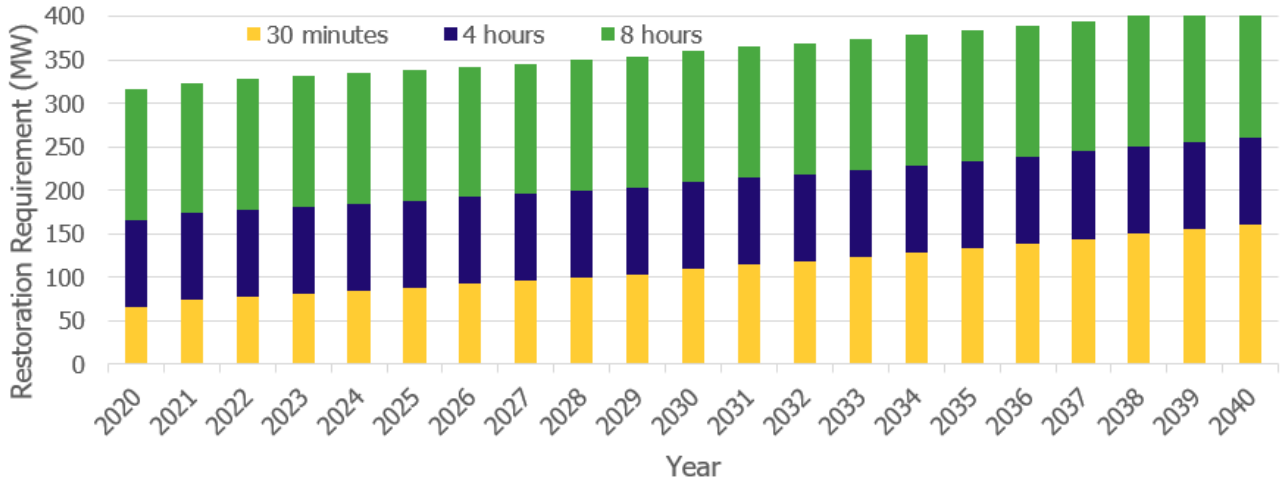


Table 6.1 | Conditions for Which Supply Capacity Needs Identified

Timeframe	Outage	Contingency	Overloaded Circuit	Cause
Medium-term	B6C	F12C	B5C	Radially serving loads at Hanlon TS, Arlen MTS, Puslinch TS, and a customer-owned station

Timeframe	Outage	Contingency	Overloaded Circuit	Cause
Long-term	-	D8S	D10H	Radially serving loads at Rush TS and Elmira TS

7 Plan Options and Recommendations

In developing the plan, the Working Group considered a range of integrated options. Considerations in assessing alternatives included maximizing use of existing infrastructure, provincial electricity policy, feasibility, cost, and consistency with longer-term needs in the area.

7.1 Conservation

Conservation is important in managing demand in Ontario and plays a key role in maximizing the useful life of existing infrastructure and maintaining reliable supply. Conservation is achieved through a mix of program-related activities including behavioural changes by customers and mandated efficiencies from building codes and equipment standards. These approaches complement each other to maximize conservation results.

Conservation expected to be achieved through codes and standards, and program delivery, has already been included in the planning forecast scenarios as described in section 5.4.

On September 30, 2020 the IESO received a Ministerial directive to implement a new 2021-2024 CDM Framework. The new CDM Framework will contribute to lowering the net demand as seen on the transmission system and ensures energy efficiency can continue to play a role in meeting the region's needs. As part of the framework, there is a Local Initiatives Program which can target CDM programs to regional and/or local areas to provide savings that are above and beyond those programs that are available provincially. These could further reduce the net demand.

The Working Group will monitor progress as the 2021-2024 CDM Framework is implemented, will assess the impact of these additional savings in further reducing the region's net demand and will explore the opportunity for participation in the Local Initiatives Program as an option to help address needs in the long term.

7.2 End-of-Life Replacement Optimization

When a piece of equipment reaches the end of its life and requires replacement, a number of alternatives often warrant consideration, for example, how the transmission and distribution system have changed, how community needs have evolved, and whether equipment standards have been updated over the decades the equipment has been in service. At the same time, opportunities for non-traditional options, such as CDM, may increasingly play a role in determining the future of a specific asset when it comes time for renewal.

Development of options considered three main alternatives:

- Replacement of the assets "like-for-like" or with the closest available standard;
- Reconfiguration of the existing assets to "right-size" the replacement option based on:
    - Demand forecast,
    - Changes to the use of the asset since it was originally installed,

    - Reliability or other system benefits that an alternate configuration may provide; and
- Retirement of a facility, considering the impact on load supply and reliability.

The asset replacement needs identified in this IRRP are all related to step-down station transformers. The Working Group considered the following opportunities of optimizations, in addition to reviewing the impact of like-for-like replacements with standard facilities:

- Upgrading transformers to address the identified near- to medium-term station capacity needs;
- Reconfiguring transformers and feeders at Hanlon TS and Arlen MTS to make more efficient use of existing facilities, as was flagged in the Scoping Assessment; and
- Permanently transferring load between nearby stations.

Working Group assessments indicated that there are no opportunities for end-of-life optimization at this time and like-for-like replacements with the closest available standard can best address the region's needs, as identified in Table 2.1.

Two possible opportunities were considered for optimization, reusing underutilized transformers and feeders at Hanlon and Arlen MTS and permanent load transfers between nearby stations. The Technical Working Group's assessments indicated that there are no opportunities for optimization at this time. Hanlon and Arlen transformers and feeders are not fully utilized because customers have purchased dedicated feeder capacity which cannot be used otherwise and LDCs cannot give up feeder positions. Permanent load transfers between stations are also restricted due to limitations at 13.8 kV distribution voltage and density of load on feeders and line sections. Distribution system challenges have been taken into consideration and is found already optimized to the local needs.

7.3 Near/Medium-Term Station Capacity Needs

The station capacity needs can be managed by transferring the load to other stations with spare capacity on a permanent or temporary basis. Transformers at four stations with capacity needs are due for end-of-life replacement. Although the end-of-life replacements are considered to be like-for-like, the current standard transformers available have higher ratings which help alleviate the station capacity needs. Table 2.2 summarizes the recommended solutions to resolve these needs.

7.4 Near/Medium-Term Supply Capacity Needs

There were no near- to medium-term supply capacity needs identified for the loss of a single element. When examining contingencies involving the loss of multiple elements, a marginal near- to medium-term supply capacity need was identified on B5C, with a contingency on B6C under an outage on F12C. Since this is a marginal need which would occur during an outage and under specific sets of system conditions, it is recommended to manage the need with operational measures in the near- to medium-term, e.g. rescheduling outages. Meanwhile, the IESO will monitor the situation and explore long-term solutions with the Working Group and communities as appropriate if the need can no longer be addressed without impacting reliability.

7.5 Long-term Needs

In addition to station capacity needs on six stations, a marginal long-term supply capacity need was identified on D10H for post-contingency condition after the loss of D8S.

None of the identified long term needs are significant and therefore early development work for major infrastructure projects in the KWCG Region is not required at this time. There may be opportunities for the Working Group to work with communities and local utilities to manage future electricity demand through the development of community-based solutions under the IESO's new CDM Framework or other mechanisms or opportunities that may evolve between planning cycles.

The IESO will re-evaluate these needs periodically and explore non-wire solutions with the Working Group and communities as appropriate.

7.6 Load Restoration Need

After the 2015 KWCG IRRP recommendation regarding the circuit switchers on M20D and M21D at Galt junction was implemented, the load restoration in the Cambridge and Kitchener areas following contingencies on these circuits has substantially been improved. The circuit switchers now allow for the quick isolation of any section with a permanent fault and the ability to place the other sections back into service for restoring load.

By 2040, faults on M20D and M21D will result in the loss of up to 400 MW of load in the Cambridge area. Up to 150 MW of this load must be restored within 30 minutes as required by ORTAC. This is within the capability of the system and, so, no load restoration concern has been identified in this cycle of the IRRP. However, developments in the area not considered in the load forecast may result in a load restoration concern before 2040 and, as such, the Working Group will continue to monitor this need.

Appendix B includes options to alleviate these future restoration needs. However, since the appropriate solution for this need is highly dependent on future electricity demand growth (potentially from future developments identified in section 5.6), it is recommended to continue monitoring the situation and devise an appropriate solution when any new demand growth and associated future developments are sufficiently certain.

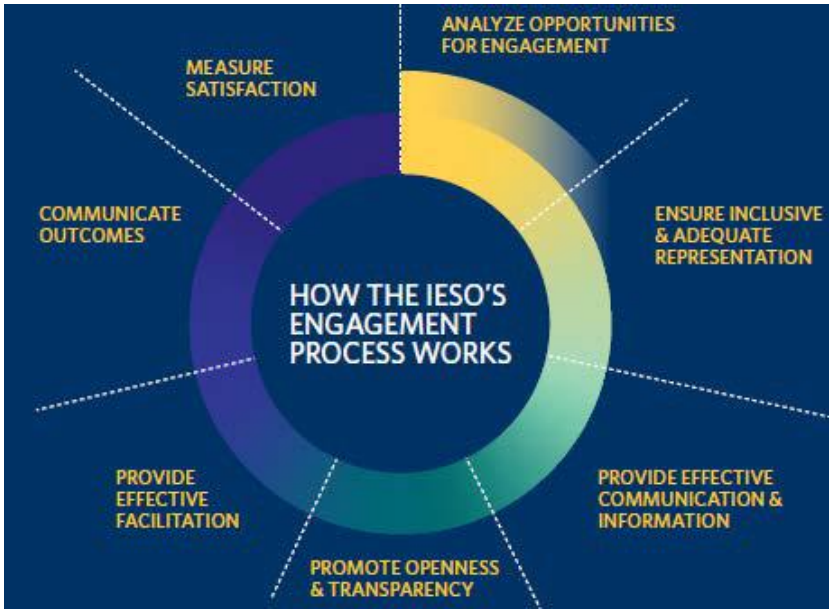
8 Engagement

Engagement is critical in the development of an IRRP. Providing opportunities for input in the regional planning process enables the views and preferences of communities to be considered in the development of the plan, and helps lay the foundation for successful implementation. This section outlines the engagement principles as well as the activities undertaken to date for the KWCG IRRP.

8.1 Engagement Principles

The IESO's engagement principles[3] help ensure that all interested parties are aware of and can contribute to the development of this IRRP. The IESO uses these principles to ensure inclusiveness, sincerity, respect and fairness in its engagements, striving to build trusting relationships as a result.

Figure 8.1 | The IESO's Engagement Principles



8.2 Creating an Engagement Approach for KWCG

The first step in ensuring that any IRRP reflects the needs of community members and interested stakeholders is to create an engagement plan to ensure that all interested parties understand the scope of the IRRP and are adequately informed about the background and issues in order to provide meaningful input on the development of the IRRP for the region.

- Creating the engagement plan for this IRRP involved:
- Discussions to help inform the engagement approach for the planning cycle;

[3] https://www.ieso.ca/en/sector-participants/engagement-initiatives/overview/engagement-principles

- Developing and implementing engagement tactics to allow for the widest communication of the IESO's planning messages, using multiple channels to reach audiences; and
- Identifying specific stakeholders and communities that should be targeted for one-on-one consultation, based on identified and specific needs.

As a result, the engagement plan[4] for this IRRP included:

- A dedicated webpage[5] on the IESO website to post all meeting materials, feedback received and IESO responses to the feedback throughout the engagement process;
- Regular communication with interested communities and stakeholders by email or through the IESO weekly Bulletin;
- Public webinars;
- Face-to-face meetings; and
- One-on-one outreach with specific stakeholders to ensure that their identified needs are addressed (see Section 1.4 Outreach with Municipalities).

8.3 Engage Early and Often

Leveraging existing relationships built through the previous planning cycle, the IESO held preliminary discussions to help inform the engagement approach for this new round of planning. This started with an invitation to targeted communities and those with an identified interest in regional issues to learn more about how to provide comments on the KWCG Scoping Assessment Report before it was finalized.

Early communication and engagement activities began with invitations to all subscribers and communities in the KWCG Region to learn about and provide comments on the draft Scoping Assessment Outcome Report. The final Scoping Assessment, identified the need for an IRRP for the KWCG Region. Following a written comment window, the final Scoping Assessment Outcome Report was published in May 2019. Community feedback was received on the importance of considering community energy plans and other planning initiatives in IRRP development, and strong local preference for local sustainable energy resources to defer any future electricity infrastructure.

Outreach then began with targeted communities to inform early discussions for the development of the IRRP including the IESO's approach to engagement. The launch of a broader engagement initiative followed with an invitation to subscribers of the KWCG Region to ensure that all interested parties were made aware of this opportunity for input. Two public webinars were held at major junctures during IRRP development to give interested parties an opportunity to hear about its progress and provide comments on key components. Both webinars received strong participation with cross-representation of stakeholders and community representatives attending the webinar, and submitting written feedback during a 14-day comment period.

[4] https://www.ieso.ca/-/media/Files/IESO/Document-Library/engage/KWCG-Region/KWCG-Engagement-Plan.ashx

[5] https://www.ieso.ca/en/Sector-Participants/Engagement-Initiatives/Engagements/Integrated-Regional-Resource-Plan-Kitchener-Waterloo-Cambridge-Guelph

The first webinar sought input on the draft engagement plan, the electricity demand forecast and needs. Comments received during the written feedback window touched on the following major themes:

- Impacts of climate change, energy conservation and associated initiatives
- Consideration of local developments
- Impact of Distributed Energy Resources

As a final step in the engagement initiative, a second public webinar was held to seek input on the analysis of options and draft IRRP recommendations. Feedback received during the written comment period was related to the importance of ongoing dialogue with a focus on local planning initiatives around climate change in preparation for the next electricity planning cycle for the KWCG Region.

Email updates were also sent to KWCG Region subscribers and municipalities as well as the members of the Southwest Regional Electricity Network[6] to advise on the status of the IRRP development and upcoming engagement opportunities.

Based on the discussions both through the KWCG IRRP engagement initiative and broader network dialogue, it is clear that there is broad interest in several Southwestern Ontario communities to further discuss the potential for alternative energy solutions. The medium- to long-term nature of the KWCG Region's future electricity needs presents a valuable opportunity for communities to mobilize projects and initiatives to meet local growth targets and energy priorities. To that end, ongoing discussions will continue through the IESO's Southwest Regional Electricity Network to keep interested parties engaged on local developments, priorities and planning initiatives.

All background information, including engagement presentations, recorded webinars, detailed feedback submissions, and responses to comments received, are available on the IESO's KWCG IRRP engagement webpage.

8.4 Bringing Communities to the Table

The IESO held meetings with communities to seek input on their planning and to ensure that these plans were taken into consideration in the development of this IRRP. At major milestones in the IRRP process, meetings with the upper- and lower-tier municipalities in the region were held to discuss: key issues of concern, including forecast regional electricity needs; options for meeting the region's future needs; and, broader community engagement. These meetings helped to inform the municipal/community electricity needs and provided opportunities to strengthen this relationship for ongoing dialogue beyond this IRRP process.

[6] https://iesoconnects.ca/collections/southwest-regional-electricity-network

9 Conclusion

This report documents an IRRP that has been developed for the KWCG Region, and identifies regional electricity needs and opportunities to preserve or enhance electricity system reliability for the next 20 years. The IRRP makes recommendations to address near- to medium-term issues, and lays out actions to monitor, defer, and address long-term needs.

To support the development of the plan, this IRRP includes recommendations with respect to developing alternatives, and monitoring load growth and efficiency achievements. Responsibility for these actions has been assigned to the appropriate members of the Working Group.

The Working Group will continue to meet at regular intervals to monitor developments and track progress toward plan deliverables. In the event that underlying assumptions change significantly, local plans may be revisited through an amendment, or by initiating a new regional planning cycle sooner than the five-year schedule mandated by the OEB.

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