KITCHENER-WATERLOO-CAMBRIDGE-GUELPH REGION INTEGRATED REGIONAL RESOURCE PLAN - APPENDICES

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ieso
Independent Electricity System Operator

Kitchener-Waterloo-Cambridge-Guelph IRRP

Appendix A: Demand Forecasting – Methodology and Assumptions

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A.1 Gross Demand Forecast

Table A-1 shows the gross demand forecast developed based on information provided by the LDCs in the KWCG Region. The gross demand forecast reflects the regional coincident peak demand under weather-normal conditions and is developed based on customer connection requests and the growth projections in regional and municipal plans. Appendices A.1.1 through A.1.5 describe the LDCs' gross demand forecasting methodologies and assumptions. The gross demand also includes expected peak demand consumption from three transmission-connected customers in the KWCG Region (5 MW in Cambridge/North Dumfries and 7 MW in Guelph).

Table A-1: Gross Demand Forecast 2014-2033 – KWCG Region

Gross Demand Forecast (MW)																				
Municipalities	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**
Guelph & Rockwood	284	296	310	319	329	338	350	360	371	382	394	405	418	429	444	457	471	471	471	471
Waterloo, Wellesley, & Woolwich	300	310	321	331	347	363	370	380	388	399	408	419	433	445	456	468	478	490	502	514
Cambridge & North Dumfries	294	306	312	319	327	337	349	356	366	376	387	396	407	417	430	440	453	465	478	488
Kitchener & Wilmot	402	408	415	426	433	439	446	453	460	467	474	480	487	494	501	508	515	523	530	538
Wellington County & Blandford-Blenheim (Oxford County)	166	168	170	172	173	175	177	179	181	183	185	187	190	193	196	198	201	201	203	206
Total	1445	1488	1528	1566	1609	1653	1693	1728	1766	1807	1848	1888	1936	1978	2027	2071	2118	2150	2185	2217

A.1.1 Cambridge and North Dumfries Hydro: Gross Forecast Methodology and Assumptions

Cambridge and North Dumfries Hydro Inc. ("Cambridge and North Dumfries Hydro") provides service to the City of Cambridge and the Township of North Dumfries along with a number of customers along its boundary in the County of Brant, the Township of Blanford-Blenheim and the City of Hamilton. Cambridge and North Dumfries Hydro has recently acquired Brant County Power ("BCP"). Brant County Power's distribution system is electrically separate from Cambridge North Dumfries Hydro's distribution system so BCP information is not included as part of this study area.

Cambridge and North Dumfries Hydro distributes electricity to approximately 53,000 customers, of which 89% are residential, 10.4% are commercial, and 0.05% are industrial. The remaining customers are embedded LDC's, generators, street lighting and unmetered scattered load.

Cambridge North Dumfries Hydro's service area covers 306 square kilometres. Cambridge and North Dumfries Hydro receives power from Hydro One Networks and delivers power to its customers via four high voltage transformer stations, one of which is owned by Cambridge and North Dumfries Hydro and the others are owned by Hydro One. Cambridge North Dumfries Hydro's principal primary distribution voltage is 27.6 kV.

Factors that Affect Electricity Demand

The City of Cambridge and the Township of North Dumfries are located in the Region of Waterloo. The Region of Waterloo is included in the Province of Ontario's *Places to Grow Act, 2005*. Using the Region of Waterloo published population numbers, the City of Cambridge is expected to grow from its 2013 year-end population of 132,700 to 173,000 by 2029. The Township of North Dumfries is expected to grow from its current population of 9,640 to 16,000 by 2029.

The Cambridge area is experiencing increased density in the form of high rise apartment/condominium residential buildings and re-use of decommissioned industrial land for new residential development in built-up areas.

Much of the current residential growth is coming from the South East Galt area bounded by Franklin Boulevard, Main Street, Dundas Street and the east limit of the city boundary. Residential growth is also coming from multiple residential sites throughout the city.

Significant future residential growth is expected to come from planned subdivisions located on the east side of Speedsville Road North of Highway 401. The level of residential building permit activity in recent years has been low as compared to historical norms. The activity level began to recover in 2014 and additional recovery is expected as the local economy improves and as new housing developments become available.

The City of Cambridge's current report of "Industrial Sites and Buildings" states the following:

> "Cambridge is an "Industrial City" with a history rich in industrial development dating back to the 1800's. Planned industrial building lots were marketed as early as the mid 1800's and established the cornerstone for the momentum in industrial development that exists today. Cambridge now has 4,315 acres of land zoned for industrial use."

There were 110 acres of new, serviced industrial land developed by the City of Cambridge in the "Boxwood Industrial Subdivision" which came onto the market in late 2013, and 741 net acres of industrial land are planned for the "East Side Lands" located partly in Cambridge and partly in the Township of Woolwich. The first development of these lands is scheduled to begin in 2015.

Conservation programs continue to have a positive effect by reducing peak demand. Cambridge and North Dumfries Hydro was the first electric utility in Ontario to offer a $200 incentive towards a "Nest Learning Thermostat" ™ if a customer signed up for the Nest Rush Hour Rewards program. The ongoing microFit/FIT programs add new renewable generation each year which reduces peak demand. The FIT generation reduced Cambridge North Dumfries Hydro's annual peak demand by 2.6 MW in 2014.

Cogeneration projects will reduce the demand for electricity. One large cogeneration project is underway in Cambridge North Dumfries Hydro's service area.

The level of Gross Domestic Product ("GDP") growth is a significant driver of peak demand. The GDP growth has been relatively low in recent years. Cambridge and North Dumfries Hydro also lost significant industrial load as a result of the 2008/2009 recession. As well, local export industries faced challenges with the relatively high value of the Canadian dollar. Greater economic growth and the lower Canadian dollar should boost local industrial activity and result in increased electrical demand.

Summer temperatures and humidity levels are a significant driver for peak demand. Cambridge North Dumfries Hydro's peak load can rise 50% on a hot summer day versus a day in the spring or summer with average temperatures. Air conditioning has a large impact.

Looking forward, greater adoption of electric vehicles could have a substantial impact on local electricity demand.

Forecast Methodology and Assumptions

The load forecast supplied by Cambridge and North Dumfries Hydro covers the electrical loads in the City of Cambridge and the Township of North Dumfries excluding one large industrial load that is directly connected to the 230 kV transmission system.

In 2012, Cambridge and North Dumfries Hydro developed the reference level forecast growth rate by looking at historical actual system peak load data for each year going back to 1978, then averaging the annual percentage change in summer peak load. The long-term annual percentage change was approximately 3%. However, Cambridge North Dumfries Hydro's long-term average summer peak growth rate going back to 1978 is now at 2.4%, and the trend has been down. As a result, Cambridge and North Dumfries Hydro has lowered its expected long-term growth rate going forward from 3% to 2%. Cambridge and North Dumfries Hydro expects growth to return, since the Cambridge area is designated in the provincial Places to Grow Act and there is available industrial and residential land for development.

The forecast could change significantly. It is important to be in a position to respond quickly, if needed, to accommodate the significant growth that could occur. The basic elements are in place. At the same time, it is important not to invest prematurely in facilities that could be underutilized. The plan going forward must be flexible.

A.1.2 Guelph Hydro: Gross Forecast Methodology and Assumptions

Guelph Hydro Electric Systems Inc. ("Guelph Hydro") owns and operates the electricity distribution system in its licensed service area in the City of Guelph and the Village of Rockwood serving approximately 52,000 customers. Guelph Hydro's customer base is represented by a mixture of residential customers (91% by customer count, 22% by load) and Commercial/Industrial /Institutional customers (9% by customer count and 78% by load). Guelph Hydro services five Large Use rate customers represented by a university and industrial/manufacturing facilities.

Guelph Hydro is supplied through the Hydro One transmission system at primary voltages of 115 kV and 230 kV within the City of Guelph. Electricity is then distributed through Guelph Hydro's service territory by three Hydro One owned transformer stations, Campbell TS, Cedar TS and Hanlon TS and the Guelph Hydro owned Arlen Municipal Transformer Station ("MTS"). The Guelph Hydro distribution system in the City of Guelph is serviced at 13.8 kV. The Village of Rockwood is supplied through the Hydro One distribution system at a primary voltage of 44 kV. Electricity is then distributed through the Village of Rockwood by two Guelph Hydro owned MTSs, and one Hydro One distribution station. Guelph Hydro's distribution system in the Village of Rockwood is serviced at 8.32 kV.

Factors that Affect Electricity Demand

The major variables affecting electricity demand within Guelph Hydro's service territory in the City of Guelph are related to population growth rate associated with the provincial places to grow targets as well as economic development within both the current industrial/manufacturing rate class sector and future development and use of industrial parks. The rate and level of future demand increases are highly dependent on the each one of these factors.

The City of Guelph has been designated as one of 25 municipalities listed in the Growth Plan as an Urban Growth Centre. The city is directed to increase its population to 175,000, which is an increase of over 50,000 people.

Another significant factor in the demand of electricity is linked to economic development within both our current and future customer base. A significant portion of the electricity demand within Guelph Hydro's service territory is associated with the manufacturing sector.

Economic development as it relates to future utilization of industrial park land represents a large portion of future increase to electricity demand within the city. The most significant development is the Hanlon Creek Business Park located in the south end of Guelph Hydro's service territory and represents a total land mass of over 370 acres. Approximately 8% of the land within the business park has been consumed to date and reflective in the current electricity demand with the remaining accounted for in the forecast.

Conservation and DG efforts have made an impact to the average system growth rate within the Guelph service territory since being initiated in 2002 with a net reduction of approximately 1.25% towards the overall average growth rate between 2004 and 2013.

Forecast Methodology and Assumptions

Guelph Hydro's methodology for developing the base load forecast consisted of a number of elements including historical loading trends, local knowledge of planned development and City of Guelph development planning information. Planning information from the City of Guelph was the starting point to formulate a maximum development forecast in order to set the parameters of the long-range load forecast for its service territory given the study period. Using this information along with 30+years of historic peak loading information, local knowledge and information regarding transformer stations service areas within Guelph Hydro's service territory, the load forecast was created for each delivery point location.

A.1.3 Kitchener-Wilmot Hydro: Gross Forecast Methodology and Assumptions

Kitchener-Wilmot Hydro owns and operates the electricity distribution system in its licensed service area in the City of Kitchener and the Township of Wilmot, serving approximately 91,500 Residential, General Service, Large Use, Street Light, Unmetered Scattered Load and Embedded Distributor rate customers.

Kitchener-Wilmot Hydro is supplied through the Hydro One transmission system at primary voltages of 115 kV and 230 kV. Electricity is then distributed through Kitchener-Wilmot Hydro's service area (411 square kilometers) by eight MTSs (27.6 kV and 13.8 kV) and seven municipal distribution stations (8.32 kV).

Factors that Affect Electricity Demand

There are multiple factors affecting electricity demand within the Kitchener-Wilmot Hydro service area.

The first factor driving electricity demand is population growth. In response to the Ontario's Place to Grow plan, the Region of Waterloo has published its Official Plan with forecast population growth. In Kitchener-Wilmot Hydro's service area, it is estimated that the population will increase from 232,200 in 2006 to 341,500 in 2029, and the employment will increase from 106,100 in 2006 to 139,700 in 2029. The growth in population and employment will drive the electricity demand for the next 20 years.

The second factor impacting the electricity demand is the change in the industrial sector. The City of Kitchener is experiencing a conversion from being a manufacturing-oriented economy to a more diversified and balanced economy. Kitchener-Wilmot Hydro has lost its top three load customers in the past 10 years. In the meantime, more customers with smaller demand emerge in the industrial and commercial sectors.

The third factor impacting electricity demand growth is the Region of Waterloo's Regional Official Plan. To support the provincial policy in the Places to Grow Act, as well as the city's efforts to intensify the Kitchener downtown area, the Region of Waterloo is installing a light rail transit ("LRT") system that will ultimately connect the three local cities: Waterloo, Kitchener, and Cambridge. The electrical load required to drive the trains within the Kitchener-Wilmot Hydro's service territory is expected to be in excess of 3.5 MW (or approximately 1% of the system peak) and come on line in 2017. The installation of the LRT is further expected to spur development along the train route in both the residential and commercial sectors.

The fourth factor impacting the electricity demand is the rising awareness of renewable energy generation development and CDM. Ontario's *Green Energy Act, 2009* established a new framework for electricity in the province. As directed by the OEB, Kitchener-Wilmot Hydro is currently participating in multiple provincial renewable energy programs and CDM programs, which help control and reduce the electricity demand. Time-of-Use ("TOU") is also shifting demand and conserving energy as the customers manage their electricity use and control their hydro costs.

Forecast Methodology and Assumptions

In developing the reference forecast, Kitchener-Wilmot Hydro uses trend analysis (trending) to extend past growth rates of electricity demand into the future. A linear-trend method that uses the historical data of demand growth to forecast future growth has been applied. The coincident peak data (July 7th, 2010 at hour 16) has been used as the base for load forecast. A long-term 6.86 MW annual gross demand growth from 2011 to 2030 has been projected, with 60% of the annual load growth (4.12 MW) attributable to residential customers, and 40% (2.74 MW) attributable to commercial and industrial customers. The annual demand growth has been allocated to each transformer station based on the municipal development plan, available vacant lands and other local knowledge.

This annual demand growth rate covers both load additions of new customers and load maturation of the existing customers. The projected long-term annual demand growth is derived from the average load growth for the observed summer peaks from 1993 to 2006. The more recent data of 2007-2013 were biased and ignored due to multiple factors, like loss of the largest load customers, conservation and DG, TOU pricing, and the economic downturn after the credit crisis.

In order to reflect some one-time new large load additions that are not covered by the historical trend (e.g., the Kitchener Waste Water Treatment Plant expansion, and the proposed regional LRT stations), additional loads (6.5 MW in total between 2011-2017) have been added to the near-term forecast on top of the long-term annual demand growth rate.

A.1.4 Waterloo North Hydro: Gross Forecast Methodology and Assumptions

Waterloo North Hydro Inc. ("Waterloo North Hydro") owns and operates the electricity distribution system in its licensed service area in the City of Waterloo and the Townships of Woolwich and Wellesley, serving approximately 55,000 customers. Waterloo North Hydro's customer base is comprised of primarily residential (89% by customer count) and commercial/institutional loads (10% by customer count). Waterloo North Hydro's largest loads include universities, high-tech companies and financial institutions. A small component of the Waterloo North Hydro load base comes from the industrial/manufacturing sector (1% by customer count).

Waterloo North Hydro is supplied through the Hydro One transmission system at primary voltages of 115 kV and 230 kV. Electricity is then distributed through Waterloo North Hydro's service area by three MTSs and 13 municipal distribution stations. Waterloo North Hydro's distribution system is divided into the 13.8 kV system servicing the core of the City of Waterloo, and the 27.6 kV system servicing the outskirts of the City of Waterloo as well as the township areas. Waterloo North Hydro also has some 8.32 kV distribution throughout its rural service territory and a small amount of 4.16 kV distribution in the core of the City of Waterloo and in the Town of Elmira.

Factors that Affect Electricity Demand

There are two major factors affecting electricity demand within Waterloo North Hydro's service territory and both are municipally driven; one by the City of Waterloo, and one by the Region of Waterloo.

As a result of recessions in the late 1980's and early 1990's, the City of Waterloo formulated a strategic plan to capitalize on the two very reputable local universities (University of Waterloo and Wilfrid Laurier University) and create conditions for students who attend the local universities to start new business and remain in this area. The City of Waterloo became a leader in fostering high-tech industry start-ups and full businesses, with Blackberry being an example of its global business successes as a direct result. Demand in the housing market was very strong resulting in the City of Waterloo developing to the limits of its boundaries and running out of greenfield developable land. This resulted in the city setting a new strategy of brownfield re-development, which started a few years ago and continues to grow. Most of the brownfield re-development is in the area abutting the two local universities as well as the uptown core of the City of Waterloo. In most cases, the re-development consists of the demolition of a few single dwelling residential units being replaced with multi-unit residential complexes. It is very common to see the footprint of four houses being developed into high rise apartments with 100 dwelling units.

The second driving factor for electricity demand growth in Waterloo North Hydro's service territory is the Region of Waterloo's strategy in support the provincial Places to Grow policy. The Region of Waterloo has limited urban sprawl by setting hard boundaries for greenfield development to coincide with existing city limits. To support the provincial policy as well as the city's efforts to intensify the uptown and university neighbourhoods, the Region of Waterloo is installing an LRT system that will ultimately connect the three local cities: Waterloo, Kitchener, and Cambridge. The electrical load required to drive the trains is substantial, and within the Waterloo North Hydro service territory alone is expected to be in excess of 6 MW (or approximately 2% of the system peak). A portion of the LRT load in Waterloo will come on line in 2016 for initial train testing with the balance of this load arriving in 2017 when the full LRT system goes into service.

The regional plan also sets new areas of greenfield development, labeled as East Side Lands, to be just outside of Kitchener along Highway 7 leading toward Guelph, and extending south into Cambridge and North Dumfries Hydro's service territory all the way to Highway 401. The planned land uses involve residential, commercial, and industrial sectors and is located along a railway route identified by MetroLinx as their next major growth potential location. Electrical demand in this area is expected to be at higher densities due to the industrial component of land use as well as high-tech data centre applications of the commercial space.

Over the last couple of years, Waterloo North Hydro has also observed the peak demand impact by the development of DG and conservation efforts.

Forecast Methodology and Assumptions

In developing the load forecasts, Waterloo North Hydro gathers development projection data from the local municipalities and developers to determine areas and timing of planned development as well as land uses. This information is then converted to electrical demand quantities and analyzed against past trends. A forecast is developed for each TS that is consistent with load growth potential within the service area of that station and overall system growth. Waterloo North Hydro uses geometric growth trend methodology (trending) to extend past growth rates of electricity demand into the future.

The coincident peak data (July 7th, 2010 at hour 16) has been used as the base for the load forecast. The gross load forecast has been prepared such that by the end of the study period in 2033, the geometric growth rate is consistent with past trends and long-term development potential. Year-to-year load projections were adjusted in terms of timing and location (station) based on knowledge with respect to local development conditions. This resulted in an overall geometric system growth rate of 3.3% up to year 2018 and 2.5% thereafter. This represents an addition of, on average, 10.3 MW of load per year over the study period.

A.1.5 Hydro One Distribution: Gross Forecast Methodology and Assumptions

Hydro One Distribution provides service to counties and townships surrounding the Region of Waterloo and Guelph area (Wellington County, and Oxford County - Blandford-Blenheim Township). Three step-down stations supply the area from the transmission system as follows:

- 230/44 kV Fergus TS supplied by 230 kV circuits D6V and D7V
- 115/27.6 kV Puslinch DS supplied by 115 kV circuits B5G and B6G
- 115/27.6 kV Wolverton DS supplied by 115 kV circuit D7F

There are about 14,000 Hydro One Distribution retail customers directly connected to Hydro One's distribution system. There are embedded LDCs connected to Hydro One's distribution system.

Factors that Affect Electricity Demand

Hydro One Distribution serves mostly the rural areas outside the major cities such as Kitchener, Waterloo, Guelph and Cambridge. The demand growth in the Hydro One distribution service area is largely driven by the economic activities in these large communities and is expected to be modest as the population moves from the urban centers to the rural areas.

Some of the smaller communities such as Elora, Fergus and Rockwood are in the embedded LDCs to Hydro One Distribution. The load growth in these communities is therefore factored in the Hydro One Distribution load forecast.

Forecast Methodology and Assumptions

The reference level forecast is developed using macro-economic analysis, which takes into account the growth of demographic and economic factors. The forecast corresponds to the expected weather impact on peak load under average weather conditions, known as weather-normality. Furthermore, the forecast is unbiased such that there is an equal chance of the actual peak load being above or below the forecast. In addition, local knowledge, information regarding the loading in the area within the next two to three years, is utilized to make minor adjustments to the forecast.

Hydro One Distribution conducts distribution area studies to examine the adequacy of the existing local supply network in the next 10 to 15 years and determine when new stations need to be built. These studies are performed on a needs basis, such as:

- Load approaching the planned capacity
- Issues identified by the field and customer
- Issues discovered during our 6-year cycle studies
- Additional supply required for large-step load connections
- Poor asset condition

A.2 Estimated Peak Demand Savings from Provincial Energy Conservation Targets

Table A-2 shows the estimated peak demand savings from provincial conservation energy targets in the KWCG Region. These estimates were developed using the methodology described in Appendix A.2.1 below, and were considered in the development of near- and medium-term planning forecast and the high-growth long-term demand scenario. Estimated peak demand savings from provincial energy conservation targets were not applied to the low-growth scenario since the scenario already accounts for the anticipated impact of the 2032 conservation targets in its overall growth rate assumptions.

Table A-2: Estimated Peak Demand Savings from Provincial Energy Targets in the KWCG Region - 2014-2033

Estimated Peak Demand Savings from Provinicial Energy Conservation Target (MW)																				
Municipalities	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**
Guelph & Rockwood	5	6	8	10	12	17	20	24	27	30	35	38	42	46	52	55	60	64	67	67
Waterloo, Wellesley, & Woolwich	5	7	9	10	13	18	22	26	29	32	37	40	44	49	54	58	62	67	73	74
Cambridge & North Dumfries	5	7	9	10	12	17	20	24	27	30	35	37	41	45	50	54	58	63	68	70
Kitchener & Wilmot	7	9	12	13	16	22	26	31	34	37	43	46	50	54	59	63	67	72	77	78
Wellington County & Blandford-Blenheim (Oxford County)	3	4	5	5	6	9	10	12	13	15	17	18	19	21	23	24	26	28	29	30
Total	24	33	42	47	58	82	99	116	129	144	166	179	196	215	239	254	273	294	314	319

A.2.1 Methodology to Estimate Peak Demand Savings from Provincial Energy Targets

The estimated peak demand savings assumptions considered in the planning forecast were derived from the provincial conservation forecast, which aligns with the conservation targets described in the 2013 LTEP: "Achieving Balance: Ontario's Long-Term Energy Plan". The LTEP set an electrical energy conservation target of 30 TWh in 2032, with about 10 TWh of the energy savings coming from codes and standards ("C&S"), and the remaining 20 TWh from energy efficiency (EE) programs. The 30 TWh energy savings target will also lead to associated peak demand savings. It is important to note that the TOU rates and demand response (DR) resources focus on peak demand reduction rather than energy savings and, as such, are not reflected in the 30 TWh energy target. Therefore the savings from potential DR resources and TOU are not included in the forecast and are instead considered possible solutions to identified needs.

To assess the peak demand savings from the provincial conservation targets, two provincial demand forecasts are developed. A gross demand forecast is produced that represents the anticipated electricity needs of the province based on growth projections, for each hour of the year. This forecast is based on a model that calculates future gross annual energy consumption by sector and end use. Hourly load shape profiles are applied to develop province-wide gross hourly demand forecasts. Natural conservation impacts are included in the provincial gross demand forecast, however the effects of the planned conservation are not included. A net hourly demand forecast is also produced, reflecting the electricity demand reduction impacts of C&S, EE programs, and TOU. The gross and net forecasts were then compared in each year to derive the peak demand savings. In other words, the difference between the gross and net peak demand forecasts is equal to the demand impacts of conservation at the provincial level.

The above methodology was used to derive the combined peak demand savings from three categories: (1) TOU rates, (2) C&S and (3) EE programs. Peak demand savings associated with load shifting in response to TOU rates were estimated using an econometric model based on customers' elasticity of substitution and the TOU price ratio. The remaining peak savings were allocated between C&S and EE programs based on their energy saving projections, with about 1/3 attributed to C&S and 2/3 to EE programs.

The resulting peak demand savings in each year are represented as a percentage of total provincial peak demand shown in Table A-3, using 2013 as a base year.

Table A-3: Estimated Peak Demand Savings from Provincial Energy Conservation Targets (percent of gross load)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
C&S	0.1%	0.2%	0.3%	0.7%	0.8%	1.2%	1.7%	2.1%	2.5%	2.7%	2.7%	2.9%	3.1%	3.3%	3.8%	4.2%	4.5%	4.9%	5.2%	5.5%	5.5%
TOU	0.2%	0.4%	0.5%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
EE programs	0.6%	1.1%	1.4%	1.5%	1.7%	1.8%	2.7%	3.6%	3.7%	4.1%	4.7%	5.5%	5.9%	6.3%	6.6%	7.0%	7.2%	7.4%	7.9%	8.3%	8.3%
Total	**0.9%**	**1.7%**	**2.2%**	**2.8%**	**3.1%**	**3.6%**	**5.0%**	**6.3%**	**6.8%**	**7.4%**	**8.0%**	**9.0%**	**9.5%**	**10.2%**	**10.9%**	**11.9%**	**12.3%**	**13.0%**	**13.7%**	**14.4%**	**14.4%**

These percentages were applied to the gross demand forecasts at the TS level to determine the peak demand savings assumed in the planning forecast. This allocation methodology relies on the assumption that the peak demand savings from provincial conservation will be realized uniformly across the province. Actions recommended in the KWCG IRRP to monitor actual demand savings, and to assess conservation potential in the Region, will assist in developing region-specific conservation assumptions going forward.

A.3 Expected Peak Demand Contribution of Contracted Distributed Generation

The installed capacity of contracted DG is adjusted to reflect the expected power output at the time of local area peak, based on resource-specific peak capacity contribution value (solar, biomass/gas, wind, and hydro generation) obtained from IESO's 2014 "Methodology to Perform Long Term Assessments" (see Appendix A.3.2). Table A-4 shows the estimated peak demand contribution of contracted DG in the KWCG Region, as of December 2014. These estimates were considered in the development of near- and medium-term planning forecast and long-term demand scenarios, and considers the higher-growth forecast in the Places to Grow growth plan, and a lower-growth forecast of the 2013 LTEP. The total installed capacity of contracted DG in the KWCG Region can be found in Appendix A.3.1. Future DG uptake was not included due to difficulties forecasting uptake and the potential to consider this as an option for meeting identified needs.

Table A-4: Expected Peak Demand Contribution of Contracted Distributed Generation[1]

Expected Peak Demand Contribution of Contracted Distributed Generation (MW)																				
Municipalities	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**
Guelph & Rockwood	5	5	5	5	5	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Waterloo, Wellesley, & Woolwich	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Cambridge & North Dumfries	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Kitchener & Wilmot	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Wellington County & Blandford-Blenheim (Oxford County)	6	8	8	8	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Total	20	24	25	25	25	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35

[1] Distributed generation that came into commercial operation prior to 2010 was not explicitly considered in the development of planning forecast. The expected peak demand contribution of this DG (in-service prior 2010) was accounted for in the gross demand forecast assumptions.

A.3.1 Installed Capacity of Contracted Distributed Generation in the KWCG Region

Table A-5 shows the installed capacity of contracted DG in the KWCG Region, which was active as of December 2014.

Table A-5: Installed Peak Demand Contribution of Contracted Distributed Generation [2]

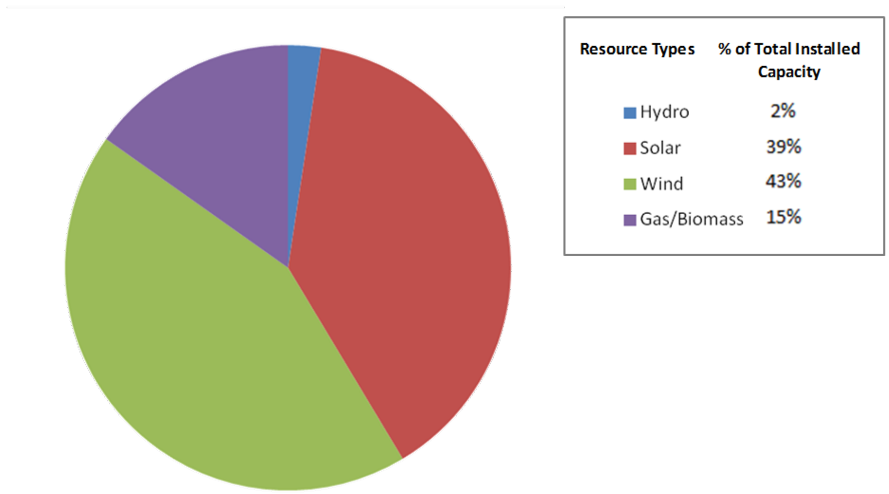
Installed Capacity of Contracted Distributed Generation (MW)																				
Municipalities	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**
Guelph & Rockwood	11	11	11	11	11	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
Waterloo, Wellesley, & Woolwich	7	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Cambridge & North Dumfries	6	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Kitchener & Wilmot	6	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Wellington County & Blandford-Blenheim (Oxford County)	37	46	47	47	47	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48
Total	67	85	86	86	86	98	98	98	98	98	98	98	98	98	98	98	98	98	98	98

[2] Distributed generation that came into commercial operation prior to 2010 was not explicitly considered in the development of planning forecast. The expected peak demand contribution of DG that came in-service prior 2010 was accounted for in the gross demand forecast assumptions.

Figure A-1 below shows the breakdown the installed capacity of contracted DG in the KWCG Region by resource type.

Installed capacity of contracted DG in the KWCG Region by resource type.

Figure A-1: Installed Capacity of Contracted Distributed Generation in the KWCG Region by Resource Type



A.3.2 Peak Capacity Contribution Assumptions

The peak capacity contribution of wind, solar, biomass, wind, and hydro generation obtained from the IESO's 2014 "Methodology to Perform Long Term Assessments"[3] is shown in Table A-6 below. The peak capacity contribution values are applied to installed capacity to reflect the expected power output from DG at the time of local area peak.

[3] http://www.ieso.ca/Documents/marketReports/Methodology_RTAA_2014feb.pdf

Table A-6: Peak Capacity Contribution Assumptions

Resource Type	Peak Capacity Contribution (% of installed capacity)
Biomass/Gas	98%
Hydro	71%
Solar	30%
Wind	14%

A.4 Planning Demand Forecast and Scenarios

A.4.1 Near- and Medium-Term Planning Forecast 2014-2023

Table A-7: Near- and Medium-Term Planning Forecast 2014-2023 – KWCG Region

Near-and Medium-Term Planning Forecast (MW)										
Municipalities	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Guelph & Rockwood	291	301	314	322	331	325	334	341	349	357
Waterloo, Wellesley, & Woolwich	308	316	326	335	349	361	364	371	376	384
Cambridge & North Dumfries	304	313	318	324	330	336	345	348	356	363
Kitchener & Wilmot	417	421	425	435	439	440	443	445	449	453
Wellington County & Blandford-Blenheim (Oxford County)	166	166	166	168	169	168	168	168	169	170
Total	1486	1517	1549	1584	1619	1629	1653	1673	1699	1727

A.4.2 Long-Term Planning Forecast Scenarios

High-Growth Scenario

The high-growth scenario is developed based on gross demand forecast by LDCs within their service territories. It was then adjusted by the IESO to account for the anticipated peak demand impacts of provincial conservation energy targets, the effect of contracted DG, and the effect of extreme summer temperature conditions. The underlying growth projection of the higher-growth forecast is provided by LDCs relying on their own local growth plans, which were heavily influenced by *Places to Grow Growth Plan for the Greater Golden Horseshoe* (2013 consolidation). [4] This scenario is an extension of the near- and medium-term forecast and assumes use 2023 peak demand value as a starting point.

Table A-8: High-Growth Scenario Planning Forecast 2023-2033 – KWCG Region

High-Growth Scenario Planning Forecast 2024-2033 (MW)										
Municipalities	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**
Guelph & Rockwood	365	373	383	390	400	410	420	416	413	413
Waterloo, Wellesley, & Woolwich	388	397	407	415	421	430	436	443	450	461
Cambridge & North Dumfries	370	376	384	390	399	406	415	422	430	440
Kitchener & Wilmot	454	458	462	464	466	470	473	475	479	486
Wellington County & Blandford-Blenheim (Oxford County)	170	171	172	173	174	175	177	175	175	177
Total	1747	1775	1808	1833	1859	1891	1920	1932	1947	1976

[4] https://www.placestogrow.ca/index.php?option=com_content&task=view&id=359&Itemid=12

Low-Growth Scenario

The low-growth scenario assumes that KWCG Region grows at annual rate of 0.2 % beyond 2023. This assumption aligns with growth rate forecast for the IESO southwest zone in the 2013 LTEP and assumes significant peak demand savings from future conservation efforts and peak demand contribution of DG. This scenario is an extension of the near- and medium-term forecast and assumes 2023 peak demand value as a starting point.

Table A-9: Low-Growth Scenario Planning Forecast 2023-2033 – KWCG Region

Low-Growth Scenario Planning Forecast 2024-2033 (MW)										
Regional Subsystems	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**
Guelph & Rockwood	358	359	360	361	361	362	363	364	365	365
Waterloo, Wellesley, & Woolwich	385	386	387	388	388	389	390	391	392	393
Cambridge & North Dumfries	364	365	366	367	367	368	369	370	371	372
Kitchener & Wilmot	454	455	456	457	458	459	460	461	462	463
Wellington County & Blandford-Blenheim (Oxford County)	170	170	171	171	172	172	172	173	173	174
Total	1731	1735	1739	1743	1747	1751	1755	1759	1763	1767

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Appendix B: Needs Assessment

Appendix B: Needs Assessment

B.1 Application of Ontario Resource and Transmission Assessment Criteria (ORTAC)

In accordance with Ontario Resource and Transmission Assessment Criteria ("ORTAC"), the system must be designed to provide continuous supply to a local area, under specific transmission and generation outage scenarios summarized in Table B-1. Voltage and thermal limitations should be respected under these outage conditions.

Table B-1: ORTAC Criteria – Transmission and Generation Outage Scenarios

Pre-contingency		Contingency[1]	Thermal Rating	Maximum Permissible Load Rejection
All transmission elements in-service	Local generation in-service	N-0	Continuous	None
		N-1	LTE[2]	None
		N-2	LTE[2]	150 MW
	Local generation out-of-service	N-0	Continuous	None
		N-1	LTE[2]	150 MW[3]
		N-2	LTE[2]	>150 MW[3] (600 MW total)

1. N-0 refers to all elements in-service; N-1 refers to one element (a circuit or transformer) out of service; N-2 refers to two elements out of service (for example, loss of two adjacent circuits on same tower, breaker failure or overlapping transformer outage); N-G refers to local generation not available (for example, out of service due to planned maintenance).
2. LTE: Long-term emergency rating (50-hr rating for circuits, 10-day rating for transformers).
3. Only to account for the capacity of the local generating unit out of service.

ORTAC Load Security and Restoration

With respect to supply interruptions, ORTAC requires that the transmission system be designed to minimize the impact to customers of major outages, such as a contingency on a double-circuit tower line resulting in the loss of both circuits, in two ways: by limiting the amount of customer load affected; and by restoring power to those affected within a reasonable timeframe.

Specifically, ORTAC requires that no more than 600 MW of load be interrupted in the event of a major outage involving two elements. Further, load lost during a major outage is to be restored within the following timeframes:

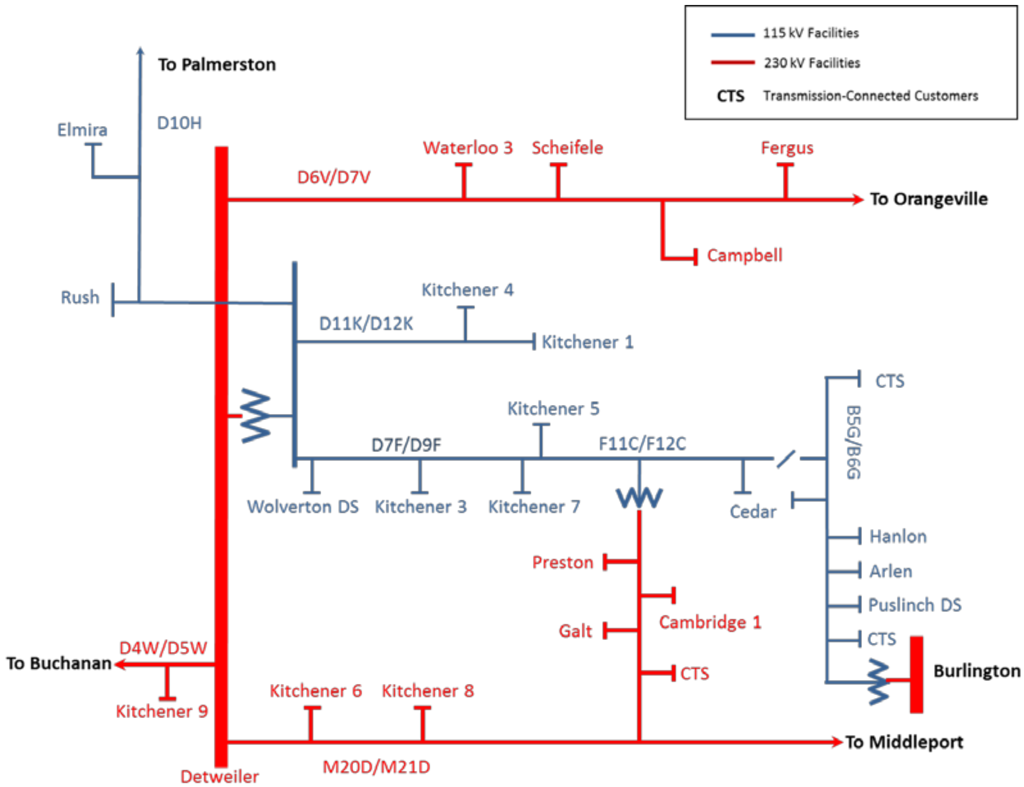
- All load lost in excess of 250 MW must be restored within 30 minutes;
- All load lost in excess of 150 MW must be restored within four hours; and

- All load lost must be restored within eight hours.

B.2 Study Assumptions

Planning criteria was applied to assess supply capacity and reliability needs of the KWCG transmission system, shown in Figure B-1.

Figure B-1: KWCG Transmission System



There is no major generation station in the KWCG Region. The majority of supply to the load is provided by a number of 500 kV to 230 kV and 230 kV to 115 kV auto-transformers as follows:

- Two 500/230 kV auto-transformers at Middleport TS
- Four 230/115 kV auto-transformers at Burlington TS
- Three 230/115 kV auto-transformers at Detweiler TS
- Two 230/115 kV auto-transformers at Cedar TS
- One 230/115 kV auto-transformers at Preston TS

A number of existing voltage support facilities are installed on the transmission and distribution system and are assumed to be available as part of the needs analysis.

PSS/E Base case and Bulk System Conditions

The KWCG transmission system was assessed using PSS/E Power System Simulation software. The PSS/E base case for the KWCG Region regional planning study was adapted from the 2015 base case that was produced by the IESO for the 2010 Northeast Power Coordinating Council ("NPCC") review.

The following bulk system conditions were assumed for purpose of the power flow simulation studies:

- All eight Bruce units and the new 500 kV double-circuit line between the Bruce Complex and Milton SS. All units at Darlington are assumed to be in-service, and all of the units at Pickering GS are assumed to be unavailable.
- Renewable generation in the Bruce and other parts of southwestern Ontario will have an impact on the bulk system flows into the KWCG Region. About 1,800 MW of wind output in the Bruce area and about 400 MW of renewable output from southwestern Ontario (Buchanan, Chatham and Sarnia).

Equipment Rating

For transmission facilities, continuous and limited time ratings based on an ambient temperature of 35°C for summer and a wind speed of 4 km/hour were respected.

Demand Forecast

The KWCG transmission system is assessed under the near- and medium-term planning forecast (2014-2023) and longer-term planning forecast scenarios (2024-2033), provided in Appendix A.4.

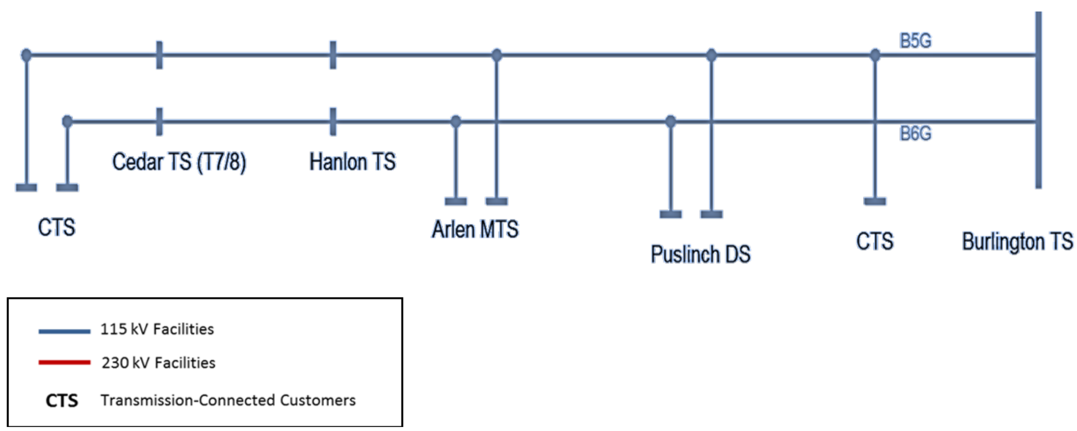
B.3 Load Meeting Capability (LMC) of the Existing KWCG Transmission System

Supply capacity describes the electricity system's ability to provide continuous supply to a local area. This is limited by the load meeting capability ("LMC"). The LMC of transmission or sub-system is defined the maximum demand that can be supplied on a transmission line or sub-system under applicable transmission and generation outage scenarios as prescribed by ORTAC.

B.3.1 South Central Guelph 115 kV Sub-system: LMC and Supply Capacity Needs

The South-Central Guelph 115 kV sub-system (B5/6G) is a double circuit 115 kV transmission line supplying Cedar TS (T7/8), Hanlon TS, Arlen MTS, Puslinch DS and two transmission-connected customers, as shown in Figure B-2.

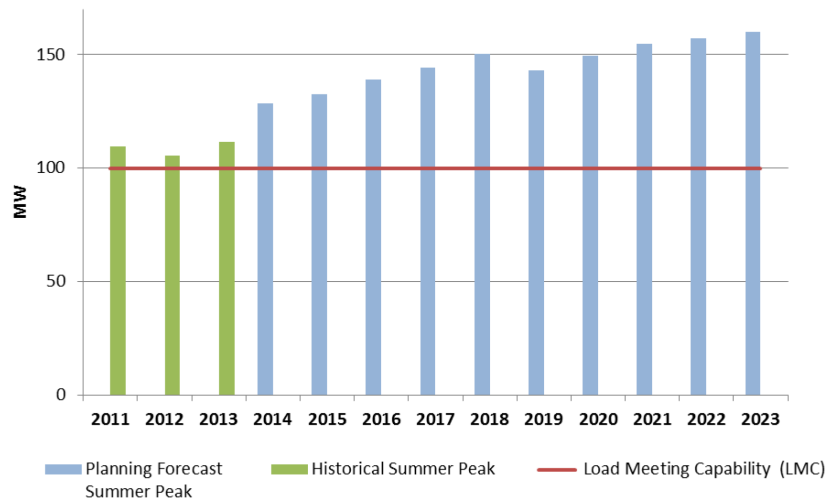
Figure B-2: South-Central Guelph 115 kV Sub-system



Based on the application of ORTAC criteria, this system has an LMC of 100 MW. This limit is based on the voltage limitations of the B5G circuit, assuming the B6G is out-of-service.

As shown in Figure B-3, the summer peak demand in the South-Central Guelph area has already exceeded the 100 MW LMC limit of the South-Central Guelph 115 kV system over the last couple of years. The existing South-Central Guelph 115 kV system does not meet the ORTAC supply capacity criteria.

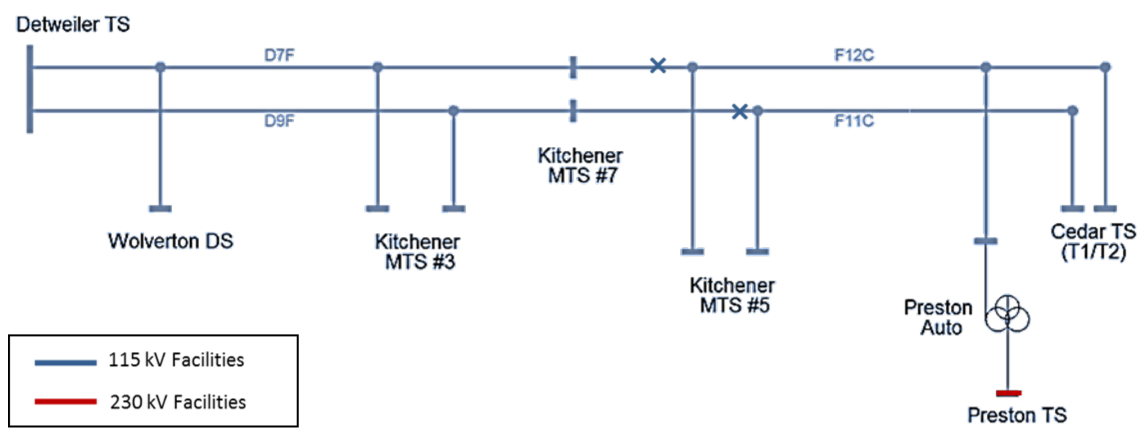
Figure B-3: Summer Peak Demand on South-Central Guelph 115 kV Sub-system



B.3.2 Kitchener-Guelph 115 kV Sub-system: LMC and Supply Capacity Needs

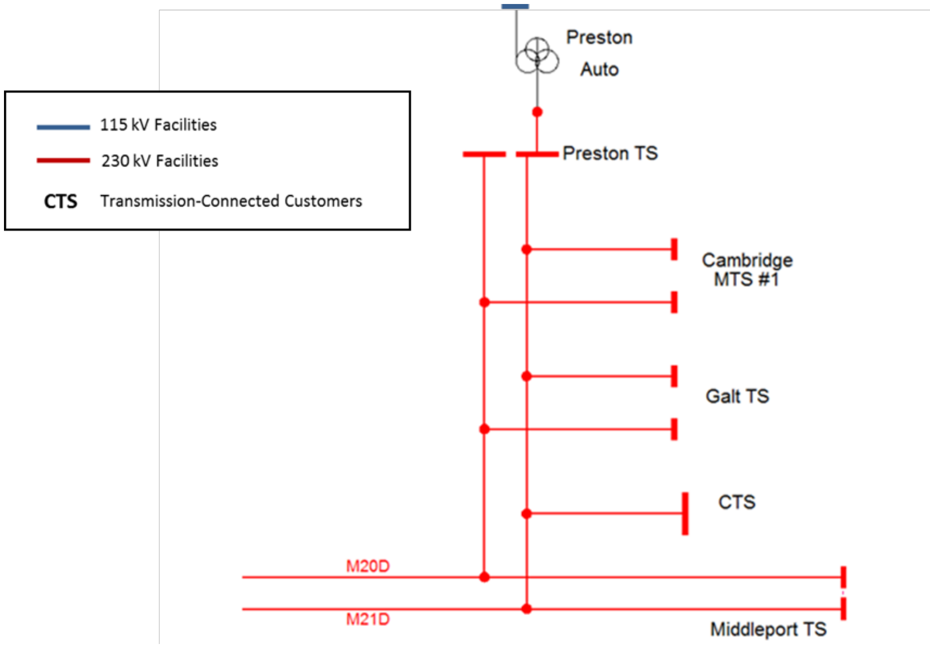
The Kitchener-Guelph 115 kV sub-system (D7/9F and F11/12C) is a double circuit 115 kV transmission line supplying Cedar TS (T1/T2), Kitchener MTS #5, Kitchener MTS #7, Kitchener MTS #3, and Wolverton DS, as shown in Figure B-4.

Figure B-4: Kitchener-Guelph 115 kV Sub-system



Based on the application of ORTAC criteria, this system has a LMC of 260 MW. This limit is based on the thermal overloading of the D7F circuit, assuming the D9F circuit is out-of-service.

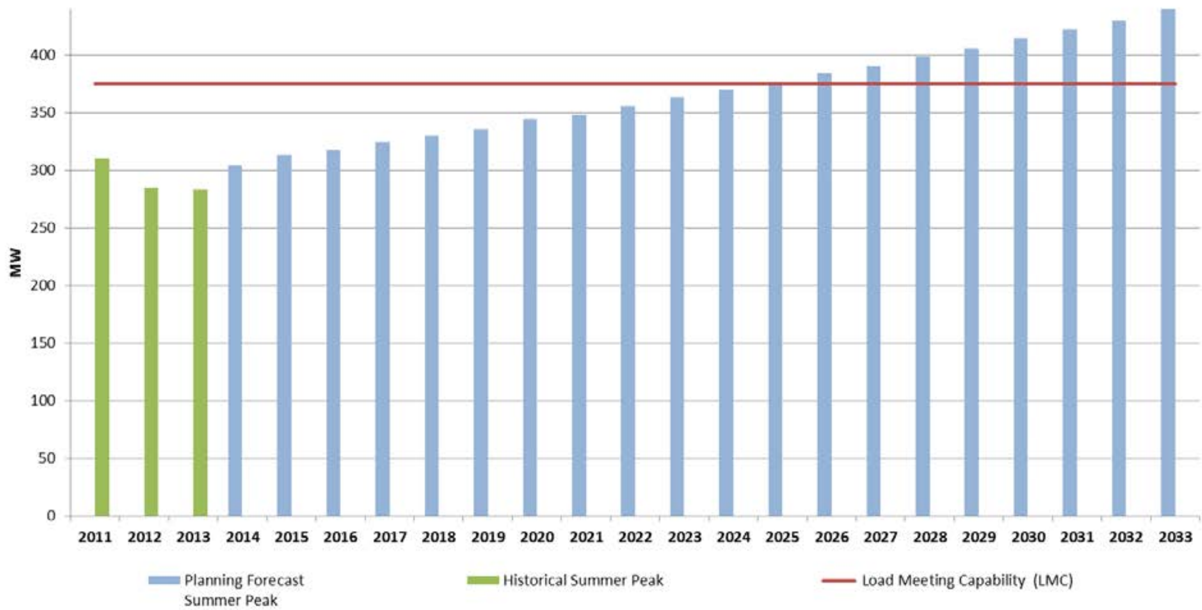
Figure B-6: Cambridge 230 kV Sub-system



Based on the application of ORTAC criteria, this system has a LMC of 375 MW. This limit is based on the thermal overloading of the M20D circuit, assuming the M21D circuit is out-of-service.

Under the high-growth scenario (Figure B-7), the summer peak demand on the Cambridge 230 kV sub-system will exceed the 375 MW LMC limit in the summer of 2026 and will not meet the ORTAC supply capacity criteria.

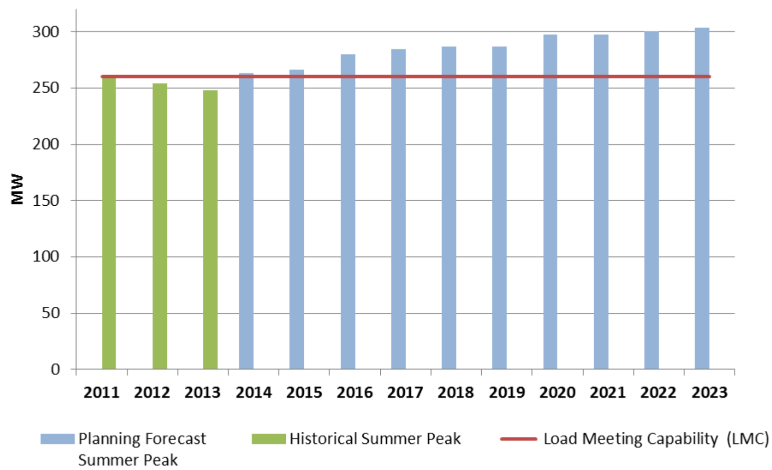
Figure B-7: Summer Peak Demand on Cambridge 230 kV Sub-system



Over the longer term, future electricity demand growth in Cambridge can be supplied on the Kitchener-Guelph 115 kV sub-system. Once the GATR project comes into service around 2016, there will be sufficient capacity on the Kitchener-Guelph 115 kV system to supply up to 100 MW of peak demand growth in the Cambridge area. Therefore, there are no supply capacity needs identified in the Cambridge area beyond 2023.

As shown in Figure B-5, the summer peak demand in the Kitchener and Guelph area exceeded the 260 MW LMC limit of the Kitchener-Guelph 115 kV system in the summer of 2014. Given the forecast near- and medium-term summer peak demand growth, the existing Kitchener-Guelph 115 kV system does not meet the ORTAC supply capacity criteria.

Figure B-5: Summer Peak Demand on Kitchener-Guelph 115 kV Sub-system



B.3.3 Cambridge 230 kV Sub-system: LMC and Supply Capacity Needs

The Cambridge 230 kV sub-system (M20/21D) is a double circuit 230 kV transmission line supplying Preston TS, Cambridge MTS #1, Galt TS and a transmission-connected customer, as shown in Figure B-6 below. Today, this 230 kV transmission is the main source of supply to customers in the Cambridge area.

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Appendix C: Transmission Options to Improve Load Restoration on Cambridge-Kitchener 230 kV Sub-system

Appendix C: Transmission Options to Improve Load Restoration on Cambridge-Kitchener 230 kV Sub-system

Figure C-1: Options to Improve Restoration on Cambridge-Kitchener 230 kV Sub-system

Option	Options to Improve Restoration	Fault on Middleport X Detweiler - Restorable Load (Note 2)	Fault on Galt junction X Preston TS – Restorable Load (Note 2)	Cost (Note 3)	Cost/Load Restored
--	Cambridge-Kitchener 230 kV sub-system (After GATR comes in-service – Note 1)	100 MW (Cambridge & North Dumfries Hydro's load – Note 4)	100 MW (Cambridge & North Dumfries Hydro's load – Note 4)	0	$0/MW
1	230 kV in-line switches on M20/21D at **Preston Junction**	100 MW (Cambridge & North Dumfries Hydro's load – Note 4)	100 MW (Cambridge & North Dumfries Hydro's load – Note 4)	$6M	$60k/MW
2	230 kV in-line switches on M20/21D at **Galt Junction**	135 MW (Kitchener Wilmot Hydro's load) 400 MW (Cambridge & North Dumfries Hydro's load – Note 4)	135 MW (Kitchener Wilmot Hydro's load) 100 MW (Cambridge & North Dumfries Hydro's load – Note 4)	$6M	$11k/MW to $25k/MW
3	One 230 kV cap bank at Preston TS plus 230 kV in-line switches on M20/21D at **Preston Junction**	140 MW (Cambridge & North Dumfries Hydro's load – Note 4)	140 MW (Cambridge & North Dumfries Hydro's load – Note 4)	$11M	$79k/MW
4	2nd auto-transformer at Preston TS plus 230 kV in-line switches on M20/21D at **Preston Junction**	200 MW (Cambridge & North Dumfries Hydro's load – Note 4)	200 MW (Cambridge & North Dumfries Hydro's load – Note 4)	$21M	$105k/MW
5	2nd auto-transformer at Preston TS plus 230 kV in-line switches on M20/21D at Preston Junction plus two 230 kV cap banks at **Preston TS**	280 MW (Cambridge & North Dumfries Hydro's load – Note 4)	280 MW (Cambridge & North Dumfries Hydro's load – Note 4)	$31M	$111k/MW

<u>**Notes:**</u> (1) Prior to the installation of the GATR project, only 65 MW of electricity supply in Cambridge can be restored within 30 minutes through the existing auto-transformers at Preston TS. (2) Restorable load values are approximate values only as the actual amount of restorable load will depend on the prevailing system conditions and Operating/Control Centre protocols and priorities and are based on the KWCG IRRP planning forecast. (3) All prices are based on historical data: taxes extra, overhead extra, no escalation considered, no assumptions are made to feasibility or construction, no assumptions made as to space requirements, real estate and environmental cost extra. (4) Restoration of 230 kV connected load (Cambridge and North Dumfries Hydro's load) via the Preston TS auto-transformer may require operational measures on the 115 kV system to secure the transmission system to hand a subsequent contingency e.g., open low voltage bus-tie breakers/switches at 115 kV connected stations.