10-YEAR OUTLOOK:

An Assessment of the Adequacy of Generation and Transmission Facilities to Meet Future Electricity Needs in Ontario

From January 2006 to December 2015

ieso
Power to Ontario.
On Demand.

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Executive Summary

The provincial government's plan to phase out coal-fired generation in favour of cleaner forms of generation represents one of the most significant undertakings in the 100-year history of Ontario's electricity sector.

Aging generation facilities and the continued increase in demand for electricity add to the urgency of proceeding with new generating and transmission facilities over the next 10 years.

Over the last 12 months 650 MW of new gas-fired generation has been put in place and 515 MW of nuclear generation and 370 MW of renewable generation is expected to be in service within the next 18 months. There are also a number of projects totalling more than 9,000 MW of additional capacity that are in various stages of discussion, development or negotiation. Timely progress to achieve this additional capacity must continue if Ontario is to ensure a reliable supply of electricity over the next decade and beyond.

This 10-year Outlook from the Independent Electricity System Operator (IESO) provides an assessment of the demand-supply picture for the province over the next decade and provides a plan identifying the timing and requirements of system changes needed to meet the government's coal shutdown timeframe. Under the provisions of Bill 100, the Ontario Power Authority (OPA) is responsible for long term forecasting. However, the IESO has agreed to produce the 10-year Outlook in 2005 while the OPA determines how best to address its forecasting responsibilities.

Electricity Supply Outlook

There have been a number of positive developments in Ontario's electricity sector since the IESO published the previous 10-year Outlook on April 29, 2004.

These new developments include the introduction of 650 MW of gas-fired generation into the Ontario market, the decision to proceed with restarting Pickering Unit 1 (bringing an additional 515 MW on line in September 2005), and the announcement of 2,200 MW of new supply initiatives and 395 MW in renewable energy projects under the provincial government's recent Request for Proposals process. All of the new supply resources announced under the RFP process are expected to be in service within the next four years.

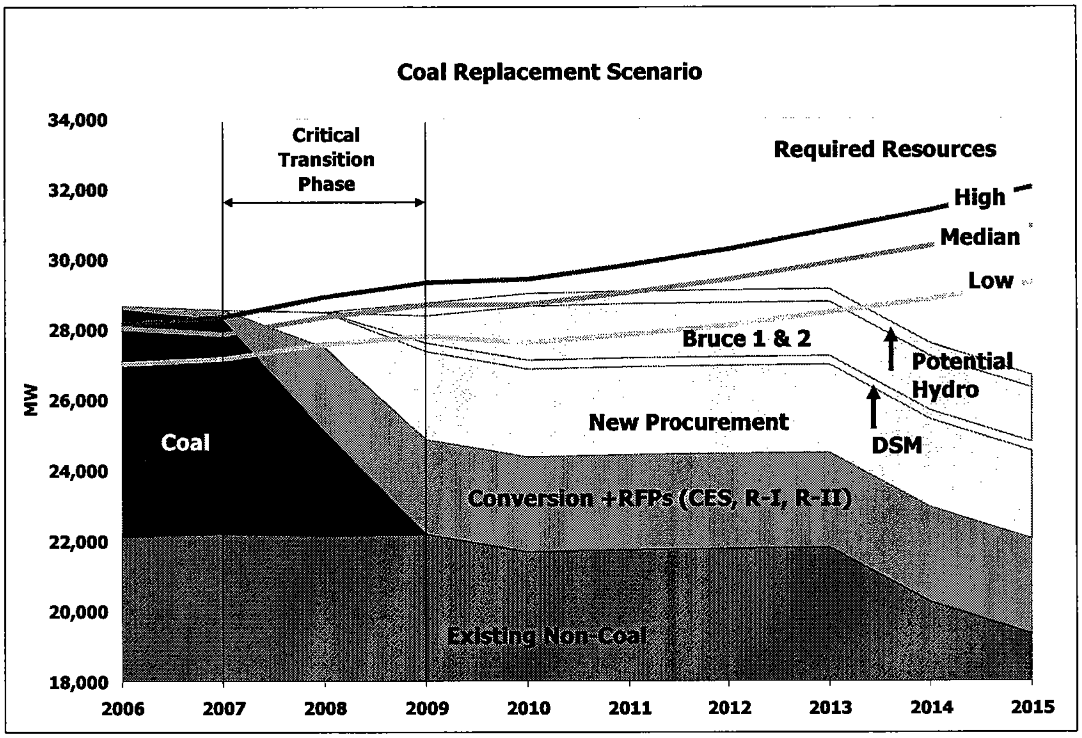
The government has also clarified the timing associated with the commitment to phase out coal-fired generation, which has extended the phase out period for the units at the Nanticoke Generating Station until 2009.

In addition to the committed projects discussed above, there are a number of other projects which are in various stages of discussion, development, or negotiation. These projects represent more than 9,000 MW of additional generation and include:

- the return to service of Bruce GS Units 1 and 2;
- increasing the energy capability of Beck 2 GS by construction of a third tunnel;
- the development of additional hydro-electric generation capacity in Northern Ontario;
- recently announced plans for additional generation in downtown Toronto and the western Greater Toronto Area (GTA), co-generation across the province and demand-side measures;
- the return to service of Pickering GS Units 2 and 3;

- the development of conservation programs under the Ontario Power Authority;
- the development of additional renewable generation to meet the Renewable Portfolio Standard of 2,700 MW by 2010; and
- Long-term power purchases from Manitoba and Newfoundland and Labrador.

Timely decisions on these projects will be key to addressing the projected shortfall which would occur if coal were shut down and not replaced. Continuing progress toward establishing and meeting in-service dates is critical. The supply picture with the first four items included, these being considered to be the more advanced projects, is provided in the diagram below.



Ontario Demand Forecast

The government has set aggressive targets for energy conservation to reduce peak electricity consumption by 5% by 2007. However, because the impact of new conservation initiatives is as yet difficult to forecast, the effects of conservation efforts are not reflected in the Ontario demand forecast used in this Outlook. These conservation efforts can make a significant difference. Without them energy consumption is forecast to grow from about 157 terawatt-hours (TWh) in 2006 to about 170 TWh in 2015, an average annual growth rate of energy of 0.9%.

Normal weather peak demands are expected to increase from about 24,200 MW in 2006 to 26,900 MW in the summer of 2015, an increase of 2,700 MW. Under extreme weather conditions, the summer peak is projected to approach the 30,000 MW level by the end of the forecast period.

Update

This Outlook provides an update on three key issues identified in last year's assessment:

- the Ontario Government's off-coal program (the subject of recent policy pronouncements, the implications of which are reflected in this assessment);
- the supply to downtown Toronto, and;
- the need for additional supply in the western GTA.

Coal Replacement

The Ontario government is committed to phasing out the remaining 6,500 MW of coal-fired generation in the province beginning in 2007 and ending in 2009 as replacement resources become available.

This transition represents the largest and most significant electricity system change ever undertaken in Ontario and involves major technical considerations. It also involves significant risks and challenges that need to be addressed.

The IESO will monitor and assess the coal shutdown and replacement resource plans and will provide advice to all parties regarding the actions or adjustments required to ensure reliability is maintained.

New generation units typically encounter more operating issues affecting their reliability for a period of time after they come in service. These can be significant. Accordingly, a critical requirement of the coal replacement plan is that while coal plants can be scheduled to stop running, those units will be held available for a period of time to operate if necessary to maintain reliability.

Coal supply makes up a large part of Ontario's flexible generation, and it has traditionally been required to meet changing demand, to supply demand when other supply sources are unreliable, and to balance load and generation at all times. The specific operating characteristics of new generation will require changes to current practices in order to provide operating flexibility and sustained energy production capability as and when it is needed.

The impact of new generation on the transmission system will also be assessed, and necessary transmission upgrades must be completed to ensure reliable system operation.

A plan is provided illustrating timing and requirements of system changes needed to meet the government's coal replacement objective.

Supply to Downtown Toronto

New generation and transmission facilities supplying the downtown Toronto area are urgently needed over the next five years to meet this area's growing need for electricity.

The government has requested that the OPA procure 500 MW of new supply to address the concerns raised in the last 10-Year Outlook about supply to downtown Toronto.

There is an increasingly high risk of transmission facilities supplying downtown Toronto becoming overloaded during heavy demand periods and a combination of new generation capacity, demand-side initiatives and transmission are needed to alleviate this concern. The present transmission facilities are already operated at or near their capacity during hot summer days when electricity demand is high due to the heavy use of air conditioning. As electricity demands continue to grow faster than new transmission can be built, it is vitally important for generation to be located in the downtown area within the next two to three years in order to reduce power flows through heavily loaded transmission facilities to acceptable levels.

In the absence of additional generation as well as demand-side initiatives, it is expected that, emergency load shedding would be required in order to prevent the overloading of transmission facilities.

The immediate risk that load shedding will be necessary in Toronto will be addressed for a number of years by locating additional generation in the area. However, over time, this risk will again grow to unacceptable levels as electricity demand in downtown Toronto continues to grow, and new transmission, or even more generation, must be built to provide more supply capability to downtown Toronto. Hydro One has proposed two alternative transmission projects to address this need – a Direct Current (DC) Option and an Alternating Current (AC) Option. Both options meet IESO criteria and improve the reliability of supply to downtown Toronto. However the DC option is preferred as it requires fewer other transmission system upgrades and provides desirable geographic diversity.

Supply to Western Greater Toronto Area (GTA)

The previous 10-Year Outlook indicated that additional generation capacity or demand-side initiatives were required in the western GTA to replace generation previously supplied by the Lakeview coal-fired station, and to thereby alleviate the risk of auto-transformer overloading.

The recently completed first phase of the Parkway Transformer Station in Markham, the extension of an existing 230 kV double circuit line between Richmond Hill and Markham, and the installation of new transmission equipment in a number of stations within the GTA have provided necessary short term relief.

Several successful RFP projects are located within the western GTA, to be brought into service between fall 2005 and summer 2009. However, these projects are not sufficient to address the growing problem. The need for additional supply in this area is still urgently required. The government's plan includes procurement of an additional 1,000 MW to meet this need.

This Outlook also updates other reliability concerns identified in previous Outlooks and their potential solutions, and identifies emerging reliability concerns.

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1.0 Introduction

This report presents a 10-year forecast and assessment of the adequacy of generation and transmission facilities in Ontario. Its primary purpose is to provide information to the industry for long-term planning and investment decisions.

In addition, this report provides a plan identifying the timing and requirements for system changes needed to meet the government's coal shutdown timeframe.

This report incorporates information received from market participants and others between December 2004 and June 2005. It supersedes the previous 10-Year Outlook published by the Independent Electricity Market Operator (IESO) on April 29, 2004.

The objective of this Outlook is to report the required infrastructure development, including the need for new or modified IESO-controlled grid facilities to maintain the reliability of the system and to assist the IESO-administered markets to operate efficiently. A reporting period of ten years spans the lead-time to install most new generation and transmission facilities. The assessment of generation adequacy is based upon ensuring that sufficient resources are available to meet the forecast demand plus required reserves. Ontario generation that is available to operate is assumed to supply Ontario demand. The assessment of transmission adequacy is based upon ensuring that sufficient transmission capability is available to transmit power to forecast loads in a secure manner.

This Outlook focuses on the assessment of resource and transmission adequacy to reliably supply load. Other supporting information, forecasts and assessments are contained in separate documents. These documents will be updated as required.

The document titled "Ontario Demand Forecast from January 2006 to December 2015" (IESO_REP_0246) (found on the IESO Web site at http://www.ieso.ca/imoweb/pubs/marketReports/10Year_ODF_2005jul.pdf describes in detail the forecast of electricity demand for Ontario used in this Outlook. The document provides the details regarding peak and energy demand forecasts for Ontario and parts thereof. It also contains information regarding variations in demand due to weather, economic growth and calendar day types.

The document titled "Methodology to Perform Long Term Assessments" (IESO_REP_0266) (found on the IESO Web site at http://www.ieso.ca/imoweb/pubs/marketReports/Methodology_RTAA_2005jun.pdf contains information regarding the methodology used to perform the demand forecasts, and resource and transmission adequacy assessments in this Outlook.

The document titled "Ontario Transmission System" (IESO_REP_0265) (found on the IESO web site at http://www.ieso.ca/imoweb/pubs/marketReports/OntTxSystem_2005jun.pdf provides specific details on the transmission system, including the major internal transmission interfaces and interconnections with neighbouring jurisdictions.

Readers are invited to provide comments on this report or to give suggestions as to the content of future reports. To do so, please call the IESO Customer Relations at 905-403-6900 or 1-888-448-7777 or send an email to forecasts.assessments@ieso.ca.

1.1 Changes from the Previous 10-Year Outlook

Changes to Forecast Demands

The most significant impacts on the current electricity demand forecast have been the actual events of 2004 and the updated economic outlook for Ontario. In 2004, the system exceeded historical maximums and set ever higher all-time winter peak demand – twice. The first record winter peak occurred on January 15th, 2004 when the peak demand was 24,937 MW. This record level was exceeded again later in the year on December 20th, 2004 as demand surpassed the January peak by 42 MW to reach 24,979 MW. Overall, the winters of 2003-04 and 2004-05 were milder than normal. As well, the summer of 2004 was also milder than normal. Despite the moderate weather, actual electricity demand grew by 1.1% over 2004 or 1.0% on a weather-corrected basis.

Much of the strength in the growth in 2004 can be attributable to the resource sectors of the economy. Demand for commodities pushed prices up and helped push up electricity demand from the spring through to the end of the year. Low interest rates continued to facilitate domestic demand, construction and business investment leading to economic growth for Ontario in 2004. However, the economy shed manufacturing jobs in 2004 and purchases were funded through higher debt. Growth was not broad-based in 2004.

The economic outlook for the near term (2005-2006) is more moderate than the previous forecast. This is due to the higher dollar, higher oil prices, manufacturing job losses and mixed economic signals. Whereas, the resource sectors drove growth in 2004, these same sectors have started 2005 on a much weaker note. The U.S. has displayed much stronger growth than Canada despite higher interest rates and large budget and trade deficits. Over the near term, high oil prices are expected to slow the economy but at the same time put upward pressure on the Canadian dollar. Lower interest rates compared to the U.S. put downward pressure on the dollar and help facilitate domestic investment and spending. Ultimately, Ontario's economy will benefit from lower oil prices, a lower dollar and continued growth in the U.S.A.

Over the long-term, economic growth is expected to be slightly higher than the last 10 year forecast. This is due to strong economic fundamentals: low interest rates, low inflation and budget surpluses.

After taking into account the actual experiences of 2004 – both economic and electricity demand – in conjunction with the updated economic forecast, the energy and peak demand forecast is lower than the previous 10-Year Outlook. Given that energy and peak demand for 2004 were lower than expected, this forecast begins at a lower starting point. The weaker economic growth in the near term is somewhat offset by the stronger economic growth over the long term. Therefore, although the levels are lower, the growth rates are very similar. Energy demand (under Normal weather) is expected to exhibit average growth of 0.9% per annum over the forecast horizon. This compares to 0.9% for the previous 10-Year Outlook. The low growth scenario predicts energy demand to have average growth of 0.4%, while the high growth scenario has average growth of 1.3% per year. The summer peak is expected to grow at 1.3% (versus 1.1% previously) and the winter peak is expected to grow at an annual average rate of 0.7% (versus 0.7% previously). The Normal weather peaks are predicted to be 25,500 MW for the winter of 2014 (versus 25,600 MW previously) and the forecast summer 2014 peak is 26,500 MW (versus 26,600 MW).

Changes to Resources

The amount of existing installed generation resources has been updated from the previous 10-Year Outlook to include all generators that are registered to participate in the IESO-administered markets. The latest generation resource additions and upgrades, and the latest capacity ratings are also included. The list does not include generators that are not registered to participate in the IESO-administered markets.

The June 15, 2005 announcement by the Ontario Government of their coal shutdown plan has prompted the IESO to define two resource scenarios rather than just a base reference scenario as was the case in 2004. These scenarios are fully described in Section 2. The Reference Resource Scenario is based on existing generation plus the capacity contributions expected from the three RFP's issued to date. The second scenario, which builds on the reference case, includes the capacity contributions expected from the Ministry of Energy's announced plan plus several initiatives previously announced.

Changes to Transmission Outlook

This 10-Year Outlook focuses on transmission constraints critical to the province. Previous deliverability and contingency studies have not been repeated this year since little has changed over the intervening months from the 2004 Outlook. Historical patterns of congestion are expected to change significantly as new supply and infrastructure is implemented associated with the coal replacement plan.

Readers interested in this information may obtain a copy of the 2004 10-Year Outlook from the IESO web site.

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2.0 Resources

This section describes the generation resources that are forecast to be in service throughout the ten-year assessment period, taking into account existing generation, generation resource additions and unit retirements, based on information available to the IESO.

2.1 Existing Generation Resources Included in this Assessment

The existing installed generation capacity included in this assessment is summarized in Table 2.1. It includes nuclear, coal, oil, gas, hydroelectric, wood and waste-fuelled generation, which results in a total installed capacity of 30,114 MW.

The capacity of installed generation resources in Table 2.1 includes Bruce A Units 3 and 4.

With the uncertainty around the reactivation of the remaining Pickering A nuclear units, the IESO has decided to only include the one operable unit, Unit 4, in the list of existing installed generation resources.

Table 2.1 Existing Installed Generation Resources

Resource Type	Total, MW	Percentage of Total, %	# of Stations
Nuclear	10,882	36.1	5
Coal	6,434	21.4	4
Oil / Gas	4,976	16.5	20
Hydroelectric	7,756	25.8	67
Miscellaneous	66	0.2	2
Total	30,114	100.0	98

2.2 Committed and Contracted New Generation Resources and Demand-Side Projects

Table 2.2 summarizes the new generation projects which are under construction or have signed contracts with the provincial government as a result of the first 300 MW Renewables Request for Proposal and the 2,500 MW Clean Generation and Demand-Side Projects RFP. The in-service dates in Table 2.2 have been provided either by generator owners directly or by the Ontario Government, based on the contract date.

This Outlook does not provide a summary of all generation projects in the IESO queue. Details regarding the IESO's Connection Assessment and Approval (CAA) process and the status of all projects in the queue, including copies of available Preliminary Assessment and System Impact Assessment Reports, can be found on the IESO's web site www.ieso.ca under the "Services - Connection Assessments" link.

Table 2.2 Committed and Contracted Generation Resource Additions and Demand-Side Projects

Project	Zone	Fuel Type	Installed Capacity MW	Connection Applicant's Estimated I/S Date
Pickering Unit 1	Toronto	Uranium	515	2005-Q3
Greater Toronto Airports Authority	Toronto	Gas	117	2005-Q4
Kingsbridge Wind Power Project	Southwest	Wind	40	2005-Q4
Melancthon Grey Wind Project	Southwest	Wind	68	2005-Q4
Prince Wind Farm	Northeast	Wind	99	2006-Q1
Erie Shores Wind Farm	Southwest	Wind	99	2006-Q2
Loblaws Properties	distributed	Demand	10	2006-Q2
Blue Highlands Wind Farm	Southwest	Wind	50	2006-Q3
Umbata Falls Hydroelectric	Northwest	Water	23	2007-Q1
Greenfield South Power Project	Toronto	Gas	284	2007-Q4
Greenfield Energy Centre	West	Gas	1,015	2007-Q4
St. Clair Power	West	Gas	688	2008-Q1
Greenfield North Power Project	Toronto	Gas	330	2009-Q2
Total			3,338	

2.3 Summary of Generation Resource Scenarios

Two resource scenarios have been developed for this Outlook, in view of the Ontario Government's recently announced plan to phase out coal-fired generation in the province. These scenarios are described below.

2.3.1 Reference Resource Scenario

The Reference Resource Scenario incorporates existing and committed resources as follows:

- existing Ontario resources, summarized in Table 2.1, will be in-service for the duration of the study period, with the following exceptions:
  - Lambton units will be removed from service by December 31, 2007 following the reliable incorporation of replacement generation;
  - Coal-fired generation at Atikokan will be retired and Thunder Bay will be replaced with cleaner generation by December 31, 2007;
  - Bruce A Unit 3 will be removed from service beginning November 1, 2009. This is a conservative assumption that will be reviewed as part of the market participant's normal business planning process. Further operation beyond this date will depend on the material condition of the unit and market conditions;
  - Pickering B Units 5, 6 and 7 pressure tubes reach the end of their life by 2013. For analysis purposes, the three units were assumed to be out of service starting January 1, 2014, pending development of refurbishment plans by Ontario Power Generation, (OPG).
  - Bruce Unit 6 reaches the end of life for its pressure tubes and is assumed to come out of service in 2015.

- the additional committed resources listed in Table 2.2 were assumed to be in service on the dates indicated;
- of the remaining three Pickering A units, Unit 1 was assumed to return to service prior to the 2006 system peak. The return to service date is planned for Q4 2005 based on information provided by OPG;
- no price-responsive demand beyond that shown in Table 2.2 was assumed to provide the equivalent of dependable capacity to the power system. This approach has been adopted because of the ease with which dispatchable and other price-responsive demands can change their operation within the market, easily shifting from being price responsive to being a price taker. Although price-responsive demands will continue to be recognized for operational decision making in the 18-Month Outlooks, the IESO has adopted the approach that these demands will need to be supplied in the longer-term;
- Nanticoke units were considered to be in-service for the entire 10-Year period. Based on the assumptions of the Reference Resource Scenario, all Nanticoke units were required to be in-service for the entire 10-Year period, since the generation and demand side additions in Table 2.2 are insufficient to allow for the removal from service of any of the Nanticoke units;
- Wind generation is assumed to provide a capacity contribution of 10% of the installed capacity of the project at the time of the annual peak; and
- the second renewables RFP was assumed to attract 1,000 MW by 2009. For purposes of analysis, the IESO assumed all of the successful projects for this RFP would be wind generation with a capacity contribution of 10% of the maximum rating of each project at the time of the annual peak.

2.3.2 Coal Replacement Scenario

The Coal Replacement Scenario incorporates existing, committed and additional announced initiatives in various stages of discussion, development or negotiation. This scenario assumes the Reference Resource Scenario with the following modifications:

- Bruce GS Units 1 and 2, amounting to 1540 MW, return to service in 2009;
- Additional power is procured for downtown Toronto (500 MW) and for western GTA (1,000 MW) before the end of 2008 at the latest;
- Cogeneration amounting to 1,000 MW is assumed to come in service in 2008.
- Demand side measures are expected to provide the equivalent of 250 MW of supply starting in 2009
- Potential hydroelectric development of up to 380 MW in the Northeast is assumed to come in service in 2009
- Nanticoke GS generating units (4,000 MW) are assumed to be shutdown over the period 2008 to 2009, as replacement generation and required system infrastructure are brought into service.

The purpose of the coal replacement scenario is to provide a plan identifying timing and requirements of system changes needed to meet the government's coal shutdown timeframe. More details of the plan can be found in Section 5.0.

2.3.3 Installed Resources at the Summer Peak

Table 2.3 shows the installed generation resources, at the time of the summer peak demand, under the Reference Resource Scenario and the Coal Phase out Scenario. The values in the table do not include the 10 MW of demand response contracted under the 2,500 MW RFP.

For the assessment of the entire ten year period, the resource analysis in this Outlook focuses on the summer peak period since this is usually the most challenging seasonal peak to meet. Our examination of the transition period later in the Outlook considers both summer and winter peak periods to provide greater detail.

Table 2.3 Installed Generation Resources at Summer Peak

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Reference Resource Scenario	**31,052**	**30,992**	**32,024**	**32,423**	**31,911**	**31,984**	**32,018**	**32,054**	**30,502**	**29,595**
Coal Replacement Scenario	**31,052**	**30,992**	**32,042**	**32,128**	**32,386**	**32,459**	**32,493**	**32,529**	**30,977**	**30,070**

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3.0 Resource Adequacy Assessment

This section provides an assessment of the adequacy of the two resource scenarios described in Section 2 to meet the forecast demand. Capacity analyses were performed using the IESO's Load and Capacity program (L&C). The general methodology and tools used to carry out these analyses are described in detail in the document titled "Methodology to Perform Long Term Assessments" (IESO_REP_0266v2.0). Variations from the standard methodology are described in Section 3.1.

3.1 Supply/Demand Modeling Approach

The two resource availability scenarios described were created based on the assumptions provided in Section 2.3. Generator deratings, planned and long-term generator outages, generation constrained-off due to transmission interface limitations and allowances for non-utility and hydroelectric generation production below rated capacity were also included in the resource assumptions.

For the first year of the study period, specific generator outage plans were used. For the ten year study period a hypothetical outage plan was used which reflects known cyclic outages (such as nuclear station containment outages) and planned outage factors supplied by generator participants. This is referred to as a "generic" outage plan to reflect the fact the majority of assumptions were modeled repetitively for the ten years studied.

The forecast demand scenarios used to perform the adequacy assessment correspond to low, median and high demand growth. Comprehensive analyses were carried out for all combinations of demand growth scenarios and the Reference Resource Scenario. Results for the Coal Replacement Scenario were derived by arithmetic extrapolation from the Reference Resource Scenario.

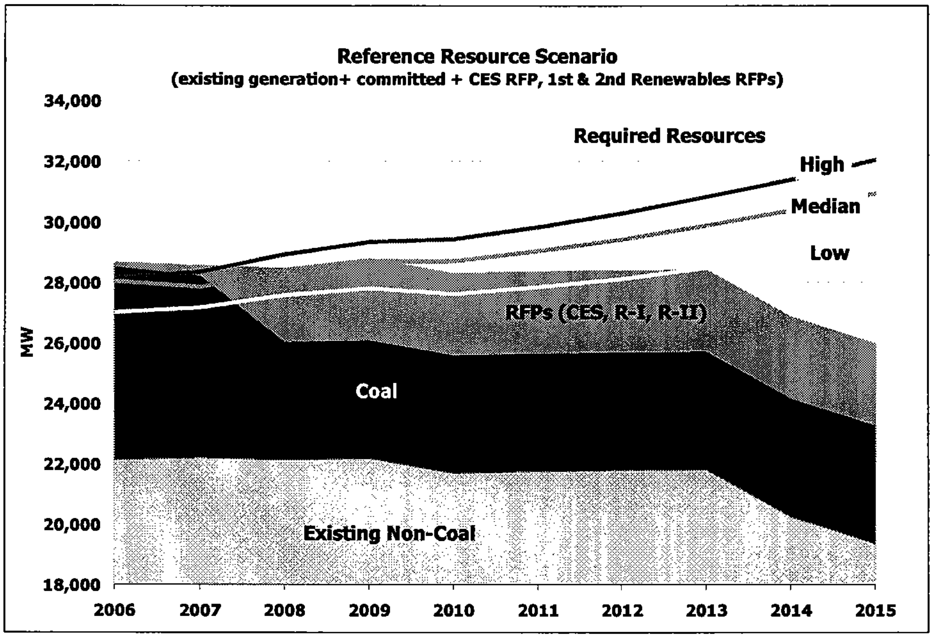
3.2 Load and Capacity Results

Reference Resource Scenario

Load and Capacity (L&C) model calculations were performed for the Reference Resource Scenario described in Section 2.3, with reserves calculated for the weekly peaks of each year in the study period, for each demand scenario. Graphical results of the L&C program calculations, for the summer peaks, are shown in Figure 3.1. Tables A1 to A3 in Appendix A provide more numerical details.

L&C results indicate that Ontario could be facing substantial delays to the coal phase-out and a growing supply shortfall beyond the first few years of the 10 year period, if committed projects are delayed. Reserve requirements will be met in the first five years under the median demand growth scenario if no in-service delays are encountered for the RFP projects. For the low demand scenario, reserve requirements are met until 2013. However, if high demand growth occurs, additional supply will be required by 2008 and possibly earlier.

Figure 3.1 Resource Adequacy Outlook – Summer Peak



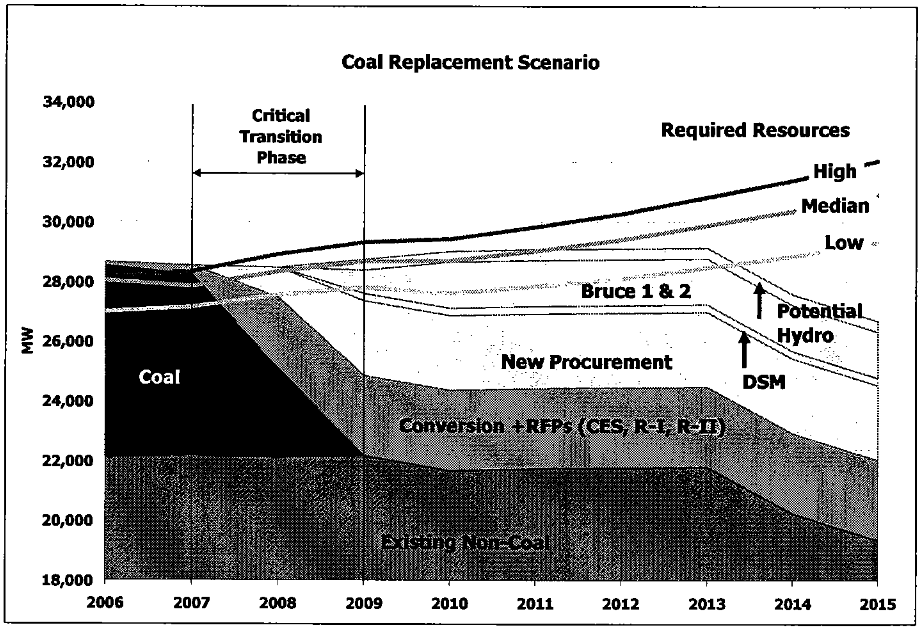
In order to avoid extensive reliance on external supply, any supply shortfall would have to be made up from generation additions and demand-side initiatives within Ontario. Events that would decrease supply availability or increase demand, such as extreme weather, higher than expected generator forced outages, and lower than forecast hydroelectric resources, would result in increased need for additional supply and dependence on external supply through interconnections.

Coal Replacement Scenario

Supply adequacy calculations were also performed for the Coal Replacement Scenario described in Section 2.3, with reserves calculated for the summer peaks of each year in the study period, for each demand scenario. Graphical results of the calculations are shown in Figure 3.2. Tables A4 to A6 in Appendix A provide more numerical details.

The supply adequacy calculations shown in Figure 3.2 illustrate the dependence on achieving all elements of the replacement supply associated with the coal replacement plan. This is a very challenging plan, requiring most actions to be committed before the end of 2005. Any delays in regulatory approvals or construction would result in delays to the coal shutdown for most demand growth assumptions. Once a target shutdown has been established for each plant, the risk that it will be inoperable or less reliable increases as the shutdown date approaches. Because of the high level of uncertainty and the severity of the consequences of supply shortages, it is critically important that replacement supply be fully proven before permanently removing each coal-fired station from service. A period of at least nine months overlap of replacement generation operation with coal-fired generation kept in reserve is required. Retaining coal units in an operable state should not impact on expected emission reductions since unit operation could be limited to periods when operation is essential.

Figure 3.2 Resource Adequacy Outlook – Coal Replacement Scenario



3.3 Other Considerations and Influencing Factors

There are many factors that are important considerations in the redevelopment of Ontario's electricity infrastructure, some of which could cause the long-term supply-demand balance to change. On the supply side, failure to meet the requirements discussed in this section would tend to reduce the operable generation from that assumed in the adequacy analysis.

3.3.1 Demand Growth

Higher demand growth than that assumed under the high demand growth scenario, would create an earlier and larger need for additional resources or demand response. Lower demand growth than assumed under the low demand growth scenario above, would delay and lower the need for additional resources. Lower energy and peak demand growth can be achieved through implementation of conservation programs oriented to demand-side management, energy efficiency and peak demand shifting.

3.3.2 Capacity Sustainability

Experience over the summer has also shown that, even when sufficient capacity is available, its use can be limited because of a lack of energy. An example of this occurs when peaking hydroelectric generation is operated extensively early during summer peak demand periods, in response to market demands and, as a result, the resources have insufficient water available in storage reservoirs to support required levels of operation later in the peak summer demand period. An exceptionally dry season can have the same effect. About 24 percent of the capacity within Ontario is hydroelectric with much of it subject to this risk.

Similarly, wind capacity is only available when the wind blows. During winter periods, a relatively strong coincidence of wind output and peak demand is expected, especially since wind chill drives heating demand higher. However during summer periods, peak demands typically occur during hot periods with little wind, the type of weather which pushes air conditioning loads to their maximum. The reduced contribution from wind during these periods increases the power system's reliance on alternative supplies of capacity.

3.3.3 Hydroelectric Generation Flexibility

The IESO is concerned with the future management of the Province's water resources as they relate to electricity production. The flexibility in the operation of hydroelectric facilities is of value to the Ontario power system. The importance of this needs to continue to be reflected and balanced with other options which may influence provincial requirements with respect to water management.

Ontario's electricity consumption pattern has changed over the last decade. Consumers have historically used a lot more electricity in the winter than they did in the summer. This has reversed. Peak electricity demands now occur during the summer, the season in which water management is typically most restricted.

Within a typical day, the total hydroelectric energy production pattern follows the shape of the total Ontario electricity demand. This flexibility of hydroelectric generation is significant; these plants can store potential energy when it is needed least (e.g., overnight) and can deliver their energy very quickly when it is needed (e.g., during morning load pickup when Ontario consumers increase their electricity use, at times greater than 3,000 MW per hour). Similar benefit exists from managing the water for electricity production on a weekly and seasonal basis.

The flexibility of hydroelectric generation has always been of value but its importance will increase even more in the future. Coal-fired generation, while not as flexible, currently provides an important capability to meet load pick up and drop out requirements. That capability may be reduced when the coal plants shutdown. Conservation, while reducing overall requirements, will not likely change the load pick-up requirement. Much of the renewable generation is expected to be wind power which has many positive features but cannot effectively be ramped up or down to meet changes in demand. Demand management is likely to help reduce peak demands but is not likely to affect ramping requirements. Gas-fired generation will have the required flexibility but even it can be limited if the plant is an efficient cogeneration facility. Given the expected future mix of resources in Ontario, the value of hydroelectric flexibility will increase.

In addition to providing energy and ramping capability, the flexibility of waterpower makes it extremely valuable for two other essential reliability products; operating reserve and automatic generation control.

- Hydroelectric generation is ideally suited for operating reserve; there is often not enough water to allow full hydro production all of the time, but frequently there is enough to run to full output quickly and maintain it until slower acting generators can increase production.
- The provincial demand for electricity varies second to second, sometimes by surprisingly large amounts. Hydroelectric generation is used very effectively to continuously keep this varying demand and supply in balance, and to keep Ontario's trade with other states and provinces on schedule. Historically in Ontario, very short-time balancing "automatic generation control" has been provided by a small number of hydroelectric plants. Restrictions on the allowable limits within which hydroelectric facilities operate would

require extending the use of automatic generation control to more market participant generators.

Ontario's future generation supply mix will place an increasing reliability value on the flexibility of generating assets to provide load following capability, operating reserve and automatic generation control. Preserving operating flexibility of hydroelectric generating facilities (whether old or new) should be a critical consideration in the development of water management plans.

3.3.4 Integration of Wind Supply

Even prior to the Renewable RFP's, several thousand MW of wind generation had made application to the IESO for connection approval. With the awarding of contracts to several wind proponents, exceeding 350 MW in total with more expected from the second Renewable RFP, it will not be long before significant amounts of wind generation are contributing to the energy needs of the province.

Like the integration of gas-fired generation, connecting large amounts of wind to the grid will not be without challenges. Early studies indicate wind should make significant contributions to energy but there is less certainty with respect to the peak-meeting capacity contribution that wind will make. The geographic diversity of projects around the province should provide some stability to wind output and reduce the impact of local wind fluctuations. Improving the understanding of daily patterns and fluctuations of wind generation will be necessary to determine if changes are needed in IESO operating practices and perhaps the Market Rules. Even the act of assessing the connection of wind generation has needed careful examination with respect to aspects such as a facility's ability to stay connected during low voltage excursions, its ability to supply reactive power, data monitoring requirements and others. Notwithstanding these considerations, the presence of wind on the Ontario grid will be a positive contribution to Ontario's future supply mix. For the purposes of this study, it is assumed 10% of the installed capacity of wind powered generation can be relied on at the time of the annual peak.

3.3.5 New Generation Mix

A diverse generation mix is critical for resource adequacy and market efficiency, through the provision of dispatch flexibility, reduced vulnerability to fuel supply contingencies and fuel price fluctuations. In developing a balanced generation portfolio to minimize fuel supply vulnerability, consideration should be given to providing dual fuel capability at plants which are unable to maintain fuel inventories onsite. In particular, this aspect may be necessary for some new gas-fired generation to ensure operational capability during winter peak periods when gas demand and electricity demand peak simultaneously.

Baseload Generation

Baseload generation largely consists of nuclear and run-of-the-river hydroelectric resources which cannot routinely be cycled on and off in response to demand fluctuations. In future, significant additions of gas-fired cogeneration is expected to also contribute to baseload generation. These types of generators have limited dispatch flexibility, and must be operated at a fixed output, at or near their full capability. If too much baseload generation is present in the supply mix, the amount of generation can have the potential to exceed the market demand, thereby creating a situation known as unutilized baseload generation (UBG). An analysis of the minimum peak demands in the latter years of the study period suggests that up to approximately

4,000 MW of nuclear and run-of-the-river generation resources could be added to the existing in-service baseload facilities towards the end of the ten-year period without causing undue risk of UBG. This amount will be affected by load growth and any load shifting patterns between on-peak periods and off-peak periods.

Intermediate and Peaking Generation

Existing intermediate and peaking generation in Ontario consists mainly of generation fuelled by coal, some gas, oil, and those hydroelectric generators with storage capability. New intermediate and peaking generation must be added to the Ontario resource mix in order to implement the coal replacement plan.

Renewable Generation Resources

Renewable resources consist primarily of hydroelectric, wind, biomass, solar, and geothermal energy sources. These are considered the cleanest and least environmentally impactive of all generation resources. Only wind and a small amount of hydroelectric generation have been contracted under the RFPs for connection to the IESO-controlled grid (ICG). Wind generation, by its nature has very little dispatch flexibility; only when the wind blows, can energy be produced. The diversity among wind projects selected under the RFPs will tend to moderate local fluctuations. Further utilization of wind energy can be achieved through partnering with suitable hydroelectric facilities to co-optimize both types of resources.

3.3.6 Conservation and Demand-Side Measures

The IESO has been identifying the suitability of conservation and demand-side (CDM) measures as part of the supply picture for several years and believes demand reductions and demand shifting should be vigorously pursued in Ontario, as clean and potentially less expensive ways to reduce future supply requirements. The application of such demand initiatives is virtually unrestricted in location.

CDM programs would improve the supply-demand balance in three main ways:

- Price-responsive demand which reacts to market price signals;
- Demand reduction through technological or process efficiency improvements ; and
- Shifting the time of use from peak to off-peak periods through demand-response programs would achieve peak demand reductions.

The Conservation Bureau of the Ontario Power Authority (OPA) has been charged with leading development of conservation and demand-side measures. The provincial government has targeted a 5% demand reduction by 2007 through CDM developments, or approximately 1,350 MW.

The system requires more reactive resources during the summer than the winter for the same level of primary demand. Air-conditioning load is the most significant component of the higher reactive power demand in the summer than in the winter. IESO recommends that Ontario work with other jurisdictions to raise the power factor requirements of new air-conditioning equipment. This would in the long term reduce the need for generation and transmission enhancements to meet the reactive power demand in Ontario. A move to energy efficient appliances has already been encouraged by government programs within Ontario and in other jurisdictions; however, most of these programs have focused on reductions to active (real) power consumption.

3.3.7 Interconnections

In real-time system operation, reliance on external supply through interconnections is mutually beneficial to all interconnected systems, for both reliability and market efficiency reasons. During off-peak periods, attractively priced external supply can provide cost savings to the electricity market. Similarly the interconnections provide access to broader markets for inexpensive Ontario generators. During peak hours, due mainly to the non-coincidence of the peak demands with one or more neighbouring systems, external supply can contribute to meeting peak demand.

Two main aspects are relevant to utilization of interconnection benefits: transmission interconnection capability and external supply availability.

Interconnection Capability

Ontario has a coincident import capability of approximately 4,000 MW through its existing interconnections. Transmission projects have been identified to the IESO through the CAA process to enhance the interconnection capability. An HVDC interconnection with Hydro Quebec of 1,250 MW transfer capability would improve interchanges between Ontario and Quebec. At this time, this project has high project uncertainty.

Although not yet formally submitted for Connection Assessment, an upgrade to the Ontario - Manitoba interconnection would give access to hydroelectric capacity from Manitoba. A joint proposal to receive power from the Lower Churchill Falls area could provide incentive for completion of the development of the proposed HVDC tie with Hydro Quebec.

External Supply Availability

The Northeast Power Coordinating Council (NPCC) CP-5 study entitled "Review of Interconnection Assistance Reliability Benefits" published in May 1999, provided an assessment that over 2,500 MW of interconnection assistance is reasonably available to the Ontario system when needed. More recent studies, conducted in 2004, suggest that a range of 3,150 to 4,050 MW is a reasonable assumption of tie benefit for Ontario from its neighbours, based on interconnection transmission capability and forecast spare supply external to the province.

Future levels of imports into Ontario will vary depending on several factors, including the availability and economic benefits associated with resources in external jurisdictions capable of supplying the Ontario market, and the availability of required transmission capacity. For interconnected supply to contribute to the capacity needs of Ontario, the dependability of supply contracts will need to have an equivalent level of certainty to that of Ontario-based generation.

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4.0 Transmission Adequacy Assessment

The transmission adequacy assessment provides information to market participants, connection applicants and other stakeholders to assist in planning a reliable transmission system. Where applicable, the assessment also identifies the potential need for IESO-controlled grid (ICG) investments or other actions by market participants to maintain reliability of the IESO-controlled grid and to permit the IESO-administered markets to function efficiently.

The assessments presented in this Outlook, represent the areas of the ICG for which the IESO has concerns or for which transmission enhancement requirements have been identified. Many of the proposed solutions have already been considered by Hydro One in their *"Transmission Solutions, A 10 Year Transmission Plan for the Province of Ontario 2005 – 2014"*.

The general methodology used to assess the transmission adequacy is described in the IESO document titled "Methodology to Perform Long Term Assessments" (see Section 1 for a link to that report). Previous deliverability and contingency studies have not been repeated this year since little has changed over the intervening months from the 2004 Outlook. Readers interested in this information may obtain a copy of the 2004 10-Year Outlook from the IESO web site.

Section 4.0 does not exhaustively assess all areas of the IESO-controlled grid. It is possible that other deficiencies in the IESO-controlled grid may exist or emerge. The IESO continuously monitors, assesses and reports the adequacy of the IESO-controlled grid. If additional concerns are identified they will be managed through existing IESO processes.

4.1 Greater Toronto Area

GTA Issues

4.1.1 Lakeview Retirement and the Loading on Claireville and Trafalgar Auto-transformers

The importance of completing the first stage of the development of Parkway TS, together with the installation of the shunt capacitor banks at Richview TS, Burlington TS, Trafalgar TS and John TS was demonstrated during the June 2005 hot spell when a new system peak of 26,157 MW was recorded. The peak transfer through the new 750 MVA auto-transformer at Parkway TS exceeded 600 MVA while the corresponding transfers through each of the four auto-transformers located at Claireville TS and Cherrywood TS were approximately 780 MVA. In addition, the two auto-transformers at Trafalgar TS were operating at close to their nameplate rating of 750 MVA.

Without the new facilities at Parkway TS, it is expected that the 10-day limited-time-ratings of the auto-transformers at Claireville TS, and possibly those at Trafalgar TS, would have been exceeded, necessitating supply interruptions.

4.1.2 New GTA Generation Capacity

Under the Government of Ontario's RFP for 2,500 MW of New Clean Generation Projects, contracts have been awarded to the following three generation projects in the Greater Toronto Area:

Project	Contract Capacity	Connection
Greenfield-South Project	280 MW	230 kV Circuit R24C
Greenfield-North Project	280 MW	230 kV circuits R19T & R21T
GTAA Project	90 MW	44 kV systems of Bramalea TS & Woodbridge TS

The RFP contract capacity indicated in the table above may be less than the expected installed capacity of the generation facilities.

Diagram 1 shows the locations of the new generating facilities.

Analysis has shown that these new generating facilities are expected to result in the following reductions in the transfers through the critical auto-transformers at Claireville TS and Trafalgar TS:

Project		Expected Flow Reductions			
		Claireville TS		Trafalgar TS	
Greenfield-North	280 MW	74 MW	26% of output	44 MW	16% of output
Greenfield-South	280 MW	94 MW	34% of output	23 MW	8% of output
GTAA	90 MW	36 MW	48% of Bramalea Gen.	0 MW	0% of output
		7 MW	48% of Woodbridge Gen.		
Totals	650 MW	211 MW	31% of combined output	67 MW	10% of output

Assuming that the loading on the Claireville and Trafalgar auto-transformers would increase in direct proportion with any increase in the system peak load, then for a peak load of about 27,500 MW, (forecast extreme weather peak for the summer of 2008) these new generating facilities would be expected to be adequate to maintain the transfers through the auto-transformers at Trafalgar TS within their continuous rating.

The new generating facilities would also provide additional margin on the auto-transformers at Claireville TS to accommodate load transfers from the Leaside to the Manby Sector during peak load periods via the new John-to-Esplanade Link without exceeding their continuous rating. However, the new generating facilities would not be able to provide any additional margin on the auto-transformers at either Claireville TS or Trafalgar TS to accommodate future load growth. In addition, the loss of any one of the six auto-transformers at these two transformer stations could cause the 10-day limited-time-ratings of the remaining units to be exceeded, requiring load to be interrupted. Therefore more generation, in addition to the projects listed above, is required beyond summer 2008 to reduce the loading on the Claireville and Trafalgar auto-transformers.

4.1.3 Additional Generation Capacity in the Western GTA

The Government of Ontario has recently announced that the OPA is to procure additional generating capacity totalling approximately 1,500 MW beyond that for which contracts have already been awarded. Of this, approximately 1000 MW is to be incorporated into the western GTA. This is expected to provide further relief for the auto-transformers at Claireville TS, thereby reducing the risk of overloading of the remaining units in the event of a protracted outage involving one of the four Claireville auto-transformers during peak load periods. Depending on the exact location of this new generating capacity, the relief could amount to 480 MW (48%) if the new generation is connected to one of the radial 230 kV circuits from Claireville TS. This would provide an additional deferral of approximately 6 years (until 2014) before the loading on the Claireville auto-transformers would be expected to become an issue once again.

If the new generation is connected to one of the existing 230 kV circuits that are to be reterminated on the new busbar at Cooksville TS, then the relief could amount to 340 MW (34%). The deferral that this would provide before further measures would be required to reduce the loading on the Claireville auto-transformers is expected to be an additional 4 years (until 2012).

Should a portion of the new generation capacity planned for the western GTA be located so that it provides the maximum relief for the loading on the auto-transformers at Trafalgar TS, then this could defer the need for other measures to reduce the transfers through this TS. Incorporating 500 MW of new generation capacity into the 230 kV system between Burlington TS and Richview TS would be expected to defer the need date for further measures until approximately 2013.

Need Date for Additional Generating Capacity in the Western GTA

The completion of the John-to-Esplanade Link at the end-2007 will allow approximately half the load at Terauley TS in the Leaside Sector to be transferred to the Manby Sector during critical supply periods. However, in order to accommodate the transferred load and avoid overloading the auto-transformers at Claireville TS, additional generating capacity will be required in the western GTA, incorporated into the transmission system directly associated with the corridor between Claireville TS, Richview TS and Cooksville TS.

The three Projects that have already been selected for the western GTA (Eastern Power's Greenfield-North, Eastern Power's Greenfield-South and the GTAA Project) will collectively result in a reduction of approximately 210 MW in the transfers through Claireville TS. However, since the Greenfield-North Project is not scheduled to be in-service until the spring-2009, the expected reduction in the transfers through the Claireville auto-transformers during the summer-2008 due to the presence of the other two Projects will only total approximately 130 MW. During peak load periods, this would not be sufficient to accommodate the transferred load as well as the expected load growth in the area that is supplied from Claireville TS.

Consequently, additional generating capacity will be required in the western GTA prior to the summer-2008, so that, in the event of a contingency involving critical facilities in the Leaside Sector during peak load periods, transfers can be made to the Manby Sector via the John-to-Esplanade Link without overloading the auto-transformers at Claireville TS.

4.1.4 500/230 kV Auto-transformers at Trafalgar

The auto-transformers at Trafalgar TS are heavily loaded during summer demands. Actual June 2005 loading was such that an extended outage to one of these auto-transformers would have resulted in overloading of the remaining transformer such that load interruptions would have been required.

If the new 1,000 MW of generation capacity that is proposed to be installed in the western GTA is located so that it provides the maximum relief for the Claireville auto-transformers, then it is expected that it will provide little relief for the loading on the auto-transformers at Trafalgar TS.

Installing additional auto-transformer capacity at Trafalgar TS would also require the installation of an additional 500 kV line between Milton SS and Trafalgar TS so as to avoid the simultaneous loss of more than two auto-transformers in response to a double-circuit line contingency.

4.1.5 New 230 kV Facilities at Milton SS

One option to unload the Trafalgar and Claireville auto-transformers would involve the installation of two 500/230 kV auto-transformers at Milton SS and the re-termination of the existing connections to Halton TS and Meadowvale TS on to the new 230 kV busbar at Milton SS. This would also reduce the potential for significant load interruption following the loss of any of the existing or proposed radial 230 kV double-circuit lines associated with the Milton - Claireville corridor or the Burlington - Richview corridor. This solution has been proposed by the IESO in earlier versions of the 10-Year Outlook. These new auto-transformers could be connected directly to two of the existing 500 kV circuits in a similar manner to the auto-transformers at Parkway TS so as to minimise the disruption to the existing 500 kV gas-insulated-switchgear at that location.

These new auto-transformers would allow the peak load of approximately 300 MW at Halton TS and Meadowvale TS to be transferred from circuits T38B and T39B, which are supplied predominately from Trafalgar TS, onto the two new auto-transformers. In addition, by extending the connections from Meadowvale TS eastwards to Cardiff TS and Bramalea TS, there would be an opportunity to transfer additional load from the following transformer stations. This would also provide an alternative source of supply to these loads thereby enhancing their supply security:

<table>
<tr><th>Station</th><th>Peak Load</th><th>Existing Supply</th></tr>
<tr><td>Jim Yarrow TS</td><td>~ 100 MW</td><td rowspan="2">230 kV Circuits R19T & R21T from Richview TS & Trafalgar TS</td></tr>
<tr><td>Pleasant TS</td><td>~ 260 MW</td></tr>
<tr><td>Cardiff TS</td><td>~ 40 MW</td><td rowspan="2">230 kV circuits V72R & V73R from Claireville TS</td></tr>
<tr><td>Bramalea TS</td><td>~ 320 MW</td></tr>
</table>

Diagram 2 shows the proposed arrangement which includes an additional 230 kV switching station at the intersection of the right-of-way of the new 230 kV line between Meadowvale TS and Cardiff TS and that of the existing line to Pleasant TS. This proposal, or an equivalent is needed urgently as actual loading in June 2005 combined with an extended forced outage to one transformer would have exceeded the 10-day limited time rating of the remaining transformers, and necessitated load interruptions.

4.1.6 Reactive Compensation at Halton TS, Meadowvale TS and Palermo TS

None of these transformer stations has any low voltage capacitor banks installed and while their power factors of 0.9 comply with the Market Rules, it means that during peak load periods, over half the output of the new 300 MVAr shunt capacitor bank that was recently installed at Trafalgar TS is effectively being used to supply the reactive power demand of these particular loads together with the associated transmission lines losses.

Since it should be possible to install low voltage shunt capacitor banks at these three transformer stations relatively quickly, the additional reactive compensation would then allow the maximum benefit to be derived from the new 300 MVAr capacitor bank at Trafalgar TS during the period until the new generating facilities can be incorporated into the system. This upgrade is needed as soon as possible.

4.2 Downtown Toronto

4.2.1 Supply to Downtown Toronto

The downtown area of Toronto is supplied from two sources; Manby TS in the west and Leaside TS in the east, as shown in Diagram 3.

As load grows, the supply to downtown Toronto will be exposed to the potential overload of:

- The 230 kV circuits from Cherrywood to Leaside,
- the 115 kV circuits from Leaside to Hearn,
- the auto-transformers at Manby East and Manby West, and
- the 230 kV circuits from Richview to Manby.

4.2.2 Manby Zone

Manby TS consists of two separate switchyards; Manby East TS and Manby West TS - each of which is equipped with three 230/115 kV auto-transformers. These auto-transformers are all rated at 250 MVA except for unit T8 at Manby East TS which is rated at 225 MVA. The two 230 kV switchyards at Manby TS are each supplied radially from Richview TS via two 230 kV circuits (the R x K circuits).

Although the two switchyards cannot be directly interconnected at Manby TS due to fault level constraints imposed by the existing switchgear, an indirect connection exists between the two 230 kV switchyards via Cooksville TS (via circuits K23C and K21C). This connection is also interconnected with Richview TS via the 230 kV circuit R24C. Apart from providing the supply to southern Mississauga and Oakville, this arrangement is also vital to the supply to Manby TS under contingency conditions involving any of the Richview TS to Manby TS circuits.

To enhance the effectiveness of this indirect connection, which is over twice the length of each of the direct connections, it was Hydro One's original intention to install series capacitors in the 230 kV circuit R24C at its Cooksville terminal. However, with the approval of the Eastern Power Greenfield - South Project, which is to be incorporated into the system via circuit R24C and will have the effect of increasing the flows over this indirect connection, the installation of the series capacitors has been deferred.

4.2.3 Leaside Zone

Leaside TS is supplied radially from Cherrywood TS via six 230 kV circuits that are individually terminated on to the 115 kV busbar via a dedicated 250 MVA 230/115 kV auto-transformer. These six auto-transformers are connected together in pairs, via 230 kV bus-section breakers. Due to fault level constraints, the 115 kV busbar at Leaside TS is normally operated split.

While a limited number of the 115 kV transformer stations in the Leaside sector (Dufferin TS, Bridgman TS, Glengrove TS and Duplex TS) are supplied from both the eastern and western halves of the Leaside 115 kV busbar, all of the remaining transformer stations are supplied exclusively from only one half of the busbar. The 115 kV busbar at Hearn SS, which is normally operated closed, provides the only connection between the two halves of the 115 kV system in the Leaside sector.

4.2.4 Load Transfers between the Manby and Leaside Sectors

Due to fault level constraints, the Manby and Leaside sectors cannot be operated permanently interconnected. However, facilities exist to transfer either the load at Dufferin TS, or the combined load at Dufferin TS and Bridgman TS, from the Leaside Sector to Manby East TS. Since these loads are supplied from both halves of the Leaside 115 kV busbar, their transfer results in an evenly distributed reduction in the loading on each of the six auto-transformers at Leaside TS.

Facilities also presently exist to transfer that portion of the load at Esplanade TS, which is supplied exclusively from 115 kV circuit H2JK, to Manby West TS. This represents approximately one third of the total load at Esplanade TS, and since circuit H2JK is supplied directly from Hearn SS, this transfer also results in an evenly distributed reduction in the loading on each of the six Leaside auto-transformers.

Hydro One has now received all of the approvals required for the construction of the John-to-Esplanade Link, which is scheduled to be completed by the spring-2007. This Link, which is shown in Diagram 4, will allow approximately half the load at Terauley TS to be transferred to Manby West TS. Since only that portion of the load at Terauley TS that was being supplied exclusively from Hearn SS can be transferred, the transfer will result in an approximately even reduction in the loading on each of the six Leaside auto-transformers.

4.2.5 Need Dates

The following need dates are based on the weather-corrected load forecast provided by Toronto Hydro. To ensure continuity of supply under extreme weather conditions, it would be necessary to advance the need dates by at least one to two years.

4.2.6 Leaside Sector

Based on the ability of the remaining facilities to continue to supply the load following a single-element contingency, the IESO has determined that the load meeting capability of the 115 kV transmission facilities in the Leaside Sector will need to be enhanced prior to the summer-2008. This need date can be deferred by transferring load to Manby West TS, but forecast load growth in the Leaside sector will offset this deferral beyond summer 2009. Therefore the need date for enhancing the Leaside sector is summer 2010. These dates are highly dependent on the load forecast, on taking full advantage of the facilities to transfer load out of the Leaside sector, on the capability of the Manby West facilities to accommodate additional load transfers, and on the availability of resources in the western GTA part of the grid to control voltages and supply Manby West TS.

The existing transmission facilities that comprise the 230 kV corridor between Cherrywood TS and Leaside TS are not expected to be adequate to accommodate the forecast peak loads beyond the summer-2008. Consequently the load meeting capability of these facilities will need to be enhanced prior to the summer-2009. While the transfer of the load at Dufferin TS to Manby East TS would benefit the auto-transformers at Leaside TS as well as the 230 kV circuits on the Cherrywood to Leaside corridor by reducing the respective flows, it would have no impact on the 115 kV transmission facilities between Leaside TS and Hearn SS. Consequently it would not influence the need date for those 115 kV facilities. Furthermore, the transfer of the Dufferin TS load is not expected to be possible during peak load periods beyond the summer-2008 due to limitations imposed by the thermal ratings of the existing 115 kV transmission facilities associated with Manby East TS..

However, with the scheduled completion of the John-to-Esplanade Link in the spring-2007, it would then be possible to reliably transfer approximately half the load at Terauley TS across to Manby West TS. The 115 kV transmission facilities as well as the 230/115 kV auto-transformers associated with Manby TS are expected to be adequate to accommodate the transfer of approximately half the load at Terauley TS through the summer-2009. This capability could be extended through to the summer-2011 by installing an additional 115 kV shunt capacitor bank at either Manby West TS (rated at 125MVAr) or at John TS (rated at 100MVAr). However, following the summer-2009 the benefits derived from transferring half the Terauley load would be offset by the expected load growth within the Leaside sector. Consequently, the need date for enhancing the load-meeting-capability of the Leaside Sector is expected to be the summer of 2010.

4.2.7 Manby Sector

i. Manby East TS

Manby East TS is expected to be able to accommodate future load growth at the three transformer stations that are normally supplied from this station (Fairbank TS, Runnymede TS and Wiltshire TS) to well beyond 2020. However, should this station be required to accommodate the transfer of the load at Dufferin TS during peak load periods beyond the summer-2008, then additional 230/115 kV auto-transformer capacity would need to be installed and the 115 kV transmission lines would also have to be uprated and/or augmented with additional circuits.

Routine maintenance at this station during off-peak periods is not expected to be an issue, since the load at Wiltshire can be readily transferred to the Leaside sector. Consequently, should either of the remaining auto-transformers fail while one unit is out-of-service for maintenance, the off-peak loads could be maintained within the limited-time-rating of the last remaining auto-transformer.

ii. Manby West TS

There is no existing capability for transferring only a portion of the load at John TS to the Leaside sector while maintenance is being performed on those facilities associated with Manby West TS.

Consequently, it is becoming increasingly difficult to schedule maintenance outages. Even with new generation capacity incorporated into the Leaside Sector, it would not be possible to transfer the entire off-peak load at John TS (estimated at 190 MVA) to the Leaside Sector via the new John-to-Esplanade Link while maintaining acceptable voltages and avoiding overloading of the existing facilities supplying Esplanade and Terauley from Hearn SS. Installing additional switching facilities at John TS to permit only a portion of the load to be transferred has already been rejected due to space constraints.

Additional auto-transformer capacity will therefore need to be installed at Manby West TS as soon as possible to allow the existing equipment to be maintained.

4.2.8 Installing New Generation Capacity at Hearn SS

Incorporating additional generation capacity via the 115 kV busbar at Hearn SS would increase the load-meeting-capability of the Leaside Sector by reducing the loading on the following: the 230 kV corridor from Cherrywood TS; the 230/115 kV auto-transformers at Leaside TS; and the 115 kV transmission facilities between Leaside TS and Hearn SS. However, the IESO's analysis has shown that to incorporate additional generation capacity into the Leaside Sector certain specific requirements would need to be satisfied.

To ensure that the fault levels with new generation capacity incorporated do not exceed the interrupting capability of the existing switchgear, the Leaside Sector would need to be operated split into two discrete halves from Cherrywood TS. This would require the 230 kV and 115 kV busbars at Leaside TS as well as the 115 kV busbar at Hearn SS to be operated open at their mid-points. This would introduce an imbalance of approximately 200 MW between the loads supplied from the western half of the Leaside busbar and those supplied from the eastern half. Consequently, the rating of any new generation capacity that it is proposed to incorporate into the western half of the Leaside Sector would need to be at least 200 MW just to restore the transfers through the associated Leaside auto-transformers to their present levels. In addition, the maximum rating of the new generation facility would need to be limited to approximately 600 MW (720 MVA) to respect the fault interrupting capability of the existing equipment. Of this, a maximum of approximately 400 MW (470 MVA) could be connected to the western half of the Hearn 115 kV busbar.

Should the 500 MW of new generating capacity that the Government of Ontario has recently announced for the downtown Toronto core be installed within the Leaside sector, then depending on its exact location and configuration, it could provide a deferral in the need date for further enhancements to the load-meeting-capability of the Leaside Sector to beyond 2012, based on the present, weather-corrected load forecast.

Furthermore, if generation capacity were to be installed in the Leaside Sector prior to the summer-2008, then load transfers to the Manby Sector in response to equipment outages are not expected to be necessary.

It is also worth noting that a 500 MW generation project, incorporated directly into the 115 kV portion of the Leaside Sector, would provide similar benefits in terms of its actual power output, reactive support for voltages in the area and the effect on the transfers through the auto-transformers at Cherrywood TS, as a single generating unit at Pickering GS.

4.2.9 Third Supply for Downtown Toronto

Even with additional generating capacity installed in the downtown Toronto core, it is expected that a third transmission supply (3rd Supply) will need to be installed prior to the summer-2013 to ensure a secure supply for downtown Toronto. However, should additional load growth occur, beyond that which is currently being forecast, it would be necessary to advance this need date.

The IESO has proposed that the John-to-Esplanade Link should be extended through to Hearn SS to allow any new generating capacity that is to be installed in the downtown Toronto core to benefit the Manby Sector as well as the Leaside Sector. This would also allow the requirement for additional auto-transformer capacity to be installed at Manby West TS to be deferred by allowing a portion of the load to be supplied from the Leaside Sector during those periods when maintenance is being performed.

Furthermore, should the dc Option be selected for the 3rd Supply, then installing the back-to-back facilities at Hearn SS in advance of the main phase of the development would provide both the IESO and Hydro One with invaluable operational experience.

4.3 Supply Issues in the Newmarket - Aurora Area

The rapid increases in the load within the Newmarket - Aurora area that have been experienced are taxing the capability of the existing double-circuit line between Claireville TS and Armitage TS. While the initial proposal for enhancing the supply to this area involved the extension of the existing 230 kV double-circuit line from Buttonville TS through to Armitage TS, other options are being examined by the Ontario Power Authority. A recommendation is expected during the fall.

4.4 Kitchener, Waterloo, Cambridge, Guelph and Orangeville Area

This area, which is supplied primarily via the 230 kV system emanating from Detweiler TS continues to be a problem with lower than ideal pre-contingency voltages and with severely depressed post-contingency voltages following the critical 500 kV double-circuit contingency involving the Bruce to Milton/Claireville circuits.

In addition, the 115 kV system between Detweiler TS and Guelph-Cedar TS that is supplied by circuits D7G and D9G is also subject to very low post-contingency voltages following the loss of either 115 kV circuit.

Since these areas are experiencing very high load growth, the situation continues to deteriorate and remedial measures are required urgently.

As the initial stage of their proposed plan for enhancing the load-meeting capability of the area, Hydro One is planning to install a single 230/115 kV auto-transformer at Cambridge-Preston TS, connected to the 230 kV circuits M20D and M21D between Middleport TS and Detweiler TS. The 115 kV terminals of the new auto-transformer are to be connected to circuits D7G and D9G, as shown in Diagram 5. While this arrangement will provide critically-needed support to the 115 kV system following the loss of either of the 115 kV circuits D7G or D9G, the additional load that will be transferred to the 230 kV system will only aggravate the problems with low voltage at the 230 kV transformer stations supplied from circuits M20D and M21D following a contingency involving either of these circuits.

Since this contingency condition is already an operational issue during high load periods, the second stage of the proposed plan will involve the installation of two new 230/115 kV auto-transformers on the right-of-way of the 500 kV circuits M585M and V586M between Middleport TS and the Milton/Claireville transformer stations, together with the construction of a new 230 kV double-circuit line into Cambridge-Preston TS. This stage of the proposed development is also shown in Diagram 5. A second 500/230 kV auto-transformer would then be installed at Cambridge-Preston TS to further enhance the supply reliability of the 115 kV system.

Preliminary studies by the IESO have shown that this proposal would have substantial merit since it would improve the voltage profile of those 230 kV-connected transformer stations in the Cambridge area while also transferring a portion of the load at the Guelph-Cedar TS that is presently supplied from Burlington TS via the 115 kV circuits B5G and B6G, on to the new supply. However, the voltages at the 230 kV transformer stations supplied from circuits D6V and D7V between Detweiler TS and Orangeville TS were shown to remain below 238 kV, which would present problems under contingency conditions.

The IESO has therefore examined the effect of including a further 500/230 kV interconnection in the vicinity of Bellwood Junction where the existing 500 kV right-of-way of circuits B560V and B561M and the 230 kV right-of-way of circuits D6V and D7V intersect. This proposed connection, which is shown in Diagram 5, together with the connection from the 500 kV system into Cambridge-Preston TS, resulted in a significant improvement in the system voltages for the condition with a peak system load of 26,800 MW. In particular, the voltage at Detweiler TS increased from 234 kV, with the existing facilities, to 241 kV, while that at Orangeville TS increased from 234 kV to 246 kV.

This plan, or an alternative that provides equivalent voltage performance, must be included as part of the transmission enhancements used to facilitate the shutdown of Nanticoke TGS in the off-coal strategy. This area is also a good candidate for conservation, demand management and additional generation supply.

It should also be noted that whatever plans are eventually implemented for this area, it will be essential that they be completed prior to the summer-2008 to correspond with the present schedule for the retirement of the generating units at Nanticoke GS.

4.5 Burlington TS

While the recent installation of the additional 230 kV and 115 kV capacitor banks, rated at 300 MVAr and 125 MVAr respectively, has helped to improve the voltage profile in the Burlington area, the loading on the 230/115 kV auto-transformers at Burlington TS remains near their maximum ratings. A decision to proceed with the new 500/230 kV connection into Cambridge-Preston TS and the installation of 230/115 kV auto-transformers to connect to the existing 115 kV system in the area, as discussed above, would then allow some of the load at Burlington TS to be transferred to the new connection. This would improve the situation, although the extent of any benefit would depend on how much load can be transferred.

However, until the two lower-rated 215 MVA auto-transformers are replaced with 250 MVA units, the operational capacity of Burlington TS will continue to be restricted putting equipment at an increased risk of overload and failure, and requiring load transfers and possibly load interruptions at high demands.

4.6 Bruce Complex

Installation of Series Capacitors in the 500 kV Circuits Associated with the Bruce Complex

Hydro One has submitted an application to the IESO for a connection assessment of their proposal to install series capacitors at the approximate mid-points of the following 500 kV circuits, as shown in Diagram 6:

Circuits	Location	Provides Approximate Compensation
B562L and B563L	Bruce GS to Longwood TS	70%
B560V and B561M	Bruce GS to Claireville TS / Milton TS	10%
N582L	Longwood TS to Nanticoke GS	70%

Preliminary analysis shows that this plan has the potential to accommodate the proposed return-to-service of Bruce A Units 1 and 2, and also intended to reduce the reactive power losses of the existing system, particularly under contingency conditions, and thereby decreasing the dependence on Nanticoke GS for voltage support, so that this generation facility can be removed from service.

In order to comply with the Government of Ontario's recently announced schedule for the retirement of the units at Nanticoke GS, the new facilities will need to be in service no later than the spring-2008.

The IESO has yet to perform its full assessment of the impact of the proposed 500 kV series capacitors, coincident with Nanticoke GS no longer operating and with the additional 1,500 MW of generating capacity that is planned to be procured for the western GTA and downtown Toronto in service. However, a limited number of load flow studies with the additional generating capacity included at arbitrary locations have been completed. These have shown that the series capacitors, together with new shunt capacitor banks at Middleport TS and with some of the units at Nanticoke GS converted to synchronous condenser operation, should be sufficient to enhance the transfer capability of the existing transmission facilities to allow Units 1 and 2 at Bruce A GS to be incorporated without the need for any new transmission lines.

To achieve these results, the local-area supply requirements for the Kitchener, Waterloo, Cambridge, Guelph and Orangeville areas must also be addressed. IESO analysis assumed the proposed plans for the Detweiler area as well as the proposed 500/230 kV auto-transformers at Milton SS were in service.

It is intended that the IESO's connection assessment studies will help quantify the following within the next few months:

- the extent of any generation rejection that might be required with the additional generating capacity at the Bruce complex in-service to ensure that post-contingency stability can be maintained for all of the various contingency conditions.
- the requirements for retaining some of the units at Nanticoke in operation as synchronous condensers in order to maintain acceptable post-contingency voltages within the western GTA under all operating conditions.

- the effect that retaining units as synchronous condensers might have on any requirements for initiating generation rejection in response to system contingencies.
- if synchronous condenser capacity is required at Nanticoke GS, then the effect that the installation of new shunt capacitor banks at Middleport TS, and possibly Detweiler and Orangeville would have on this requirement.
- the effect of the series capacitors on the present operating limits for eastward flows across the Buchanan-Longwood Input (Negative BLIP) Interface.

4.7 Northeastern Ontario

4.7.1 System north of Sudbury (Hanmer TS)

The north-eastern part of the Ontario power grid is made up of multiple generating units, a few very large and many small loads, and a relatively sparse transmission system. The grid north of Sudbury is connected to the rest of Ontario via one 500 kV circuit (P502X, Porcupine TS near Timmins, to Hamner TS), and one 115kV circuit (Kirkland Lake TS to Dymond TS). See Diagram 7. The IESO has employed a variety of specific operating procedures and special protection systems to ensure that all of the generation in north-eastern Ontario could be reliably transmitted to the rest of the grid. In doing so, especially when the generation is near maximum, there is some risk of abnormal operation if the 500 kV circuit were to trip (operating statistics show a trip could happen about once a year).

Over the years generation has been added and a reduction in local load has taken place in north-eastern Ontario. Analysis by the IESO has shown that the previous operating measures were insufficient to ensure acceptable operation following the trip of P502X. The studies showed that when southward flows are above about 650 MW, a trip of P502X could result in voltages exceeding equipment limits of 575 kV and 260 kV, a loss of synchronism and transmission separation between north-eastern and southern Ontario, and abnormal voltages and frequencies for facilities that are islanded and remain operational north of Timmins.

To address this and improve reliability for the area, the IESO has recently adopted operation measures during high southward transfers (about 650 MW) to automatically cross trip 500 kV circuit D501P and shutdown the 230 kV system connected to Pinard TS. Normally this will only be initiated following the trip of the 500 kV circuit, will avoid the risk of abnormal voltages and frequencies, and will also allow a quick and orderly re-start of the system. Enhancements to existing transmission facilities and the existing generation rejection scheme are required to allow all of the 115 kV system to remain in service while increasing the threshold above 650 MW.

For contingencies involving 500 kV circuit D501P, the only connection remaining between north and south would be via 115 kV circuit H9K between Kapuskasing TS and Hunta SS. Similar operating measure will be required to respond to any trip of circuit D501P.

Without these measures the existing generation could be significantly restricted with a resulting cost to the market. It is anticipated that these new operating measures would pose little additional risk, would allow all of the generation to be utilized, and would also be of benefit if future generation development were to take place.

4.7.2 System south of Sudbury

Diagram 7 shows the North-South Transmission Interface, which consists of the two 500 kV circuits X503E and X504E between Hanmer TS and Essa TS (in Barrie) and the 230 kV circuit D5H between Otto Holden GS and Des Joachims GS. The existing Flow-South limit for transfers across this interface is 1,400 MW when accompanied with 100 MW of generation rejection. With flows restricted to this maximum transfer, post-contingency stability can be maintained in response to contingencies involving either of the 500 kV circuits X503E or X504E.

Earlier studies have shown that due to the inherent time delay before generation rejection can occur, this limit cannot be increased through an increase in the amount of generation rejection that is initiated.

During recent years there has been an increase in the amount of generation capacity that has been incorporated into the system, together with an increase in the output of many of the existing generating plants. This has been accompanied by a reduction in the local area load, particularly with the closure of some of the mines. The net result has been an increase in the transfers south which occasionally requires generation output to be constrained so that the existing limit is respected.

Hydro One has therefore submitted a proposal to the IESO for a connection assessment that involves installing series capacitors at Nobel SS, the approximate mid-point of circuits X503E and X504E between Hanmer TS and Essa TS. These capacitors are to provide 60% compensation for the line reactance, and preliminary studies by the IESO have shown that they should allow the Flow-South limit to be increased by at least 600 MW depending on how additional resources and associated transmission facilities are developed.

4.7.3 Mattagami Expansion

The existing generating facilities on the lower Mattagami River consist of the following stations:

Generation Station	Connection Voltage	Generating Units
Little Long GS	230 kV	Two 61 MW units
Smoky Falls GS	110 kV	Four 13.5 MW units
Harmon GS	230 kV	Two 68 MW units
Kipling GS	230 kV	Two 68 MW units

Harmon, Kipling and Little Long GS were designed and constructed for their eventual expansion to four-unit generating stations. However, operation of these three plants is presently restricted by the presence of Smoky Falls GS, which is located down-stream of Little Long GS and has only a limited forebay. Smoky Falls GS presently operates as a base-load station providing a back-up supply to the Spruce Falls mill in Kapuskasing in the event that the existing 230 kV supply is interrupted.

Redeveloping Smoky Falls as a peaking facility would therefore allow additional generating capacity to be installed at the other three 230 kV-connected stations.

In the early 1990s, EA Approval was granted for the installation of an additional generating unit at the Harmon, Kipling and Little Long plants and the construction of a new three-unit generating station at Smoky Falls GS. On the assumption that the existing Smoky Falls facility would be retired, this would have increased the capacity of the generating facilities on the lower Mattagami River by approximately 380 MW.

With the adoption of the new policy for the area north of Hanmer TS, requiring the intentional shutdown of a portion of the north-east system for transfers above a pre-determined threshold in response to 500 kV contingencies, the additional generating capacity could be accommodated within the existing north-east system with only new shunt capacitors installed at Little Long GS, Porcupine TS and Hanmer TS. However, since the existing transfers already exceed the 1,400 MW Flow-South Limit, additional facilities would be required to raise the transfer limit to allow the full increase from the Mattagami Expansion to be accommodated.

Analysis has shown that installing series capacitors in the 500kV circuits P502X, D501P and in X503E & X504E, together with shunt capacitors at Little Long GS and Hanmer TS, would provide the necessary increase in the Flow-South limit to accommodate all of the increased capacity which may be possible from the Mattagami Expansion as well as those existing transfers that exceed the present limit of 1,400 MW.

The facilities that have been proposed to achieve the required increase in the Flow-South Limit to accommodate the Mattagami Expansion, should it be decided to proceed with this development, are also shown in Diagram 7.

4.7.4 Abitibi Canyon GS/Pinard TS

The existing 115 kV switchgear at Abitibi Canyon GS has been deemed to be at end-of-life and Hydro One has proposed that, instead of perpetuating the existing arrangement which suffers from very constricted access, the new switchgear should be consolidated at a new 115 kV busbar at Pinard TS.

This arrangement would have the added benefit of providing a suitable location for a future 230/115 kV auto-transformer to reinforce the existing connection via circuit H9K between the local 230 kV and 115 kV systems in the area.

4.8 Sarnia-Windsor Area

4.8.1 Incorporation of New Generation Capacity

Under the Government of Ontario's RFP for 2,500 MW of New Clean Generation Projects, contracts have been awarded to the following two Projects in the Sarnia area:

Generating Project	Contract Capacity	Connection Point
Greenfield Energy Centre	1,005 MW	230 kV busbar at Lambton SS
St. Clair Power Project	570 MW	Into two of the Lambton to Sarnia-Scott 230 kV circuits

The recent development of new generating facilities within the Michigan system, in close proximity to the Ontario-Michigan Interconnections, has gradually increased the fault levels at Lambton SS, although these presently remain within the rating of the existing switchgear.

However, it is expected that the fault levels will exceed the interrupting capability of the existing 230 kV switchgear at Lambton SS if the existing generation at Lambton GS is operated coincidently with the new generation facilities, as is proposed in the off-coal plan. To avoid restrictions on the amount of generating capacity that could be connected to the system simultaneously within the Sarnia area, and to ensure that fault levels remain within the rating of the existing equipment, the Lambton 230 kV busbar must be operated split. To accommodate split operation it will be necessary to reconfigure the terminations at Lambton SS.

Since this work is expected to take approximately two years to complete, then a decision will need to be made as soon as possible to meet the proposed start of commissioning in late-2007 for an expected in-service date of early-2008 for the new generating facilities.

4.8.2 Windsor Area

Operation of the 115 kV system in the Windsor area continues to be a challenge during high load conditions due to the restrictive thermal ratings of the 115 kV circuits and the two 230/115 kV auto-transformers at Keith TS. It is also becoming increasing difficult to schedule outages, while ensuring continuity of supply in the event of a contingency.

Depending on the generation dispatch in the Windsor area, either a contingency involving one of the 115 kV circuits J3E and J4E between Keith TS and Essex TS or the loss of either of the 230/115 kV auto-transformers at Keith TS can be most severe.

The normal response for a J3E or a J4E circuit contingency, with both the Brighton Beach and West Windsor Power Projects in-service, involves opening the 115 kV breakers of each auto-transformer at Keith TS to limit the flow on the companion circuit. Should either of these generation projects be out-of-service, then the situation would be even more critical.

Uprating of the 115 kV circuits J3E and J4E, together with the replacement of the auto-transformers at Keith TS with higher-rated units, is therefore required urgently. However, before the outages required to complete this work can be scheduled it will be necessary to complete the re-termination of some of the existing 115 kV circuits at Essex TS together with the expansion of the existing Special Protection System so that additional post-contingency responses can be initiated.

In addition, the installation of the proposed 230/115 kV auto-transformer at Kent TS, to allow the Tilbury-area loads to be transferred from the 115 kV busbar at Lauzon TS, would provide some critical relief for the 115 kV system between Lauzon TS and Kingsville TS, and should therefore be undertaken as soon as possible.

During peak load periods, with the Brighton Beach Project out-of-service, a contingency involving either of the 230 kV circuits C23Z or C24Z between Chatham TS and Lauzon TS is expected to result in overloading of either the companion 230 kV circuit and/or the companion auto-transformer at Lauzon TS. To avoid the load interruption required to correct this overload situation, the IESO recommends that Hydro One assess the feasibility of establishing a new 230 kV connection between Keith TS and Lauzon TS, together with a third 230/115 kV auto-transformer at Lauzon TS.

This new connection would also reduce the area's potential vulnerability to the consequences of double-circuit contingencies involving either the Chatham to Keith 230 kV circuits, C21J and C22J, or the Chatham to Lauzon 230 kV circuits C23Z and C24Z.

The proposed system enhancements for the Windsor area are shown in Diagram 8.

The Windsor area is a good candidate for conservation, demand management and additional generation supply.

4.8.3 J5D Interconnection with Michigan

Since the gas-turbine units of the Brighton Beach Project are not equipped with by-pass facilities, any contingency that involves the loss of the steam-turbine unit will result in the automatic tripping of either of the gas-turbine units should they remain connected. To compensate for the sudden loss of the entire Brighton Beach Project, increased transfers, representing approximately half of the pre-contingency output from the Project, will appear on the J5D Interconnection with Michigan.

The limiting element of the Interconnection is a section of the 230 kV line between the two terminal points, the maximum pre-contingency flows that can occur on this Interconnection must be limited to allow for the increased transfers that would occur following the loss of the entire Brighton Beach Project. However, since the limited-time-rating of the phase-shifter in the Interconnection is higher than that of the limiting line section, higher pre-contingency transfers could be accommodated if the limiting line section were to be uprated.

The IESO therefore recommends that Hydro One assess the feasibility of uprating the 230 kV line so that its continuous and limited-time-rating better matches that of the phase-shifter, thereby allowing the transfers from Michigan to Ontario over the J5D Interconnection to be increased by at least 200 MW. It is also important to note that should a decision be made to proceed with this work that it only be scheduled after the upgrading of the 115 kV Keith-to-Essex circuits and the replacement of the Keith auto-transformers have been completed.

4.9 Supply to the Loads in the Oshawa and Belleville Areas

4.9.1 Oshawa Area Supply

The Oshawa area is supplied via two pairs of 230 kV circuits:

- Circuits B23C and M29C, which supply Whitby TS and Wilson TS with a combined peak load of ~ 430 MW
- Circuits H24C and H26C, which supply LASCO, Atlantic Packaging, Thornton TS and Oshawa-GM TS. with a combined peak load of ~ 425 MW

In addition, circuits H24C and H26C provide the exclusive supply to Otonabee TS, which has a peak load of approximately 120 MW.

Circuit B23C, together with circuit H23B from Hinchinbrooke TS, also supplies the substantial load at Belleville TS.

The IESO, in their assessment of the replacement Oshawa GM TS, determined that circuits H24C and H26C would not be capable of accommodating any additional load growth beyond that expected at the Oshawa GM Complex without additional shunt compensation being installed. Furthermore, the peak load supplied exclusively from these two circuits has now exceeded the IESO's threshold of 500 MW for the maximum amount of load that should be exposed to a supply interruption for any recognised system contingency.

Hydro One is proposing to develop Whitby No. 2 TS to accommodate the significant load growth within the Whitby area. However, because of the limited capability of circuits B23C and M29C to accommodate any additional load without adversely affecting their post-contingency performance, it has been proposed to connect the new TS to circuits H24C and H26C.

The Oshawa area is a good candidate for conservation, demand management and additional generation supply.

4.9.2 Belleville Area Supply

Belleville TS is supplied via two 230 kV connections: from Cherrywood TS in the west, via circuit B23C whose length is approximately 164 km; and from Hinchinbrooke TS in the east, via circuit H23B, whose length is approximately 85 km.

The peak load supplied from Belleville TS is approximately 140 MW and this is expected to exceed 150 MW within the next three years. Contingencies involving the companion circuit M29C between Cherrywood TS and Merivale TS, or either of the 230 kV circuits supplying Belleville TS (B23C and H23B) will result in very high post-contingency flows and severely depressed voltages during peak-load periods.

4.9.3 Proposed System Enhancements

To address the loading on circuits H24C and H26C it is proposed that either of the following should be considered for implementation:

- Establish a new 500/230 kV connection in the Bowmanville area in the vicinity where the existing 500 kV and 230 kV rights-of-way cross, by installing one or more 500/230 kV auto-transformers. or
- Reinforce the existing 230 kV connection from Cherrywood TS into the Oshawa area with a new 230 kV double-circuit line approximately 27km long, to allow some of the existing load to be transferred to it.

To address the loading on circuits M29C and B23C it is proposed that the following should be considered for implementation:

- Establish a direct connection between the 230 kV and 500 kV systems in the vicinity where the existing 500 kV and 230 kV rights-of-way cross, by installing one or more 500/230 kV auto-transformers.

The proposed system enhancements are shown in Diagram 9.

4.10 Northwest

Approximately 25% of the load in Northwest Ontario is concentrated near Thunder Bay.

The installation of a shunt capacitor at Birch TS and the subsequent remove from service of the synchronous condenser at Thunder Bay may make it practicable to parallel circuit Q4B, Q5B, and Q8B. This would enhance supply reliability to several very large loads near Thunder Bay. This change should be considered when the Thunder Bay GS units are converted from coal to gas.

Atikokan can cease burning coal and be put on reserve once shunt capacitors are placed in service at Fort Frances and/or Mackenzie TS.

4.11 Ottawa Area

IESO's forecast is showing load growth near Ottawa will exceed the capability of the present transmission system to securely supply this demand. Although not a pressing problem at the moment, the security of supply to Ottawa should be closely monitored. There have been few generation proposals near Ottawa submitted into IESO's Connection and Assessments process. If no generation is situated in the vicinity then additional transmission will be required. The proposed 1,250 MW Ontario-Quebec high voltage direct current (HVdc) connection would provide another significant supply to Ottawa. The status of this HVdc connection is very uncertain and no other major transmissions proposals have been submitted to the IESO. Ottawa also would be a good location for some of the 1,000 MW of cogeneration that is part of the coal replacement plan. The Ottawa area is also a good candidate for conservation, demand management and additional generation supply.

4.12 Niagara Area

The Queenston Flow West (QFW) circuits, between Niagara Falls and Hamilton, have been limiting under hot windless conditions. They currently limit import capability from New York. Without expanding the thermal capability of QFW, adding generation in the Niagara area also does not increase generation availability as the import capability from New York is correspondingly reduced.

Hydro One is proposing to install new transmission facilities to augment the five existing 230 kV circuits that, together, form the QFW Interface.

The facilities that are planned to be installed consist of two new 230 kV circuits between Allanburg TS and Middleport TS. In addition the three existing 230 kV transformer feeders Q26A, Q28A and Q32A between Beck 2 GS and Allanburg TS are to be reconfigured. This will then create two new 230 kV connections between Beck 2 GS and Middleport TS.

The Hydro One proposal is currently in the regulatory approval process. These new facilities are expected to increase the transfer capability of the QFW circuits by approximately 800 MW. This plan is seen as an important risk mitigation measure for the coal replacement plan.

In the past, under peak summer conditions, and recently during hot weather in June 2005, the 230 kV transmission facilities into Burlington TS have also congested Ontario generation and constrained power flows on the QFW circuits. Without reinforcing these 230 kV transmission facilities into Burlington, the full benefit in upgrading the QFW interface may not be realized.

4.13 Summary of Transmission Enhancements Identified in the 10-Year Outlook

The following table summarizes all the key transmission enhancements the IESO recommends for installation across the province to provide necessary IESO-controlled grid reliability. The diagrams are contained in Appendix B.

Table 4.1 Summary of Transmission Enhancements Identified in the IESO 10-Year Outlook

<table>
<tr><th colspan="2">Summary of Transmission Enhancements Identified in the IESO 2005 10-Year Outlook</th><th>Need date</th><th>Comments</th><th>Diagram No.</th></tr>
<tr><td colspan="5">Facilities required to accommodate the planned shutdown of Nanticoke GS and the return to service of Bruce A units 1 and 2</td></tr>
<tr><td>1</td><td>Series Capacitors in the following 500kV circuits associated with the Bruce Complex:
Circuits B562L & B563L between Bruce GS & Longwood TS
Circuits B560V & B561M between Bruce GS & Claireville TS/Milton TS
Circuit N582L between Longwood TS & Nanticoke GS</td><td>Spring-2008</td><td rowspan="3">Scheduled for the spring-2009 & the fall-2009, respectively</td><td rowspan="3">6</td></tr>
<tr><td>2</td><td>Shunt Capacitors at Middleport TS (nominally rated at between 400MVAr & 500MVAr)</td><td>Spring-2008</td></tr>
<tr><td>3</td><td>Conversion of two (or more) generating units at Nanticoke GS to synchronous condenser operation.</td><td>Spring-2009</td></tr>
<tr><td>4</td><td>Installation of a 230 kV connection into Cambridge-Preston TS from a new 500/230 kV TS established on the right-of-way of the existing 500kV double-circuit line, M585M & V586M, between Nanticoke GS & Claireville TS/Milton TS.
This work would also include the installation of two 230/115kV auto-transformers at Cambridge-Preston TS to provide a connection to the local 115kV system between Detweiler TS and Guelph-Cedar TS.</td><td>Spring-2008</td><td rowspan="2">To improve voltages and increase the supply capability in the Kitchener, Waterloo, Cambridge, Guelph & Orangeville area.

This work is also required to ensure that adequate post-contingency voltages can be maintained following the loss of the Bruce-to-Milton 500kV line.</td><td rowspan="2">5</td></tr>
<tr><td>5</td><td>Installation of a new 500/230 kV TS at Bellwood Junction, where the existing 500kV (circuits B560V & B561M) & 230 kV (circuits D6V & D7V) rights-of-way intersect.</td><td>Spring-2008</td></tr>
<tr><td>6</td><td>Although not a transmission enhancement, the installation of the planned 1,500 MW of additional generating capacity in downtown Toronto & the western GTA is also crucial to the plan to shutdown Nanticoke GS.</td><td>Fall-2008</td><td>These facilities are required to ensure that adequate post-contingency voltages can be maintained in the GTA following the loss of the Bruce-to-Milton 500kV line.</td><td></td></tr>
<tr><td colspan="5">Facilities required to accommodate the planned shutdown of Lambton GS</td></tr>
<tr><td>7</td><td>Reconfigure the termination of the existing 230 kV circuits at Lambton TS to allow the busbar to be operated split and respect the fault interrupting capacity of the existing breakers</td><td>Fall-2007</td><td>To accommodate the commissioning of the new generating facilities in the Sarnia area while the existing units at Lambton GS are still operational.</td><td></td></tr>
<tr><td colspan="5">Facilities required to address the issues related to the supply to downtown Toronto</td></tr>
<tr><td>8</td><td>Completion of the John-to-Esplanade Link</td><td>Fall-2007</td><td>This will defer the need date for supply in the Leaside Sector by two-years: to 2010 with weather-corrected loads & 2008 with extreme-weather loads</td><td>4</td></tr>
</table>

Summary of Transmission Enhancements Identified in the IESO 2005 10-Year Outlook		Need date	Comments	Diagram No.
9	Incorporation of 500 MW of generation capacity into the Hearn 115kV busbar	Spring-2008	The need date for this facility is governed by the planned shutdown of Nanticoke GS. This facility will defer the need date for the 3rd Supply to 2012 (with weather-corrected loads) & 2010 (with extreme-weather loads).	
10	Incorporation of 1000 MW of generation capacity within the western GTA	Fall-2008	The need date for this facility is governed by both the planned shutdown of Nanticoke GS and the requirement to support transfers from the Leaside Sector to the Manby Sector, via the John-to-Esplanade Link.	
11	Extension of the John-to-Esplanade Link to Hearn	Spring-2008	This will address the requirements to perform maintenance on the existing facilities in the Manby West TS.	
12	3rd Supply to Downtown Toronto	Spring-2010	To secure the supply for extreme-weather loads.	
		Spring-2012	To secure the supply for weather-corrected loads.	
Facilities required to accommodate the planned shutdown of Atikokan GS				
13	Install shunt capacitors at Fort Frances or Mackenzie TS.	Before 2007	To offset the reactive capability removed from the system with Atikokan retirement.	
Facilities required to address existing or emerging system issues				
14	Series Capacitors at Nobel SS in the 500kV circuits X503E & X504E, between Hanmer TS & Essa TS.	Existing	To address the worsening congestion situation on the north-south corridor.	7
15	Installation of two 500/230 kV auto-transformers at Milton TS and the extension of the existing double-circuit line from Meadowvale TS through to Cardiff TS via a new 230 kV switching station on the right-of-way of the existing double-circuit line (R19T & R21T) supplying Pleasant TS.	Spring-2008	To relieve the 500/230 kV auto-transformers at Trafalgar TS and also improve supply reliability to Georgetown, north Oakville, north Mississauga & Brampton.	2
16	Installation of a 230/115kV auto-transformer at Kent TS.	Immediate	To improve supply reliability to the Windsor area & avoid supply	8

Summary of Transmission Enhancements Identified in the IESO 2005 10-Year Outlook			Need date	Comments	Diagram No.
17	Uprating of the 115kV circuits J3E & J4E between Keith TS and Essex TS and the replacement of the existing auto-transformers at Keith TS with higher-rated units.			interruptions in the event of equipment failures.	
18	Construction of a new 230 kV connection between Keith TS and Lauzon TS.		Immediate		
19	Increase the transfer capability of J5D conductor to better match the phase-shifter regulating transformer rating.		Not determined	To increase import capability by at least 200 MW.	
20	Installation of a new 500/230 kV TS in the vicinity of the intersection of the Bowmanville TS to Lennox GS 500kV corridor and the 230 kV right-of-way of the circuits supplying Belleville TS		Not determined	To enhance the load meeting capability of the existing facilities to accommodate the growth demand in the Oshawa and Belleville areas.	9
21	Construction of a new double-circuit 230 kV line from Cherrywood TS into the Oshawa area OR The installation of a new 500/230 kV TS at a suitable location east of Wilson Junction along the 500/230 kV corridor between Cherrywood TS and Bowmanville TS.		Not determined		
22	Replacement of the two 215MVA 230/115kV auto-transformers at Burlington TS with higher-rated units		Immediate	To avoid supply interruptions	
23	Reinforcement of the Queenston Flow West (QFW) Interface	230 kV reinforcement between Allanburg TS & Middleport TS	Fall-2007	Identified in IESO's 2004 10-year Outlook	
		Uprating of the existing 230 kV circuits into Burlington TS	Immediate		
24	Implementation of measures within the Ottawa area to address voltage decline issues		Not determined		
25	Enhance reactor switching and P502X special protection system in north-east.		Immediate	To increase the generation and load rejection arming threshold and improve the reliability to northeast 115 kV system.	
Facilities required to accommodate the expansion of the Mattagami River Plants					
26	Installation of series capacitors in the 500kV circuits north of Hanmer TS, together with the installation of shunt capacitor banks at Little Long GS & Hanmer TS, should a decision be made to proceed with the expansion of the Mattagami River Plants.		To suit schedule		7

Notes:
The exact requirements for Items 2 and 3 are to be determined as part of the IESO's assessment of the proposal to install series capacitors in the 500kV circuits associated with the Bruce Complex.
All the items in the table above have been identified in Hydro One's 10 Year Plan or are included in a Connection Assessment and Approval application with the exception if items 2,3,13,15,18, and 26.

- End of Section -

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5.0 Coal Replacement Plan

The Ontario government is committed to phasing out the remaining 6,500 MW of coal-fired generation in the province beginning in 2007 as replacement resources become available.

This transition represents the largest and most significant electricity system change ever undertaken in Ontario and involves major technical considerations, significant risks and challenges that need to be addressed.

The coal replacement plan incorporates existing, committed and announced initiatives with respect to additional supply and demand response in various stages of discussion, development, or negotiation. In addition, transmission infrastructure enhancements required to integrate these initiatives have been identified. It must be recognized that significant changes to either the resource or infrastructure plans or timing of the plans will likely jeopardize the ability to retire coal on the timeline proposed.

The IESO will monitor and assess the coal shutdown and replacement resource plans and will provide advice to all parties regarding the actions or adjustments required to ensure reliability is maintained.

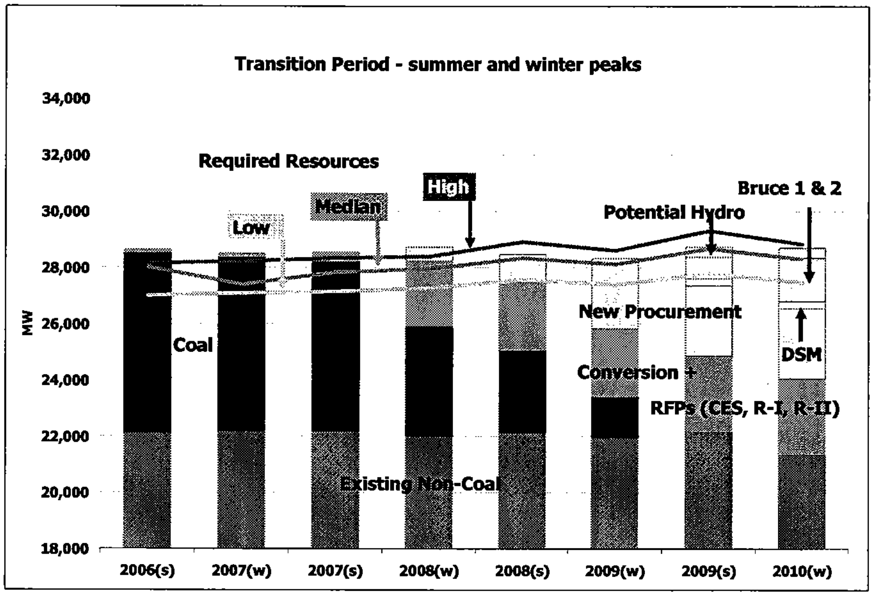
New generation units typically encounter more operating issues affecting their reliability for a period of time after they come in service. These can be significant. Accordingly, a critical requirement of the coal replacement plan is that while coal plants can be scheduled to stop running, those units will be held available for a period of time to operate if necessary to maintain reliability.

Coal supply makes up a large part of Ontario's flexible generation, and it has traditionally been required to meet changing demand, to supply demand when other supply sources are unreliable, and to balance load and generation at all times. Replacement supply must have similar characteristics to provide operating flexibility and sustained energy production as and when it is needed.

The impact of new generation on the transmission system will also be assessed, and necessary transmission upgrades must be completed to ensure reliable system operation.

A plan is provided, illustrating timing and requirements of system changes needed to meet the government's coal shutdown objective. Figure 5.1 provides a graphical comparison of required resources and planned available resources for the critical transition period and includes assessments for both the summer and winter peaks.

Figure 5.1 Critical Transition Period



5.1 System Aspects of the Coal Replacement Plan

In order to preserve grid reliability while implementing the coal replacement program, it is important that replacement generation have suitable operating characteristics, be sited in appropriate locations and that necessary enhancement to transmission infrastructure be undertaken. These requirements are discussed in more detail below.

5.1.1 Location

The location of replacement generation is important to maintaining the capability of the Ontario power system. Reactive power support in critical locations is needed in order to maintain adequate voltages throughout the system, particularly in the Greater Toronto, Golden Horseshoe and the Kitchener-Waterloo-Guelph areas where a significant portion of the load is concentrated. Without voltage support, the ability of the system to transfer energy would be reduced and the ability to supply energy to loads would be lessened. Nanticoke Generating Station is particularly important in this regard.

Under peak load conditions, a minimum of six Nanticoke units are currently required to be in service to ensure reliable system operation. Without these units in service, reductions in the output of the Bruce nuclear generating station would be necessary. In the event that all units at Nanticoke are shut down, and equivalent replacement voltage support is not available, the allowable output from the Bruce generating station would be significantly restricted and the feasibility of returning Units 1 and 2 to service would be jeopardized. This is described in more detail in Section 5.1.6.

The flow eastward on transmission lines into Toronto could also be restricted by substantial amounts, depending on the availability of Nanticoke generation or equivalent replacement generation sources. This could require the operation of other more expensive generation east of this interface and, under peak load conditions, could result in load interruptions in the Toronto area.

The permissible flow eastward on the transmission lines from southwestern Ontario can be reduced in the order of about 1,000 MW (25 %) in the absence of any Nanticoke units. This could significantly restrict imports from Michigan, thus increasing electricity prices and degrading the adequacy of supply.

Ontario's ability to import and export energy is an essential element of secure and reliable interconnected system operation, and provides large financial benefits to Ontario market participants and rate payers. The ability to import and export energy is dependent on where replacement supply is located.

Replacement generation ideally should be located so that the existing import and export capability is not reduced. If replacement resources are located such that they utilize transmission capability that is normally required to deliver imported power, there could be a decrease in the supply available for Ontario consumers, and degradation in overall system reliability. Some offset of import capability with new resources internal to Ontario may be acceptable. Where practical this should be avoided by locating the replacement supply near the load, near existing generation sites or on transmission paths that do not connect the major tie lines to the load centre in the Greater Toronto Area.

The capability of the Ontario power system can only be maintained with the addition of replacement capacity in the right amounts in the most effective locations. Generation investment in the right locations will take advantage of existing transmission lines and facilitate the continued operation of the remaining non-coal generation.

The generation and demand response which has been selected under the Clean Energy Supply RFP, and the additional generation procurement identified for downtown Toronto and western GTA meet these requirements. This replacement generation has been identified to resolve developing reliability risks and to maximize the benefits of existing transmission. Locating generation in undesirable locations could require substantial (and difficult) transmission investments, strand existing transmission assets and generation investments, and increase risks to the adequacy and reliability of electricity supply to the province.

5.1.2 Energy Capability

In 2004, 7,500 MW of coal-fired generation supplied 26.8 TWh of energy, or about 17% of the total Ontario energy demand, at an average capacity factor of about 40%. Although the energy characteristics of individual replacement generating facilities may differ from existing coal-fired generating stations, the aggregate of the new replacement resources must closely resemble the overall energy capability of existing coal-fired generating stations to ensure that energy is available to serve load with the same level of reliability.

5.1.3 Capability of Replacement Resources to Provide Operating Reserve

The ability to maintain sufficient operating reserve is critical to system reliability, and the IESO is required by NPCC to maintain Operating Reserve in accordance with established criteria. Operating Reserve is required for unexpected system events such as random forced outages of generation or transmission equipment, unexpected increases in load, and uncertainty associated with the performance of generation facilities or dispatchable loads in responding to IESO dispatch instructions. The IESO operates markets to procure both 10 minute and 30 minute reserves.

Generation and demand response resources providing Operating Reserve must be capable of responding to the IESO's request to increase generation or decrease consumption within 10 or 30 minutes. Coal-fired generation has typically been an important source of operating reserve, and replacement generation will need to have similar capability. Experience in New England has shown that the provision of Operating Reserve from gas-fired generating units may require some changes in unit commitment practice due to their reduced range of flexibility, but gas-fired generating units should otherwise be capable of replacing Operating Reserve currently carried on coal-fired generating units.

However, not all replacement supply is capable of providing Operating Reserve. Nuclear supply, while capable of efficiently providing energy, is typically operated at its' maximum capability and hence cannot contribute to meeting system requirements for Operating Reserve. Similarly, wind facilities typically operate to take full advantage of existing wind conditions, a mode of operation characterized as 'intermittent'. This replacement supply normally cannot contribute to meeting system requirements for Operating Reserve.

The mix of resources brought in service must be capable of continuing to meet system needs for operating reserve.

5.1.4 Flexibility for Load Following

Coal-fired generators currently play an important role in responding to load changes that occur during five-minute intervals throughout the day. The largest load change typically occurs during the morning pick-up period, and is about 60 to 70 MW per minute, with periods of sustained increase or decrease lasting for up to four hours or more. Experience to date indicates that existing Ontario gas-fired generators typically offer load following capability over the upper 25% of their capacity range, whereas coal-fired units can typically achieve load following from minimum load up to maximum output, which represents the upper 80% of each unit's capacity range. Although nuclear units can ramp down and off the system rapidly, existing units are restricted from varying their output up and down for the purposes of load following. Having sufficient load-following capability is essential to reliability, and the mix of replacement generators will need to have sufficient load following capability to meet system needs.

5.1.5 Frequency Stabilization

System frequency of 60 Hz is maintained only when load and generation are in perfect balance. More generation than load will cause the frequency to rise; less generation than load will cause the frequency to fall. If frequency excursions exceed certain small thresholds, load or generation will be automatically removed from service to protect the equipment. Generating units with appropriate governor settings can automatically adjust unit power output in response to frequency deviations to restore the load/supply balance and stabilize frequency at 60Hz. Replacement generators will need to meet IESO Market Rules requirements for speed governor response characteristics.[1]

[1] Market Rules, Appendix 4.2

5.1.6 System Requirements Associated with the Shutdown of Nanticoke

Located in Haldimand County, the Nanticoke coal-fired generating station can supply almost 4,000 MW of capacity – enough to meet approximately 20 per cent of Ontario's peak demand on a spring or fall day. The shutdown of the station is particularly complex due to a number of factors, including the growing demand for power in the Greater Toronto Area (GTA) and the need to supply that demand from power sources outside the area. Nanticoke also provides reactive power to support the heavy power flows from those areas to the GTA as shown in Figure 5.2.

Supply to the GTA remains a critical concern. Current GTA demand is about 10,000 MW or 40% of Ontario's total demand and is expected to increase by approximately 1,500 MW in the next decade. This is compounded by a lack of generation within the area to supply the forecasted increase in demand. As a result, and until additional sources of supply or demand-side initiatives become available within the GTA, the load must be supplied by generation outside the area. The Nanticoke station provides both energy and capacity to help supply the GTA in addition to providing reactive power to support the transfer of power from southern Ontario supply located some distance from the GTA.

Reactive power, a pre-requisite to the reliable operation of a power system, has been cited as a root cause of the August 14, 2003 blackout. After careful study, experts determined that a severe shortage of reactive power in northern Ohio, caused by power plant and transmission line failures, lead to the blackout.

Produced by generators and consumed by most loads, reactive power is an inherent part of transmitting power over long distances. The longer the distance and the greater the amount of power traveling over that distance, the more reactive power which must be produced by generators to support those power flows.

Currently Nanticoke supplies the greater part of the reactive power needed to transport power to consumers in south-central Ontario and the western GTA, including Brantford, greater Hamilton, Burlington, Guelph, Cambridge, Kitchener-Waterloo, Milton, and parts of Oakville, Mississauga and Brampton. This includes the reactive power needed to support transmission of the Nanticoke station's own energy production to the GTA as well as increasing amounts of power produced at the Bruce GS and in southwest Ontario. As power flows from these areas increase, the importance of Nanticoke to reliable operation increases.

In addition, Nanticoke units contribute to the voltage control requirements of the grid, especially immediately following disturbances or system events that redirect power along the transmission circuits that connect to the Nanticoke plant. Following a disturbance or system event, the Nanticoke generators automatically provide additional reactive power to the system to support the increased power flows resulting from the event, thus preventing a system collapse.

Reactive power and voltage control capability cannot be supplied over long distances. These capabilities will continue to be required locally from Nanticoke until it can be replaced, either at Nanticoke, from generation located within the major load centres such as the GTA, or by other system developments that reduce the need for reactive power and voltage control at Nanticoke.

It must be recognized that the system requirements associated with the shutdown of Nanticoke are significantly affected by the need to incorporate additional Bruce units.

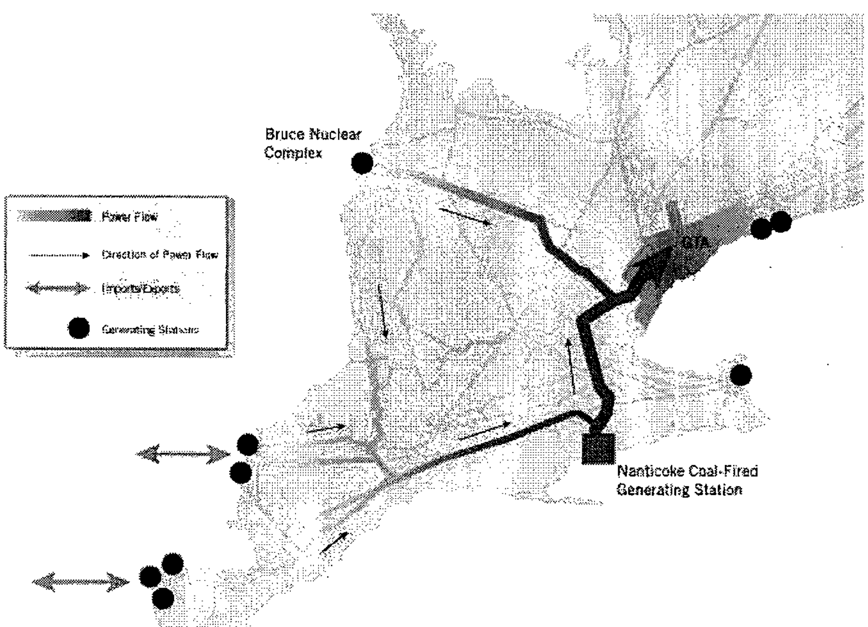
These system requirements address the need for reactive power from Nanticoke and include the following;

- Installation of generation in proximity to the large GTA demand. Location of generation close to the load reduces the need for Nanticoke in two ways; first, less energy needs to be transported long distances to the GTA, and second, reactive power needs of the system are met by the local generation.
- Installation of series compensation in the 500 kV lines serving Bruce and Nanticoke. This form of compensation reduces the need for reactive power to support the large power flows to support the GTA, and reduces the need for post-contingency voltage support
- Installation of shunt capacitors in southwestern Ontario. This form of compensation can provide blocks of reactive power to support voltage and to free reactive capability of generating units. The continuously variable reactive power of generating units is necessary to fine tune voltage in steady state and to regulate voltage following contingencies. The inherent voltage regulation of shunt capacitors is very poor.

It is unlikely that these measures will eliminate the need for dynamic voltage support from the Nanticoke site. The most effective means to provide this capability while meeting the government's policy to cease burning coal at Nanticoke is to convert several units to synchronous condenser operation. In this mode of operation the generator remains connected to the system with full capability to provide reactive power to the system. The steam side of the generating unit may be decommissioned as it is not required in this mode. A minimum of two units are anticipated to be required. The precise requirements will be defined in the near future as the requirements of the coal replacement plan are refined.

A combination of these alternatives has been incorporated into the coal replacement plan.

Figure 5.2 Power Flow – Southwestern Ontario and the GTA



5.1.7 System Requirements Associated with the Incorporation of Bruce Units

The Bruce system consists of eight nuclear units, totaling approximately 6,500 MW of capacity, connected to the power system through four 500 kV lines (two circuits from Bruce to Milton TS, one of which continues on to Claireville and two circuits from Bruce to Longwood TS), and six 230 kV circuits (two circuits from Bruce to Orangeville, two circuits from Bruce to Detweiler and two circuits to Owen Sound, one of which connects to the 115 kV network through to Essa). The Bruce complex is the largest concentration of generating units in North America.

The generation was installed over the mid 70's to mid 80's. Four units were removed from service in 1998, at the same time as four Pickering units. Of these four Bruce units, two units have since been returned to service in 2003. Two units (1 and 2) remain out of service.

The transmission additions constructed to incorporate the station into the Ontario network were not as desired by Ontario Hydro. The preferred implementation included a double circuit 500 kV line from Bruce to Essa in the Barrie area. Public opposition to these circuits ultimately prevented this construction. The Bruce to Longwood 500kV circuits were installed as a somewhat less capable alternative. As a result of this change, the full output of the Bruce complex could not be accommodated by the transmission system. In order to increase the capability of the transmission system to the level required, an automated "Special Protection Scheme" (SPS) was installed. In taking this step, the reliability of both the Bruce generation and many customers in Ontario was reduced to achieve increased economic benefits of the Bruce complex. In essence, the SPS allows for detection of certain power system events and immediately disconnects generators at Bruce and a large amount of customer load throughout southern Ontario to prevent a system disturbance such as that experienced in August 2003.

Without the SPS, Bruce output is limited to approximately 5,000 MW (capacity equivalent to approximately six Bruce units). With the SPS, Bruce output with eight units in operation (6,500 MW) could be accommodated provided up to four units (3,200 MW) were 'rejected' or disconnected instantaneously together with 1,500 MW of customer load (approximately half the load in downtown Toronto). These extensive and complex automatic actions, representing by far the largest use of an SPS by an interconnected system operator, were considered a temporary measure until additional transmission could be constructed. Ontario's neighbouring system operators insisted on stringent conditions with respect to the design and use of the SPS in order to protect their own systems from a cascading disturbance. The majority of the SPS has not been used in over a decade following the shutdown of four Bruce units in 1998.

In the consideration of additional Bruce generation, it is important to understand the relationships of the various factors which impact on the ability of the system to accommodate increased Bruce generation, as well as how the evolution of the electricity system has affected this capability. This information is summarized in the following table.

Table 5.1 Factors which Reduce Ability to Accommodate Increased Bruce Generation

Factors	System in 1980's	Current System
1. Southern Ontario Power Flows are from West to East; - Power flows from	- Ontario is an exporter of	- Ontario is an importer of

Factors	System in 1980's	Current System
Michigan to Ontario - The amount of generation in south western Ontario increases	power to Michigan - Lambton is the only generation in the area (2000 MW)	power from Michigan - Lambton (2000 MW) - TA Sarnia & Dow (635 MW) - Brighton Beach (580 MW) - Imperial Oil (100 MW) - TA Windsor (80 MW) - West Windsor (130 MW)
2. The number of Nanticoke units in Operation is reduced	- Eight units available	- Eight units available - Unit reliability declining
3. Increased need for power flows into the GTA from the west		
- Increased load in the GTA	Peak system load (1984) Winter 18,800 MW Summer 15,800 MW	Peak system Load Winter 25,000 MW Summer 25,500 MW The large majority of this increased load is in the GTA and vicinity
- The power factor of load decreases	Reasonable power factor	Power factor has declined markedly as a result of air-conditioner load, reflecting summer peaking trend in Ontario
- The generation in the GTA decreases	Lakeview 1,200 MW Hearn 400 MW Pickering 4,120 MW	Lakeview 0 MW Hearn 0 MW Pickering 2,575 MW (unit reliability degraded) Darlington 3,600 MW

In each case, the evolution of the system has been to reduce the capability of the system to accommodate additional Bruce generation. Of course this is not exclusively true; for example, Darlington was constructed to help meet GTA load, expansion of the 500 kV network in south western Ontario has been undertaken and a large number of shunt capacitors have been added in the GTA. However, in general, the net effect has been negative from the perspective of accommodating additional Bruce generation.

In addition, the past reliance on the large 'Special Protection Scheme' to accommodate Bruce output is no longer a desirable practice. The three and four unit rejection associated with this scheme as well as associated customer load rejection have not been required to be used in a decade. The experience of the August 2003 blackout has altered industry and system operators view of the risks associated with use of these schemes. The side-effects of their operation may no longer be acceptable. The IESO does not recommend reliance on an SPS of this magnitude that involves the rejection of more than 2 generating units combined with extensive load rejection. There is a high degree of uncertainty with respect to our neighbours' agreement with such a scheme's future use. The IESO believes it is prudent to enhance the transmission system so that generation rejection is limited to 2 Bruce units, and the load rejection portion of the special protection scheme is not required to be used in conjunction with generation rejection to maintain Bruce stability. The load rejection portion of the scheme should be maintained only to overcome difficulties in the operating time frame that would otherwise require pre-contingency load shedding. From the late 1990's this was not a major concern as there were no firm plans to rehabilitate units at Bruce. When this became desirable, the studies performed by the IESO, Hydro One and Bruce Power have identified the need for transmission expansion to accommodate additional generation at Bruce. This may take the form of series compensation of existing transmission lines or the additional of new transmission lines.

In summary, the existing system is much less capable of accommodating additional supply at Bruce than it was in the past. A number of factors associated with the dynamic and changing nature of the system have contributed to this including:

- High load growth in the GTA, particularly in summer as air conditioner use has surged;
- Changing nature of the load in the GTA;
- The shutdown of Pickering A;
- The shutdown of Lakeview;
- The growth of imports from Michigan on-peak;
- The addition of generation in southwest Ontario;
- The overall reduction in dependability of some OPG facilities; and
- Changing industry expectations with respect to use of large 'Special Protection Schemes'.

Even with transmission enhancements, it is recognized that the incorporation of additional Bruce units together with the need to cease burning coal at Nanticoke will require significant changes in the supply and delivery infrastructure.

Fortunately, the same types of system developments required to eliminate the need for Nanticoke generation described earlier this section are the same enhancements needed to accommodate additional generation at the Bruce site. These developments include the following:

- Installation of generation in proximity to the large GTA demand. Location of generation close to the load facilitates the installation of additional generation at Bruce in two ways; first, less energy needs to be transported long distances to the GTA reducing competition for transmission capability between Nanticoke and Bruce, and second, reactive power needs of the system are met by the local generation in the GTA;
- Installation of series compensation in the 500 kV lines serving Bruce and Nanticoke. This form of compensation reduces the need for reactive power to support the large power flows to support the GTA, and reduces the need for post-contingency voltage support; and
- Installation of shunt capacitors in southwestern Ontario. This form of compensation provides voltage support to the steady state power system, freeing up dynamic voltage control capability of generating units.

- As was the case for the shutdown of Nanticoke, it is unlikely that these measures will eliminate the need for dynamic voltage support from the Nanticoke site. The most effective means to provide this capability while meeting the government's policy to cease burning coal at Nanticoke is to convert several units to synchronous condenser operation.

5.1.8 Retirement of Atikokan Facilities

A reliability assessment of the Northwest Zone of Ontario has demonstrated that the Atikokan station may be shut down without replacement. These studies demonstrate that the Northwest Zone of Ontario will continue to be compliant with the NPCC A-2 reliability criterion requiring a Loss of Load Expectation (LOLE) of not more than 0.1 days per year, under conservative input assumptions. Under normal operation the area far exceeds the specified reliability criterion. Due to the nature of the northwest system, the study considered probabilistic reductions to transmission interface capabilities between the Northwest and Northeast Zones, and assumed significantly lower than median resource availability from hydroelectric resources in the Northwest zone.

While operation without Atikokan capacity is acceptable from an adequacy perspective, transmission infrastructure changes are required to ensure system security needs are met. Retirement of Atikokan removes an important source of voltage support necessary to support energy flows throughout the long distances inherent to the Northwest system. The additional of shunt capacitors at Fort Frances and or Mackenzie TS will compensate for the retirement of Atikokan.

5.1.9 Treatment of Interconnections in the Coal Replacement Plan

Interconnection capability provides a number of benefits to the Ontario system and market participants. One very important aspect of the availability of energy from interconnections is in response to unforeseen near-term capacity and demand variations. The large centralized nuclear generation facilities in Ontario can expose the system to large capacity availability variations. Similarly, extreme weather in Ontario can result in extremely high temporary requirements for generation. For these reasons it was decided not to rely on interconnections for capacity requirements during the coal replacement transition, but rather to consider generation in Ontario for this purpose. Long term use of interconnections for capacity purposes should be based on the construction of additional interconnection capability, ensuring sufficient capability remains for current purposes.

5.2 System Transition Risk Mitigation

The transition from coal to replacement clean supply is an extremely challenging objective. In terms of the amount of coal generation to be replaced, an amount of clean supply larger than all of the hydroelectric capacity in Ontario must be arranged for, constructed, commissioned and reach a reliable state of operation.

This transition must take place:

- Without jeopardizing electricity reliability;
- Within the capabilities of the industry to deliver; and
- Within the tolerance for change of electricity consumers.

Managing a challenging objective such as this requires planning, monitoring and adjustment of schedules and plans to ensure that reliability is maintained and the transition proceeds efficiently. The IESO will monitor and assess the coal shutdown and replacement resource plans and will provide advice to all parties regarding the actions or adjustments required to ensure reliability is maintained.

The coal replacement plan is made up of a series of broad activities to achieve the desired transition.

1. Identify needs of replacement capacity – the first step is to establish the required characteristics, amounts, and general location of replacement capacity to meet the objectives of transition.
2. Procure the capacity – maximize use of existing processes such as RFP's to procure efficient and economic replacement supply to meet needs.
3. Identify infrastructure enhancements required to support the transition. This can include many diverse areas; however, it is certain to include transmission enhancements to integrate the replacement capacity and gas supply infrastructure to support new gas-fired capacity.
4. Build the new capacity and supporting infrastructure.
5. Integrate the new capacity and infrastructure into a reliably functioning system. This involves well-established commissioning activities and market entry processes.
6. Once replacement capacity has demonstrated reliable operation, only then will coal capacity be retired.

There are many risks associated with these plan activities.

1. Bringing new supply and delivery capacity in service on schedule
2. Maintaining existing coal plants operable and reliable until the new capacity and delivery infrastructure is available. This becomes more challenging as soon as a retirement date is announced for coal facilities.

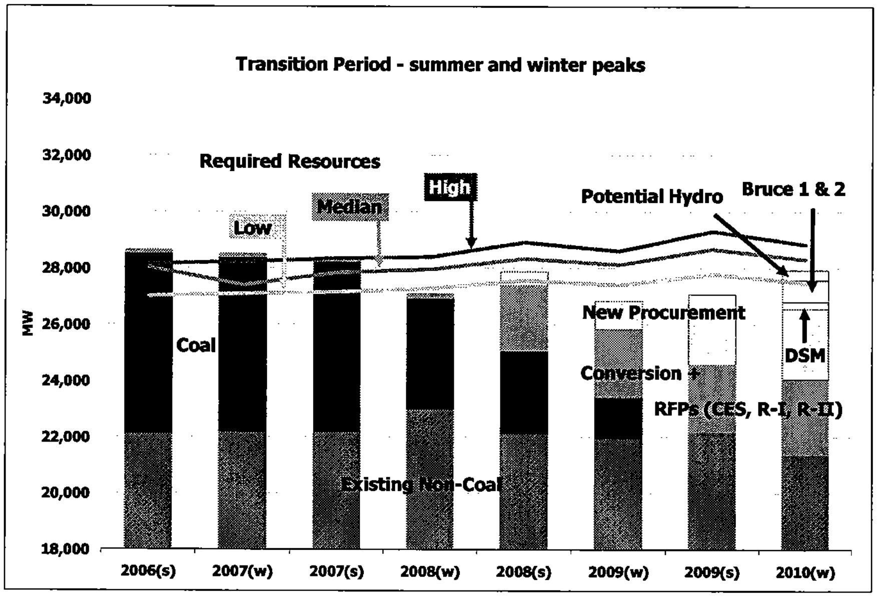
The transition plan incorporates risk mitigation strategies to address known risks. These include:

- Accelerated approvals processes for supply and deliver infrastructure;
- Maximizing use of existing delivery infrastructure to the extent possible;
- Early identification and procurement of necessary infrastructure;
- Establishing coal plants in a reserve state following the in-service of new capacity. This would involve minimizing the need for operation of these coal plants after replacement capacity is available, but retaining the capability for a period of time to guarantee a reliable transition, recognizing inherent risks with respect to early operation of replacement capacity. The importance of this requirement must not be understated;
and
- Continuous planning and monitoring of the elements of transition and adjustment of schedules in response to reliability requirements.

It is through these strategies that the IESO proposes to facilitate a reliable transition.

Figure 5.3 illustrates the impact a six month delay in each of the replacement supply elements would have on reserve margins without the availability of coal plants on reserve to address this situation, large supply shortfalls would occur immediately.

Figure 5.3 Impact on Transition Period of Replacement Generation Delays



5.3 Coal Replacement Plan

The coal replacement plan has been developed based on the identified system requirements and incorporates elements of the risk mitigation strategies identified in earlier sections. Where firm plans for new capacity do not exist, the identified in-service dates for new supply should be considered as need dates for purposes of meeting the transition timeline identified by the Ontario Government.

Assumptions inherent in the plan are as follows:

- Best available information is used for in-service dates;
- Coal plants are assumed to remain operable and on reserve for a period of nine months after replacement capacity is declared in service; and
- The dates for coal plants to cease burning coal are based on forecast system conditions. For purposes of the plan, the dates are chosen such that system reserve above requirement is never less than zero for the median demand growth scenario, exclusive of coal capacity operable but on reserve.

The milestone dates identified in the plan represent the required in-service dates to achieve the coal replacement objectives. Achievement of these milestones is expected to be extremely challenging in some cases. Where milestones are not achieved, the retirement of existing capacity must be delayed.

A summary of the milestone dates for the coal replacement plan are contained in the following table.

Table 5.2 Coal Replacement Plan Milestones

Time Period	Summary of the Plan
2007	- Atikokan can cease burning coal and be put on reserve once Northwest transmission enhancements are complete. These enhancements are for shunt capacitors to be placed in service at Fort Frances and/or Mackenzie TS. - Atikokan must remain available for operation, on reserve, until transition of Thunder Bay to gas or equivalent replacement capacity is in service in the same location. - Thunder Bay conversion or replacement must be complete before end of 2007. If the conversion option is chosen, outages to two Thunder Bay units must be scheduled in spring and fall respectively to meet capacity needs over peak periods. - A natural gas pipeline to the Thunder Bay site must be available to meet either Thunder Bay option. - Lambton units can cease burning coal and be put on reserve once replacement capacity is in service. This includes: 1,005 MW Calpine project, 570 MW Invenergy project, and 280 MW Eastern Power GTA project plus completion of 500 MW of centrally located generation assumed to be met by the cogeneration commitment. - It will be necessary to reconfigure the Lambton switchyard to permit commissioning operation of the new supply in the area at the same time as the existing Lambton units.
2008	- Shunt capacitors in southwestern Ontario are required to be in service prior to the shutdown of Nanticoke units - Series compensation of the Bruce and Nanticoke transmission corridors and shunt capacitors in southwestern Ontario are required to be in service prior to the shutdown of Nanticoke units - Nanticoke Units 1 and 2 can cease burning coal and be put on reserve following the January – March winter peak period in 2008. - 500 MW of new capacity is required to be in service by June 2008. This is assumed to be met by the cogeneration commitment. - 1,000 MW of new capacity assumed to be in service in western GTA by fall 2008. - 500 MW of new capacity assumed to be in service in downtown Toronto by the fall of 2008. - Nanticoke units 3 and 4 can cease burning coal and be placed on reserve prior to the winter peak period 2008/9. - Nanticoke Unit 5 ceases burning coal and is placed on reserve by the end of 2008.

Time Period	Summary of the Plan
2009	- Nanticoke Units 1 and 2 are required to be converted to synchronous condenser operation. These outages are assumed to take place in early spring 2009 with actual unit outages limited to a maximum three month period. These facilities must be completed prior to Bruce Units 1 and 2 being placed in service. - 770 MW Bruce A unit returned to service by spring 2009. - Nanticoke Unit 6 ceases burning coal and is placed on reserve by spring of 2009. - Nanticoke Units 7 and 8 cease burning coal and are placed on reserve before summer peak 2009. - 280 MW Eastern Power GTA project placed in service prior to summer 2009. - Up to 380 MW of Mattagami expansion placed in service and series compensation of northeast transmission completed by summer 2009. - Demand side measures equivalent to 250 MW of supply in place by summer 2009 - Second 770 MW Bruce A unit returned to service by fall 2009. - Bruce A Unit 3 is removed from service by late fall 2009.

- End of Section -

6.0 Overall Observations, Findings and Conclusions

Resources

Demand/Supply Balance

- The phase out of coal-fired generation, aging generation facilities and the continued increase in demand for electricity all contribute to the need for new generating and transmission facilities over the next 10 years. Additional Ontario electricity supply and demand-side measures are required to maintain supply adequacy into the future and to reduce Ontario's dependency on supply from other jurisdictions
- Under the Reference Resource Scenario, Ontario could be facing a growing supply shortfall beyond the first few years of the 10 year period. Reserve requirements will be met in the first five years under the median demand growth scenario if no in-service delays are encountered for the RFP projects, or alternatively, if there are delays, coal replacement must be deferred. For the low demand scenario, reserve requirements are met until 2013. However, if high demand growth occurs, additional supply will be required by 2010 and possibly earlier.
- Under the Coal Replacement Scenario, reserve requirements will be met until 2011 under median demand growth assumptions if a number of challenging conditions are met -- no in-service delays are encountered for the successful RFP projects, the procurement of additional generation by the OPA is successful in the right amounts and locations, Bruce Units 1 and 2 are returned to service on-schedule, the development of additional Mattagami generation or similar capacity is completed on-schedule and demand side management projects are implemented. Additional supply is required after 2011.
- A diverse generation mix of operating types (baseload, intermediate, peaking) as well as diversity among the fuel used by the various supply (hydroelectric, wind, gas, nuclear) is critical for resource adequacy and market efficiency, through the provision of dispatch flexibility, reduced vulnerability to fuel supply contingencies and fuel price fluctuations.
- Continued flexibility with respect to water use is important to system operation. The IESO is concerned with the future management of the Province's water resources as they relate to electricity production. The flexibility in the operation of hydroelectric facilities is of great benefit to the Ontario power system. The importance of this flexibility needs to continue to be reflected and balanced with other options which may influence provincial requirements with respect to water management. Hydroelectric resources provide energy, ramping capability, operating reserve and automatic generation control. Preserving operating flexibility of hydroelectric generating facilities (whether old or new) should be a critical consideration in the development of water management plans.
- Connecting large amounts of wind powered generation to the grid will involve challenges, including improving the understanding of daily patterns and fluctuations of wind generation to determine if changes are needed in IESO operating practices and Market Rules. The connection assessment of wind generation needs careful examination with respect to a facility's ability to stay connected during low voltage excursions, its ability to supply reactive power, data monitoring requirements and others. Notwithstanding these considerations, the presence of wind on the Ontario grid will be a positive contribution to Ontario's future

supply mix. For the purposes of this study, it is assumed 10% of the installed capacity of wind powered generation can be relied on at the time of the annual peak.

- The IESO has been identifying the suitability of conservation and demand-side (CDM) measures as part of the supply picture for several years and believes demand reductions and demand shifting should be vigorously pursued in Ontario, as clean and potentially less expensive ways to reduce future supply requirements. The application of such demand initiatives is virtually unrestricted in location.
- IESO recommends that Ontario work with other jurisdictions to raise the power factor requirements of new air-conditioning equipment. This would in the long term reduce the need for generation and transmission enhancements to meet the active power demand in Ontario.
- Interconnections are an important source of energy for Ontario. In real-time system operation, reliance on external supply through interconnections is mutually beneficial to all interconnected systems, for both reliability and market efficiency reasons. During off-peak periods, attractively priced external supply can provide cost savings to the electricity market and access to broader market for inexpensive Ontario generators. During peak hours, due mainly to the non-coincidence of the peak demands with one or more neighbouring systems, external supply can contribute to meeting peak demand.
- Additional interconnections between Ontario and its neighbours have been proposed. An HVDC interconnection with Hydro Quebec of 1,250 MW transfer capability would improve interchanges between Ontario and Quebec and would be required for future power procured from Lower Churchill Falls. Although not yet formally submitted for Connection Assessment, an upgrade to the Ontario - Manitoba interconnection would give access to hydroelectric capacity from Manitoba
- Interconnection capability provides a number of benefits to the Ontario system and market participants. One very important aspect of the availability of energy from interconnections is in response to unforeseen near-term capacity and demand variations. The large centralized nuclear generation facilities in Ontario can expose the system to large capacity availability variations. Similarly, extreme weather in Ontario can result in extremely high temporary requirements for generation. Long term use of interconnections for capacity purposes should be based on the construction of additional interconnection capability, ensuring sufficient capability remains for current purposes.

Transmission

Downtown Toronto

- For expected summer peak load conditions, the power flow on the transmission equipment supplying this zone is expected to be at or near its maximum capability. As load grows annually, the flows through these circuits and transformers will continue to increase, to the point that the downtown Toronto load would have to be interrupted in the event of a failure of a single circuit or transformer. The system is normally designed and operated with some redundancy – i.e., the ability to withstand such an outage without interrupting load. This redundancy is forecast to be lost by summer 2008, but a higher rate of load growth or extreme weather could make it as early as summer 2006.

The transmission system within downtown Toronto is also very heavily loaded and could reach its maximum capacity as early as the summer of 2006, depending on the rate of load growth in the downtown core. Since much of the downtown system consists of underground cables, equipment failure could take a substantial time to repair, exposing the loads to extended supply interruptions. The addition of generation and demand response in downtown Toronto would reduce the power transfers through the heavily loaded transmission facilities between Cherrywood and Leaside, and through the transformers at Leaside TS, and would reduce the loading on the transmission system in downtown Toronto. Hydro One has a transmission reinforcement plan for downtown Toronto (the proposed third supply), and advises that the first stage could be completed no earlier than 2010. An initial phase of this first stage could be in service as early as 2007 (the John-to-Esplanade link), but the capability of this link to provide relief during peak load periods is dependant on transmission or generation reinforcement in the western GTA (Manby sector). Hence additional generation or demand response in the area is crucial to maintaining reliability of supply until 2010. System studies indicate that the maximum amount of generation that can be connected directly to the transmission system in downtown Toronto is limited by transmission equipment short circuit considerations to about 550 MW.

- New generation capacity is required within the Toronto area and must be sited so that it can be connected directly to the 115kV busbar at Hearn SS. The new capacity must be limited to approximately 720 MVA so that the ratings of the existing switchgear at Leaside TS are not exceeded. This will also require that the generator step-up transformers be suitable for being equipped with neutral reactors.

  With all of the new generation capacity incorporated, the existing transmission system in the Toronto area must be operated split into two discrete halves from Cherrywood TS through to Hearn TS. The new capacity is therefore required to comprise individual generating units that will allow between 300 MW and 400 MW to be connected to the western half of the split system and with any remaining capacity connected to the eastern half. In addition, under equipment outage conditions, at least 50% of the generation capacity connected to the western half of the Hearn busbar is required to be available for service.

- In the absence of additional generation as well as demand-side initiatives, a single transmission facility failure may make it necessary at times to interrupt load in the area in order to prevent the overloading of transmission facilities supplying downtown Toronto, particularly during hot weather conditions. The risk that load shedding will be necessary increases as electricity demand in downtown Toronto continues to grow.

- With the scheduled completion of the John-to-Esplanade link in the fall of 2007, the need date for additional supply to downtown Toronto may be deferred until the summer of 2008, under extreme weather conditions.

- Depending on its exact location and configuration, the 500 MW of new generating capacity to be procured by the OPA for the downtown Toronto core could provide a deferral in the need date for further supply to beyond 2010, under extreme weather conditions.

- Even with additional generating capacity installed in the downtown Toronto core, it is expected that a third supply will need to be installed prior to the summer of 2010 to ensure a secure supply for downtown Toronto. However, should additional load growth occur, beyond that which is currently being forecast, it would be necessary to advance the installation of a third supply.

- Additional auto-transformer capacity is required at Manby West TS as soon as possible to allow existing equipment to be taken out of service for maintenance without requiring load interruptions.

Greater Toronto Area

- The electrical loads in the western GTA are supplied by transmission lines and auto-transformers that connect the local transmission and distribution systems to the rest of the high voltage grid. These auto-transformers are key sources of supply to the area. The immediate transmission system impacts arising from the shutdown of the Lakeview coal fired Generating Station in Mississauga on April 30, 2005 have been addressed. Hydro One completed the first phase of the Parkway Transformer Station which alleviates transformer overload concerns. Voltage support requirements have been dealt with by the installation of additional shunt capacitors and related transformer controls by Hydro One. These temporary measures were required to avoid overloading of auto-transformers at the Claireville Transformer Station and Milton Switching Station and lower than acceptable voltages in the western portion of the GTA during heavy load conditions. However additional steps are required to address this growing problem.
- Once all of the planned facilities are in-service, and depending on the number of remaining generating units that are operational in south central Ontario during peak load periods, the IESO has concluded that the system would only exhibit acceptable voltage performance, without interrupting load, through the summer of 2007.
- The capability of the existing 230 kV transmission corridor between Richview TS and Manby TS to accommodate further increases in load is already severely limited. To support additional load transfers using the John-to-Esplanade Link would require reinforcement before summer 2007. Consequently, generation capacity located to the south of Manby TS that would reduce the required flows from Richview TS would defer the need to reinforce the Richview-Manby corridor, and will also reduce the transfers through the Claireville auto-transformers.
- In order to limit the peak flows through the Claireville auto-transformers to a level at or near their continuous ratings during the period 2006 to 2010, it will be necessary to install at least 1000 MW of additional generation and demand response on the 230 kV system in the Claireville area. Load growth and extreme weather could require this as early as summer 2007. Generation capacity connected to the 230 kV circuits that terminate on to the 230 kV busbar at Claireville TS would not only reduce the transfers through the auto-transformers but would also provide direct voltage support for the Claireville busbar following contingencies.
- Three new generating facilities selected under the 2,500 MW RFP - Greenfield South, Greenfield North and GTAA - are expected to be adequate to maintain the transfers through the auto-transformers at Trafalgar TS within their continuous rating for peak demands up to 27,500 MW. The new generating facilities would also provide additional margin on the auto-transformers at Claireville TS to accommodate possible transfers from the Leaside to the Manby Sector during peak load periods via the new John-to-Esplanade Link without exceeding their continuous rating. However, the new generating facilities are not expected to be sufficient to provide any additional margin on the auto-transformers at either Claireville TS or Trafalgar TS to accommodate future load growth.

- The approximately 1,000 MW of additional generating capacity to be procured by the OPA for the western GTA, beyond the three Projects that were previously announced for this area, is expected to provide further relief for the auto-transformers at Claireville TS. However, depending on its location, this generation may do little to relieve the loading on the Trafalgar auto-transformers.
- One option to relieve the loading on the Trafalgar auto-transformers would be the installation of two 500/230 kV auto-transformers at Milton TS and the re-termination of the existing connections to Halton TS and Meadowvale TS.
- Due to the high load growth in the Newmarket - Aurora area, additional supply capability is required. Options to provide this capability are being examined by the OPA.

Kitchener, Waterloo, Cambridge, Guelph and Orangeville Areas

- Remedial measures are required urgently to improve voltages and increase supply in the Kitchener, Waterloo, Cambridge, Guelph and Orangeville areas which are primarily supplied from Detweiler TS.
- Hydro One has proposed a plan for enhancing the load-meeting capability of this area involving the installation of 230/115 kV auto-transformers at Cambridge-Preston TS, the installation of two 500/230 kV auto-transformers on the right-of-way of the 500 kV circuits between Middleport TS and Milton TS/Claireville TS, and the construction of a new 230 kV double-circuit line into Cambridge-Preston TS. IESO studies indicate that this plan has substantial merit, but poor voltages can still result under contingency conditions.
- The IESO has examined the effect of including a further 500/230 kV interconnection in the vicinity of Bellwood Junction where the existing 500 kV right-of-way of circuits B560V and B561M and the 230 kV right-of-way of circuits D6V and D7V intersect. Preliminary Assessment of this proposed connection, together with the connection from the 500 kV system into Cambridge-Preston TS, resulted in a significant improvement in the system voltages under peak load conditions.
- Local generation should be considered as an alternative or complementary solution to the transmission proposals indicated.

Bruce Area

- One of the potential sources of replacement supply for coal fired generation is the return to service of Bruce units 1 and 2. Preliminary IESO studies indicate that the proposed 500 kV series capacitors on the lines emanating from the Bruce Complex should sufficiently enhance the transfer capability of the existing transmission facilities to allow the additional capacity at Bruce GS to be incorporated without the need for any new transmission lines. IESO studies assumed that:
    - Nanticoke GS was no longer operating as a generating station, but at least two units were operating as synchronous condensers;
    - additional generating capacity that is expected in the western GTA and in downtown Toronto was in-service; and,
    - New capacitor banks at Middleport TS were in-service.

Northeastern Ontario

- The north-eastern part of the Ontario power grid is made up of multiple generating units, a few very large and many small loads, and a relatively sparse transmission system. The grid north of Sudbury is connected to the rest of Ontario via one 500 kV circuit, and one 115kV circuit.

  Currently the IESO employs a variety of specific operating procedures and special protection systems to ensure that all of the generation in north-eastern Ontario can be reliably transmitted to the loads in Southern Ontario. In doing so, especially when the generation is operating near maximum output, there is some risk of abnormal operation if the 500 kV circuit were to trip (operating statistics show a trip could happen about once a year).

  Over the years generation has been added and a reduction in local load has taken place in north-eastern Ontario. Recent analysis by the IESO indicates that the existing operating measures are no longer sufficient to ensure acceptable operation following the loss of the 500 kV circuit connecting the North-east to the south. To address this, the IESO is adopting operational measures that rely on an automatically cross tripping 500 kV circuit D501P and shutdown the 230 kV system connected to Pinard TS. of the system during high southward transfers. This would only be initiated following the trip of the 500 kV circuit, would avoid the risk of abnormal voltages and frequencies, and would also allow a quick and orderly re-start of the system.

  Without these new measures the existing generation could be significantly restricted with a resulting cost to the market. It is anticipated that these new operating measures would pose little additional risk, would allow all of the generation to be utilized, and would also be of benefit if the Mattagami development were to take place.

- Enhancements to the existing transmission facilities and the existing generation rejection scheme are required in order to maintain all of the existing 115 kV system in-service following a 500 kV contingency, while also increasing the transfers between Hanmer TS (Sudbury) and Porcupine TS (Timmins) above 650 MW. This will minimise the impact of the new policy on consumers within the area, and help in the supply restoration process.

- The existing limit for transfers south from Hanmer TS (Sudbury) to Essa TS (Barrie) over 500 kV circuits X503E and X504E is 1,400 MW when accompanied with 100 MW of generation rejection. During recent years there has been an increase in the transfers south which occasionally requires generation output to be constrained so that the present limit is respected.

- Hydro One has proposed installing series capacitors at Nobel SS, the approximate mid-point of circuits X503E and X504E. These capacitors would provide 60% compensation for the line reactance, and preliminary studies by the IESO have shown that they should allow the Flow South limit to be increased by at least 600 MW.

- Additional analysis has shown that installing series capacitors in circuits P502X and D501P, together with shunt capacitors at Little Long GS and Hanmer TS, would provide the necessary increase in the Flow-South limit to accommodate all of the increased capacity from the proposed Mattagami Expansion as well as the existing generating capacity that currently exceeds the present limit of 1,400 MW.

Sarnia-Windsor Area

- It is necessary to reconfigure the terminations at Lambton SS so that the 230 kV busbar can be operated split in order to ensure that fault levels remain within equipment ratings. Since this work is expected to take approximately two years to complete, it will need to commence as soon as possible to meet the proposed start of commissioning in 2007 for an expected in-service date of early-2008 for the new RFP generating facilities in the Sarnia area.
- Uprating of the 115 kV circuits J3E and J4E, together with the replacement of the auto-transformers at Keith TS with higher-rated units, is urgently required. Before this work can be undertaken, it will be necessary to complete the re-termination of some of the existing 115 kV circuits at Essex TS together with the expansion of the existing Special Protection System.
- Installation of a proposed 230/115 kV auto-transformer at Kent TS should be undertaken as soon as possible. This would allow the Tilbury-area loads to be transferred from the 115 kV busbar at Lauzon TS, and would provide critical relief for the 115 kV system between Lauzon TS and Kingsville TS.
- During peak load periods, with the Brighton Beach Project out-of-service, a contingency involving either of the 230 kV circuits C23Z or C24Z between Chatham TS and Lauzon TS is expected to result in overloading of either the companion 230 kV circuit and/or the companion auto-transformer at Lauzon TS. To avoid the load interruption required to correct this overload situation, the IESO recommends that assess the feasibility of establishing a new 230 kV connection between Keith TS and Lauzon TS, together with a third 230/115 kV auto-transformer at Lauzon TS.
- The IESO recommends that Hydro One assess the feasibility of uprating the 230 kV line so that its continuous and limited-time-rating better matches that of the phase-shifter, thereby allowing the transfers from Michigan to Ontario over the J5D Interconnection to be increased by at least 200 MW. It is also important to note that should a decision be made to proceed with this work that it only be scheduled after the upgrading of the 115 kV Keith-to-Essex circuits and the replacement of the Keith auto transformers have been completed

Oshawa and Belleville Areas

- To address the loading on circuits H24C and H26C, either of the following alternatives should be considered for implementation:
  - Establish a new 500/230 kV connection in the Bowmanville area in the vicinity where the existing 500 kV and 230 kV rights-of-way cross, by installing one or more 500/230 kV auto-transformers. or
  - Reinforce the existing 230 kV connection from Cherrywood TS into the Oshawa area with a new 230 kV double-circuit line approximately 27km long, to allow some of the existing load to be transferred to it.

To address the loading on circuits M29C and B23C, consideration should be given to establishing a direct connection between the 230 kV and 500 kV systems in the vicinity where the existing 500 kV and 230 kV rights-of-way cross, by installing one or more 500/230 kV auto-transformers.

Niagara Area

- Thermal loading on circuits between Niagara Falls and Hamilton (QFW) and into Burlington continue to cause congestion and limit import capability from New York. Hydro One's plan to expand the transfer capability on the QFW circuits is in the regulatory approval process. The upgrade, if approved, is expected to provide an increase in transfer capability of about 800 MW on QFW. This plan is seen as an important risk mitigation measure for the coal replacement plan.

- In the past, under peak summer conditions, and recently during hot weather in June 2005, the 230 kV transmission facilities into Burlington TS have also congested Ontario generation and constrained power flows on the QFW circuits. Without reinforcing these 230 kV transmission facilities into Burlington, the full benefit in upgrading the QFW interface may not be realized.

Coal Replacement Plan

- The coal replacement plan incorporates existing, committed and announced initiatives with respect to additional supply and demand response in various stages of discussion, development, or negotiation. In addition, transmission infrastructure enhancements required to integrate these initiatives have been identified. It must be recognized that significant changes to either the resource or infrastructure plans or timing of the plans will likely jeopardize the ability to retire coal on the timeline proposed.
- The IESO will monitor and assess the coal shutdown and replacement resource plans and will provide advice to all parties regarding the actions or adjustments required to ensure reliability is maintained.
- As new generation is brought into service, there will be an initial period of "running in" before it becomes fully reliable. Accordingly, one critical aspect of the coal replacement plan is the essential requirement to maintain existing coal-fired plants available for service for a period of time after the actual in-service date of replacement supply. This risk mitigation requirement will help to ensure the continued reliability of the system during this period of substantial system change.
- Because of the high level of uncertainty and the severity of the consequences of supply shortages, it is critically important that the coal replacement plan incorporate rigorous risk mitigation measures and controls
- Coal supply makes up a large part of Ontario's flexible generation, and it has traditionally been required to meet changing demand, to supply demand when other supply sources are unreliable, and to balance load and generation at all times. Replacement supply must have similar characteristics to provide operating flexibility and sustained energy production as and when it is needed.
- The impact of new generation on the transmission system will also be assessed, and necessary transmission upgrades must be completed to ensure reliable system operation.

Replacement of Nanticoke GS and the Addition of Generation at Bruce

- Achieving the replacement of Nanticoke generation in appropriate locations is critical to supporting power transfers toward Toronto and to avoiding restrictions on the output from Bruce. The shutdown of the station is particularly complex due to a number of factors, including the desire to refurbish Bruce units 1 and 2, the growing demand for power in the Greater Toronto Area (GTA) and the need to supply that demand from power sources outside the area. Nanticoke also provides reactive power to support the heavy power flows from those areas to the GTA.

- Developments which are required to support the shutdown of Nanticoke include the following:
  - Installation of generation in proximity to the large GTA demand;
  - Installation of series compensation in the 500 kV lines serving Bruce and Nanticoke; and
  - Installation of shunt capacitors at Middleport TS, in southwestern Ontario.

  It is unlikely that these measures will eliminate the need for dynamic voltage support from the Nanticoke site. The most cost-effective means to provide this capability while meeting the government's policy to cease burning coal at Nanticoke is to convert several units to synchronous condenser operation.
- The coal replacement plan requires that at least two of the Nanticoke units be converted to synchronous condenser operation.
- Nanticoke units are planned to cease burning coal and be place on reserve for a period of time beginning in 2008 with the last units placed on reserve in 2009.

Replacement of Lambton GS

- Lambton can cease burning coal and be put on reserve once replacement capacity is in service. This includes the 1,005 MW Calpine project, the 570 MW Invenergy project, and the 280 MW Eastern Power GTA project all expected in service near the end of 2007 and early 2008.

Replacement of Thunder Bay GS and Atikokan GS

- Atikokan can cease burning coal and be put on reserve once Northwest Transmission enhancements are complete. These enhancements are for shunt capacitors in service at Fort Frances and/or Mackenzie TS. Atikokan must remain available for operation, on reserve, until transition of Thunder Bay to gas or equivalent replacement capacity is in service in the same location.

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Appendix A – Resource Adequacy Assessment Details

List of Tables

Resource Adequacy Assessment Tables

The following tables provide numeric results of the resource adequacy assessment. Red with white text cell shading in the 'Reserve Above Requirement' column means the forecast supply deficiency exceeds the current Ontario coincident import capability of ~4,000 MW.

Table A1 Reserve Above Requirement Values Under Low Demand Growth, Summer Peak, Reference Resource Scenario

Year	Summer Peak Demand MW	Week Ending	Available Resources MW	Required Resources MW	Available Reserve MW	Required Reserve MW	Available Reserve %	Required Reserve %	Reserve Above Requirement MW
2006	23,292	16-Jul-06	28,671	27,003	5,379	3,711	23.1	15.9	1,668
2007	23,607	15-Jul-07	28,541	27,155	4,934	3,548	20.9	15.0	1,386
2008	23,883	13-Jul-08	28,457	27,570	4,574	3,687	19.2	15.4	887
2009	24,213	12-Jul-09	28,787	27,800	4,574	3,587	18.9	14.8	987
2010	24,300	18-Jul-10	28,292	27,617	3,992	3,317	16.4	13.7	675
2011	24,516	17-Jul-11	28,356	27,848	3,840	3,332	15.7	13.6	508
2012	24,733	15-Jul-12	28,388	28,110	3,655	3,377	14.8	13.7	278
2013	24,954	14-Jul-13	28,416	28,482	3,462	3,528	13.9	14.1	-66
2014	25,159	13-Jul-14	26,860	28,852	1,701	3,693	6.8	14.7	-1,992
2015	25,475	12-Jul-15	25,962	29,311	487	3,836	1.9	15.1	-3,349

Table A2 Reserve Above Requirement Values Under Median Demand Growth, Summer Peak, Reference Resource Scenario

Year	Summer Peak Demand MW	Week Ending	Available Resources MW	Required Resources MW	Available Reserve MW	Required Reserve MW	Available Reserve %	Required Reserve %	Reserve Above Requirement MW
2006	24,089	9-Jul-06	28,655	28,037	4,566	3,948	19.0	16.4	618
2007	24,301	15-Jul-07	28,541	27,848	4,240	3,547	17.5	14.6	693
2008	24,627	13-Jul-08	28,457	28,344	3,830	3,717	15.6	15.1	113
2009	25,045	12-Jul-09	28,787	28,685	3,742	3,640	14.9	14.5	102
2010	25,228	18-Jul-10	28,292	28,701	3,064	3,473	12.2	13.8	-409
2011	25,534	17-Jul-11	28,356	29,037	2,822	3,503	11.1	13.7	-681
2012	25,840	15-Jul-12	28,388	29,411	2,548	3,571	9.9	13.8	-1,023
2013	26,158	14-Jul-13	28,416	29,883	2,258	3,725	8.6	14.2	-1,467
2014	26,461	13-Jul-14	26,860	30,371	399	3,910	1.5	14.8	-3,511
2015	26,874	12-Jul-15	25,962	30,925	-912	4,051	-3.4	15.1	-4,963

Table A3 **Reserve Above Requirement Values Under High Demand Growth, Summer Peak, Reference Resource Scenario**

Year	Summer Peak Demand MW	Week Ending	Available Resources MW	Required Resources MW	Available Reserve MW	Required Reserve MW	Available Reserve %	Required Reserve %	Reserve Above Requirement MW
2006	24,442	16-Jul-06	28,652	28,151	4,210	3,709	17.2	15.2	501
2007	24,756	15-Jul-07	28,541	28,344	3,785	3,588	15.3	14.5	197
2008	25,116	13-Jul-08	28,457	28,917	3,341	3,801	13.3	15.1	-460
2009	25,594	12-Jul-09	28,787	29,325	3,193	3,731	12.5	14.6	-538
2010	25,844	18-Jul-10	28,292	29,423	2,448	3,579	9.5	13.9	-1,131
2011	26,213	17-Jul-11	28,356	29,830	2,143	3,617	8.2	13.8	-1,474
2012	26,583	15-Jul-12	28,388	30,272	1,805	3,689	6.8	13.9	-1,884
2013	26,968	14-Jul-13	28,416	30,827	1,448	3,859	5.4	14.3	-2,411
2014	27,342	13-Jul-14	26,860	31,385	-482	4,043	-1.8	14.8	-4,525
2015	27,829	12-Jul-15	25,962	32,036	-1,867	4,207	-6.7	15.1	-6,074

Table A4 **Reserve Above Requirement Values Under Low Demand Growth, Summer Peak, Coal Replacement Scenario**

Year	Summer Peak Demand MW	Week Ending	Available Resources MW	Required Resources MW	Available Reserve MW	Required Reserve MW	Available Reserve %	Required Reserve %	Reserve Above Requirement MW
2006	23,292	16-Jul-06	28,655	27,003	5,363	3,711	23.0%	15.9%	1,652
2007	23,607	15-Jul-07	28,541	27,155	4,934	3,548	20.9%	15.0%	1,386
2008	23,883	13-Jul-08	28,477	27,570	4,594	3,687	19.2%	15.4%	907
2009	24,213	12-Jul-09	28,741	27,800	4,528	3,587	18.7%	14.8%	941
2010	24,300	18-Jul-10	29,016	27,617	4,716	3,317	19.4%	13.7%	1,399
2011	24,516	17-Jul-11	29,080	27,848	4,564	3,332	18.6%	13.6%	1,232
2012	24,733	15-Jul-12	29,112	28,110	4,379	3,377	17.7%	13.7%	1,002
2013	24,954	14-Jul-13	29,140	28,482	4,186	3,528	16.8%	14.1%	658
2014	25,159	13-Jul-14	27,584	28,852	2,425	3,693	9.6%	14.7%	-1,268
2015	25,475	12-Jul-15	26,686	29,311	1,211	3,836	4.8%	15.1%	-2,625

Table A5 **Reserve Above Requirement Values Under Median Demand Growth, Summer Peak, Coal Replacement Scenario**

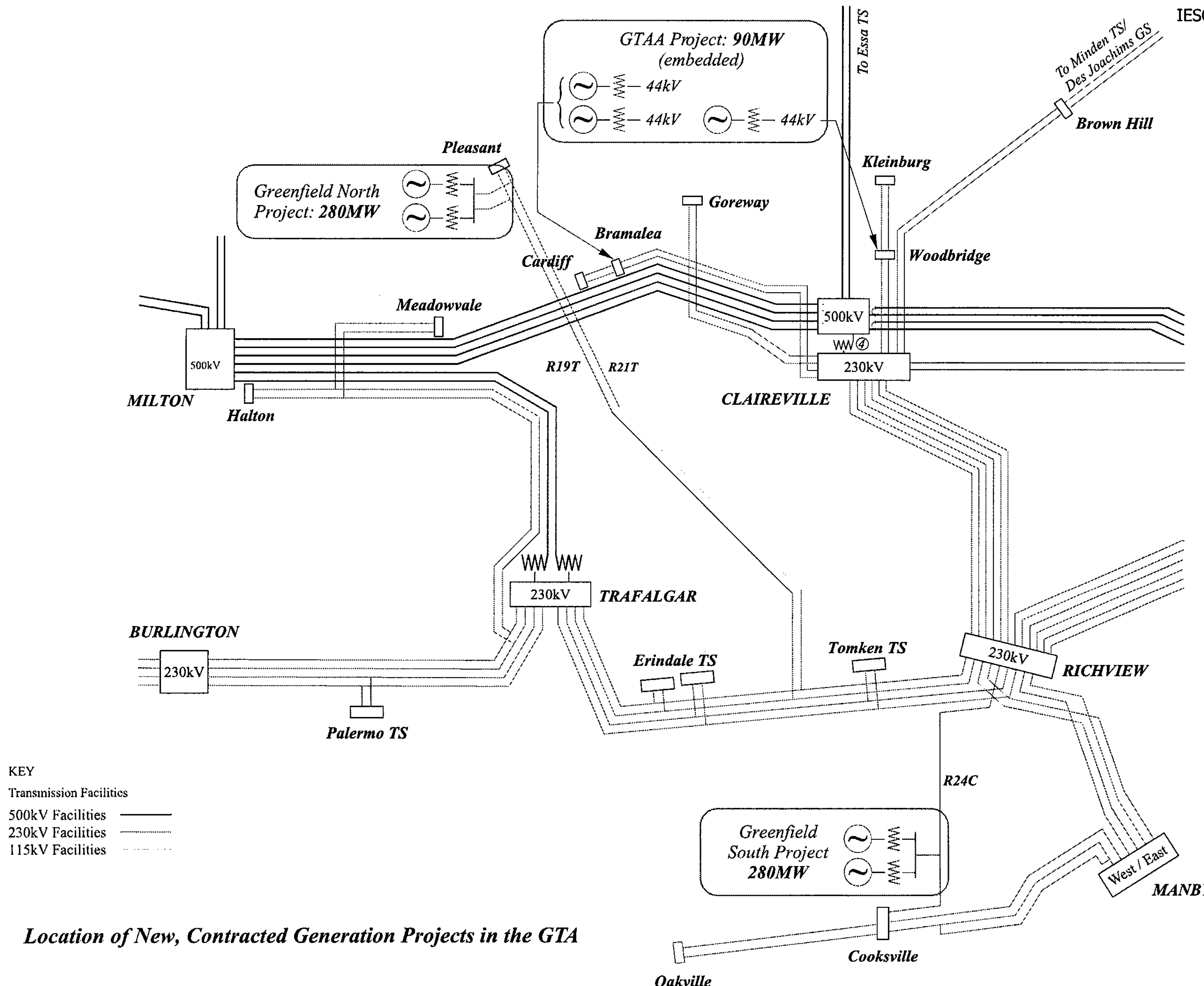
Year	Summer Peak Demand MW	Week Ending	Available Resources MW	Required Resources MW	Available Reserve MW	Required Reserve MW	Available Reserve %	Required Reserve %	Reserve Above Requirement MW
2006	24,089	9-Jul-06	28,655	28,037	4,566	3,948	19.0%	16.4%	618
2007	24,301	15-Jul-07	28,541	27,848	4,240	3,547	17.4%	14.6%	693
2008	24,627	13-Jul-08	28,477	28,344	3,850	3,717	15.6%	15.1%	133
2009	25,045	12-Jul-09	28,741	28,685	3,696	3,640	14.8%	14.5%	56
2010	25,228	18-Jul-10	29,016	28,701	3,788	3,473	15.0%	13.8%	315
2011	25,534	17-Jul-11	29,080	29,037	3,546	3,503	13.9%	13.7%	43
2012	25,840	15-Jul-12	29,112	29,411	3,272	3,571	12.7%	13.8%	-299
2013	26,158	14-Jul-13	29,140	29,883	2,982	3,725	11.4%	14.2%	-743
2014	26,461	13-Jul-14	27,584	30,371	1,123	3,910	4.2%	14.8%	-2,787
2015	26,874	12-Jul-15	26,686	30,925	-188	4,051	-0.7%	15.1%	-4,239

Table A6 **Reserve Above Requirement Values Under High Demand Growth, Summer Peak, Coal Replacement Scenario**

Year	Summer Peak Demand MW	Week Ending	Available Resources MW	Required Resources MW	Available Reserve MW	Required Reserve MW	Available Reserve %	Required Reserve %	Reserve Above Requirement MW
2006	24,442	16-Jul-06	28,655	28,151	4,213	3,709	17.2%	15.2%	504
2007	24,756	15-Jul-07	28,541	28,344	3,785	3,588	15.3%	14.5%	197
2008	25,116	13-Jul-08	28,477	28,917	3,361	3,801	13.4%	15.1%	-440
2009	25,594	12-Jul-09	28,741	29,325	3,147	3,731	12.3%	14.6%	-584
2010	25,844	18-Jul-10	29,016	29,423	3,172	3,579	12.3%	13.8%	-407
2011	26,213	17-Jul-11	29,080	29,830	2,867	3,617	10.9%	13.8%	-750
2012	26,583	15-Jul-12	29,112	30,272	2,529	3,689	9.5%	13.9%	-1,160
2013	26,968	14-Jul-13	29,140	30,827	2,172	3,859	8.1%	14.3%	-1,687
2014	27,342	13-Jul-14	27,584	31,385	242	4,043	0.9%	14.8%	-3,801
2015	27,829	12-Jul-15	26,686	32,036	-1,143	4,207	-4.1%	15.1%	-5,350

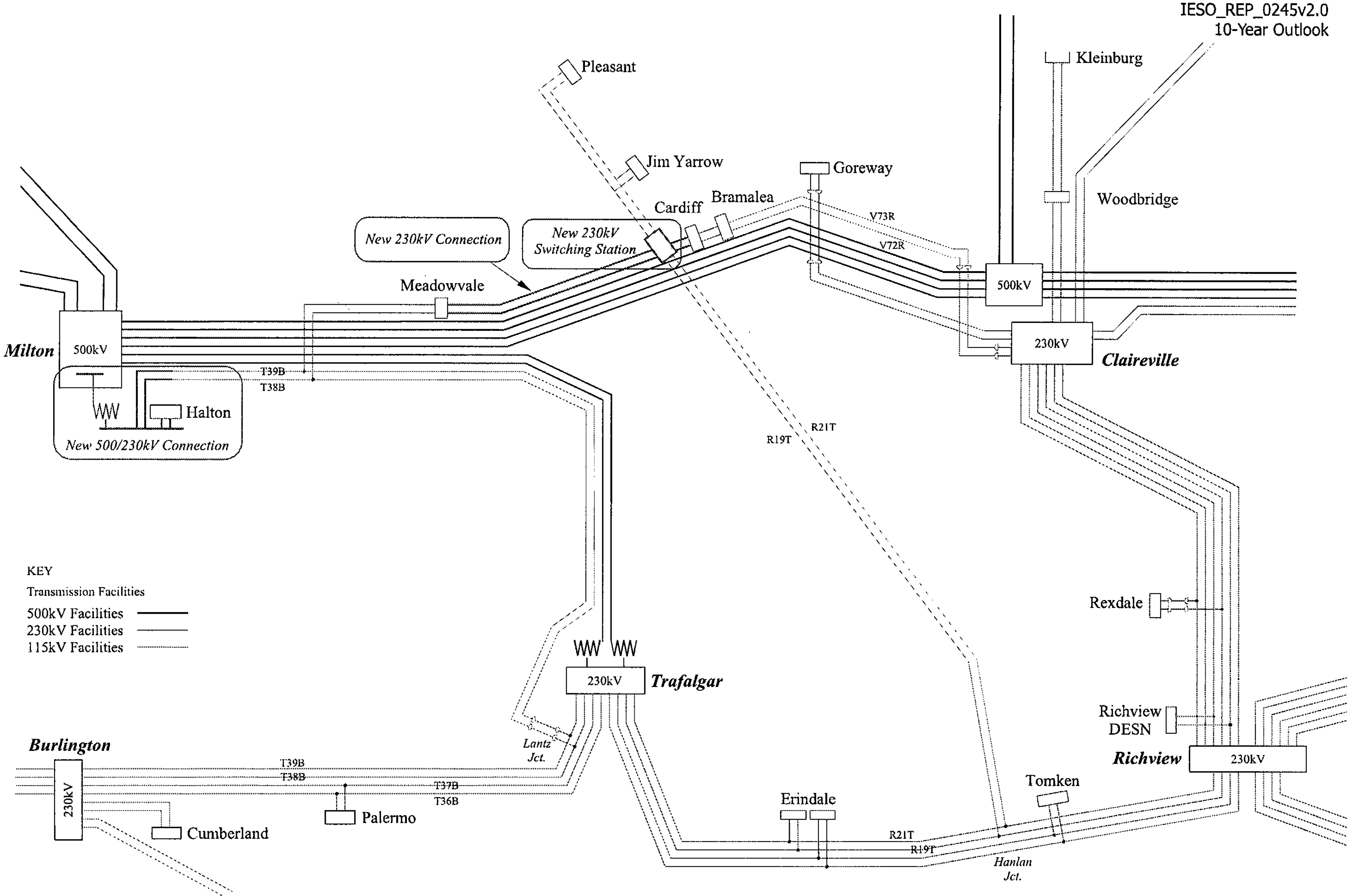
Appendix B.. Transmission Diagrams

List of Diagrams



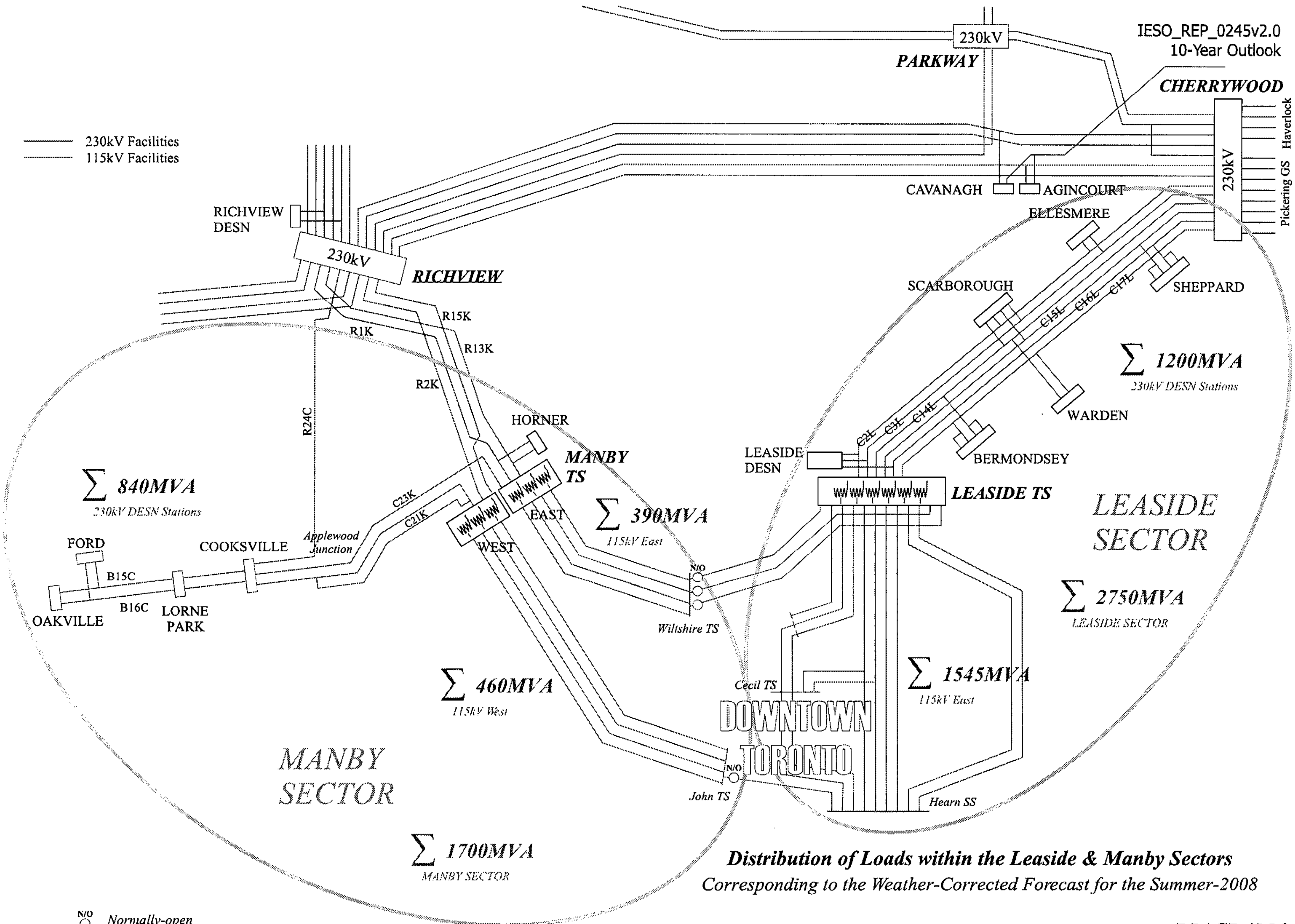
Location of New, Contracted Generation Projects in the GTA

DIAGRAM 1



System Enhancements for the Milton Area - Brampton Area

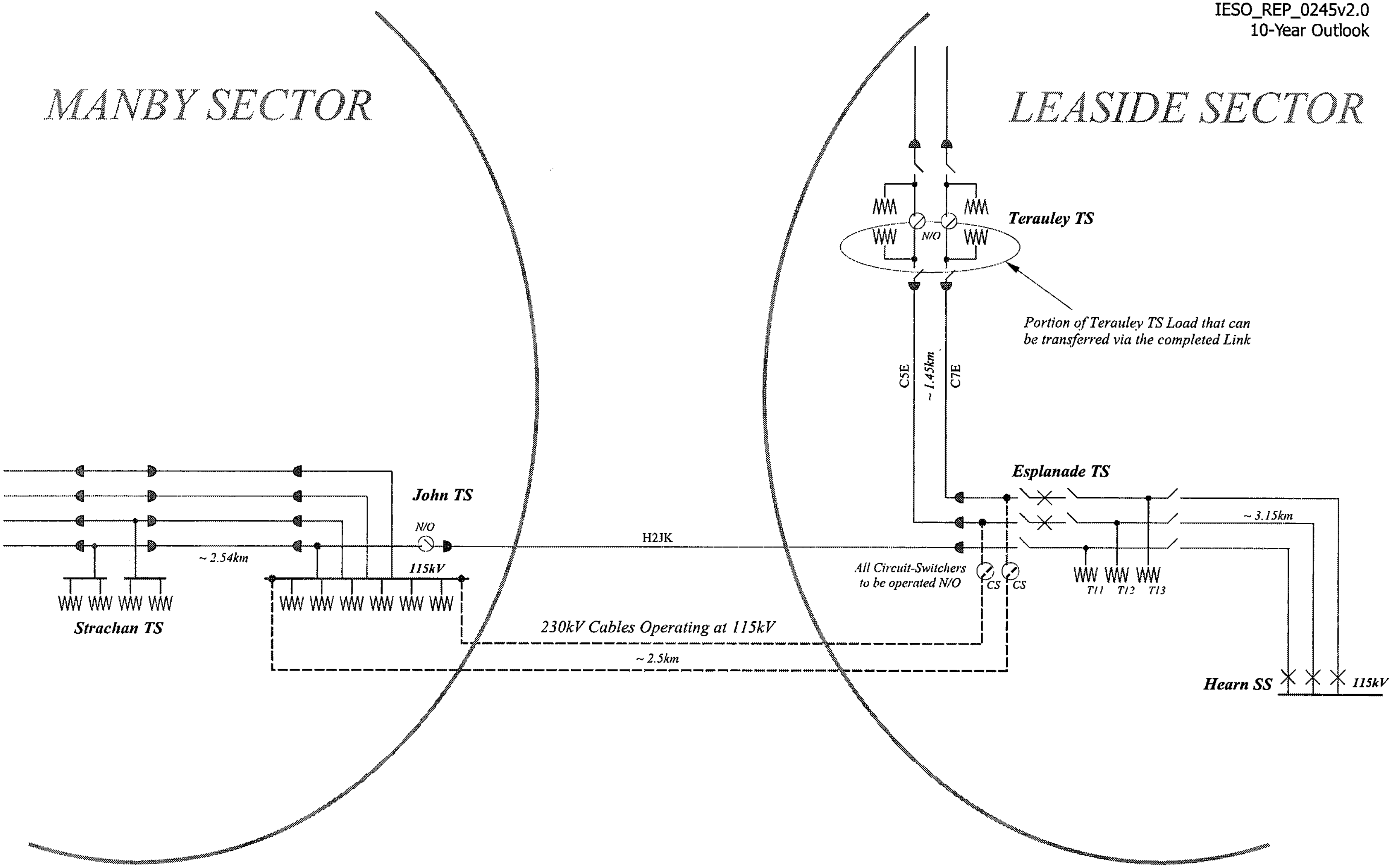
DIAGRAM 2



Distribution of Loads within the Leaside & Manby Sectors

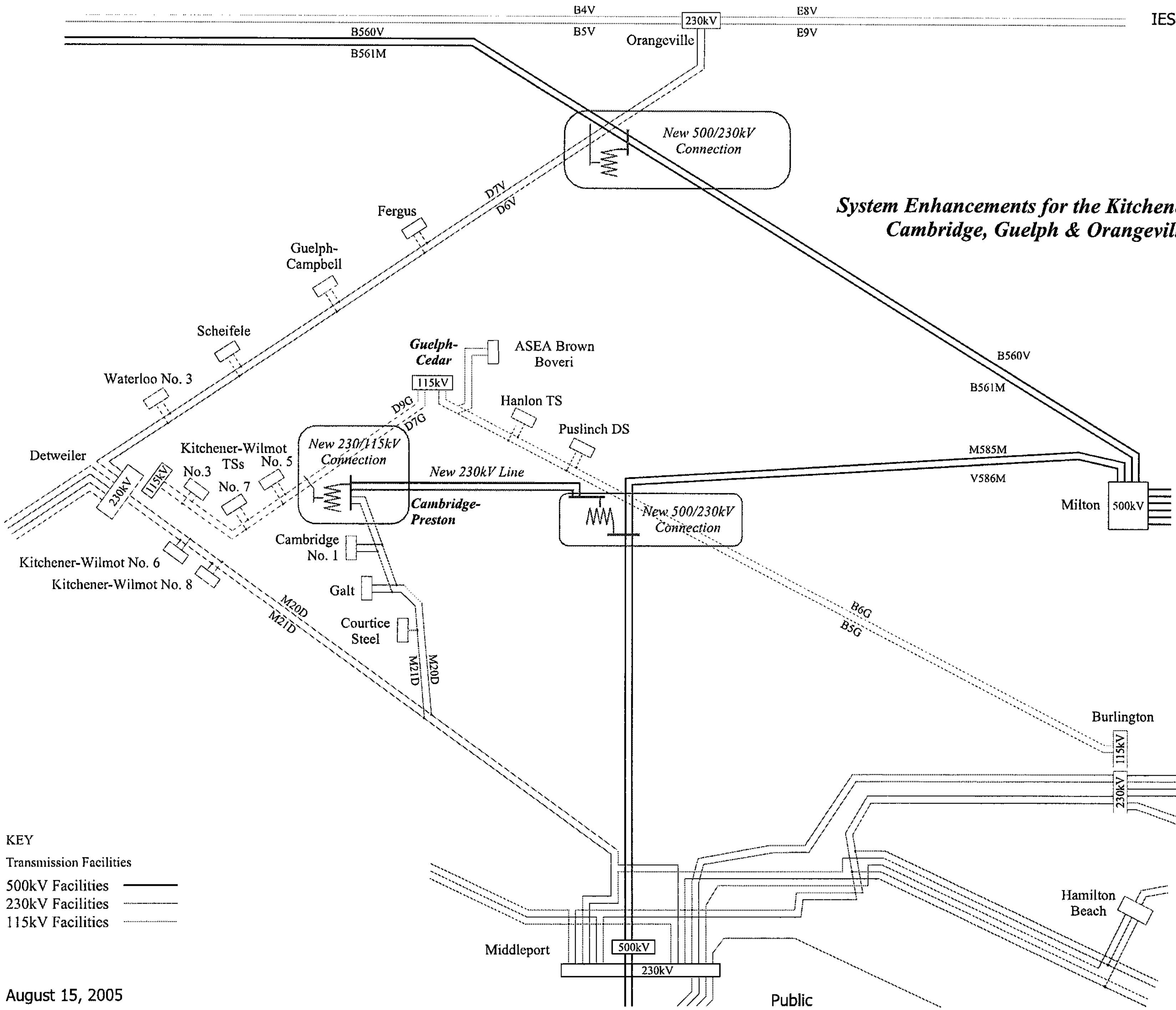
Corresponding to the Weather-Corrected Forecast for the Summer-2008

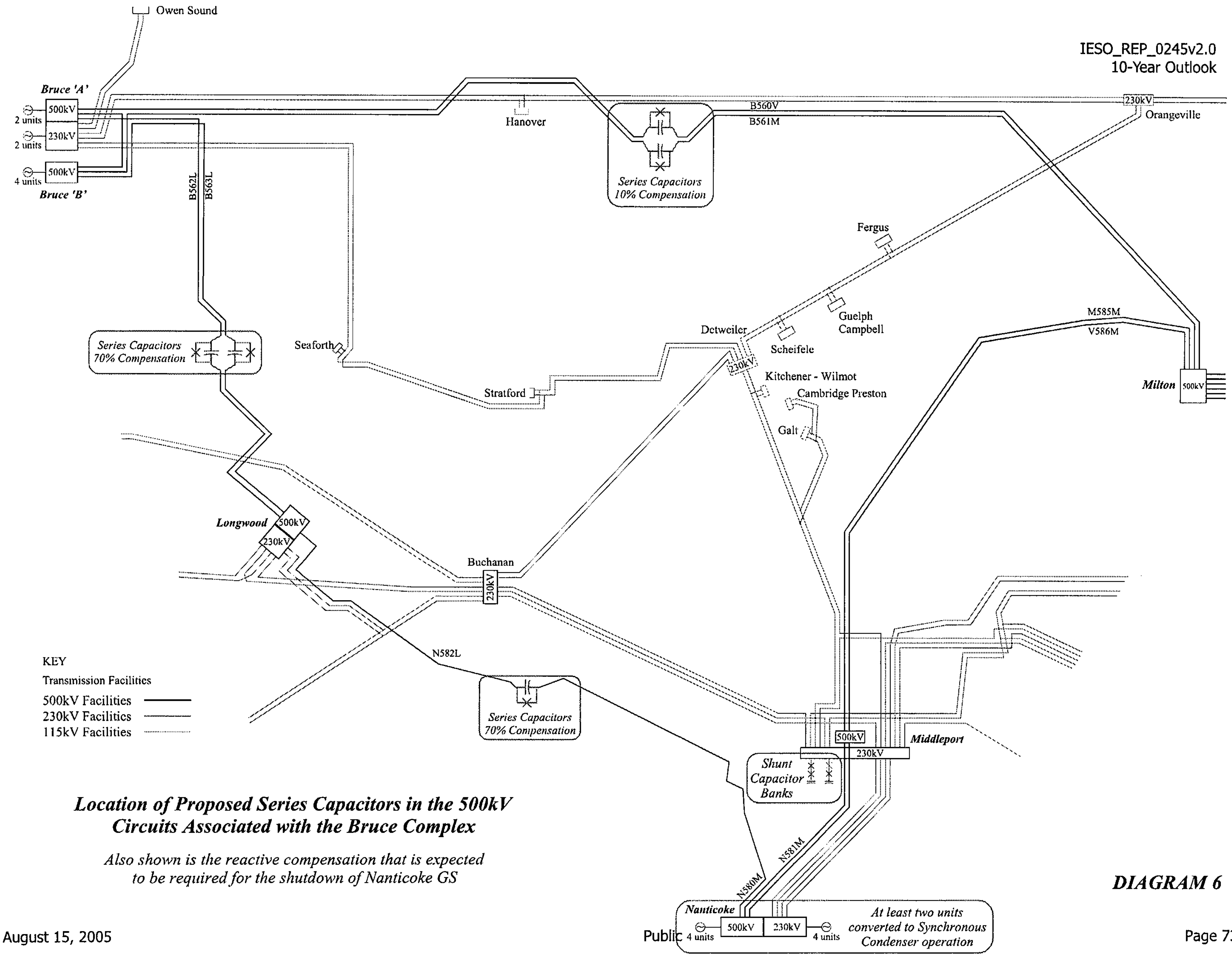
DIAGRAM 3



Initial Phase of the 3rd Supply for Downtown Toronto: The John TS-to-Esplanade TS Link

DIAGRAM 4


B4V
B5V
E8V
E9V
230kV
Orangeville
B560V
B561M
New 500/230kV Connection
D7V
D6V
System Enhancements for the Kitchener, Waterloo, Cambridge, Guelph & Orangeville Area
Fergus
Guelph-Campbell
Scheifele
Waterloo No. 3
Guelph-Cedar
115kV
ASEA Brown Boveri
Hanlon TS
Puslinch DS
D9G
D7G
B560V
B561M
M585M
V586M
Detweiler
Kitchener-Wilmot TSs
No.3
No. 5
No. 7
230kV
115kV
New 230/115kV Connection
New 230kV Line
Cambridge-Preston
New 500/230kV Connection
Milton
500kV
Cambridge No. 1
Kitchener-Wilmot No. 6
Kitchener-Wilmot No. 8
Galt
Courtice Steel
M20D
M21D
B6G
B5G
Burlington
115kV
230kV
KEY
Transmission Facilities
500kV Facilities
230kV Facilities
115kV Facilities
Hamilton Beach
Middleport
500kV
230kV
DIAGRAM 5



Location of Proposed Series Capacitors in the 500kV Circuits Associated with the Bruce Complex

Also shown is the reactive compensation that is expected to be required for the shutdown of Nanticoke GS

Proposed System Enhancements in North-eastern Ontario

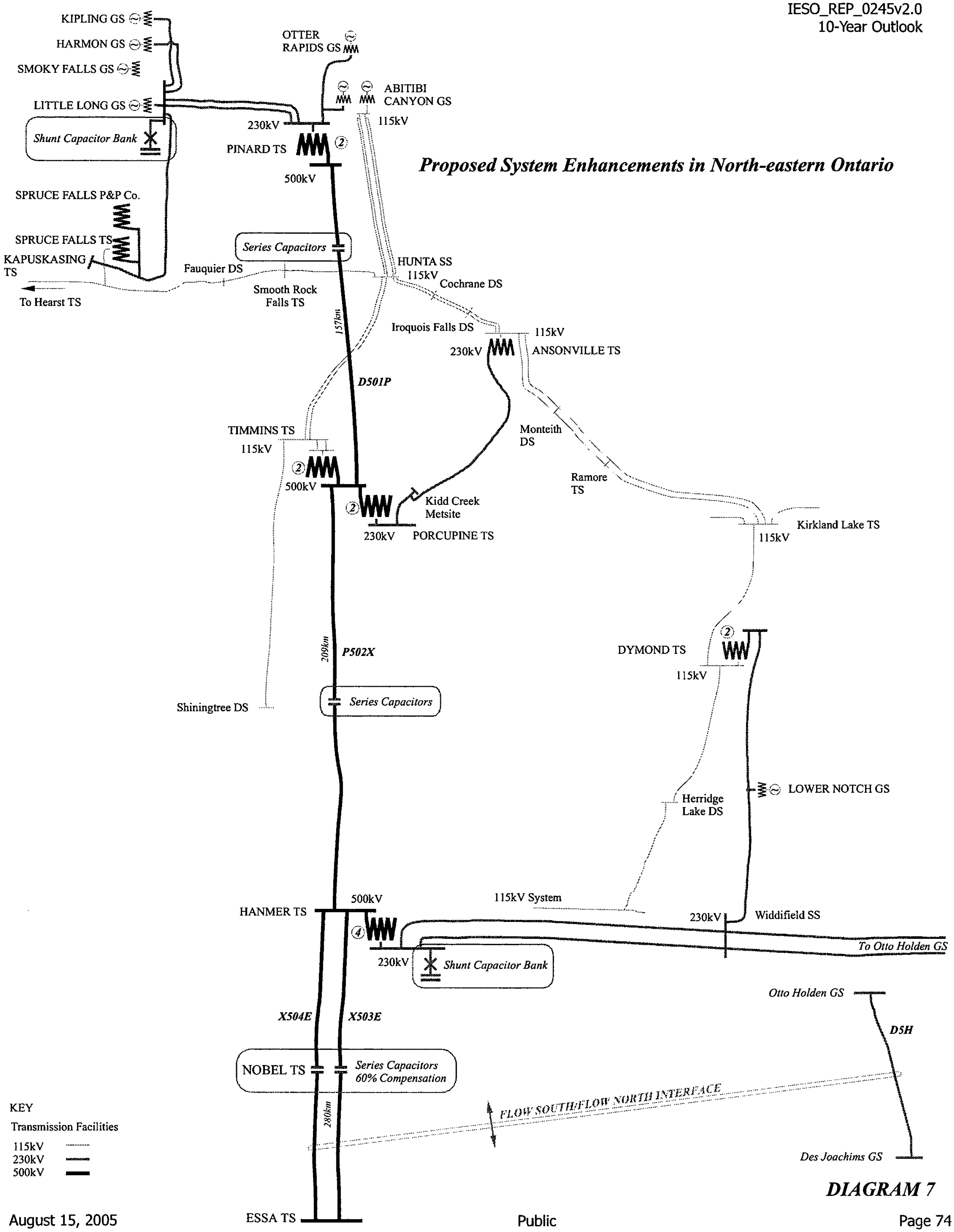
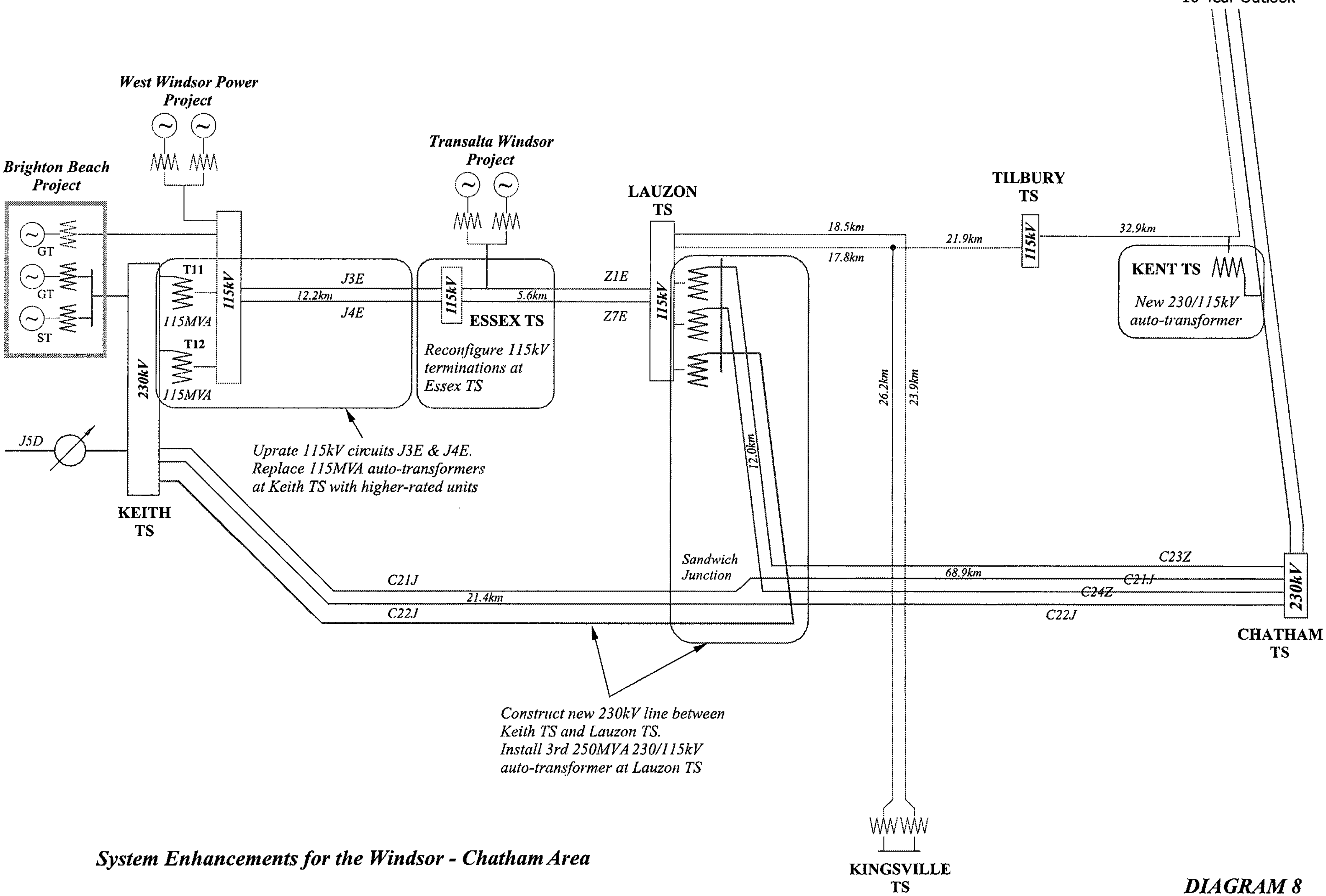


DIAGRAM 7



System Enhancements for the Windsor - Chatham Area

DIAGRAM 8

System Enhancements for the Oshawa - Belleville Area

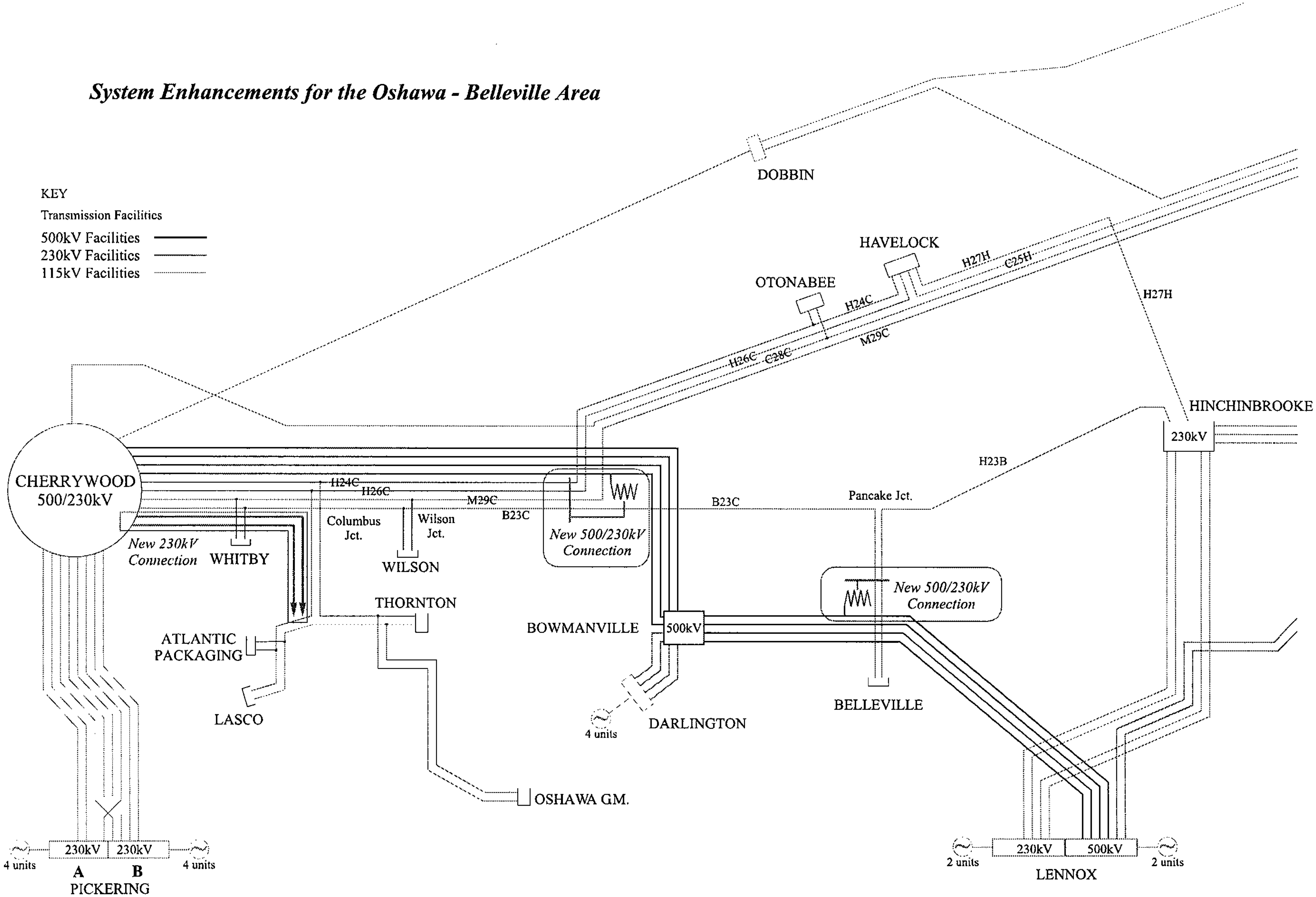


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DIAGRAM 9