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**REPORT**

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**August 3<sup>rd</sup> and 4<sup>th</sup>, 2005:  
Energy Shortfall and  
Voltage Reductions**

**Issue 1.0**

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# 1. Executive Summary

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This report describes the events leading up to and during the energy shortfalls on August 3<sup>rd</sup> and 4<sup>th</sup>, 2005.

The day-ahead forecasts indicated that energy shortfalls were expected for both August 3<sup>rd</sup> and August 4<sup>th</sup>. Toronto temperatures were projected to be 33° C with humidex in the 40° C range. The weather forecast for both days called for increasing cloud cover in the early afternoon through eastern Ontario and electrical storm activity for most of the daylight hours in northwestern Ontario. The expected IESO peak demand for August 3<sup>rd</sup> was 25,500 MW (in hour 16) with imports at 3,005 MW. On August 4<sup>th</sup>, the peak demand was forecast at 26,000 MW (in hour 16) with imports at 3,200 MW.

A prolonged dry heat wave that set six record-breaking days for electricity consumption in July contributed to a reduction in energy availability due to diminished water resources at Ontario's hydroelectric plants and an increase in thermal effluent limitations at fossil generator stations.

The capacity/reserve requirements were not a major concern as the energy-limited hydro-electric were mostly scheduled for reserve. In the overnight hours on both days, to help maximize the availability of resources, the IESO constrained on all four units at Lennox GS and all 3 Brighton Beach GS units for a total of 2824 MW of capacity.

During the Operations Managers conference calls with neighbouring control areas it was noted that since the heat wave was affecting most of the North East, PJM, MISO and NYISO were also expecting record levels of electricity consumption. However, neighbouring Reliability Coordinators were reporting adequate reserve and energy. Moreover, MISO and NYISO reported having 500 MW of emergency energy available.

The IESO issued a NERC Energy Emergency Alert (EEA) level 2 on both Aug 3<sup>rd</sup> and 4<sup>th</sup> and initiated NERC TLR (Transmission Loading Relief) procedures to relieve congestion on the QFW (Queenston Flow-West) flowgate.

To prevent limit violations and to avoid load shedding later in the afternoon, the IESO also implemented 5% voltage reductions for 8.5 hours on August 3<sup>rd</sup> and for 4 hours on August 4<sup>th</sup>, which resulted in a reduction in primary demand of approximately 500 MW.

## 2. System Operation

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### 2.1 August 3, 2005

The weather leading into August 3<sup>rd</sup> had been hot, humid and with very little precipitation. On August 3<sup>rd</sup> temperatures were expected to reach 33° C with a humidex value in the 40° C range. The IESO forecasted energy shortfalls over several hours and across the peak hour (hour 16) when demand was expected at 25,500 MW with imports at 3,005 MW. The total unavailable capacity during the peak hour was 4,327 MW. There were 4 generating units greater than 500 MW out of service.

On August 3<sup>rd</sup>, the IESO elevated its previous appeal (issued on August 2<sup>nd</sup>) to reduce electricity use to a Power Warning, asking consumers to immediately reduce their use of electricity in order to alleviate the increased strain on Ontario's electricity system.

With depleted hydro-electric storages and continuing TEEP (Thermal Effluent Environmental Program) limitations at Lambton GS, the shortage of energy was of utmost concern. Capacity/reserve requirements were sufficient, as the energy-limited hydro-electric were mostly scheduled for reserve. Resources such as Lennox GS and Brighton Beach GS, which were normally shut down overnight, were constrained on to help maximize the resource availability.

In anticipation of a tight energy day, the IESO issued a NERC EEA level 1 at 5:57. PJM issued their EEA level 1 at 4:49 followed by the NYISO at 6:07. As the morning load pick-up progressed, the IESO constrained up Lennox GS units to prevent energy-limited hydro-electric resources from loading and depleting their forebays.

The phase-shifting transformers at St. Lawrence TS on the Adirondack (NYISO – IESO) interface and the Michigan – Ontario interface at Keith TS were being operated to control post-contingency overloads at both locations. Unfortunately, these control actions increased the flow through the QFW flowgate, which was already heavily loaded due to significant Lake Erie circulation flows.

At 7:31, the IESO initiated a NERC TLR level 1 on the QFW flowgate and alerted NYISO and MISO that the IESO intended to use local procedures to control the flow rather than implement TLR level 3. The intent of invoking local control actions rather than implementing a TLR level 3 was due to the experience on August 2<sup>nd</sup>, 2005 when a TLR level 3 initiated by the IESO for QFW caused 800 MW of IESO hourly imports to be curtailed by NYISO to preserve their day-ahead transactions.

As forecasted, at 8:12 the northwest portion of the province experienced electrical storm activity which resulted in the automatic operation of the 115 kV circuit K3D (Kenora x Dryden) and the 230 kV circuit K24F (Kenora x Fort Frances). The electrical storms in the northwest exacerbated the tight energy situation as the IESO operated to more restrictive storm limits which resulted in further bottling of energy and capacity. In addition, 230 kV circuit X1P (Chenault x Dobbins) was removed from service due to protection failures, this resulted in an additional 80 MW of bottled energy and capacity.

At 10:22, the Chatham SC22 (192 MX) capacitor was manually forced from service due to a multipoint alarm. This resulted in having only SC23 (192 MX) capacitor in service at Chatham due to an ongoing outage to SC21 (192 MX). Although not of immediate concern, the contingent loss of SC23 would have resulted in severe voltage decline in the Windsor-Chatham transmission system, which could most likely be resolved only by curtailing imports from the Michigan interface. For this reason, the IESO requested immediate investigation of the SC22, which returned to service at 13:15.

The energy situation began to deteriorate from the expected schedule at 10:25 when the transaction checkout with NYISO determined that 676 MW of IESO imports would be curtailed at 11:00 due to NYISO economics. As well, just prior to 11:00, TVA issued a TLR level 3 that would have curtailed 600 MW of IESO imports from Michigan. The IESO contacted TVA and explained the energy concerns and that IESO was about to issue EEA level 2. TVA then exempted the IESO curtailments.

At 10:30, the IESO implemented the following actions to prevent energy limited hydro-electric resources from being exhausted:

- constrained off 300 MW of Dispatchable Load,
- constrained off all exports,
- constrained on the remainder of all non-energy limited resources (approximately 100 MW)
- constrained on 630 MW of imports from Quebec to begin at 11:00.

Although the hydro-electric resources were in the pre-dispatch schedule, it was felt that, with the deteriorating energy situation on the interconnections, it would be prudent to conserve the energy until closer to peak hour.

At 10:56 the IESO issued an EEA2 and declared an Emergency Operating State. It became apparent that further emergency actions were most likely needed. The transmission system was highly stressed, the QFW flowgate was above 90% capability and the Adirondack interface at St. Lawrence TS was above 95% capability. Lake Erie parallel path flow was varying between 800 MW and 1000 MW east to west. As the morning progressed with increasing ambient temperatures and light wind speeds, the transmission ampacity ratings were reducing each hour. To maximize transmission transfer capability, a transmitter in Ontario implemented sag monitoring of the QFW flowgate circuits.

For hour ending 13, imports from NYISO were reduced by 200 MW due to NY economics. To preserve the energy limited hydro-electric resources, the IESO requested and received 200 MW of emergency energy from NY beginning at 12:00. In addition, the IESO requested that Market Participants seek approval for environmental variances. The IESO contacted the MOE (Ministry of the Environment) and MNR (Ministry of Natural Resources) to alert them that variances would be requested by Market Participants. At this time the QFW flowgate and the Adirondack interface at St. Lawrence were loaded in excess of 100% predictive post-contingency loading. Immediate action was necessary to secure the transmission system and respect Normal Condition limits.

At 12:00, after coordinating with MISO, the IESO requested a transmitter in Ontario to implement phase-shifter adjustments on the Michigan – Ontario interface at Lambton. The objective was to increase the flow into Ontario from Michigan thereby relieving the QFW and Adirondack interfaces. The L33P and L34P (Adirondack) phase-shifters had already been reduced to minimum tap position therefore further reductions of flow into Ontario at St. Lawrence were not possible.

At 12:21, it was recognized that the implementation of phase-shifter adjustments on the Michigan – Ontario interface at Lambton was proceeding much slower than expected and as a result of the continuing transmission violations the IESO implemented 5% voltage reductions in all areas except the Northwest, where the resources were bottled due to transmission constraints. This control action reduced the demand by 500 MW from 24,800 MW to 24,300 MW. The 500 MW of relief was quickly used to reduce generation at the Sir Adam Beck hydro-electric complex (located on the New York – Ontario interface at Niagara) solving the QFW flowgate constraint and preventing a NERC SOL violation. However, reducing generation at Beck resulted in increased power flows from NY into Ontario, thus increasing the congestion on the Adirondack interface.

At 12:28, the IESO issued an EEA3.

At 12:36, the IESO declared Emergency Condition Limits for the Adirondack interface at St. Lawrence. This action allowed IESO to operate to respect single contingencies and avoid shedding load to respect the more restrictive NPCC Normal Condition Limits that respect double contingencies.

At 12:51, as efforts continued on adjusting the Michigan - Ontario phase-shifters, the Lambton PS51 suffered a differential operation thereby tripping circuit L51D (Lambton x St. Clair). The post-contingency loading on the remaining Michigan – Ontario circuits L4D (Lambton x St. Clair) and J5D were within continuous limits but the post-contingency loading of PS4 was well in excess of LTR (Limited Time Rating) for the Lambton P1P2 breaker failure contingency which removed Lambton G2 and G4 (500 MW each). The local Ontario transmitter indicated that PS51 would have to be inspected prior to its return and that it would take more than 30 minutes for staff that had been dispatched to arrive and assess. In these circumstances, the IESO initiated operation to Emergency Condition Limits to prevent shedding load to avoid a NERC SOL violation.

At 12:53, the IESO requested Market Participants to implement Environmental Variances. The resultant improvement was most notable on the Mattagami River system in Northeast Ontario, where previously the river was limited to 3 unit-hours/day at each GS, but was now available for 60 hours of double unit operation at each generating station. This resulted in an additional 24,336 MWh of energy available. Lambton GS, which previously was scheduled to reduce by approximately 850 MW at 18:00 due to thermal effluent concerns, was now available for continued 4-unit full-load operation. The remainder of the environmental variances brought only minor improvements.

The Ontario demand continued to increase as the afternoon progressed and reached a maximum of 25,000 MW in hour 16. During the afternoon, the IESO continued to purchase emergency energy from NY for a daily total of 2,259 MWh.

As the evening load declined the emergency actions were reduced as follows:

- Environmental variances ended at 18:15;
- Operation to Emergency Condition Limits for Southern Ontario ended at 17:45;
- Operation to Emergency Condition Limits for Eastern Ontario ended at 18:20;
- EEA3 ended at 18:20;
- the 5% voltage reduction ended at 20:49 (demand increased 250 MW as a result);
- EEA2 ended at 21:45;
- EEA1 ended at 23:08;

### **2.1.1 Voltage Reduction Issues**

The following is a list of issues encountered during the 5% Voltage Reduction:

- At 15:10, the Gardiner T2 transformer was placed on manual tap control and taps adjusted to increase voltage. A hospital had approximately 20% of load trip off when the 5% VR was implemented. At 19:36, the Gardiner transformer station was exempt from 5% voltage reductions due to natural gas pump problems that supply Lennox GS (gas fired generating station).
- At 15:19, a distributor requested to implement a 3% voltage reduction from a 5% reduction at Kitchener MS #6 station. This was due to the a hospital having trouble maintaining the operating room at proper temperature for heart surgery. At 15:20, a 3% voltage reduction was implemented for public safety.
- At 16:11, an Ontario transmitter received a complaint from a distributor that the diesel generator supplying load to a hospital connected to the M2 feeder at Murray transformer station tripped due to low voltage. IESO approved tap changer adjustments to control the supply voltage.
- At 19:00, the Carlton transformer station was exempted from the 5% voltage reduction due to voltage concerns at a hospital.
- 19:40 - Napanee "B" bus was exempted from 5% voltage reductions due to natural gas pump problems that supply Lennox GS.

- A distributor did not initially implement the 5% voltage reduction as they were not contacted. The participant was made aware of the Emergency Operating State and requested to implement the voltage reduction. The participant agreed and implemented the reduction.

## 2.2 Operation August 4, 2005

The IESO again forecasted energy shortfalls over several hours across the peak hour 16. The heat wave continued from the past few days and the temperatures in the Toronto area were expected to reach 33° C with humidex values over 40° C. The IESO peak demand was expected in hour 16 at 26,000 MW with imports at 3,200 MW. The total unavailable capacity during the peak hour was 4,907 MW. There were 4 generating units greater than 500 MW out of service.

On August 4<sup>th</sup>, the IESO extended its Power Warning issued on August 3<sup>rd</sup>, continuing to ask consumers to immediately reduce their use of electricity in order to alleviate the increased strain on Ontario's electricity system.

Similar to August 3<sup>rd</sup>, the energy concerns were centered on continuing TEEP (Thermal Effluent Environmental Program) limitations at Lambton GS and low water inflows throughout northeastern and eastern Ontario hydro electric facilities. The capacity/reserve requirements were not a major concern as the energy-limited hydro electric facilities were mostly scheduled for reserve. Resources such as Lennox GS and Brighton Beach GS, which were normally shut down overnight, were again constrained on to help maximize the resource availability.

Although neighboring ISOs such as PJM, MISO and NYISO reported that they expected to set all time record peak demands, they indicated having adequate capacity and energy reserves. Furthermore, MISO and NYISO reported that they had 500 MW of emergency energy available.

At 6:25, the IESO issued an EEA 1. Control actions (e.g. constraining up Lennox GS units) were implemented to prevent energy-limited hydro-electric resources from loading and further depleting the already extremely low water reserves in the forebays. The phase-shifting transformers on both the Adirondack interface at St. Lawrence and at Keith TS on the Michigan – Ontario interface were being adjusted to control post-contingency overloads at both locations. Unfortunately, as experienced on August 3<sup>rd</sup>, these control actions were at the same time increasing the QFW flowgate flows.

At 8:35 the IESO initiated a TLR level 1 on QFW and alerted NYISO and MISO that the IESO intended to use local procedures to control the flow rather than implement TLR level 3. The reason for invoking local control actions rather than implementing a TLR level 3 was due to the experience on August 2<sup>nd</sup>, 2005 when a TLR level 3 initiated by the IESO for QFW caused 800 MW of IESO hourly imports to be curtailed by NYISO to preserve their day-ahead transactions. Further control actions were taken to protect energy limited resources. Imports from Quebec and the Michigan interfaces were constrained on and these control actions were maintained from hour 9 through hour 23.

At 9:03, the EEA was raised to level 2.

At 9:08, the IESO operated the transmission system in the St. Lawrence area to Emergency Condition limits to prevent having to reduce Quebec imports at Beauharnois and New York imports. Maximizing the import intake allowed the IESO to preserve water resources and avoid shedding load later during the day.

At 9:10, the Ministry of the Environment and the Ministry of Natural Resources were notified of the potential for Market Participants to request environmental variances.

Further straining the energy situation, Nanticoke G2 was forced out-of-service due to high hydrogen dew point levels. Generation loss was 380 MW. With continued concern over energy requirements over the afternoon peak and the depletion of energy limited resources, all dispatchable loads were constrained off at 10:25.

At 12:08, the IESO implemented a 5% voltage reduction in all areas except the Northwest, as the resources in this area were bottled due to transmission constraints. As a result, demand was reduced by 500 MW, from approximately 25,200 to 24,700. A discussion was held with Reliability Coordinators that had issued TLR 3 on the interconnection that would affect imports into Ontario. TVA, MISO, and PJM were notified and all agreed that TLR curtailments for IESO imports could be denied based on the risk of cutting firm load.

As the afternoon progressed, cloud cover began to build across Southern Ontario which slowed the increase in demand. Environmental variances were subsequently not required.

At 16:21, the 5% voltage reduction was cancelled. As a result, the demand increased approximately 400 MW.

At 18:10, operation to Emergency Condition limits was cancelled for the St. Lawrence area as the demand continued to drop out.

At 19:30, all dispatchable loads were allowed to reload.

At 21:25, the EEA2 was reduced to EEA1 and that level was terminated at 22:39. All constraining on of imports for resource adequacy was ended at 23:00.

## **2.2.1 Voltage Reduction Issues**

- At 07:42, Gardiner T2 was exempted from 5% VR reductions. This is to prevent a reoccurrence of August 3<sup>rd</sup> when a hospital tripped off 20% of their load due to the 5% reduction.
- At 07:42, Murray T.S was exempted from 5% VR reductions. The station has a hospital tapped off with a diesel generator carrying load that tripped off on August 3<sup>rd</sup> due to low voltage.

- At 08:48, Napanee T1 was exempted from 5% VR due to problems to the equipment of a natural gas distributor on August 3<sup>rd</sup> with reduced voltage. Gas is being supplied to Lennox GS.
- At 11:13, Hanover transformer station was exempted from the reduction as a result of customer concerns.
- At 11:23, a 40 MW feeder at Kitchener MTS#6 was exempted from 5% VR due to impact on a hospital's equipment.
- At 13:54, an Ontario transmitter requested that Smith Falls transformer station be exempted from the reduction as two hospitals are supplied from this station.

## 3. Conclusions

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The incidents on August 3<sup>rd</sup> and 4<sup>th</sup> developed during a prolonged heat wave that was responsible for six record-breaking days for electricity consumption in July. The IESO implemented 5% voltage reduction measures and operated to emergency condition limits to avoid load shedding and mitigate three main reliability concerns:

- Reduced energy availability, mainly due to diminished water reserves and thermal effluent limitations;
- Increased congestion on the QFW flowgate, caused by high inertia and parallel flows; and
- Unplanned extensions to generation outages.

The analysis of the two events revealed the following conclusions:

- While very helpful in most cases, the NYISO-IESO inertia scheduling protocol does not overcome all issues inherent in coordinating two back to back markets. This resulted in failed transactions in real-time that together with loop flow played a major role and precipitated the events on August 3<sup>rd</sup> and August 4<sup>th</sup>;
- Flow control measures on the NY Adirondack and Michigan interfaces contributed to overloading the QFW flowgate. To reduce the risk of having hourly scheduled imports curtailed by NYISO under a TLR-Level 3 process, the IESO chose to initiate a TLR-Level 1 and implement local congestion management procedures;
- Phase shifter operation on the Michigan interface proved problematic in real-time on August 3<sup>rd</sup>, as the adjustments requested were not sufficient to prevent the IESO from reducing voltage by 5%;
- 5% voltage reduction measures reduced demand by approximately 500 MW for several hours. However, the amount of MW recovered at the end of the voltage reduction activation period was noticeably lower than the MW recovered during regular voltage reduction tests and during the voltage reduction activation on April 7<sup>th</sup> (approx. 1 hr in both cases). This is consistent with an earlier observation that the load drop obtained from reducing voltage seems to decrease during longer activation periods;
- There were issues reported around the voltage reduction activation, especially involving hospitals and fuel supply facilities that requested to be exempt from the obligation to reduce their consumption. These exemptions may have contributed to the decrease in load drop previously mentioned;

- Implementing environmental variances helped by providing greater assurance that additional energy was available to prevent load shedding;
- Similar to the events on April 7<sup>th</sup> 2005, the emergency control actions carried out on August 3<sup>rd</sup> and 4<sup>th</sup>, resulted in a reduction in market demand that led to a reduction in market clearing prices. The report on April 7<sup>th</sup> events recommended software changes that would preserve market demand during emergency control actions. These changes were implemented on August 11<sup>th</sup>. Had these software changes been in place before August 3<sup>rd</sup>, the energy market prices would have increased by an average of about \$300, thus providing more appropriate market signals, reflective of the shortfall conditions.

## 4. Corrective Actions

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- The IESO will continue to investigate means of reducing the number of failed imports in real-time. An immediate concern should be the scheduling protocol with NYISO. In longer run, the IESO should continue to pursue improved mechanisms that help diminish the risk that transactions are cut in real time;
- The IESO will be working to finalize the transmitter agreements that would allow the full use of the phase shifters at the Michigan interface to control loop flow;
- The IESO will ensure that the owners of voltage reduction facilities maintain an up-to-date list of exempted feeders or stations to avoid managing exemptions from voltage reduction obligations in real-time;
- The IESO will advise the owners of voltage reduction facilities of the importance of educating their customers on the impact of voltage reductions and available ride through equipment;
- The IESO will investigate the performance of voltage reduction facilities during prolonged activations and assess the impact of such performance on the IESO procedures and tools and implement corrective actions, as necessary