REPORT

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System Impact Assessment Report

CONNECTION ASSESSMENT & APPROVAL PROCESS

Final Report

CAA ID: **2012-472**
Project: **East Durham Wind Energy Centre**

Applicant: **Hydro One Networks Inc.**
Proponent: **East Durham Wind, Inc.**

Market Facilitation Department
Independent Electricity System Operator

Date: December 20, 2012

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System Impact Assessment Report

Acknowledgement

The IESO wishes to acknowledge the assistance of Hydro One in completing this assessment.

Disclaimers

IESO

This report has been prepared solely for the purpose of assessing whether the connection applicant's proposed connection with the IESO-controlled grid would have an adverse impact on the reliability of the integrated power system and whether the IESO should issue a notice of approval or disapproval of the proposed connection under Chapter 4, section 6 of the Market Rules.

Conditional approval of the proposed connection is based on information provided to the IESO by the connection applicant and the transmitter(s) at the time the assessment was carried out. The IESO assumes no responsibility for the accuracy or completeness of such information, including the results of studies carried out by the transmitter(s) at the request of the IESO. Furthermore, the connection approval is subject to further consideration due to changes to this information, or to additional information that may become available after the conditional approval has been granted.

If the connection applicant has engaged a consultant to perform connection assessment studies, the connection applicant acknowledges that the IESO will be relying on such studies in conducting its assessment and that the IESO assumes no responsibility for the accuracy or completeness of such studies including, without limitation, any changes to IESO base case models made by the consultant. The IESO reserves the right to repeat any or all connection studies performed by the consultant if necessary to meet IESO requirements.

Conditional approval of the proposed connection means that there are no significant reliability issues or concerns that would prevent connection of the proposed facility to the IESO-controlled grid. However, conditional approval does not ensure that a project will meet all connection requirements. In addition, further issues or concerns may be identified by the transmitter(s) during the detailed design phase that may require changes to equipment characteristics and/or configuration to ensure compliance with physical or equipment limitations, or with the Transmission System Code, before connection can be made.

This report has not been prepared for any other purpose and should not be used or relied upon by any person for another purpose. This report has been prepared solely for use by the connection applicant and the IESO in accordance with Chapter 4, section 6 of the Market Rules. The IESO assumes no responsibility to any third party for any use, which it makes of this report. Any liability which the IESO may have to the connection applicant in respect of this report is governed by Chapter 1, section 13 of the Market Rules. In the event that the IESO provides a draft of this report to the connection applicant, you must be aware that the IESO may revise drafts of this report at any time in its sole discretion without notice to you. Although the IESO will use its best efforts to advise you of any such changes, it is the responsibility of the connection applicant to ensure that it is using the most recent version of this report.

Hydro One

The results reported in this study are based on the information available to Hydro One, at the time of the study, suitable for a System Impact Assessment of a new generation or load connection proposal.

The short circuit and thermal loading levels have been computed based on the information available at the time of the study. These levels may be higher or lower if the connection information changes as a result of, but not limited to, subsequent design modifications or when more accurate test measurement data is available.

This study does not assess the short circuit or thermal loading impact of the proposed connection on facilities owned by other load and generation (including OPG) customers.

In this study, short circuit adequacy is assessed only for Hydro One breakers and does not include other Hydro One facilities. The short circuit results are only for the purpose of assessing the capabilities of existing Hydro One breakers and identifying upgrades required to incorporate the proposed connection. These results should not be used in the design and engineering of new facilities for the proposed connection. The necessary data will be provided by Hydro One and discussed with the connection proponent upon request.

The ampacity ratings of Hydro One facilities are established based on assumptions used in Hydro One for power system planning studies. The actual ampacity ratings during operations may be determined in real-time and are based on actual system conditions, including ambient temperature, wind speed and facility loading, and may be higher or lower than those stated in this study.

The additional facilities or upgrades which are required to incorporate the proposed connection have been identified to the extent permitted by a System Impact Assessment under the current IESO Connection Assessment and Approval process. Additional facility studies may be necessary to confirm constructability and the time required for construction. Further studies at more advanced stages of the project development may identify additional facilities that need to be provided or that require upgrading.

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Executive Summary

Notification of Conditional Approval

East Durham Wind, Inc., (the "proponent") is developing a new 22.68 MW wind power facility, East Durham Wind Energy Centre (the "project"), in Grey County, Priceville , Ontario, under a Feed-In-Tariff (FIT) contract with the OPA. The generating facility will be embedded into Hydro One's distribution system. Hydro One Networks Inc. (the "connection applicant") performed the Connection Impact Assessment (CxIA) for this project and submitted the SIA application on behalf of the proponent.

The assessment concludes that the proposed connection of East Durham Wind Energy Centre, operating up to 22.68 MW, subject to the requirements specified in this report, is expected to have no material adverse impact on the reliability of the IESO-controlled grid. Thus, it is recommended that a *Notification of Conditional Approval for Connection* be issued for the East Durham Wind Energy Centre project subject to the implementation of the requirements outlined in this report.

IESO Requirements for Connection

Transmitter Requirements

No requirement is applicable for the transmitter for the incorporation of the project.

Connection Applicant Requirements

The connection applicant shall ensure that the proposed connection complies with all the applicable requirements from the Transmission System Code (TSC), IESO Market Rules, standards and criteria, and specific requirements identified in this SIA. The most relevant requirements are summarized below and presented in more detail in Section 2 of this report.

1. The connection applicant must ensure that the requirements from the Distribution System Code are being followed. Specifically, the connection applicant shall ensure that the connection of the generation facility will not cause any material increase in the reactive power requirements at the transmission transformer station, under any distribution feeder load conditions.
2. The generation facility should be able to operate continuously between 59.4Hz and 60.6Hz and for a limited period of time in the region above straight lines on a log-linear scale defined by the points (0.0s, 57.0Hz), (3.3s, 57.0Hz), and (300s, 59.0Hz). If the new EG units trip prematurely on under-frequency, the connection applicant must revise the amount of load connected to under-frequency relays to account for the early tripping of the EG units.
3. The connection applicant shall revise the automatic load shedding scheme behind the substation to account for the generation facility tripping by configuration, if the feeder where the generation facility connects to is connected to the Under Frequency Load Shedding (UFLS) relays. In this case, the connection applicant in conjunction with the relevant transmitter have to either increase the demand connected to UFLS relays to compensate for the loss by configuration of generation from the generation facility, or to substitute the feeder with a different feeder with at least the same amount of load for the participation in the UFLS program.

4. The connection applicant shall ensure that the generation facility will respond to frequency increase by reducing the active power with an average droop based on maximum active power adjustable between 3% and 7% and set at 4%. Regulation dead band shall not be wider than ± 0.06%.

   The connection applicant shall ensure that the generation facility will respond to system frequency decline by temporarily boosting its active power output for some time (i.e. 10 s) by recovering energy from the rotating blades.

5. If the generation facility has automatic reconnection capability, the connection applicant shall ensure that the generation facility has the capability to disable the automatic reconnection to allow for orderly power system restoration by preventing unwanted generation during a system restoration process. The connection applicant shall ensure that the automatic reconnection is disabled when the system frequency is above 60.5 Hz. The frequency supervisory relay shall allow for settings to be changed, and changes shall be made only at the IESO request.

6. The connection applicant shall ensure that the telemetry requirements are satisfied as per the applicable Market Rules requirements. The finalization of telemetry quantities and telemetry testing will be conducted during the IESO Facility Registration/Market Entry process.

7. The connection applicant must ensure that the generation units will ride through transmission contingencies in the IESO-controlled grid that do not disconnect the facility by configuration. This will require adequate low and high voltage ride through capability.

8. The actual performance of the equipment must meet or exceed the predicted performance observed in simulations done by the IESO for this SIA. The connection applicant may be required to take corrective actions up to generation facility disconnection if the performance of the facility would result in adverse impact on the IESO-controlled grid, e.g. sustained oscillations or excessive voltage decline.

9. The registration of the new facility will need to be completed through the IESO's Market Entry process before any part of the new facility can be placed in-service. During the IESO Market Entry process, the connection applicant will be required to demonstrate to the IESO that all requirements identified in this SIA report have been satisfied.

10. The Market Rules governing the connection of renewable generation facilities in Ontario are currently being reviewed through the SE-91 stakeholder initiative and, therefore, new connection requirements (in addition to those outlined in the SIA), may be imposed in the future. The connection applicant is encouraged to follow developments and updates through the following link: http://www.ieso.ca/imoweb/consult/consult_se91.asp.

Assessment Conclusions

The following conclusions are achieved based on this assessment:

(1) The system fault levels after the incorporation of the proposed project will not exceed the interrupting capabilities of the existing breakers on the IESO-controlled grid near this facility.

(2) Based on the data provided by the connection applicant, the incorporation of the project will not require additional reactive compensation to be installed behind Hanover TS.

(3) The voltage performance and thermal loading with the proposed project in service are expected to be acceptable under both pre-contingency and post-contingency operating conditions.

(4) The incorporation of the project will have no adverse impact on the existing protections of transmission lines.

– End of Section –

1. Project Description

East Durham Wind, Inc., is proposing to develop a wind generating station, East Durham Wind Energy Centre, in Grey County, Priceville, Ontario, under a power purchase contract (FIT program) with the OPA.

The generation facility will be a 22.68 MW embedded generation facility, connected to the Hydro One Networks Inc., (the connection applicant) distribution system. The generation facility will connect to the 44 kV feeder H1E out of Hanover transformer station, at approximately 29.5 km from the transformer station. The feeder is normally connected to the 44 kV B bus at Hanover TS.

The project will consist of 14 GE wind turbines. A 34.5 kV underground collector system will deliver the power from the turbines to the switching station. The switching station will consist of a 34.5/44 kV 15/20/25 MVA step up transformer and a 44 kV breaker.

The proposed in service date for the generation facility is January 3, 2014.

Hydro One distribution performed the Connection Impact Assessment (CxIA) for this project and submitted the SIA application on behalf of the proponent. Hydro One distribution provided the CxIA study results for all EG projects behind Hanover TS, as shown in Table 1. This table shows the net substation loads with the EG projects as they are scheduled to connect. All EG units are operated in power factor control, as required by Hydro One distribution.

Table 1: Hydro One CxIA study results

EG projects included	Light Load (bus voltage 1.05 p.u)				Peak Load (bus voltage 1.05 p.u)				SC Current At LV Bus (kA)		MW
	Transformer Flow		EG Project		Transformer Flow		EG Project				
	MW	MX	Power Factor	V_{Term} (pu)	MW	MX	Power Factor	V_{Term} (pu)	LLL	LG	
No Generation	38.74	4.970			100.06	21.48			11.14	16.22	
+Existing	37.31	4.95	N/A	1.036	98.61	21.28	N/A	0.998	11.29	16.43	1.42
+Existing, CAE, and	30.87	4.882	N/A	1.038	91.84	20.02	N/A	1.002	11.50	16.73	7.83
+(Subject Project)	9.32	11.64	0.98 leading	1.054	69.52	24.71	0.98 leading	1.024	11.99	17.43	22.68

– End of Section –

2. General Requirements

The IESO's System Impact Assessment (SIA) determines the impact of the connection proposal on the reliability of the IESO-controlled grid and identifies project modifications and transmission system enhancements that would be required in order to mitigate any adverse reliability impacts.

The IESO has the following general requirements for the proposed EG facility:

1. The connection applicant must ensure that the requirements from the Distribution System Code are being followed. Specifically, the connection applicant shall ensure that the connection of the generation facility will not cause any material increase in the reactive power requirements at the transmission transformer station, under any distribution feeder load conditions.
2. The generation facility should be able to operate continuously between 59.4Hz and 60.6Hz and for a limited period of time in the region above straight lines on a log-linear scale defined by the points (0.0s, 57.0Hz), (3.3s, 57.0Hz), and (300s, 59.0Hz). If the new EG units trip prematurely on under-frequency, the connection applicant must revise the amount of load connected to under-frequency relays to account for the early tripping of the EG units.
3. The connection applicant shall revise the automatic load shedding scheme behind the substation to account for the generation facility tripping by configuration, if the feeder where the generation facility connects to is connected to the Under Frequency Load Shedding (UFLS) relays. In this case, the connection applicant in conjunction with the relevant transmitter have to either increase the demand connected to UFLS relays to compensate for the loss by configuration of generation from the generation facility, or to substitute the feeder with a different feeder with at least the same amount of load for the participation in the UFLS program.
4. The connection applicant shall ensure that the generation facility will respond to frequency increase by reducing the active power with an average droop based on maximum active power adjustable between 3% and 7% and set at 4%. Regulation dead band shall not be wider than ± 0.06%.

   The connection applicant shall ensure that the generation facility will respond to system frequency decline by temporarily boosting its active power output for some time (i.e. 10 s) by recovering energy from the rotating blades. This usually refers to "inertia emulation control" function within the WF control system.

   The connection applicant will need to indicate to the IESO whether the function of inertia emulation control is commercially available for the proposed type of wind turbine generator at the time when the wind farm comes into service. If this function is available, the connection applicant is required to implement it before the project can be placed in-service. If this function is commercially unavailable, the connection applicant shall install this function in the future, once it is commercially available for the proposed type of wind turbine generator.
5. If the generation facility has automatic reconnection capability, the connection applicant shall ensure that the generation facility has the capability to disable the automatic reconnection to allow for orderly power system restoration by preventing unwanted generation during a system restoration process. The connection applicant shall ensure that the automatic reconnection is disabled when the system frequency is above 60.5 Hz. The frequency supervisory relay shall allow for settings to be changed, and changes shall be made only at the IESO request.
6. According to Section 7.3 of Chapter 4 of the Market Rules, the connection applicant shall provide to the IESO the applicable telemetry data listed in Appendix 4.15 of the Market Rules on a continual basis. As per Section 7.1.6 of Chapter 4 of the Market Rules, the connection applicant

shall also provide data to the IESO in accordance with Section 5 of Market Manual 1.2, for the purposes of deriving forecasts of the amount of energy that the project is capable of producing. The whole telemetry list will be finalized during the IESO Facility Registration/Market Entry process.

The data shall be provided with equipment that meets the requirements set forth in Appendix 2.2, Chapter 2 of the Market Rules and Section 5.3 of Market Manual 1.2, in accordance with the performance standards set forth in Appendix 4.19 subject to Section 7.6A of Chapter 4 of the Market Rules.

As part of the IESO Facility Registration/Market Entry process, the connection applicant must complete end to end testing of all necessary telemetry points with the IESO to ensure that standards are met and that sign conventions are understood. All found anomalies must be corrected before IESO final approval to connect any phase of the project is granted.

7. The connection applicant must ensure that the generation units will ride through transmission contingencies in the IESO-controlled grid that do not disconnect the facility by configuration. This will require adequate low and high voltage ride through capability. The voltage settings shown in Table 2 will meet the IESO's requirements.

   Table 2: Over/Under voltage settings for EG units

Voltage Range (% of Nominal Voltage)	Disconnection Time (s)
V <50	0.16
50 ≤ V< 88	2.0
110 < V < 120	1.0
V ≥ 120	0.16

8. The actual performance of the equipment must meet or exceed the predicted performance observed in simulations done by the IESO for this SIA. The connection applicant may be required to take corrective actions up to generation facility disconnection if the performance of the facility would result in adverse impact on the IESO-controlled grid, e.g. sustained oscillations or excessive voltage decline.

9. The registration of the new facility will need to be completed through the IESO's Market Entry process before any part of the new facility can be placed in-service. During the IESO Market Entry process, the connection applicant will be required to demonstrate to the IESO that all requirements identified in this SIA report have been satisfied.

The Market Rules governing the connection of renewable generation facilities in Ontario are currently being reviewed through the SE-91 stakeholder initiative and, therefore, new connection requirements (in addition to those outlined in the SIA), may be imposed in the future. The connection applicant is encouraged to follow developments and updates through the following link: http://www.ieso.ca/imoweb/consult/consult_se91.asp.

-End of Section-

3. Technical Assessments

Since the project is not directly connected to the IESO-controlled grid, only a limited range of technical studies need to be performed for this SIA.

3.1 Study Assumptions

In this assessment, the 2014 summer base cases were used with the following assumptions:

(1) **Study Basecases:** Two basecases, in terms of load level, were used in this SIA study: peak load and light load. The system demand and the primary interface flows are listed in Table 3. Circuit S2S was assumed open-loop at Owen Sound.

Table 3: System demand and primary interface flows for basecases (MW)

Base case	System Demand	NBLIP	FABC	FETT	QEW	FS	FIO
Peak Load	26880	2023	6412	6913	1146	1250	1585
Light Load	11621	643	3845	906	34	-1048	746

(2) **Transmission facilities**: All existing and committed major transmission facilities with 2014 in-service dates or earlier were assumed in service. The committed facilities primarily include:

- Second 500 kV Bruce-Milton double-circuit line (CAA2006-250);
- Buchanan TS: one 250 MVAr shunt capacitor;
- Nanticoke and Detweiler SVCs;
- Series capacitors at Nobel SS in each of the 500 kV circuits X503E & X504E;

(3) **Generation facilities:** All existing and committed major generation facilities with 2014 in-service dates or earlier were assumed in service.

(4) **Equivalent Model for EG project:** For thermal and voltage decline assessments, an EG project was modelled as a negative load connected to the LV bus. The load was equal to the net substation load change caused by the EG project based on the CxIA study results in Table 1.

3.2 Power Factor Analysis

The connection applicant shall ensure that the proposed EG project shall not deteriorate the power factor of Hanover TS to a level that the power factor of Hanover cannot meet the Market Rules' requirement. If the load power factor at Hanover TS cannot meet the Market Rules' requirement after the proposed project is in service, additional corrective measures will be required behind the LV bus of Hanover TS.

The Market Rules (Appendix 4.3, reference 1) require that wholesale customers and distributors connected to the IESO-controlled grid shall operate at a power factor within the range of 90% lagging to 90% leading as measured at the defined meter point. For Hanover TS, the defined meter point would be considered the HV sides of the 115 kV/44 kV transformers at Hanover TS.

Power flow simulations show that under the peak load condition, the active load of Hanover TS is 100.28 MW and the reactive flow at the HV sides of the transformers after the connection of East Durham Wind Energy Centre is about 29.9 Mvar, thus, the load power factor at Hanover TS is 0.958

lagging, meeting the Market Rules' requirement. No additional correction measures are required behind Hanover TS.

Note that when calculating the power factor of transformer station after the incorporation of EG projects, the IESO will use the active flow through the transformers plus total active output of all EG units as the active load for the power factor equation and the reactive flow through the transformers as the reactive load for the power factor equation.

3.3 Thermal Assessment

As the proposed project will not result in a reverse flow through the transformers at Hanover TS under light load conditions, the incorporation of the project will have no adverse impact on the thermal loading of transmission lines. Thus, a thermal assessment is not required for this SIA.

3.4 Voltage Decline Assessment

Voltage analysis below indicates there are no voltage concerns with the incorporation of the project.

The ORTAC states that with all facilities in service pre-contingency, the following criteria shall be satisfied:

- The pre-contingency voltage on 230 kV buses must not be less than 220 kV and voltages on 115kV buses cannot be less than 113 kV;
- The post-contingency voltage on 230 kV buses must not be less than 207 kV and voltages on 115V buses cannot be less than 108 kV; and
- The voltage drop following a contingency must not exceed 10% pre-ULTC and 10% post-ULTC.

The voltage performance of the IESO-controlled grid was evaluated by examining if pre- and post-contingency voltages and post-contingency voltage declines remain within criteria at various facilities.

Contingency of the loss of the Embedded Generators (EGs) at Hanover TS was simulated under the peak and light load conditions. The study results are presented in Table 4 which indicates that all voltage criteria are met and there are no voltage concerns with the incorporation of the project.

Table 4: Voltage assessment results

Base Case	Bus Name	Pre-Contingency	Loss of EGs at Hanover TS			
			Pre ULTC		Post ULTC	
		Voltage (kV)	Voltage (kV)	Change (%)	Voltage (kV)	Change (%)
Peak Load	HANOVER TS 115 kV	122.3	122.1	-0.2%	122.1	-0.2%
	HANOVER TS 44 kV	46.5	46.5	-0.1%	46.5	-0.1%
	PALMERSTON 115 kV	117.3	117.1	-0.2%	117.1	-0.2%
Light Load	HANOVER TS 115 kV	123.5	123.7	0.2%	123.7	0.2%
	HANOVER TS 44 kV	46.7	46.9	0.6%	46.9	0.5%
	PALMERSTON 115 kV	121.1	121.3	0.2%	121.3	0.2%

3.5 Short circuit Assessment

Fault level studies were completed by the transmitter to examine the effects of the project on fault levels at existing facilities in the surrounding area. Studies were performed to analyze the fault levels with and without the project and other recently committed generation projects in the system.

The interrupting capability of the lowest rated circuit breakers near the project will not be exceeded after the incorporation of the project.

3.5.1 Study Assumptions

The short circuit study was carried out with the following primary system assumptions:

(1) Generation Facilities In-Service

East			
Lennox	G1-G4	Chenaux	G1-G8
Kingston Cogen	G1-G2	Mountain Chute	G1-G2
Wolf Island	300 MW	Stewartville	G1-G5
Arnprior	G1-G2	Brockville	G1
Barrett Chute	G1-G4	Havelock	G1
Chats Falls	G2-G9	Saunders	G1-G16
Cardinal Power	G1, G2		
Toronto			
Pickering units	G1, G4-G8	Sithe Goreway	G11-13, G15
Darlington	G1-G4	TransAlta Douglas	G1-G3
Portlands GS	G1-G3	GTAA	G1-G3
Algonquin Power	G1, G2	Brock west	G1
Whitby Cogen	G1		
Niagara			
Thorold GS	GTG1, STG2	Beck 2	G11-G26
Beck 1	G3-G10	Beck 2 PGS	G1-G6
Decew	G1, G2, ND1		
South West			
Nanticoke	G1, G2, G5-G8	Kingsbridge WGS	39.6 MW
Halton Hills GS	G1-G3	Amaranth WGS	199.5 MW
Bruce			
Bruce A	G1-G4	Ripley WGS	76 MW
Bruce B	G5-G8	Underwood WGS	198 MW
Bruce A Standby	SG1		
West			
Lambton units	G3-G4	Imperial Oil	G1
Brighton Beach	G1, G1A, G1B	Kruger Port Alma WGS	101.2 MW
Greenfield Energy Centre	G1-G4	Gosfield Wind Project	50.6 MW
St. Clair Energy Centre	CTG3, STG3, CTG4, STG4	Kruger Energy Chatham WF	101 MW
East Windsor Cogen	G1-G2	Raleigh WEC	78 MW
TransAlta Sarnia	G861, G871, G881, G891	Talbot Wind Farm	98.9 MW
Ford Windsor CTS	STG5	Port Burwell WGS	99 MW
TransAlta Windsor	G1, G2	Fort Chicago London Cogen	23 MVA
West Windsor Power	G1, G2	Great Northern Tri-Gen Cogen	15 MVA
Dow Chemicals	G1, G2, G5		

(2) Previously Committed Generation Facilities

- Bruce G1, G2
- Big Eddy GS and Half Mile Rapids GS
- White Pines Wind Farm
- Amherst Island
- York Energy Centre
- Conestogo Wind Energy Centre 1
- Dufferin Wind Farm
- Summerhaven Wind Farm
- Port Dover and Nanticoke
- Grand Renewable Energy Park
- Greenfield South
- Comber East C24Z
- Comber West C23Z
- Pointe-Aux-Roches Wind
- South Kent Wind Farm

(3) Recently Committed Generation Facilities

- Bluewater Wind Energy Centre
- Jericho Wind Energy Centre
- Bornish Wind Energy Centre
- Goshen Wind Energy Centre
- Cedar Point Wind Power Project Phase II
- Adelaide Wind Energy Centre
- Grand Bend Wind Farms
- Grand Valley Wind Farms (Phase 3)
- Erieau Wind
- East Lake St. Clair Wind
- Adelaide Wind Power Project
- Gunn's Hill Wind Farm
- Silvercreek Solar Park
- K2 wind
- Armow
- 300 MW wind at Orangeville
- 100 MW wind at S2S

(4) Existing and Committed Embedded Generation

- Essa area: 264 MW
- Ottawa area: 90 MW
- East area: 580 MW
- Toronto area: 168 MW
- Niagara area: 52 MW
- Southwest area: 348
- Bruce area: 26 MW
- West area: 585 MW

(5) Transmission System Upgrades

- Leaside - Bridgman reinforcement: Leaside TS to Birch JCT: new 115 kV circuit (CAA2006-238);
- St. Catherines 115 kV circuit upgrade: circuits D9HS, D10S and Q11S (CAA2007-257);
- Tilbury West DS second connection point for DESN arrangement using K2Z and K6Z (CAA2008-332);
- Second 500kV Bruce-Milton double-circuit line (CAA2006-250);
- Woodstock Area transmission reinforcement (CAA2006-253);
    - Karn TS in service and connected to M31W & M32W at Ingersol TS
    - W7W/W12W terminated at LFarge CTS
    - Woodstock TS connected to Karn TS
- Rodney (Duart) TS DESN connected to W44LC and W45LS 230 kV circuits (CAA2007-260)

(6) System Operation Conditions

- Lambton TS 230 kV operated *open*
- Claireville TS 230 kV operated *open*
- Leaside TS 230 kV operated *open*
- Leaside TS 115 kV operated *open*
- Middleport TS 230 kV bus operated *open*
- Hearn SS 115 kV bus operated *open*
- Cherrywood TS north & south 230kV buses operated *open*
- Richview TS 230 kV bus operated *open*
- All tie-lines in service and phase shifters on neutral taps
- Maximum voltages on the buses

3.5.2 Study Results

Table 5 shows the projected fault levels at facilities near the project with and without the project and other recently committed generation projects.

Table 5: Fault levels at facilities near the project

Bus	Before the Project		After the Project and Other Committed Projects		Lowest Rating of Circuit Breakers (kA)
	3-Phase	L-G	3-Phase	L-G	
Symmetrical (kA) [1]					
Hanover 115 kV	12.193	13.287	12.736	13.732	40
Owen Sound 115 kV	9.396	9.930[4]	9.775	10.389[4]	10.5 (for 3-ph fault) 12.075[5] (for LG fault)
Orangeville 230 kV	18.246	16.912	19.640	21.113	46.2
Bruce A 230 kV	42.966	54.361	44.634	56.152	60[3]
Asymmetrical (kA) [1]					
Hanover 115 kV	14.013	15.961	14.822	16.690	47.9
Owen Sound 115 kV	10.194	11.323[4]	10.598	11.818[4]	11.4 (for 3-ph fault) 13.11[5] (for LG fault)
Orangeville 230 kV	20.595	20.109	22.387	25.121	54.2
Bruce A 230 kV	57.645	78.446[2]	59.730	80.815[2]	72.6[3]

[1] Based on a pre-fault voltage level of 550 kV for 500 kV buses, 250 kV for 230 kV buses, and 127 kV for 115 kV buses.
[2] The asymmetrical fault level is based on a breaker contact parting time of 44 ms.
[3] Three lower rated Bruce A 230 kV breakers (D1L81, K1L82 and L23T25) are scheduled to be replaced by December 2012 (see CAA ID#2010-EX511). The listed lowest rated circuit breaker value for Bruce A 230 kV assumes these breakers being replaced.
[4] Maximum fault current seen by the station's lowest rated circuit breaker
[5] Extended breaker rating for LG faults as provided by Hydro One.

Table 5 shows that fault levels increase by a small amount due to the addition of the project and other recently committed generation projects. The interrupting capability of circuit breaker at the project is adequate for the anticipated fault levels.

The results also show that the line-to-ground asymmetrical fault current at Bruce A 230 kV before and after the incorporation of the project and other committed projects will exceed the interrupting capability of the existing breakers. This issue has been investigated in the 2nd SIA addendum for the project of Bruce G1 and G2 restart (CAA ID 2004-163), where the IESO has identified a requirement to replace all the Bruce 230 kV breakers with higher fault current interrupting capability and assessed potential mitigation measures for this issue until these circuit breakers are replaced. Hydro One has planned to replace the Bruce 230 kV breakers.

With the exception of Bruce A 230 kV, the interrupting capability of the lowest rated circuit breakers near the project will not be exceeded after the incorporation of the project.

3.6 Frequency Control Performance

The function of frequency control of the project meets the requirements of the Market Rules.

The generation facility shall respond to frequency increase by reducing the active power with an average droop based on maximum active power adjustable between 3% and 7% and set at 4%.

Regulation dead band shall not be wider than ± 0.06%. The generation facility shall respond to system frequency decline by temporarily boosting its active power output for some time (i.e. 10 s) by recovering energy from the rotating blades. This usually refers to "inertia emulation control" function within the WF control system. It is not required for wind facilities to provide a sustained response to system frequency decline.

The project will be equipped with the GE WindCONTROL System. The project will provide frequency droop control which controls the wind farm power output based upon the grid frequency. This function is similar to governor droop control for a conventional rotating generator.

The WindINERTIA feature enables the GE 1.6 MW WTG to provide inertial response to help stabilize grid frequency. This feature supports the grid during under frequency events by providing a temporary increase in power production for a short duration, contributing towards frequency recovery. This is achieved by tapping into the stored kinetic energy in the rotor mass. The response is equivalent to that of a synchronous generator with an inertia constant of 3.5 sec.

3.7 Protection Impact Assessment

Hydro One has indicated that the incorporation of the proposed project will have no adverse impact on the existing protections of transmission lines, thus a detailed Protection Impact Assessment was not required for the purposes of this System Impact Assessment.

-End of Document-