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CUSTOMER IMPACT ASSESSMENT

Proposed 230 MW
Niagara Region Wind Farm

FIT-FLKZ509

Revision: **Final**

Date: **August 3rd, 2012**

Issued by: **Transmission System Department**
Transmission Projects Division
Hydro One Networks Inc.

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Disclaimer

This Customer Impact Assessment was prepared based on preliminary information available about the connection of the proposed Niagara Region Wind Farm generation facilities, near the town of Beamsville, Ontario. It is intended to highlight significant impacts, if any, to affected transmission customers early in the project development process and thus allow an opportunity for these parties to bring forward any concerns that they may have including those needed for the review of the connection and for any possible application for leave to construct. Subsequent changes to the required modifications or the implementation plan may affect the impacts of the proposed connection identified in this Customer Impact Assessment. The results of this Customer Impact Assessment and the estimate of the outage requirements are also subject to change to accommodate the requirements of the IESO and other regulatory or municipal authority requirements.

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This Final Customer Impact Assessment incorporates all comments received during the customer review period which ended on August 3rd 2012.

CUSTOMER IMPACT ASSESSMENT

PROPOSED 230 MW
NIAGARA REGION WIND FARM

1.0 INTRODUCTION

1.1 Scope of the Study

This Customer Impact Assessment (CIA) study assesses the potential impacts of the proposed Niagara Region Wind Farm on the load customers and generators in the local vicinity. This study is intended to supplement the System Impact Assessment "CAA ID 2012-466" issued by the IESO.

This study covers the impact of the generation addition of the Niagara Region Wind Farm on the Hydro One Networks Inc. (Hydro One) system in the area. The primary focus of this study is to identify the impact on the transmission customer connected facilities and operating constraints based on facility voltage performance. The study also assists to determine if any transmission system upgrade will be required to integrate the proposed interconnection during possible system conditions.

This study does not evaluate the overall impact of the Niagara Region Wind Farm on the bulk system. The impact of the new generator on the bulk system is the subject of the System Impact Assessment (SIA) which is issued by the Independent Electricity System Operator (IESO).

This study does not evaluate the impact of the Niagara Region Wind Farm on the existing network Protection and Control facilities. Protection and Control aspects are reviewed under the Protection Impact Assessment, which is part of the SIA.

1.2 Background

Niagara Region Wind Corporation is proposing to develop a wind farm near the town of Beamsville located in Southern Ontario. The new development will provide a total installed capacity of 230MW. This customer impact assessment (CIA) will address the connection to the Hydro One grid via the 115kV circuit "Q5G".

The Niagara Region Wind Farm is comprised of 77 Enercon inverter based wind turbines connected to six (6) collector circuits. Of the six collector wind farm circuits, 5 circuits will produce a maximum of 39MW (13 turbines) and one circuit will produce a maximum of 36MW (12 wind turbines). Each turbine can produce a maximum of at 3MW each. The maximum installed capacity for all six collector circuits will be 231MW. These circuits will be stepped up via a new 115-44kV substation.

The Niagara Region Wind Farm substation will be connected though a privately owned 115kV circuit approximately 20 km in length into the idle Hydro One 115kV circuit "Q5G". The line tap is approximately 25km from Beach Jct. Beach Jct will be connected into Beach TS.

An overview geographical diagram is provided in Figure 1. A single line diagram of the connection is provided in Figure 2.

The facility has a commercial contractual in-service date of Feb 25 2014.

METHODOLOGY & CRITERIA

1.3 Voltage Performance - Planning Criteria

To establish the impact of incorporating the proposed Niagara Region Wind Farm facilities, the following post-fault voltage decline criteria would have to be observed:

- At the Bulk Electricity System level (115kV and up): The loss of a single transmission circuit should not result in a voltage decline greater than 10% for pre- and post- transformer tap-changer action
- The maximum and minimum phase-to-phase voltages given in the IESO's Transmission Assessment Criteria and Canadian Standard Association document CAN-3-C235-83 were considered. In Northern Ontario, the maximum continuous voltage for the 230 and 115kV systems can be as high as 260kV and 132kV respectively. [from IESO document IESO_REQ_0041 Issue 2.0]
- With all planned facilities in service pre-contingency, system voltage changes in the period immediately following a contingency shall not result in a voltage decline greater than 10% for pre-transformer tap-changer action (including station loads less than 50kV) and 10% post transformer tap-changer action (5% for station loads less than 50kV). In addition, the steady state voltage at station loads less than 50kV are to remain within 6% of the nominal voltage.

The voltage performance on Hydro One customers supplied by Q5G and in the area has to meet the above standard subsequent to the addition of the Niagara Region Wind Farm Project.

1.4 Customers Connected

The focus of this study is on customers supplied by stations connected to Beach TS. The affected customers are shown below.

Station	Customer
Lake TS	Horizon Utilities Corporation Hydro One Networks Inc
Dofasco Kenilworth CTS	Dofasco Inc. (Kenilworth)
Dofasco Bay Front CTS	Dofasco Inc. (Bay Front)
Kenilworth TS	Horizon Utilities Corporation
Stirton TS	Horizon Utilities Corporation
Speciality Bar CTS	Hamilton Speciality Bar Inc.
Birmingham TS	Horizon Utilities Corporation
Beach TS	Horizon Utilities Corporation

2.0 POWER SYSTEM ANALYSIS

Power System Analysis is an integral part of the transmission planning process. It is used by Hydro One to evaluate the capability of the existing network to deliver power and energy from generating stations to provide a reliable supply to customers. Two relevant aspects of Power System Analysis were used for this assessment, namely:

a. Short-circuit Studies: A Short Circuit Analysis program was used to determine the impact on customers. Due to the unavailability of some of the data, typical values were used when necessary.

b. Load Flow Studies: An AC load flow program was used to set up a base case with the Niagara Region Wind Farm generating facility.

SHORT- CIRCUIT STUDIES

Short-circuit studies were carried out to assess the fault contribution when the Niagara Region Wind Farm generators are placed in-service. The impact of the new facility on the fault levels in the Hydro One customers supplied in the Beach TS area was analyzed.

The study results are summarized in Table 1 below showing both symmetric and asymmetric fault currents in kA. Table 1 shows the fault levels based on the following assumptions:

- All existing generating facilities in-service in the area. The study assumptions are identical to Section 4.1 of the IESO System Impact Assessment Report for this project, which include committed generation.
- The maximum pre-fault voltage considered for the voltage levels is shown on the table below for fault levels at critical buses near the new generation.

Fault Location	Bus Voltage (kV)	Present				With Niagara Region Wind Farm			
		3 Phase Fault (kA)		L-G Fault (kA)		3 Phase Fault (kA)		L-G Fault (kA)	
		Sym	Asym	Sym	Asym	Sym	Asym	Sym	Asym
Beach 230	250	37.777	44.52	35.98	45.752	38.281	45.162	36.42	46.356
Beach 115	127	26.711	32.72	32.3	41.509	27.792	33.977	33.553	43.012
Beach B Bus	14.2	18.488	22.92	8.842	11.045	18.549	22.994	8.851	11.056
Beach Y Bus	14.2	18.536	22.97	8.849	11.054	18.598	23.047	8.859	11.065
Beach Q Bus	14.2	17.683	22.62	7.479	10.538	17.691	22.638	7.48	10.54
Beach J Bus	14.2	17.388	22.33	7.444	10.494	17.396	22.342	7.445	10.496
Burlington BY Bus	29	13.42	18.33	10.19	14.416	13.423	18.335	10.192	14.418
Burlington JQ Bus	29	13.403	18.29	10.19	14.413	13.406	18.296	10.188	14.415
Cumberland B Bus	29	13.107	16.98	11.92	16.212	13.109	16.989	11.925	16.215
Cumberland Q Bus	29	13.029	16.88	11.88	16.144	13.032	16.887	11.877	16.147
Dofasco Bay Front	14.2	18.345	24.67	0.234	0.234	18.354	24.69	0.234	0.234
Dofasco Bay Front H35D	250	34.634	40.09	32.39	38.45	35.057	40.603	32.737	38.865
Dofasco Bay Front H36D	250	34.236	39.56	31.94	37.737	34.649	40.063	32.285	38.137
Kennilworth Q24HM	250	36.413	42.36	34.22	40.946	36.881	42.944	34.612	41.421
Kennilworth Q29HM	250	36.413	42.36	34.22	40.95	36.881	42.944	34.612	41.425
Kenilworth A1 Bus	127	25.108	29.66	28.98	32.383	26.057	30.69	29.982	33.38
Kenilworth A3 Bus	127	24.808	29.17	28.65	32.227	25.733	30.167	29.617	33.198
Kenilworth EJ Bus	14.2	18.531	23.14	14.77	19.407	18.595	23.219	14.797	19.442
Lake B18H	250	24.93	28.41	20.74	23.29	25.122	28.64	20.869	23.424
Lake B20H	250	24.923	28.41	20.74	23.287	25.116	28.631	20.868	23.421
Lake BY Bus	29	16.607	21.49	11.11	12.365	16.62	21.513	11.117	12.37
Lake J Bus	14.2	17.856	22.52	7.553	10.615	17.863	22.536	7.554	10.617
Lake Q Bus	14.2	17.856	22.52	7.551	10.612	17.863	22.536	7.552	10.614
Specialty Bar B Bus	14.2	7.448	9.092	0.579	0.579	7.46	9.106	0.579	0.579
Specialty Bar Y Bus	14.2	7.448	9.092	0.579	0.579	7.46	9.106	0.579	0.579
Specialty Bar HL3	127	16.145	17.73	14.06	14.776	16.534	18.122	14.289	14.999
Specialty Bar HL4	127	16.148	17.73	14.06	14.776	16.536	18.125	14.288	14.998
Stirton HL3	127	14.822	16.08	12.41	12.947	15.148	16.411	12.588	13.12
Stirton HL4	127	14.824	16.09	12.41	12.947	15.15	16.413	12.587	13.119
Stirton BY Bus	14.2	15.62	19.67	7.049	9.769	15.673	19.732	7.056	9.779
Stirton QZ Bus	14.2	15.679	19.63	7.055	9.758	15.732	19.698	7.062	9.768
Winona LV	29	11.767	13.73	9.375	12.126	11.826	13.794	9.4	12.157
Winona Junction	127	11.431	12.23	8.6	8.95	11.624	12.417	8.686	9.032

Table 1 – Short Circuit Levels of Buses at Neighbouring Stations/Junctions with Niagara Region Wind Farm

Table 1 shows the fault levels after the incorporation of the new Niagara Region Wind Farm meets the maximum symmetrical three-phase and single line-to-ground faults (kA) of 115 kV stations as set out in Appendix 2 of the *Transmission System Code* (**TSC**) [2] and reproduced below. It also meets the requirements of Hydro One equipment in the stations identified.

Nominal Voltage (kV)	Max. 3-Phase Fault (kA)	Max. SLG Fault (kA)
230	63	80(1)
115	50	50
27.6 (4-wire)	17(2)	12(2)
13.8	21(2)	10(2)

Notes :

(1) – Usually limited to 63 kA

(2) – Effective September 1, 2010, Hydro One requires a 5 % margin on the acceptable TSC limits at voltage levels of <50kV to account for other sources of fault current on the distribution system such as unmodelled synchronous motors and data inaccuracies.

2.1 Impact at Stations Mitigated for Fault Level

The results of the fault levels studies shown on these tables above show that the Niagara Region Wind Farm does not have a measureable (>= 0.01kA) impact at the fault level at any of the stations (Windsor Walker #1 TS, Kingsville TS, Caledonia TS & Martindale TS) where mitigation measures are necessary to limit fault levels to acceptable values.

LOAD FLOW STUDIES

Load flow studies were carried out to analyze the impact of the new facilities on the voltage performance of Hydro One customers in the affected area. The load flow model used for the load flow analysis performed by Hydro One was based on information supplied by the IESO.

2.2 Base Case and Study Assumptions

The 2012 Summer Peak load conditions within operating limits in the area were used in the load flow analysis. The Niagara Region Wind Farm generation was modeled into the base case prior to performing contingency studies.

The Niagara Region Wind Farm supplied 230MW with the worst case scenario of 0.9 PF to the surrounding area.

2.3 Contingency Analysis

The following single transmission element contingencies were considered for this local impact assessment with Niagara Region Wind Farm operating at maximum output.

1) Loss of a Beach TS 230/115kV autotransformer;
2) Loss of H5K; and
3) Loss of HL3

In addition, the impact on the local area with the loss of Niagara Region Wind Farm was assessed.

The studies indicated that under this contingency the voltage change on the HV customer connections are well within the acceptable range of the voltage performance criteria mentioned in Section 1.3. The results are tabulated in Table 2.

		Loss of NRWF		Loss of Beach Auto		Loss of H5K		Loss of HL3	
BUS NAME	**BASE V**	**Pre ULTC**	**Post ULTC**	**Pre ULTC**	**Post ULTC**	**Pre ULTC**	**Post ULTC**	**Pre ULTC**	**Post ULTC**
NRWF HV	122.29	***OOS***		122.01	122.01	122.25	122.24	122.25	122.24
NRWF Tap	122.26	***OOS***		121.97	121.97	122.21	122.21	122.21	122.21
Beach 115kV	122.98	123.66	123.55	122.50	122.50	122.90	122.89	122.90	122.89
Winona Jct	122.37	123.06	122.95	121.89	121.89	122.29	122.28	122.29	122.29
Kenilworth A1	122.96	123.65	123.53	122.49	122.48	121.34	121.29	122.88	122.88
Kenilworth A3	122.96	123.64	123.53	122.48	122.48	122.86	122.84	122.88	122.87
Gage TS K1G	122.98	123.66	123.55	122.50	122.50	122.87	122.85	122.90	122.90
Gage TS K2G	122.98	123.66	123.55	122.50	122.50	121.37	121.31	122.90	122.90
Birmingham HL3	122.54	123.23	123.11	122.07	122.06	122.46	122.45	116.28	116.40
Birmingham HL4	123.19	123.88	123.76	122.71	122.71	123.11	123.10	122.64	122.63
Speciality Bar HL3	122.41	123.09	122.98	121.93	121.93	122.33	122.32	116.22	116.36
Speciality Bar HL4	123.26	123.95	123.84	122.78	122.78	123.18	123.17	122.62	122.60
Stirton TS HL3	122.40	123.08	122.97	121.92	121.91	122.32	122.30	116.24	116.37
Stirton TS HL4	123.24	123.93	123.81	122.76	122.75	123.16	123.14	122.55	122.54
Beach 230kV	242.70	242.68	242.47	242.72	242.72	242.64	242.63	242.64	242.63
Beach B Bus	13.96	14.04	14.03	14.04	14.04	13.95	13.95	13.95	13.95
Beach Y Bus	14.08	14.17	14.15	14.38	14.38	14.08	14.07	14.08	14.07
Trafalgar 230kV	245.22	245.09	245.04	245.23	245.23	245.20	245.19	245.19	245.19
Lake TS B18H	242.45	242.43	242.22	242.48	242.48	242.40	242.39	242.40	242.39
Lake TS B20H	242.45	242.43	242.22	242.48	242.47	242.39	242.38	242.39	242.39
Dofasco Ken Q24HM	242.70	242.68	242.47	242.72	242.72	242.64	242.63	242.64	242.63
Dofasco Ken Q29HM	242.70	242.68	242.47	242.72	242.72	242.64	242.63	242.64	242.63
Dofasco Bay H35D	242.73	242.72	242.50	242.76	242.76	242.67	242.66	242.67	242.67
Dofasco Bay H36D	242.74	242.73	242.51	242.77	242.76	242.68	242.67	242.68	242.67
Beach TS Q12	14.61	14.60	14.59	14.61	14.61	14.60	14.60	14.60	14.60
Beach TS J12	14.55	14.55	14.53	14.55	14.55	14.54	14.54	14.54	14.54

Table 2: Voltage Levels in the Surrounding Area

3.0 CUSTOMER RELIABILITY

The proposed Niagara Region Wind Farm will add another position in the existing 115kV ring bus at Hamilton Beach TS. A new high voltage breaker will be added to the ring bus. Faults along the the HV and LV station bus of the project will be cleared by the ring bus breakers and have minimum impact on the customers supplied by the 115kV Hamilton Beach TS.

3.1 <u>Preliminary Outage Impact Assessment</u>

Exact outage schedule will be made available during the detailed engineering phases of the project development and established in consultation with load customers in the area. The outage duration will be minimized and risk managed with proper outage planning and co-ordination.

CONCLUSIONS AND RECOMMENDATIONS

The Customer Impact Assessment (CIA) Report presents the results of short circuit, and voltage performance study analyses.

The overall findings of this CIA provided that the above recommendations are implemented are:

- The results of the short circuit analysis showed that some area's stations encountered small increases in fault level at the connection points. The largest increase observed was at Beach TS with an increase of 4%. The Kenilworth TS HV bus connection will also increase by 3.8% (~1kA).
- These increases were within the capability of the existing Hydro One facilities. However, the customers connected in the area should review the fault levels at their connection points to confirm their equipment is capable of withstanding the increased fault and voltage levels.
- When in operation, the Niagara Region Wind Farm will assist in supporting the voltages seen by the connected customers under system disturbances and will not adversely impact the local voltage performance in the local area

The study has confirmed that the proposed 230 MW Generation at the Niagara Region Wind Farm can be incorporated without any adverse impact on Hydro One customers.

References

[1] Independent Electricity System Operator (IESO), ***System Impact Assessment Report (Draft)- Niagara Region Wind Farm*****,** CAA ID-2012-466, June 20, 2012.

[2] Independent Electricity System Operator (IESO), ***IESO Transmission Assessment Criteria*****,** Issue 2.0.

[3] Ontario Energy Board, **Transmission System Code**, June 10, 2010

Figure 1: Geographical Location of Niagara Region Wind Farm

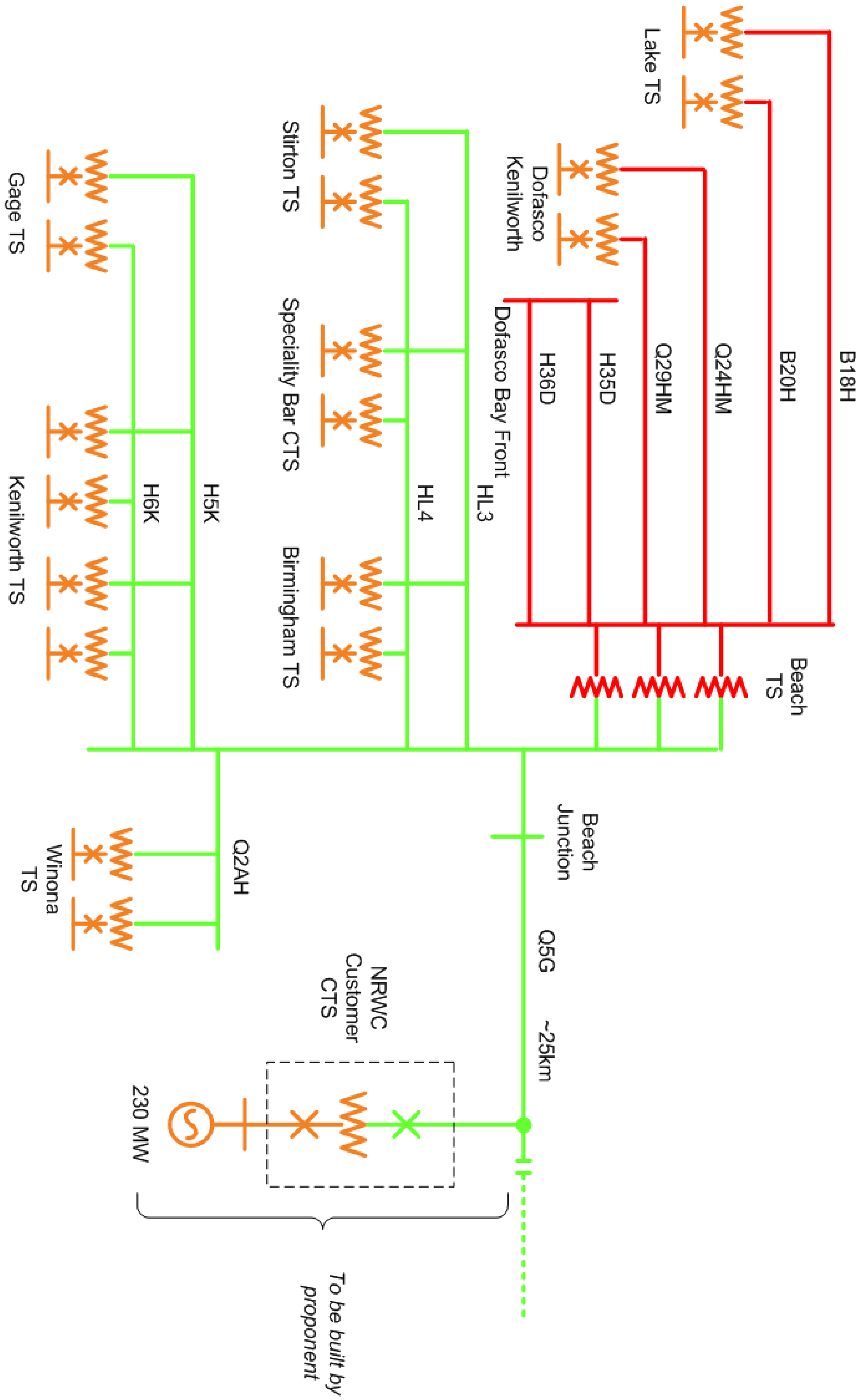

Figure 2: Single Line Diagram for the Niagara Region Wind Farm