REPORT

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System Impact Assessment Report

SOP – EG Projects at Various Stations

Connection Assessment & Approval Process

Final Draft

CAA ID 2007-269

Applicant: Hydro One Network Inc.

Market Facilitation Department

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System Impact Assessment Report

SOP – EG Projects at Various Stations

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 conditional 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 Hydro One 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 Hydro One at the request of the IESO. Furthermore, the conditional 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, the 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, the connection applicant must be aware that the IESO may revise drafts of this Report at any time in its sole discretion without notice to the connection applicant. 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 the most recent version of this Report is being used.

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1. Project Description

In response to the Renewable Energy Standard Offer Program (RESOP) initiated by the OPA, many embedded generation (EG) projects seek connection to distribution systems that are supplied from various transformer stations connected to the IESO-controlled grid. Since the launch of the RESOP local distribution companies received a large number of Connection Assessment applications for projects 10 MW or lower. Hydro One in particular, has performed assessments for hundreds of such projects.

These small projects, when connected to the distribution system, could result in an active power injection into the ICG and have a significant impact on the overall reliability of the power system. The IESO has expanded the Connection Assessment and Approval Process to require Local Distribution Companies (LDC) to apply for a System Impact Assessment for their transformer stations where the reversed power flow into the grid could potentially exceed 10 MW.

The SIA Agreement CAA ID 2007-269 dated February 26, 2008, in relation to Hydro One's application for the assessment of "Transformation Stations with Multiple SOP Embedded Generation" covered assessments by the IESO to determine:

- The amount of embedded generation that can be connected which causes no impact to the transmission system and requires no mitigation measures.
- The transmission upgrades required to connect the requested amount of generation at various transformer stations.

The agreement envisaged that Hydro One would submit to the IESO, on a periodic basis, the data related to the transformer stations, and applicable Embedded Generation.

By the end of Q3 2008, the IESO has received from Hydro One applications for 27 transformer stations where the active power injection into the ICG could potentially be greater than 10 MW. This data is based on Connection Impact Assessments (CIAs) that Hydro One has completed in accordance with the Distribution System Code requirements.

The IESO has completed a number of assessments for the individual transformer stations and concluded that dynamic reactive compensation is required to mitigate the impact on reliability. The IESO also conducted special technical studies on high-penetration of EG into the ICG which confirmed the need for dynamic reactive compensation. In the course of these studies it was also concluded that studies for individual stations are not necessary and that by grouping the transformer stations by geographical areas the assessment process could be simplified and expedited.

It is therefore proposed that all EG applications received within a certain period of time be assessed on an area/zonal basis and general system requirements be summarized in a single SIA report.

The SIA report is to be updated periodically based on Hydro One's new/updated applications.

- End of Section -

2. IESO Requirements[1]

This section summarizes the IESO expected requirements for reliable incorporation of EG projects in distribution systems connected to **27** Hydro One transformer stations. Performance standards that may apply to EG units or distribution systems to which the EG units are connected have not been finalized yet.

(1) The dynamic reactive power amounts on an area basis, as shown in Table 1, are required to accommodate the proposed EG units.

Table 1: Dynamic MVAr Requirements Based on Geographic Areas

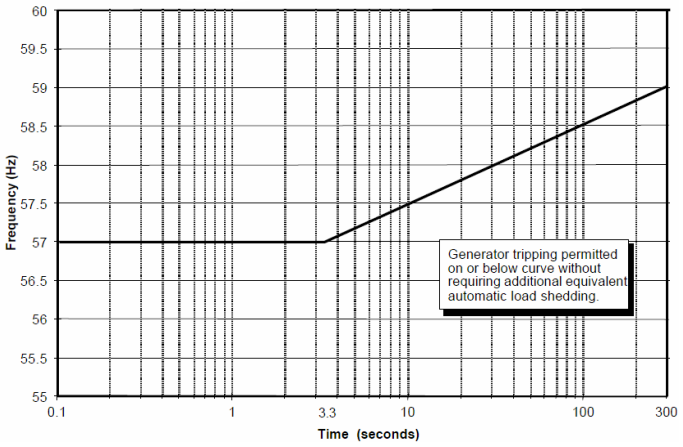
Areas	Zones(*)	Capacitive MVAr Required	Inductive MVAr Required
East		+89	-60
Essa		+21	-14
Northeast	Manitoulin	+21	-14
	(Rest)	+15	-10
Northwest		+10	-7
Ottawa		+18	-12
Southwest		+26	-17
West		+156	-106
Total:		**+355**	**-241**

Note: (*) Due to specific system configuration, some amount of dynamic reactive facilities is required to be located in specified zones within a geographic area.

[1] The IESO has initiated a stakeholder engagement process (SE-57) to allow stakeholders the opportunity to provide feedbacks on issues that will drive the successful integration of increased EG in Ontario. Details of SE-57 are available at http://www.ieso.ca/imoweb/consult/consult_se57.asp.

While the results were derived assuming that the dynamic reactive facilities are located at the LV bus of the transformers, the spread and the location of this compensation could be modified to provide the appropriate level of compensation and lowest cost option. Some alternative locations could include (i) a suitable location to aggregate the reactive requirement over a geographic area, (ii) along LV feeder lines and (iii) at the EG sites. Further studies need to be performed by Hydro One to investigate these options.

(2) The EG units must operate continuously at full power in the range of 59.4 to 60.6 Hz. The EG units are also capable of operating at full active power for a limited period of time for frequencies as low as 58.8 Hz. The EG units do not trip for under-frequency system conditions that are below 60 Hz but above 57.0 Hz and above the curve shown in the figure below . If the EG units trip prematurely on under-frequency, Hydro One must revise the amount of load connected to under-frequency relays to account for the early tripping of the EG units.



(3) The EG units must ride through transmission contingencies on the IESO-controlled grid that do not disconnect the facility by configuration. This will require adequate low and high voltage ride through capability.

(4) The EG units must have the capability to disable the automatic reconnection to allow for orderly power system restoration by preventing unwanted generation during system restoration process.

(5) Hydro One must revise the automatic load shedding scheme behind the substation to account for the EG tripping with feeders disconnected by UFLS relays.

(6) The IESO requires the real-time information of aggregate real and reactive power of EG units and data associated with all other new devices at the substation.

(7) If new dynamic reactive equipments are installed at the LV buses of transformer stations, Hydro One should have the capability to adjust voltage regulating facilities such as shunt capacitors and transformer ULTCs during operation so that these dynamic reactive facilities normally operate at zero reactive output or absorbing some amount of reactive power.

(8) As per the Distribution System Code (DSC), Hydro One should finalize requirements related to static reactive compensation for the proposed EG projects, so as not to cause any material increase in the reactive power requirements at the transmission transformer station due to operation of the EG units, at any distribution feeder load conditions.

- End of Section -

3. Dynamic Reactive Compensation

The Market Rules require that new facilities to be connected to the IESO-controlled grid should not have material adverse impact on the system reliability. Based on the assessments of individual substations performed to date, the main impact of EGs on the system reliability is related to the deficiency of dynamic reactive power created by the EG aggregate in excess of minimum station load displacing conventional generation. A study initiated to assess the effect of 1000MW EG in southwest Ontario also confirmed that replacing conventional generation which has dynamic reactive capability with EGs would result in a significant slowdown in post-contingency voltage recovery due to the lack of dynamic reactive power.

To avoid the adverse impact of proposed EG units on the voltage performance of the IESO-controlled grid, dynamic reactive compensation is required to accommodate the EG units. The IESO developed a methodology for calculation of the reactive power deficiency. By this methodology, dynamic reactive compensation is calculated based on the dynamic reactive requirement in the Market Rules for the generating capacity equal to maximum reverse power through substation transformers under the light load condition.

The Market Rules require that a synchronous generator unit connecting to the ICG must have the minimum capability to supply reactive power continuously at all active power outputs in the range of 0.9 lagging to 0.95 leading power factor based on rated active power at its generator terminal. As shown in Figure 1, assuming aggregate EG capacity behind one substation is P_{EG}, and total load behind this substation at the light load condition, including distribution losses and transformer losses, is $P_{L,\,Light}$, the maximum reverse power through substation transformers would be $P_{REV} = (P_{EG}-P_{L,\,Light})$. Required capacity of dynamic reactive facilities for this substation could be deduced as $+0.484P_{REV}/-0.329P_{REV}$.

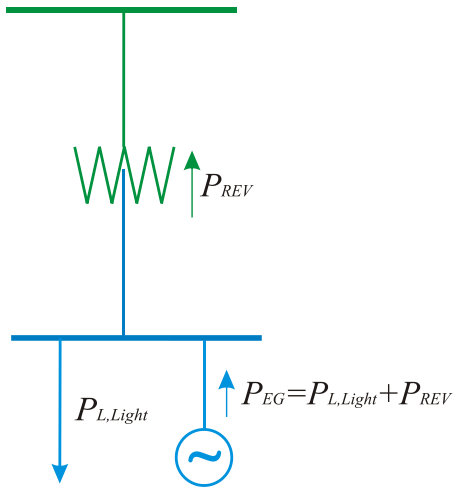


Figure 1: Transformer Flow with EG Units under Light Load Conditions

Dynamic study of EG projects behind Orangeville and Manitoulin TS, and the study of 1000MW EG in southwest Ontario confirmed that dynamic reactive compensation calculated by the developed methodology is adequate and appropriate to eliminate the adverse impact of EG unit on system dynamic performance.

While the results were derived assuming that the dynamic reactive facilities are located at the LV bus of the transformers, the spread and the location of this compensation could be modified to provide the appropriate level of compensation and lowest cost option. The study of 1000MW EG in southwest Ontario also concluded that viable solutions would be to locate dynamic reactive facilities at optimal positions in the ICG.

Based on the developed methodology, Table 2 lists the dynamic reactive requirements for all transformer stations where reverse power is identified. The transformer stations have been grouped based on different geographic areas/zones within the IESO controlled grid. The proposed EG capacity and the reverse power (Column IV and V, respectively) were provided to the IESO through Hydro One CIA studies, which have been included in the appendix. Column VI and VII show the deduced capacitive and inductive capacity of dynamic reactive compensation.

Note that the proposed EG units are presently required by Hydro One to operate in power factor control mode. If Hydro One revises this requirement in the future to allow these EG units to operate in voltage control mode, there may be some opportunity to reduce the amount of dynamic reactive power compensation shown in Table 1.

Table 2: Dynamic MVAr Requirements for EG Implementation

Area	Station	Transformer	Proposed MW of EG	Reverse Power (P_{REV},MW)	Capacitive MVAr Required (P_{REV} x0.484)	Inductive MVAr Required (P_{REV} x0.329)
East	Picton TS		51.9	-19.1	9.2	-6.3
	Napanee TS	T1	36.5	-20.2	9.8	-6.6
		T2	24.5	-17.0	8.2	-5.6
	Smiths Falls TS		63.2	-21.0	10.2	-6.9
	Port Hope TS		56.8	-38.0	18.4	-12.5
	Dobbin TS		87.0	-49.6	24.0	-16.3
	Chesterville TS		30.0	-18.4	8.9	-6.1
	Subtotal		**349.9**		**88.7**	**-60.3**
Essa	Wallace TS	T4	31.2	-20.7	10.0	-6.8
	Parry Sound TS		36.0	-22.0	10.6	-7.2
	Beaverton TS		On Hold	N/A	N/A	N/A
	Subtotal		**67.2**		**20.6**	**-14.0**
Northeast	Dymond TS		46.3	-20.4	9.9	-6.7
	Kapuskasing TS		20.0	-10.0	4.8	-3.3
	Subtotal		**66.3**		**14.7**	**-10.0**
Northeast-Manitoulin	Manitoulin TS	T3	26.1	-21.3	10.3	-7.0
		T4	26.0	-21.2	10.3	-7.0
	Subtotal		**52.1**		**20.6**	**-14.0**
Northwest	Fort Williams		33.2	-20.9	10.1	-6.9
	Subtotal		**33.2**		**10.1**	**-6.9**
Ottawa	Longueuil TS		30.0	-14.2	6.9	-4.7
	St. Isidore TS		39.7	-23.2	11.2	-7.6
	Subtotal		**69.7**		**18.1**	**-12.3**
Southwest	Meaford TS		29.7	-15.9	7.7	-5.2
	Orangeville TS	T1/T2	35.5	-13.7	6.6	-4.5
		T3/T4	55.9	-23.1	11.2	-7.6
	Subtotal		**121.1**		**25.5**	**-17.3**
West	Strathroy TS		39.0	-23.7	11.5	-7.8
	Belle River TS		29.9	-20.8	10.1	-6.9
	Forest Jura DS		16.5	-14.6	7.0	-4.8
	Keith TS		55.0	-37.0	17.9	-12.2
	Lauzon TS	DESN 2	61.8	-34.2	16.6	-11.3
	Lambton TS	T5	60.0	-43.9	21.2	-14.4
	Tillsonburg TS		69.6	-35.5	17.2	-11.7
	St. Thomas TS		22.5	-14.7	7.1	-4.8
	Kent TS		102.6	-57.3	27.7	-18.9
	Wanstead TS	T3	24.8	-18.4	8.9	-6.1
		T1/T2	10.0	-3.1	1.5	-1.0
	Modeland TS		61.6	-20.0	9.7	-6.6
	Subtotal		**553.3**		**156.5**	**-106.4**
System Total			**1312.7**		**354.9**	**-241.2**

- End of Section -

4. Next Steps for Implementation

The IESO and Hydro One have recognized that some installation of the aforementioned facilities on the transmission system may not be economical, since the size of the facilities would be relatively small compared to size of the reactive facilities normally connected to the transmission system. Further, while the sizes noted above are based on the EG applications for which Hydro One has already completed a Connection Impact Assessment in accordance with the Distribution system Code, there are several other EG applications in the queue, for a total amount of over 3,000 MW. It is expected that even more EG applications may be forthcoming as a result of the government initiatives in relation in renewable energy supply.

Based on these observations, the IESO and Hydro One have agreed that the assessment of the dynamic reactive facilities should be carried by the IESO on the basis of geographical areas and a forecast of potential for future Embedded Generation in these areas, instead of focusing solely on the Embedded Generation for which Hydro One has completed Connection Impact Assessment. Therefore, Hydro One has undertaken to provide to the IESO a forecast of Embedded Generation by area, based on all applications deemed to be eligible for Connection Impact Assessment studies. The IESO will then update the SIA to identify dynamic reactive requirements using this forecast for consideration by Hydro One to implement new dynamic reactive equipments to satisfy these requirements. The proposal of new dynamic reactive equipments will be submitted to the IESO for the SIA to justify the adequacy of dynamic reactive compensation based on the EGs with completed CIA.

The issue pertaining to the appropriate size of dynamic voltage support facilities to be installed based on economy of scale and on the forecast of potential future installation of EGs is being currently dealt with in various forums. It is envisaged the final recommendations in relation to SIA for EG Projects will be granted after additional data and guidance are obtained about this matter.

Appendix – Hydro One CIA Studies

This appendix is a collection of all Hydro One CIA studies submitted to the IESO as of the writing of this report. The studies show expected reversed power flow results at various transformer stations where EG facilities have been proposed. The results have been grouped by the different geographic zones on the IESO Controlled Grid.

A.1 East

Table A.1.1: Impact of New Generation on Flows at Picton TS

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T1 and T2; bus tie normally close)

		Light Load				Peak Load							
Criteria	Queue Position	MW	MX	PF at Generator Terminals	Voltage at PCC	MW	MX	PF at Generator Terminals	Voltage at PCC	EG Model & Manufacturer Name	# Units	MW of each unit	Total MW
NMS Readings		30.9	14.68			61.8	25.8						
Adept Readings		30.06	14.7			61.8	25.5						
ID 131a	1	21.2	17.93	0.961 Lead	1.047	52.74	24.74	1	1.038	GE/1.5SLE	6	1.5	9
ID 131b	2	12.91	22.09	0.963 Lead	1.05	44.12	25.2	1	1.06	GE/1.5SLE	6	1.5	9
ID 35	3	-9.97	29.37	0.996 Lead	1.045	21.12	32.16	0.996 Lead	1.04	GE/1.5SLE	16	1.5	24
ID 467	4	-19.1	35.79	0.911 Lead	1.03	11.57	32.8	1	1.053	Vestas V82	6	1.65	9.9

Table A.1.2: Impact of New Generation on Flows at Napanee TS Transformer T1

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T1 and T2; bus tie normally open)

		Light Load				Peak Load				EG Model &	Unit	Unit	Total
Criteria	Queue Position	MW	MX	PF at EG terminal	V_{PCC}(pu)	MW	MX	PF at EG terminal	V_{PCC}(pu)	Manufacturer	#	MW	MW
NMS Reading	-	14.8	4.6	-	-	38.3	14.8	-	-	-	-	-	-
Adept Reading	-	14.7	4.7	-	-	38.5	14.6	-	-	-	-	-	-
ID 1071	1	4.2	4.9	1	1.053	30.1	14.6	1	1.047	Satcon / Powergate	17	0.5	8.5

ID 1321	4	-3.2	8.7	0.94 Lead	1.05	20.3	18.1	1	1.054	Xantrex / GT 500E	20	0.5	10
ID 788	5	-12.6	13.5	0.93 Lead	1.05	10.8	22.6	0.93 Lead	1.049	Fuhrlaender / FL2500	4	2.5	10
ID 789	6	-20.2	14.7	1	1.051	3	23.3	1	1.024	Synchronous / DeWind D8.2	4	2	8

Table A.1.3: Impact of New Generation on Flows at Napanee TS Transformer T2

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T1 and T2; bus tie normally open)

		Light Load				Peak Load				EG Model &	Unit	Unit	Total
Criteria	Queue Position	MW	MX	PF at EG terminal	V_{PCC}(pu)	MW	MX	PF at EG terminal	V_{PCC}(pu)	Manufacturer	#	MW	MW
NMS Reading	-	6.7	1.8	-	-	34.3	13.1	-	-	-	-	-	-
Adept Reading	-	6.9	1.9	-	-	34.1	13.3	-	-	-	-	-	-
ID 1072	2	-2	2.2	1	1.05	26.6	12.8	1	1.026	Satcon / Powergate	15	0.5	7.5
ID 1073	3	-11.7	2.8	1	1.057	18.2	12.4	1	1.033	Satcon / Powergate	17	0.5	8.5
ID 1505	7	-17	2.5	1	1.056	9.8	12.6	1	1.038	Satcon / Powergate	17	0.5	8.5

Table A.1.4: Impact of New Generation on Flows at Smiths Falls TS

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T3 and T4; bus tie normally close)

		Light Load				Peak Load				EG Model &	Unit	Unit	Total
Criteria	Queue position	MW	MX	PF at EG Terminal	V_{PCC}(pu)	MW	MX	PF	V_{PCC}(pu)	Manufacturer	#	MW	MW
NMS Readings		41.1	16.2	-	-	98.8	48.2			-	-	-	-
Adept Readings		41.4	13.1	-	-	115.1	52.5			-	-	-	-
Merrickville GS*		40.6	13.0	1.0	1.037	114.3	52.3	1.0	1.001	Hydro	2	0.38	0.76
High Falls GS*		38.2	12.8	1.0	1.032	111.6	51.3	1.0	0.944	Hydro	3	0.8	2.4
ID:1200	1	28.2	13.3	1.0	1.046	101.5	51.5	1.0	1.032	Satcon	20	0.5	10
Id:1201	2	18.3	14.2	1.0	1.046	91.5	51.9	1.0	1.032	Satcon	20	0.5	10
ID:1204	3	8.3	14.9	1.0	1.046	81.4	52.1	1.0	1.024	Satcon	20	0.5	10
ID:1205	4	-1.5	16	1.0	1.051	71.4	52.7	1.0	1.024	Satcon	20	0.5	10
ID:1206	5	-11.4	16.9	1.0	1.056	61.4	53.4	1.0	1.046	Satcon	20	0.5	10
ID:1207	6	-21	19.7	0.9	1.052	51.7	56	1.0	1.054	Satcon	20	0.5	10

* These are the existing facilities on M26 and M23 feeder of Smith Falls TS.

Table A.1.5: Impact of New Generation on Flows at Port Hope TS

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T1 and T2; bus tie normally close)

Criteria	Queue position	Light Load				Peak Load				EG Model & Manufacturer	Unit #	Unit MW	Total MW
		MW	MX	PF at EG Terminal	V_{PCC}(pu)	MW	MX	PF at EG Terminal	V_{PCC}(pu)				
NMS Readings		16.08	7.04	-	-	31.04	10.56	-	-	-	-	-	-
Adept Readings		16.08	7.04	-	-	31.04	10.56	-	-	-	-	-	-
ID 914	1	6.973	7.12	0.999lag	1.053	21.13	10.381	0.999lag	1.043	Vestas V/82	6	1.65	9.9
ID 911	2	-2.875	7.145	0.999lag	1.049	11.105	9.969	0.999lag	1.028	Vestas V/82	6	1.65	9.9
ID 844	3	-12.538	7.893	0.992lag	1.059	1.316	9.912	0.992lag	1.043	Fuhrlaender FL 2500	4	2.5	10
ID 847	4	-21.929	13.193	0.982lead	1.05	-8.262	10.978	0.991lag	1.053	Fuhrlaender FL 2500	4	2.5	10
ID 845	5	-26.504	14.355	0.995lag	1.056	-12.939	11.769	0.995lag	1.052	Fuhrlaender FL 2500	2	2.5	5
ID 990 *	6	-28.482	16.078	0.819lead	1.05	-15.971	12.811	0.743lead	1.04	Solar HPE / HPE250XL	8	0.25	2
ID 701	7	-38.017	19.575	0.982lead	1.05	-25.668	13.373	0.999lag	1.054	Enercon E 82	5	2	10

* Note: The Project ID#990 is embedded at Newtonville DS

Table A.1.6: Impact of New Generation on Flows at R. L. Dobbin TS

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T3 and T4; bus tie normally close)

Criteria	Queue position	Light Load				Peak Load				EG Model & Manufacturer	Unit #	Unit MW	Total MW
		MW	MX	PF at EG Terminal	V_{PCC}(pu)	MW	MX	PF	V_{PCC}(pu)				
NMS Readings		34	14.5	-	-	101	43.6	-	-	-	-	-	-
Adept Readings		33.6	14.2	-	-	100.8	43.8	-	-	-	-	-	-
ID 242	1	25.7	14.8	1	1.048	92.819	44.174	1	1.039	VA Tech	2	4	8
ID 1215	2	15.8	15.1	0.998lead	1.05	83	44.4	0.988lead	1.049	Satcon/ AE-500-60-PV-HV	20	0.5	10
ID 1109	3	6.2	19.4	0.95lead	1.04	73.1	44.5	0.95lead	1.044	Fuhrlaender/ FL2500	4	2.5	10
ID 1110	4	-3.5	19.2	1	1.049	63.3	45.3	1	1.045	DeWind D8.2	5	2	10
ID 1111	5	-13.3	19.8	0.95lead	1.058	53.7	53.4	0.95lead	1.037	Fuhrlaender/ FL2500	4	2.5	10
ID 1112	6	-22.7	25.4	0.95lead	1.047	43.757	46.3	0.95lag	1.054	Fuhrlaender/ FL2500	4	2.5	10
ID 1113	7	-32.2	27.2	1	1.049	34.1	47.6	1	1.051	DeWind D8.2	5	2	10
ID 1358	8	-35.6	28.2	0.996lead	1.057	30.9	51.9	0.91lead	1.043	Enercon E82	2	2	4
ID 1359	9	-39.7	32	0.91lead	1.047	26.7	55.5	0.91lead	1.044	Vestas/V82	3	1.65	4.95
ID 1412	10	-49.6	32.2	0.995lead	1.049	16.7	55.5	0.995lead	1.04	Enercon E82	5	2	10

Table A.1.7: Impact of New Generation on Flows at ChestervilleTS

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T1 and T2; bus tie normally close)

Criteria	Queue position	Light Load				Peak Load				EG Model & Manufacturer	Unit #	Unit MW	Total MW
		MW	MX	PF at EG Terminal	V_{PCC}(pu)	MW	MX	PF	V_{PCC}(pu)				
NMS Readings		11.3	4.7	-	-	36.7	12.3			-	-	-	-
Adept Readings		11.3	4.7	-	-	36.7	12.3			-	-	-	-
ID 1191	1	1.4	4.7	1	1.05	26.8	12.2	1	1.05	Satcon/AE-500	20	0.5	10
ID 1192	2	-8.5	4.7	1	1.05	16.8	12.1	1	1.05	Satcon/AE-500	20	0.5	10
ID 1193	3	-18.4	4.7	1	1.05	6.9	12.1	1	1.05	Satcon/AE-500	20	0.5	10

A.2 Essa

Table A.2.1: Impact of New Generation on Flows at Wallace TS, T3 Transformer (Q BUS)

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T3 and T4; bus tie normally open)

Q Bus

Criteria	St'n Queue Position	Light Load				Peak Load				EG Model & Manufacturer	# Units	MW of each unit	Total MW
		MW	MX	PF at EG terminal	Vpcc (p.u.)	MW	MX	PF at EG terminal	Vpcc (p.u.)				
NMS Readings		4.32	1.2			15.2	6.16						
Adept Readings		4.47	1.06			15.14	6.75						
ID 31	1	3.86	1.05	1	1.029	14.47	6.61	1	0.997	Potencia Industrial	2	0.3	0.6

Table A.2.2: Impact of New Generation on Flows at Wallace TS, T4 Transformer (Y BUS)

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T3 and T4; bus tie normally open)

Y Bus

Criteria	St'n Queue Position	Light Load				Peak Load				EG Model & Manufacturer	# Units	MW of each unit	Total MW
		MW	MX	PF at EG terminal	Vpcc (p.u.)	MW	MX	PF at EG terminal	Vpcc (p.u.)				
NMS Readings		6.24	0.88			24.28	8.32						
Adept Readings		5.97	0.82			22.45	8.8						
ID 585	2	-2.49	5.97	0.95 lead	1.042	13.24	12.58	0.95 lead	1.047	ABB/ AMA 500L4 BAYH	4	2.3	9.2
ID 656	3	-8.39	15.39	0.92 lead	1.02	7.38	21.36	0.96 lead	0.936	GE/ 1.5 SLE 60 Hz	6	1.5	9
ID 695	4	-16.77	20.8	0.95 lead	1.019	-1.66	21.05	0.99 lag	1.008	GE/ 1.5 SLE 60 Hz	6	1.5	9

ID 549	5	-20.69	20.83	1	1.055	-5.66	20.85	1	1.026	ABB/ AMG560L4 and ABB/ AMG450S4	2	2.8 and 1.15	3.95

Table A.2.3: Impact of New Generation on Flows at Parry Sound TS

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T1 and T2; bus tie normally close)

Criteria		Light Load				Peak Load				EG Model &			
	Queue position	MW	MX	PF at EG terminal	Vpcc(pu)	MW	MX	PF at EG terminal	Vpcc(pu)	Manufacturer	# Units	MW of each unit	Total MW
NMS Readings		13.9	4.4			63.4	13.9						
Adept Readings		13.9	4.4			63.4	13.9						
ID 728	1	4.9	4.5	1	1.055	54.28	13.78	1	1.046	GE 1.5 SLE	6	1.5	9
ID 729	2	-4.2	4.6	1	1.055	45.18	13.83	1	1.05	GE 1.5 SLE	6	1.5	9
ID 730	3	-13.1	9.1	0.94 lead	1.05	36.2	13.85	1	1.054	GE 1.5 SLE	6	1.5	9
ID 731	4	-22	13.3	0.94 lead	1.05	27.23	14.04	1	1.057	GE 1.5 SLE	6	1.5	9

A.3 Northeast

Table A.3.1: Impact of New Generation on Flows at Dymond TS

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T3 and T4; bus tie normally close)

Criteria	Queue position	Light Load				Peak Load				EG Model &	Unit	Unit	Total
		MW	MX	PF at EG Terminal	V_{PCC}(pu)	MW	MX	PF	V_{PCC}(pu)	Manufacturer	#	MW	MW
NMS Readings		22.5	10.895	-	-	50.5	24.458	-	-	-	-	-	-
Adept Readings		22.5	10.895	-	-	50.5	24.458	-	-	-	-	-	-
OPG*		13.713	15.411	0.949lead	1.05	41.707	28.961	0.949lead	1.049	-	1	10.16	10.16
OPG*		8.009	16.725	1.0	1.06	35.998	29.965	1.0	1.06	-	1	6.6	6.6
ID 252	1	-0.455	22.844	0.951lead	1.053	27.529	36.374	0.951lead	1.05	INDAR	2	4.75	9.50
ID 1119	2	-10.44	22.846	0.9911ag	1.05	17.501	36.265	0.9911ag	1.045	SMA/FirstSolar	10	1	10
ID 1326	3	-20.39	22.925	0.9911ag	1.052	7.487	36.184	0.9911ag	1.045	SMA/FirstSolar	10	1	10

* These are the existing facilities on M3 feeder of Dymond TS.

Table A.3.2: Impact of New Generation on Flows at Kapuskasing TS

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T5 or T6; bus tie normally close)

Criteria	St'n Queue Position	Light Load				Peak Load				Manufacturer name	# Units	MW of each unit	Total MW
		MW	MX	PF at EG terminal	Vpcc (p.u.)	MW	MX	PF at EG terminal	Vpcc (p.u.)				
NMS Readings		9.3	-7			28.6	5						
Adept Readings		9.2	0.8			27.5	7.5						
ID 67	1	-0.4	1.5	0.996 lagging	1.051	17.5	6.5	0.996 lagging	1.046	Basler	4	2.5	10
ID 68	2	-10	1.65	0.993 lagging	1.057	7.8	6.6	0.993 lagging	1.055	Basler	4	2.5	10

A.4 Northeast - Manitoulin

Table A.4.1: Impact of New Generation on Flows at Manitoulin TS

Generation on T3 - J

Projects	Light Load		Peak Load		Type of generator	Manufacturer name	Units MW	Total MW	Feeder Impedance: From Station to PCC	
	MW	MX	MW	MX					R1/X1	R0X0
No EG	3.6	1.7	11.7	5.8						
ID 130a	-5.2	1.8	3.0	5.2	doubly fed induction	GE/1.5SLE	6 x 1.5	9	3.7/5.2	5.7/21
ID 130b	-13.9	2.1	-6.0	5.1	doubly fed induction	GE/1.5SLE	6 x 1.5	9	3.7/5.2	5.7/21
ID 11a	-15.5	2.1	-7.8	4.8	synchronous(SPC)	Enercon/E-48	2 x 0.8	1.6	16.7/23.1	25.1/90.3
ID 11bi	-21.3	6.6	-14.4	4.3	synchronous(SPC)	Enercon/E-70	4 x 2	6.5	11.4/15.4	17.2/61.6

Generation on T4 - Q

Projects	Light Load		Peak Load		Type of generator	Manufacturer name	Units MW	Total MW	Feeder Impedance: From Station to PCC	
	MW	MX	MW	MX					R1/X1	R0X0
No EG	3.8	1.8	15.9	8.1						
ID 130c	-5.2	1.9	6.8	8.0	doubly fed induction	GE/1.5SLE	6 x 1.5	9	3.7/5.2	5.7/21.0
ID 130d	-14.0	2.1	-2.2	8.0	doubly fed induction	GE/1.5SLE	6 x 1.5	9	3.7/5.2	5.72/21.0
ID 177a	-21.2	7.9	-10.1	7.8	synchronous(SPC)	Enercon/E-82	4 x 2	8	11.4/15.4	17.2/61.6

A.5 Northwest

Table A.5.1: Impact of New Generation on Flows at Fort Williams TS

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T1 and T2; bus tie normally close)

Criteria	Queue Position	Light Load				Peak Load				EG Model & Manufacturer	Unit #	Unit MW	Total MW
		MW	MX	PF at EG Terminal	V_{PCC}(pu)	MW	MX	PF	V_{PCC}(pu)				
NMS Reading	-	29.6	14.3	-	-	86.6	46.4	-	-	-	-	-	-
Adept Reading	-	28.9	14.1	-	-	85.5	45.5	-	-	-	-	-	-
ID 862	-	1.64	16.28	1	1.03	57.13	44.11	1	0.951	Enercon / E-82	5	2	10
ID 865	-	-1.44	16.6	0.886 Lead	1.03	54.04	44.43	0.891 Lead	1.03	Synchronous / Caterpillar	2	1.6	3.2
ID 863	-	-11.14	17.99	1	1.05	44.34	45.8	1	1.049	Enercon / E-82	5	2	10
ID 864	-	-20.85	19.35	1	1.049	34.61	47.09	1	1.046	Enercon / E-82	5	2	10

A.6 Ottawa

Table A.6.1: Impact of New Generation on Flows at Longueuil TS

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T3 and T4; bus tie normally close)

Criteria	Queue position	Light Load				Peak Load				EG Model & Manufacturer	Unit #	Unit MW	Total MW
		MW	MX	PF at EG Terminal	V_{PCC}(pu)	MW	MX	PF	V_{PCC}(pu)				
NMS Readings		13.5	8.0	-	-	75.0	35.0	-	-	-	-	-	-
Adept Readings		13.2	5.7	-	-	74.0	35.3	-	-	-	-	-	-
ID 927	1	3.4	6.5	1.0pf	1.06	63.6	34.8	1.0pf	1.004	SatCon	20	0.5	10
ID 964	2	-5.7	12.5	0.94 lead	1.05	53.9	35.9	1.0pf	1.028	SatCon	20	0.5	10
ID 965	3	-14.2	20.2	0.94 lead	1.03	44.8	38.2	1.0pf	1.045	SatCon	20	0.5	10

Table A.6.2: Impact of New Generation on Flows at St.Isidore TS

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T3 and T4; bus tie normally close)

Criteria	Queue Position	Light Load				Peak Load				EG Model & Manufacturer	Unit #	Unit MW	Total MW
		MW	MX	PF at EG Terminal	V_{PCC} (pu)	MW	MX	PF	V_{PCC} (pu)				
NMS Reading	-	16.4	4.3	-	-	69.7	19.2	-	-	-	-	-	-
Adept Reading	-	16.0	4.8	-	-	70.2	20.4	-	-	-	-	-	-
ID 1074	1	8.7	3.3	0.99 lead	1.056	62.8	18.8	0.99 lead	1.055	GE 1.5 SLE	5	1.5	7.5
ID 891	2	4.5	3.3	Unity	1.045	58.5	19.0	Unity	1.018	Stamford	4	1.06	4.24
ID 1211	3	-5.3	2.9	Unity	1.059	48.7	18.8	Unity	1.044	Satcon - AE-500-60-PV-HV	20	0.5	10
ID 1212	4	-15.2	2.8	Unity	1.052	38.6	19.0	Unity	1.042	Satcon - AE-500-60-PV-HV	20	0.5	10
ID 1214	5	-23.2	2.8	Unity	1.051	30.7	19.0	Unity	1.051	Satcon - AE-500-60-PV-HV	16	0.5	8

A.7 Southwest

Table A.7.1: Impact of New Generation on Flows at Meaford TS

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T1 and T2; bus tie normally close)

Criteria	Queue Position	Light Load				Peak Load				Manufacturer name	# Units	MW of each unit	Total MW
		MW	MX	PF at EG Terminal	V_{PCC}(pu)	MW	MX	PF at EG Terminal	V_{PCC}(pu)				
NMS Reading		10	5.6			43.3	24.6						
Adept Reading		10	5.6			43.3	24.6						
ID # 165	1	8.3	5.4	1	1.036	41.5	24.2	0.99	1	Vestas V82	1	1.65	
ID # 4	2	-0.1	10.96	0.92	1.044	32.5	24.1	1	1.059	GE /1.5	6	9	6.3/19.1
ID # 5	3	-7.7	18.9	0.89	1.055	24.3	29.9	0.92	1.05	GE /1.5	6	9	8.0/17.7
ID # 109	4	-15.9	25.3	0.99	1.053	15.6	34.6	1	1.059	Enercon 82	5	10	6.9/14.9

Table A.7.2: Impact of New Generation on Flows at Orangeville DESN-1 (JQ Bus)

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T1 and T2; bus tie normally close)

Criteria	Queue Position	Light Load				Peak Load				Manufacturer name	Unit #	Unit MW	Total MW
		MW	MX	PF at EG Terminal	V_{PCC}(pu)	MW	MX	PF	V_{PCC}(pu)				
NMS Reading		7.2	4.1			17.4	10						
Adept Reading		7.3	4.1			17.5	10.1						
ID # 153 -C	1	-1.4	6.9	0.98 lead	1.036	8.4	9.1	0.99 lag	1.006	GE/ 1.5	6	1.5	9
ID # 153 -D	2	-9.6	10.7	0.98 lead	1.035	-0.3	8.7	0.99 lag	1.03	GE/ 1.5	6	1.5	9
ID # 153 -E	3	-14.6	14	0.98 lead	1.031	-6	8.7	0.99 lag	1.046	GE/ 1.5	4	1.5	6
ID # 113	4	-22.6	23.8	0.93 lead	1.001	-14.8	11.6	1	1.055	Enercon E-82	5	2	10

Table A.7.3: Impact of New Generation on Flows at Orangeville DESN-1 (EZ Bus)

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T3 and T4; bus tie normally close)

Criteria	Queue Position	Light Load				Peak Load				Manufacturer name	Unit #	Unit MW	Total MW
		MW	MX	PF at EG Terminal	V_{PCC}(pu)	MW	MX	PF	V_{PCC}(pu)				
NMS Reading		10.4	4.4			26.4	6.4						
Adept Reading		10.4	4.4			26.4	6.4						
ID # 365	1	8.9	4.4	1	1.045	24.9	6.3	1	1.045	GE/ 1.5	1	1.5	1.5

Table A.7.4: Impact of New Generation on Flows at Orangeville DESN-2

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T3 and T4; bus tie normally close)

Criteria	Queue Position	Light Load				Peak Load				Manufacturer name	Unit #	Unit MW	Total MW
		MW	MX	PF at EG Terminal	V_{PCC}(pu)	MW	MX	PF	V_{PCC}(pu)				
NMS Reading		29.2	15.1			93.7	-26.5						
Adept Reading		29.2	15			94.3	-26.8						
ID # 153 -A	1	20.6	19.2	0.93	1.037	85.4	-27.4	1	1.029	GE/ 1.5	6	1.5	9
ID # 153 -B	2	12.4	24.3	0.93	1.031	76.7	-27.5	1	1.047	GE/ 1.5	6	1.5	9
ID # 154	3	2.6	29.7	0.93	1.045	66.6	-25.3	0.99	1.025	Enercon E-82	5	2	10
ID # 6-B	4	-5.4	36.2	0.93	1.021	58	-24.7	1	1.06	GE/ 1.5	6	1.5	9
ID # 36	5	-14.1	39.7	0.98	1.053	58.9	-21.7	0.97	1.029	GE/ 1.5	6	1.5	9
ID # 51	6	-23.1	41.2	1	1.05	39.8	-20.4	1	1.042	Vestas V-82	6	1.65	9.9

A.8 West

Table A.8.1: Impact of New Generation on Flows at Strathroy TS

Bus BQ (Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T1 and T2; bus tie normally close)

Criteria	Queue position	Light Load				Peak Load				EG Model & Manufacturer Name	# Units	MW of each unit	Total MW
		MW	MX	PF at EG terminal	Vpcc (p.u.)	MW	MX	PF at EG terminal	Vpcc (p.u.)				
NMS Readings		13.3	6.0			48.5	25.0						
Adept Readings		13.3	5.6			48.2	24.3						
ID 1042	1	4.6	8.9	0.96 lead	1.05	39.5	28	0.99 lead	1.05	Induction, GE 1.5	6	1.5	9
ID 1043	2	-3.5	13	0.98 lead	1.05	31.2	30	0.98 lead	1.05	Induction, GE 1.5	6	1.5	9
ID 1044	3	-12.2	16.5	0.95 lead	1.05	22.5	33.4	0.95 lead	1.05	Induction, GE 1.5	6	1.5	9
ID 892	4	-14.1	16.8	1	1.05	20.6	33.6	1	1.049	Inverter, Enercon	1	2	2
ID 1282	5	-23.7	18	1	1.058	10.9	34.9	1	1.057	Solar, SatCon	20	0.5	10

Table A.8.2: Impact of New Generation on Flows at Belle River TS

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T1 and T2; bus tie normally close)

Criteria	Queue	Light Load	Peak Load	EG Model &	# Units	MW	Total

	position	MW	MX	PF at Generator Terminals	Volatge at PCC	MW	MX	PF at EG terminal	Voltage at PCC	Manufacturer Name		of each unit	MW
NMS Readings		7.3	2.1			34.6	8.6						
Adept Readings		7.4	2.2			34.3	9.7						
ID 8	1	-2	7.2	0.945 Lead	1.03	24.4	9	1	1.035	Enercon E82	5	2	10
ID 556	2	-11.5	13.92	0.91 Lead	1.032	14.9	15.24	0.91 Lead	1.031	Vestas	6	1.65	9.9
ID 994	3	-20.83	18.868	0.95 Lead	1.031	5.2	19.84	0.955 Lead	1.029	Enercon E82	5	2	10

Table A.8.3: Impact of New Generation on Flows at Forest Jura HVDS

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T1 and T2; bus tie normally open)

		Light Load				Peak Load							
Criteria	Queue Position	MW	MX	PF at Generator Terminals	Volatge at PCC	MW	MX	PF at EG terminal	Volatge at PCC	EG Model & Manufacturer Name	# Units	MW of each unit	Total MW
NMS Readings		1.6	0.4			3.78	1.2						
Adept Readings		1.61	0.362			3.82	0.603						
ID 27	1	-8.133	1.73	0.995Lead	1.058	-5.79	2.018	Unity	1.059	Vestas V82	6	1.5	9.9
ID 69a	2	-14.56	4.42	0.97 Lead	1.057	-12.23	4.541	0.973 Lead	1.057	Vestas V82	4	1.5	6.6

Table A.8.4: Impact of New Generation on Flows at J.Clarke Keith TS

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T22 and T23; bus tie normally close)

Criteria	Queue Position	Light Load				Peak Load				EG Model & Manufacturer	Unit #	Unit MW	Total MW
		MW	MX	PF at EG Terminal	V_{PCC} (pu)	MW	MX	PF	V_{PCC} (pu)				
NMS Reading	-	16.0	6.0	-	-	65.3	31.2	-	-	-	-	-	-
Adept Reading	-	15.6	5.9	-	-	64.1	30.1	-	-	-	-	-	-
ID 524	1	5.7	6.2	Unity	1.054	53.7	28.1	Unity	1.035	Enercon E82	5	2	10
ID 689	2	-4.2	6.9	Unity	1.045	43.6	28.0	Unity	1.035	Satcon - AE-500-60-PV-HV	20	0.5	10
ID 1053	3	-12.6	8.0	Unity	1.055	33.9	29.0	Unity	1.037	Satcon - AE-500-60-PV-HV	20	0.5	10
ID 1136	4	-23.1	9.7	Unity	1.048	23.3	28.8	Unity	1.002	Satcon - AE-500-60-PV-HV	20	0.5	10
ID 1137	5	-27.7	11.6	Unity	1.052	18.5	29.6	Unity	1.012	Satcon - AE-500-60-PV-HV	10	0.5	5
ID 1172	6	-37.0	18.6	0.912 lead	1.03	8.9	33.4	Unity	1.048	Satcon - AE-500-60-PV-HV	20	0.5	10

Table A.8.5: Impact of New Generation on Flows at Lauzon TS DESN I

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T5 and T6; bus tie normally close)

Criteria	Queue	Light Load	Peak Load	EG Model &	Unit	Unit	Total

	Position	MW	MX	PF at EG Terminal	V_{PCC}(pu)	MW	MX	PF	V_{PCC}(pu)	Manufacturer	#	MW	MW
NMS Reading	-	24.9	11.7	-	-	114.8	57	-	-	-	-	-	-
Adept Reading	-	24.8	11.8	-	-	114.2	57.2	-	-	-	-	-	-
ID 1067	1	15	13	1	1.058	104.22	57.46	1	1.03	Enercon / E 82	5	2	10
ID 1068	2	5.7	19.7	0.91	1.03	94.59	59.14	1	1.04	Enercon / E 82	5	2	10

Table A.8.6: Impact of New Generation on Flows at Lauzon TS DESN II

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T7 and T8; bus tie normally close)

		Light Load				Peak Load							
Criteria	St'n Queue Position	MW	MX	PF at EG Terminals	V at PCC	MW	MX	PF at EG Terminals	V at PCC	EG Model and Manufacturer	# Units	MW of each unit	Total MW
NMS Readings		25	12.1			121.262	21.28						
Adept Readings		25	12.1			121.267	21.27						
ID 88	1	15.197	12.797	1	1.057	111.202	20.856	1	1.038	Enercon/E-82	5	2	10
ID 89	2	5.484	16.523	0.968 lead	1.053	100.123	18.64	1	1.05	Enercon/E-82	5	2	10
ID 897	3	-3.499	19.977	0.99 lead	1.049	90.899	21.1	1	1.048	Vestas/V-82	6	1.65	9.9
ID 822	4	-13.26	20.013	1	1.056	80.99	20.492	1	1.031	Enercon/E-82	5	2	10
ID 960	5	-13.97	18.63	1	1.06	84.05	26.97	1	1.059	Kohler/Reozm	1	1	1
ID 961	6	-14.16	20.25	1	1.046	81.81	38.71	1	1.022	Kohler/Reozm	1	1	1
ID 995	7	-24.16	21.58	1	1.049	73.36	28.48	1	1.054	Enercon/ E-82	5	2	10
ID 1036	8	-34.24	29.6	0.97 lead	1.03	61.67	42.44	0.98 lead	1.03	Vestas / V82	6	1.65	9.9

Table A.8.7: Impact of New Generation on Flows at Lambton TS, Transformer T5

(Vlight = 1.05pu; Vpeak = 1.05pu; Transformer T5)

		Light Load				Peak Load							
Criteria	Queue position	MW	MX	PF at EG terminal	Vpcc (p.u.)	MW	MX	PF at EG terminal	Vpcc (p.u.)	EG Model and manufacturer	# Units	MW of each unit	Total MW
NMS Readings		12.8	3.7			35.4	18.9						
Adept Readings		12.78	3.708			35.4	18.9						
ID 1007	1	2.927	4.666	1	1.049	25.283	18.765	1	1.007	Satcon/AE-500	20	0.5	10
ID 1008	2	-6.688	6.563	1	1.055	15.41	19.667	1	1.016	Satcon/AE-500	20	0.5	10
ID 856	3	-16.11	8.909	0.998 lag	1.051	5.648	19.173	0.996 lag	1.049	Goldwind/77 & 92	5 x 1.5 + 1 x 2.5	1.5 & 2.5	10
ID 1100	4	-25.97	9.842	1	1.052	-4.287	19.809	1	1.039	Satcon/AE-500	20	0.5	10
ID 1101	5	-35.64	11.475	1	1.058	-14.028	21.179	1	1.045	Satcon/AE-500	20	0.5	10

ID 807	6	-43.9	18.253	0.996 lag	1.031	-22.58	27.097	0.998 lag	1.03	Enercon/E-82	5	2	10

Table A.8.8: Impact of New Generation on Flows at Lambton TS, Transformer T6

(Vlight = 1.05pu; Vpeak = 1.05pu; Transformer T6)

		Light Load				Peak Load							
Criteria	Queue position	MW	MX	PF at EG terminal	Vpcc (p.u.)	MW	MX	PF at EG terminal	Vpcc (p.u.)	EG Model and manufacturer	# Units	MW of each unit	Total MW
NMS Readings		22.2	8.8			36.8	12.9						
Adept Readings		22.2	8.7			36.8	12.8						
ID 1141	7	12.42	8.796	0.997 lag	1.04	27.026	12.885	0.997 lag	1.052	Enercon/E-82	5	2	10
ID 1142	8	2.672	9.062	0.997 lag	1.042	17.274	13.151	0.997 lag	1.054	Enercon/E-82	5	2	10

Table A.8.9: Impact of New Generation on Flows at Tillsonburg TS

		Light Load				Peak Load				EG Model &			
Criteria	Queue Position	MW	MX	PF at EG terminal	Vpcc(pu)	MW	MX	PF at EG terminal	Vpcc(pu)	Manufacturer	# Units	MW of each unit	Total MW
NMS Readings		30.1	15.8			93.8	47.4						
Adept Readings		28.2	14.4			92.2	44.2						
ID 281	1	18.9	17.8	0.852 lead	1.05	82.5	44.6	0.849 lead	1.035	Vestas V82	6	1.65	9.9
ID 282	2	11.1	26.6	0.851 lead	1.044	73.8	48.8	0.845 lead	1.06	Vestas V82	6	1.65	9.9
ID667	3	2.1	32.1	0.853 lead	1.045	64.0	49.5	0.852 lead	1.046	Vestas V82	6	1.65	9.9
ID668	4	-7.5	33.8	0.851lead	1.047	54.3	49.7	0.851 lead	1.038	Vestas V82	6	1.65	9.9
ID511	5	-16.4	40.1	0.952 lead	1.049	44.9	53.5	0.986 lead	1.045	Enercon E82	5	2	10
ID881	6	-25.7	44.65	0.963 lead	1.029	35.1	53.7	1	1.044	Fuhrlaender FL2500	4	2.5	10
ID693	7	-35.5	47.6	0.981 lead	1.039	25.1	55.6	1	1.039	Enercon E82	5	2	10

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T1 and T2; bus tie normally closed)

Table A.8.10: Impact of New Generation on Flows at St.Thomas TS

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T3 and T4; bus tie normally close)

Criteria	Queue position	Light Load				Peak Load				EG Model & Manufacturer	# Units	MW of each unit	Total MW
		MW	MX	PF at EG terminal	Vpcc (p.u.)	MW	MX	PF at EG terminal	Vpcc (p.u.)				
NMS Readings		6.2	3.9			17.5	11.1						
Adept Readings		5.4	2.4			16.3	10.2						
West Lorne Co-gen		3.1	1.9	1	1.06	14.5	9.4	1	0.98	West Lorne	1	2.5	2.5
ID:1014	1	6.4	4.3	0.992 lead	1.04	3.9	8.2	1	0.99	Saturn Power	5	2	10
ID:1169	2	-14.7	10.9	0.988 lead	1.05	-5.2	11.8	0.99 lead	1.01	Greengate Power	5	2	10

Table A.8.11: Impact of New Generation on Flows at Kent TS B Bus

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T1-B and T2-B; bus tie normally closed)

Criteria	Queue position	Light Load				Peak Load				EG Model & Manufacturer	Unit #	Unit MW	Total MW
		MW	MX	PF at EG Terminal	V_{PCC}(pu)	MW	MX	PF	V_{PCC}(pu)				
NMS Readings		19.937	7.921	-	-	39.988	12.796	-	-	-	-	-	-
Adept Readings		19.937	7.921	-	-	39.988	12.796	-	-	-	-	-	-
ID 49	1	10.421	12.342	0.96 lead	1.05	30.113	13.879	0.998 lead	1.05	Enercon E82	5	2	10
ID 163	4	2.145	18.091	0.987 lead	1.05	21.510	19.087	0.986 lead	1.05	Vestas V82	6	1.65	9.9
ID 182	5	-7.006	22.141	0.985 lead	1.05	11.568	19.894	1	1.008	Vestas V82	6	1.65	9.9
ID 487	10	-13.833	27.14	0.986 lead	1.05	3.95	21.087	1	1.05	Satcon/ AE-500-60-PV-HV	17	0.5	8.5
ID 537	11	-23.458	30.187	0.987 lead	1.05	-5.897	22.859	0.994 lead	1.05	Vestas V82	6	1.65	9.9

Table A.8.12: Impact of New Generation on Flows at Kent TS Y Bus

(Vlight = 1.05pu; Vpeak = 1.05pu); Transformers: T1-Y and T2-Y; bus tie normally closed)

Criteria	Queue position	Light Load				Peak Load				EG Model & Manufacturer	Unit #	Unit MW	Total MW
		MW	MX	PF at EG Terminal	V_{PCC}(pu)	MW	MX	PF at EG Terminal	V_{PCC}(pu)				
NMS Readings		16.015	7.071	-	-	34.652	15.290	-	-	-	-	-	-
Adept Readings		16.015	7.071	-	-	34.652	15.290	-	-	-	-	-	-
ID 38	2	6.43	10.258	0.979 lead	1.05	24.556	14.856	0.998 lead	1.038	Enercon E82	5	2	10
ID 76	3	-3.242	13.018	0.99 lead	1.05	13.692	12.761	0.998 lead	1.009	Enercon E82	5	2	10
ID 273	6	-12.761	16.421	0.977 lead	1.05	3.716	13.338	0.999 lead	1.05	Enercon E82	5	2	10

ID 274	7	-21.221	22.321	0.97 lead	1.05	-5.093	18.869	0.96 lead	1.05	Enercon E82	5	2	10
ID 184	8	-29.871	27.707	0.978 lead	1.05	-14.164	22.658	0.99 lead	1.05	Vestas V82	6	1.65	9.9
ID 441	9	-33.809	30.292	0.96 lead	1.05	-18.662	22.461	0.999 lag	1.028	GE / 1.5 sle	3	1.5	4.5

Table A.8.13: Impact of New Generation on Flows at Wanstead TS

B Bus

Criteria	Light Load		Peak Load		Type of generator	Manufacturer name	# Units	MW of each unit	Total MW	Feeder Impedance: From Station to PCC	
	MW	MX	MW	MX						R1/X1	R0X0
NMS Readings	6.355	2.09	14.976	6.355							
Adept Readings	5.89	2.289	13.921	6.273							
ID 571	-3.975	2.895	3.924	6.497	SPC	Enercon E-82	5	2	10	1.5/4.4	3.9/12.3
ID 589	-13.671	4.007	-5.786	7.551	SPC	Enercon E-82	5	2	10	0.6/2.3	1.6/6.2
ID 598	-18.429	4.311	-10.58	7.734	Synchronous	Caterpillar SR4	6	0.8	4.8	1.0/3.7	2.7/10.0

Y Bus

Criteria	Light Load		Peak Load		Type of generator	Manufacturer name	# Units	MW of each unit	Total MW	Feeder Impedance: From Station to PCC	
	MW	MX	MW	MX						R1/X1	R0X0
NMS Readings	6.385	2.0986	26.3	8.644							
Adept Readings	6.214	2.071	26.242	9.485							
ID 590.	-3.146	8.745	16.308	9.626	SPC	Enercon E- 82	5	2	10	4.5/8.3	9.9/23.3

Table A.8.14: Impact of New Generation on Flows at Modeland TS

Criteria	Light Load		Peak Load		Type of generator	Manufacturer name	# Units	MW of each unit	Total MW	Feeder Impedance: From Station to PCC	
	MW	MX	MW	MX						R1/X1	R0X0
NMS Readings	40.2	19.4	116.5	55.7							
Adept Readings	39.8	19.1	116.1	55.4							
ID 551	30.62	21.17	106.82	59.55	SPC	Satcon	10	1	10	0.88/4.45	3.33/13.89
ID 553	20.72	22.01	96.86	60.19	SPC	Satcon	10	1	10	0.79/3.89	2.87/11.14
ID 554	10.97	23.37	87.05	61.33	SPC	Satcon	10	1	10	0.66/3.62	2.66/1077
ID 769	9.43	23.63	87.51	61.57	Synchronous	Caterpillar	1	1.6	1.6	0.88/4.45	3.33/13.89
ID 1012	-0.63	23.9	75.17	60.94	SPC	Satcon	10	1	10	1.06/5.16	3.58/15.60
ID 1013	-10.42	20.12	65.08	56.17	SPC	Satcon	10	1	10	1.06/5.16	3.58/15.60
ID 1183	-20	26.7	55.41	62.61	SPC	Satcon	20	0.5	10	0.79/3.89	2.87/11.14

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