

Ontario Transmission System



Power to Ontario. On Demand.

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1.0 Introduction

The Ontario Electricity Market Rules (Chapter 5) require that the Independent Electricity System Operator (IESO) provide forecasts and assessments of the reliability of the existing and committed resources and transmission facilities of the Ontario Market. These forecasts and assessments of the Ontario Electricity System are contained in the IESO 18-Month Outlook, which is released quarterly.

The Ontario Transmission system document is intended to complement the transmission assessments contained in the 18-Month Outlook by providing specific details on the Ontario transmission system, including the transfer capabilities of major internal transmission interfaces and interconnections with neighbouring jurisdictions. Unless indicated otherwise, these transfer capabilities are considered to be representative of both the current transfer capability as well as the anticipated transfer capability during the time horizon of this Outlook.

This document is published twice a year in the second and fourth quarters, alongside the 18-Month Outlook, and is organized in three sections as follows:

The first section discusses the geographical zones of the power transmission system in Ontario. The primary characteristics of each zone are summarized.

The second section discusses Ontario's major internal transmission interfaces. Transfer capability limits of each interface are provided. These limits are representative of both the current transfer capability as well as the anticipated transfer capability of the interfaces during the time horizon of this Outlook. The historical flow distribution on each interface during the previous twelve months is provided in graphical format.

The third section discusses Ontario's transmission interconnections with neighbouring jurisdictions. Transfer capability limits of each interconnection are provided. These limits are representative of both the current transfer capability as well as the anticipated transfer capability of the interconnections during the time horizon of this Outlook. The historical flow distribution on each interconnection during the previous twelve months is provided in graphical format.

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- End of Section -

2.0 Transmission Zones

The Ontario transmission system is mainly comprised of a 500 kV transmission network, a 230 kV transmission network and several 115 kV transmission networks. It is divided into ten zones whose characteristics are described in Section 2.1 below. Zonal boundaries have been chosen to correspond with the major interfaces described in Section 3.0. Figure 2.1.1 shows the geographical zones in Ontario's power transmission system.

2.1 Zone Characteristics

Bruce Zone

- The total resources are much greater than the zone peak demand.
- The generation is mostly nuclear, and some wind.
- There are no external interconnections.

East Zone

- The total resources exceed the zone peak demand.
- The generation is a mix of hydroelectric, oil, gas and some wind.
- The zone is connected externally to the Quebec grid via ties that are used to switch load or generation radially onto either system.
- The zone is also connected externally to the St. Lawrence interface with New York via phase angle regulator control.

Essa Zone

- The total resources are much less than the zone peak demand.
- The generation is totally hydroelectric.
- For analytical purposes, Des Joachims generation and load, which is physically located in the East zone, has been modeled to be part of the Essa zone. There are no external interconnections.

Niagara Zone

- The total resources are much higher than the zone peak demand.
- The generation is mostly hydroelectric with some gas.
- There is a free-flowing interconnection with New York.

Northeast Zone

- The total resources exceed the zone peak demand.
- The generation is mainly hydroelectric with some cogeneration, wind and wood waste.
- The existing interconnections with Quebec are radial.

Northwest Zone

- The total resources generally exceed the zone peak demand.
- The generation is mainly hydroelectric with some coal gas, wind and biomass.
- The zone is externally connected to the Manitoba and Minnesota systems.
- The 230 kV Manitoba interconnections and the Minnesota 115 kV interconnection are controlled by phase angle regulators. The Manitoba 115 kV interconnection is radial.

Ottawa Zone

- The total resources are much less than the zone peak demand.
- The generation is cogeneration.
- The interconnections with Quebec consist of the two 115 kV circuits, three 230 kV circuits, and the new 230 kV circuits A41T and A42T. The first five interconnections are radial, while the new two interconnections are bidirectional, connecting Ontario to Quebec through two back-to-back HVDC convertors located at Outaouais station, in Quebec.

Southwest Zone

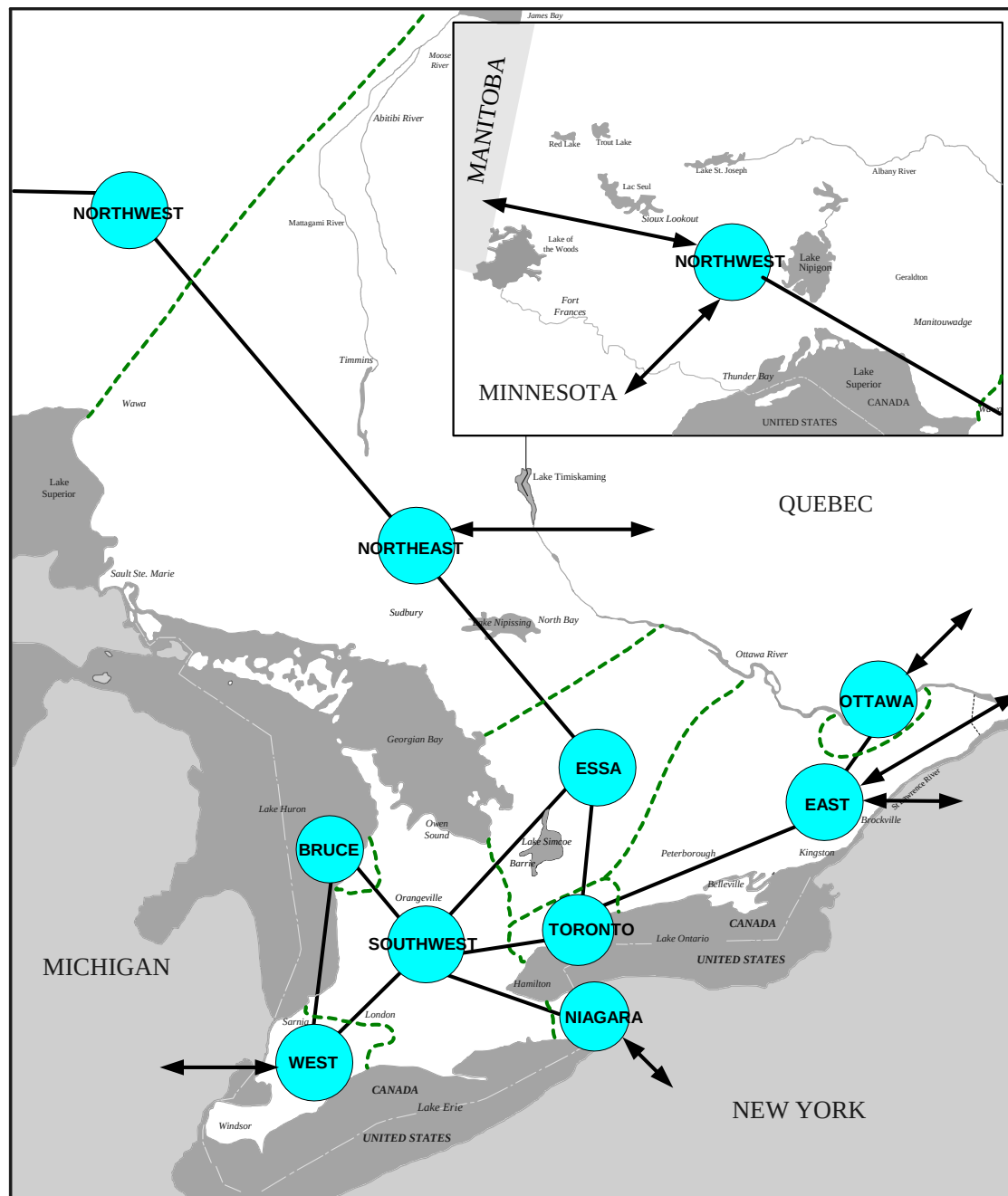
- The total resources are generally balanced with the zone peak demand.
- The generation is mostly coal with some wind.
- There are no external interconnections.

Toronto Zone

- The total resources are less than the zone peak demand.
- The generation is mostly nuclear with some gas.
- There are no external interconnections.

West Zone

- The total resources generally exceed the zone peak demand.
- The generation is mostly coal and gas with some wind.
- The zone is externally connected to the Michigan system.
- The Michigan interconnection is controlled by phase angle regulators.

Figure 2.1.1 Geographical Zones in Ontario's Power Transmission System

- End of Section -

3.0 Transmission Interfaces

There are nine major internal interfaces in the Ontario transmission system. The characteristics of each interface are described in Section 3.2. Figures 3.3.1 provides a geographic depiction of Ontario's internal transmission zones and major transmission interfaces. Operating security limits for these interfaces are also included in Figures 3.3.1 as well as in Table 3.3. The interface limits are used to ensure system and/or plant stability, acceptable pre-contingency and post-contingency voltage levels and/or acceptable thermal loading levels.

Detailed information on interface definitions and limits can be found in IESO System Control Orders (SCOs). The release of SCO limit related information to market participants will be considered by the IESO on a need to know and case by case basis. Requests for further information should be directed to the IESO Customer Relations.

3.1 Interface Definitions

Interfaces are defined by grouping one or more lines for the purpose of measuring their combined flow and enforcing a power flow limit or, as it is more commonly called, an interface limit. Interface limits are directional and interfaces may have limits imposed in one or both directions.

3.2 Interface Characteristics

The EWTE/EWTW Interface

The East-West Transfer East (EWTE) and East-West Transfer West (EWTW) flows are functionally related to the power flows between Ontario and Manitoba, and Ontario and Minnesota. In this relationship, the Ontario – Manitoba and Ontario – Minnesota flows can be generally thought of as the independent variables as they are under phase angle regulator control and can be adjusted to permit increased EWTE or EWTW flows.

The maximum limits on the East-West tie are 325 MW to the east and 350 MW to the west. The EWTE and EWTW interfaces are constrained by voltage and stability limitations. A sample of historical flow distribution on the East West Interface is shown in Figure 3.3.2.

The FN/FS Interface

The Flow South (FS) limit is 1,550 MW and the Flow North (FN) limit is 1,900 MW. The Flow North and Flow South interfaces are constrained by voltage and stability limits respectively. A sample of historical flow distribution on the FN/FS interface is shown in Figure 3.3.2.

The CLAN/CLAS Interface

The Claireville North (CLAN) limit is 2,000 MW and the Claireville South (CLAS) limit is 1,000 MW. These limits have been defined to determine the boundary conditions for which the other system limits, in particular FABCW, are valid. A sample of historical flow distribution on the CLAN/CLAS interface is shown in Figure 3.3.2.

The FABCW Interface

The Flow Away from Bruce Complex plus Wind (FABCW) is the sum of power flows away from the Bruce Complex plus the power output from the wind farms near the Bruce zone. The limit depends on the number of Bruce units in-service, the BLIP/NBLIP interface flow, the sum of the QFW interface flow and the output of Nanticoke generating station, as well as a number of other system parameters. The FABCW limit is required for preserving system and/or plant transient stability, and to protect against post-contingency voltage collapse in Southwestern Ontario. Separate stability and voltage limits are defined for each recognized contingency. With the two new Bruce-Milton lines now in service, the FABCW interface limit is 6,550 MW, based on the most restrictive contingency. The unavailability of transmission elements and other system parameters such as reactive support provided from major generating stations and reactor switching may result in a lower limit.

The FABCW limit can be improved through the use of generation rejection (G/R) of Bruce 500 kV units. The resulting limit improvements with G/R are not specified in this document, but are described in detail in the appropriate SCO.

A sample of historical flow distribution on the FABCW interface is shown in Figure 3.3.2.

The BLIP/NBLIP Interface

Buchanan Longwood Input (BLIP) interface is limited to 3,000 MW to the west due to stability and voltage limitations. The Negative Buchanan Longwood Input (NBLIP) interface limit is a function of a variety of parameters. Normally the limit is near its high end of about 1,500 MW. The interface is typically constrained by voltage limitations. A sample of historical flow distribution on the BLIP interface is shown in Figure 3.3.2.

The QFW Interface

The Queenston Flow West (QFW) interface is limited to 2080 MW for flows to the west in the winter. In the summer, the limit is 1,780 MW to the west. This interface could be constrained by thermal limitations. There is no limit specified for flows to the east (towards New York), as the level of flows expected in that direction will not cause system concerns. A sample of historical flow distribution on the QFW interface is shown in Figure 3.3.2.

The FETT Interface

The Flow East Towards Toronto (FETT) interface limit was defined to prevent voltage collapse in the Toronto Area. Based on historical and expected flows, it was determined that the FETT interface is no longer limiting under normal conditions. As a result, the FETT interface limit becomes a boundary condition for which the other Southern Ontario limits are valid. The limit of this interface is 4,500 MW.

There is no limit specified for flows to the west, as the current level of flows expected in that direction is low. A sample of historical flow distribution on the FETT interface is shown in Figure 3.3.2.

The TEC Interface

The Transfer East from Cherrywood (TEC) interface does not have a pre-defined limit for up to any one single element out of service. The TEC interface is included to provide a boundary between the Toronto and East transmission zones. With these zones defined, specific studies can be conducted to consider the impact of varying resource dispatch scenarios on reliability.

The FIO Interface

With the addition of the new interconnection between Ontario and Quebec, the Flow Into Ottawa (FIO) interface is limited to 2,900 MW to control pre-contingency and post-contingency voltage instability in the Ottawa zone. There is no limit specified on this interface for flows to the East zone. Under certain conditions, the FIO limit can be improved with the use of load rejection in the Ottawa zone. A sample of the historical flow distribution on the FIO interface is shown in Figure 3.3.2.

3.3 Interface Capability Limits

Table 3.3 summarizes the base limits for the major interfaces in Ontario; normal system (all transmission elements in-service) limits under normal conditions are shown.

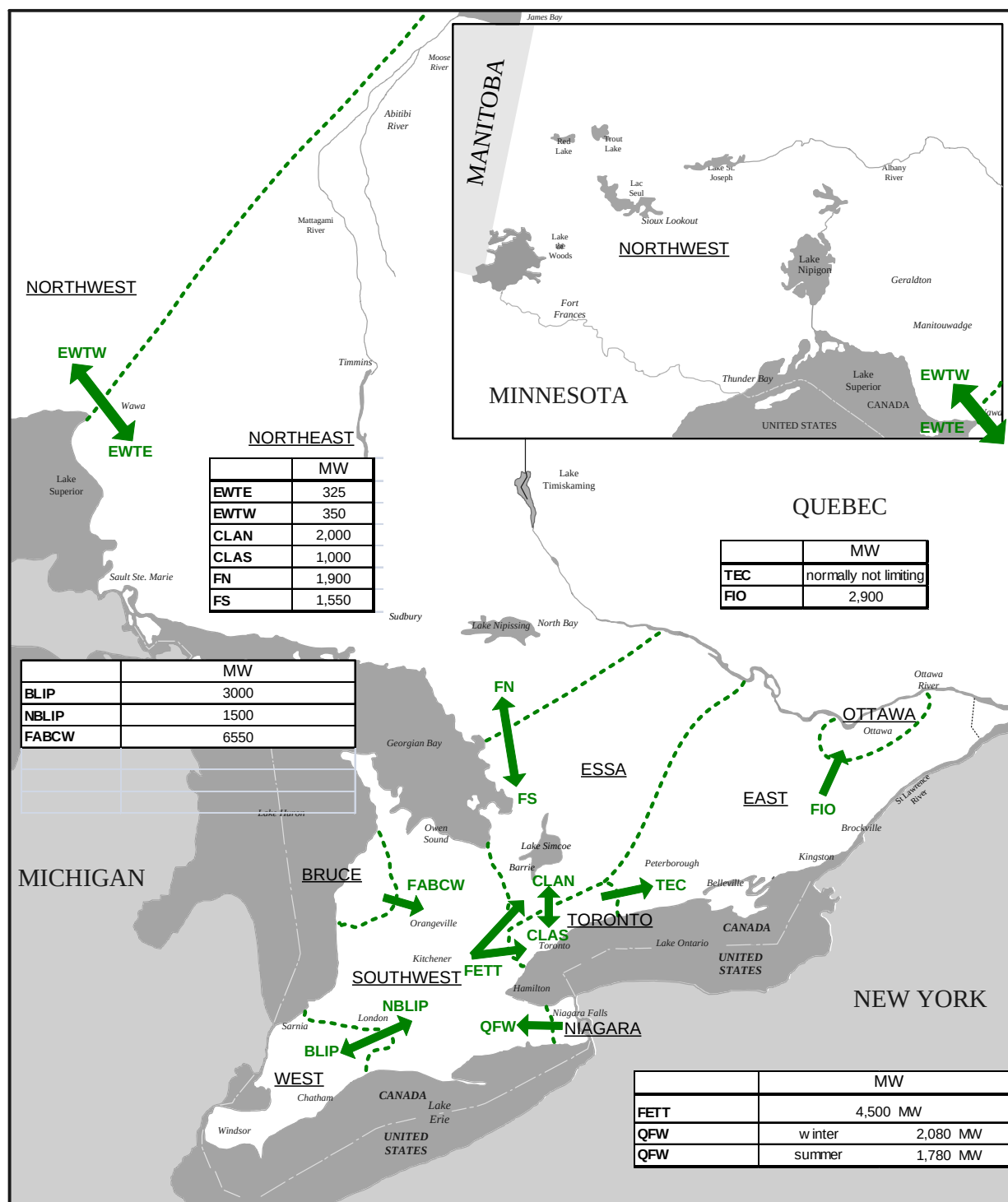
Note that some limits are simple constants (e.g. BLIP, FETT) whereas others are more complicated and may depend on parameters such as status of specific generator units, other transmission flows, Ontario demand, etc. (e.g. NBLIP, FABCW). In cases where interface limits are based on thermal capability, separate ratings are shown for summer and winter conditions.

Table 3.3 Interface Base Limits

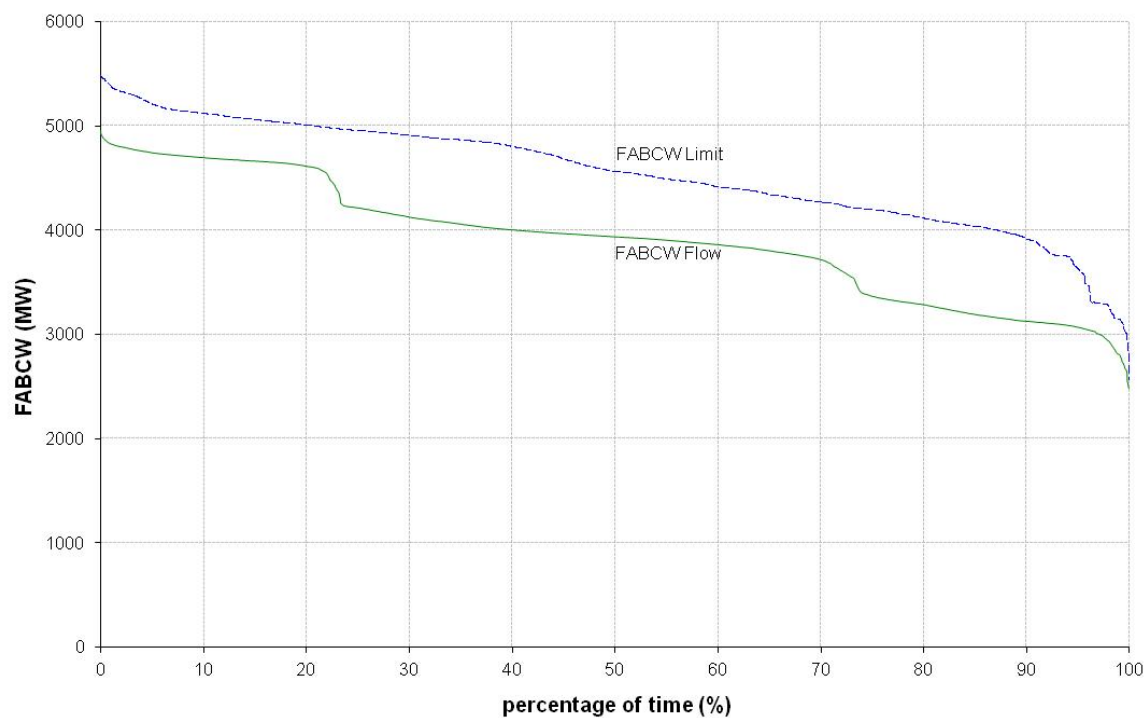
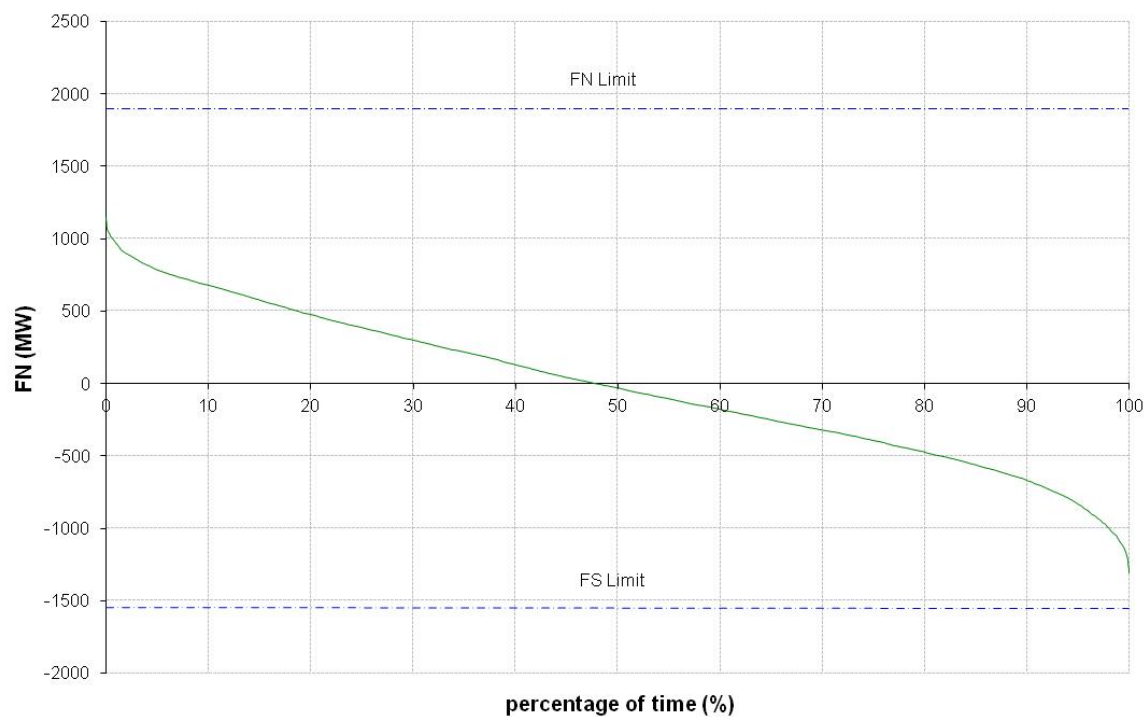
Interface	Operating Security Limits (MW)
BLIP	3,000
NBLIP	1,500
QFW	1,780 Summer, 2,080 Winter
FABCW	6,550
FETT	4,500 *
CLAN	2,000
CLAS	1,000
FIO	2,900
FN	1,900
FS	1,550
EWTE	325
EWTW	350

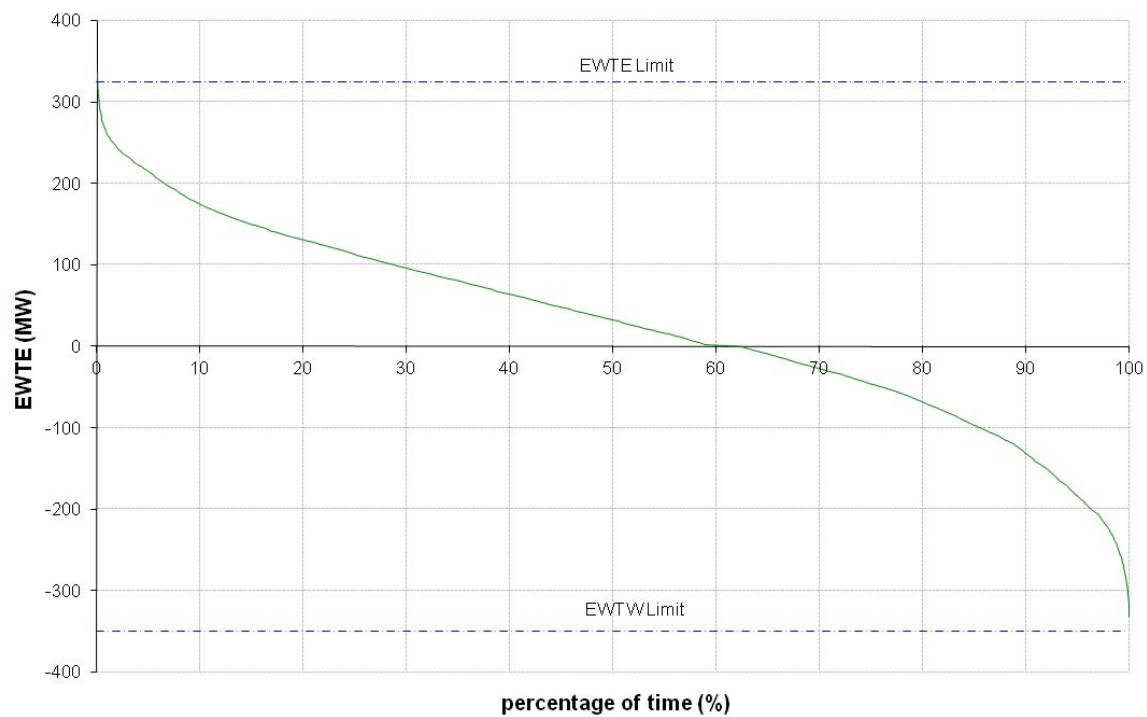
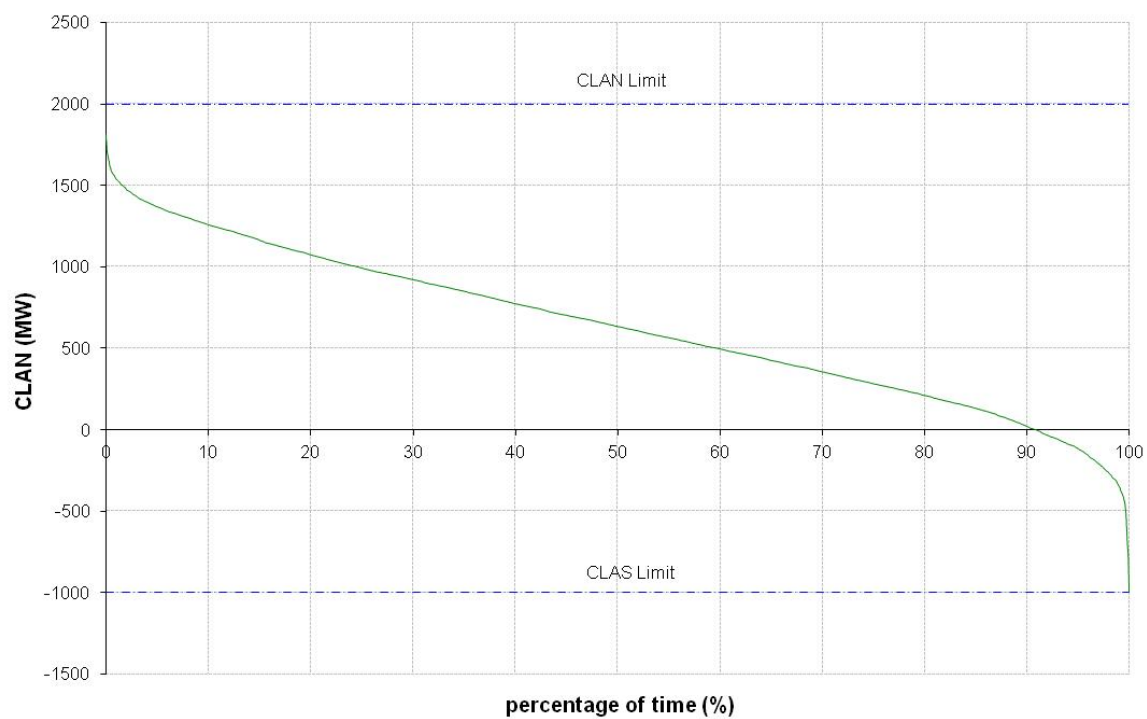
Summer Limits apply from May 1 to October 31. Winter Limits apply from November 1 to April 30.

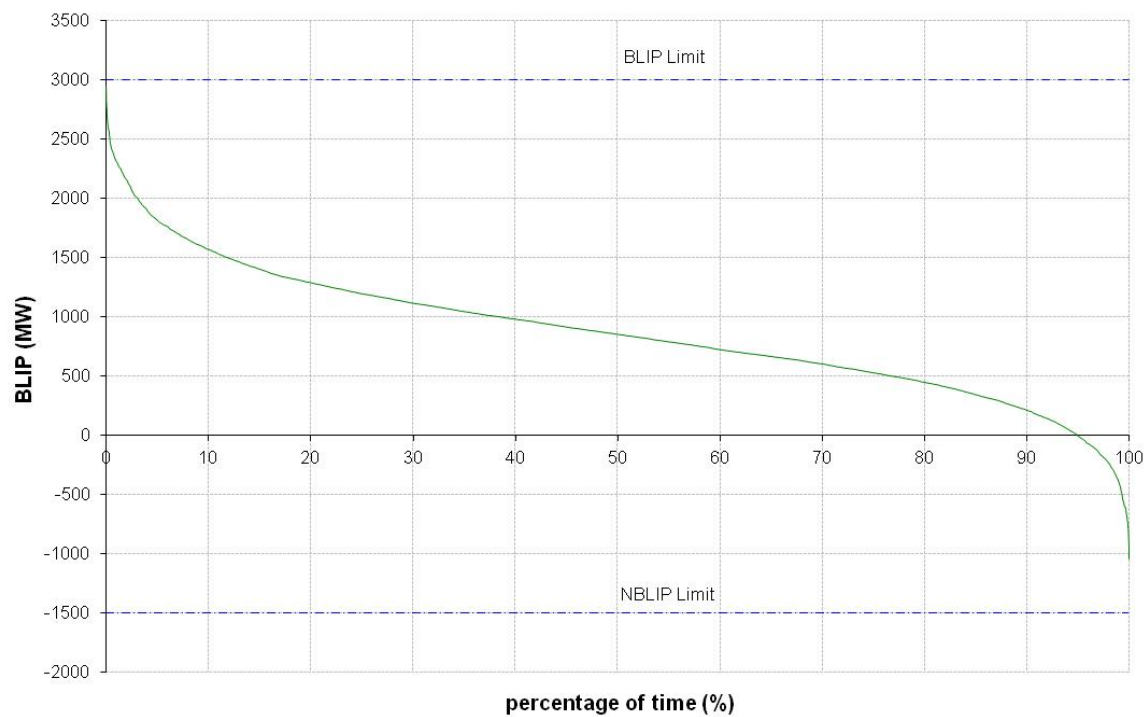
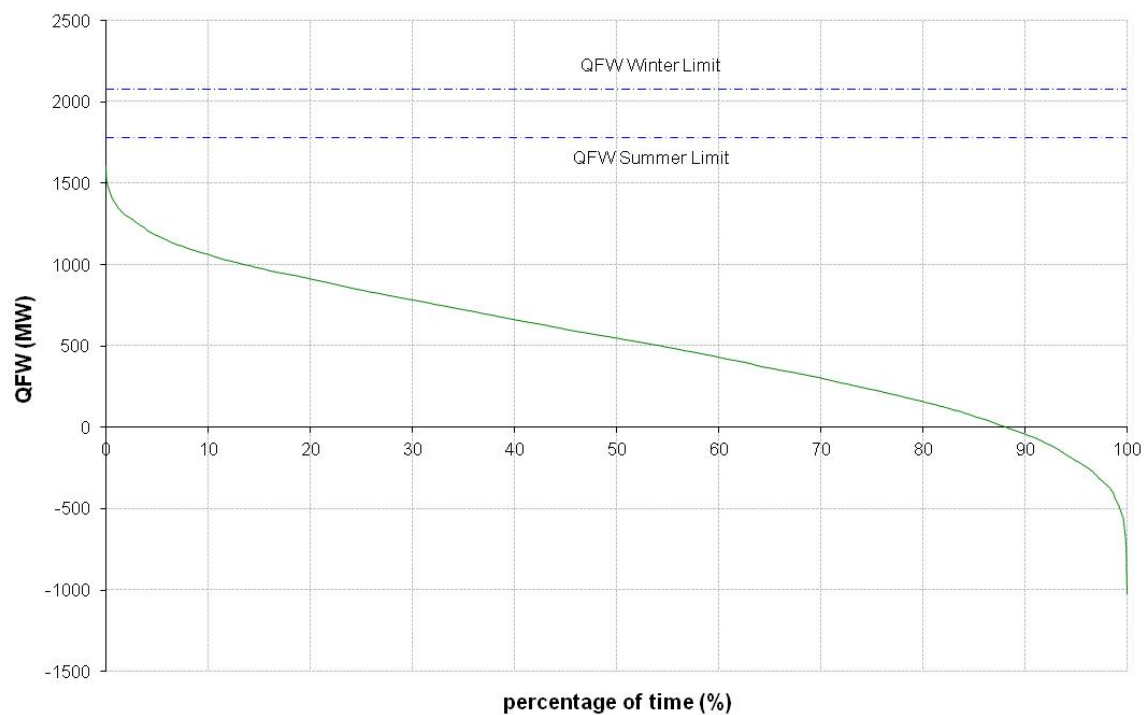
(*) FETT limit is a fixed boundary condition limit

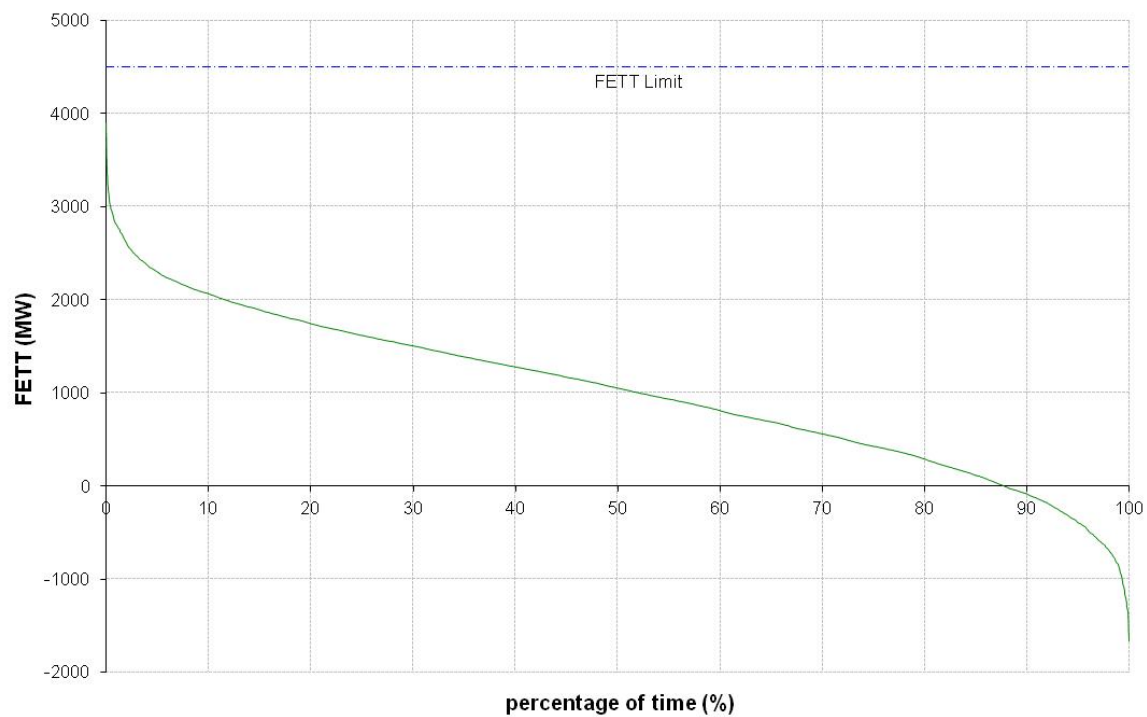
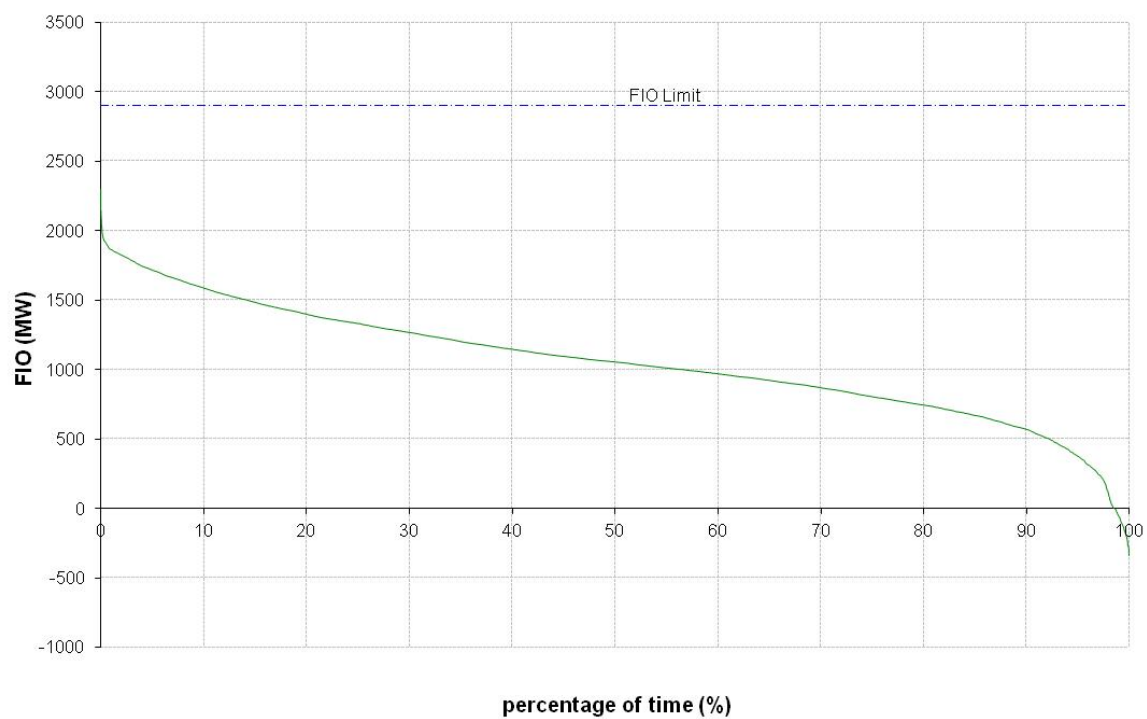
Figure 3.3.1 Ontario's Major Internal Transmission Interfaces**Notes to Figure 3.3.1:**

1. Tables indicate interface base limits (all transmission elements in-service).
2. FABCW = FABC + MW Output of Wind Farms near Bruce Zone

Figure 3.3.2 One Year Rolling (April 2011 – April 2012) Historical Flow Distribution - Interfaces**FABCW 2011-2012****FN/FS 2011-2012**

EWTE/EWTW 2011-2012**CLAN/CLAS 2011-2012**

BLIP/NBLIP 2011-2012**QFW 2011-2012**

FETT 2011-2012**FIO 2011-2012****- End of Section -**

4.0 Transmission Interconnections

The term interconnection is used to describe interfaces that join Ontario to other jurisdictions (external control areas).

Ontario has interconnections with Manitoba, Minnesota, Quebec, Michigan, and New York. The characteristics of each interconnection are described in Section 4.2. Figure 4.3.1 provides a geographic depiction of Ontario's internal transmission zones and transmission interconnection points with these jurisdictions. Operating security limits for these interconnections are also included in Figure 4.3.1 as well as in Table 4.3. Figure 4.3.2 summarizes the relationship between Ontario's zones, major internal interfaces and interconnections in a single diagram. The interconnection limits are used to ensure system and/or plant stability, acceptable pre-contingency and post-contingency voltage levels and/or acceptable thermal loading levels.

4.1 Interconnection Definitions

Like transmission interfaces, interconnection definitions are formed by grouping one or more lines for the purpose of measuring their combined flow and enforcing a power flow limit. Interconnections limits are defined for flows into Ontario (imports) and out of Ontario (exports).

4.2 Interconnection Characteristics

All of Ontario's synchronous interconnections are normally linked with phase angle regulators (PARs), except for the Quebec radial interconnections and the New York – Niagara interconnection. A sample of historical flow distribution on the Ontario interconnections is shown in Figure 4.3.3.

The Ontario – Manitoba Interconnection

The Ontario – Manitoba interconnection consists of two 230 kV circuits and one 115 kV circuit.

The 230 kV interconnection is defined as the Ontario- Manitoba Transfer. The transfers on this interconnection are the Ontario – Manitoba Transfer East (OMTE) and the Ontario – Manitoba Transfer West (OMTW), and are constrained by stability and thermal limitations. The OMTW and OMTE limits are 300 MW in the winter and 288 MW in the summer. These limits do not include the dead-band margins associated with the phase angle regulator taps.

The 115 kV interconnection is limited to 68 MW for flows into Ontario in the wintertime and summertime. No flow out of Ontario is allowed on the 115 kV interconnection.

Ontario and Manitoba are synchronously connected on the 230 kV interconnection, while the 115 kV interconnection is operated normally open.

The Ontario – Minnesota Interconnection

The Ontario – Minnesota interconnection consists of one 115 kV circuit. The transfers on this interconnection are the Minnesota Power Flow North (MPFN) and the Minnesota Power Flow South (MPFS).

The MPFN and MPFS limits are 100 MW and 150 MW respectively and are constrained by stability and thermal limitations. These limits do not include the dead-band margins associated with the phase angle regulator taps. Ontario and Minnesota are synchronously connected.

The Ontario – Michigan Interconnection

The Ontario – Michigan interconnection consists of two 230/345 kV circuits, one 230/115 kV circuit and one 230 kV circuit. The interconnection is constrained by thermal limitations.

With one PAR by-passed, for the flows out of Ontario, the winter and summer scheduling limits are 2,170 MW and 2,070 MW, respectively. For the flows into Ontario, the winter and summer limits are 1,740 MW and 1,700 MW, respectively.

When all four PARs are in service, the flows out of Ontario scheduling limits will be 2,000 MW and 1,900 MW, in winter and summer respectively. Flows into Ontario scheduling limits with the PARs in service will be 1,600 MW for both winter and summer.

The Ontario – New York Niagara Interconnection

The Ontario – New York Niagara interconnection consists of two 230/345 kV circuits, two 230 kV circuits and one 115 kV circuit.

One of the 230 kV circuits, BP76, is on a long term outage because of the failure of its voltage regulator. Until its return to service scheduled for December 2012, for flows out of Ontario the winter and summer scheduling limits are 1,490 MW and 1,200 MW respectively. For flows into Ontario the winter and summer limits are 1,210 MW and 910 MW respectively.

With circuit BP76 in service, for flows out of Ontario, the winter and summer scheduling limits will be 2,080 MW and 1,760 MW respectively. For flows into Ontario with BP76 in service, the winter and summer scheduling limits will be 1,570 MW and 1,320 MW respectively.

The Queenston Flow West (QFW) interface is in series with the NY Niagara interconnection. All flows entering Ontario on the NY Niagara interconnection will also appear on the QFW interface; this includes imports and parallel path flows. Based on past experience and studies, the QFW interface would reach its limit before the limit is reached on the NY Niagara interconnection for flows entering Ontario; as a result, the capability of the NY Niagara interconnection could be constrained by thermal limitations in the QFW interface, which are very dependent on weather conditions.

Ontario and New York Niagara are synchronously connected.

The Ontario – New York St. Lawrence Interconnection

The Ontario – New York St. Lawrence interconnection consists of two 230 kV circuits. The interconnection is constrained by thermal limitations and is under the control of phase angle regulators.

The limit on this interconnection is 300 MW for flows into Ontario and out of Ontario. The interconnection is constrained by thermal limitations in the winter and summer or NY scheduling limits. Ontario and New York St. Lawrence are synchronously connected.

The Ontario – New York Total

The power transfers on the Niagara and St. Lawrence interconnections could be further limited by the New York scheduling limits on the Ontario – New York flowgate. When all transmission circuits are in service, the scheduling limits are 1,650 MW to Ontario and 1,900 MW out of Ontario.

With BP76 circuit on outage, the New York scheduling limits on the Ontario – New York flowgate are 1,200 MW to Ontario and 1,650 MW out of Ontario.

The Ontario – Quebec North Interconnection

The Ontario – Quebec North Interconnection consists of two radial 115 kV circuits (D4Z, H4Z) and is thermally limited.

For flows into Ontario from radial generation in Quebec, the limit is 85 MW under winter conditions and 65 MW under summer conditions. For flows out of Ontario, the limit is 110 MW in the wintertime and 95 MW in the summertime.

The Ontario – Quebec South Interconnection

The Ontario – Quebec South Interconnection consists of two 230 kV circuits (B31L, B5D) in the East zone, and five 230 kV circuits (P33C, Q4C, A41T, A42T, D5A) and two 115 kV circuits (X2Y, H9A) in the Ottawa zone. This includes the 230 kV interconnection from Hawthorne to the HVDC converters located at Outaouais station in Québec.

The Quebec South Interconnection limits for flows into Ontario are 2,723 MW in summer and 2,798 MW in winter, constrained by the transmission limitations and generation availability. For flows out of Ontario, due to stability and thermal limitations, the limits are 1902 MW for the summer and 1972 MW for the winter.

Parallel Path flows between Michigan & New York Niagara

Parallel path flows may occur between Michigan and New York Niagara, north of Lake Erie through Ontario and south of Lake Erie through Pennsylvania, due to a combination of transmission system impedance with interconnection-wide load/generation dispatch. As a result, the actual flows on the Michigan and New York Niagara interconnections may not equal the scheduled flows. For scheduled Ontario – Michigan power flows, part of the scheduled flows may flow on the NY Niagara interconnection due to parallel path flows. Likewise, for scheduled Ontario – New York power flows, part of the scheduled flows may flow on the Ontario – Michigan interconnection.

With full phase angle regulator control on the interties between Ontario and Michigan the inadvertent power flow across the interface is expected to be mitigated. When full PAR control of the Ontario – Michigan interconnection is utilized, parallel path flows of up to 600 MW in either direction are expected to be controlled. Control of parallel path flows should allow scheduled power flows to be maintained most of the time between Ontario, Michigan and New York, and should also greatly reduce the incidence of constrained operation of QFW interface.

Without full PAR control of the Ontario – Michigan interconnection, power flows across the Michigan interconnection are comprised of scheduled direct flows, scheduled New York Niagara parallel path flows and LEC. Likewise, power flows across the New York Niagara interconnection are comprised of scheduled direct flows, scheduled Michigan parallel path flows and LEC. This means that the total transfer from these two areas is usually limited to a flow that is less than the sum of the two interconnection flow limits.

Lake Erie Circulation (LEC) is a measure of the use of the Ontario transmission system by external parties in neighbouring jurisdictions. It is calculated using measured flows on the Michigan interconnection, measured flows on the New York interconnection, scheduled Michigan transactions and scheduled New York transactions, and measured internal generation located close to these interconnections. The flow can circulate through Ontario in a clockwise direction, in at Michigan and out at New York, or in counterclockwise direction, in at New York and out at Michigan. LEC flows also appear on the BLIP and QFW interfaces as they are in a direct series path.

Ontario Coincident Import/Export Capability

In the summer, with all transmission elements in service, the theoretical maximum capability for exports could be up to 6,000 MW, and imports up to 6,300 MW; in the winter, 6,200 MW and 6,800 MW respectively. With the circuit BP76 on outage, the theoretical export capability could be reduced by up to 500 MW in summer and 250 MW in winter; the import capability could be reduced by up to 400 MW in summer and 450 MW in winter.

These values represent theoretical levels that could be achieved only with a substantial reduction in generation dispatch in the West and Niagara transmission zones. In practice, the generation dispatch required for high import levels would rarely, if ever, materialize. Therefore, at best, due to internal constraints in the Ontario transmission network in conjunction with external scheduling limitations, Ontario has an expected coincident import capability of approximately 5,200 MW with all the transmission elements in service and 4,800 MW with the circuit BP76 on outage.

Previous studies have shown that when full PAR control is available on the Ontario – Michigan interconnection, flow control of up to about 600 MW in either direction could be achieved. When circulation is limiting, this control will act to improve the coincident import/export capability.

4.3 Interconnection Flow Limits

Table 4.3 summarizes the flow limits for the interconnections; normal system (all transmission elements in-service) limits are shown. In addition, emergency transfer limits are shown when they differ from the normal system limits. All limits provided are Total Transfer Capability (TTC) values.

For Michigan and New York, flow limits are given for summer and winter flows into and out of Ontario. With favourable conditions, the flow capabilities of the interconnections will not be affected by internal limitations in the transmission network. The amount of power that can be transferred may be lower than the table values under unfavourable dispatch and weather conditions. With unfavourable conditions, the flow capabilities may also be affected by internal limitations in the transmission network, in Ontario or in external areas.

When ambient weather conditions permit, flow limits over paths restricted by thermal considerations may be increased during real-time operation.

Table 4.3 Interconnection Total Transfer Capability (TTC) Limits

Interconnection	Limit - Flows Out of Ontario MW	Limit - Flows Into Ontario MW
Manitoba – Summer*	288 ⁽³⁾	288 ^(3,6)
Manitoba – Winter*	300 ⁽³⁾	300 ^(3,6)
Minnesota	150 ⁽³⁾	100 ⁽³⁾
Quebec North (Northeast) – Summer*	95 ⁽⁵⁾	65
D4Z	0	65
H4Z	95	0
Quebec North (Northeast)– Winter*	110 ⁽⁴⁾	85
D4Z	0	85
H4Z	110	0
Quebec South (Ottawa) – Summer*	1,482	1,923
X2Y	0	65
Q4C	32	88
P33C	0	270
D5A	200	250
H9A	60	120
HVDC (A41T+A42T)	1,250	1,250
Quebec South (Ottawa) – Winter*	1,502	1,998
X2Y	0	65
Q4C	52	88
P33C	0	345
D5A	200	250
H9A	60	176
HVDC (A41T+A42T)	1,250	1,250
Quebec South (East) – Summer*	420	800
B31L + B5D	420	800
Quebec South (East) – Winter*	470	800
B31L + B5D	470	800
New York St. Lawrence – Summer and Winter*	300	300
New York Niagara – Summer*	1,760 ⁽¹⁾	1,320 ^(1,7)
Emergency Transfer Limit - Summer*	2,160 ⁽¹⁾	1,860 ^(1,7)
New York Niagara – Winter*	2,080 ⁽¹⁾	1,570 ^(1,7)
Emergency Transfer Limit - Winter*	2,200 ⁽¹⁾	2,200 ^(1,7)
Michigan – Summer*	1,900 ^(2,3)	1,600 ^(2,3)
Emergency Transfer Limit - Summer*	2,520 ^(2,3)	1,950 ^(2,3)
Michigan – Winter*	2,000 ^(2,3)	1,600 ^(2,3)
Emergency Transfer Limit - Winter*	2,450 ^(2,3)	2,000 ^(2,3)

* Summer Limits apply from May 1 to October 31. Winter Limits apply from November 1 to April 30.

(1) Flow limits depend on generation dispatch outside Ontario.

(2) Normal limits are based on LT ratings and phase shifters regulating; Emergency limits are based on ST ratings and phase shifters regulating. Flow limits vary depending on the generation dispatch within Ontario.

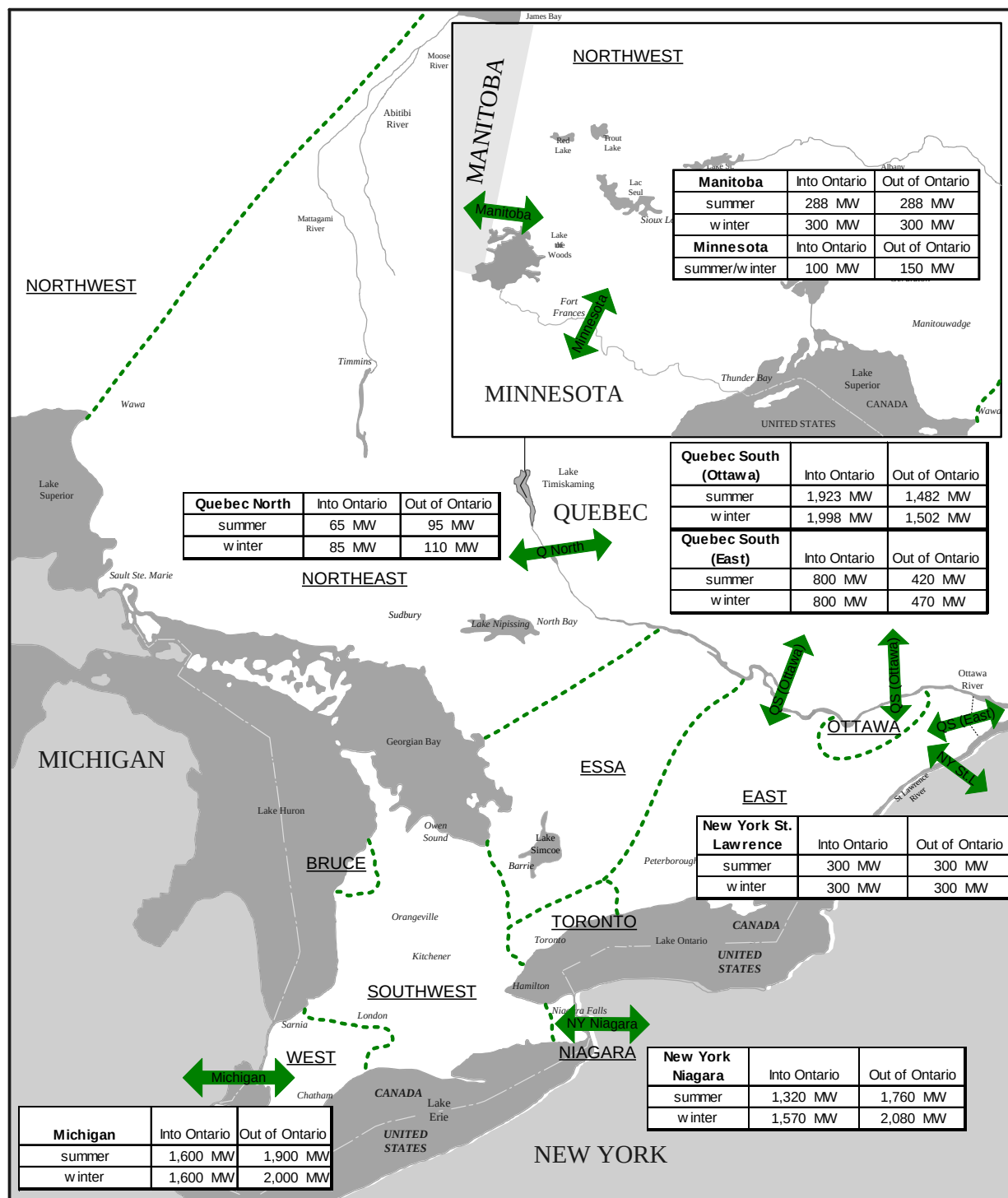
(3) For real time operation of the interconnection, limits are based on ambient conditions.

(4) Limit based on 0-4 km/hr wind speed and 10 Deg.C ambient temperature.

(5) Limit based on 0-4 km/hr wind speed and 30 Deg.C ambient temperature.

(6) Flows into Ontario do not include flows on circuit SK1.

(7) Flow Limits into Ontario are shown here without considering QFW transmission constraints within Ontario.

Figure 4.3.1 Ontario's Points of Interconnection with Neighbouring Areas**Notes to Figure 4.3.1:**

1. Tables indicate flow limits for each interconnection. Note the Ontario coincident import/export capability is not necessarily the arithmetic sum of the individual flow limits.

Ontario's Internal Zones, Internal Interfaces and External Interconnections

The diagram illustrates the internal zones and interconnections of Ontario's power system. The zones are represented by circles, and the interconnections are represented by lines with arrows indicating the direction of power flow.

Internal Zones:

- Northwest Zone
- Northeast Zone
- Bruce Zone
- West Zone
- Southwest Zone
- Essa Zone
- Toronto Zone
- Niagara Zone
- Ottawa Zone
- East Zone

Internal Interfaces:

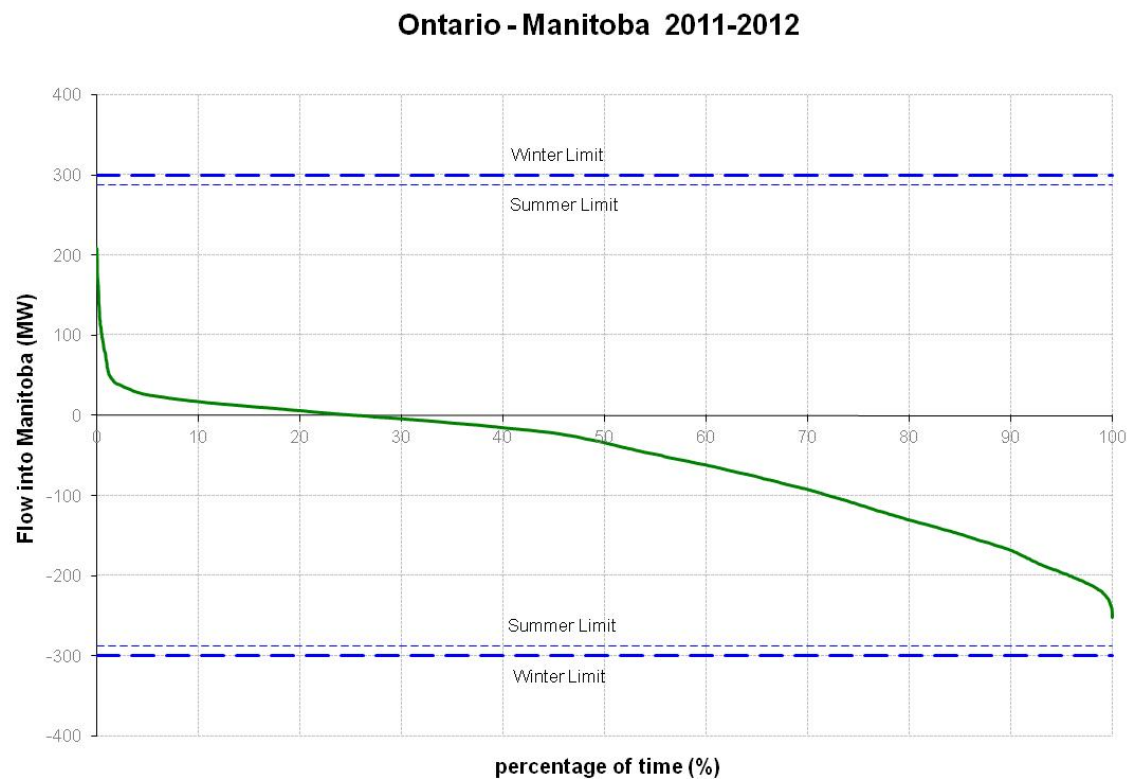
- EWTE (Northwest to Northeast)
- EWTW (Northeast to Northwest)
- ES (Northeast to Essa)
- EN (Essa to Northeast)
- CTAS (Essa to Toronto)
- CIAN (Toronto to Essa)
- FET (Southwest to Toronto)
- TEC (Toronto to East)

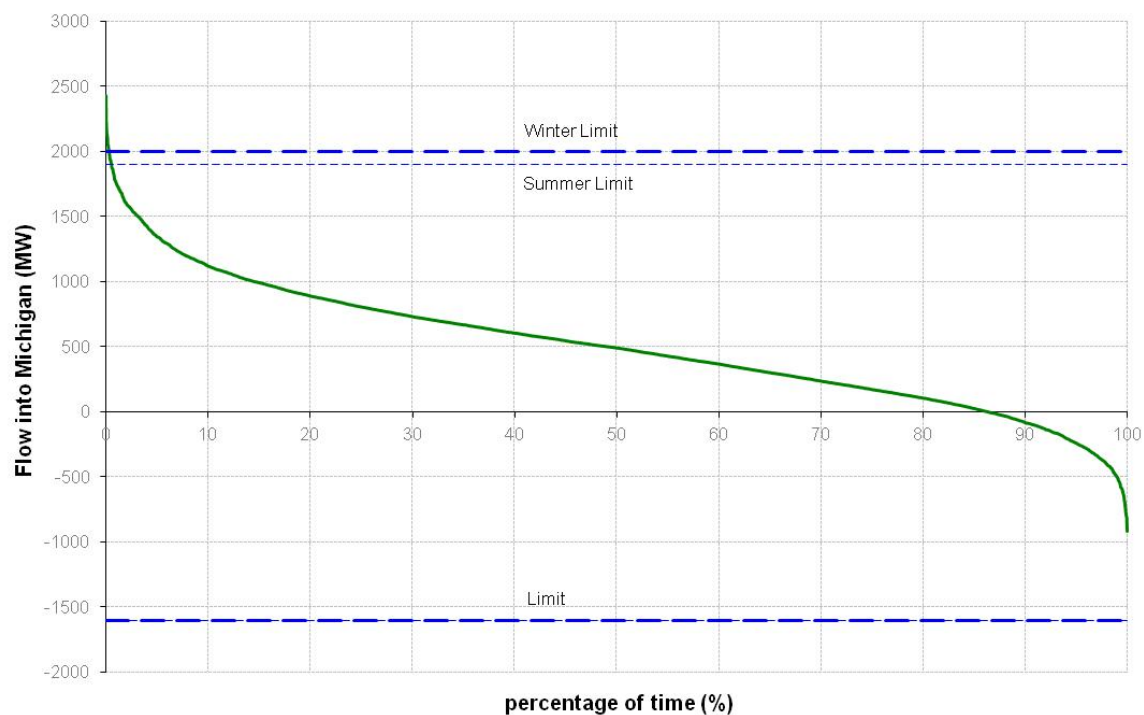
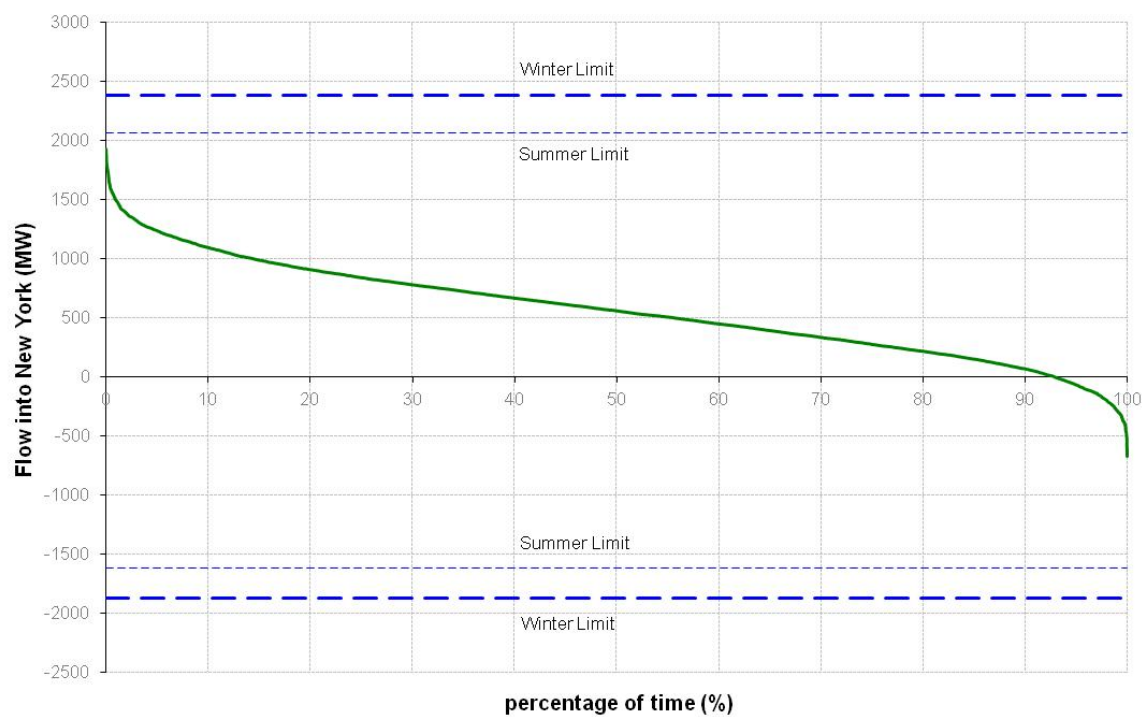
External Interconnections:

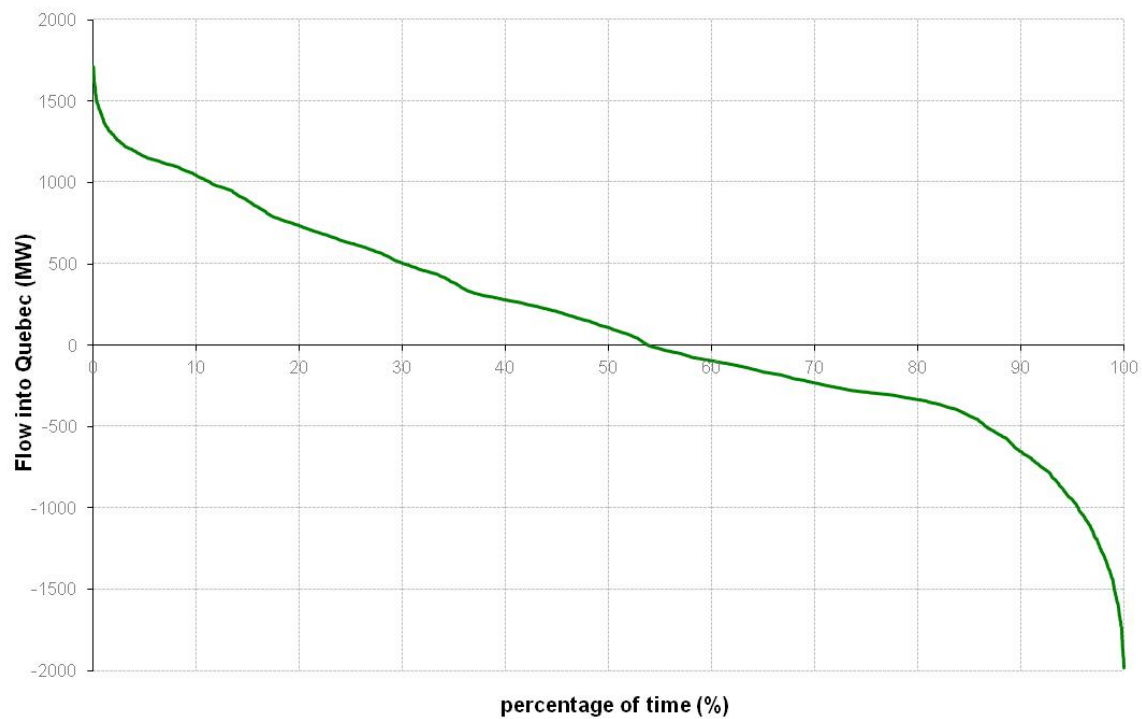
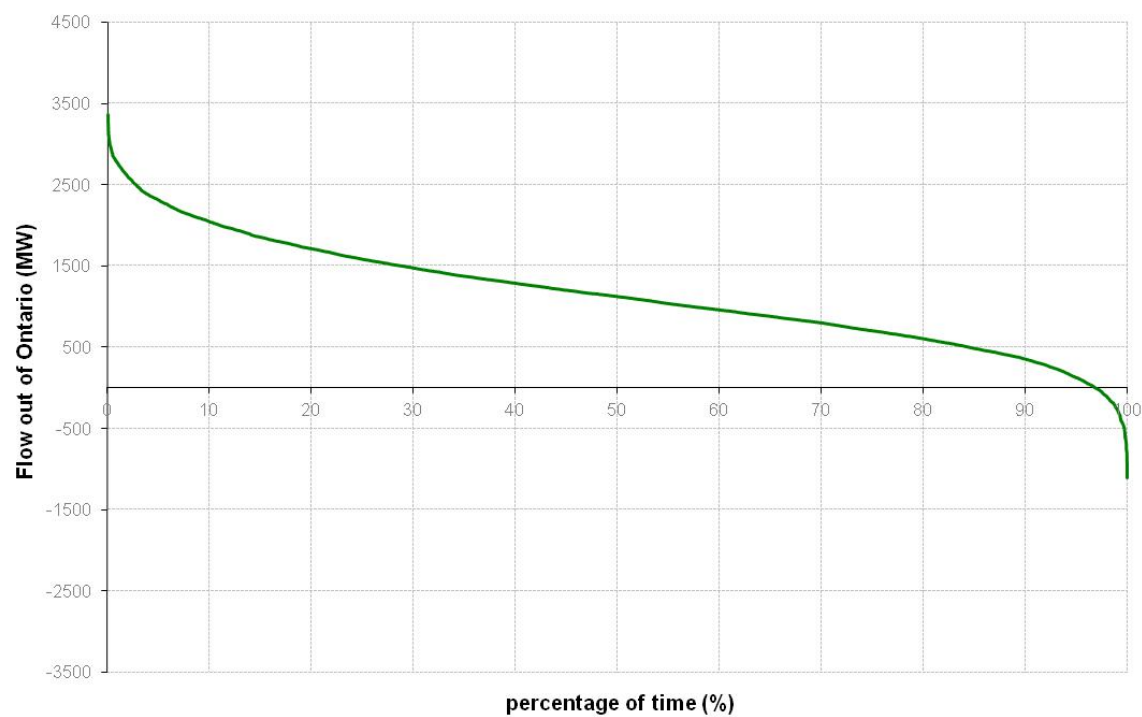
- Manitoba Interconnection (PAR Controlled) to Northwest Zone
- Minnesota Interconnection (PAR Controlled) to Northwest Zone
- Quebec Interconnection (Radial) to Northeast Zone
- Outaouais HVDC Converter to Ottawa Zone
- Quebec Interconnection (Radial) to Ottawa Zone
- New York Interconnection (PAR Controlled) to East Zone
- New York Interconnection (Free Flowing) to Niagara Zone
- Michigan Interconnection (Partial PAR Controlled) to West Zone

1. $FABCW = FABC + \text{MW Output of Wind Farms near Bruce Zone}$

1. $FABCW = FABC + \text{MW Output of Wind Farms near Bruce Zone}$

Figure 4.3.3 One Year Rolling (April 2011 – April 2012) Historical Flow Distribution - Interconnections

Ontario - Michigan 2011-2012**Ontario - New York 2011-2012**

Ontario - Quebec 2011-2012**Ontario Net Export 2011-2012**

- End of Document -