Ontario Transmission System

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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 representative of both the present 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:

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. 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. The historical flow distribution on each interconnection during the previous twelve months is provided in graphical format.

Readers are invited to provide comments and/or suggestions on this document. To do so, please contact us at:

Toll Free: 1-888-448-7777

Tel: 905-403-6900

Fax: 905-403-6921

E-mail: customer.relations@ieso.ca.

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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. 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 with some wind.

East Zone

- The total resources exceed the zone peak demand.
- The generation is a mix of hydroelectric, oil, natural gas, and some wind.
- The zone is connected to the Quebec grid via ties that are used to switch load or generation radially onto either system.
- The zone is also connected 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 modelled to be part of the Essa zone.

Niagara Zone

- The total resources are much higher than the zone peak demand.
- The generation is mostly hydroelectric with some natural 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.
- Two 115 kV circuits connect radially to Quebec.

Northwest Zone

- The total resources generally exceed the zone peak demand.
- The generation is mainly hydroelectric with some wind and biomass.
- The zone is 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 zones peak demand.
- The generation is cogeneration.
- The interconnections with Quebec consist of two 115 kV circuits and five 230 kV circuits. Two of the 230 kV circuits connect Ontario and Quebec via bidirectional back-to-back HVDC converters located at Outaouais in Quebec.

Southwest Zone

- The total resources are generally balanced with the zone peak demand.
- The generation is natural gas and wind.

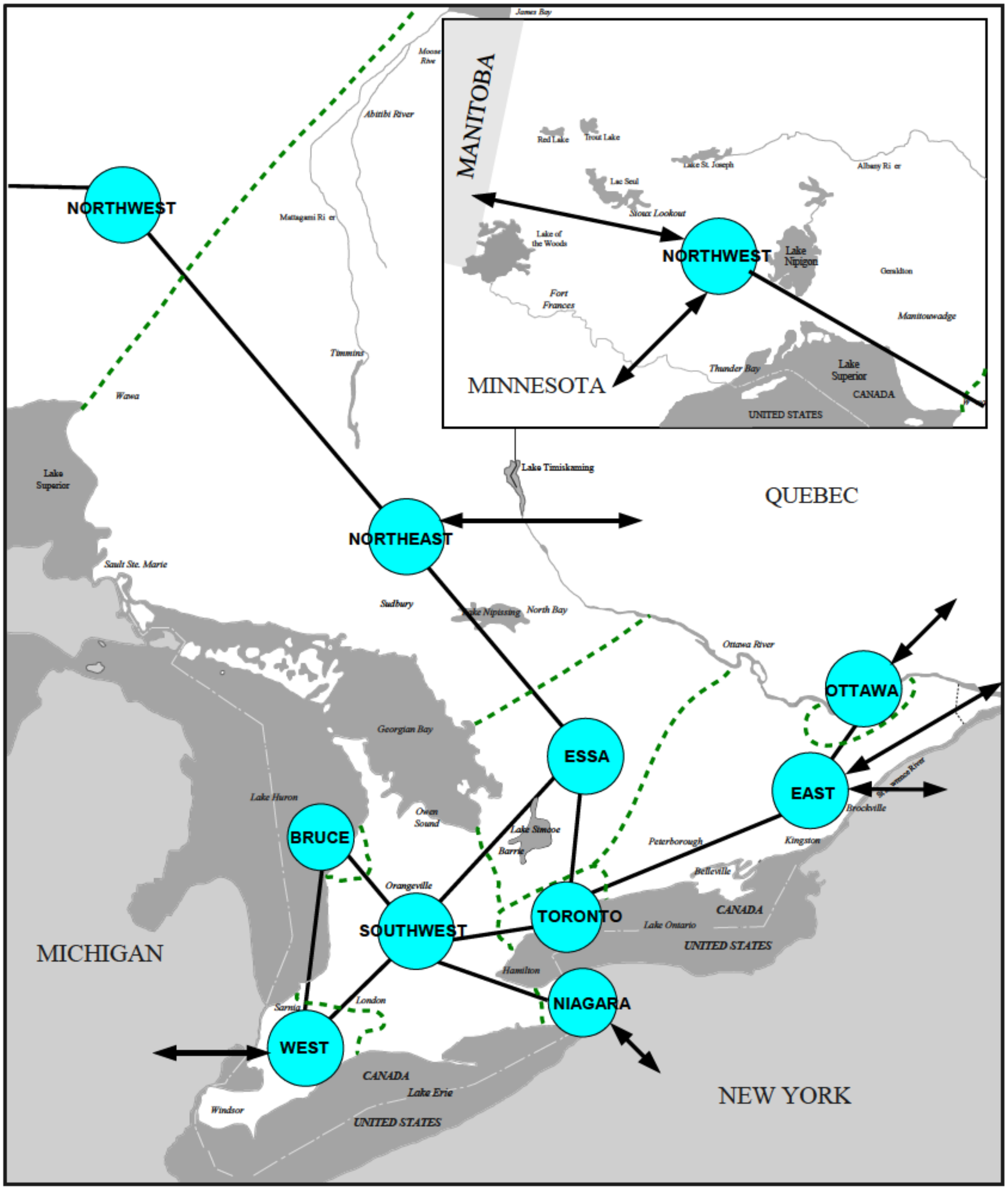
Toronto Zone

- The total resources are less than the zone peak demand.
- The generation is mostly nuclear with some natural gas.

West Zone

- The total resources generally exceed the zone peak demand.
- The generation is mostly natural gas with some wind.
- The zone is connected to the Michigan system via two 230/345 kV circuits, one 230/115 kV circuit, and one 230 kV circuit. All four circuits have in-service phase angle regulators.

Figure 2.1.1 Geographical Zones in Ontario's Power Transmission System



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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 Figure 3.3.1 as well as in Table 3.3. The interface limits are used to ensure system stability, acceptable pre-contingency and post-contingency voltage levels, and 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 the historical flow duration curve on the East-West Interface is shown in Figure 3.3.2.

The FN/FS Interface
The Flow South (FS) limit is 2,100 MW and the Flow North (FN) limit is 1,500 MW. The Flow North interface limit is a boundary condition since historical flows have never reached the voltage constrained limit of 1,900 MW and the Flow South interface is limited by transient stability. The Flow South limit increased to 2,100 MW from 1,550 MW as a result of the Lower Mattagami Expansion project. A sample of the historical flow duration curve 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

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 QFW interface flow, and 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. The FABCW interface limit is 7,200 MW based on the most restrictive contingency with all eight Bruce units in service. The FABCW limit increased from 6,650 MW to 7,200 MW due to the increase in wind generation near the Bruce zone. 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

The Buchanan Longwood Input (BLIP) interface is limited to 2,800 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, but is normally 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 approximately 1,990 MW for flows to the west in the winter. In the summer, the limit is approximately 1,600 MW to the west. 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 5,000 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 predefined 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 the 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.

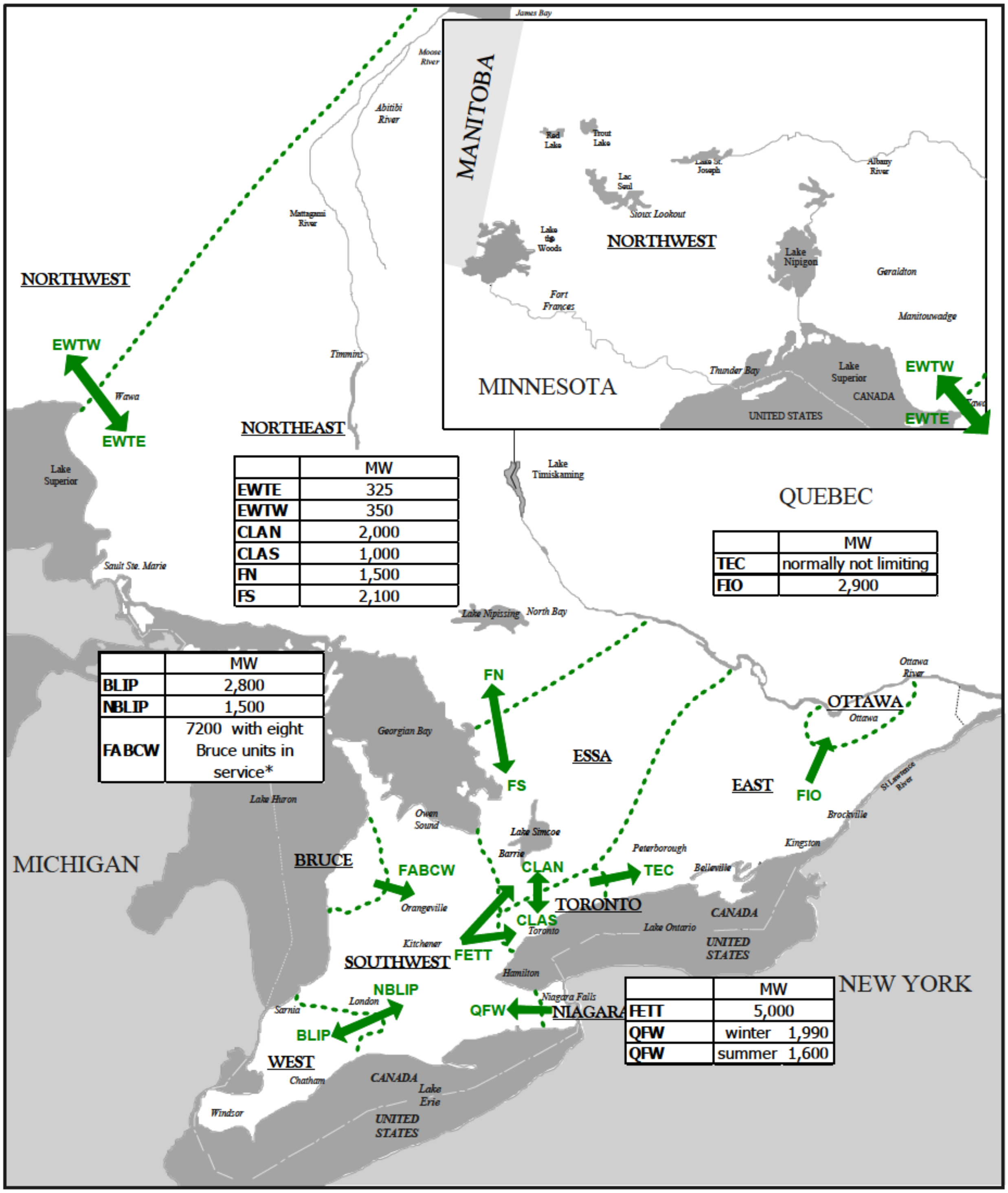
Table 3.3 Interface Base Limits

Interface	Operating Security Limits (MW)
BLIP	2,800
NBLIP	1,500
QFW	1,600 Summer, 1,990 Winter *
FABCW	7,200 **
FETT	5,000 ***
CLAN	2,000
CLAS	1,000
FIO	2,900
FN	1,500 ***
FS	2,100
EWTE	325
EWTW	350

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

(*) QFW limit based on weather conditions.
(**) FABCW limit varies according to BLIP flow.
For each recognized contingency, separate voltage and stability limit ranges are defined.
Published limit range based on the most restrictive contingency under optimal Bruce System Conditions in SCO-South Tab1.
(***) Fixed boundary condition limit.

Figure 3.3.1 Ontario's Major Internal Transmission Interfaces



	MW
EWTE	325
EWTW	350
CLAN	2,000
CLAS	1,000
FN	1,500
FS	2,100

	MW
TEC	normally not limiting
FIO	2,900

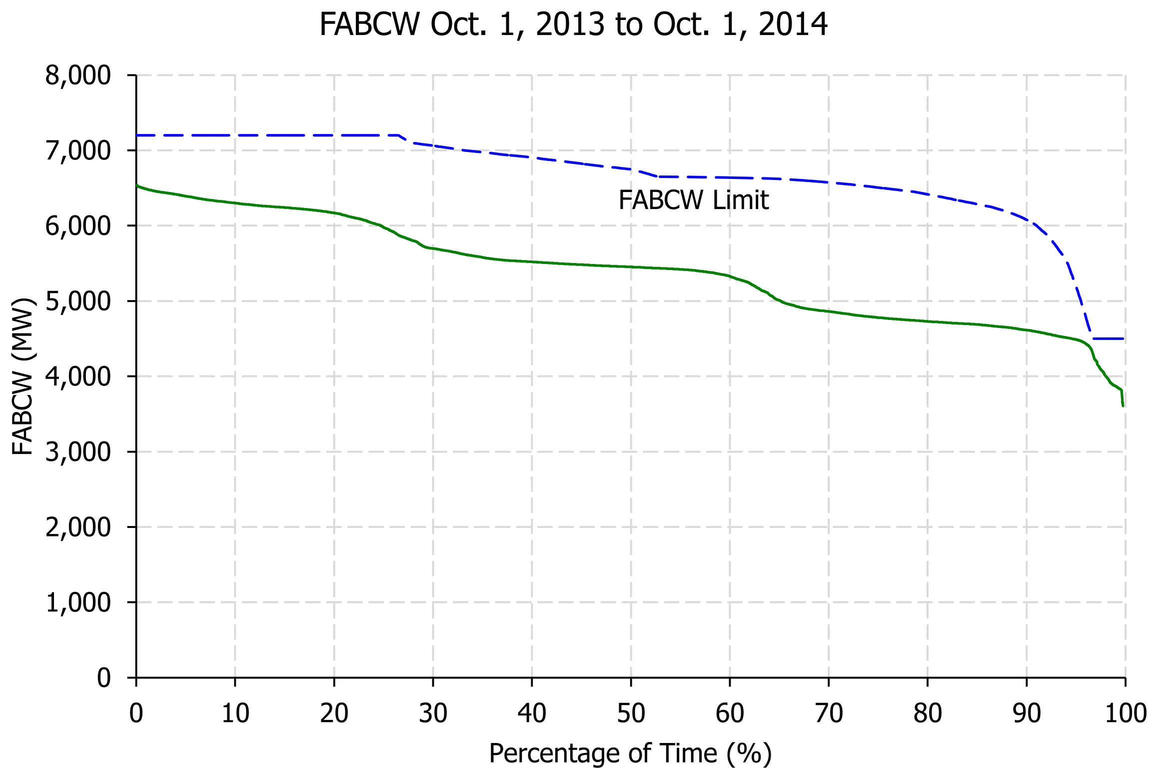
	MW
BLIP	2,800
NBLIP	1,500
FABCW	7200 with eight Bruce units in service*

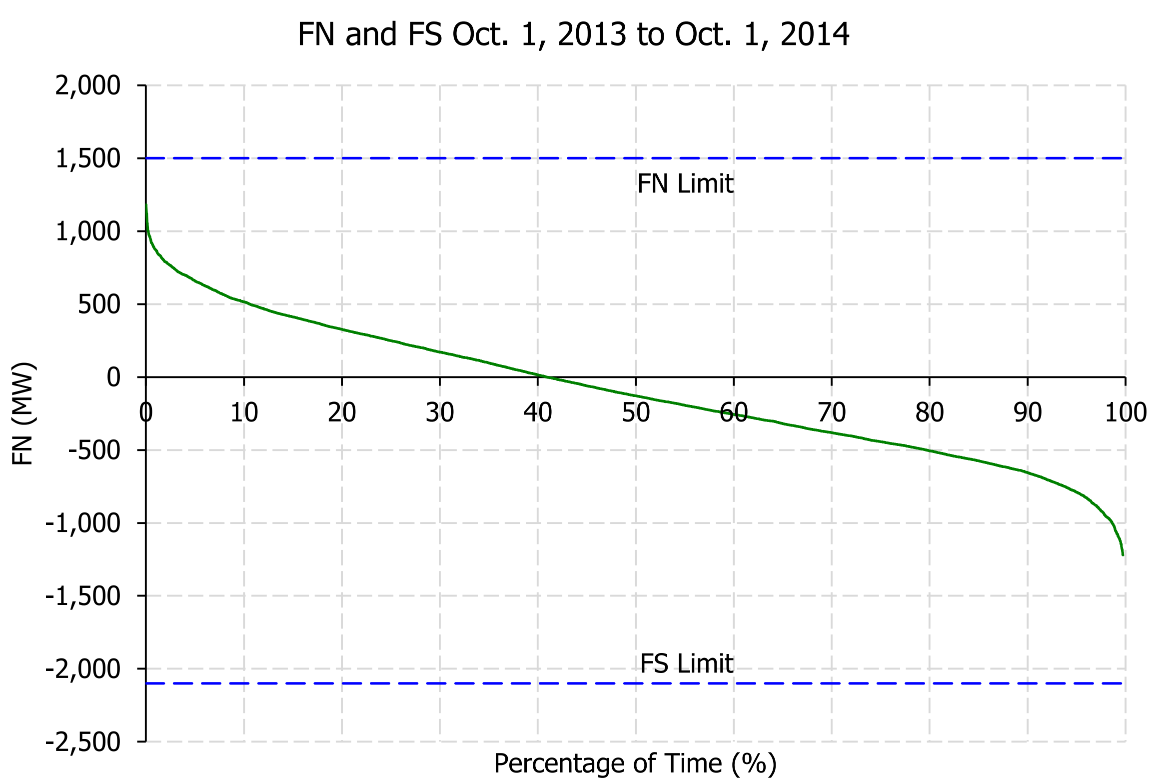
	MW
FETT	5,000
QFW	winter 1,990
QFW	summer 1,600

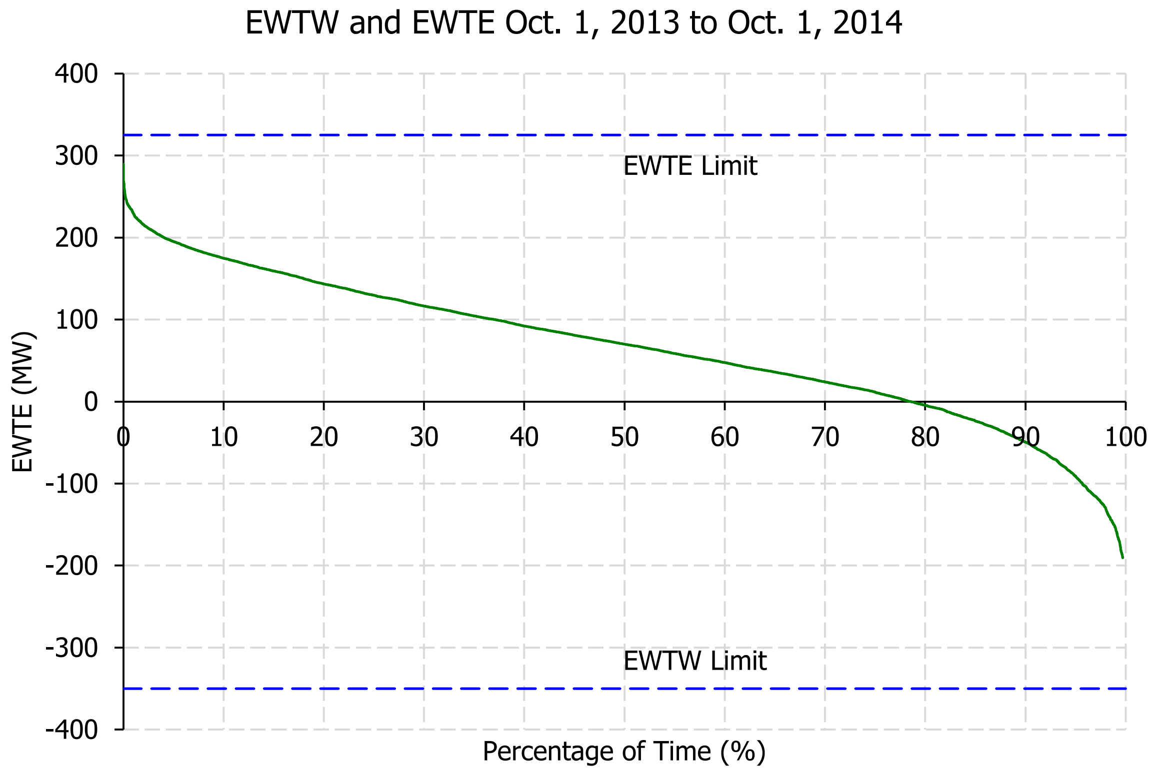
Notes to Figure 3.3.1:

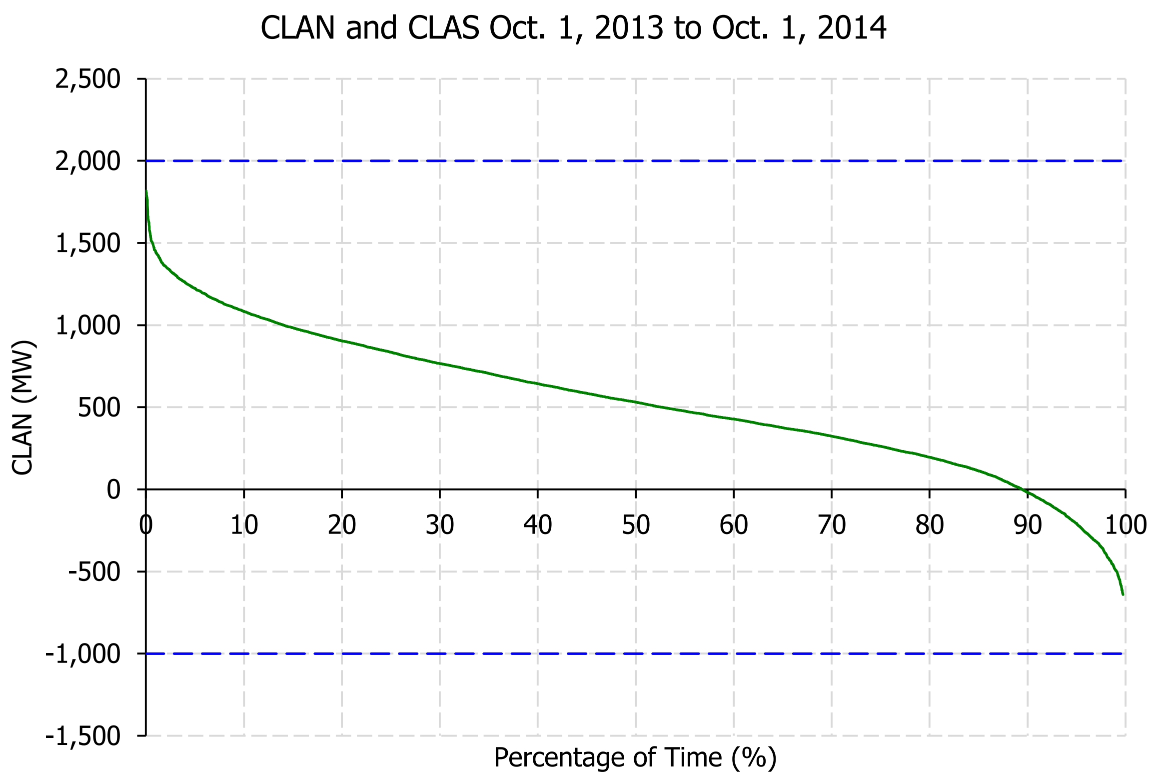
1. Tables indicate interface base limits (all transmission elements in service).
2. FABCW = FABC + MW Output of Wind Farms near Bruce Zone

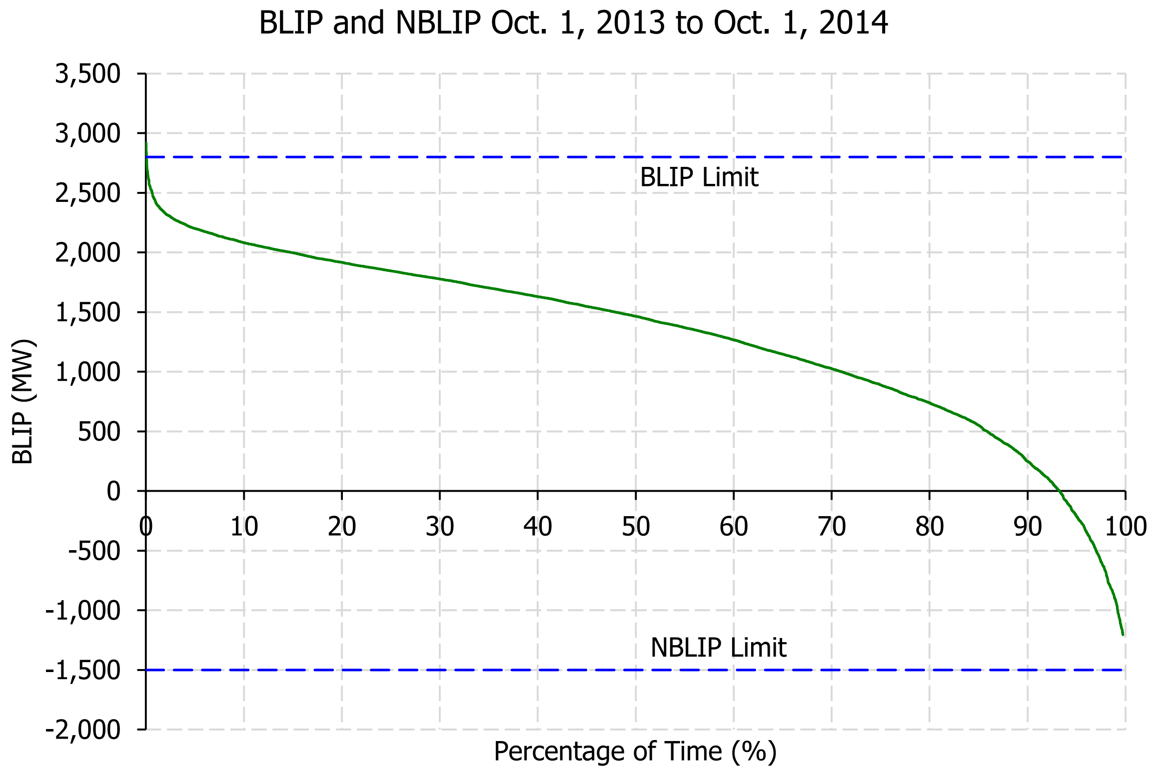
Figure 3.3.2 One Year Rolling (Oct. 2013 – Oct. 2014) Historical Flow Distribution - Interfaces

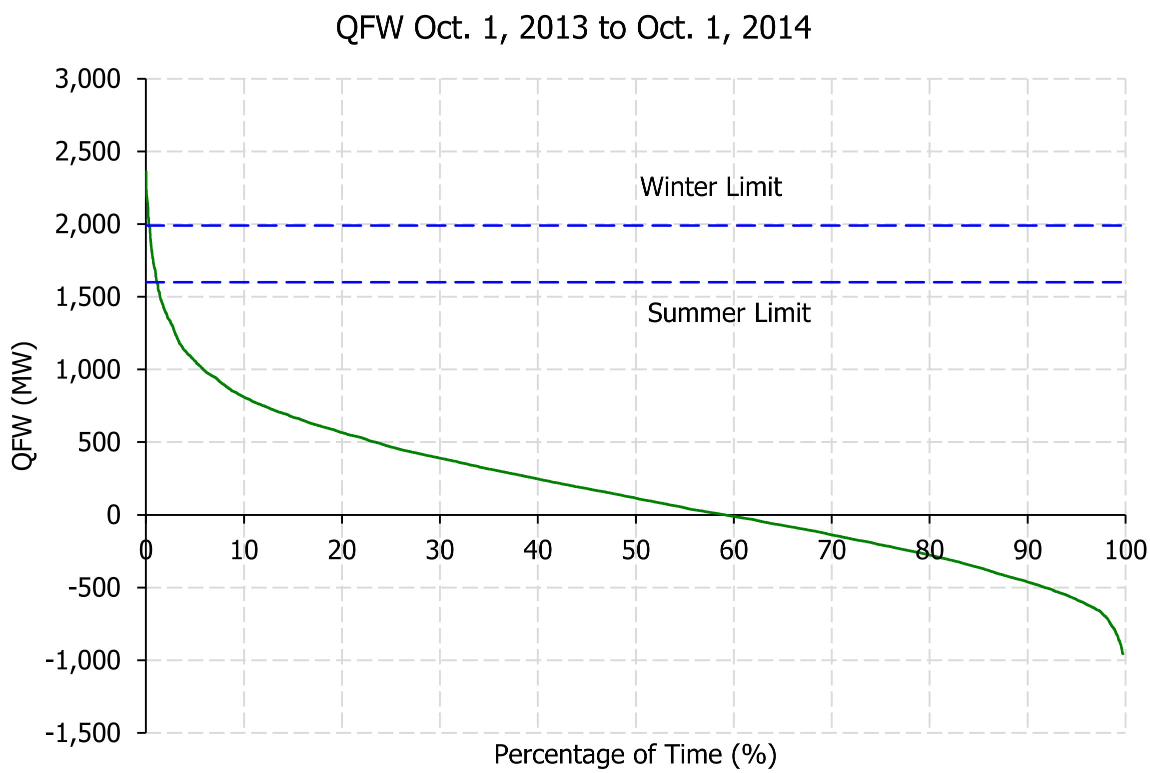


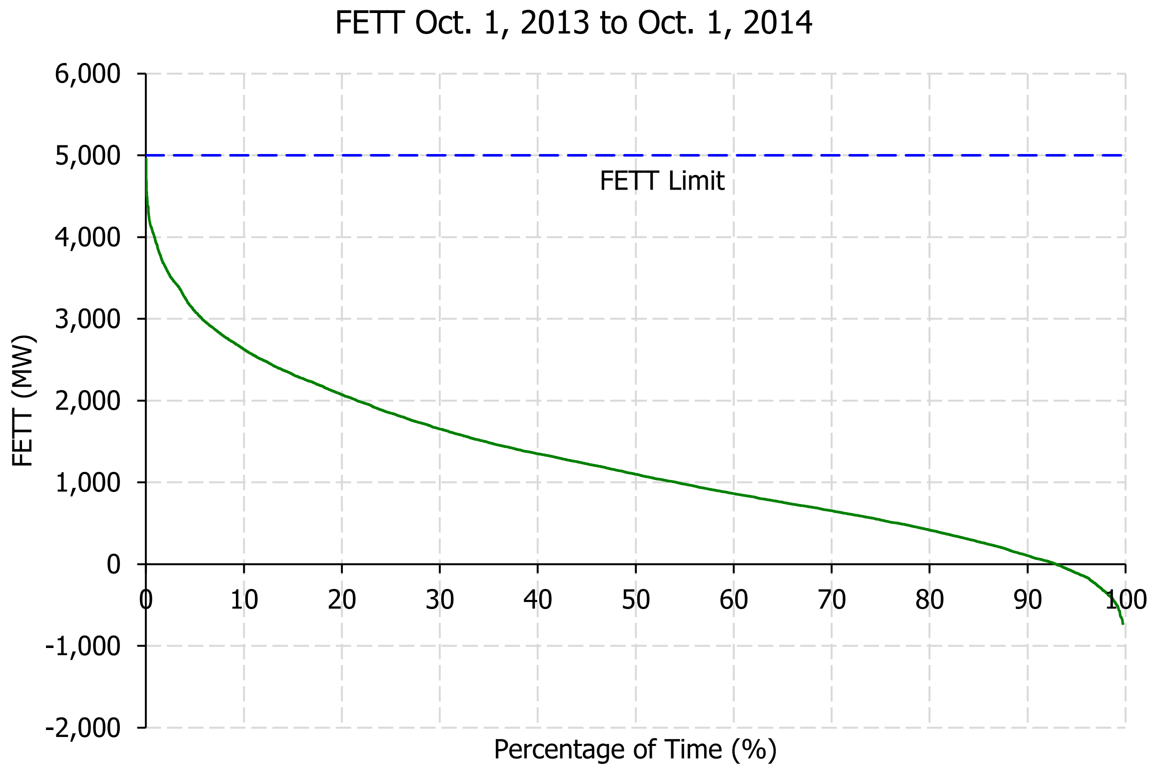


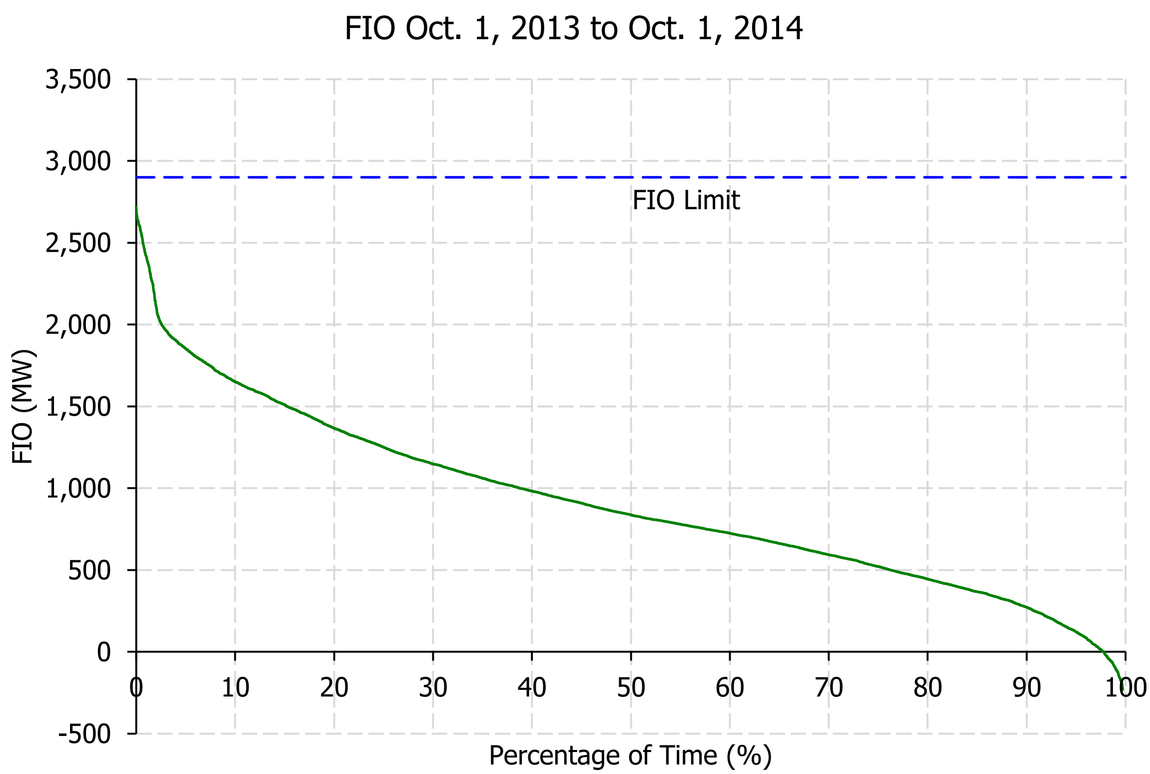

EWTW and EWTE Oct. 1, 2013 to Oct. 1, 2014
400
300
200
100
0
-100
-200
-300
-400
EWTE (MW)
0
10
20
30
40
50
60
70
80
90
100
EWTE Limit
EWTW Limit
Percentage of Time (%)


CLAN and CLAS Oct. 1, 2013 to Oct. 1, 2014
2,500
2,000
1,500
1,000
500
0
-500
-1,000
-1,500
CLAN (MW)
0
10
20
30
40
50
60
70
80
90
100
Percentage of Time (%)


BLIP and NBLIP Oct. 1, 2013 to Oct. 1, 2014
BLIP (MW)
3,500
3,000
2,500
2,000
1,500
1,000
500
0
-500
-1,000
-1,500
-2,000
0
10
20
30
40
50
60
70
80
90
100
BLIP Limit
NBLIP Limit
Percentage of Time (%)


QFW Oct. 1, 2013 to Oct. 1, 2014
QFW (MW)
3,000
2,500
2,000
1,500
1,000
500
0
-500
-1,000
-1,500
0
10
20
30
40
50
60
70
80
90
100
Winter Limit
Summer Limit
Percentage of Time (%)





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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 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 transfers on the 230 kV interconnection defined as the Ontario – Manitoba Transfer are the Ontario – Manitoba Transfer East (OMTE) and the Ontario – Manitoba Transfer West (OMTW), and are constrained by stability and thermal limitations. The OMTW limits are 300 MW in the winter and 288 MW in the summer. The OMTE limits are 368 MW in the winter and 356 MW in the summer. These limits do not include the deadband margins associated with the phase angle regulator taps.

The flow on the 115 kV interconnection is limited to 68 MW for flows into Ontario in the winter and summer while no flow out of Ontario is allowed.

Ontario and Manitoba are synchronously connected at 230 kV, 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 deadband 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.

Presently all four phase angle regulators are in service. From Ontario to Michigan, the winter and summer limits are both 1,650 MW. From Michigan to Ontario, the winter and summer limits are both 1,600 MW. The summer limits were increased to 1,650 MW from 1,500 MW and increased to 1,600 MW from 1,550 MW, for flows from Ontario to Michigan and flows from Michigan to Ontario, respectively, due to the updated study limits based on the solid operation of the Lambton bus.

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.

The scheduling limits for flows out of Ontario in the winter and summer are 1,800 MW and 1,500 MW respectively, while scheduling limits for flows into Ontario in the winter and summer are 1,800 MW and 1,500 MW respectively, based on updated study limits.

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 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 for flows both into Ontario and out of Ontario are 2,100 MW and 1,800 MW in the winter and summer respectively.

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 in the winter and 65 MW in the summer. For flows out of Ontario, the limit is 110 MW in the winter and 95 MW in the summer.

The Ontario – Quebec South Interconnection

The Ontario – Quebec South Interconnection consists of two 230 kV circuits in the East zone, five 230 kV circuits in the Ottawa zone, and two 115 kV circuits in the Ottawa zone. This includes the 230 kV interconnection from Hawthorne to the HVDC converters located at Outaouais station in Quebec.

The Quebec South Interconnection limit for flows into Ontario is 2,710 MW, constrained by the transmission limitations and generation availability. For flows out of Ontario, due to stability and thermal limitations, the limits are 2,040 MW in the summer and 2,060 MW in the winter.

Due to the short circuit current limitations of the Hawthorne 115 kV breakers, H9A is not permitted to be connected at Masson and consequently cannot be used for importing or exporting until the breakers are replaced.

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 the 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, 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 is up to 5,960 MW and for imports is up to 6,631 MW; in the winter the theoretical maximum capability for exports is 6,295 MW and for imports is 6,963 MW.

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.

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.

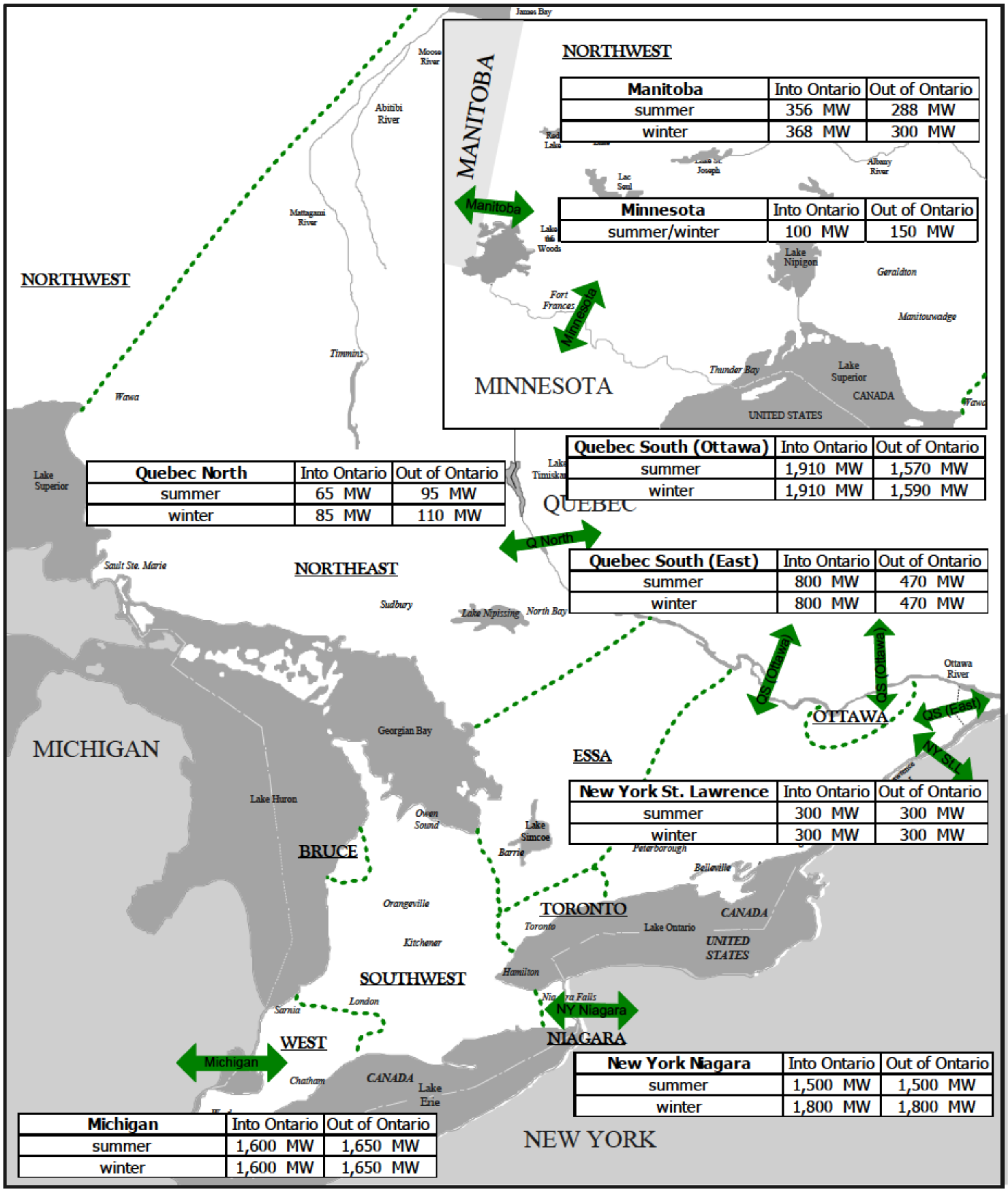
When ambient weather conditions permit, flow limits over paths restricted by thermal considerations may be increased during real-time operation.

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)	**356**	(3,5)
Manitoba – Winter*	**300**	(3)	**368**	(3,5)
Minnesota	**150**		**100**	(3)
Quebec North (Northeast) – Summer*	**95**		**65**	
D4Z	0	(4)	65	
H4Z	95	(4)	0	
Quebec North (Northeast)– Winter*	**110**		**85**	
D4Z	0		85	
H4Z	110		0	
Quebec South (Ottawa) – Summer*	**1570**		**1910**	
X2Y	0		65	
Q4C	120		0	
P33C	0		345	
D5A	200		250	
H9A	0		0	
HVDC	1250		1250	
Quebec South (Ottawa) – Winter*	**1590**		**1910**	
X2Y	0		65	
Q4C	140		0	
P33C	0		345	
D5A	200		250	
H9A	0		0	
HVDC	1250		1250	
Quebec South (East) – Summer*	**470**		**800**	
B31L + B5D	470		800	
Quebec South (East) – Winter*	**470**		**800**	
B31L + B5D	470		800	
New York St. Lawrence – Summer*	**300**		**300**	
New York St. Lawrence – Winter*	**300**		**300**	
New York Niagara – Summer*	**1,500**	(1)	**1,500**	(1,6)
Emergency Transfer Limit - Summer*	**2,160**	(1)	**1,860**	(1,6)
New York Niagara – Winter*	**1,800**	(1)	**1,800**	(1,6)
Emergency Transfer Limit - Winter*	**2,200**	(1)	**2,200**	(1,6)
Michigan – Summer*	**1,650**	(2,3,7)	**1,600**	(2,3,7)
Emergency Transfer Limit - Summer*	**2,520**	(2,3)	**1,950**	(2,3)
Michigan – Winter*	**1,650**	(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 LTE ratings and Emergency limits are based on STE ratings.
(3) For real time operation of the interconnection, limits are based on ambient conditions.
(4) Limit based on 0 to 4 km/h wind speed and 30 °C ambient temperature.
(5) Flows into Ontario include flows on circuit SK1.
(6) Flow limits into Ontario are shown here without considering QFW transmission constraints within Ontario.
(7) Flow limits during planned outages can be found in section 4.2.

Figure 4.3.1 Ontario's Points of Interconnection with Neighbouring Areas



Manitoba	Into Ontario	Out of Ontario
summer	356 MW	288 MW
winter	368 MW	300 MW

Minnesota	Into Ontario	Out of Ontario
summer/winter	100 MW	150 MW

Quebec South (Ottawa)	Into Ontario	Out of Ontario
summer	1,910 MW	1,570 MW
winter	1,910 MW	1,590 MW

Quebec North	Into Ontario	Out of Ontario
summer	65 MW	95 MW
winter	85 MW	110 MW

Quebec South (East)	Into Ontario	Out of Ontario
summer	800 MW	470 MW
winter	800 MW	470 MW

New York St. Lawrence	Into Ontario	Out of Ontario
summer	300 MW	300 MW
winter	300 MW	300 MW

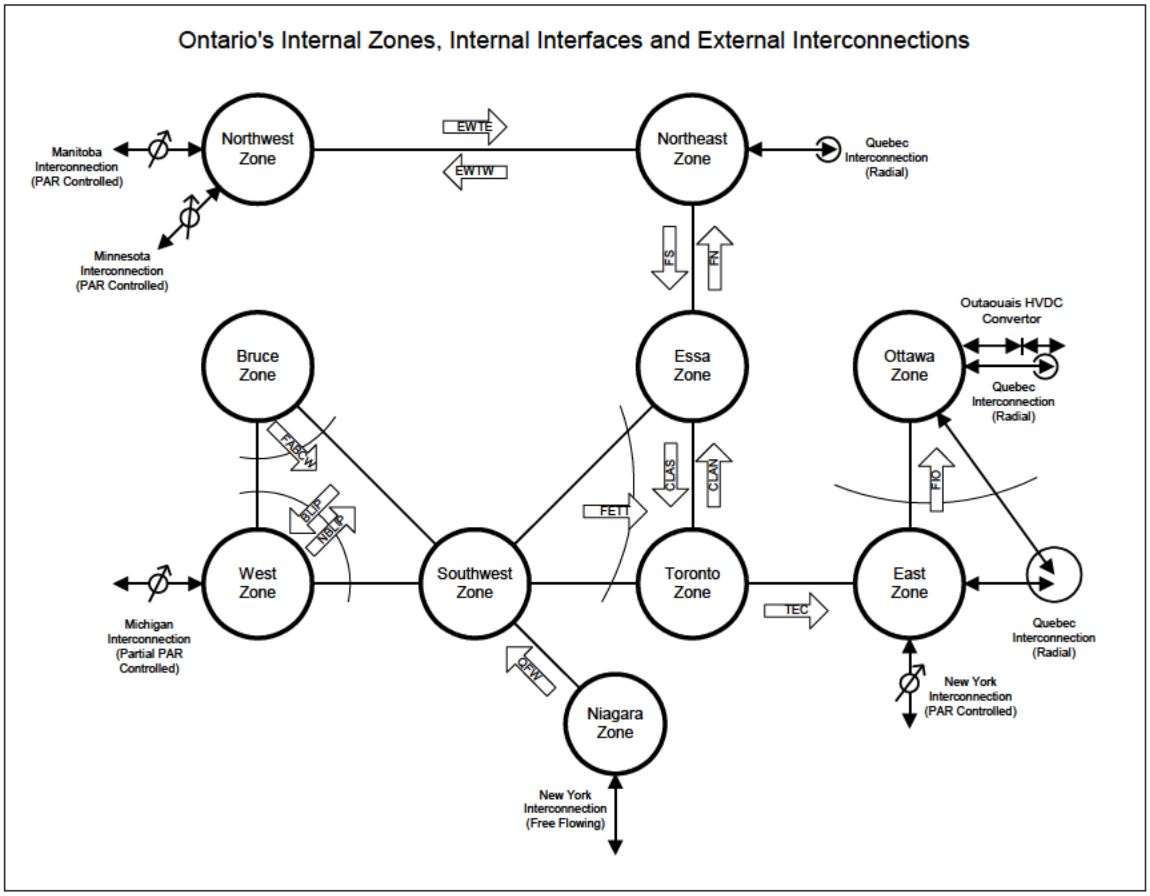
New York Niagara	Into Ontario	Out of Ontario
summer	1,500 MW	1,500 MW
winter	1,800 MW	1,800 MW

Michigan	Into Ontario	Out of Ontario
summer	1,600 MW	1,650 MW
winter	1,600 MW	1,650 MW

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.

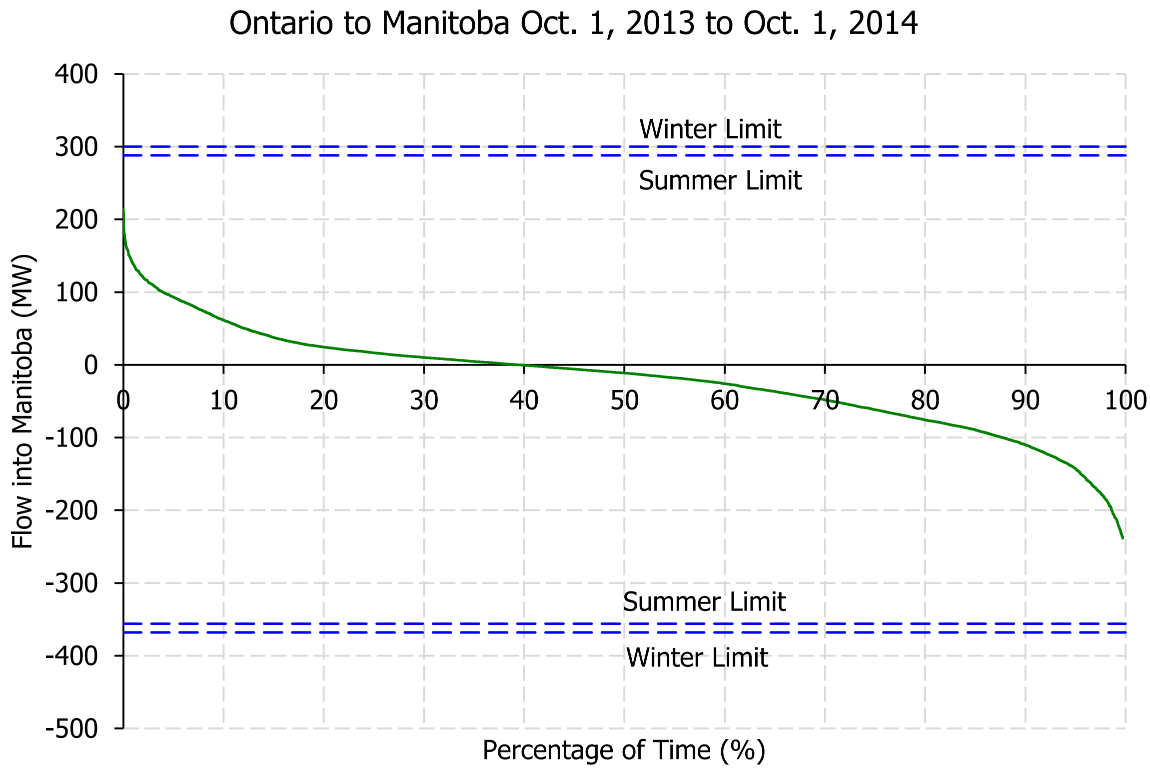
Figure 4.3.2 Ontario's Zones, Interfaces and Interconnections

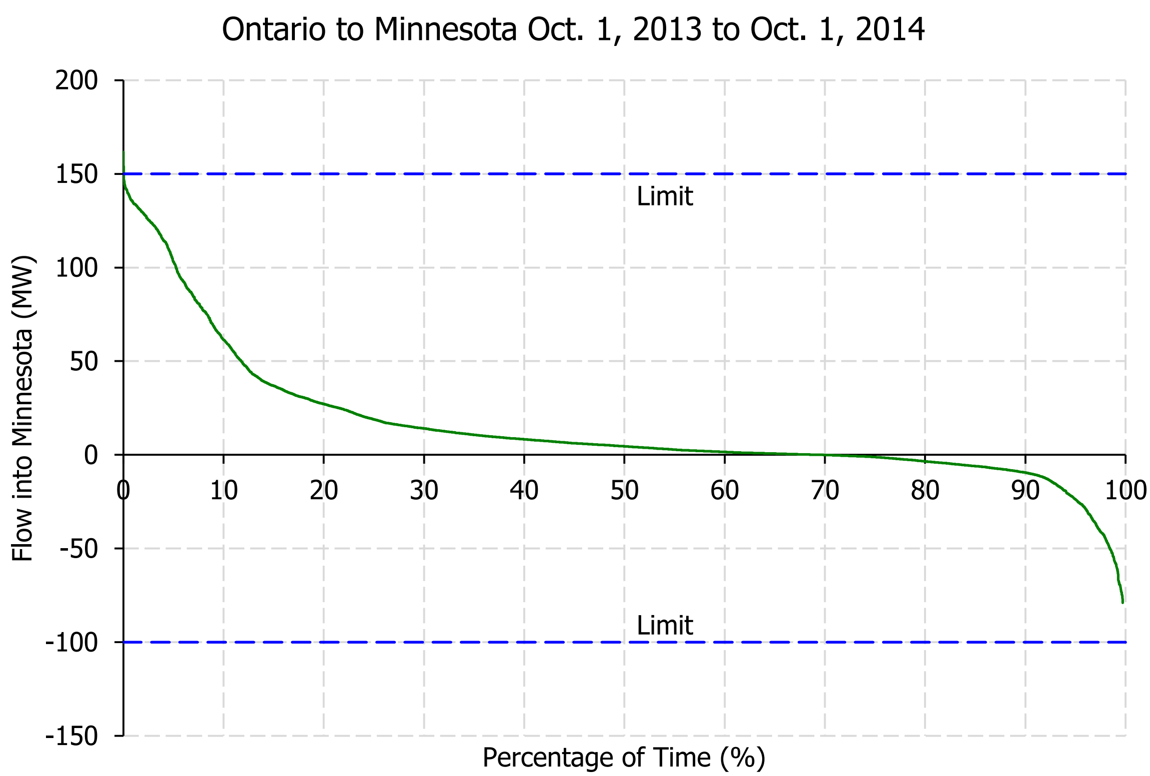


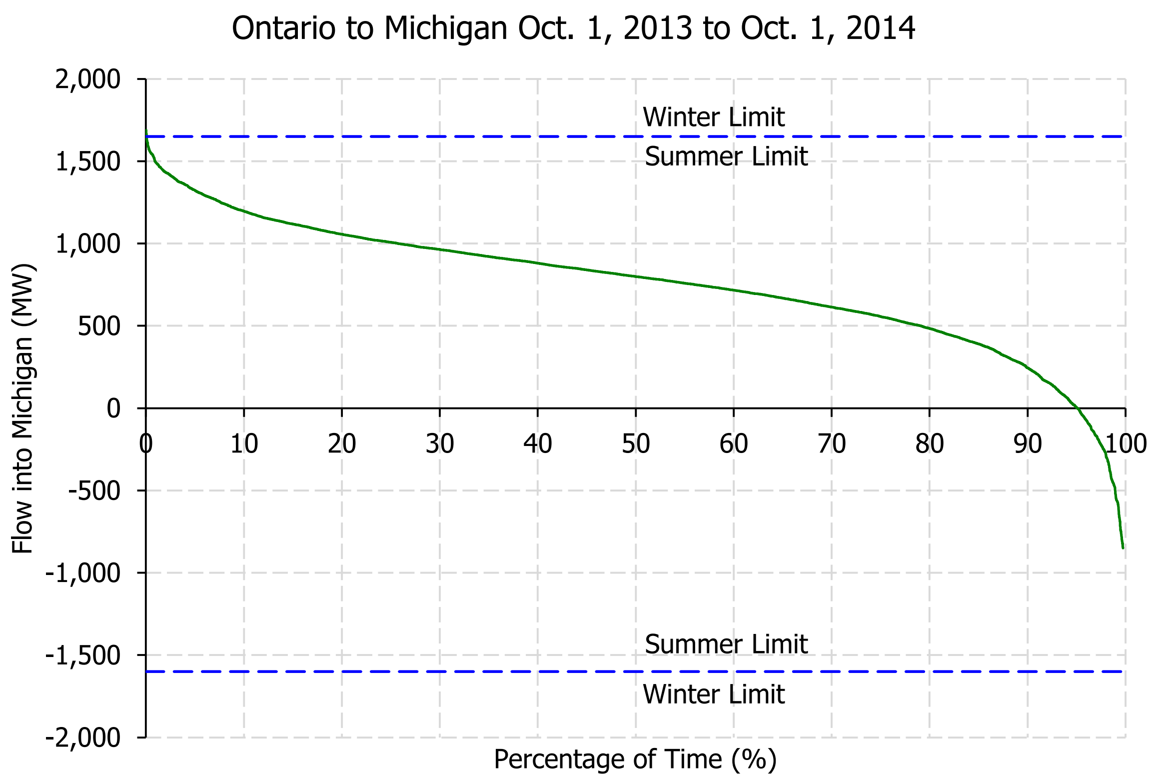
Notes to Figure 4.3.2:

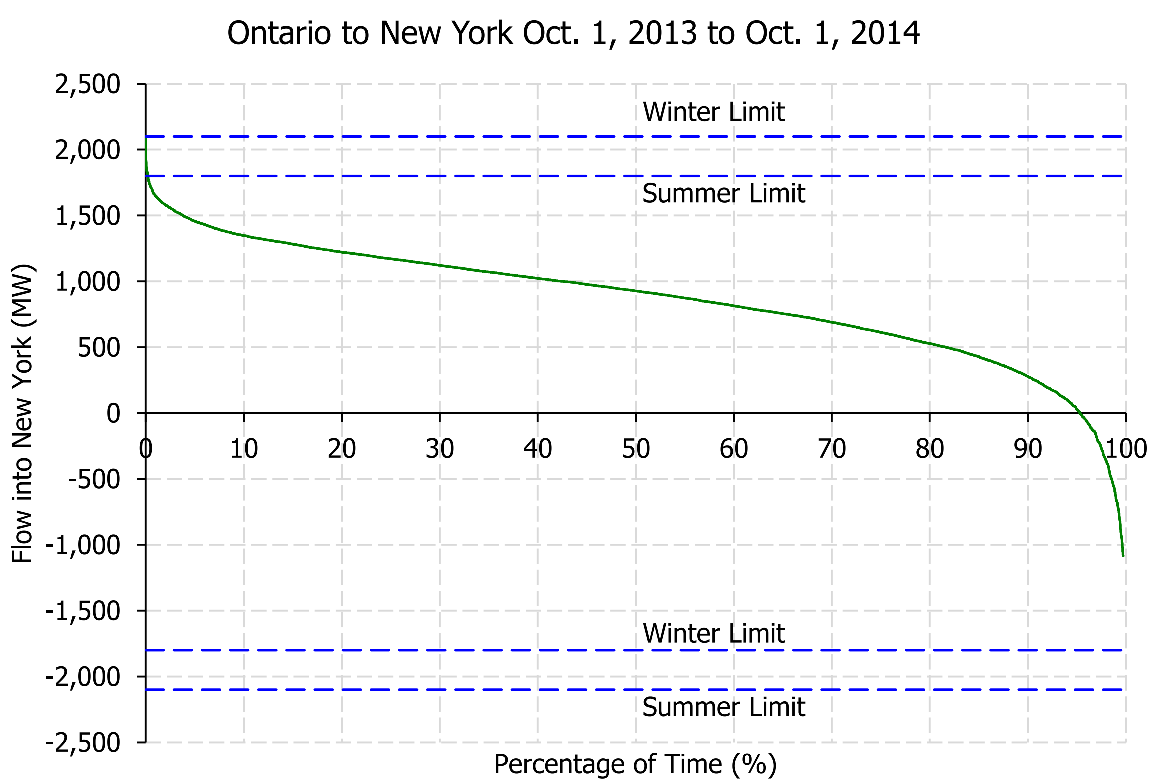
1. FABCW = FABC + MW Output of Wind Farms near Bruce Zone

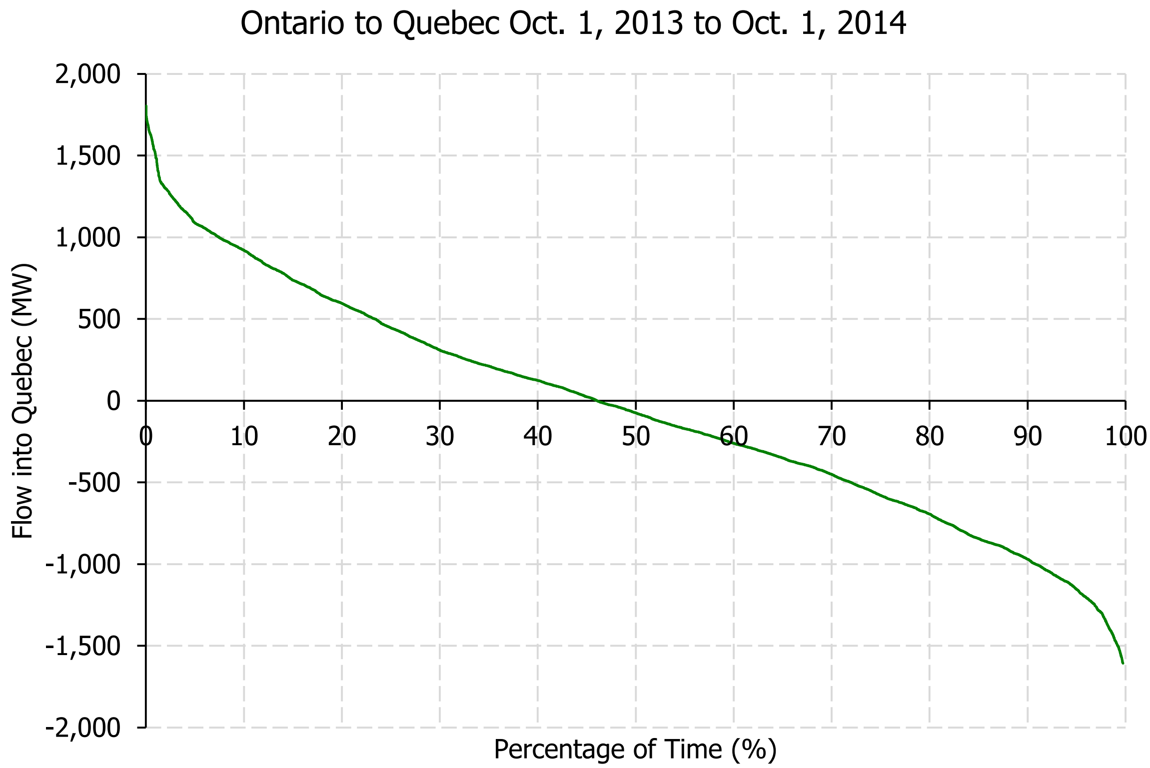
Figure 4.3.3 One Year Rolling (Oct. 2013 – Oct. 2014) Historical Flow Distribution - Interconnections

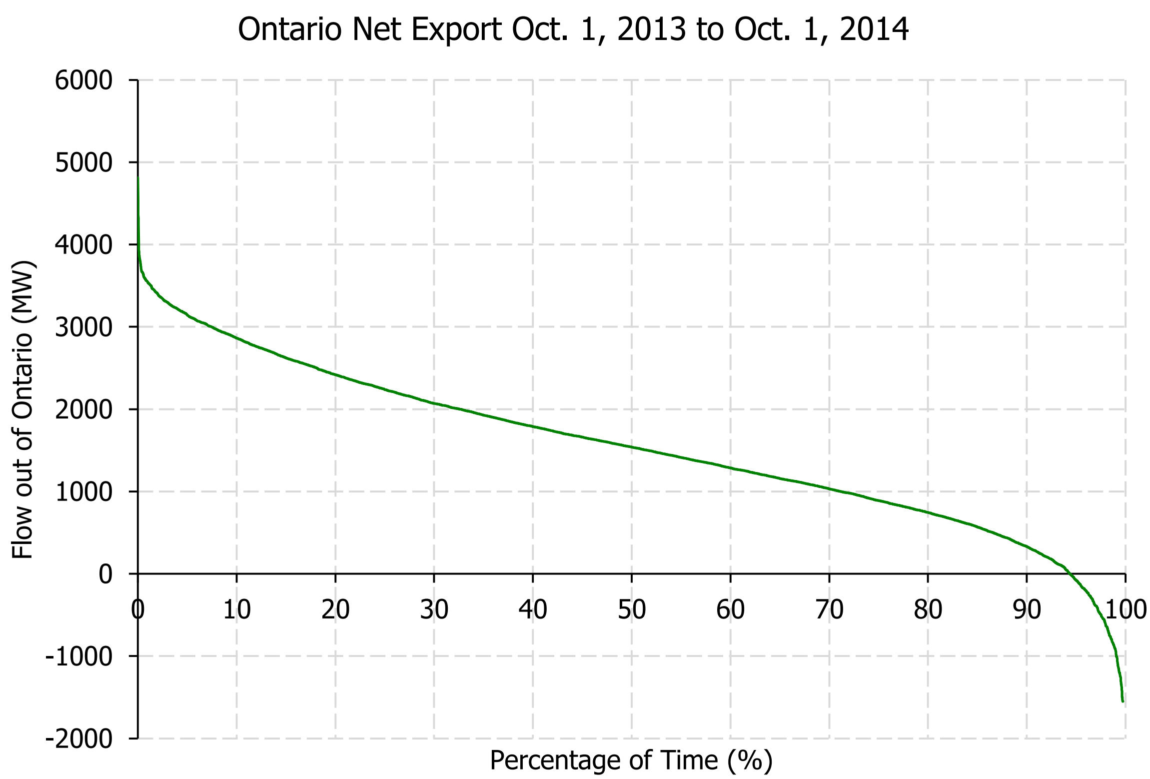





Ontario to Michigan Oct. 1, 2013 to Oct. 1, 2014
Winter Limit
Summer Limit
Summer Limit
Winter Limit
Flow into Michigan (MW)
Percentage of Time (%)
2,000
1,500
1,000
500
0
-500
-1,000
-1,500
-2,000
0
10
20
30
40
50
60
70
80
90
100


Ontario to New York Oct. 1, 2013 to Oct. 1, 2014
Winter Limit
Summer Limit
Winter Limit
Summer Limit
Flow into New York (MW)
Percentage of Time (%)
2,500
2,000
1,500
1,000
500
0
-500
-1,000
-1,500
-2,000
-2,500
0
10
20
30
40
50
60
70
80
90
100





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