Preliminary Connection Guidance for the Long-Term 2 RFP – Energy Stream

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Executive Summary

This document is intended to provide preliminary connection guidance information to potential proponents in the Long-Term 2 Request for Proposal – Energy Stream (LT2 RFP ES), to help inform project siting decisions to maximize the success of projects through the RFP evaluation process. As this procurement is focused on meeting reliability needs, the IESO aims to ensure projects awarded contracts can connect and operate with minimized risk of curtailment and congestion on the system. At its discretion and in consideration of rules and timing of procurement activities, the IESO will update this document should there be new information or if substantial changes to the procurement are required.

The IESO will release a separate connection guidance document for the LT2 RFP Capacity Stream.

The deliverability process for the LT2 RFP ES includes the following two steps:

1. Provide **preliminary connection guidance information** ahead of proposal submission to help proponents select project locations that will more likely contribute to addressing emerging energy reliablity needs (this document);
2. Conduct an **evaluation stage deliverability test** for projects submitted to the LT2 RFP ES as part of the proposal evaluation stage to assess whether submitted projects can contribute effectively to addressing emerging reliability needs. The evaluation stage deliverability test methodology will be based on principles and criteria similar to those used in this document. The energy deliverability evaluation methodology is under development at this time, and will be provided at a later date.

The IESO, with support from Hydro One Networks Inc. (HONI), has developed a set of preliminary connection guidance information, which considers both system congestion and system reliability factors, as follows:

1. System congestion limitations, as presented in Sections 2, 3 and 5 of the report;
2. Inverter-Based Resource (IBR) limitations, decribed in Section 4;
3. Protection and short circuit limitations, presented in Section 6; and
4. Distribution limitations (HONI stations only), as presented in Section 7.

Given the structure of the Enhanced Power Purchase Agreement (E-PPA) contract to be used for the LT2 RFP ES procurements, the IESO assumed that the resources participating in this RFP will have a relatively low capacity factor (below 50%). For resources with higher capacity factors, consultations with IESO staff is recommended as some connection locations may limit the delivery of energy from those resources.

Some locations could be subject to multiple types of limitations. Where multiple limitations apply to a particular location, the most constraining limitation should be used.

Table 1 summarizes the most constraining area limitations identified in this document, indicating the maximum amount of new generation that can connect.

Further below, Figures 1 and 2 identify all of the area limitations for Northern and Southern Ontario, respectively.

Table 1 | Most constraining Area limitations summary

Zone	IBR Limit[1] (MW)	Area Congestion Limit (MW)[2,3]	Short Circuit Limited Stations (50 km radius)
Northwest	North = 1,000	West of Wawa TS = 600	No limitation observed
Northeast		East of Widdifield SS = 150	
Essa	East of Toronto = 1,400	East of Minden TS = 250	No limitation observed
Ottawa		East of Dobbin TS = 275 East of Lennox TS = 900	No limitation observed
East			Lennox TS
Toronto	N/A	N/A	Cherrywood TS Clarington TS Richview TS Manby TS
Niagara[4]	West of Toronto = 2,400	West of Detweiler TS = 600 West of Middleport TS = 1,300 West of Milton SS = 1,100	Beck 2 TS
Southwest			Trafalgar TS Burlington TS Richview TS Manby TS
Bruce[4]		See West and Southwest Limits	No limitation observed
West		West of Buchanan TS = 1,100 West of Chatham SS = 600	No limitation observed

[1] IBR Limits apply to inverter-based resources and depend on the size and location of resources. For example, in Northern Ontario, the "North" IBR limit increases to 1,200 MW if 230 kV circuit connections are limited to 100 MW instead of 200 MW.

[2] Area congestion limits are valid for new resources with capacity factors below 50%. The limits could be further reduced for new resources with a capacity factor above 50%.

[3] Area congestion limits are approximations based on maximum generation that could be injected into the station mentioned as the area limit.

[4] Zonal probabilistic limits for certain technologies in Bruce and Niagara zones are more restrictive – see Section 2 of the document.

Figure 1 | Overall Northern Ontario Limitations Map

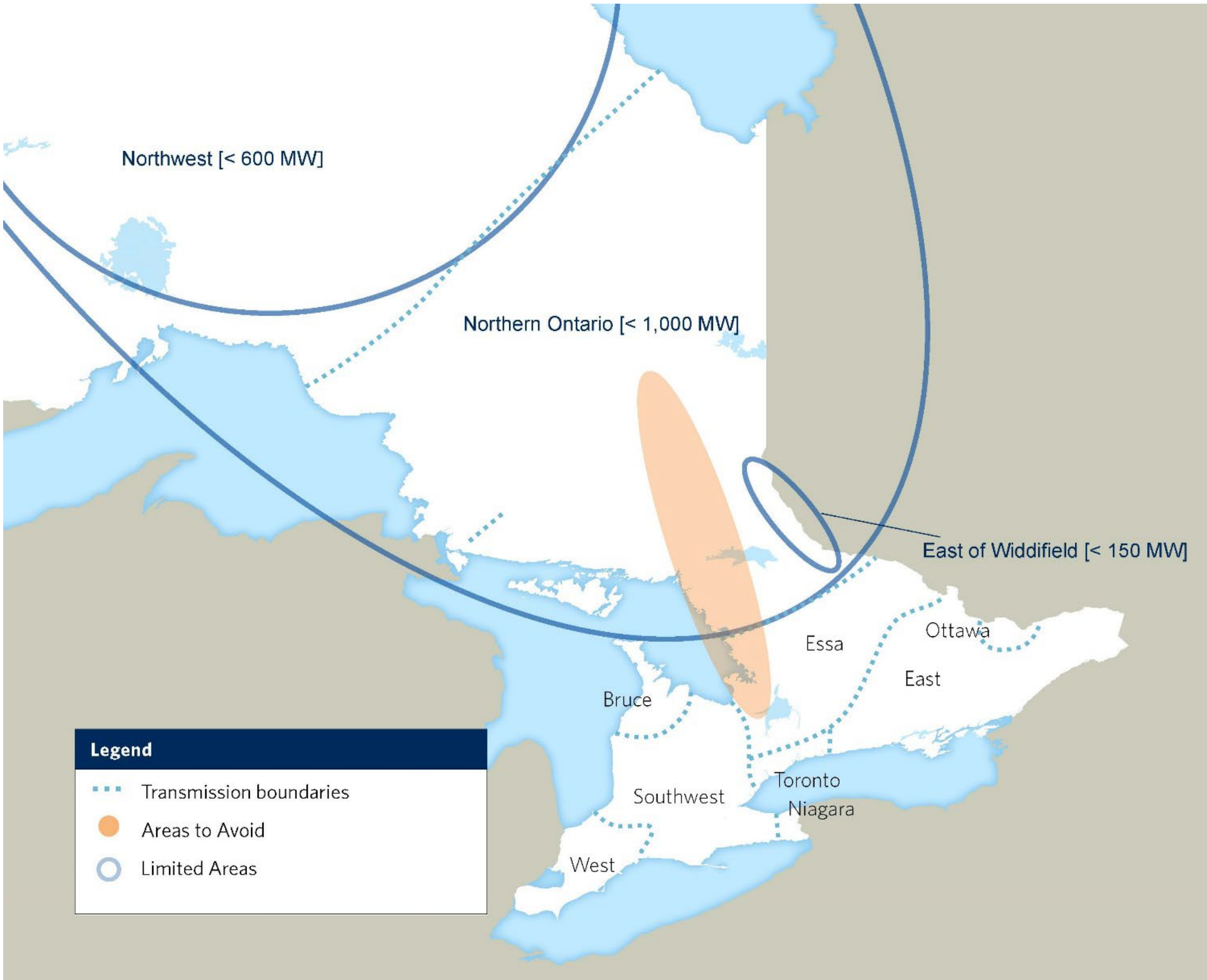
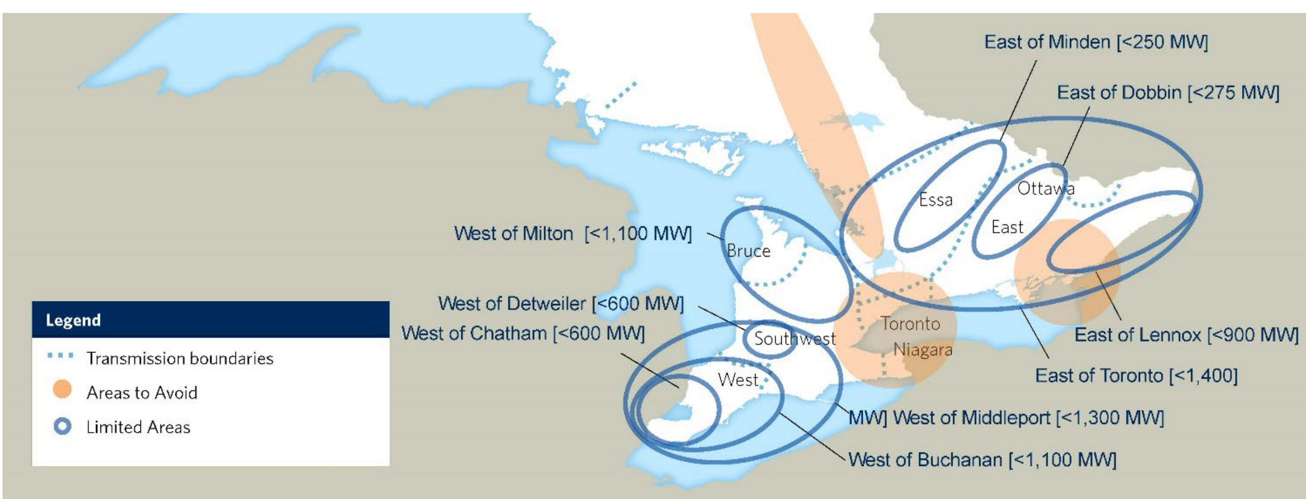


Figure 2 | Overall Southern Ontario Limitations Map



In addition to the zonal and area limitations above, the amount of generation that can connect directly to any single circuit is limited, in general, to the bright-line[1] thresholds as follows:

- 75 MW per 115 kV circuit in both Northern and Southern Ontario;
- 200 MW per 230 kV circuit in Northern Ontario; and
- 250 MW per 230 kV circuit in Southern Ontario.

However, there are circuits that would need to be avoided, as well as circuits with available capacity below the bright-line thresholds mentioned above. Appendix A lists the transmission circuits to avoid as well as the transmission circuits with restricted capacity for the various limitations assessed.

The results of the RFP evaluation will be highly dependent on the size and location of LT2 RFP ES proposals in the same electrical proximity – proposals may end up competing for the same transmission system availability as determined using the information in this document, during the evaluation stage deliverability test.

While this document considers only the electricity system impacts of project siting, proponents are encouraged to take a fulsome view of where they site their projects and examine other regulatory, permitting, RFP and policy requirements. For example, IESO received policy direction from the Ministry of Energy on project considerations for siting on agricultural land. Section 8 of this document lists other connection considerations that the users of this guidance should be aware of.

As this document is only providing preliminary connection guidelines, proponents are still free to submit proposals for projects at locations either not assessed in this document or recommended to avoid, as well as proposals for project sizes that exceed the limits presented in this document. However, there is a higher risk to those proposals during the evaluation stage deliverability test.

[1] Bright-line is a non-objective rule or standard.

1. Introduction

The goal of the LT2 RFP ES is to secure at least 5 TWh of energy from new resources to connect by 2030 or earlier.

In addition to the LT2 RFP ES, the IESO has introduced another procurement stream under the LT2 RFP, the LT2 RFP Capacity Stream. The IESO has also indicated that it will be launching a Long Lead-Time Resource Procurement, for which engagement will be separately conducted.

Since the LT2 RFP ES is designed to primarily address an energy need, the approach for ensuring procured resources contribute towards the reliability need will be different from past E-LT1 and LT1 RFPs that mainly addressed a capacity need (i.e., the ability to meet system needs at peak times). During the December 2023, February 2024 and April 2024 LT2 RFP webinars, the IESO has proposed a deliverability process comprised of two steps:

1. Provide **preliminary connection guidance information** ahead of proposal submission to help proponents select projects locations that will more likely contribute to addressing emerging energy reliablity needs (this document); and
2. Conduct an **evaluation stage deliverability test** for projects submitted to the LT2 RFP ES as part of the proposal evaluation stage, to assess whether submitted projects can contribute effectively to addressing emerging reliability needs. The evaluation stage deliverability test methodology will be based on principles and criteria similar to those used in the development of this guidance document. The energy deliverability evaluation methodology is under development at this time, and will be provided at a later date.

Stakeholders provided feedback that showed support for this approach, and indicated they would like to know availability and congestion data on a zonal, circuit and bus basis across Ontario.

To respond to the needs of stakeholders, the IESO, with support from HONI, have developed preliminary connection guidance information that takes into account six types of limitations, as follows:

1. Zonal probabilistic limitations – identify the total new generation that could connect into each of Ontario's electrical zones with a positive contribution to Ontario's global resource adequacy, by using a probabilistic resource assessment;
2. Area (multi-zonal, zonal, sub-zonal) congestion limitations – identify the total new generation that can connect into an area and result in a minimum risk of energy curtailments by using load-flow simulations;
3. Inverter-based resource limitations – identify the total amount of new inverter-based generation that can connect to a zone or a circuit and minimize the possibility of unwanted sub-synchronous control interactions (SSCI) with other inverter-based resources and sub-synchronous resonance (SSR) with series capacitors;

4. Circuit congestion limitations – identify the total amount of new generation that can connect to a circuit and result in a minimum risk of energy curtailments by using load-flow simulations;
5. Short-circuit & protection limitations (HONI system only) – identify areas where new resources should avoid connecting because short-circuit levels may exceed the capability of the transmission equipment or circuit protections may become inadequate; and
6. Distribution asset limitations (HONI stations only) – identify available capacity at distribution level assets.

The following sections of the document present the objective, methodology, assumptions and results for each of the six types of limitations. Given the structure of the Enhanced Power Purchase Agreement (E-PPA) contract to be used for the LT2 RFP ES procurements, the IESO assumed that the resources participating in this RFP will have a relatively low capacity factor (below 50%). For resources with higher capacity factors, consultations with IESO staff is recommended, as some connection location may limit the delivery of energy from those resource.

Some locations could be subject to multiple types of limitations. For example, availability in a distribution system identified through Section 7 could be further restricted by transmission-level limitations that are applicable to the station, or the area, the distribution system connects to. As well, multiple types of limitations could apply to the transmission connections. Where multiple limitations apply to a particular location, the most constraining limitation should be used.

The preliminary connection guidance information in this version of the document was updated to take into consideration the successful projects as per the LT1 RFP[2] process and the increase of project sizes that could connect per circuit, in response to stakeholders' feedback. Area and circuit congestion limitation changes were mainly due to the incorporation of LT1 RFP projects; whereas changes to IBR limitations were due to larger project sizes assumed to connect.

The preliminary connection guidance information in this document is presented to help potential LT2 RFP ES proponents identify project locations where a project is more likely to be found deliverable in the evaluation stage deliverability assessment of the LT2 RFP ES. See Disclaimer above.

[2] Details of LT1 projects can be found in the following document: https://ieso.ca/-/media/Files/IESO/Document-Library/long-term-rfp/LT1-RFP-results-table-20240509.pdf

2. Zonal Probabilistic Limitations

2.1 Objective

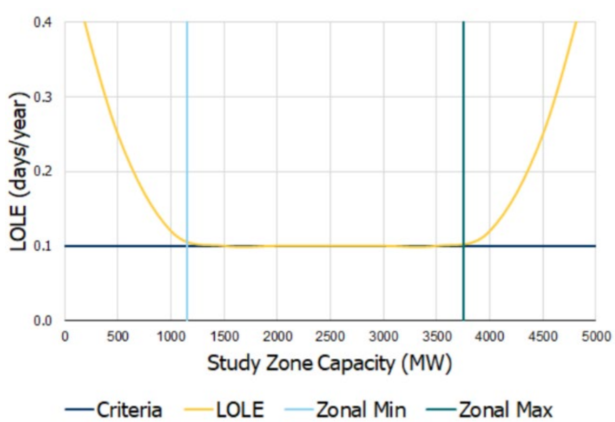
The goal of the probabilistic zonal energy assessment performed was to determine the total new capacity that could be added into an electrical zone and have a positive contribution towards provincial resource adequacy. New energy resources in a zone can contribute toward provincial resource adequacy when the energy is not congested at times of system need. The limit on the total capacity for each zone was determined for scenarios with new generation composed of 100% wind, 100% solar, and a solar - wind energy mix. Limitations for other technologies would depend on their respective capacity factors and production profiles.

2.2 Assumptions and Methodology

To calculate the zonal probabilistic limitations , the methodology used for 'perfect capacity' assessments was modified for renewables. This methodology is outlined in the Annual Planning Outlook: Supply, Adequacy and Energy Outlook Module [1], and is detailed as follows.

Zonal capacity limits are calculated using zonal constraint curves. Zonal constraint curves are developed by adding or removing capacity in a zone and removing or adding a corresponding amount of capacity in the rest of the system, such that the total incremental capacity is constant. The zonal constraint curve is developed using a 'two-zone' representation of the transmission system. The only interfaces that are represented in the capacity adequacy tool should be those that are connected to the study zone; the remainder are removed or set to a non-limiting value. The resulting system loss-of-load expectation (LOLE)[3] across a range of study zone capacities creates the zonal constraint curve, as shown in Figure 3.

Figure 3 | General Shape of Zonal Constraint Curve



[3] Loss-of-load expectation represents the expected probability of occurrence of a power system's inability to meet the demand for electricity within a specified period.

The flat portion of the curve represents the range of study zone capacity where the system LOLE will remain approximately unchanged for an equal and offsetting amount of capacity in the rest of the system. Where the curve slopes downwards to the left, LOLE is decreasing as study zone MWs are added and an equal amount of MWs are removed from the rest of the system. This indicates that additional MWs in the study zone improve total system adequacy. When the curve starts to rise, those additional MW cannot be fully utilized to offset capacity in the rest of the system and a zonal maximum can be established where the LOLE is greater than the LOLE threshold.[4]

2.3 Results

For the LT2 RFP ES preliminary connection guidance, the IESO determined the following zonal limits for new generators that could contribute to the adequacy needs of the system and avoid or minimize energy curtailments in each electrical zone, as shown in Table 2.

Table 2 | LT2 RFP ES Zonal Capacity Limits

Zone	Solar only Maximum (MW)[1]	Wind only Maximum (MW)[1]	Mix Solar & Wind Maximum (Solar MW, Wind MW)[1]	Other Technologies
Northwest	1,200	1,400	1,200, 600	Zone limits are project dependent
Northeast	2,000	1,800	1,600, 800	
NE + NW	2,000	1,800	1,600, 800	
East	Maximum Studied	1,800	Maximum Studied, 1,800	
Ottawa	2,400	Maximum Studied	1,600, 800	
Essa	Maximum Studied	Maximum Studied	Maximum Studied	
Southwest	Maximum Studied	Maximum Studied	Maximum Studied	
West	2,000	800	1,600, 800	
Niagara	800	0	N/A	
Bruce	0	1,800	N/A	
Toronto	2,400	0	N/A	

[1]The studies for each zone have tested up to 2,000 MW of wind and up to 4,000 MW of solar generation (solar has a lower capacity factor than wind), and up to 1,000 MW wind + 2,000 MW solar in the mixed case.

[4] LOLE threshold = System LOLE using target capacity requirement (per seasonal allocation) + 0.001 days/year

3. Area Congestion Limitations

3.1 Objective

The goal of the area (multi-zonal, zonal, sub-zonal) congestion limitation guidance assessment is to determine the total amount of new generation that can connect into an area and have a minimum risk of energy curtailment to prevent thermal overload of the transmission equipment downstream of that area.

3.2 Assumptions and Methodology

To determine area congestion limitations, the IESO created three main basecases for three larger sub-systems of focus:

- Northern Ontario sub-system – includes the Northwest and Northeast electrical zones;
- West of Toronto sub-system – includes the Southwest, West, Bruce and Niagara electrical zones; and
- East of Toronto sub-system – includes the Essa, East and Ottawa electrical zones.

Each of these cases was adjusted to deliver energy towards Toronto, and included the following assumptions:

- 2030 coincident minimum load demand for each sub-system of focus, as per the 2024 Annual Planning Outlook (APO) forecast;
- Non-energy-limiting resources, such as nuclear generators, gas generators and run-of the river hydro, were assumed in service at their maximum or normal operating output; with the exception of quick-starting gas fired generators, two Lennox units and one Bruce generating unit, which were assumed out of service;
- Dispatchable energy-limited resources, such as hydroelectric plants, were assumed at 50th percentile MW production, because they were considered able to generate around the intermittent resources and maximize the use of the transmission system;
- Existing wind and solar resources were assumed at 90% of their installed capacity;
- All contracted E-LT1 and LT1 RFP resources were assumed in service, with the storage resources charging at 50% capacity, and any new gas generators were dispatched as per the gas generation assumptions above;
- All major transmission projects committed to come into service by 2030 were considered, as per 2024 APO;
- Summer thermal ratings were used; and

- For any results that indicated a high level of congestion due to high natural gas generation output, additional sub-cases were tested, one with a 50th percentile demand forecast, and one with 50% gas fired generation level. The lowest limit between the two sub-cases is reported for the area limits.

For each of the three cases and sub-cases developed, new generation was injected at various major stations until pre or post-contingency thermal violations were observed. The use of Remedial Action Schemes (RAS) for the purpose of accommodating new resources was not considered in the assessments to avoid reliance on RAS with all transmission elements in-service.

The maximum injection determined using the methodology above was used as an approximation for the amount of generation that could connect into the area upstream of the station under assessment, and includes the station under assessment. For those scenarios where any upstream transmission circuits are recommended to be avoided (as per Appendix A), new generators may be required to connect directly into the stations.

3.3 Results

For Northern Ontario, the following limitations were identified:

Table 3 | Northern Ontario Area Congestion Limits

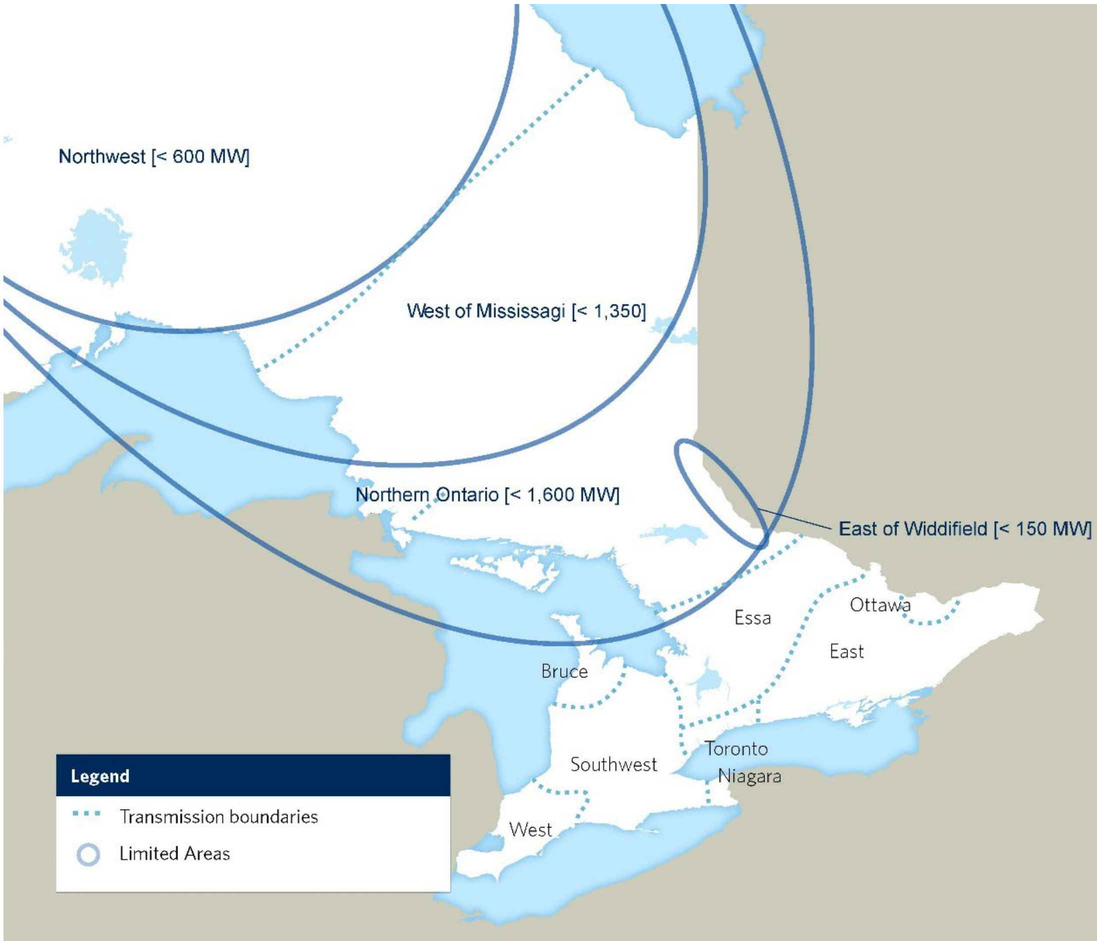
Area	Area Limit (MW) [2]
Northwest[1]	600
West of Mississagi TS	1,350
East of Widdifield SS	150
Northern Ontario	1,600

[1]The West of MacKenzie TS and West of Lakehead TS areas were tested and are not limiting beyond the West of Wawa zone.

[2]Area limits are approximations based on maximum generation that could be injected into the station.

Figure 4 illustrates approximate geographical boundaries for each area above.

Figure 4 | Area Congestion Limits within Northern Ontario



In addition, certain areas that are prone to transient instability and where congestion is often present, such as North and West of Pinard TS, the 115 kV system North of Lakehead TS and the 115 kV system North of Kenora TS, are also to be avoided.

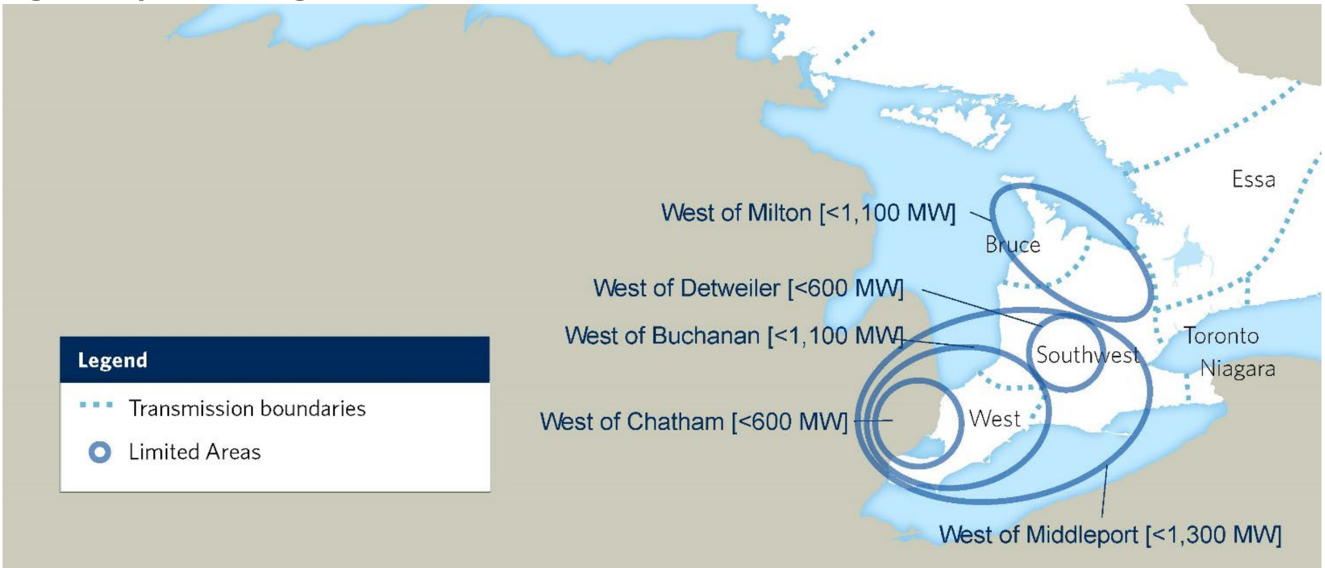
For the West of Toronto scenario, the following area limitations were determined:

Table 4 | West of Toronto Area Congestion Limits

Area	Area Limit (MW)
West of Chatham SS	600
West of Buchanan TS	1,100
West of Detweiler TS	600
West of Middleport TS	1,300
West of Nanticoke TS	1,300
West of Milton SS	1,100

Figure 5 shows the approximate geographical boundaries for some of the areas above.

Figure 5 | Area Congestion Limits for West of Toronto



For the East of Toronto scenario, the following area limitations were determined:

Table 5 | East of Toronto Area Congestion Limits

Area	Area Limit (MW)
East of Dobbin TS	275
East of Minden TS	250
East of St. Lawrence TS	400
East of Hinchinbrooke TS	1,100
East of Lennox TS	900
East of Bowmanville SS	1,900

Figure 6 shows the approximate geographical boundaries for some of the areas above.

Figure 6 | Area Congestion Limits for East of Toronto

In addition, certain areas that are prone to transient instability and where congestion is often present, such as the 115 kV system bounded by the Barrett Chute, Merivale and Cataraqui stations, should also be avoided.

4. Inverter Based Resource Limitations

4.1 Objectives

The goal of the Inverter Based Resource (IBR) limitations guidance assessment is to provide information on the amounts of IBR generation that could connect to different parts of the grid with minimal risk of introducing sub-synchronous resonance (SSR) with the existing series capacitors located at the Nobel Switching Station (SS), or introducing undesirable sub-synchronous control interactions (SSCI).

4.2 Assumptions and Methodology

IBRs have a history of oscillating under certain system conditions, typically when they are in proximity of other IBRs in weakly connected systems, or when they are radially connected to series compensated transmission circuits.

In order to avoid potential SSR issues with the series capacitors at Nobel SS on circuits X503E and X504E, the IESO performed a topology scan and excluded certain connection points that could become radially connected to these series capacitors for credible scenarios.

Potential SSCI were determined by the IESO using a screening tool that was developed in-house and that takes the following factors into consideration:

- System topology;
- Ratings and location of neighbouring IBRs; and
- Minimum short circuit ratio (SCR) specified by the OEM for stable operation of the IBR.

The following was assumed:

- For each IBR, a minimum SCR of 5 at its point of interconnection is assumed for stable operation;
- An SCR of 2-3 is used for existing IBRs at the inverter level; and
- Available Fault Level (AFL) is an indicator of whether the system is strong enough to support stable operation of a new IBR connection at the location measured without the risk of SSCI. It is calculated using the methodology explained in Section 6.6 of 'Connection of wind farms to weak AC networks' [2].

The size and locations of IBR injections were tested as follows[5]:

- Northern Ontario (Northeast + Northwest)

[5] This issue 2.0 of the document evaluated an increase of project sizes from the originally developed document as follows: 75 MW instead of 30 MW for 115 kV circuits, 200 MW instead of 100 MW for the 230 kV circuits in the Northern Ontario, and 250 MW instead of 150 MW for 230 kV network circuits and 100 MW radial circuits in the Southern Ontario.

- Tested up to 2,200 MW of IBRs using the following bright-line connection criteria:
  - Limit IBR 115 kV connections to 75 MW per circuit – the 115 kV network was found incapable of accommodating significant IBR injections in comparison to a stronger 230 kV network;
  - Limit IBR 230 kV connections to 200 MW per circuit; and
  - A maximum of one injection per circuit was assessed.

- Southern Ontario
  - Size and location of IBRs were chosen using the following bright-line connection criteria:
    - Avoid the limiting circuits of a major transmission interface – to avoid reducing the transfer capability of those interfaces that may have an imbalance of flows;
    - Limit IBR 115 kV connections to 75 MW per circuit;
    - Limit IBR 230 kV circuit connections to 250 MW per circuit; and
    - A maximum of one injection per circuit was assessed.
  - West of Toronto case – tested up to 2,400 MW of IBRs, following the criteria above
  - East of Toronto case – tested up to 1,400 MW of IBRs, following the criteria above.

4.3 Results

4.3.1 Sub-Synchronous Resonance

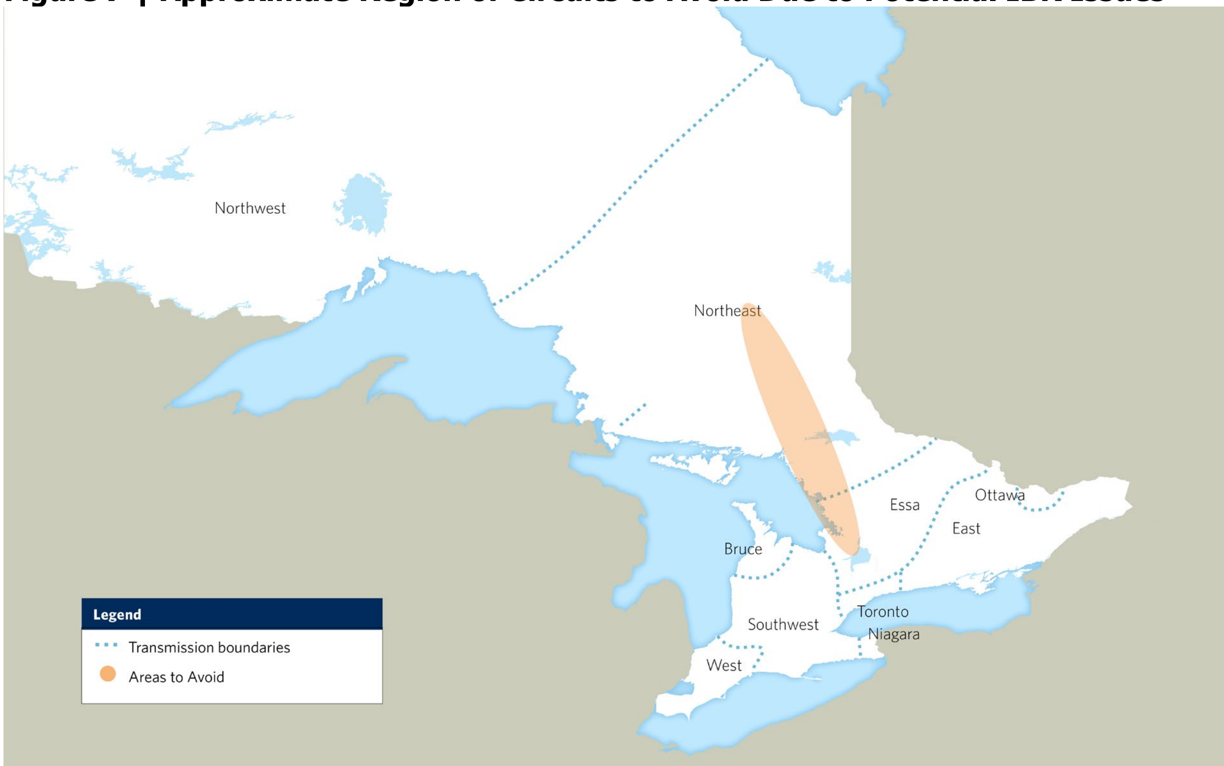
The results of the SSR topology scan identified that the following circuits could end up in a radial connection to the Nobel SS series capacitors for credible contingencies, and should be avoided for all IBRs.

Table 6 | Circuits to Avoid Due to Potential SSR Issues

Circuits connected to Hanmer	Circuits connected to Martindale	Circuits connected to Essa	
X74P	S22A	E510V	E20S
X27A	S21N	E511V	E21S
X23N	H23S	E26	
X25S	H24S	E27	
X26S	L1S	E28	
X29S	S2B	E29	
X505P	S5M	M6E	
P502X	S6F	M7E	
X503E		E8V	
X504E		E9V	

In eliminating the identifed circuits for SSR issues, connecting approximately 1,200 MW of IBRs to the remaining northern 230 kV circuits was tested and passed in Northern Ontario. The approximate region where these circuits are located is illustrated in Figure 7.

Figure 7 | Approximate Region of Circuits to Avoid Due to Potential IBR Issues



4.3.2 Sub-Synchronous Control Interactions

Out of the 1,200 MW of IBRs that passed the SSR scan in Northern Ontario, approximately 1,000 MW were found to be feasible for connection in Northern Ontario due to SSCI, where connection sizes to 115 kV circuits are limited to 75 MW and 230 kV circuits are limited to 200 MW per circuit. Amounts up to 1,200 MW can be connected in Northern Ontario where connections to 115 kV and 230 kV circuits are reduced in size to 30 MW and 100 MW, respectively.

For both West and East of Toronto cases in Southern Ontario, injections of 2,400 MW and 1,400 MW respectively, were found to be feasible from an SSCI perspective, where connections to 115 kV circuits are limited to 75 MW and 230 kV circuits are limited to 250 MW per circuit.

4.4 Other Considerations

In regards to utilizing the above results for guidance, the following must be taken into consideration:

- The analysis is meant to be used for high-level screening purposes only, and is not expected to cover all possible LT2 RFP ES combinations that may be submitted, as the outcomes of these tests are highly dependent on the size and location of the IBRs modeled;
- A further IBR SSCI assessment will be performed by the IESO during the evaluation stage deliverability test, once the size and location of LT2 RFP ES projects are known;

- Connection of IBRs can introduce voltage unbalance on the transmission system. This issue can be particularly severe for generation connecting to radial circuits. Typically, voltage unbalance will become unacceptable if the product of the line length (in km) and generation (in MW) exceeds 10,000 for 230kV radial lines (e.g. 100 MW on a 100 km long radial circuit) and 2,500 for 115kV radial lines (e.g. 50 MW on a 50 km long radial circuit). Generation proponents will be responsible for mitigating any unacceptable unbalance observed;
- Voltage unbalance can also occur on (non-radial) network circuits; however, it is most likely to only become an issue under outage conditions (e.g. if one line terminal opens, leaving the generation connected radially to the other terminal). In these scenarios, generation will need to be reduced or curtailed for the duration of the outage to mitigate the issue; and
- More detailed SSR, SSCI, voltage unbalance, and additional Electromagnetic Transient (EMT) studies, will be required once detailed models are known, which will most likely occur during the Connection Assessment stage as part of a System Impact Assessment (SIA).

5. Circuit Congestion Limitations

5.1 Objective

The goal of the circuit congestion limitations guidance assessment is to determine the amount of new generation that could inject into a circuit and not require energy curtailments to prevent thermal overload of the transmission equipment.

5.2 Assumptions and Methodology

To determine the maximum incremental generation that could inject into a circuit, the same cases that were developed for the Area Congestion Limitations analysis were used. Using the three basecases and the two additional sub-cases for the West of Toronto area and two sub-cases for the East of Toronto area described in the Area Congestion Limitations section, the maximum incremental injection into each circuit in each of the three areas of study was calculated by determining the remaining capacity between the short-term emergency thermal rating of the circuit and the post-contingency flow through the circuit following the most limiting recognized contingency, for the most limiting section of the main circuit.

In determining these limits, the following additional criteria was used:

- Where the load-flow study results indicated that a circuit has a capability that exceeds the bright-line connection criteria from the IBR Limitations section, the limit for the circuit was capped at the bright-line level;
- The 115 kV circuits that participate in remedial action schemes would need to be avoided, as they have a higher likelihood of being near their limits;
- The more limiting circuits of a major transmission interface would need to be avoided. This is to prevent reducing the the transfer capability of those interfaces;
- Available capacity was discounted for circuits on which connecting new resources would have a direct impact on the operability of existing generation units, even those dispatchable. Direct impact could occur if a new resource is located in the proximity of an existing resource and the local transmission capability to evacuate energy is limited, and would significantly inhibit the existing resource to generate, requiring frequent generation redispatch.

5.3 Results

Based on the the studies and additional criteria presented above, the following limitations were determined:

- Northern Ontario
    - Limit new 115 kV connections to 75 MW per circuit;
    - Limit new 230 kV connections to 200 MW per circuit; and
    - New connections to the circuits listed in Table 7 should be avoided.

Table 7 | List of Circuits in Northern Ontario to Avoid

Circuits to avoid					Circuits with Restricted Capacity		
115 kV				230 kV	115 kV (< 75 MW)		230 kV (< 200 MW)
A1B	C2M	K5A	R9A	D23G	A6P (30)	P5M (50)	P91G (100)
A4H	C3A	K5W	S1C	D5H	A8L (30)	W2C (50)	
A4L	C3W	L8L	S2B	H22D	D2H (50)		
A5A	D3K	M1M	T1B	K38S	D2L (50)		
A5H	D4	M1S	T1M	L20D	D3H (50)		
A7L	D6T	M2W	T7M	L21S	D5D (50)		
A7V	E1C	M3E	T8M	R21D	E4D (30)		
A8K	E2R	M3K	W3C		F1B (50)		
A9K	F1E	M9K			K2M (30)		
B15	H6T	P13T			K3D (50)		
B5	H7T	P15T			K6F (50)		
B6M	H9K	P7G			L3P (50)		
C1A	K2	R1LB			L5H (50)		
C2A	K4W	R2LB			M2D (50)		

- West and East of Toronto
    - Limit new 115 kV connections to 75 MW per circuit;
    - Limit new 230 kV connections to 250 MW;
    - For West of Toronto, new connections to the circuits listed in Table 8 should be further restricted. This table lists circuits which should be avoided, as well as circuits with available capacity below the bright-line thresholds above; and
    - For East of Toronto, new connections to the circuits listed in Table 9 should be further restricted to minimize energy congestion. This table lists circuits which should be avoided, as well as circuits with available capacity below the bright-line thresholds above.

Table 8 | List of Circuits West of Toronto Subject to Further Restrictions

Circuits to Avoid					Circuits with Restricted Capacity		
115 kV		230 kV			115 kV (< 75 MW)	230 kV (< 250 MW)	
B5C	K6Z	B18H	H26J	Q24HM	B12BL (50)	C42H (200)	N5M (100)
B6C	L7S	B20H	M20D	Q25BM	B13BL (50)	D4W (200)	S24V (150)
CP1J	Q2AH	B20P	M21D	Q28A	D10H (50)	D5W (200)	W36 (150)
D10S	S1H	B22D	M31W	R14T	W2S (50)	D6V (200)	W37 (150)
E1B	S2N	B23D	M32W	R17T		D7V (200)	W42L (200)
E6L	S2S	B24P	M33W	R19TH		H53Z (200)	W43L (200)
E8F	W14	B27S	N6S	R21TH		H54Z (200)	

E9F	W1W	B28S	N7S	T38B	H75 (150)
G1S	W8T	B4V	N21W	T39B	H76 (150)
H9W	WT1A	B5V	N22W		L24L (150)
J1B	WT1T	C43H	Q10P		L26L (150)
J3E	Z1E	E8V	Q21P		L29C (125)
J4E	Z7E	E9V	Q22P		M27B (200)
K2Z		H25J	Q23BM		M28B (200)

Table 9 | List of Circuits East of Toronto Subject to Further Restrictions

Circuits to Avoid				**Circuits with Restricted Capacity**
115 kV		**230 kV**		**230 kV (< 250 MW)**
A6R	S7M	C25H	L22H	C27P (150)
B1S	W3B	C28C	L24A	D1M (100)
B5QK	W6CS	D5H	P15C	D2M (100)
C7BM	X6	E26	S25L	D3M (100)
D6		E27	S26L	D4M (100)
L1MB		E34M	S30L	M80B (150)
L5C		E8V	S32L	M81B (150)
L2M		E9V	T22C	T25B/H23B (150)
M1R		L20H	T31H	T32H/H27H (100)
Q6S		L21H	X1P	T33E (150)

5.4 Other Considerations

- Connection to 500 kV circuits should be avoided;
- Connections to intertie circuits should be avoided;
- Any connection to HONI transmission circuits will need to comply with Hydro One Transmission Generation Interconnection Requirements document;
- Connection to circuits forming a parallel transmission path may require a configuration that balances the flows on all circuits in the path; and
- Connections to new transmission circuits that have a committed in-service date beyond December 31, 2029, as confirmed by the transmission developer at the time of the proposal submission deadline, are not allowed. This is to minimize the risk of procuring new resources that may not be able to connect due to potential delays with the new transmission projects.

6. Short-Circuit & Protection Limitations (HONI transmission system only)

6.1 Objective

The goal of the short-circuit limitations guidance assessment is to identify areas where the short-circuit levels are close to, or exceed, the short-circuit capability of the transmission equipment, and there are no feasible solutions to be implemented before year 2030; therefore, those areas should be avoided by the potential proponents in the LT2 RFP.

6.2 Assumptions and Methodology

HONI has identified transmission stations and equipment with short-circuit capabilities that could be close to their limits or exceeded by 2030 considering the committed generation and transmission projects expected to be in-service prior to the connection of the LT2 RFP ES projects, as specified by the IESO.

Because any addition of generation resources will increase the short-circuit levels in the proximity of their connection, HONI has recommended that proposals should avoid to connect within a radius of 50 km (electrical) from a station with short-circuit limitations.

A short-circuit assessment will be performed for all proposals in the evaluation stage deliverability test, regardless of their location.

6.3 Results

The following table presents HONI's transmission stations with known short circuit limitations:

Table 10 | Short-Circuit Limiting Stations (HONI)

Station	Limiting Issue
Cherrywood	Breaker rating
Burlington	Breaker rating
Manby	Station grounding
Lennox	Station grounding
Clarington	Breaker rating
Trafalgar	Breaker rating
Richview	Breaker rating
Beck #2	Breaker rating

Other limitations due to station grounding, skywires, strain buses and cable sections will be identified after the size and connection point of the proposed generators are known. Although HONI had indicated that the approximate distance to avoid was 50 km (electrical), to give the reader a rough geographical context, Figure 8 illustrates the approximate regions to avoid by drawing a 50 km radius around each of the stations identified in Table 10.

Figure 8 | Approximate Regions to Avoid Due to Potential Short-Circuit Limitations

6.4 Constraints Due to Protection

The total generation capacity and number of taps that could connect into a circuit may be limited due to line protection considerations. For example, protection may not reliably detect a circuit fault with a new generator connection on the circuit if the circuit is supplied by stations with low short-circuit levels. This determination can be made only after generator parameters and connection points are known.

Connecting into circuits limited by line protection, especially those protected by line differential may introduce major complexities and costly solutions, from installing sectionalizing breakers and new protection elements, to installing a full switching station at the connection point. It is, therefore, recommended to avoid connecting into these circuits.

A list of circuits recommended to avoid connecting new generation due to these issues, are shown in Table 11.

Table 11 | HONI Owned Circuits to avoid due to line protection constraints

Circuit	Voltage (kV)	Reason	Circuit	Voltage (kV)	Reason
J3E	115	Line differential	Q23BM	230	Line differential
J4E	115	Line differential	Q24HM	230	Line differential
J20B	230	Line differential	Q25BM	230	Line differential
K21C	230	Line differential	Q26M	230	Line differential
K23C	230	Line differential	Q28A	230	Line differential
L25V	230	Line differential	Q29HM	230	Line differential
L27V	230	Line differential	Q30M	230	Line differential
L28C	230	Line differential	Q35M	230	Line differential
M20D	230	Too many taps	R24C	230	Line differential
M21D	230	Too many taps	S39M	230	Line differential
M31W	230	Too many taps	S47C	230	Line differential
M32W	230	Too many taps	V41N	230	Line differential
M33W	230	Too many taps	V43N	230	Line differential
N20K	230	Line differential	W44LC	230	Line differential
N37S	230	Line differential	W45LS	230	Line differential

7. Distribution Asset Limitations (only HONI stations)

Available capacity at the HONI distribution assets can be found using HONI's Station and Feeder Capacity Calculator, located here. This list shows an approximate amount of generation that can be added at each bus or station owned by HONI.

Please note that upstream restrictions on the high voltage stations may limit the number of resources connecting at the distribution level. Transmission connected resources near a station will increase the fault level in the distribution system of that station, and will therefore compete for the available capacity.

This document does not provide guidance regarding any limitations or availability for connections to the distribution systems owned by Local Distribution Companies (LDCs) beyond the available capacity at distribution level stations supplied from Hydro One stations. Interested proponents are recommended to contact the LDCs operating the distribution system they intend to connect to.

8. General Considerations

The preliminary connection guidance provided in this document is intended to only be used in the context of the procurement of energy under the LT2 RFP, and only addresses electrical transmission system availability and energy deliverability limitations. Proponents are encouraged to take a fulsome view of where they site their projects and examine other regulatory, permitting, RFP and policy requirements. Any residual capacity needs that may need to be addressed through the LT2 RFP or subsequent procurements will rely on different methodologies and may leverage the deliverability testing processes established under the E-LT1 and LT1 RFPs, pending further detail.

In making use of this guidance document, there are several considerations and limitations, in addition to those detailed in other sections, that are important to consider. They are listed as follows:

- The connection guidance provided in this document is valid for resources with lower capacity factors (below 50%) for the the Energy Stream of the LT2 RFP. For resources with higher capacity factors, consultations with IESO staff is recommended as some connection locationsmay limit the delivery of energy from those resources;
- Some locations could be subject to multiple types of limitations. Where multiple limitations apply to a particular location, the most constraining limitation should be used;
- The conclusions of this document are highly dependent on the size and location of LT2 RFP ES proposals in the same electrical proximity. For example, the total amount that could be injected into a multi-circuit line or corridor could be less than the sum of the maximum single circuit injection value. As a result, proposals in LT2 RFP ES may compete for the same transmission system availability during the evaluation stage deliverability test;
- The assumptions and methods used to provide this guidance document are reflective of a limited number of historical and forecasted operating scenarios. At the time of the evaluation stage deliverability test, there may be other scenarios, methods and changes to forecasts to consider, which could provide different results;
- Direct connections into a transmission station were not assessed for possible limitations due to physical space available, auto-transformer rating and other operability issues at the station, beyond the limitations described in this document;
- In order to avoid a situation where a connection configuration turns out to be infeasible, impractical or too costly, applicants are encouraged to have discussions with transmitters and LDCs prior to making a submission into the LT2 RFP. Connection configurations must meet the transmitter's or LDC's connection requirements;
- The IESO strongly recommends that potential generation proponents with proposed projects connecting to the transmission system, or proposed projects larger than or equal to 10 MW connecting to the distribution system, delay their SIA applications until the results of the LT2 RFP ES are announced. If an applicant chooses to apply for an SIA, it is important to note that the SIA may need to be updated or restarted after the results of the LT2 RFP ES are

announced, as an SIA completed earlier would not have included all successful projects in the assessment; and

- Potential proponents considering projects for future procurements should be aware that the outcome of the LT2 RFP, as well as the purpose of the procurement (e.g., acquisition of energy or capacity), will make the information in this document inadequate for purpose of siting projects for these future procurements.

9. Conclusions

The results of the assessments presented in this document indicate locations that are more viable and locations that are more limited from an energy deliberability perspective, and is intended to guide the siting of new generation for the purpose of participating in the LT2 RFP.

As this document is only intended to provide preliminary connection guidelines, proponents are still free to submit proposals into the LT2 RFP ES for projects at locations that are either not assessed or recommended to avoid in this document, as well as proposals for project sizes that exceed the limits presented in this document. However, there is a higher risk that those proposals will not be successful in the energy deliverability test in the evaluation stage of the LT2 RFP.

10. References

[1] IESO, "Annual Planning Outlook: Supply, Adequacy and Energy Outlook Module", March 2024.

[2] CIGRE Working Group B4.62, "Connection of wind farms to weak AC networks", December 2016.

11. Appendix A: Transmission Circuits with Restrictions

Table 12 lists the transmission circuits to avoid for the various limitations assessed. Please keep in mind that this table does not list:

- All 500 kV circuits as it is recommended to avoid all 500 kV circuits
- All intertie circuits as it is recommended to avoid all intertie circuits
- All circuits connected within 50 km (electrical) of a short circuit limited stations listed in Table 10, as these circuits should be avoided

Table 12 | Transmission Circuits to Avoid

Circuit	Voltage (kV)	Zone	Circuit	Voltage (kV)	Zone	Circuit	Voltage (kV)	Zone
A1B	115	Northwest	H22D	230	Northeast	K2	115	Northeast
A4L	115	Northwest	H23S	230	Northeast	K5A	115	Northeast
A5A	115	Northwest	H24S	230	Northeast	L1S	115	Northeast
A7L	115	Northwest	K38S	230	Northeast	L8L	115	Northeast
B15	115	Northwest	L20D	230	Northeast	M3K	115	Northeast
B5	115	Northwest	L21S	230	Northeast	M9K	115	Northeast
B6M	115	Northwest	R21D	230	Northeast	P13T	115	Northeast
C1A	115	Northwest	S21N	230	Northeast	P15T	115	Northeast
C2A	115	Northwest	S22A	230	Northeast	P7G	115	Northeast
C2M	115	Northwest	X23N	230	Northeast	S2B	115	Northeast
C3A	115	Northwest	X25S	230	Northeast	S5M	115	Northeast
C3W	115	Northwest	X26S	230	Northeast	S6F	115	Northeast
E1C	115	Northwest	X27A	230	Northeast	T1B	115	Northeast
E2R	115	Northwest	X29S	230	Northeast	T7M	115	Northeast
K4W	115	Northwest	X74P	230	Northeast	T8M	115	Northeast
K5W	115	Northwest	A4H	115	Northeast	D5H	230	Essa
M1M	115	Northwest	A5H	115	Northeast	E20S	230	Essa
M1S	115	Northwest	A7V	115	Northeast	E21S	230	Essa
M2W	115	Northwest	A8K	115	Northeast	E26	230	Essa
M3E	115	Northwest	A9K	115	Northeast	E27	230	Essa
R1LB	115	Northwest	D3K	115	Northeast	E28	230	Essa
R2LB	115	Northwest	D4	115	Northeast	E29	230	Essa
R9A	115	Northwest	D6T	115	Northeast	E8V	230	Essa
S1C	115	Northwest	F1E	115	Northeast	E9V	230	Essa
T1M	115	Northwest	H6T	115	Northeast	M6E	230	Essa
W3C	115	Northwest	H7T	115	Northeast	M7E	230	Essa
D23G	230	Northeast	H9K	115	Northeast	D6	115	Essa

Circuit	Voltage (kV)	Zone
L24A	230	Ottawa
A6R	115	Ottawa
L2M	115	Ottawa
M1R	115	Ottawa
S7M	115	Ottawa
C25H	230	East
C28C	230	East
E34M	230	East
L20H	230	East
L21H	230	East
L22H	230	East
P15C	230	East
S25L	230	East
S26L	230	East
S30L	230	East
S32L	230	East
T22C	230	East
T31H	230	East
X1P	230	East
B1S	115	East
B5QK	115	East
C7BM	115	East
L1MB	115	East
L5C	115	East
Q6S	115	East
W3B	115	East
W6CS	115	East
X6	115	East
K21C	230	Toronto
K23C	230	Toronto
R14T	230	Toronto
R17T	230	Toronto
R19TH	230	Toronto
R21TH	230	Toronto
R24C	230	Toronto
Q10P	230	Niagara
Q21P	230	Niagara
Q22P	230	Niagara
Q23BM	230	Niagara

Circuit	Voltage (kV)	Zone
Q24HM	230	Niagara
Q25BM	230	Niagara
Q26M	230	Niagara
Q28A	230	Niagara
Q29HM	230	Niagara
Q30M	230	Niagara
Q35M	230	Niagara
D10S	115	Niagara
Q2AH	115	Niagara
B18H	230	Southwest
B20H	230	Southwest
B22D	230	Southwest
B23D	230	Southwest
B4V	230	Southwest
B5V	230	Southwest
M20D	230	Southwest
M21D	230	Southwest
M31W	230	Southwest
M32W	230	Southwest
M33W	230	Southwest
N20K	230	Southwest
N37S	230	Southwest
S39M	230	Southwest
T38B	230	Southwest
T39B	230	Southwest
B5C	115	Southwest
B6C	115	Southwest
S1H	115	Southwest
S2S	115	Southwest
B20P	230	Bruce
B24P	230	Bruce
B27S	230	Bruce
B28S	230	Bruce
CP1J	115	Bruce
C43H	230	West
H25J	230	West
H26J	230	West
J20B	230	West
L25V	230	West

Circuit	Voltage (kV)	Zone
L27V	230	West
L28C	230	West
N6S	230	West
N7S	230	West
N21W	230	West
N22W	230	West
S47C	230	West
V41N	230	West
V43N	230	West
W44LC	230	West
W45LS	230	West
E1B	115	West
E6L	115	West
E8F	115	West
E9F	115	West
G1S	115	West
H9W	115	West
J1B	115	West
J3E	115	West
J4E	115	West
K2Z	115	West
K6Z	115	West
L7S	115	West
S2N	115	West
W14	115	West
W1W	115	West
W8T	115	West
WT1A	115	West
WT1T	115	West
Z1E	115	West
Z7E	115	West

Table 13 lists the transmission circuits with restricted capacity for the various limitations assessed.

Table 13 | Transmission Circuits with Restricted Capacity

Circuit	Capacity	Voltage (kV)	Zone	Circuit	Capacity	Voltage (kV)	Zone
A6P	30 MW	115	Northwest	T33E	150 MW	230	East
A8L	30 MW	115	Northwest	D4W	200 MW	230	Southwest
D5D	50 MW	115	Northwest	D5W	200 MW	230	Southwest
E4D	30 MW	115	Northwest	D6V	200 MW	230	Southwest
F1B	50 MW	115	Northwest	D7V	200 MW	230	Southwest
K2M	30 MW	115	Northwest	M27B	200 MW	230	Southwest
K3D	50 MW	115	Northwest	M28B	200 MW	230	Southwest
K6F	50 MW	115	Northwest	N5M	100 MW	230	Southwest
L3P	50 MW	115	Northwest	S24V	150 MW	230	Southwest
M2D	50 MW	115	Northwest	B12BL	50 MW	115	Southwest
P5M	50 MW	115	Northwest	B13BL	50 MW	115	Southwest
P91G	100 MW	230	Northeast	D10H	50 MW	115	Southwest
D2H	50 MW	115	Northeast	C42H	200 MW	230	West
D2L	50 MW	115	Northeast	H53Z	200 MW	230	West
D3H	50 MW	115	Northeast	H54Z	200 MW	230	West
L5H	50 MW	115	Northeast	H75	150 MW	230	West
W2C	50 MW	115	Northeast	H76	150 MW	230	West
D1M	100 MW	230	Essa	L24L	150 MW	230	West
D2M	100 MW	230	Essa	L26L	150 MW	230	West
D3M	100 MW	230	Essa	L29C	125 MW	230	West
D4M	100 MW	230	Essa	W36	150 MW	230	West
M80B	150 MW	230	Essa	W37	150 MW	230	West
M81B	150 MW	230	Essa	W42L	200 MW	230	West
C27P	150 MW	230	East	W43L	200 MW	230	West
T25B/H23B	150 MW	230	East	W2S	50 MW	115	West
T32H/H27H	100 MW	230	East				

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