# Need for Northeast Bulk System Reinforcement

October 2022

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# List of Abbreviations

| | |
|---|---|
| APO | Annual Planning Outlook |
| CCGT | Combined Cycle Gas Turbine |
| EAF | Electrical Arc Furnaces |
| ELS | East Lake Superior |
| EWTE | East West Tie East |
| EWTW | East West Tie West |
| FN | Flow North |
| FS | Flow South |
| IRRP | Integrated Regional Resource Plan |
| kV | Kilovolt |
| LTE | Long-Term Emergency |
| LTR | Limited Time Rating |
| LV | Low-voltage |
| MISSE | Mississagi East |
| MISSW | Mississagi West |
| MW | Megawatt |
| NERC | North American Electric Reliability Corporation |
| NPCC | Northeast Power Coordinating Council |
| NE | Northeast |
| NELGR | Northeast Load and Generation Rejection |
| NW | Northwest |
| OEB | Ontario Energy Board |
| ORTAC | Ontario Resource and Transmission Assessment Criteria |
| RAS | Remedial Action Scheme |
| RIP | Regional Infrastructure Plan |
| SIA | System Impact Assessment |
| SMR | Small Modular Reactors |
| SSM | Sault Ste. Marie |
| STE | Short-Term Emergency |
| SVC | Static VAR Compensator |
| TS | Transformer Station |
| UCAP | Unforced Capacity |

# Executive Summary

The Northeast Bulk Plan (the Plan) was developed to reliably supply the substantial load growth expected in the areas west of Sudbury to Wawa and north of Sudbury to Timmins, while maintaining the power transfer required to supply the forecasted load in the Northwest and the rest of the Northeast.

This report documents the results of a planning study that the IESO has undertaken to assess the reliability of the bulk transmission system in the Northeast due to the expected load growth. The study reviewed existing transmission system adequacy, identified bulk system needs, evaluated options to address these needs, and recommended a transmission reinforcement plan outlined in this report.

Electricity demand from the industrial sector in the Northeast is forecast to grow at a rapid pace over next 10 years, primarily driven by electrification initiatives and anticipated policies to reduce carbon emissions. This growth is expected to be concentrated in the Sault Ste. Marie (SSM) and Timmins areas (referred to as the "Focus Areas").

In response to this growing need, the IESO performed a technical analysis to assess the capability of the transmission system to supply this growth while maintaining reliability. The issues that were identified through this study are described as follows:

- The existing transmission system has insufficient capability to reliably supply forecasted load growth in the Focus Areas. This need is forecasted to begin in 2029[1], and is sustained through the planning horizon (20 years).
- The addition of the forecast industrial load growth in the SSM focus area could decrease the existing westbound transfer capability from Sudbury to Mississagi by approximately 75 MW (12.8%), which is more than the 5% threshold allowed by the IESO's Ontario Resource and Transmission Assessment Criteria (ORTAC).
- Load growth in the Timmins focus area would exacerbate existing operational challenges, increasing reliance on an existing Remedial Action Scheme (RAS) to protect the system against outages to the main 500 kV circuit from Sudbury to Timmins, and limit future demand growth in the Timmins area.

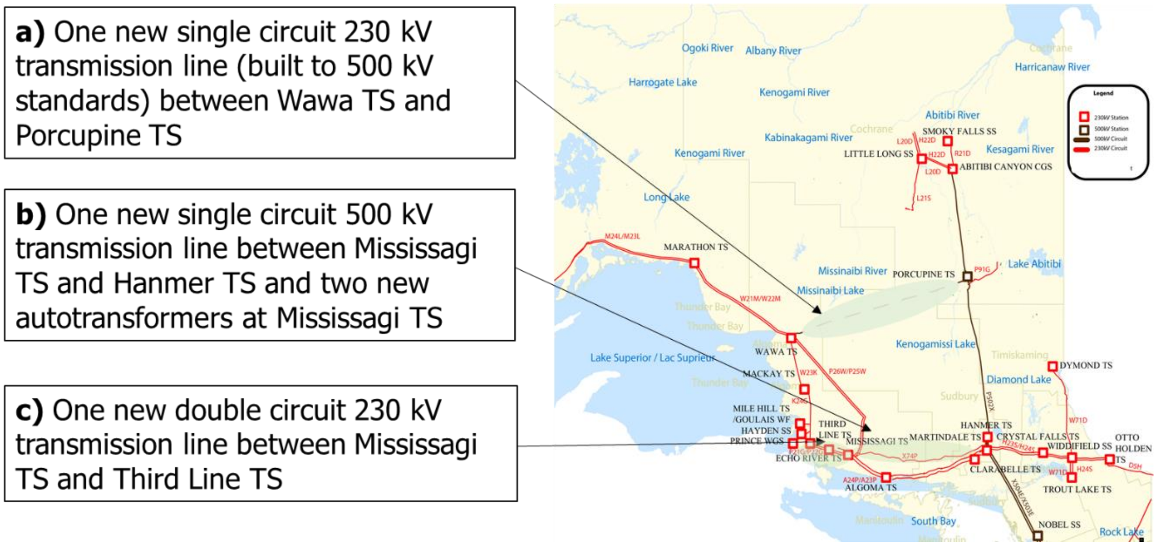
To address these reliability issues the Plan recommends the following transmission reinforcements (as shown in Figure 1):

- A new single circuit 230 kV transmission line (built to 500 kV standards) between Wawa TS and Porcupine TS (estimated length of ~260 km, and In-Service Date of 2030).
- A new single circuit 500 kV transmission line between Mississagi TS and Hanmer TS (estimated length of ~205 km), and addition of two new autotransformers at Mississagi TS (estimated In-Service Date of 2029).

[1] To identify the need timing in this plan, a demand forecast was developed for the Focus Areas and surrounding regions. Given the time required to build electricity infrastructure, it could be challenging to accommodate a higher demand prior to 2029 than what was forecasted in this plan.

- A new double circuit 230 kV transmission line between Mississagi TS and Third Line TS (estimated length of ~75 km, and In-Service Date of 2029).
- Voltage Control devices (to be identified through a broader IESO study of reactive needs throughout the North that is currently underway, and incorporated in the detailed design of the proposed transmission facilities).

**Figure 1 | Map of Recommended Solutions**




The estimated capital cost of the proposed transmission reinforcements is between $1.25 billion to $1.53 billion. The recommended In-Service Date (ISD) based on the growth forecast is year 2029 to 2030.

The recommended plan provides further benefits beyond accommodating forecast load growth (including a higher growth scenario). These additional benefits are summarized as follows:

- Increasing the power transfer capability from Sudbury to regions west of Sudbury by up to 900 MW to supply future loads that are located around the SSM focus area and Northwest regions.
- Improving reliability for existing and future loads that are located around the Timmins area through reduced reliance on Remedial Action Schemes.
- Strengthening the connection between the Northeast and the Northwest zones; improving the resiliency of the Northern Ontario transmission network.
- Providing a foundation and reserving the ability to expand the reinforcements in the future based on input from other relevant planning activities in the North.

Both wires (i.e., transmission) and Non-Wires Alternatives (NWA) options were assessed and compared in an economic assessment to arrive at the recommended solution. For NWA options, a wide range of resource types were explored, including natural gas, solar, wind, hydroelectric, biomass and storage.

Given the technical requirements of the expected production profile and the high capacity factor of large industrial loads, the NWA analysis concluded that natural gas generation would be the most suitable option to use as a benchmark for comparing the transmission option.[2]

The economic assessment found that the natural gas generation option would result in a much higher cost by a range of approximately $2.1 billion to $2.4 billion.[3] To meet the demand in a higher growth scenario, the generation cost would be higher by a range of approximately $4.1 billion to $4.4 billion, compared to the recommended transmission option.

In addition to the economic analysis, the following key factors were also taken into consideration when assessing NWA options:

- Ontario's supply mix will undergo significant change over the next two decades as the available capacity from the nuclear fleet continues to be impacted by refurbishments and retirements, and many resource contracts expire. The IESO recently released a "Resource Eligibility Interim Report"[4] that recommends a diverse resource set, including natural gas, be included in IESO's near-term competitive procurements. Over time, the IESO expects that natural gas generation will be replaced by a portfolio approach that includes new non-emitting generation, storage, as well as demand-side and transmission solutions.
- NWA options would need to be matched to the characteristics of the forecasted industrial loads in order to address the specific needs in Northeast. For example, an industrial load could require 24/7 operation, making options that are energy limited less suitable.
- Locational constraints of the existing transmission infrastructure would limit the system benefits of adding a new NWA into the Northeast. It is important to consider if the existing transmission system can deliver excess power to where it's needed; otherwise the NWA would only benefit particular local loads and would not be able to provide broader system benefits.

Engagement on the Northeast Bulk Plan has been ongoing throughout the plan's development, with three public webinars held in July 2021, April 2022, and September 2022. Targeted outreach to relevant communities took place in March and April 2022.

The IESO will continue working with stakeholders and communities throughout the implementation of the Northeast Bulk Plan.

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[2] The use of new natural gas to compare with transmission option in the economic analysis is for illustrative purposes as it is capable of meeting the technical requirements and is the least cost option commercially available.

[3] The Net Present Value (NPV) of the cash flows in $2021 over 70 years of the transmission asset.

[4] The report can be found at https://www.ieso.ca/-/media/Files/IESO/Document-Library/resource-eligibility/resource-eligibility-interim-report.ashx

# 1. Introduction

With rapid growth forecast in the industrial sector in Northeastern Ontario, bulk system planning was initiated to ensure continued reliable supply to existing and future demand.

This bulk plan addresses the capacity needs that arise due to anticipated industrial load growth within the Northeast, particularly in the Sault Ste. Marie and Timmins areas. To develop the Plan, the IESO performed technical assessment to analyze the transfer capabilities of major transmission interfaces and identify bulk system needs in the Northeast. Analysis was also performed to assess various options and find an optimal solution to cost-effectively address those needs.

This report documents the inputs, methodology, findings and options evaluation performed for this study and provides recommended actions for the various entities responsible for plan implementation. It is organized into the following sections:

- Section 2 provides background on the Northeast bulk transmission system and outlines the scope of this planning study;
- Section 3 highlights the demand forecast scenarios and considerations;
- Section 4 provides an overview of the existing supply to the Focus Areas;
- Section 5 analyzes the transmission system capability in the Northeast, discusses the issues and identifies the bulk system needs;
- Section 6 evaluates the options including Wires options and Non-Wires Alternatives;
- Section 7 concludes the study findings and recommends a preferred solution;
- Section 8 goes over the engagement activities to date and the next steps for the Plan.

# 2. Background and Scope

## 2.1 Background

The Northeast bulk transmission system is located in Northern Ontario and is part of the bulk system connecting the Northwest and Essa zones[5]. As shown in Figure 2, this part of bulk system consists of 500 kV circuits (e.g., a circuit between Hanmer TS and Porcupine TS and a circuit between Pinard TS and Porcupine TS) that connect the area north of Sudbury, a 230 kV transmission system (e.g., the circuits across Hanmer TS, Mississagi TS and Wawa TS) that generally connects the east and the west, and an underlying 115 kV system.

The 230 kV system is an important part of the Northeast transmission system to transfer power westbound to supply load located west of Sudbury and Northwest, or eastbound to deliver excess power to Sudbury and then the rest of province.

**Figure 2 | Northeast Transmission System**


The electricity supply mix in the Northeast is a combination of various different energy resource types. Hydroelectric generation accounts for the majority of existing resources with a small portion of natural gas, wind, solar, and bioenergy.

[5] Visit the IESO's zonal map (https://www.ieso.ca/localContent/zonal.map/index.html) illustrating the 10 electrical zones.

Industrial load forms a large component of electricity demand in the Northeast, particularly in the mining and mineral processing sub-sectors. Significant demand growth is forecasted between today and the early-2030's driven primarily by mining and other industrial developments. For example, the Federal Government is providing substantial support for decarbonization initiatives that would promote intensification of electricity use (e.g., electric arc furnaces) and result in a potentially large increase in industrial electricity demand in the Northeast. Furthermore, Ontario's Critical Mineral Strategy and economic development activities could also result in more investment in mineral exploration and development, driving further electricity demand growth.

The aforementioned policies related to economic development and decarbonization are expected to put upward pressure on electricity demand growth in the North. A few industrial loads have already begun to materialize through applications to the IESO for System Impact Assessments (SIAs).

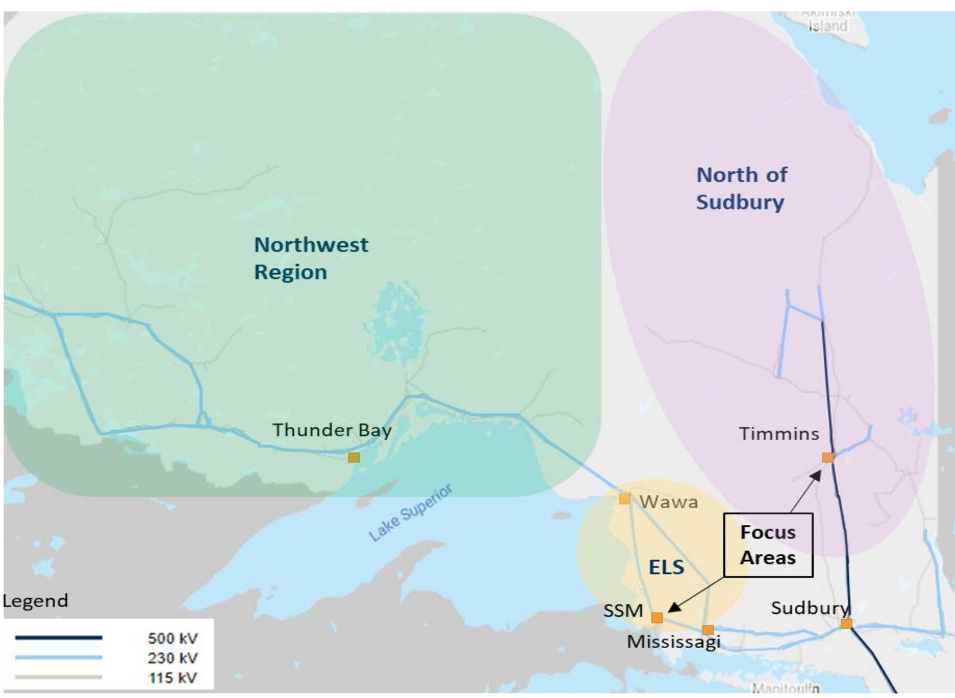
## 2.2 Purpose and Scope of the Northeast Bulk Plan

Given that the major industrial load growth in Northeast is forecasted to be concentrated in the SSM and Timmins areas, these two areas were referred to as "Focus Areas". The transmission infrastructure of interest are the transmission circuits that transfer power to supply these Focus Areas (see section 5, for a description of the transmission interfaces and circuits of interest).

It is important to note that this transmission infrastructure also supplies other customers in the Northeast that are outside of these Focus Areas. Therefore, the following two areas of interest within the Northeast were considered and are shown in Figure 3:

- East Lake Superior (ELS): Geographically it includes areas that are located west of Mississagi to Wawa. The SSM area is a subset of the ELS.
- North of Sudbury: This area includes Timmins and adjacent areas (e.g., Hunta and Pinard) that are located north of Timmins and mainly supplied from the 500 kV circuit from Sudbury to Timmins.

**Figure 3 | Map of Northern Ontario with Focus Areas**



In addition, the Northwest region is also supplied from the rest of the province through the same transmission path between Sudbury and Mississagi.

Accordingly, the main purpose of this plan is to identify what is needed to ensure the reliable supply to the identified Focus Areas, while maintaining the required power transfers to supply the forecasted demand in the Northwest and the rest of the Northeast.

In parallel with this bulk study, transmission planning continues to address local customer supply needs at the regional level through the on-going North & East of Sudbury Integrated Regional Resource Plan (IRRP)[6] and through the East Lake Superior IRRP[7] which was completed in April 2021. The recommendations for the bulk system in this plan will support the regional plans by reinforcing the system to which regional supply networks connect.

[6] Visit the IESO's Regional Planning website for the North & East of Sudbury (https://www.ieso.ca/en/Get-Involved/Regional-Planning/Northeast-Ontario/North-East-Sudbury)

[7] Visit the IESO's Regional Planning website for the East Lake Superior (https://www.ieso.ca/en/Get-Involved/Regional-Planning/Northeast-Ontario/East-Lake-Superior)

# 3. Demand Forecast

This section describes the forecasted demand for the Northeast and the Focus Areas.

To construct the forecast for the Northeast, a number of data sets were compiled and leveraged. The Northeast Zone[8] forecast information from the IESO's 2021 Annual Planning Outlook (APO) was used as a base scenario. As per the APO, the primary metal sub-sector is expected to grow robustly, with electrification already beginning and expected to materialize in the medium-term. Electrification incorporated in the demand forecasts includes implementation of electric arc furnaces in steel production, as a switch from traditional blast furnaces, in order to reduce greenhouse gas emissions.

In general, the industrial sector is expected to be influenced by emerging de-globalization trends, supported by various levels of Government interested in increasing local industrial production capability and economic development, and interested in electrification and general carbon emissions reduction over the outlook period.

Throughout the planning and development of the Northeast bulk plan, the IESO has held discussions with stakeholders, customers and communities in the Northeast; the IESO continues to monitor developments that may affect electricity demand in the region. Engagement with stakeholders and communities continues to provide valuable insight into the status of future developments. The demand outlook in this report reflects information gathered from these various engagements. Furthermore, the IESO's demand outlook considers:

- Information received from those who have applied for an IESO System Impact Assessment (SIA); and
- Information received by the IESO from potential connection applicants who have inquired about SIAs or feasibility assessments.

Northeast electrical demand is dominated by large, industrial customers and can fluctuate significantly in response to changing economic and market conditions. Considering the likelihood of identified projects proceeding, the following two demand outlook scenarios were developed to reflect the inherent uncertainties related to industrial development in the Northeast:

- The **Potential Growth Scenario** incorporates the already-existing loads, facilities for which an SIA has been received, and proposed load for which a feasibility assessment has been studied.
- The **High Growth Scenario** builds upon the Potential Growth Scenario assumptions, and reflects additional customer connection requests that have been communicated to the IESO but have not been confirmed. More specifically, additional load growth near the SSM area or within the Northwest zone is assumed in the High Growth Scenario.

[8] The Northeast Zone is illustrated the IESO's zonal map (https://www.ieso.ca/localContent/zonal.map/index.html).

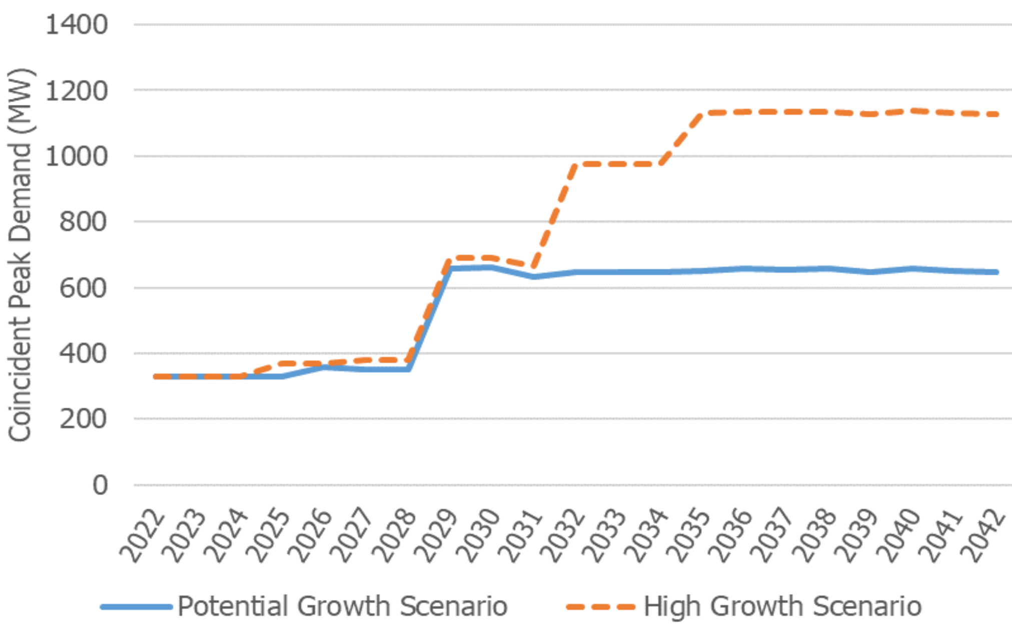
## 3.1 Focus Areas Demand Forecast

As described in section 2, the Focus Areas are located in two broader areas of interest within the Northeast. The SSM area is within the East Lake Superior (ELS) and the Timmins area is within North of Sudbury. This section describes the demand forecast for these two areas of interest.

### 3.1.1 Demand Forecast for ELS

A demand forecast for the ELS, which contains SSM is shown in Figure 4. The coincident extreme weather peak demand in the ELS is anticipated to reach approximately 700 MW in 2029. In the High Growth Scenario, this peak demand is anticipated to reach approximately 1,000 MW and 1,150 MW in 2032 and 2035 respectively.

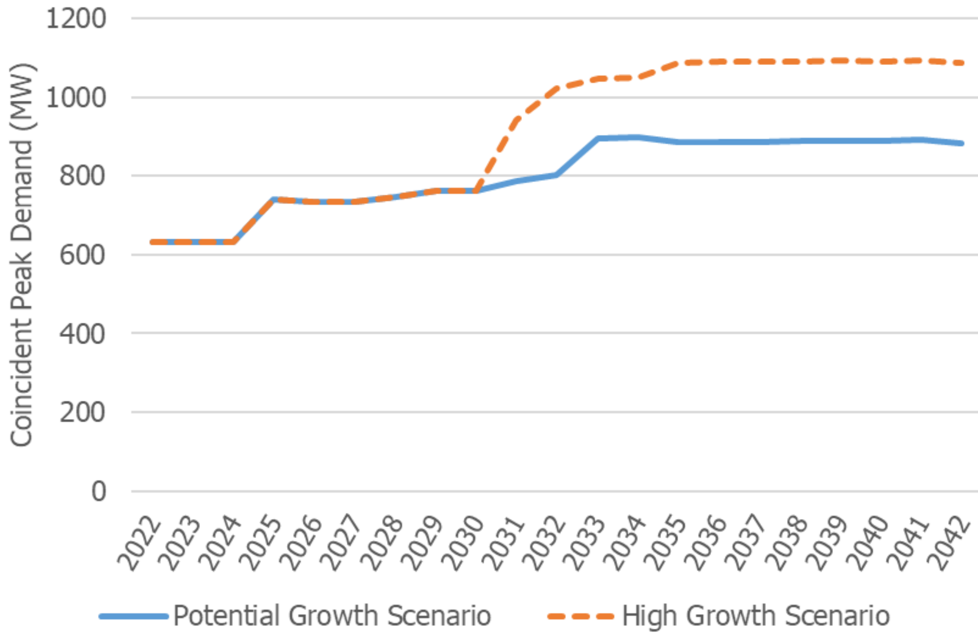
**Figure 4 | ELS Peak Demand Forecast**




### 3.1.2 Demand Forecast for North of Sudbury Area

As major industrial load growth is also concentrated in the Timmins area, a demand forecast was developed for the North of Sudbury area and is shown in Figure 5. The coincident extreme weather peak demand in the North of Sudbury area is anticipated to reach approximately 780 MW and 900 MW in 2025 and 2033 respectively. In the High Growth Scenario, this peak demand is anticipated to reach approximately 1,100 MW in 2031.

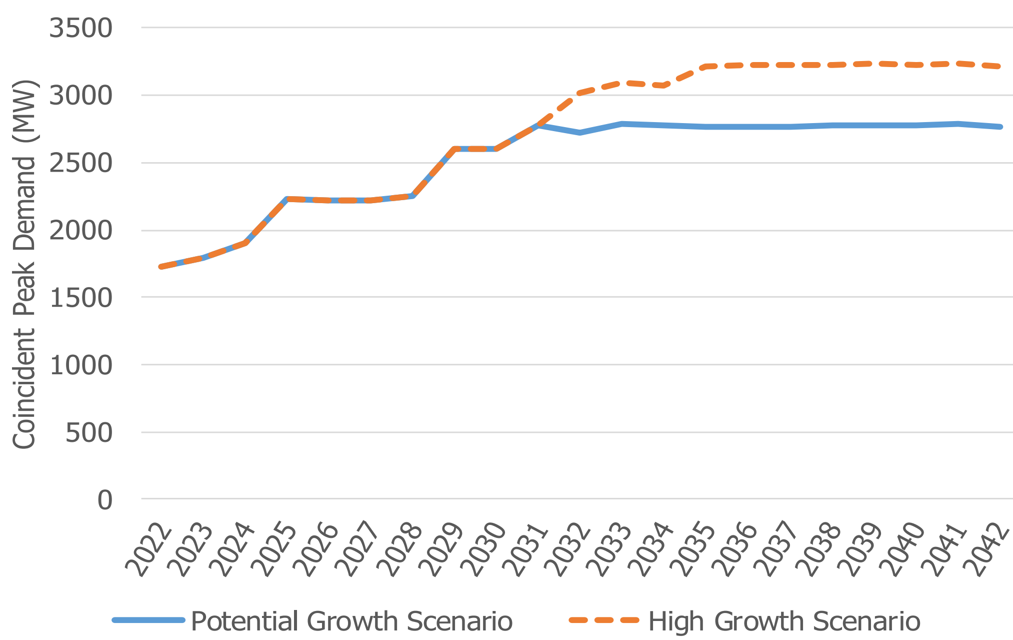
**Figure 5 | North of Sudbury Area Peak Demand Forecast**




## 3.2 Overall Northeast Demand Forecast

Figure 6 shows the demand forecast for the entire Northeast region that was assumed when developing this plan. The coincident extreme weather peak demand in the Northeast is anticipated to reach approximately 2,600 MW and 2,800 MW in 2029 and 2031 respectively. In the High Growth Scenario, this peak demand is anticipated to reach approximately 3,100 MW and 3,250 MW in 2032 and 2035 respectively.

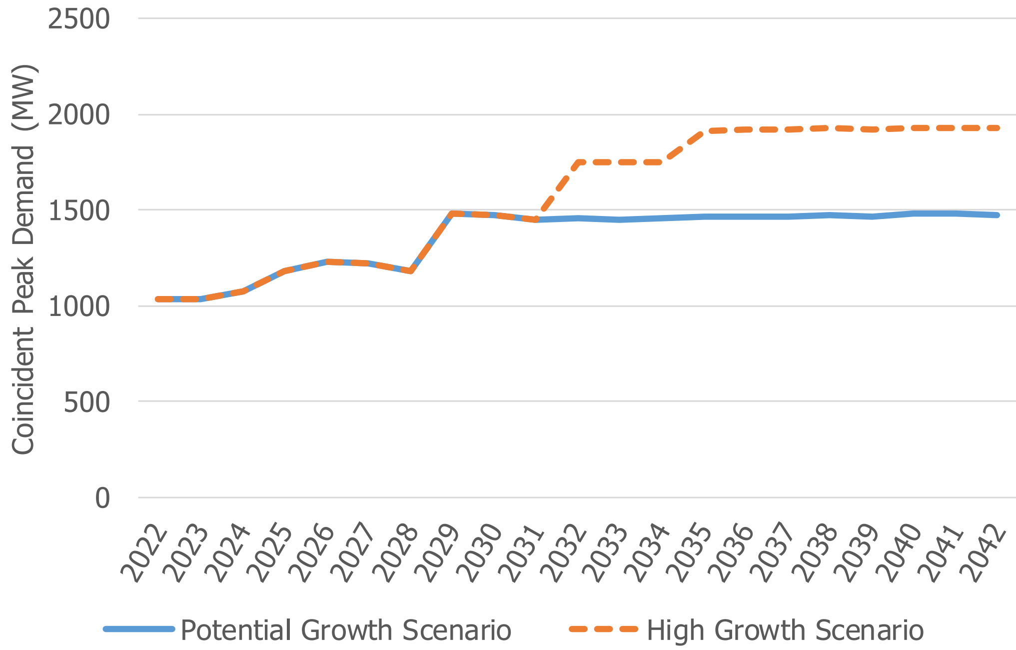
**Figure 6 | Total Northeast Peak Demand Forecast**



## 3.3 Demand Forecast for ELS and Northwest

As described in section 2, the transmission infrastructure that supplies the ELS in the Northeast also supplies the Northwest region. To account for the demand located west of Mississagi, a forecast was developed for the combined coincident peak demand of the ELS and the Northwest[9]. As shown in Figure 7, the coincident extreme weather peak demand in the ELS region and the Northwest, is anticipated to reach approximately 1,500 MW in 2029. In the High Growth Scenario, this peak demand is anticipated to reach approximately 1,800 MW and 1,950 MW in 2032 and 2035 respectively.

**Figure 7 | Combined ELS and Northwest Peak Demand Forecast**




[9] The Northwest Zone forecast information from the 2021 Annual Planning Outlook (APO) was used for the Northwest.

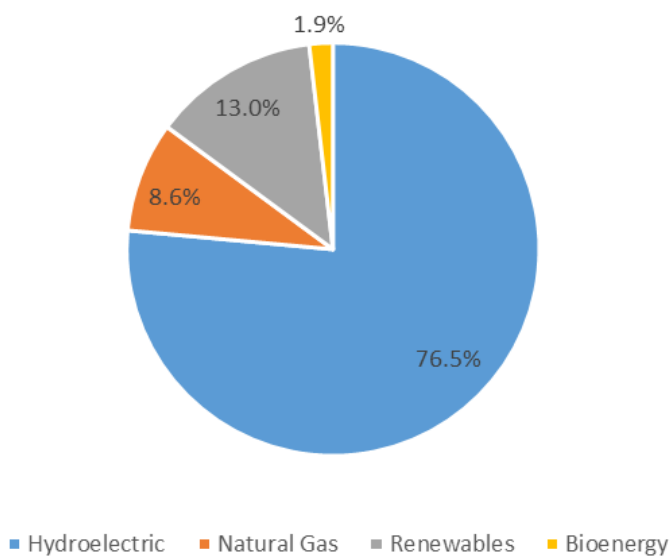
# 4. Existing Supply to the Focus Areas

The Northeast relies upon both internal resources (i.e., generation located within the Northeast) and external resources (i.e., generation outside the Northeast accessed through existing transmission system) to meet its electricity supply and reliability requirements.

## 4.1 Existing Resources in Overall Northeast

The total installed capacity of internal resources in the Northeast for the year 2022 is approximately 4,200 MW and is shown by fuel type in Figure 8.

**Figure 8 | Northeast Internal Resources – Installed Capacity**




Hydroelectric generation accounts for over three quarters of the existing installed generation capacity in the Northeast. Most of the hydroelectric facilities in the Northeast are run of river plants that have limited storage capability. The inability to store water from year to year, combined with variations in hydraulic conditions, result in large annual variations in energy production.

To establish the required transfers and outlook for security of the transmission interfaces, dependable generation are assumed in accordance with the IESO's Transmission Security Outlook Methodology[10]. Dependable outputs from the hydroelectric generation are assumed at its historical generation level that is available 98% and 85% of the time, for the assessments with all transmission elements initially in-service and one element initially out-of-service, respectively. Table 1 shows the hydroelectric generation (transmission connected) dependable levels that are assumed for the Northeast.

[10] https://www.ieso.ca/-/media/Files/IESO/Document-Library/planning-forecasts/apo/Dec2021/Transmission-Security-Methodology.ashx

**Table 1 | Dependable Hydroelectric Assumptions within Northeast**

| Subsystem | Installed Capacity (MW) | 98% Dependable (MW) | 85% Dependable (MW) |
|---|---|---|---|
| **Northeast** | **2985** | **932** | **1151** |

## 4.2 Existing Supply to the Focus Areas in the Northeast

As described in section 2, the Focus Areas are located in two broader areas of interest within the Northeast. The SSM area is within the ELS and the Timmins area is within North of Sudbury. This section describes the supply to these two areas of interest.

The supply to ELS is provided through a number of internal generation resources, as well as external resources accessed through the existing 230 kV transmission systems (e.g., the 230 kV transmission path between Sudbury and Mississagi).

Hydroelectric generation facilities that account for the majority of the existing installed generation capacity in the ELS are run of river plants which have limited storage capability. Due to varying availability of hydroelectric generation capacity and energy output, the assumptions for 98% and 85% dependable output from the hydroelectric generation within the ELS are summarized in Table 2.

**Table 2 | Dependable Hydroelectric Assumptions within ELS**

| Subsystem | Installed Capacity (MW) | 98% Dependable (MW) | 85% Dependable (MW) |
|---|---|---|---|
| **ELS** | 718 | 212 | 277 |

The North of Sudbury area contains an internal generation mix of hydroelectric, natural gas, solar, and wind generation. Historically this part of system was supplied by its own internal resources. Under certain conditions (e.g., drought and low hydroelectric output), the supply to this area is provided mainly through the 500 kV transmission line from Sudbury to Timmins.

To account for the low water conditions, the assumptions for 98% and 85% dependable output from the hydroelectric generation within the North of Sudbury area are summarized in Table 3.

**Table 3 | Dependable Hydroelectric Assumptions within North of Sudbury**

| Subsystem | Installed Capacity (MW) | 98% Dependable (MW) | 85% Dependable (MW) |
|---|---|---|---|
| **North of Sudbury** | 1686 | 367 | 547 |

# 5. Needs Determination

This section describes the assessment of whether or not the existing transmission system is sufficient to securely supply the forecasted demand growth, particularly in the Focus Areas.

## 5.1 Criteria and Methodology

There are various reliability standards which the IESO is obliged to apply when conducting system studies. North American Electric Reliability Corporation (NERC) and Northeast Power Coordinating Council (NPCC) criteria require the bulk system be planned to consider specific operating conditions, such as peak and light load, and a set of contingencies to ensure the bulk system is planned reliably and meets standards.

The IESO also defines its own performance criteria to meet under the specified conditions. The Ontario Resource and Transmission Assessment Criteria (ORTAC) defines the planning performance criteria for Ontario, which are more specific and generally more stringent than those required by NERC/NPCC. A full list of reference documents and relevant sections is detailed in "Appendix 1 – Reference Document and Planning Assessment Criteria".

A transmission security analysis was performed to examine the capability of the transmission system to securely meet power transfer requirements for the respective system demand and supply outlooks.

The methodologies that were applied in this transmission security analysis are detailed as follows.

**Part 1 – Identifying Study Interfaces**

For study purpose, transmission interfaces are usually defined as any circuit or group of transmission circuits connecting two sub-systems of the IESO-controlled grid.

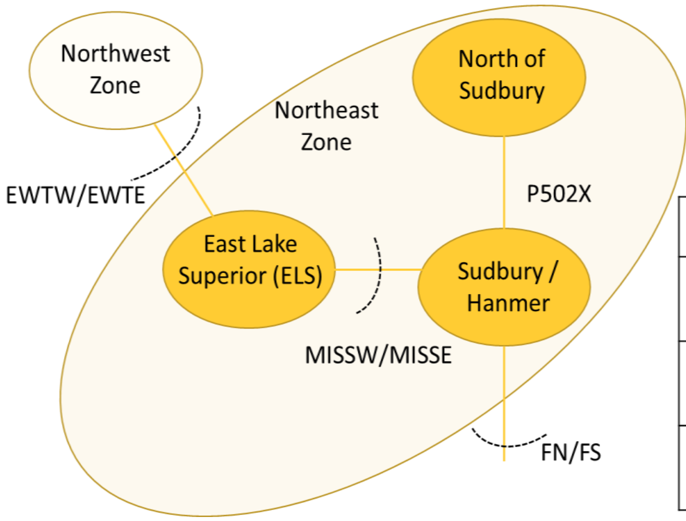
As illustrated in Figure 9, there are existing major transmission interfaces that are connecting the Northeast with Essa and Northwest zones, respectively:

- **Flow North (FN) / Flow South (FS):** The FN interface comprises the circuits connecting the Essa Zone and the Northeast Zone. This includes two 500-kV circuits north from Essa TS and one 230-kV circuit north into Otto Holden TS. FN transfer capability is important to reliably supply demand in the Northeast and Northwest zones, and to facilitate exports to Manitoba, Minnesota and Quebec. The FS interface is defined identically to the FN interface, but the power transfer is measured in the reverse direction.
- **East West Tie West (EWTW) / East West Tie East (EWTE):** The EWTW interface comprises four 230 kV circuits connecting the Northwest and the Northeast (from the Wawa TS). The EWTW interface represents the flow from the Northeast to supply load in the Northwest. The EWTE interface is defined identically to the EWTW interface, but the power transfer is measured in the reverse direction; I.e., the flow is from the Northwest into the Northeast.

This study is focused on an important tranmission interface within the Northest zone:

- **Mississagi West (MISSW) / Mississagi East (MISSE):** The MISSW interface comprises three 230 kV circuits connected to Mississagi TS (A23P and A24P from Algoma to Mississagi and X74P from Hanmer to Mississagi). MISSW transfer capability is important to reliably supply loads that are located in the ELS and Northwest zones. It is important to note that MISSW interface is the upstream transmission path to supply the Northwest.
  The MISSE interface is defined identically to the MISSW interface, but the power transfer is measured in the reverse direction. MISSE transfer capability is important to deliver supply from the Northwest zone and ELS towards the east and then the rest of the province through the FS interface.

**Figure 9 | Diagram to Illustrate Transmission Interfaces and Subsystems**




| Interface | Interconnected Subsystems |
|---|---|
| Flow North / South (FN/FS) | Northeast and Essa Zone |
| East West Tie West / East (EWTW/EWTE) | Northeast and Northwest Zone |
| Mississagi West / East (MISSW/MISSE) | Sudbury and ELS subsystem |

As shown in Figure 9, the Northeast bulk system includes two distinct subsystems that come together at Sudbury: a single circuit 500 kV system (i.e., P502X) running north from Sudbury to Timmins and beyond; and a 230 kV system running west from Sudbury to ELS through the MISSW / MISSE (this 230 kV system continues westward through the EWTW / EWTE interface to supply the Northwest).

### Part 2 – Determining Transfer Capability

To determine the transfer capability for identified study interfaces, the IESO's adopts the following methodology:

- Power transfer is incrementally increased by using the IESO's Guidelines for Determining Transfer Capability. The point at which the power transfer being simulated is marginally meeting performance criteria for credible Planning Events and Contingency Events – in accordance with NPCC Directory #1, NERC TPL-001, and ORTAC – is deemed the Transfer Capability of the Bulk Transmission Interface.
- Performance is measured by conducting steady state assessments and transient assessments. In general, steady state assessments are performed first until a power transfer is achieved that marginally meets performance requirements associated with steady state performance (the "Steady State Result"). The ORTAC requires transient performance requirements to be met with 10% margin, and so power transfer is further simulated 10% above the Steady State Result, and transient performance is assessed. If transient performance requirements

are met, it is concluded that the Transfer Capability is equal to the Steady State Result. If transient performance requirements are not met, the power transfer will be reduced until transient performance requirements are marginally met (the "Transient Result"), and it will be concluded that the Transfer Capability is 10% less than the Transient Result.

**Part 3 – Identifying Needs**

The Transfer Capabilities are then compared against the required transfer in accordance with the IESO's Transmission Security Outlook Methodology. The Transmission Security Analysis constitutes two tests:

1. Comparing the transfer capability with all elements initially in-service with a required transfer determined from the net of extreme weather peak demand and dependable generation[11] (e.g., 98% hydroelectric) in the "sink" subsystem[12].
2. Comparing the transfer capability with an element initially out-of-service with a required transfer determined from the net of normal weather peak demand and dependable generation (e.g., 85% hydroelectric) in the "sink" subsystem.

In contingency analysis, the studied contingencies are in accordance with Planning Events P0-P7 listed in the NERC standard TPL-001-4. For BPS elements, contingencies are in accordance with Category I and II Contingency Events listed in the NPCC Directory #1. A full list of contingencies is included in "Appendix 2 – Studied Contingency List".

## 5.2 Existing Transmission System Capability

In accordance to the methodology listed in section 5.1, the analysis determined the transfer capabilities for MISSW and MISSE interfaces; the results are summarized in Table 4. Detailed assumptions and technical assessment results can be found in "Appendix 3 – Technical Assessments to Identify Transfer Capabilities".

**Table 4 | Transfer Capabilities for MISSW and MISSE**

| | MISSW (MW) | MISSE (MW) |
|---|---|---|
| **Existing System** | 585 | 715 |
| **2029 System (with addition of forecasted demand)** | 510 | 715 |

As shown in the table above, the addition of the forecasted demand would potentially decrease the existing transfer capability on the MISSW interface by approximately 75 MW (12.8%). This decrease is greater than the 5% threshold allowed by ORTAC. The reduction in transfer capability on MISSW would result in reducing the ability to securely supply loads that are located west of MISSW (as far as northwestern Ontario).

[11] Dependable output from other generation, such as natural gas, renewables and bioenergy, was assumed as its system capacity contribution. This is typically equal to the facilities unforced capacity (UCAP).

[12] The "sink" subsystem is referred to the portion of the power system that the transmission interface is transferring power to.

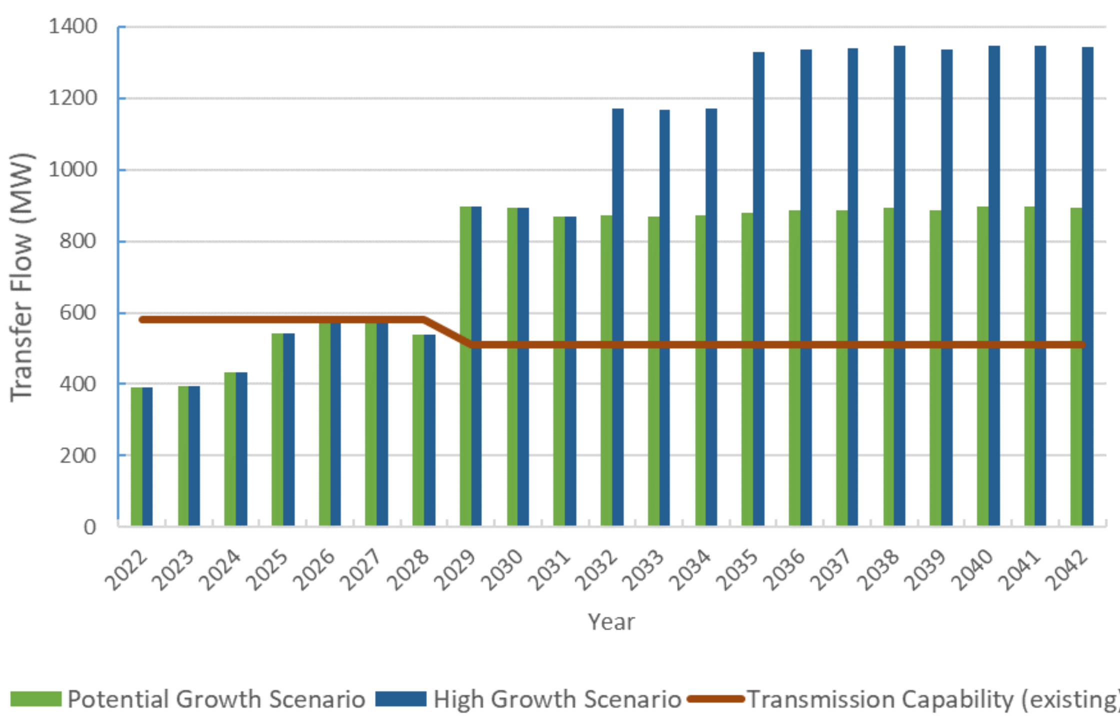
## 5.3 Needs Identification – Supply to the ELS Region and Northwest

According to the criteria and methodologies described in section 5.1, the transmission security analysis concluded that the existing system would not be sufficient to securely meet power transfer requirements to supply the forecasted demands in the areas that are located west of Mississagi (including the ELS and the Northwest region).

The reliability issues are summarized as follows:

- **Transmission Security Issues**: the existing bulk system is unable to reliably supply the forecasted load growth in the Focus Areas. As shown in Figure 10, this security need is due to the limitation of the existing transmission infrastructure as represented by the MISSW interface. The need is forecasted to begin in the year 2029, with a magnitude of approximately 350 MW, and is sustained through the planning horizon. In the High Growth Scenario, the magnitude of the need will increase to approximately 650 MW and 800 MW in 2032 and 2035, respectively.
- **Transfer Capability Reduction**: the addition of forecasted industrial load in the SSM area would potentially decrease the existing transfer capability on the MISSW interface by approximately 75 MW (12.8%), which is greater than the 5% threshold allowed by ORTAC.

**Figure 10 | Transmission Security Needs on MISSW Interface**



Due to the insufficient transfer capability at MISSW interface and the addition of the proposed industrial load located in SSM area, the supply to loads that are located west of Mississagi including the Northwest region (through the EWTW) would be constrained. To be noted, EWTW represents the power flow from Wawa TS and into the Northwest to supply demand. According to the 2021 APO demand forecast and supply outlook for the Northwest zone, the EWTW flow is forecasted to reach approximately 450 MW in 2029. Therefore, the study identified the MISSW transfer needs by assuming that the EWTW transfer requirement would be 450 MW.

## 5.4 Needs Identification – Supply to the North of Sudbury

With respect to the supply to the North of Sudbury area, the existing transmission system was designed prior to the development of planning standards (ORTAC). This system was designed to operate using a Remedial Action Scheme (RAS), the Northeast Load and Generation Rejection (NELGR) Scheme, that protects the system against post-contingency limit exceedances, enabling full use of the system to supply loads and deliver generation pre-contingency. Adding new load to the Northeast zone is expected to increase the frequency of arming the NELGR scheme. To ensure that the customers already participating in the load rejection function of this scheme will not be exposed to additional risk as a result of the new loads, these new loads would be required to participate in the load rejection portion of the NELGR scheme or participate in a local load rejection scheme.

Furthermore, there are existing operational challenges that would limit future demand growth in the Timmins area. For example, outages are extremely difficult to plan, especially to the main 500 kV circuits because of the very limited transfer capability of the underlying 115 kV circuits. In order to accommodate outages to the main 500 kV circuits, coordination to curtail existing loads in the area is sometimes required. Additionally, during outages to the main 500 kV circuits, a large loss of load in the area (a single large load or multiple smaller loads) is likely to cause instability of the northeast system, consequently resulting in significant load and generation loss.

In summary, due to the reliability issues that were identified for the existing transmission system in the Northeast, there is a need to develop a solution to supply forecast load growth in the Focus Areas of this Plan.

# 6. Options Evaluation

Section 5 indicated that there would be insufficient supply to the Focus Areas due to the forecasted electricity demand growth from the industrial sector. This Section develops and evaluates both Wires and Non-Wires options in order to find the most effective solution to supplying this load growth in the Focus Areas. Key aspects including technical feasibility, ability to address needs, cost-effectiveness and implementation lead time were taken into consideration when evaluating options.

## 6.1 Non-Wires Alternatives (NWA)

In response to the identified bulk system needs in Northeast, alternatives were considered with a wide range of new resource types including natural gas, storage, solar and wind, hydroelectric, biomass, small modular reactor and fuel cell.

After years of having surplus electricity supply, Ontario is entering a period of need. This is primarily being driven by economic growth, retirements and refurbishments of power plants and increased electrification of the transportation and manufacturing sectors. The IESO recently released a Resource Eligibility Interim Report to help inform policy decisions about the eligibility of carbon-emitting resources in IESO's competitive procurements. This report identified significant reliability risks associated with supply chain disruptions, tight market conditions which could be particularly impactful for battery storage projects, and new technology integration. To mitigate these risks, the IESO recommended pursuing a diverse portfolio of supply options. The procurement will target new capacity from a variety of resources including storage, natural gas and contributions from other non-emitting resources.

Through the engagement activities undertaken to inform plan development including public webinars and targeted discussions with communities and stakeholders, the IESO explored various opportunities for alternative resource technologies in order to find the suitable resource types that could specifically help meet the identified bulk needs in the Northeast.

The IESO's high-level assessment for various resource types is summarized as follows:

- *Natural Gas* - The natural gas generation can provide flexibility to the system by quickly ramping up and down to meet changes in demand and augmenting the availability of other forms of generation. It is capable of meeting the technical requirement to supply the forecasted industrial loads in Northeast. The IESO's Resource Eligibility Interim Report considers the natural gas as a transitional fuel. It should be noted that the evolving carbon policies could result in less gas-fired generation going forward.
- *Storage* - Battery storage is an energy-limited resource, which would not be available to provide energy over long durations or for multiple times over a day. During its charging mode, it relies on other energy resources to charge, behaving as a net load. While the IESO is working closely with storage providers and others to build a process and market rules for storage resources, it is expected that time will be needed to fully test and integrate grid scale batteries into the system.

- *Wind and Solar -* Wind and solar are intermittent resources. Base load requirement of a large capacity amount results in the elimination of these renewable options since production profiles do not match load requirement, and it would be very challenging to site these resources given the large amount of installed wind and solar generation that would be needed to reach the effective capacity. In other words, bringing large capacity of wind or solar to desired location would require additional transmission infrastructure.
- *Hydro -* Long lead-time for Hydroelectric development. To bring hydro to the desired location, additional transmission infrastructure would be required.
- *Biomass -* Biomass generation was considered as an option to meet the identified needs and future electricity demand from the forestry section. Furthermore, the IESO is continuing to explore options for renewing contracts for existing Biomass plants in the North. For example, a new five-year contract has been finalized in March 2022 for the Calstock biomass generating facility to support a longer-term transition plan for the forestry sector.
- *Small Modular Reactors (SMR) -* SMR is not considered as a viable option given the time-line of 2029. The first commercial SMR is slated for operation 2028 and is still yet to be tested. To have another larger SMR operational one year after the test pilot project at Darlington in the Northeast is not a reasonable option.
- *Fuel Cell -* Fuel Cell is not considered as a viable alternative as the commercial application of hydrogen fuel cell is yet to be developed.
- *Demand Response (DR) and Energy Efficiency (EE) -* DR is a peak shaving option and not appropriate for the base load need. EE is not considered as a viable alternative as the magnitude of bulk needs exceeds the capability of EE to cost-effectively meet the needs.

Given the production profile and the capacity factor needed by the forecasted industrial load growth, the option of natural gas combined cycle gas turbine (CCGT) was found to be the most suitable NWA that will be evaluated against the wires option. Detailed assessment and comparison with the preferred wires option will be described in the following section 6.3.

It is important to note that the use of new natural gas CCGT to compare with wires option in the economic analysis is for illustrative purposes as it is the least cost option commercially available. There are additional challenges associated with adding new NWA into the Northeast:

- The constraints on the existing transmission infrastructure would limit the system benefits of a new NWA in the Northeast. For example, the value of a local generation would be reduced if the transmission system can’t deliver excess power (beyond what can be consumed locally) to where it’s needed.
- It would be challenging to find proper locations near the load. To bring a new NWA to the desired location, transmission infrastructure would be required.

## 6.2 Wires Options

### 6.2.1 Developing Wires Options

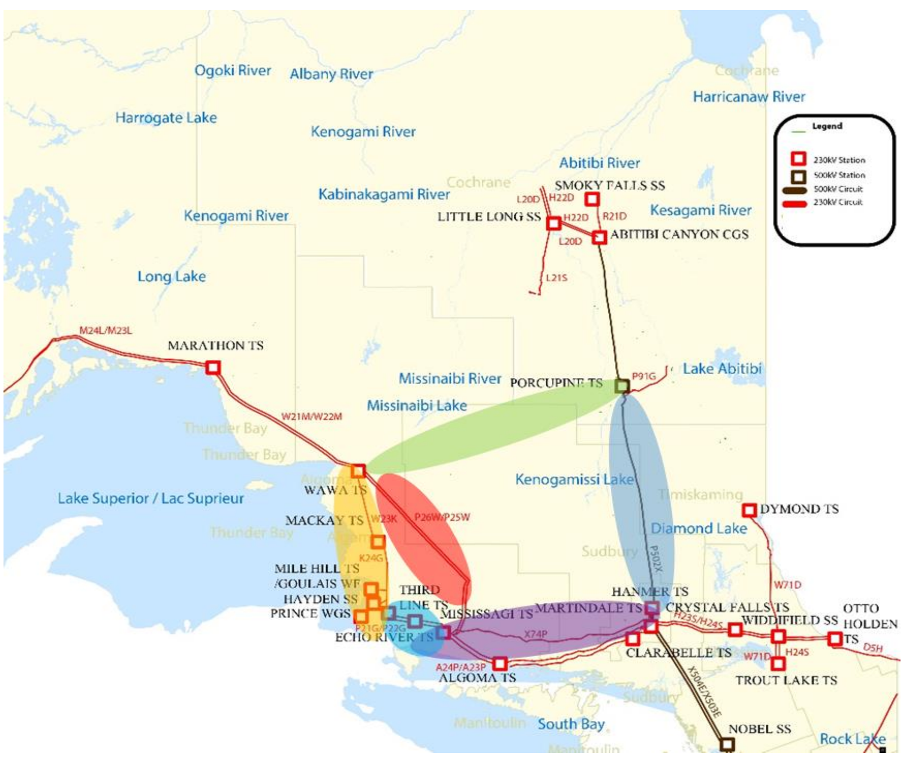
To address the identified reliability issues, various wires options were developed to improve the MISSW interface transfer capability and enhance the supply to the Focus Areas. The SSM and Timmins areas are currently supplied through separate transmission paths. The wires solution alternative included different options for reinforcing those paths (e.g., the existing Hanmer to Mississagi transmission path and Hanmer to Porcupine transmission path) and options involving new transmission corridors (e.g., a new transmission path to connect the ELS and north of Sudbury subsystems).

Within each option, different voltage level alternatives (e.g., 500 kV vs. 230 kV) and various topology alternatives were developed and compared. The developed options in each category to reinforce different parts of the transmission system and then address different needs are listed in Table 5 and illustrated in Figure 11.

**Table 5 | Conceptual Options Development**

| Parts to be Reinforced | Alternatives | | |
|---|---|---|---|
| MISSW/E | Hanmer – Mississagi – Wawa 230 kV <u>or</u> 500 kV | (purple) | (red) |
| Supply to SSM | Mississagi – Third Line <u>or</u> Wawa – Third Line 230 kV | (light blue) | (yellow) |
| Supply to Timmins | Porcupine – Hanmer 500 kV <u>or</u><br>Porcupine – Wawa 230 kV <u>or</u> 500 kV | (blue) | (green) |

**Figure 11 | Map of Northeast with Wires Options**



There are many possible combinations of the reinforcements shown in Table 5. The study applied a screening approach that performed a technical assessment on all the possible combinations of reinforcements and shortlisted them to further consider the ones that can address the identified reliability needs. At a high level, the methodology of technical assessment in order to perform the options screening is described as follows:

1. Perform steady state contingency analysis under all elements initially in-service conditions for all options. Further analysis was not performed on options that did not comply with ORTAC standards.
2. Perform steady state contingency analysis under an element initially out-of-service conditions for remaining options. Further analysis was not performed on options that did not comply with ORTAC standards.
3. Perform transient contingency analysis for all remaining options.

After the screening assessment, four combination options that would be able to address the reliability needs were developed; these options are described in Table 6. Detailed information and associated Single Line Diagrams (SLDs) to illustrate each option are included in "Appendix 4 – Wires Options".

**Table 6 | Wires Combination Options**

| Option | Parts to be Reinforced | Description |
|---|---|---|
| 1A | Supply to Timmins | a) One new single circuit 500 kV (Porcupine TS - Hanmer TS) |
| | MISSW/E (Hanmer-Mississagi) | b) One new single circuit 500 kV (Mississagi TS - Hanmer TS) |
| | Supply to SSM | c) One new double circuit 230 kV (Mississagi TS -Third Line TS) |
| | MISSW/E (Third Line-Wawa) | d) One new single circuit 230 kV (Third Line TS - Wawa TS) |
| 1B | Supply to Timmins | a) One new single circuit 500 kV (Porcupine TS - Hanmer TS) |
| | MISSW/E (Hanmer-Mississagi) | b) One new single circuit 500 kV (Mississagi TS - Hanmer TS) |
| | Supply to SSM | c) One new double circuit 230 kV (Mississagi TS -Third Line TS) |
| | MISSW/E (Mississagi-Wawa) | d) One new single circuit 230 kV (Mississagi TS - Wawa TS) |
| 2A | Supply to Timmins and Wawa | a) One new double circuit 230 kV (Wawa TS - Porcupine TS) |
| | MISSW/E | b) Conversion of the existing 230 kV circuit (Mississagi TS - Hanmer TS) to 500 kV |
| | Supply to SSM | c) One new single circuit 230 kV (Mississagi TS - Third Line TS) |
| 2B | Supply to Timmins and Wawa | a) One new single circuit 230 kV line (Wawa TS - Porcupine TS) |
| | MISSW/E | b) One new single 500 kV circuit (Mississagi TS - Hanmer TS) |
| | Supply to SSM | c) One new double circuit 230 kV (Mississagi TS - Third Line TS) |

### 6.2.2 Wires Option Evaluation

When evaluating the wires options, in addition to the technical performance and cost effectiveness, one key aspect that was taken consideration is the implementation of the options. The implementation consideration includes the physical feasibility of transmission reinforcement, environmental impact and stakeholder feedbacks. Additionally, the flexibility for future expansion is an important consideration when evaluating the wires options.

**Implementation Considerations**

Through the public webinar on April 26, 2022 and the feedback received from stakeholders, the IESO has been made aware of several challenges with respect to implementing Option 2A. Firstly, it would be very challenging to take the necessary outages to implement the conversion of the existing circuit X74P, which is a critical circuit to supply areas that are located west of Mississagi including the Northwest.

Additionally, the transmitter's information indicated challenges to accommodate two 230 kV circuits or to build a 500 kV switch yard at the existing Wawa station site due to the current 230 kV switchyard, breaker configuration and several physical constraints surrounding the station. Therefore, the IESO considered an option to build the new circuit between Porcupine TS and Wawa TS to 500 kV standards but operate the circuit at 230 kV initially to allow more time to explore options for Wawa station expansion. Building the new circuit to 500 kV standards provides the opportunity to operate it at 500 kV and saves future upgrading work when it's needed.

These implementation challenges would result in different lead times of the wires options. Additionally, if any transmission lines involve new Right of Way (ROW) and require new Environmental Assessment approvals for the line construction path, it typically requires longer lead time. The IESO took all these into considerations when estimating the In-Service Dates (ISD) for each component of the wires options in order to ensure the recommended wires options can be implemented in a timely manner.

**Technical Performance**

Full technical assessments were performed to assess all four options. Table 7 summarizes the technical assessment results with regards to the achieved transfer capabilities and enabled demand growth scenarios. Option 2B was found to be able to achieve the highest transfer capability in terms of supplying the loads that are located west of Mississagi including the Northwest. With respect to the ability to enable future demand growth, Option 1A and 1B can marginally supply High Growth Scenario while Option 2A is able to supply the Potential Growth Scenario. Option 2B is the only option that can fully supply the High Growth Scenario and also provide approximately 200 MW of additional capacity for future demand growth beyond the High Growth Scenario.

With respect to the supply to North of Sudbury, the study found that all options can improve the reliability to supply the forecasted load growth that are located around Timmins area. For example, the reliance on existing Northeastern Load and Generation Rejection (NELGR) can be potentially reduced by less arming or activation for the P502X contingency.

**Table 7 | Summary of Technical Performance of Wires Options**

| Options | Transfer Capability [13] (MW) | Enabled Demand Growth |
|---|---|---|
| Existing System (with new load into SSM area) | 510 | N/A |
| 1A | 1260 | High Growth Scenario (Marginally) |
| 1B | 1260 | High Growth Scenario (Marginally) |
| 2A | 1030 | Potential Growth Scenario |
| 2B | 1480 | High Growth Scenario |

### Cost Effectiveness

Capital costs for the wires options were estimated as a range[14] in Table 8. It is important to note that the estimated costs were used as a guide to develop approximate costs for the purpose of comparing wires options.

**Table 8 | Estimated Capital Costs of Wires Options**

| Options | Cost Estimates Range ($B) | Cost Effectiveness[15] ($/kW) |
|---|---|---|
| 1A | 1.56 - 1.85 | 1770 - 2100 |
| 1B | 1.62 - 1.925 | 1840 - 2180 |
| 2A | 1.13 - 1.405 | 1450 - 1800 |
| 2B | 1.25 - 1.53 | 1000 - 1220 |

Although Option 2A is the lowest capital cost option among those four wires options, Option 2B better enables expansion to accommodate higher load growth scenario, and is the most cost effective option (with the lowest unit cost in dollar per kilowatt).

[13] For comparison purpose, MISSW transfer capability is used for existing system and Option 1A and 1B. MISSW + Porcupine-Wawa transfer capability is used for Option 2A and 2B.

[14] The costs depend on the nature and requirements of access roads, terrain, and soil conditions.

[15] The cost effectiveness is estimated based on the capital costs and total enabled transmission capacity to supply load. It is only for the purpose of comparing the wires options and shouldn't be used to compare with NWAs.

### 6.2.3 Summary of Wires Options

Taken all aforementioned aspects into consideration, Option 2B would be the preferred wires option because it is the lowest unit cost option that can achieve the highest technical performance. This option would provide additional benefits beyond addressing the identified system needs to accommodate the forecasted load growth. Analysis showed that this option would increase the transfer capability by up to 900 MW to supply loads that are located around the East Lake Superior or Northwest regions.

Furthermore, this option would improve the reliability to supply loads that are located around the North of Sudbury. Study showed that this option would potentially reduce the reliance on the existing NELGR. [16]

Additionally, this option preserves the opportunities for further expansions if needed, to supply future demand growth in the area.

## 6.3 Economic Assessment and Comparison of NWA and Wires Options

To compare the NWA (CCGT) and the preferred wires option (Option 2B), an economic analysis was conducted by using their relative Net Present Value ("NPV"). For both cases capital and operating cost of the NWA and wires options are compiled to generate levelized annual capacity costs ($/kW-year) and evaluated a NPV basis over the lifespan of the transmission infrastructure, which is 70 years. The NWA CCGT assumes replacement cost where necessary to ensure the comparison period between the wires option. The net present value of these levelized costs are the primarily basis through which options are compared below. The detailed list of assumptions for the economic analysis are provided in "Appendix 5 – Economic Analysis Assumptions".

The Economic assessment considers two scenarios (Potential Growth Scenario and High Growth Scenario) since the preferred wires option can meet the needs to supply both scenarios. Accordingly, two natural gas CCGT options were considered by assuming the total size of 630 MW and 1075 MW to meet Potential Growth Scenario and High Growth Scenario needs, respectively. With respect to the siting assumptions, for cost comparison purpose, resources were assumed to be sited in SSM or Timmins.

Analysis indicated that the preferred wires option is a lower cost option compared to the natural gas generation (CCGT) alternative by approximately $2.1 billion to $2.4 billion (NPV in $2021) over the 70-year life of the transmission asset. The economic assessment results are summarized in Table 9.

To meet the High Growth Scenario, as shown in Table 9, the preferred wires option is a lower cost option compared to the natural gas generation (CCGT) alternative by approximately $4.1 billion to $4.4 billion (NPV in $2021). When calculating the net savings of the wires option, the full cost of system capacity and energy are included to the wires option as it was assumed that surplus generation would not be available on the system by 2029.

[16] Future modification to existing NELGR will be determined by the IESO in accordance with the implementation of recommended reinforcements.

**Table 9 | Economic Assessment Results**

| Needs Scenarios | NPV (2029 – 2098) in $2021 Real | | |
|---|---|---|---|
| | Wires Option[17] ($ billion) | CCGT Natural Gas[18] ($ billion) | Net Savings of Wires Option ($ billion) |
| Potential Growth Scenario | 10 - 10.3 | 12.4 | 2.1 - 2.4 |
| High Growth Scenario | 16.1 – 16.4 | 20.5 | 4.1 – 4.4 |

[17] Full cost of both capacity and energy are included to the wires option, as neither are projected to be available in surplus on the system by 2029. The NPV for the wires option is $1.4 billion to $1.7 billion based on the estimated capital cost range of $1.25 billion to $1.53 billion.

[18] Carbon capture sequestering (CCS) not considered since costs would only increase the generation option making the wires option more beneficial. Also, CCS in Ontario has not been fully commercialized given the lack of geological storage availability.

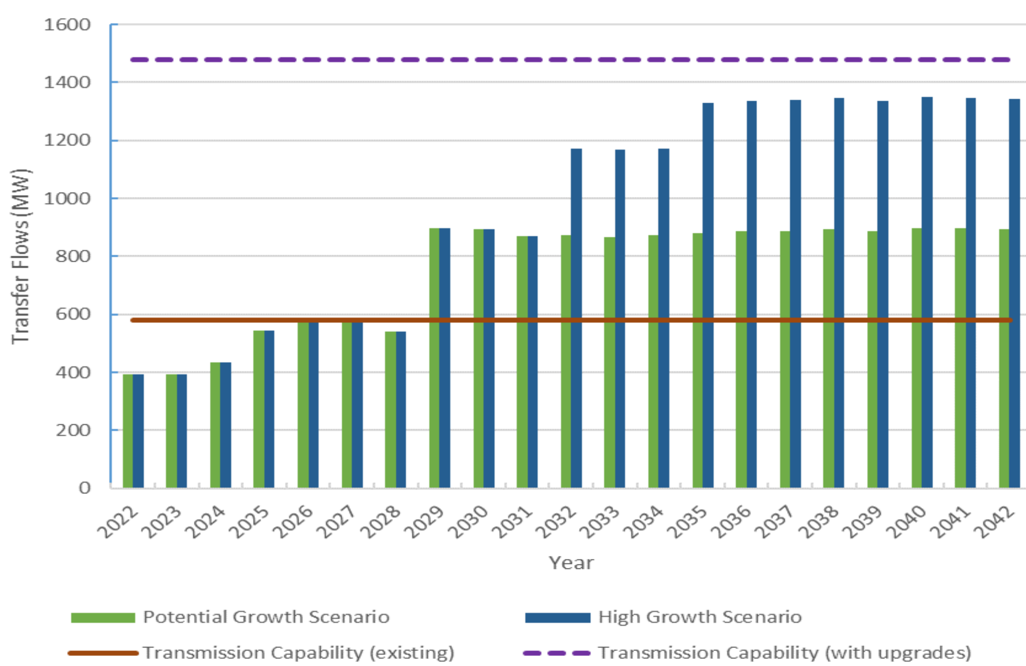
# 7. Recommended Solutions

Based on the assessments and evaluations described in Section 6, this Plan recommends the following transmission solution to supply the forecasted load growth in the Focus Areas:

- To ensure the reliable supply to SSM area, this plan recommends a new single circuit 500 kV transmission line between Mississagi TS and Hanmer TS and a new double circuit 230 kV transmission line between Mississagi TS and Third Line TS.
- To ensure reliable supply to both Timmins and west of Mississagi areas (including Northwest), this plan recommends a new single circuit 230 kV transmission line (built to 500 kV standards) between Wawa TS and Porcupine TS.
- Additional voltage control devices[19], associated with the recommended transmission reinforcements, will be identified in accordance with the detailed design of facilities.

The recommended transmission solution will address the identified needs to accommodate the forecasted load growth in the Northeast including the High Growth Scenario. With respect to the supply to the areas that are located west of Mississagi including the Northwest, the proposed plan will increase the transmission system transfer capability by approximately 900 MW. As shown in Figure 12, the upgraded transmission system will be able to meet the required transfer requirements to further enable up to 200 MW of capacity to supply the load growth (in addition to the High Growth Scenario) within the East Lake Superior (e.g., SSM or Wawa areas) or Northwest region.

**Figure 12 | Transfer Capabilities and Forecasted Requirements**




[19] A broader IESO study of reactive needs throughout the North is currently underway to find the optimal location and size of the reactive devices. Different options of the reactive compensation and absorption devices will be evaluated in that study.

Another important benefit of the proposed plan is the enhancement of the connection between the Northeast and the Northwest. It will improve the resiliency of the Northern Ontario system. Also, with the enhanced connection, the reliability of supplying loads located around the Timmins area will be improved. The technical analysis showed that the proposed plan can provide potential relief on the existing Northeastern Load and Generation Rejection (NELGR). [20] It will also optimize the Northeast transmission network and help deliver the resource to where it's needed.

The proposed plan provides the foundations that are required to supply the forecasted load growth. At the same time, it reserves the ability to expand the reinforcements in the future based on input from other relevant planning activities in the North. Depending on the timing and location of future projects, additional transmission reinforcements and/or new generation can be considered to address additional needs by building on the proposed foundational reinforcements. For example, if more load will connect in the northeast, reinforcement to Flow North (the primary path that comprises the circuits connecting the Essa Zone and Northeast Zone) can be built upon the proposed plan. If additional generation is built north of Sudbury, future expansions may also be built on top of the proposed plan to help further deliver the potential generation.

[20] The study shows that the frequency of arming or activation of the NELGR can be potentially reduced for P502X contingency. Future modification to existing NELGR will be determined by the IESO in accordance with the implementation of the recommended reinforcements.

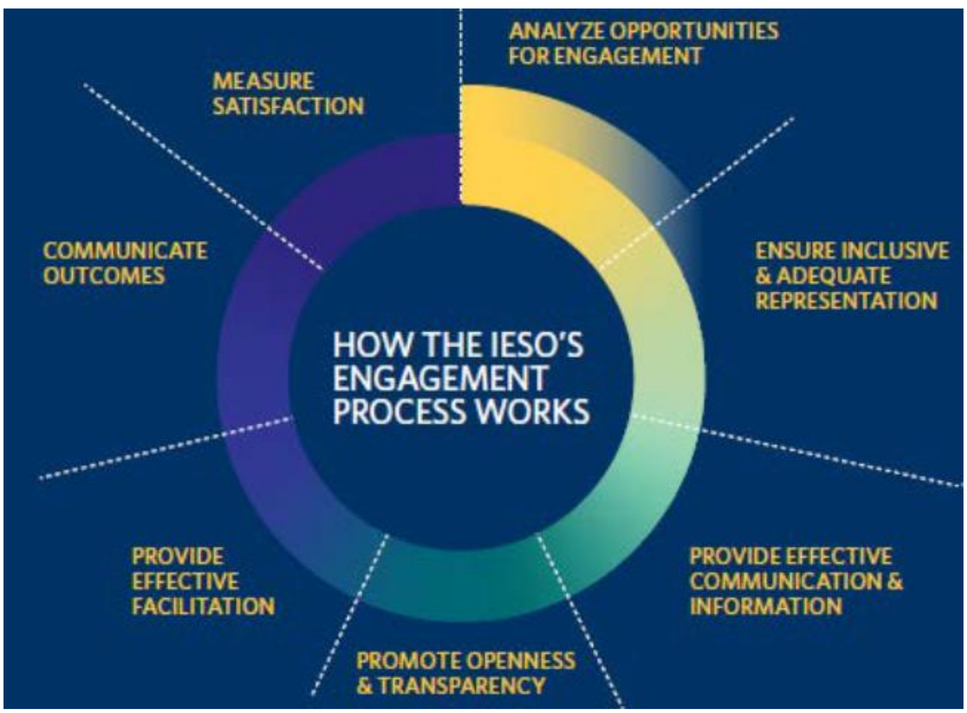
# 8. Engagement

The IESO has developed and is transitioning to a formalized process for bulk system planning to enhance transparency and opportunities for purposeful engagement and input. As part of that work, defining how stakeholders can participate in the electricity planning process and be kept informed has been identified as a critical component of the process design. Providing opportunities for input in the transmission planning process enables the views and preferences of communities and stakeholders to be considered in the development of the plan, and helps lay the foundation for successful implementation. The IESO has endeavored to encompass those principles throughout the Northeast Bulk Plan work. This section outlines the engagement principles as well as the activities undertaken to date for the Northeast Bulk Plan.

## 8.1 Engagement Principles

The IESO's engagement principles help ensure that all interested parties kept informed and enable opportunities for purposeful engagement to contribute to electricity planning initiatives such as the development of this Northeast Bulk Plan. The IESO adheres to these principles to ensure inclusiveness, sincerity, respect and fairness in its engagements, striving to build trusting relationships as a result.

**Figure 13 | The IESO's Engagement Principles**



## 8.2 Engagement Approach

To ensure that the bulk plan reflects the needs of Indigenous communities, community members and interested stakeholders, engagement involved:

- Leveraging the Northeast Bulk Planning Initiatives and dedicated engagement webpage on the IESO website to post updated information, engagement opportunities, meeting materials, input received and IESO responses to the feedback;
- Regular communication with communities, stakeholders and interested parties through email and IESO weekly Bulletin;
- Public webinars; and
- Targeted outreach throughout plan development with municipalities, customers, Indigenous communities and rights-holders, and those with an identified interest in northeast Ontario electricity issues.

Two public webinars were held at major junctures during bulk plan development to give interested parties an opportunity to hear about its progress and provide comments on key components including:

- Electricity demand forecast;
- Identified needs;
- Options evaluation; and
- Draft recommendations.

Both webinars received strong participation with cross-representation of stakeholders and municipal and Indigenous community representatives in attendance, and submitting written feedback during a 21-day comment period.

Comments received during this engagement focused on the following major themes:

- Demand forecast may be higher than anticipated:
    - Significant growth in areas beyond west of Sudbury and Timmins is expected – Temiskaming Shores, Cochrane and Iroquois Falls
    - Decarbonization, Ontario's critical minerals, forestry and hydrogen strategies, and Ring of Fire will accelerate load growth
- Non-wires including large scale solar, storage, biomass and existing generation facilities and distributed energy resources should be explored, particularly those that can also address environmental and decarbonization goals
- Strong support for transmission reinforcements
    - Solutions should enable a greater role for generation to meet both the needs in the area and the province as a whole
    - Urgency to build a robust network now to provide transmission capacity for new renewable generation resources, meet reliability needs and future load growth
    - Technical considerations to provide greater reliability, resiliency and cost effectiveness
    - Dialogue, engagement and consultation with Indigenous communities is important
- Access to additional information is important to ensure transparency in the planning process and recommendations.
- Factors to be taken into account in plan implementation including siting, routing, consultation with the public and affected communities, design and development.

- Considerations for future planning studies in the Northeast.

Additionally, a virtual Northeast Network meeting was held to provide an overview of the scope of the planning initiative and address questions at the onset to get an early sense of any top-of-mind issues and considerations to help inform plan development.

Feedback received helped to guide further discussion throughout the development of this bulk plan as well as add due consideration to the final recommendations.

All background information, including engagement meeting presentations, recorded webinars, detailed feedback submissions, and responses to comments received, are available on the IESO's Northeast Bulk Planning Initiatives engagement webpage.

## 8.3 Bringing Communities to the Table

The IESO held meetings with Northeastern communities to seek input on local planning priorities and initiatives that should be taken into consideration in the development of this bulk plan. At major milestones in the bulk plan development process, targeted discussions were held to discuss, identify and address any key issues of concern, particularly related to potential solutions to meet emerging needs. These meetings helped to build an understanding of future anticipated development incremental to what was encompassed in the demand forecast for the Northeast, gauge community preference around the proposed transmission reinforcements and further build and strengthen local relationships for ongoing dialogue beyond this bulk process.

## 8.4 Engaging with Indigenous Communities

The IESO remains committed to an ongoing, effective dialogue with communities to help shape long-term planning across Ontario. To raise awareness about the development of the Northeast Bulk Plan the IESO invited Indigenous communities located in or near the Northeast to participate in the general public online information sessions held on April 26, 2022 and September 13, 2022 as well as Indigenous-specific meetings that were held those same days, in order to provide additional opportunities to ask questions and provide input.

The First Nation communities in the northeast that the IESO invited to participate were: Atikameksheng Anishnawbek, Attawapiskat, Aundeck Omni Kaning, Batchewana, Brunswick House, Chapleau Cree, Chapleau Ojibwe, Constance Lake, Dokis, Flying Post, Fort Albany, Garden River, Henvey Inlet, Kashechewan, Magnetawan, Matachewan, Mattagami, M'Chigeeng, Michipicoten, Missanabie Cree, Mississauga, MoCreebec Council of the Cree Nation, Moose Cree, Moose Deer Point, Nipissing, Sagamok Anishnawbek, Serpent River, Shawanaga, Sheguiandah, Sheshegwaning, Taykwa Tagamou Nation, Temagami, Thessalon, Wahgoshig, Wahnapitae, Wasauksing, Whitefish River, Wikwemikoong Unceded and Zhiibaahaasing.

The Métis Nation of Ontario councils that were invited to participate were: Chapleau Métis Council, Greenstone Métis Council, Historic Sault Ste. Marie Métis Council, Mattawa Métis Council, North Bay Métis Council, North Channel Métis Council, Northern Lights Métis Council, Sudbury Métis Council, Superior North Shore Métis Council, Temiskaming Métis Council and Timmins Métis Council.

### 8.4.1 Indigenous Participation and Engagement in Transmission Development

By conducting regional planning, the IESO determines the most reliable and cost-effective option after it has engaged with stakeholders and Indigenous communities, and publishes those recommendations in the applicable regional or bulk planning report. Where the IESO determines that the lead time required to implement those solutions require immediate action, the IESO may provide those recommendations ahead of the publication of a planning report, such as through a hand-off letter to the lead local transmitter in the region, for example.

As part of the overall transmission development process, a proponent applies for applicable regulatory approvals, including an Environmental Assessment that is overseen by the Ministry of Environment, Conservation and Parks (MECP). This process includes, where applicable, consultation regarding Aboriginal and treaty rights, with any approval including steps to avoid or mitigate impacts to said rights. MECP oversees the consultation process generally but may delegate the procedural aspects of consultation to the proponent. Following development work, the proponent will then need to apply to the OEB for approval through a Leave to Construct hearing, and only if approval is granted, can it proceed with the project.

In consultation with MECP, project proponents are encouraged to engage with Indigenous communities on ways to enable participation in these projects.

# Appendices

# Appendix 1 – Reference Document and Planning Assessment Criteria

This Appendix section includes reference documents and relevant planning criteria that were used in this planning study.

| Document Name | Document ID |
|---|---|
| Ontario Resource and Transmission Assessment Criteria (ORTAC) | IMO_REQ_0041 |
| North American Electric Reliability Corporation "Transmission System Planning Performance Requirements" | NERC TPL-001-4 |
| Regional Reliability Reference Directory # 1<br>Design and Operation of the Bulk Power System | NPCC Directory #1 |

When applying the ORTAC, thermal loading, voltage performance and power transfer capability are relevant to this bulk planning study and the reference sections are summarized below.

### Thermal Loading Criteria (section 4.7.2 of ORTAC)

Based on section 4.7.2 of ORTAC, the following criteria are applied in the thermal assessment:

- With all elements in service, equipment must not be loaded greater than continuous ratings.
- With one element out of service, equipment must not be loaded greater than long-term emergency (LTE) ratings.
- Following contingencies resulting in the loss of multiple elements, equipment may be loaded up to its short-term emergency (STE) ratings only when control actions are available to reduce the loading to the LTE ratings or less within 15 minutes.

### Voltage Criteria (section 4.2, 4.3 4.4 and 4.5 of ORTAC)

Under pre-contingency conditions with all facilities in service, or with a critical element(s) out of service after permissible control actions and with loads modeled as constant MVA, the IESO-controlled grid is to be capable of achieving acceptable system voltages (minimum, maximum and deviations) as outlined in the table below.

**Table A1.1 | Voltage Limit Criteria**

| Applicable Limit | Nominal Bus Voltage (kV) | | |
|---|---|---|---|
| | 500 | 230 | 115 |
| Pre-contingency Maximum Voltage | 550 | 250 | 127* |
| Pre-contingency Minimum Voltage | 490 | 220 | 113 |

| Applicable Limit | Nominal Bus Voltage (kV) | | |
|---|---|---|---|
| | 500 | 230 | 115 |
| Post-contingency Maximum Voltage | 550 | 250 | 127* |
| Post-contingency Minimum Voltage | 470 | 207 | 108 |
| Post-contingency Maximum deviation | 10% | 10% | 10% |

* In northern Ontario, it can be as high as 132 kV

Notes: Transmission equipment must remain in service, and not automatically trip, for voltages up to 5% above the maximum continuous rating, for up to 30 minutes, to allow the system to be re-dispatched to return voltages within their normal range.

### Table A1.2 | Voltage Operating maximums for 230 and 500 kV circuits in the NE-LGR Area

| | Pre-Contingency | | Post-Contingency* | |
|---|---|---|---|---|
| | **230 kV** | **500 kV** | **230 kV** | **500 kV** |
| **NE LGR Area** | 250 | 550 | 250 | 550 |
| **Pinard TS** | 250 | 550 | 255 | 560 |
| **Porcupine TS** | 250 | 550 | 255 | 555 |
| **Ansonville TS** | 250 | ---- | 255 | ---- |
| **Kapuskasing TS** | 250 | ---- | 262.5** | ---- |

*Following automatic intervention (not including ULTC action), with no manual intervention.

**Maximum post-contingency voltage at Kapuskasing TS 230 kV bus is 250+5%=262.5 kV.

### Steady State Voltage Stability

Steady state stability is the ability of the IESO-controlled grid to remain in synchronism during relatively slow or normal load or generation changes and to damp out oscillations caused by such changes. The following checks are carried out to ensure system voltage stability for both the pre-contingency period and the steady state post-contingency period:

- Properly converged pre- and post-contingency power flows are to be obtained with the critical parameter increased up to 10% with typical generation as applicable;
- All of the properly converged cases obtained must represent stable operating points. This is to be determined for each case by carrying out P-V analysis at all critical buses to verify that for each bus the operating point demonstrates acceptable margin on the power transfer as shown in the following section; and
- The damping factor must be acceptable. The P-V curves and transient analysis are used to identify stability limits and dynamic voltage performance simulations.

The collapse point of a PV curve, or voltage instability point, is the point where the slope of the P-V curve is vertical. The maximum acceptable pre-contingency power transfer must be the lesser of:

- a pre-contingency power transfer (point a) that is 10% lower than the voltage instability point of the pre-contingency P-V curve, and

- a pre-contingency transfer that results in a post-contingency power flow (point b) that is 5% lower than the voltage instability point of the post-contingency curve

### Power Transfer Capability Criterion (section 4.1 of ORTAC)

The ability of the transmission system to transfer power across the province is defined by the capability of key interfaces. The maximum amount of power that these interfaces can deliver is known as their transfer capability, which reflects constraints to ensure system stability, voltage performance, and acceptable thermal loading. Section 4.1 of ORTAC indicates that it is important to consider the impact on the interface (transfer capability) caused by the introduction of new facilities which change power flow distribution. New connections to the IESO-controlled grid will not be permitted to lower power transfer capability or operating security limits by 5% or more.

### Load Security Criterion (section 7.1 of ORTAC)

Based on section 7.1 of ORTAC, the following criteria are applied to permissible load rejection:

- With any one element out of service, load rejection, excluding voluntary demand management, is permissible only to account for local generation outages.
- With any two elements out of service, not more than 150 MW of load may be interrupted by load rejection. Planned load curtailment or load rejection exceeding 150 MW is permissible only to account for local generation outages.

# Appendix 2 – Studied Contingency List

This Appendix section includes the contingencies that were analyzed in this planning study.

**Single Contingency List**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 67M31 | D4Z | H7T | P22G | **T8M** | **HANMER T8** | **NORTHA** | **ALGOM2** | **MACKY2** |
| A23P | D501P | H9K | P25W | W21M | HANMER T9 | PATRICK T1 | ALGOM3 | MAGPIE |
| A24P | D5H | HOGG | P26W | W22M | HOLDEN T1 | PATRICK T2 | ANDRWS | MISION |
| A4H | D6T | K2 | P502X | W35M | HOLDEN T2 | PATRICK T3 | ANJIGAMI BUS | PINARD K BUS |
| A5H | E510V | K24G | P503W | W36M | HOLDEN T3 | PATRICK T6 | COGEN1 | |
| A7V | E511V | K3 | P7G | W23K | HOLDEN T4 | PATRICK T7 | COGEN2 | |
| A8K | F1E | K38S | P91G | W71D | KAPUSKASING T5 | PORCUPINE T3 | GL1 LEO@WAWA | |
| A93I | GL1 | K4 | R21D | X23N | KAPUSKASING T6 | PORCUPINE T4 | GL4 LEO@WAWA | |
| A94N | GL1SM | K5A | S21N | X25S | KIRKLAND LAKE T1 | PORCUPINE T7 | GRTSH1 | |
| A9K | GL1TA | L1S | S22A | X26S | MACKAY T2 | PORCUPINE T8 | GRTSH2 | |
| B3E | GL2SM | L20D | S2B | X27A | M23L | SAULT3 | GRTSH3 | |
| B4B | GL2TA | L21S | S3S | X503E | M24L | SPRUCE FALLS T7 | H7T LEO@TIMMINS | |
| B4E | GL4 | L5H | S5M | X504E | M38L | THIRD LINE T1 | HARRIS | |
| C1C | H22D | L8L | S6F | X74P | M37L | THIRD LINE T2 | HIGHF1 | |
| D23G | H23S | M3K | T1B | ALGOMA T5 | MARTINDALE T21 | TIMMINS T2 | HIGHF2 | |
| D2H | H24S | M9K | T27P | ALGOMA T6 | MARTINDALE T22 | TIMMINS T4 | HOLSWT | |
| D2L | H2N | P13T | T28P | ANSONVILLE T2 | MARTINDALE T23 | CLRGU1 | L5H LEO@HOLDEN | |
| D3H | H4Z | P15T | T61S | DA WATSON T1 | MARTINDALE T25 | CLRGU2 | LEISBAY | |
| D3K | H6T | P21G | T7M | HANMER T6 | MARTINDALE T26 | ALGOM1 | MACKY1 | |

## Common Tower Contingency List

| | | |
|---|---|---|
| A23P+A24P | H9K+K38S | S21N+X23N |
| A4H+A5H | H9K+L21S | S3S+S4S |
| A8K+A9K | K38S+L21S | T2R+T61S |
| H22D+L20D | P13T+P15T | W21M+W22M |
| H24S+W71D | P25W+P26W | W35M+W36M |
| H6T+H7T | S1R+S2B | X23N+X27A |

## Breaker Failure Contingency List

| | | | |
|---|---|---|---|
| ALGOMA AL1 | DYMOND AL3 | HOLDEN DT4L4 | MACKAY 665 |
| ALGOMA AL4 | DYMOND L2L4 | HOLDEN KL23 | MACKAY 668 |
| ALGOMA DL22 | DYMOND L3L4 | HOLDEN KL24 | MACKAY 678 |
| ALGOMA DL24 | ESSA DL503 | HOLDEN L5L24 | MACKAY 682 |
| ALGOMA HL2 | ESSA JL504 | HUNTA L2L5 | MACKAY 690 |
| ALGOMA HL4 | ESSA L03L11 | HUNTA L2L9 | MAGPIE 1206 |
| ALGOMA KL23 | ESSA L04L10 | HUNTA L3L7 | MAGPIE 1212 |
| ALGOMA KL24 | GARTSHORE 1402 | HUNTA L3L9 | MAGPIE 1218 |
| ALGOMA L1L2 | GARTSHORE 1406 | HUNTA L4L6 | MAGPIE 1224 |
| ALGOMA L22L23 | GARTSHORE 1410 | HUNTA L4L7 | MARATHON HL21 |
| ANJIGAMI 834 | GARTSHORE 1414 | HUNTA L5L6 | MARATHON L21L23 |
| ANJIGAMI 844 | GARTSHORE 1418 | KAPUSKASING 27H9K | MARATHON AL22 |
| ANJIGAMI 854 | HANMER AL26 | KAPUSKASING L1L9 | MARATHON HL24 |
| ANJIGAMI 864 | HANMER AL27 | KAPUSKASING L21L38 | MARATHON AL23 |
| ANSONVILLE H1L91 | HANMER AL74 | KASHECHEWAN L3B3 | MARATHON HL38 |
| ANSONVILLE L4L8 | HANMER HL23 | KASHECHEWAN L9B3 | MARATHON L22L24 |
| ANSONVILLE L4L9 | HANMER HL25 | KIRKLAND LAKE D2D3 | MARATHON L38R3 |
| ANSONVILLE L5L8 | HANMER HL74 | KIRKLAND LAKE D2D8 | MARATHON L36R3 |
| ANSONVILLE L5LT2 | HANMER JL502 | KIRKLAND LAKE D3D11 | MARATHON AL36 |
| ANSONVILLE L9LT2 | HANMER JL503 | KIRKLAND LAKE D4D11 | MARATHON HL35 |
| CLERGUE 166 | HANMER L25L27 | KIRKLAND LAKE D4D9 | MARATHON L35R4 |
| CLERGUE 169 | HANMER PL503 | KIRKLAND LAKE D8D9 | MARATHON L37R4 |
| CRYSTAL FALLS L1L2 | HANMER PL504 | LAKE SUPERIOR POWER 1505 | MARATHON AL37 |
| CRYSTAL FALLS L1L5 | HANMER T6L23 | LITTLE LONG L20L21S | MARTINDALE AL2 |
| CRYSTAL FALLS T3L2 | HANMER T6L26 | MACKAY 615 | MARTINDALE AL6 |
| CRYSTAL FALLS T3L5 | HANMER W6L502 | MACKAY 618 | MARTINDALE DH |
| DA WATSON 1302 | HANMER W6L504 | MACKAY 632 | MARTINDALE DL6 |
| DES JOACHIMS AL5 | HOLDEN AL23 | MACKAY 635 | MARTINDALE EA |
| DES JOACHIMS L1L5 | HOLDEN AL5 | MACKAY 638 | MARTINDALE EL1 |
| DYMOND AL2 | HOLDEN DT3L5 | MACKAY 662 | MARTINDALE HL1 |

| | | | |
|---|---|---|---|
| MARTINDALE HL5 | PATRICK 217 | THIRD LINE 1601 | WAWA AL23 |
| MARTINDALE KL25 | PATRICK 222 | THIRD LINE 1604 | WAWA AL35 |
| MARTINDALE KL26 | PATRICK 225 | THIRD LINE 1607 | WAWA DL1 |
| MARTINDALE KT22 | PATRICK 228 | THIRD LINE 1610 | WAWA DL2 |
| MARTINDALE L22L25 | PATRICK 235 | THIRD LINE 1613 | WAWA HL23 |
| MARTINDALE L23T22 | PATRICK 242 | THIRD LINE 1616 | WAWA HL25 |
| MARTINDALE L24L26 | PATRICK 245 | THIRD LINE 1619 | WAWA HL26 |
| MARTINDALE L2L5 | PATRICK 248 | THIRD LINE 1622 | WAWA HL36 |

| | | | |
|---|---|---|---|
| ALGOMA AL1 | DYMOND AL3 | HOLDEN DT4L4 | MACKAY 665 |
| MARTINDALE PL22 | PINARD KL21 | THIRD LINE 1625 | WAWA KL2 |
| MARTINDALE PL23 | PINARD KL22 | THIRD LINE 1628 | WAWA KL4 |
| MARTINDALE PL24 | PINARD L20L21 | THIRD LINE 1631 | WAWA L21L25 |
| MISSISSAGI AL23 | PINARD L2L4 | THIRD LINE 1634 | WAWA L22L26 |
| MISSISSAGI AL25 | PINARD L2L6 | THIRD LINE 1637 | WAWA L35L36 |
| MISSISSAGI KL24 | PINARD L3L4 | THIRD LINE 1640 | WIDDIFIELD L71L23 |
| MISSISSAGI KL74 | PINARD L3L6 | THIRD LINE 1643 | WIDDIFIELD L71L24 |
| MISSISSAGI L23L26 | PINARD PL20 | THIRD LINE 1646 | |
| MISSISSAGI L24L25 | PINARD PL22 | THIRD LINE 1649 | |
| MISSISSAGI L26L74 | PORCUPINE H1L501 | THIRD LINE 402 | |
| MOOSONEE AL3 | PORCUPINE H1L502 | THIRD LINE 405 | |
| MOOSONEE AL9 | PORCUPINE H2L501 | THIRD LINE 408 | |
| MOOSONEE DL3 | PORCUPINE H2L502 | THIRD LINE 412 | |
| MOOSONEE DL9 | PORCUPINE HT7D1 | THIRD LINE 415 | |
| NOBEL SC503SC | PORCUPINE HT7D2 | TIMMINS H6T | |
| NOBEL SC504SC | PORCUPINE HT8D1 | TIMMINS H7T | |
| OTTER RAPIDS L6L7 | PORCUPINE HT8D2 | TIMMINS K1H6T | |
| OTTER RAPIDS L6L8 | PORCUPINE K1K2 | TIMMINS K3H7T | |
| PATRICK 205 | PORCUPINE K1K4 | TIMMINS K3T61S | |
| PATRICK 208 | PORCUPINE K2K3 | TIMMINS T61S | |
| PATRICK 211 | PORCUPINE K3K4 | WAWA AL21 | |
| PATRICK 214 | SPRUCE FALLS T7L1 | WAWA AL22 | |

All Contingencies in the Northwest, Northeast as well as Essa contingencies adjacent to the Northeast were screened. The reduced contingency sets after screening is provided in the tables below:

### Single Element Contingencies

| Single Element (N-1) | | | | |
|---|---|---|---|---|
| A23P | A24P | ALGOMA SC21 | | |
| HANMER SC21 | HANMER SC22 | HANMER T6 | HANMER T8 | HANMER T9 |
| K24G | P21G | P22G | P25W | P26W |
| P502X | P503W[21] | S22A | T27P | T28P |
| THIRD LINE T1 | THIRD LINE T2 | W21M | W22M | W23K |
| W35M | W36M | WAWA T1 | WAWA T2 | X23N |
| X25S | X26S | X27A | X505P[22] | X74P |

### Common Tower Contingencies

[21] The recommended new 500 kV circuit between Porcupine TS to Wawa TS.

[22] The recommended new 500 kV circuit between Hanmer TS to Mississagi TS.

| Common Tower (N-2) | | | | |
|---|---|---|---|---|
| A23P+A24P | P21G+P22G | P25W+P26W | P25W+P503W | P503W+PT3+PT7 |
| S21N+X23N | W21M+W22M | W35M+W36M | X23N+X27A | X505P+A23P |
| X505P+X27A | X505P+X74P | | | |

## Breaker Failure Contingencies

| Breaker Failures (N-2) | | | | |
|---|---|---|---|---|
| ALGOMA AL1 | ALGOMA AL4 | ALGOMA DL22 | ALGOMA DL24 | ALGOMA HL2 |
| ALGOMA KL23 | ALGOMA KL24 | ALGOMA L22L23 | HANMER AL26 | HANMER AL27 |
| HANMER AL74 | HANMER HL23 | HANMER HL25 | HANMER HL74 | HANMER JL502 |
| HANMER JL503 | HANMER L25L27 | HANMER PL503 | HANMER PL504 | HANMER T6L23 |
| HANMER T6L26 | HANMER W6L502 | HANMER W6L504 | MACKAY 678 | MACKAY 682 |
| MACKAY 690 | MISSISSAGI AL23 | MISSISSAGI AL25 | MISSISSAGI KL24 | MISSISSAGI KL74 |
| MISSISSAGI L23L26 | MISSISSAGI L24L25 | MISSISSAGI L26L74 | PORCUPINE H1L501 | PORCUPINE H1L502 |
| PORCUPINE H2L501 | PORCUPINE H2L502 | PORCUPINE HT7D1 | PORCUPINE HT7D2 | PORCUPINE HT8D1 |
| PORCUPINE HT8D2 | PORCUPINE K1K2 | PORCUPINE K1K4 | PORCUPINE K2K3 | PORCUPINE K3K4 |
| THIRD LINE 402 | THIRD LINE 405 | THIRD LINE 408 | THIRD LINE 412 | THIRD LINE 415 |
| WAWA AL21 | WAWA AL22 | WAWA AL23 | WAWA AL36 | WAWA HL23 |
| WAWA HL25 | WAWA HL26 | WAWA HL35 | WAWA L21L25 | WAWA L22L26 |
| WAWA L35L36 | | | | |

## Outage Scenarios (N-1-1, N-1-2)

| Outage Scenario with above contingencies Applied(N-1-1, N-1-2) | |
|---|---|
| P502X | X505P |

## Outage followed by contingency (N-1-1)

| Outage Followed by Contingency (N-1-1) | | | | |
|---|---|---|---|---|
| 3RD LINE T1 + 3RD LINE T2 | 3RD LINE T1 + K24G | HANMER T6+HANMER T8 | K24G+P503W | P503W+X503E |

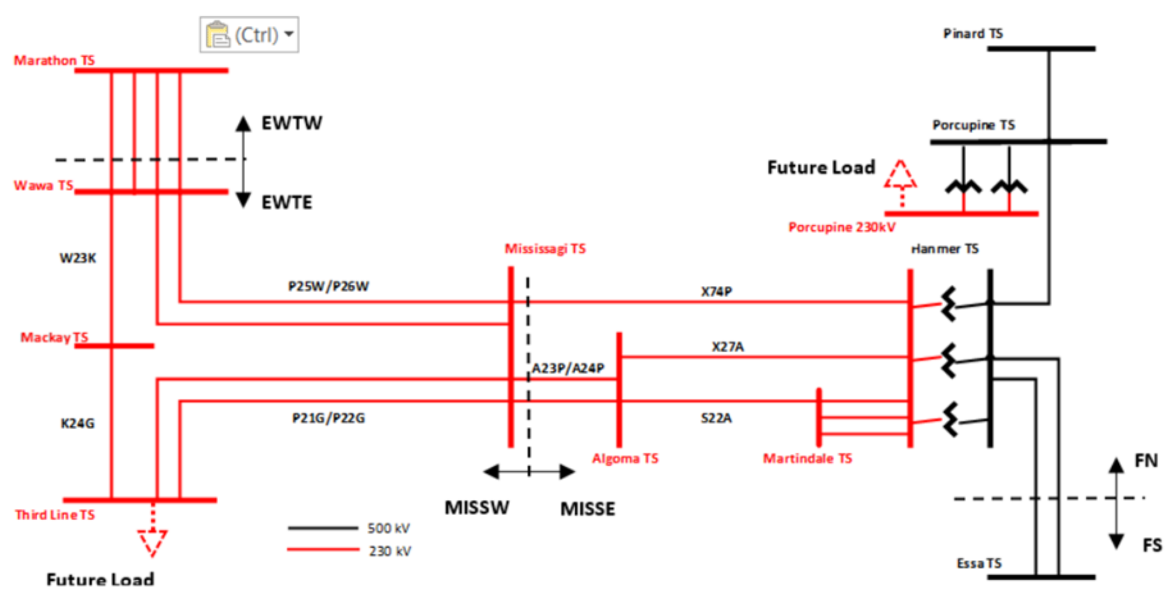
| Outage Followed by Contingency (N-1-1) | | | | |
|---|---|---|---|---|
| P21G+P22G | P25W+K24G | P25W+W23K | X27A+S22A | X74P+P503W |

# Appendix 3 – Technical Assessments to Identify Transfer Capabilities

This Appendix section documents the technical assessments that were performed to calculate the bulk system transfer capabilities. It includes:

- The identified Transfer Capability for the Bulk Transmission Interface being studied.
- The identified limiting contingency, limiting element and limiting phenomenon associated with each Transfer Capability.
- Any materially sensitive parameters.
- The next limiting contingencies, elements and phenomena in order to ensure the development of reinforcement options is sufficiently informed.

**Figure 14 | Single Line Diagram to Illustrate Northeast Bulk Transmission System and Interfaces**




## A3.1 Transfer Source and Sink

To identify Transfer Capability for the MISSW and MISSE Interface, the following source and sink are defined:

For MISSW (Northbound and Westbound transfers):

- Source – Generation in GTA and Eastern Ontario.
- Sink – Generation in Northwest[23] and ELS are initially prioritized until they are exhausted or the MISSW transfer capability is encountered, and then the rest of the Northeast is prioritized until the FN transfer capability is encountered.

For MISSE (Eastbound and Southbound transfers):

- Source – Generation in Northwest and ELS are initially prioritized until they are exhausted or the MISSE transfer capability is encountered, and the rest of the Northeast is prioritized until the FS transfer capability is encountered.
- Sink – Generation in GTA and Eastern Ontario.

## A3.2 Technical Assessment Results

**Analysis for MISSW (Northbound and Westbound Transfers)**

For existing system, the steady state transfer capability on MISSW is found approximately 585 MW:

- The limiting phenomenon is a voltage decline violation at Mississagi 230 kV bus following the A23P+A24P double circuit contingency. The next limiting phenomenon is a voltage collapse at Mississagi 230 kV bus following the A23P+A24P double circuit contingency. The voltage stability limit for MISSW is identified as 588 MW (with 5% margin applied to the voltage collapse point of approximately 620 MW.
- As per the ORTAC's transient performance requirements, MISSW transfer is further simulated 10% above 585 MW, and transient performance is assessed. The study found that transient performance requirements can be met. Therefore, the MISSW Transfer Capability of the existing system is identified as 585 MW.

With the addition of forecasted demand into SSM area (assumed in year 2029), the steady state transfer capability on MISSW would be approximately 510 MW:

- The most limiting phenomenon would be voltage violations include voltage decline and voltage collapse at Third Line 230 kV and 115 kV buses following double circuit contingencies of P21G+P22G. The next limiting contingency would be the loss of double circuit A23P+A24P.
- At a MISSW transfer of approximately 540 MW, thermal overloading of circuit P22G occurs following the Third Line 402 Breaker Failure contingency. This contingency results in the loss of 230 kV circuits P21G and K24G.
- As indicated in section 7.1 of the ORTAC, load curtailment or load rejection of up to 150 MW is permissible with two elements out of service. In this study, a contingency based RAS (Load Rejection of 150 MW load) was assumed to respect multi-element contingencies.
- The most limiting single contingency phenomenon was found to be a thermal overloading at P22G following the companion P21G contingency. This was observed when MISSW transfer is

[23] Northwest generation was reduced until it reached 98% dependable level and the EWTW was observed at approximately 450 MW.

at approximately 570 MW. As per the ORTAC, with any one element out of service, load rejection, excluding voluntary demand management, is permissible only to account for local generation outages. Therefore, no load rejection is assumed to respect the single P21G contingency.

- As per the ORTAC's transient performance requirements, MISSW transfer is further simulated 10% above 510 MW, and transient performance is assessed. The study found that transient performance requirements can be met. Therefore, the MISSW Transfer Capability for the system in year 2029 would be 510 MW.

### Analysis for MISSE (Eastbound and Southbound Transfers)

For the existing system, the steady state transfer capability on MISSE is found to be approximately 715 MW. The limiting phenomenon is a thermal overloading at circuit A24P or A23P following the companion circuit A23P or A24P contingency.

In the stressed case, the EWTE flow is observed at approximately 340 MW.

Transient performance was assessed at MISSE transfer 10% above 715 MW. The study found that transient performance requirements can be met. Therefore, the MISSE Transfer Capability is identified as 715 MW.

The study found that the addition of forecasted demand into SSM area would not change the MISSE capability. Therefore, the 715 MW of MISSE transfer capability will be maintained in 2029.

### Summary of Transfer Capabilities

Both steady state assessments and transient assessments have been performed to identify the transfer capabilities. Steady state assessments were performed first until a power transfer can be achieved that marginally meets performance requirements associated with steady state performance (the "Steady State Result"). As per the ORTAC, power transfer has been further simulated 10% above the Steady State Result, and transient performance was then assessed. The study found that transient performance requirements can be met for all assessed interfaces, the Transfer Capability was then identified as the Steady State Result.

The transfer capabilities are summarized in the following table:

### Table A3.1 Summary of Transfer Capabilities

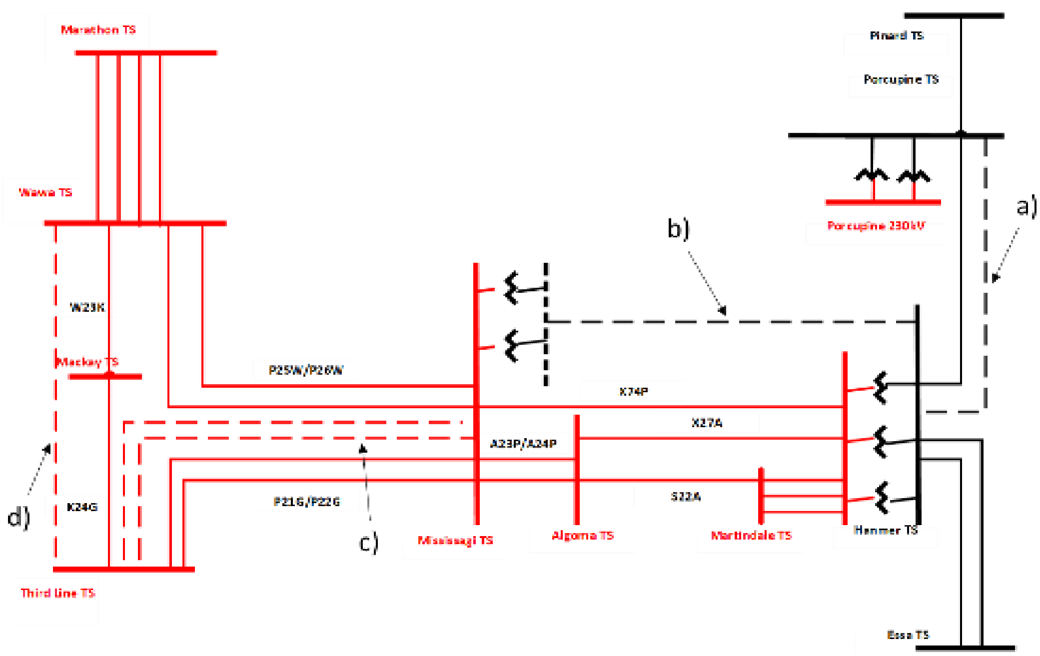
| | MISSW (Existing System) | MISSW (2029 System) | MISSE |
|---|---|---|---|
| **Transfer Capability (MW)** | 585 | 510 | 715 |
| **Limit Type** | Voltage Decline | Voltage Violations | Thermal Overload |
| **Limiting Element** | Mississagi 230 kV | Third Line 230 kV | A23P/A24P |
| **Limiting Contingency** | A23P+A24P | P21G+P22G | A24P/A23P |

# Appendix 4 – Wires Options

**Option 1A**

| **Parts to be Reinforced** | **Description** |
| --- | --- |
| Supply to Timmins | a) One new single circuit 500 kV line between Porcupine TS and Hanmer TS |
| MISSW/E (Hanmer-Mississagi) | b) One new single 500 kV circuit line between Mississagi TS and Hanmer TS |
| Supply to SSM | c) One new double circuit 230 kV line between Mississagi TS and Third Line TS |
| MISSW/E (Third Line-Wawa) | d) One new single circuit 230 kV line between Third Line TS and Wawa TS |

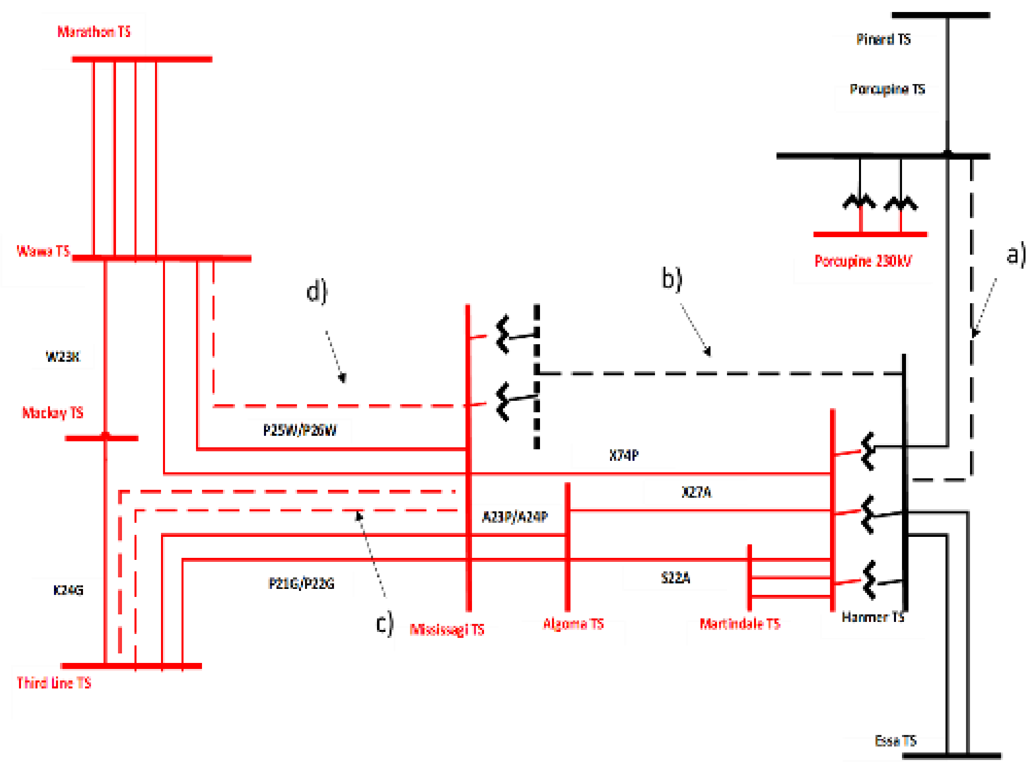
**Figure 15 | SLD to Illustrate Option 1A**



**Option 1B:**

| Parts to be Reinforced | Description |
|---|---|
| Supply to Timmins | a) One new single circuit 500 kV line between Porcupine TS and Hanmer TS |
| MISSW/E (Hanmer-Mississagi) | b) One new single 500 kV circuit line between Mississagi TS and Hanmer TS |
| Supply to SSM | c) One new double circuit 230 kV line between Mississagi TS and Third Line TS |
| MISSW/E (Mississagi-Wawa) | d) One new single circuit 230 kV line between Mississagi TS and Wawa TS |

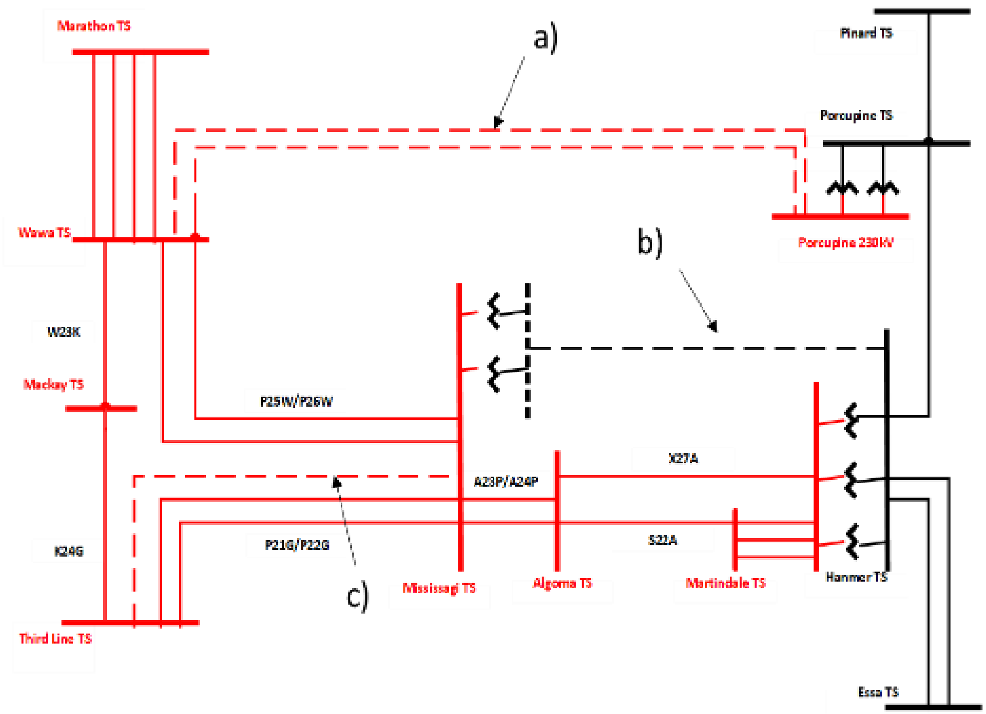
**Figure 16 | SLD to Illustrate Option 1B**



**Option 2A:**

| Parts to be Reinforced | | Description |
|---|---|---|
| Supply to Timmins and Wawa | (green) | a) One new double circuit 230 kV line between Wawa TS and Porcupine TS |
| MISSW/E | (purple) | b) Conversion of the existing 230 kV circuit between Mississagi TS and Hanmer TS to 500 kV |
| Supply to SSM | (yellow) | c) One new single circuit 230 kV line between Mississagi TS and Third Line TS |

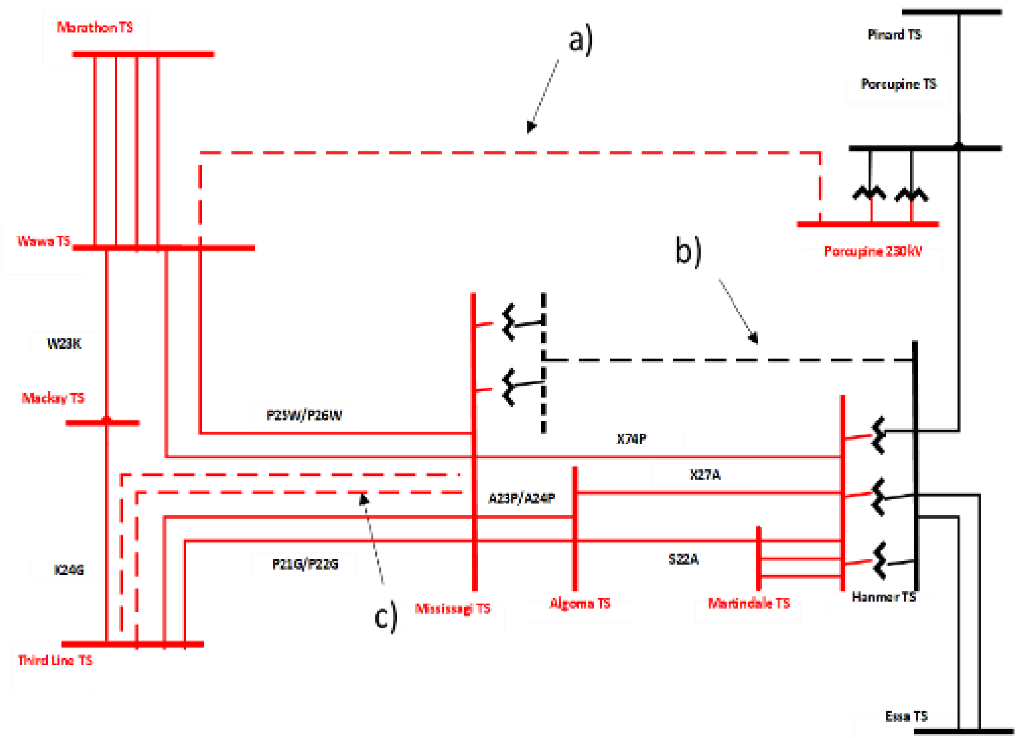
**Figure 17 | SLD to Illustrate Option 2A**



**Option 2B:**

| Parts to be Reinforced | Description |
|---|---|
| Supply to Timmins and Wawa | a) One new single circuit 230 kV line (built to 500 kV standards) between Wawa TS and Porcupine TS |
| MISSW/E | b) One new single 500 kV circuit line between Mississagi TS and Hanmer TS |
| Supply to SSM | c) One new double circuit 230 kV line between Mississagi TS and Third Line TS |

**Figure 18 | SLD to Illustrate Option 2B**



# Appendix 5 – Economic Analysis Assumptions

The following is a list of the assumptions made in the economic analysis:

- The net present value (NPV) of the cash flows is expressed in 2021 CAD.
- The USD/CAD exchange rate was assumed to be 0.76 for the study period.
- The NPV analysis was conducted using a 4% real social discount rate.
- An annual inflation rate of 2% is assumed.
- The life of the transmission line was assumed to be 70 years; and the life of the CCGT generation assets was assumed to be 30 years. Cost of asset replacement were included where necessary to ensure the same NPV study period.
- Wires option includes the bulk system cost of capacity and energy (capacity value $144 k/MW-year and energy based on 2021 APO arithmetic average of the marginal cost)
- System capacity value was $144 k/MW-year (2021 CAD) based on an estimate for the Cost of the Marginal New Resource (Net CONE), a new simple cycle gas turbine (SCGT) in Ontario.
- Production costs were determined based on energy requirements to serve the local reliability need, assuming the fixed operating and variable operating and maintenance costs for the resource (i.e., gas generation).
- Development timelines for generation was assumed to be 3 years.
- Natural gas price forecast is as per Sproule Outlook[24] @ Dawn used in the 2021 Annual Planning Outlook (APO).
- Carbon price assumption assumes the elimination of the benchmark (tCO2e/GWh) for new gas facilities by 2030 and a carbon price that escalates to $170/tCO2e by 2030.  The $170/tCO2e assumption is held constant in real dollars for the forecast period.
- The assessment was performed from an electricity consumer perspective and included all costs incurred by project developers, which were assumed to be passed on to consumers.

[24] The link of the natural gas fuel forecast:
https://www.ieso.ca/-/media/Files/IESO/Document-Library/planning-forecasts/apo/Dec2021/Fuel-Cost.ashx

**Independent Electricity System Operator**
1600-120 Adelaide Street West
Toronto, Ontario M5H 1T1

Phone: 905.403.6900
Toll-free: 1.888.448.7777
E-mail: customer.relations@ieso.ca

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