NOVEMBER 20, 2024

Quarterly Bulk Planning Update

Northern Ontario Bulk Study

IESO Transmission Planning
Independent Electricity System Operator

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Agenda

- Updates on the **Northern Ontario Bulk Study**
  - Overview of bulk planning process steps
  - Demand Forecasts and Generation Assumptions
  - Needs Identification
  - Evaluation of Options
  - Next Steps
- Updates on **South and Central Bulk Study**
  - Next Steps

IESO Feedback

- Please submit your written comments on either or both of the Bulk Studies via email to IESO Engagement at engagement@ieso.ca by **December 6, 2024**

General questions to help inform feedback on the Bulk Studies:

- Are there any additional considerations we should be aware of in developing the Study?
- What feedback do you have regarding the content delivered today?
- Are there specific areas of urgency that should drive the studies to prioritize one need or area above others?

Our Commitment to Engagement

The IESO's approach to community engagement is based on these key principles:

- Strengthening processes for early and sustained engagements with Indigenous communities, local governments and the public
- Providing Indigenous communities, local governments and the public with greater voice and responsibility
- Bringing communities to the table
- Linking local and provincial planning, and reinforcing the link between planning and procurement
- Enhancing electricity awareness and improved access to information

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Communities Have a Key Role

Significant electricity system needs are expected over the next decade, and communities have a key role, including:

- **Informing** electricity planning to ensure a reliable and adequate supply
- **Shaping** the province's energy transition by ensuring the system is prepared for future needs
- **Hosting** new generation, transmission and storage
- **Working** with project developers on the applicable approvals, and partnerships, where applicable

Your Input is Important

Indigenous communities are amongst the most influential voices to advance, manage, and shape the ongoing energy transformation. Through our engagements we've heard that it is important to:

- Inform and engage with communities in a timely manner
- Consider design requirements that incentivize developers to better understand, interact and collaborate with communities
- Keep economic development top of mind to meet future needs
- Continue to provide support and guidance for communities on how to work with developers
- Support innovative technologies and programs

Northern Ontario Bulk Study Updates

Planning Drivers for the Northern Ontario Bulk Study

Forecasts show increasing demand in Northern Ontario driven by mining developments of critical minerals, electrification of metal production, and general adoption of industrial process electrification in existing mines.

Provincial wide demand is also increasing and is driving the need for significant amounts of new supply resources across the province. Integrating these new supply resources will require the transmission expansions to enable increased bulk transfers across the province.

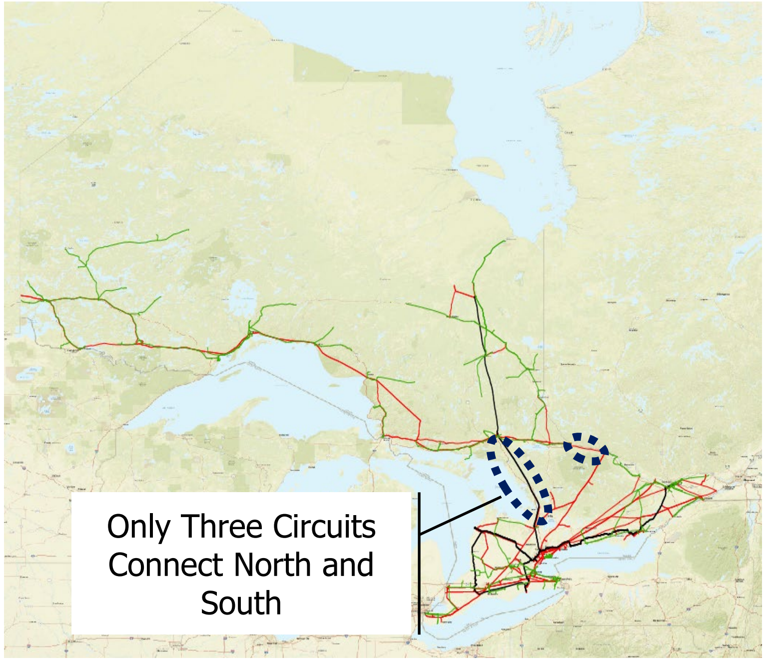
Supports the Government of Ontario's Critical Minerals Strategy (link) and responds to its Powering Ontario's Growth report (link), focusing on unlocking economic growth opportunities and enabling resources in Northern Ontario.

Background: Northern Ontario Bulk System

Northern Ontario is supplied by:

- **Three transmission circuits** that make up the North-South Interface, specifically: two 500 kV single circuits from Essa TS (Barrie Area) to Hanmer TS (Sudbury), and one 230 kV single circuit, from Otto Holden TS (in Mattawa) and Des Joachims TS (in Laurentian Hills)
- **Interconnections** with Manitoba and Minnesota, and a radial connection supplying a small load in Quebec
- **Local generation** comprising mostly of hydroelectric generation

The North-South Interface typically flows southwards during system peak when hydro-electric output is high, and northwards off-peak when hydro-electric output is low to optimize the available energy from the generation



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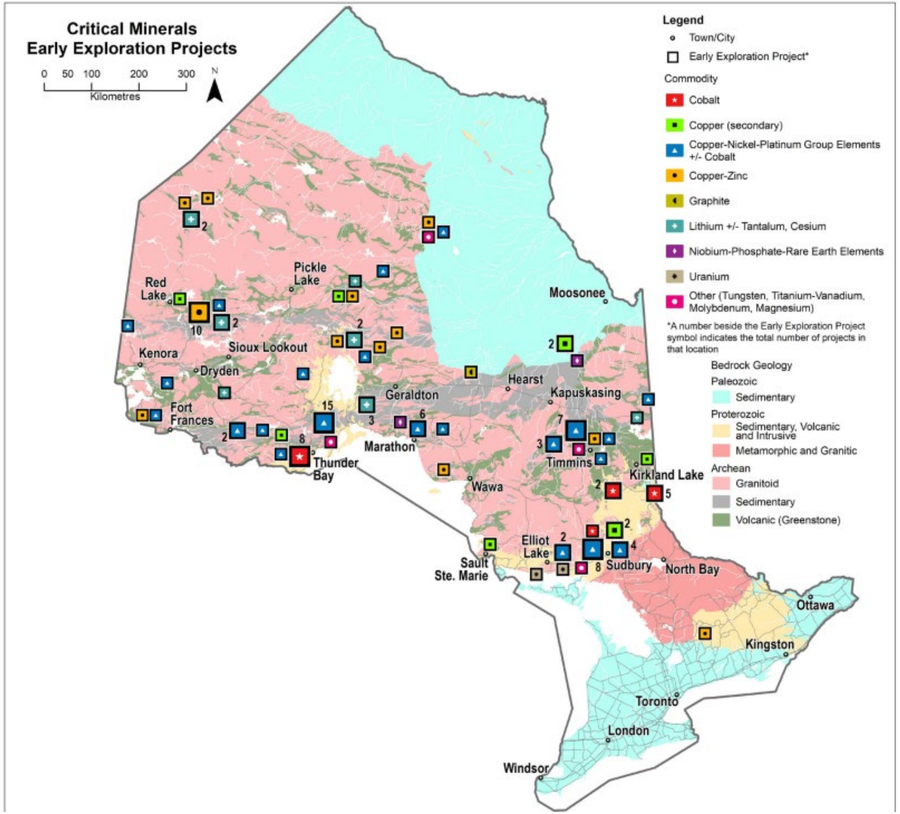
Drivers for Growth

Forecasts continue to show increasing demand growth in Northern Ontario as a result of:

- The development of significant potential mineral deposit supplies in northern Ontario to support electrification vehicle manufacturing
- Electrification of metal production sub-sector and mining
- Adoption of industrial process electrification in existing mines to improve operational economic efficiencies



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Enabling of Generation In Northern Ontario

- Provincial demand is expected to grow significantly over the next 25 years resulting in the requirement for new supply resources to address the forecast energy and capacity needs in the province
- The ability to site new supply resources in Northern Ontario will play an important role in addressing these needs especially
- However, the existing North South Interface can be a barrier to siting materially large amounts of supply resources in Northern Ontario
    - IESO’s guidance for the Long Term 2 Procurement has indicated technical challenges with connecting >1000MW renewable inverter-based resources in Northern Ontario (i.e. wind and solar)
    - Previous assessments have indicated that new 500kV circuit(s) between the Barrie area and Sudbury would be required to enable large amounts of generation in Northern Ontario

Figure 24 | Summer Capacity Surplus/Deficit

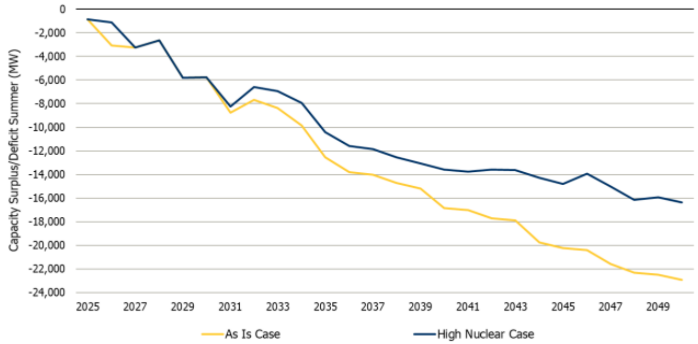
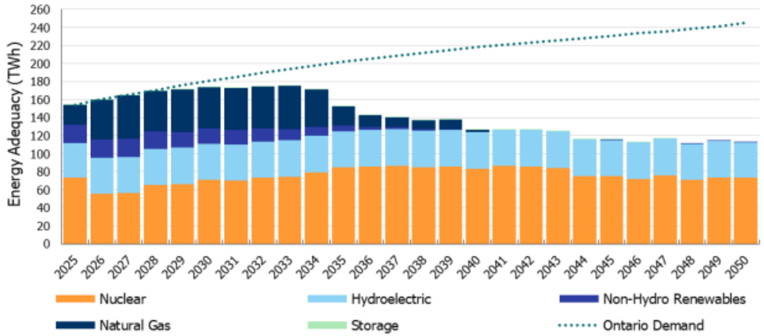


Figure 26 | Energy Adequacy Outlook (As Is Case)



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Components of a Bulk Study

Demand Forecasts	Needs	Evaluation of Options	Recommendations
How much electricity demand is forecasted to be needed over the planning timeframe? Key inputs: -Annual Planning Outlook -Mining load forecast -Regional Planning forecasts -System Impact Assessments	Can the electricity system meet customer demand via a combination of local generation and transmission capacity?	What kinds of solutions can meet the future needs for the region? For example: -transmission -generation -storage -conservation	Based on an assessment of potential options, what recommended actions will ensure a reliable and adequate electricity supply over the long-term?

Demand Forecast Scenarios

Key Details:

Two scenarios have been developed, accounting for organic load growth, electrification, industrial development and the impacts of weather:

- **Firm Demand Scenario** includes firm loads: existing and planned projects with a completed System Impact Assessment and customer commitments
- **Potential Growth Scenario** comprises of the Firm Demand scenario *plus* planned industrial projects without commitments

Demand Forecast will drive recommended solutions:

- Firm near-term recommendations required to accommodate the near- to med-term demand forecast
- Recommended actions to support potential solutions needed over the long-term

Dependability of Supply Resources

Needs

The IESO plans Ontario's power system based on several criteria and standards applicable to the province. Transmission and supply resources are counted upon to meet Load Security requirements. Supply resources of different fuel types are considered differently and based on their dependability (i.e. expected contribution during peak demand), for example:

Natural Gas

- The full seasonal capability can be counted on as the fuel source is dependable and not energy limited.

Hydro-electric

- Units can be energy limited and there are yearly variations of hydro production due to precipitation.
- Dependable hydro-electric output varies over the course of a day.

Wind/Solar

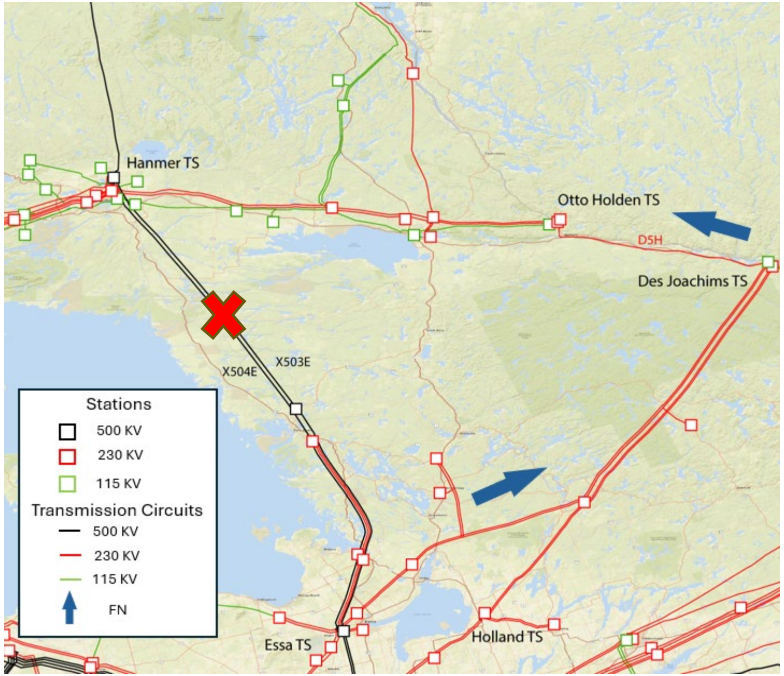
- Output from wind and solar can vary with weather conditions.

Supplying Demand in Northern Ontario

Needs

The transmission system must be planned to satisfy a wide range of planning events and forecast scenarios as identified through various planning standards (ORTAC, NERC, NPCC)

- The North-South Interface, plus dependable supply resources in northern Ontario cannot accommodate the forecasted demand for northern Ontario during "Flow North" conditions[1]
- With two transmission elements out of service (i.e. one 500 kV circuit between Hanmer TS and Essa TS on outage, followed by the loss of a second 500 kV circuit) results in unacceptable voltages and thermal overloading of equipment



[1] More information regarding load security criteria is available in section 7 or ORTAC available on the IESO's website (link)

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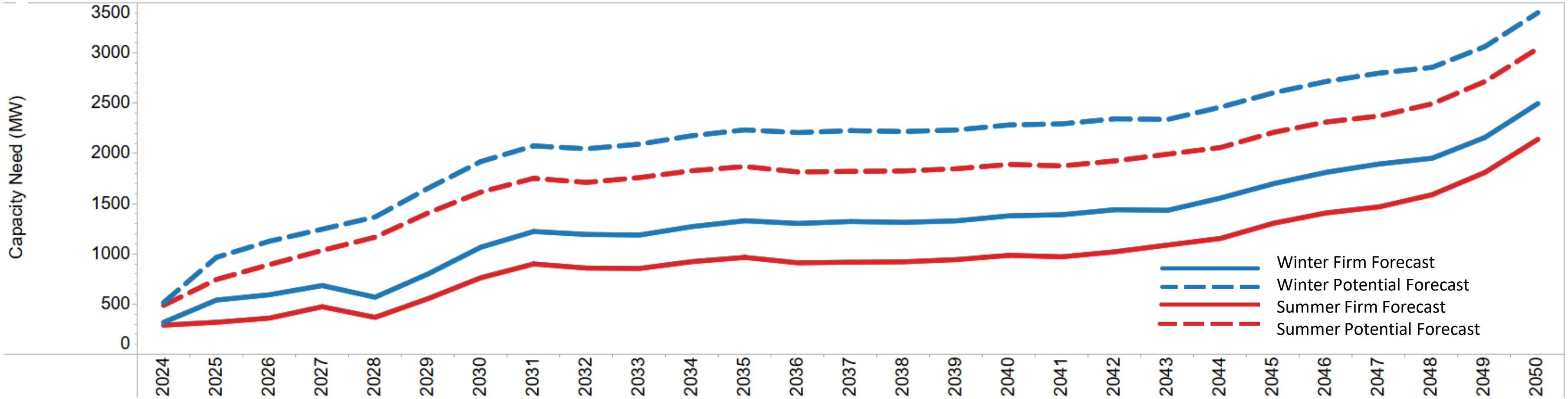
Annual Peak Capacity Need

Needs



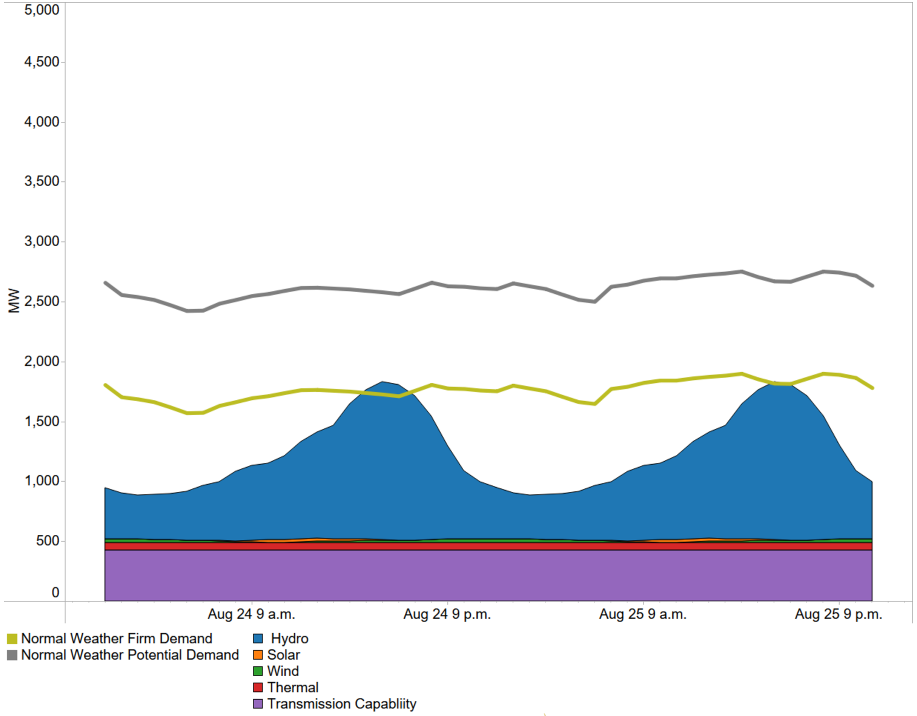
Energy Needs – Off Peak Hours

Needs

Needs exist in the firm forecast over night and over a 24hour period for the potential demand forecast due to:

- Energy limited hydro-electric resources cannot sustain continuous output and typically peaks coincident with Ontario system peak hours (evenings)
- Periods of multiple days of low output for variable resources
- Existing thermal unit contracts ending
- Relatively flat industrial demand profiles

Year = 2031



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Evaluating Options

Evaluation of Options

Potential solutions are evaluated based on the following key considerations:

Technical Feasibility	• Can the option actually be executed? i.e., proximity to customers, routing and spacing considerations, operations
Ability to Address Needs	• Are the number, magnitude, and diversity of needs adequately addressed?
Integration & Cost-Effectiveness	• What is the lowest cost solution considering the possibility that one option may be able to address multiple needs simultaneously? • Would a combination of option types be most effective?
Lead Time	• New transmission infrastructure or resource procurement/development could take 4-10 years – how does this compare to the timing of needs?

Transmission "wires" Options Considered

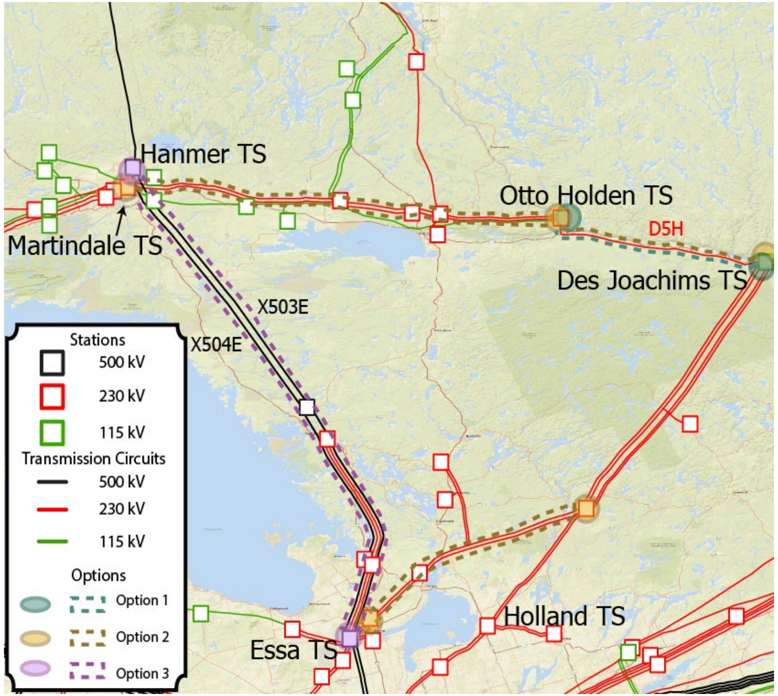
Evaluation of Options

Option 1: Reinforce the existing 230 kV circuit between Otto Holden TS (Mattawa) and Des Joachims TS (Laurentian Hills) Not Technically Feasible

Option 2: Reinforce the existing 230 kV circuits between Not Technically Feasible:

- Martindale TS (Sudbury) and Otto Holden TS (Mattawa)
- Otto Holden (Mattawa) and Des Joachims (Laurentian Hills),
- Essa TS (Barrie Area) and Minden TS (Minden)

Option 3: Reinforce the existing 500 kV system between Essa TS (Barrie Area) and Hanmer TS (Sudbury) Feasible



Non-Wires Alternatives Analysis

Evaluation of Options

- Discounted Cash Flow (DCF) analysis finds the net present value (NPV) of expected future cash flows of the resource cost and system benefit by using a discount rate.
- Future cash flows are discounted at a rate (4%) that reflects the time-value of money and the inherent risk associated with future uncertainty.
- DCF model is made for each option, which at a minimum includes the following considerations:
  - Cost of the option (i.e., capital costs, OM&A, etc.) amortized across the life.
  - Bulk system capacity benefits and bulk system energy benefits which account for any instance where the option displaces higher marginal cost resources.
- Discounted Cash Flow (DCF) analysis finds the net present value (NPV) of expected future cash flows of the resource cost and system benefit by using a discount rate.
- NWA resources situated in the north are available for provincial system adequacy and deliverable to the rest of the Province.

Comparison of Wires and Non-Wires Options

Transmission Option #3 ($1.15-1.3 B NPV cost in 2024 $)

- Accommodates firm demand forecast for northern Ontario over the long term
- Enables new supply resources in northern Ontario by providing increased southward transfer capability
- The value of enabling new supply resources in northern Ontario has not been incorporated in the costs shown

Solar, Wind, BESS Option (>$10.7 B NPV cost in 2024 $) Not Technically Feasible

- A combination of wind (3,200 MW), Solar (4,100 MW) and battery storage (2,800 MW) was determined to be required to accommodate the firm demand forecast for northern Ontario
- The amount of Inverter Based Resources identified above is significantly more than the 1,200 MW limit identified in the IESO's Long Term 2 RFP guidance (link) and would subsequently result in significant curtailments
- The cost of localized transmission reinforcements required to connect the supply resources have not been costs described above (i.e. there are incremental costs if this option were technically and economically feasible)

Recommendations

Preliminary Recommendation

Build a new ~290 km single circuit 500 kV transmission line between Hanmer TS (Sudbury) and Essa TS (Barrie Area) and initiate early development work on a second new 500 kV transmission line.

- Provides 1,500 MW of additional supply capacity and 36Gwh of additional daily energy for northward transfer to support demand growth in northern Ontario
- Provides 1,000 MW of additional southward transfer capability to support the siting of new supply resources in northern Ontario
- Estimated to cost approximately $1.3-1.5B[1] with an expected in-service date of Q1 2032[2]
- Preserves transmission option for accommodating additional future demand growth in Northern Ontario
- A new 500 kV transmission line is a first step in a series of potential actions to enable further economic development in northern Ontario:
  - A second 500 kV transmission line may be needed as demand continues to grow
  - Alternatively, there are opportunities to defer additional transmission through exploring new supply resources in northern Ontario including baseload generation

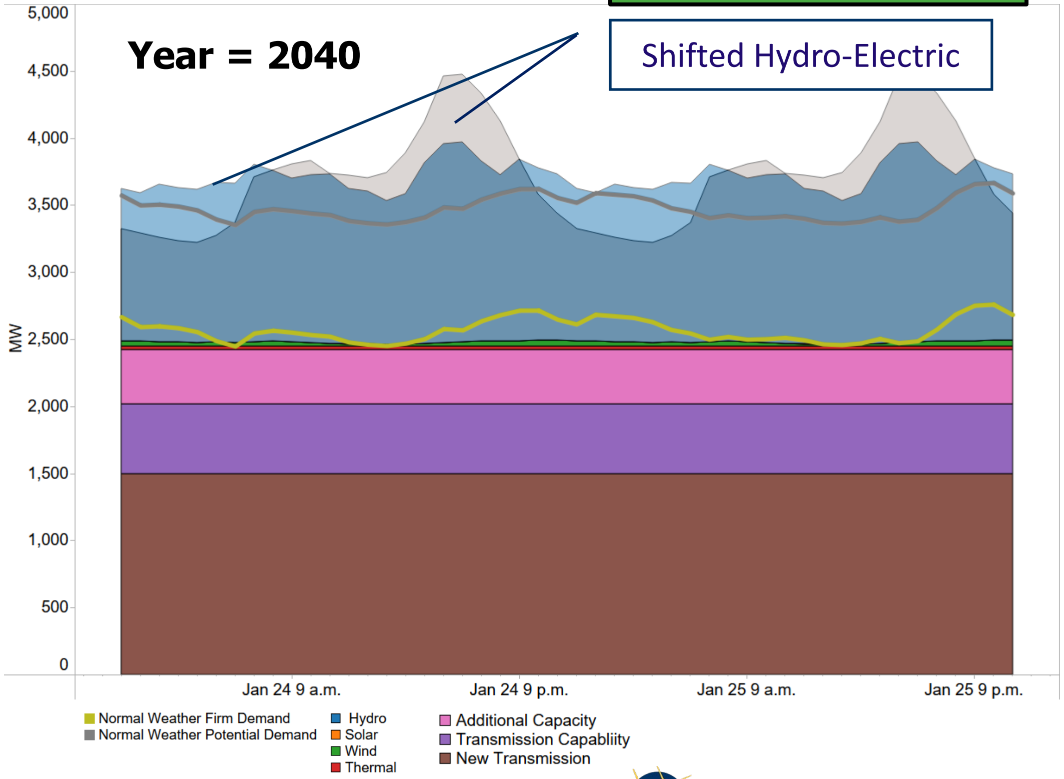
[1] Based on planning estimates with an accuracy of –30/+100%
[2] Based on typical lead time for new transmission lines built in Ontario

Preliminary Recommendation – Addressing Forecast Demand

Recommendations

A new 500kV circuit between Hanmer TS and Essa TS meets the firm demand forecast until year 2043, and meets the potential demand forecast until 2029 (where small overnight needs would be present).

The IESO will monitor and further assess future energy needs in Northern Ontario and trigger additional supply resources and/or transmission in the future as needed.



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Recommendations

Preliminary Recommendation – Enabling Supply Resources in Northern Ontario

Additional Southward Transfer Capability		All Transmission Elements I/S	One Transmission Elements O/S	Other Considerations
3 Circuits Total, No Series Compensation	**Summer**	1000	1450	• Would remove risk of subsychronous resonance (SSR) as series capacitors not used.
	Winter	320	1500	
3 Circuits Total, Series Compensated	**Summer**	1620	1330	• Provides higher all I/S limits than uncompensated, but may result in SSR restrictions
	Winter	1020	1950	
4 Circuits Total, No Series Compensation	**Summer**	2240	2330	• Would remove risk of subsychronous resonance (SSR) as series capacitors not used.
	Winter	1950	2370	

Note: at higher levels of Southward Flow Interfaces South of Barrie can become limiting

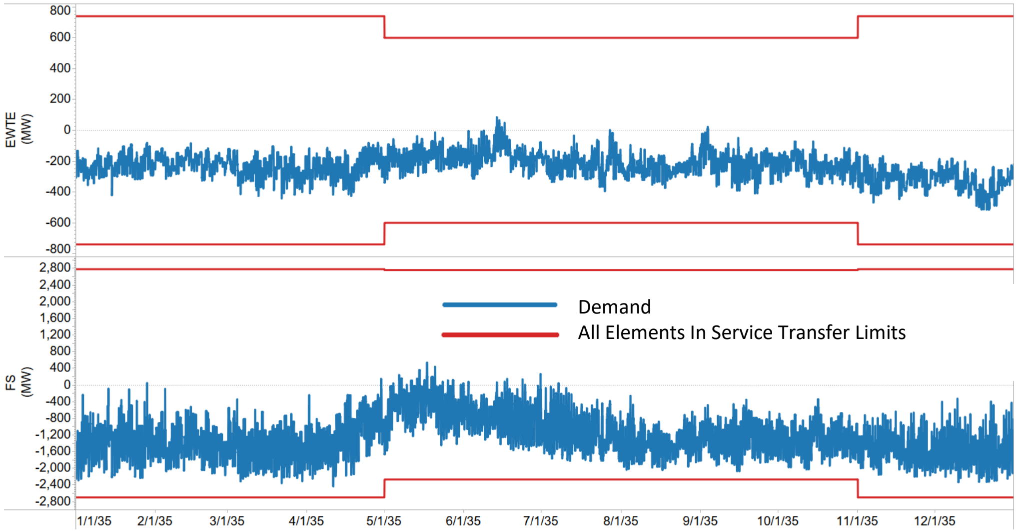
Preliminary Recommendation – Future Enablement

Recommendations

As demand continues to grow in the north, northern Ontario will be a large net importer of energy from southern Ontario

- This plan is the first logical step in a series of potential actions to enable economic development in Northern Ontario
- The plan allows for the continued buildout of transmission to serve demand in the north
- It also provides significant transmission room to locate generation on strong parts of the transmission system in Northern Ontario, including baseload generation

Potential Scenario Major Interface Flows In Northern Ontario



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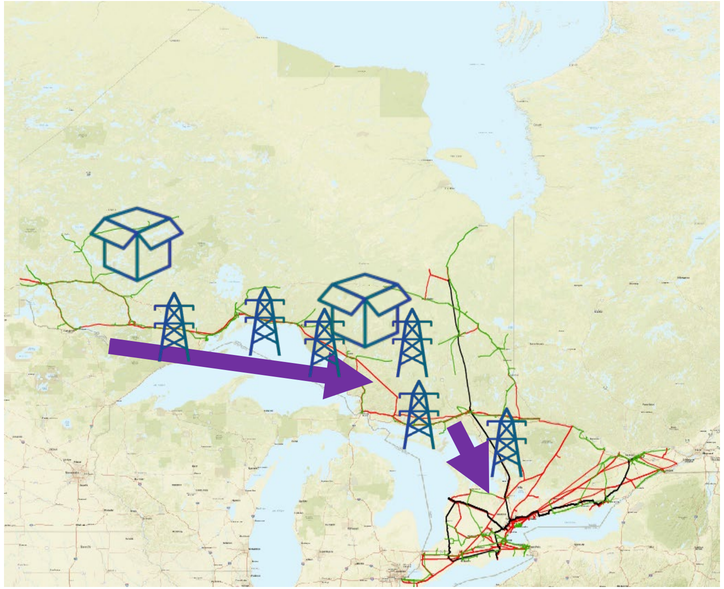
Recommendations

Preliminary Recommendation – Preserving Options for Meeting Future Needs

Explore new supply resources in northern Ontario to meet a higher demand growth.

- With this preliminary recommendation for a new 500 kV transmission line from the Barrie area to Sudbury, the IESO has recommended a series of transmission reinforcements for the entire path between the Barrie area and Dryden ~1500 linear km.
- Previously any missing link along this path would have made siting of a significant amount of supply resources difficult
- Co-locating supply resources in industry heavy areas would be ideal to defer further transmission reinforcements



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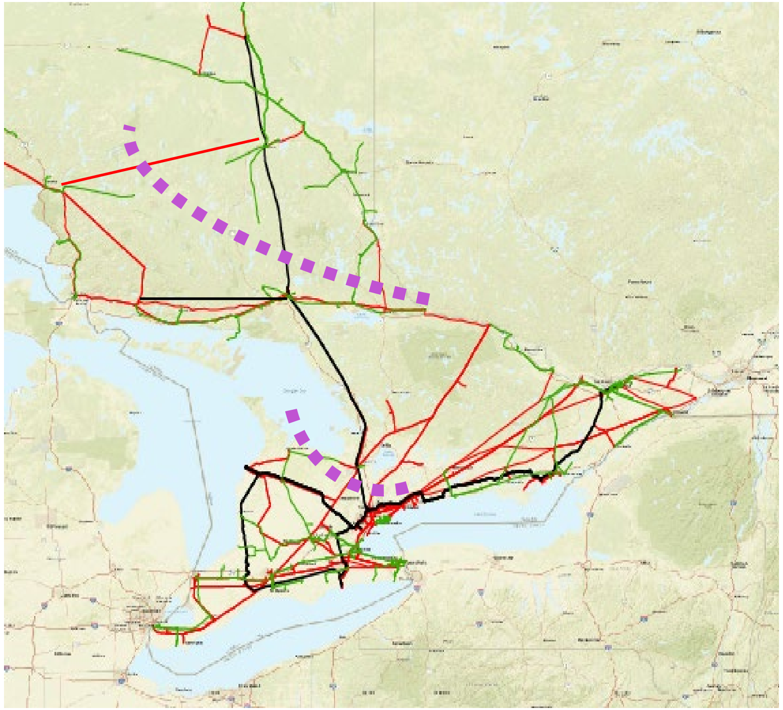
Future Challenges to Unlocking Opportunities in Northern Ontario

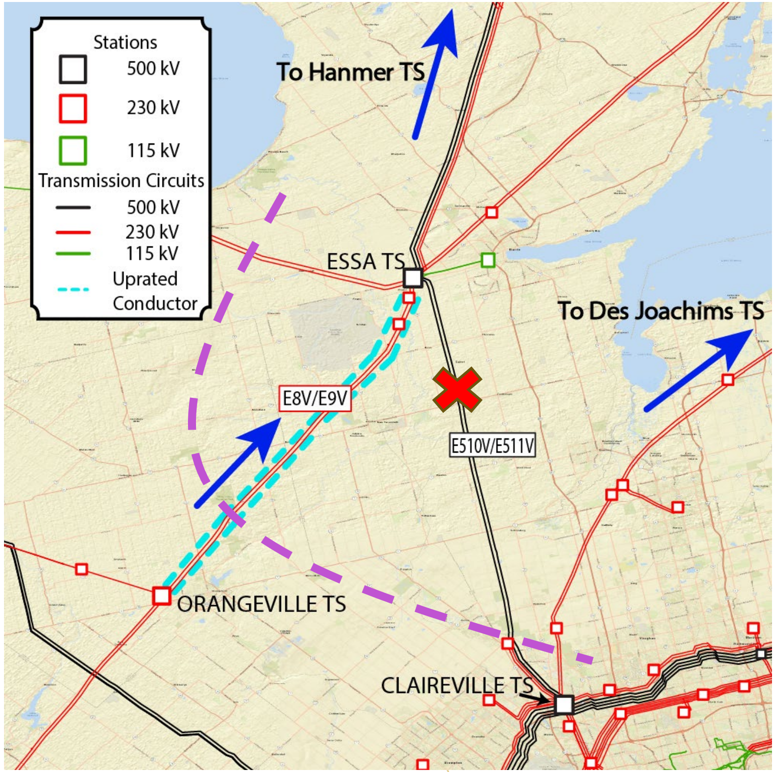
After addressing the existing transmission bottleneck between Barrie and Sudbury, the transmission system upstream (south of Barrie) and downstream (north of Sudbury) will need to be further studied.



Transmission Issues South of Barrie

Early actions underway to reduce transmission bottlenecks south of Barrie:

- The transmission system connecting Northern Ontario to Southern Ontario is downstream of a second major interface which connects the northern GTA/SW Ontario to Barrie.
- This collection of circuits supplies demand in the NE, NW and Essa zones when there is insufficient internal generation to do so.
- 230kV circuits E8V/E9V are the weakest link and become overloaded for planning criteria events.



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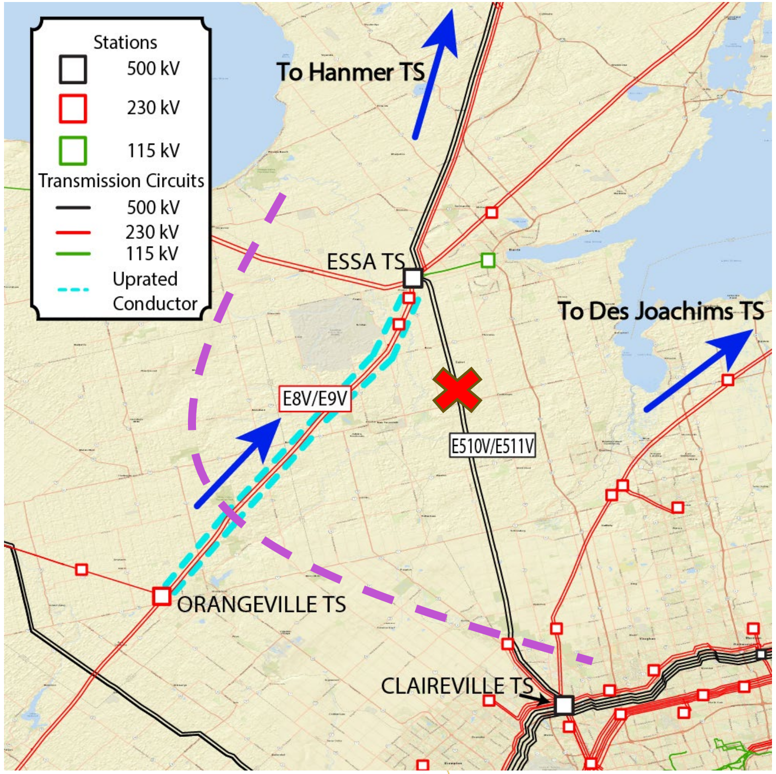
Addressing Transmission Issues South of Barrie

Early actions underway to reduce transmission bottlenecks south of Barrie:

- The previous Barrie Muskoka IRRP has identified the 230kV circuits between Orangeville and Barrie reaching end of life (EOL) and requiring replacement.
- The IESO is currently working with Hydro One to address near term needs by evaluating the potential to replace the existing conductors with advanced conductors with a higher ampacity rating
  - Will provide up to an additional 400MW of transfer capability.
- Medium and longer term needs will be addressed by the South Central Bulk Study.



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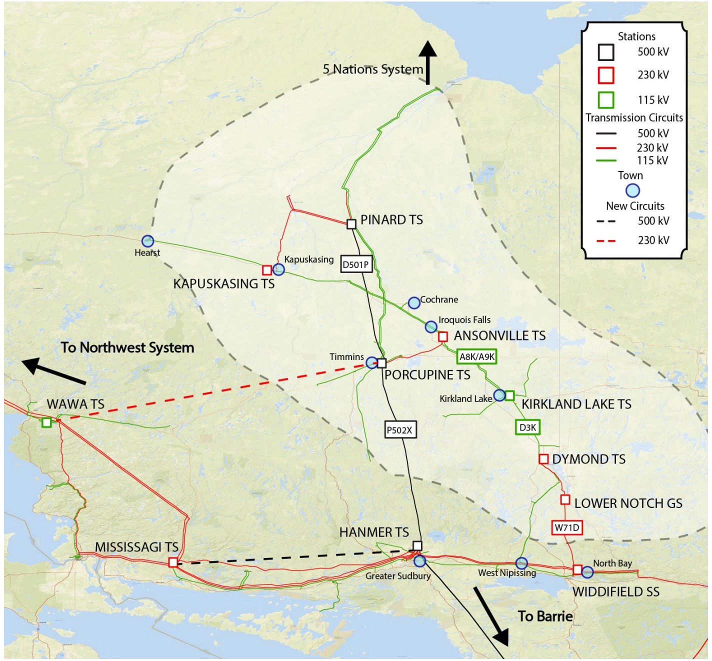
Transmission Issues North of Sudbury

A new bulk study of the area north of Sudbury is about to commence which focuses on:

- Adequacy of Electricity Supply:
  - Assess the adequacy of electricity supply to customers and potential large step load connections in the area North of Sudbury
- Generation Mix Uncertainties:
  - Assess the impacts of changing generation resources and potential retirements of gas fired generation facilities and the impact of these retirements in the area North of Sudbury
- Capacity and Integration of New Supply Resources:
  - Assess the ability to accommodate generation facilities in the area North of Sudbury



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Preliminary Recommendation Summary

To maintain reliability, mitigate demand forecast risks, preserve options to increase system capability in the future, the IESO is recommending:

- Build a new single circuit 500 kV transmission line between Hanmer TS in Sudbury to Essa TS near Barrie to accommodate demand growth (firm forecast scenario) and to enable the connection of new supply resources in northern Ontario
- Initiate early development work on a second single circuit 500 kV transmission line between Hanmer TS in Sudbury to Essa TS near Barrie to preserve transmission options for meeting higher demand growth (potential forecast scenario) in northern Ontario
- Explore new supply resources in northern Ontario to support higher demand growth and defer additional transmission reinforcements
- Continue to assess the transmission supply in the areas north of Sudbury and the south of Barrie

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Thank You

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