Interregional Transfer Capability Study Canadian Analysis

Strengthening Reliability Through the Energy Transformation

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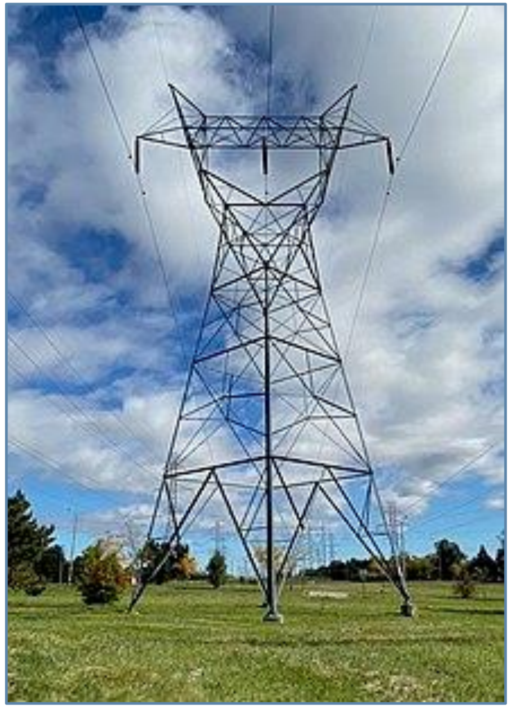
Industry Webinar
April 30, 2025

Long-Term Challenges Emerge

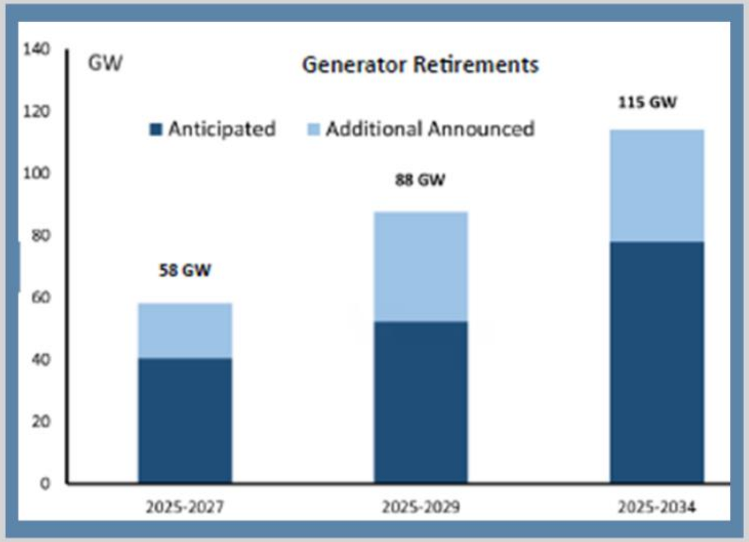
How are we going to address—

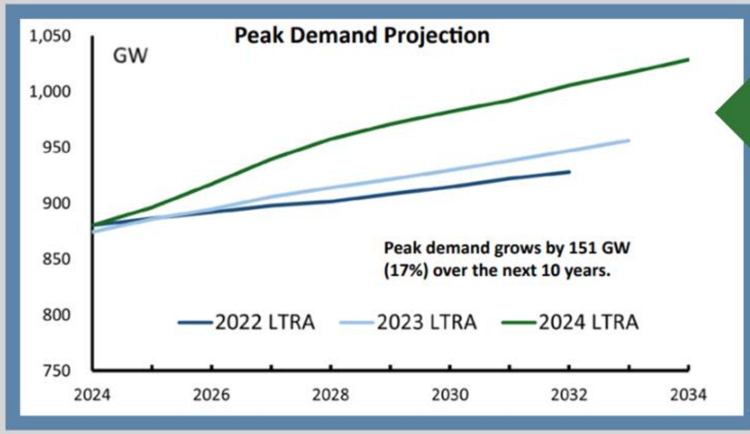
- Changing Resource Mix
- Resource Retirements
- Extreme Weather
- Demand Growth

…without more of this?



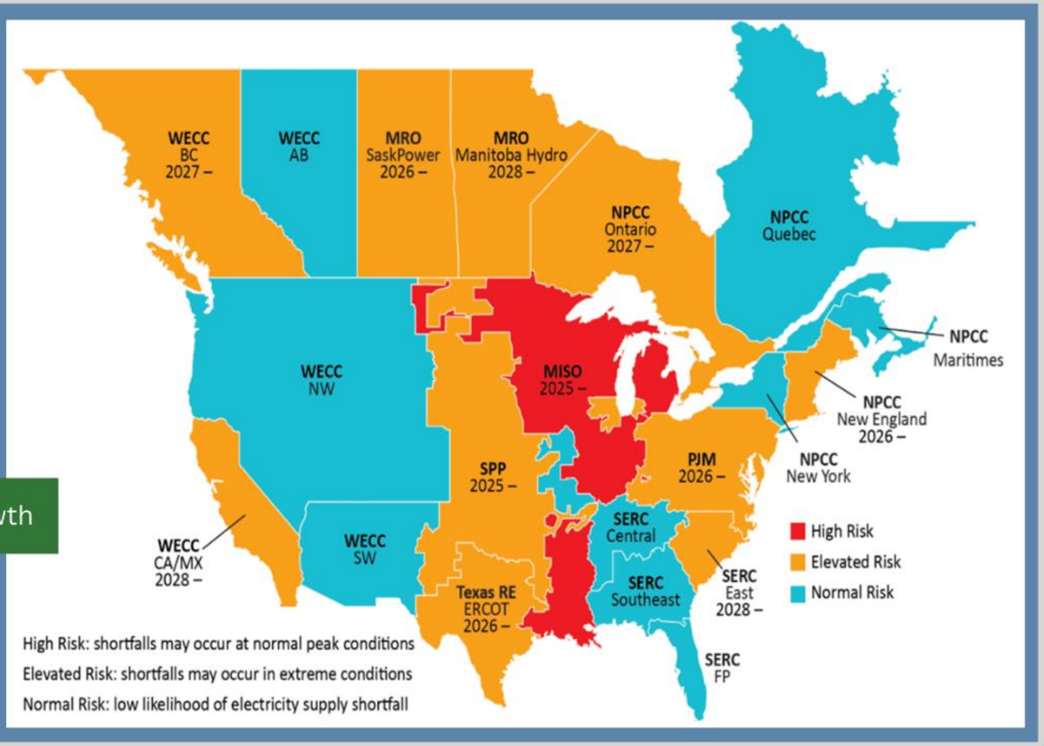
Across North America:
Tighter Resource Margins Means More Reliance on Neighbors





17% growth

2025 –2029 Risk Areas



Recent Examples Highlight Need for Wide-Area Energy Assessments

Figure 1: Hourly temperatures in Calgary, Edmonton, and Fort McMurray (January 8 to 21)

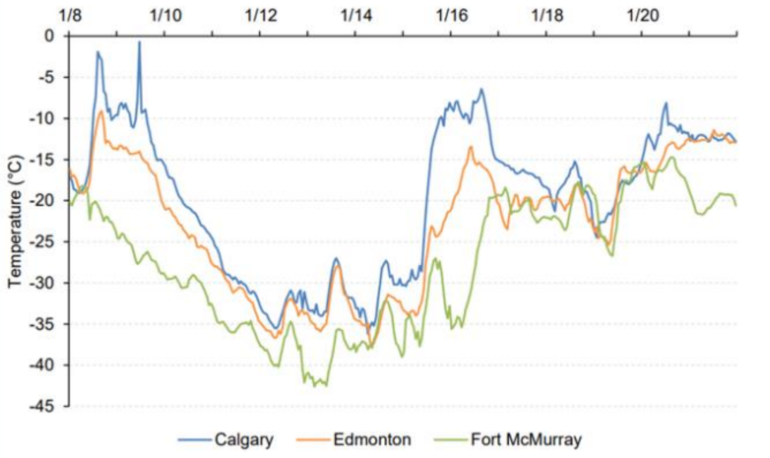
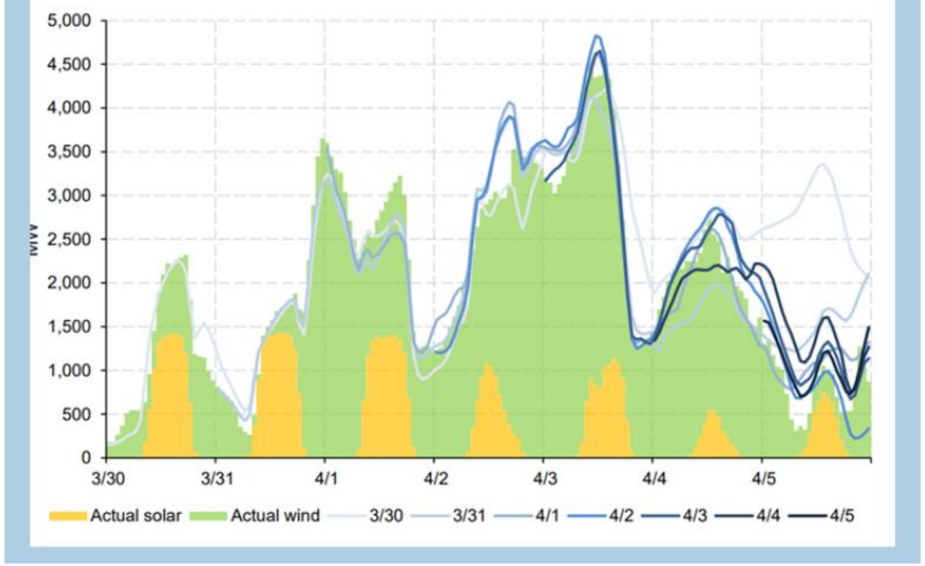
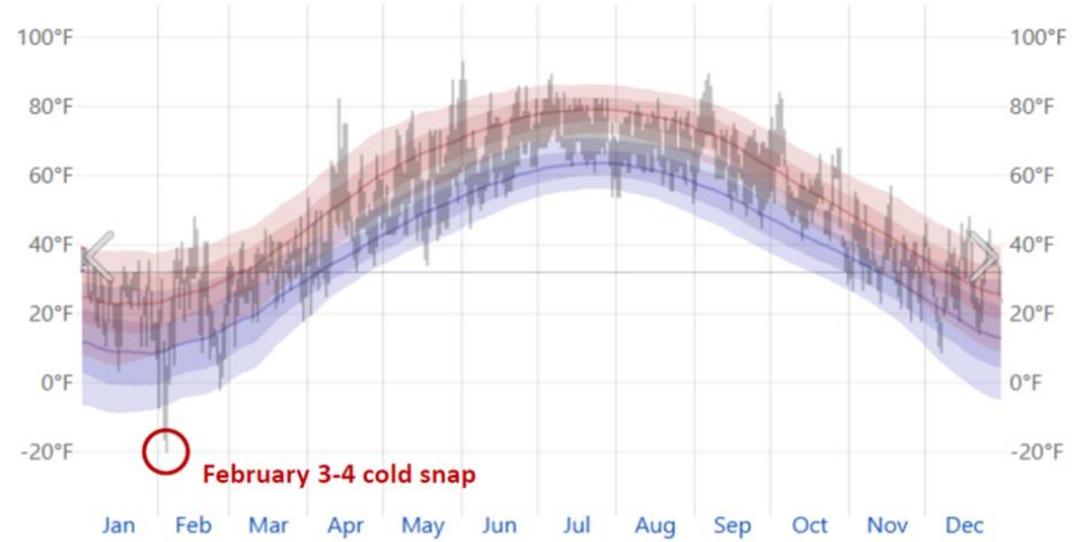


Figure 32: Wind and solar forecasts and actual generation (March 30 to April 5, 2024)



Montreal weather history (2023)



The daily range of reported temperatures (gray bars) and 24-hour highs (red ticks) and lows (blue ticks), placed over the daily average high (faint red line) and low (faint blue line) temperature, with 25th to 75th and 10th to 90th percentile bands.

Source: weatherspark.com

https://www.albertamsa.ca/assets/Documents/January-and-April-2024-Event-Report.pdf

ITCS Objectives

ITCS aligns with ERO Enterprise obligations to perform reliability assessments

- Independent and objective
- System-wide perspective
- Reliability focus
- Collaboration and coordination
- Strategic planning
- Repeatable process

Canadian Analysis: A Continuation of U.S. Analysis

- U.S. analysis conducted under the Fiscal Responsibility Act, Section 322
  - Calculated transfer capability between neighboring transmission planning regions within the United States and from Canada to the United States
  - Submitted to FERC on November 19, 2024 (Docket AD25-4-000)
  - FERC to submit report to Congress with any recommendations for statutory changes within 12 months of close of comments [February 25, 2026]
- Canadian stakeholders requested a similar study of transfer capabilities into and between Canadian provinces

Project Scope

In-Scope

- ✓ A common modeling approach to study the North American grid independently and transparently
- ✓ Evaluation of the impact of extreme weather events on hourly energy adequacy using the calculated current transfer capability and 10-year resource and load futures
- ✓ Identifying additional transfer capability that could address energy deficits when surplus is available in neighboring regions
- ✓ Extensive consultation and collaboration with industry
- ✓ Reliability improvement as the sole consideration in evaluating additional transfer capability

Out-of-Scope

- × Economic, siting, policy, or environmental impacts
- × Quantified impacts of planned projects
- × Endorsement of specific projects, as additional planning by industry would be necessary to determine project feasibility
- × Not a replacement to existing or future transmission expansion planning or capacity expansion planning efforts
- × Recent changes to load forecasts, renewable targets, or retirement announcements

Part 1 and 2 Objectives and Assumptions

	Part 1 Transfer Analysis	Part 2 Transfer Additions
Objective	Current Transfer Capability	Transfer Additions
Topology	Subdivided FERC Order 1000 Regions and Canadian Provinces	Subdivided FERC Order 1000 Regions and Canadian Provinces
Future Cases	1 Year Out	1 and 10 Years Out
Scenarios	Summer and Winter Peak	12 Weather Years Including Extreme Weather
Chronology	Single Snapshot	Hourly Assessment
Key Outputs	Interregional Transfer Capability	Hourly Energy Margins Transfer Additions

Key Findings: Highlights

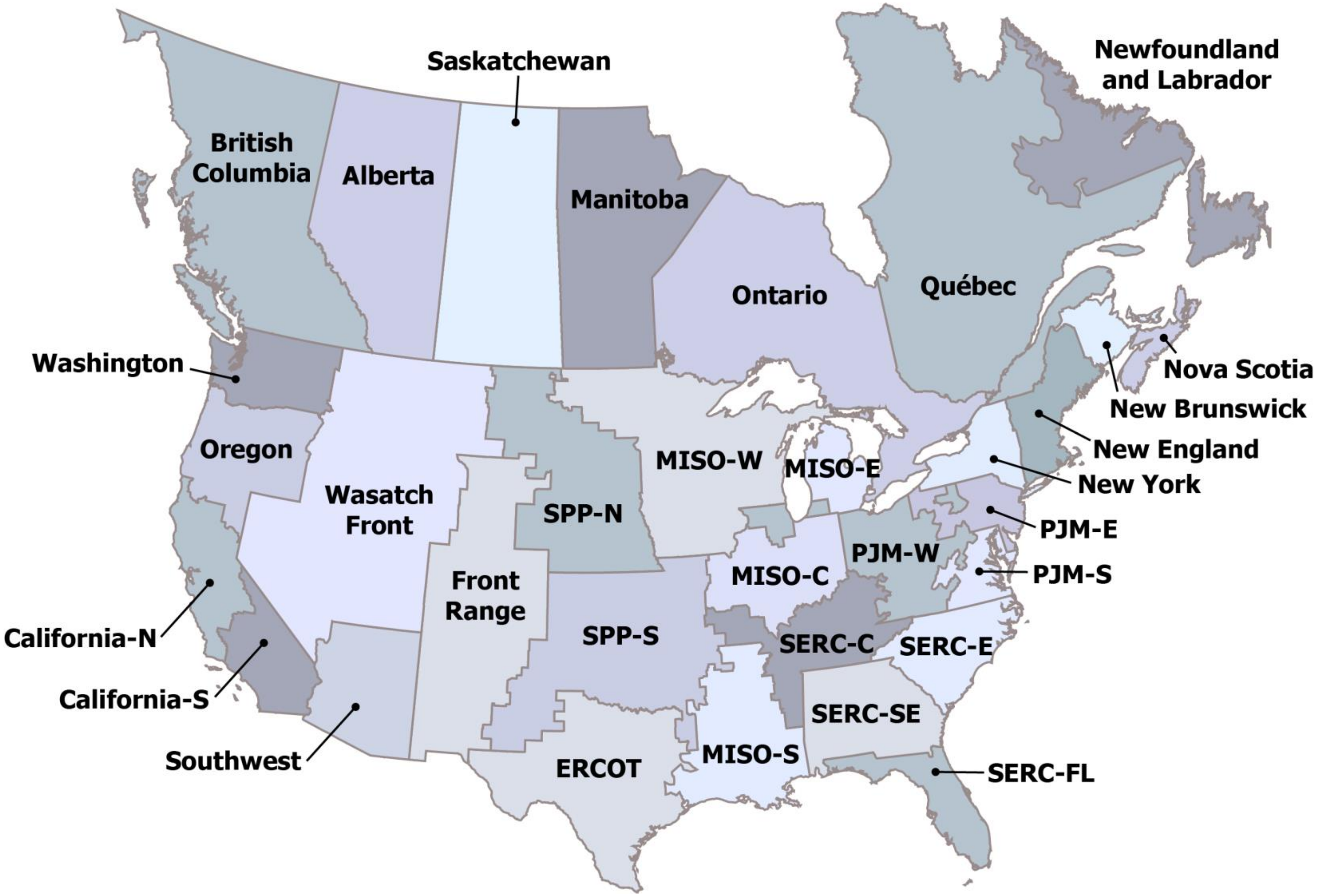
- ☐ Transfer capability varies seasonally and under different system conditions.
- ☐ Observed transfer capabilities are generally higher between Canada and the U.S. than between provinces.
- ☐ Interregional transfer capability does not equate to path ratings.
- ☐ Canadian systems are increasingly vulnerable to extreme weather, with transmission limitations and potential energy inadequacy identified in all 12 weather years studied.
- ☐ An additional 12-14 GW of transfer capability may enhance energy adequacy during extreme weather.
  - Québec could face a maximum energy deficiency of 10 GW in winter 2033 due to demand growth.
  - Nova Scotia may experience shortages in all studied weather years; expanding transfer capability with New Brunswick could help.
  - Energy deficits are also noted in Alberta, Saskatchewan, Ontario, and New Brunswick.

Key Findings: Highlights

- Recent forecasts using 2024 LTRA data indicate significant improvements in Ontario and Québec, as resource projections align with demand.
- Unexpected retirements without replacement could lead to energy shortages and increased need for transfer capabilities from neighboring regions.
- A comprehensive approach, including transmission, local resources, demand-side strategies, and storage solutions, is essential to address each province's specific vulnerabilities and policies.

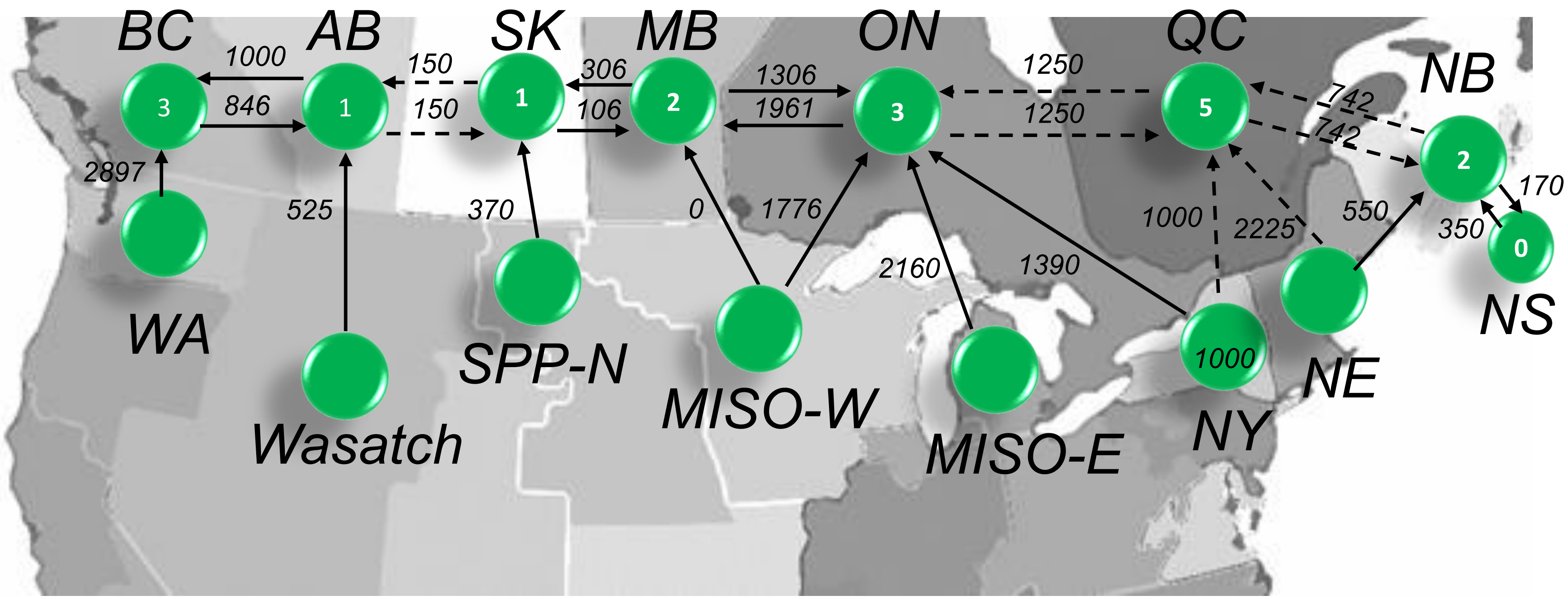
Study Results: Transfer Analysis

Transmission Planning Regions



Report Figure 1.2: Transmission Planning Regions

Transfer Capability Results (Summer) for Canadian Regions



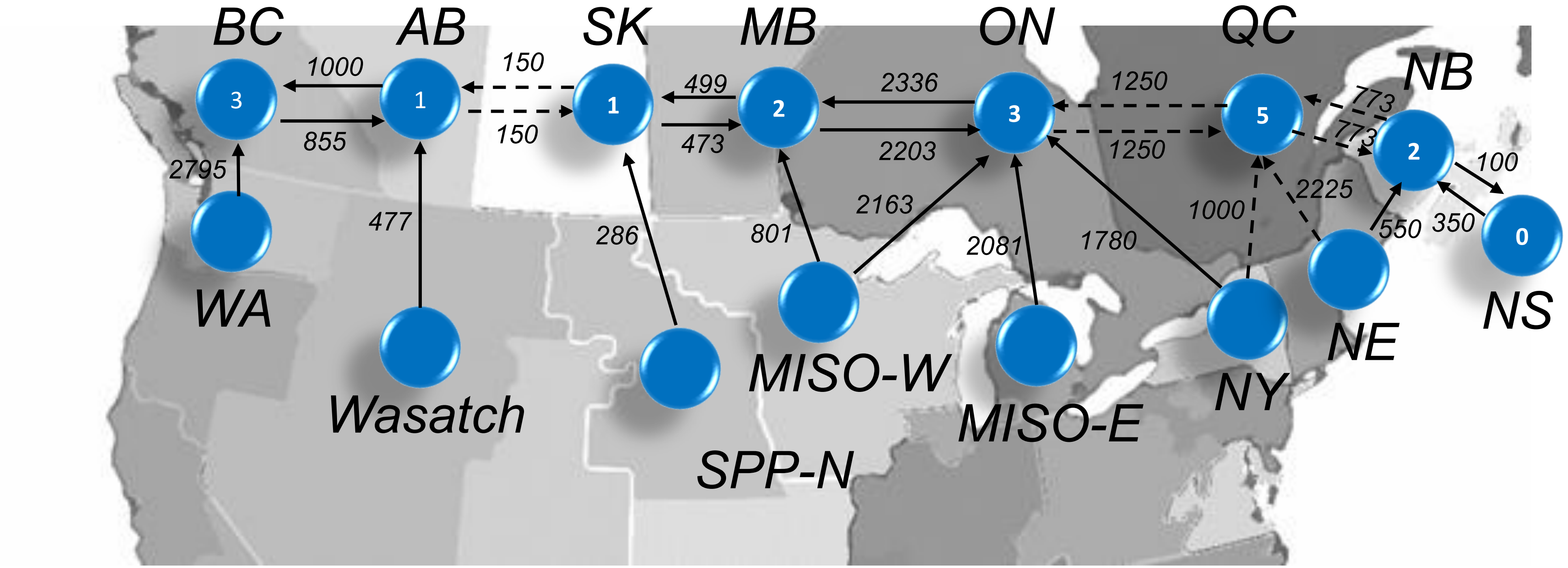
- Alberta has 1000 MW simultaneous export limitation to BC+Wasatch
- Results based on Area-to-Area Interchange Method (not a Path Limit)

⟶ *AC ties (MW)*

- - -→ *DC ties (MW)*

● - *Total Simultaneous import capability (Rounded to nearest GW)*
- *For regions with both DC and AC ties, combined AC+DC import capability is shown*

Transfer Capability Results (Winter) for Canadian Regions



- *Alberta has 1000 MW simultaneous export limitation to BC+Wasatch*
- *Results based on Area-to-Area Interchange Method (not a Path Limit)*

- - - → DC ties (MW)

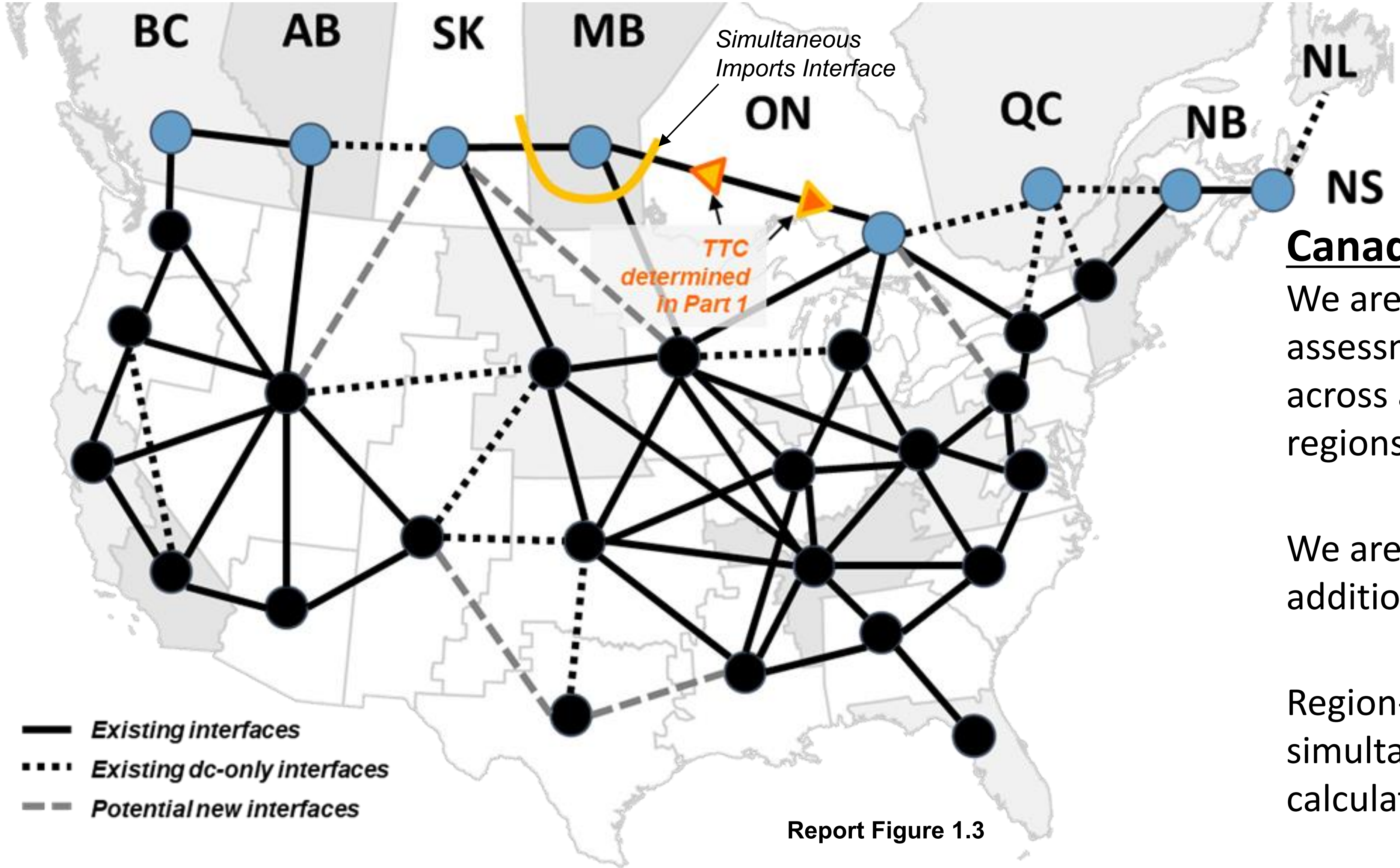
——→ AC ties (MW)

● - *Total Simultaneous import capability. (Rounded to nearest GW)*

- *For regions with both DC and AC ties, combined AC+DC import capability is shown*

Methodology: Energy Margin Analysis

Modeling the Entire North American Grid



Report Figure 1.3

Canadian Analysis

We are performing the energy assessment simultaneously across all North American regions

We are not considering transfer additions in the U.S. regions

Region-to-region and simultaneous imports were calculated for each region

A Multi-Weather Year Approach to Energy Margins

WEATHER YEARS

HOURLY LOAD

HOURLY WIND & SOLAR

DAILY THERMAL OUTAGES

Synthetic (modeled)

Historic (actuals)

<u>Example Weather Events Evaluated</u>

- **Québec cold snap, 2009**
- **Western Wide Area Heat Domes, 2020-2022**
- **Winter Storm Uri, 2021**
- **Western and Midwest Heat Waves, 2023**
- **Northeast Heat Wave, 2023**
- **Eastern Canada Cold Snap, 2023**

12 weather years
<u>X 8,760 hours/year</u>
~105,000 hours

Report Figure 4.1

Hourly Energy Margin Method and Data

Available Wind & Solar + Seasonal Hydro Capacity + Available Thermal Capacity + Storage Net Generation − Load = Regional Hourly Energy Margin

— Weather-Dependent Outages — Expected Maintenance

Report Figure 5.1

Notes:

1. All resources aggregated to the transmission planning region level
2. Available wind, solar, and load varies hourly, by weather year
3. Seasonal hydro capacity varies monthly
4. Available thermal capacity varies daily, based on weather
5. Storage net generation (Batteries, Pumped Storage, Demand Response) scheduled hourly based on energy margin

Six Step Process to Increase Transfer Capability

Identify

Identify hours of resource deficiency, *based on energy margin analysis across 12 weather years, 8,760hrs/year = ~105,120 hours per year, per region*

Quantify

Quantify maximum resource deficiency across all weather years and all hours. Use this to guide/size transfer capability additions (33%).

Prioritize

Prioritize Constrained Interfaces to add transfer capability only to interfaces that 1) import to a resource deficient region, 2) hit their limit during tight margin hours, and 3) have surplus available.

Allocate

Allocate Additional Transfer Capability to increase transfer capability with neighbors, initially equal to 33% of max deficiency.

Iterate

Iterate Until Resource Deficiencies are Resolved

by running in increments of 33% of the original max deficiency until deficiencies are resolved or saturation occurs

Finalize

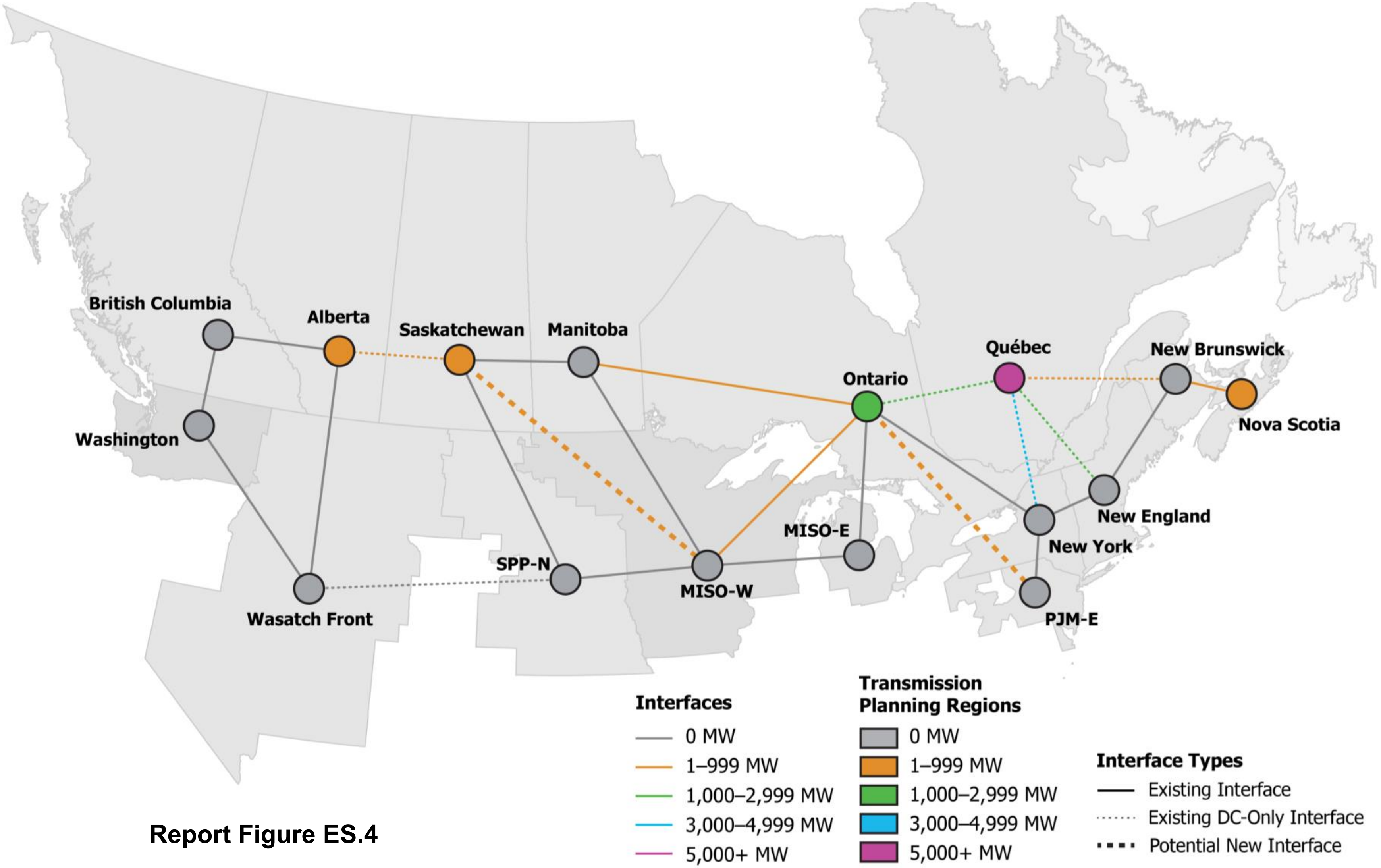
Finalize Levels of Transfer Capability

using criteria to determine when additions are considered to strengthen reliability

Report Chapter 5

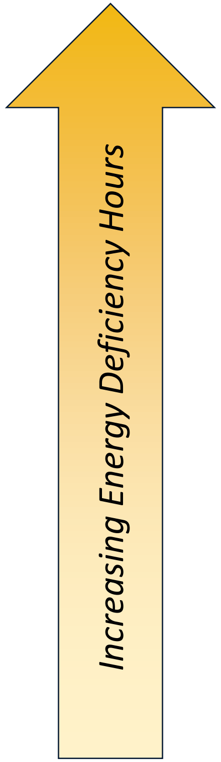
Results: Transfer Additions

Final Transfer Additions (2023 LTRA Data)



Report Figure ES.4

Additions to Transfer Capability by Region (2023 LTRA data)



Transmission Planning Region	Weather Years (WY) / Events	Resource Deficiency Hours	Maximum Deficiency (MW)	Additional Transfer Capability (MW)	Interface Additions (MW)
Nova Scotia	All 12 weather years studied	641	582	500	New Brunswick (500)
Québec	Cold weather in WY2023 and eight other years	379	10,374	10,300	New York* (4,200) Ontario* (2,600) New England* (2,600) New Brunswick* (900)
Saskatchewan	Heat wave in three weather years and cold weather in WY2013	57	543	500	MISO-W** (500)
Alberta	Cold weather in WY2022 and two other years	33	764	600	Saskatchewan* (600)
Ontario	Heat wave in WY2011 and four other years	23	3,083	1,600	PJM-E** (900) MISO-W (400) Manitoba (300)
TOTAL				**13,500**	

Additional transfer capability was able to resolve all resource deficiencies after three iterations

Report Table 6.7

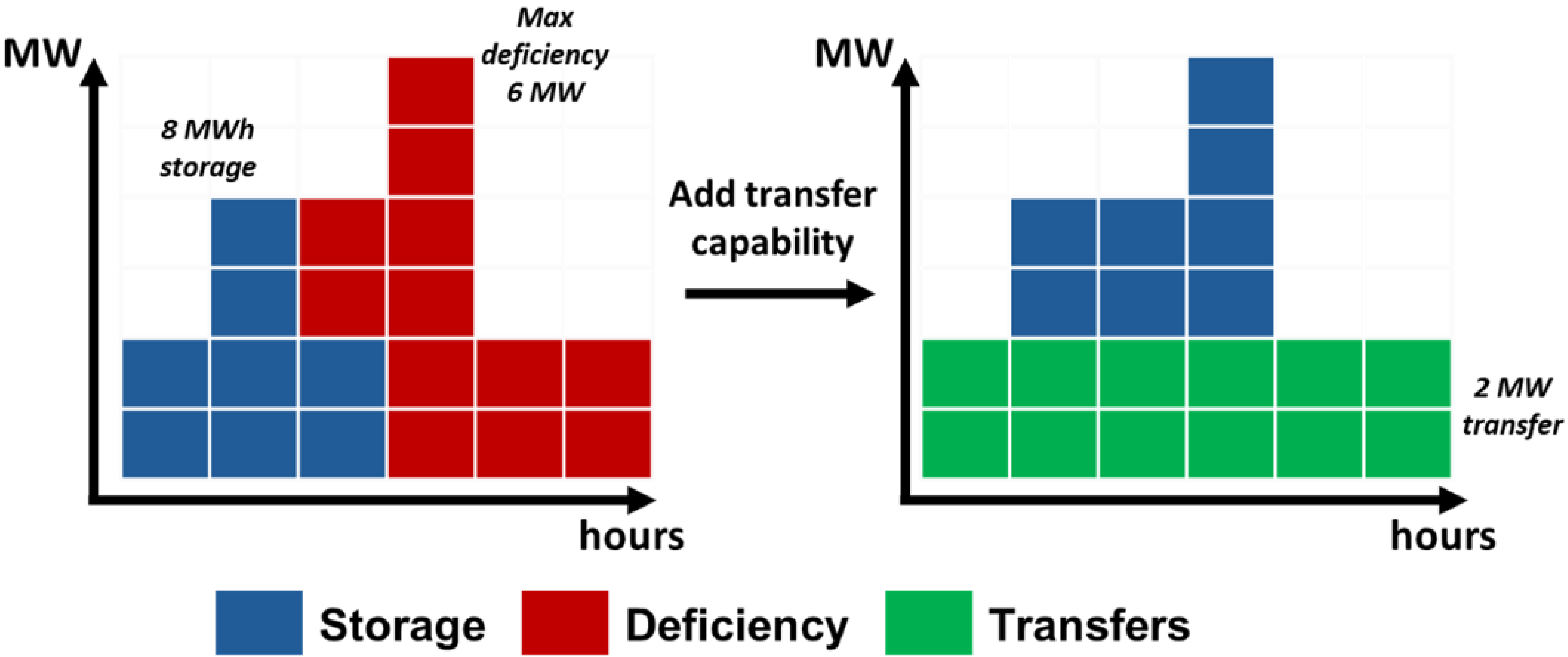
** Existing interface is dc-only*

*** Potential new interface*

Key Insights

- **Multiplier effects** that may enhance the benefits of additional transfer capability
- The intricate relationship between **generation and transmission planning**
- Pronounced benefits of transfer **capability across Interconnections**

Multiplier Effect of Storage



MW

8 MWh storage

Max deficiency 6 MW

hours

Add transfer capability

MW

2 MW transfer

hours

🟦 Storage 🟥 Deficiency 🟩 Transfers

Results: Sensitivity Analysis

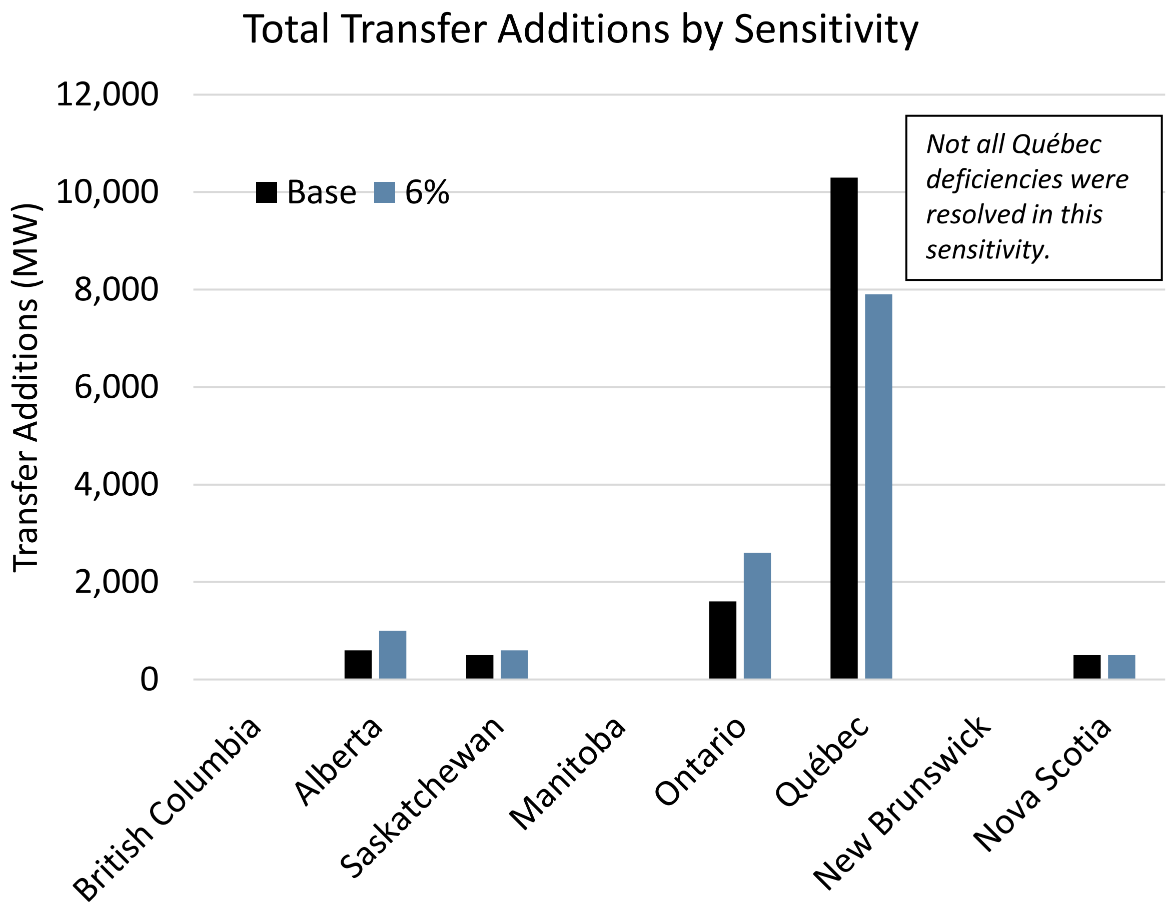
6% Minimum Margin Sensitivity Analysis

6% Minimum Margin Sensitivity

- Increases the minimum margin level to 6% (up from 3%), which is used to calculate resource deficiencies and trigger transfer additions.
- Also analogous to a higher load sensitivity
- Will increase size, frequency, and duration of resource deficiencies

Transmission Planning Region	Max Resource Deficiency (3% Margin)	Max Resource Deficiency (6% Margin)	Change in Max Resource Deficiency
British Columbia	0	0	0
Alberta	764	1463	699
Saskatchewan	543	662	119
Manitoba	0	0	0
Ontario	3083	3901	818
Québec	10374	11944	1570
New Brunswick	118	787	669
Nova Scotia	582	658	76

Report Table 7.1



Not all Québec deficiencies were resolved in this sensitivity.

Report Figure 7.1

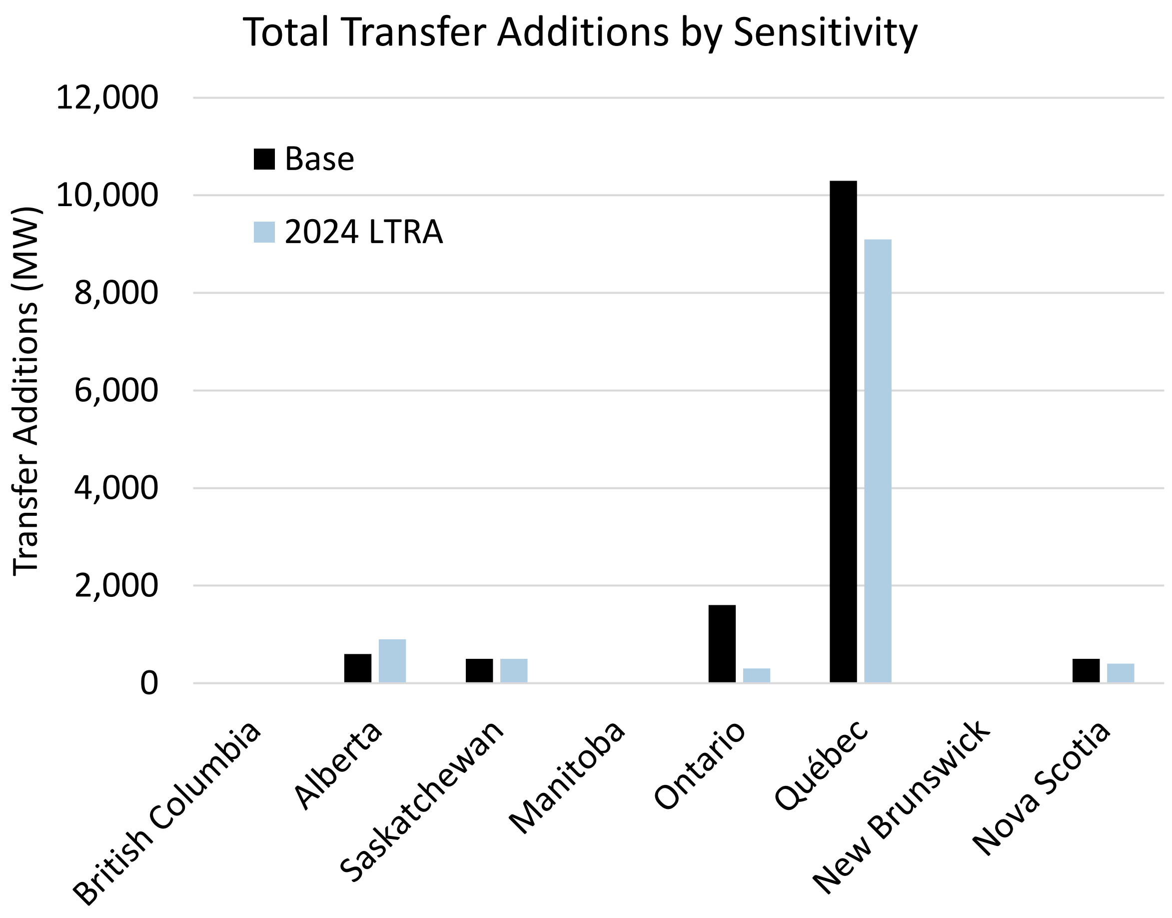
2024 LTRA Sensitivity

2024 LTRA Sensitivity

- Adjusts Canadian data to reflect the 2024 LTRA changes
- Applies a constant scalar to regional winter and summer loads based on peak demand growth in the 2024 LTRA
- Adjusts regional capacities based on recent announcements to generator additions (Tier 1) and retirements
- Retains custom assumptions provided by Canadian utilities

Transmission Planning Region	Max Resource Deficiency (2023 LTRA Data)	Max Resource Deficiency (2024 LTRA Data)	Change in Max Resource Deficiency
British Columbia	0	0	0
Alberta	764	1395	631
Saskatchewan	543	572	29
Manitoba	0	0	0
Ontario	3083	643	-2440
Québec	10374	9181	-1196
New Brunswick	118	0	-118
Nova Scotia	582	584	2

Report Table 7.2

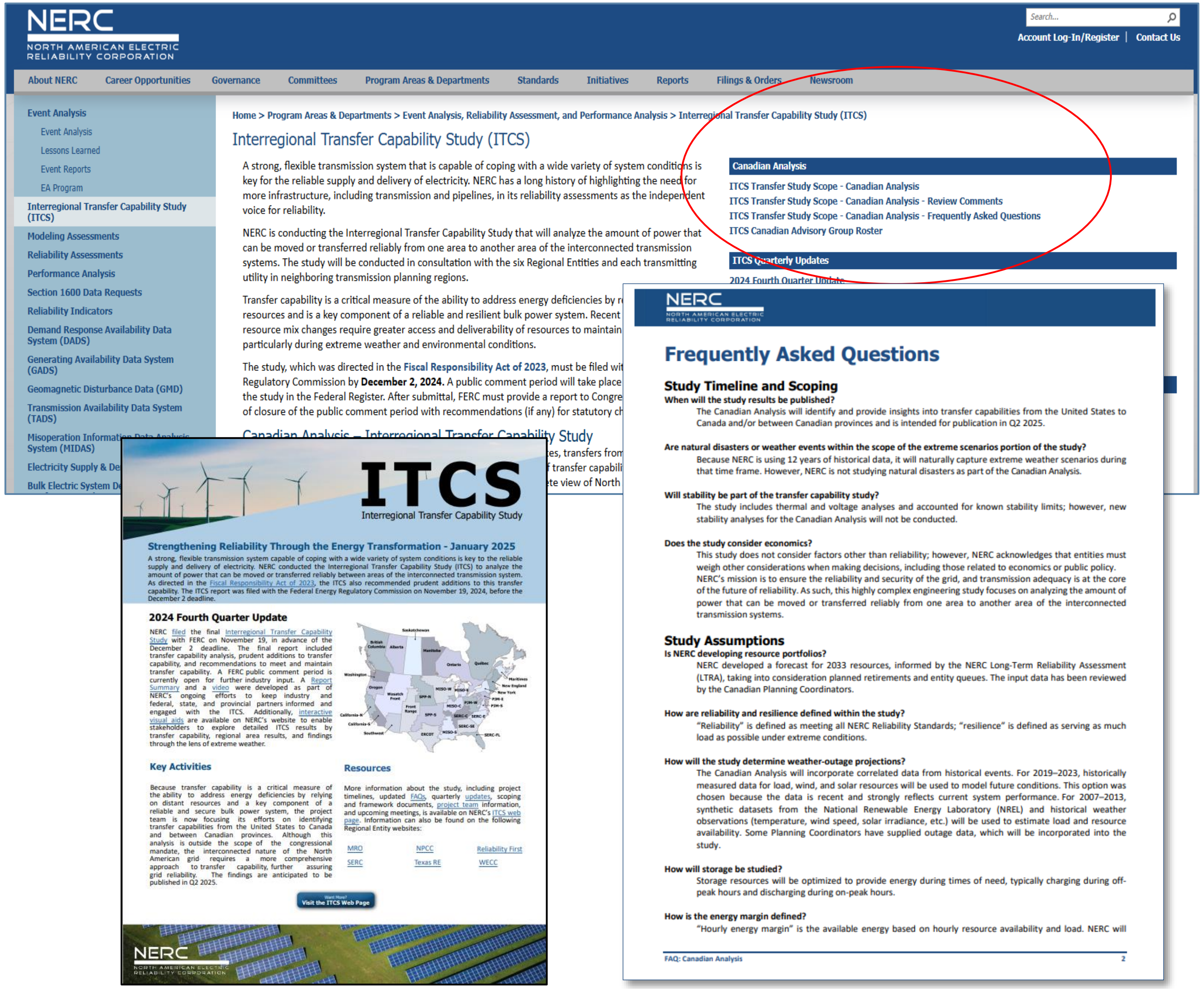


Report Figure 7.2

Resources

Report and Resources Location

- Dedicated webpage (under initiatives)
- Canadian Analysis
- Video
- Graphics
- Report Summary
- Frequently Asked Questions



Interregional Transfer Capability Study (ITCS)

A strong, flexible transmission system that is capable of coping with a wide variety of system conditions is key for the reliable supply and delivery of electricity. NERC has a long history of highlighting the need for more infrastructure, including transmission and pipelines, in its reliability assessments as the independent voice for reliability.

NERC is conducting the Interregional Transfer Capability Study that will analyze the amount of power that can be moved or transferred reliably from one area to another area of the interconnected transmission systems. The study will be conducted in consultation with the six Regional Entities and each transmitting utility in neighboring transmission planning regions.

Transfer capability is a critical measure of the ability to address energy deficiencies by r
resources and is a key component of a reliable and resilient bulk power system. Recent
resource mix changes require greater access and deliverability of resources to maintain
particularly during extreme weather and environmental conditions.

The study, which was directed in the Fiscal Responsibility Act of 2023, must be filed wit
Regulatory Commission by **December 2, 2024.** A public comment period will take place
the study in the Federal Register. After submittal, FERC must provide a report to Congre
of closure of the public comment period with recommendations (if any) for statutory ch

Canadian Analysis – Interregional Transfer Capability Study

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Canadian Analysis

ITCS Transfer Study Scope - Canadian Analysis
ITCS Transfer Study Scope - Canadian Analysis - Review Comments
ITCS Transfer Study Scope - Canadian Analysis - Frequently Asked Questions
ITCS Canadian Advisory Group Roster

ITCS Quarterly Updates

2024 Fourth Quarter Update

Strengthening Reliability Through the Energy Transformation - January 2025

A strong, flexible transmission system capable of coping with a wide variety of system conditions is key to the reliable supply and delivery of electricity. NERC conducted the Interregional Transfer Capability Study (ITCS) to analyze the amount of power that can be moved or transferred reliably between areas of the interconnected transmission system. As directed in the Fiscal Responsibility Act of 2023, the ITCS also recommended prudent additions to this transfer capability. The ITCS report was filed with the Federal Energy Regulatory Commission on November 19, 2024, before the December 2 deadline.

2024 Fourth Quarter Update

NERC filed the final Interregional Transfer Capability Study with FERC on November 19, in advance of the December 2 deadline. The final report included transfer capability analysis, prudent additions to transfer capability, and recommendations to meet and maintain transfer capability. A FERC public comment period is currently open for further industry input. A Report Summary and a video were developed as part of NERC's ongoing efforts to keep industry and federal, state, and provincial partners informed and engaged with the ITCS. Additionally, interactive visual aids are available on NERC's website to enable stakeholders to explore detailed ITCS results by transfer capability, regional area results, and findings through the lens of extreme weather.

Key Activities

Because transfer capability is a critical measure of the ability to address energy deficiencies by relying on distant resources and a key component of a reliable and secure bulk power system, the project team is now focusing its efforts on identifying transfer capabilities from the United States to Canada and between Canadian provinces. Although this analysis is outside the scope of the congressional mandate, the interconnected nature of the North American grid requires a more comprehensive approach to transfer capability, further assuring grid reliability. The findings are anticipated to be published in Q2 2025.

Resources

More information about the study, including project timelines, updated FAQs, quarterly updates, scoping and framework documents, project team information, and upcoming meetings, is available on NERC's ITCS web page. Information can also be found on the following Regional Entity websites:

MRO NPCC Reliability First
SERC Texas RE WECC

Frequently Asked Questions

Study Timeline and Scoping

When will the study results be published?

The Canadian Analysis will identify and provide insights into transfer capabilities from the United States to Canada and/or between Canadian provinces and is intended for publication in Q2 2025.

Are natural disasters or weather events within the scope of the extreme scenarios portion of the study?

Because NERC is using 12 years of historical data, it will naturally capture extreme weather scenarios during that time frame. However, NERC is not studying natural disasters as part of the Canadian Analysis.

Will stability be part of the transfer capability study?

The study includes thermal and voltage analyses and accounted for known stability limits; however, new stability analyses for the Canadian Analysis will not be conducted.

Does the study consider economics?

This study does not consider factors other than reliability; however, NERC acknowledges that entities must weigh other considerations when making decisions, including those related to economics or public policy. NERC's mission is to ensure the reliability and security of the grid, and transmission adequacy is at the core of the future of reliability. As such, this highly complex engineering study focuses on analyzing the amount of power that can be moved or transferred reliably from one area to another area of the interconnected transmission systems.

Study Assumptions

Is NERC developing resource portfolios?

NERC developed a forecast for 2033 resources, informed by the NERC Long-Term Reliability Assessment (LTRA), taking into consideration planned retirements and entity queues. The input data has been reviewed by the Canadian Planning Coordinators.

How are reliability and resilience defined within the study?

"Reliability" is defined as meeting all NERC Reliability Standards; "resilience" is defined as serving as much load as possible under extreme conditions.

How will the study determine weather-outage projections?

The Canadian Analysis will incorporate correlated data from historical events. For 2019–2023, historically measured data for load, wind, and solar resources will be used to model future conditions. This option was chosen because the data is recent and strongly reflects current system performance. For 2007–2013, synthetic datasets from the National Renewable Energy Laboratory (NREL) and historical weather observations (temperature, wind speed, solar irradiance, etc.) will be used to estimate load and resource availability. Some Planning Coordinators have supplied outage data, which will be incorporated into the study.

How will storage be studied?

Storage resources will be optimized to provide energy during times of need, typically charging during off-peak hours and discharging during on-peak hours.

How is the energy margin defined?

"Hourly energy margin" is the available energy based on hourly resource availability and load. NERC will

FAQ: Canadian Analysis 2

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Questions and Answers