NERC
NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

Interregional Transfer Capability Study (ITCS)

Strengthening Reliability Through the Energy Transformation

Overview of Study Need and Approach
June 2024

RELIABILITY | RESILIENCE | SECURITY




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Preface

Electricity is a key component of the fabric of modern society and the Electric Reliability Organization (ERO) Enterprise serves to strengthen that fabric. The vision for the ERO Enterprise, which is comprised of NERC and the six Regional Entities, is a highly reliable, resilient, and secure North American bulk power system (BPS). Our mission is to assure the effective and efficient reduction of risks to the reliability and security of the grid.

Reliability | Resilience | Security
Because nearly 400 million citizens in North America are counting on us

The North American BPS is made up of six Regional Entities as shown on the map and in the corresponding table below. The multicolored area denotes overlap as some load-serving entities participate in one Regional Entity while associated Transmission Owners/Operators participate in another.

MRO	Midwest Reliability Organization
NPCC	Northeast Power Coordinating Council
RF	ReliabilityFirst
SERC	SERC Reliability Corporation
Texas RE	Texas Reliability Entity
WECC	WECC

Statement of Purpose

Congress ordered an Interregional Transfer Capability Study (ITCS) to help inform the potential need for more electric transmission between regions for reliability. Signed into law in June 2023, section 322 of the Fiscal Responsibility Act of 2023[1] directs NERC, as the ERO under section 215 of the Federal Power Act[2] to conduct the ITCS:

> *The Electric Reliability Organization…in consultation with each regional entity…and each transmitting utility (as that term is defined in section 3(23) of such Act) that has facilities interconnected with a transmitting utility in a neighboring transmission planning region, shall conduct a study of total transfer capability as defined in section 37.6(b)(1)(vi) of title 18, Code of Federal Regulations, between transmission planning regions that contains the following:*
>
> *(1) Current total transfer capability, between each pair of neighboring transmission planning regions.*
> *(2) A recommendation of prudent additions to total transfer capability between each pair of neighboring transmission planning regions that would demonstrably strengthen reliability within and among such neighboring transmission planning regions.*
> *(3) Recommendations to meet and maintain total transfer capability together with such recommended prudent additions to total transfer capability between each pair of neighboring transmission planning regions.*

This congressional directive falls within the scope of NERC's obligation under section 215 to "conduct periodic assessments of the reliability and adequacy of the bulk power system in North America."[3] NERC and the six Regional Entities,[4] collectively called the ERO Enterprise, developed the ITCS Framework in collaboration with industry to address the congressional directive. The study must be filed with the Federal Energy Regulatory Commission (FERC) by December 2, 2024,[5] with a FERC public comment period to follow. This document describes the purpose, background, development process, and key objectives of the ITCS.

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[1] H.R.3746 - 118th Congress (2023–2024): Fiscal Responsibility Act of 2023 | Congress.gov | Library of Congress

[2] 16 U.S.C. § 824o [hereafter section 215]

[3] Section 215(g). Such reliability assessments include the Long-Term Reliability Assessment ("LTRA"), Summer Assessment, Winter Assessment, and special assessments.

[4] NERC's work with the Regional Entities is governed by Regional Delegation Agreements ("RDA") on file with FERC and posted on NERC's website. See also section 215(e)(4).

[5] See Fiscal Responsibility Act (adding that, "Not later than 12 months after the end of the public comment period in subsection (b), the Federal Energy Regulatory Commission shall submit a report on its conclusions to Congress and include recommendations, if any, for statutory changes.").

Executive Summary

The grid is a complex machine that integrates a network of generation, transmission, and distribution systems across vast geographic areas. Its resilience and adaptability are essential as it must withstand a broad array of challenges including changing resource mix,[6] various federal and state policy goals, changing consumer demand behaviors, and extreme weather events.

A strong, flexible, and resilient transmission system is key for the reliable supply and delivery of electricity. Transmission adequacy is a core element for reliability. NERC assessments[7] have demonstrated the need for more transmission to support energy transformation and the increased reliance on electrification, including for transportation, industrial loads, and data centers. At the same time, extreme weather events have become a more regular occurrence. While always important, the need for reliable power becomes most pronounced under these extreme conditions in which the grid's resilience is put to the ultimate test, with the potential to have catastrophic impacts on society, including jeopardizing security and public safety. With all this in mind, reliability requires complex system operations and planning that must be managed appropriately, beginning with adequate planning for anticipated future system conditions.

Challenges to transmission adequacy will continue to grow if not addressed in a timely, thoughtful, and fact-driven manner. As industry transforms, the ERO Enterprise must also transform how it studies and addresses these new and emerging issues. Transmission assessments, like the ITCS, are crucial to managing the future reliability risks to the North American grid.[8] With technical expertise and statutory responsibility to conduct technical assessments of the grid, NERC is uniquely positioned to conduct this highly complex analysis.

As the ERO, NERC remains focused on assuring reliability through the energy transformation, maintaining energy-demand balance at all times while minimizing reliance upon operator-directed load shed.[9] Recent operational events on the BPS show that more needs to be done to support energy adequacy to continuously meet customer demand. Therefore, ensuring sufficient transfer capability of the transmission system to support energy adequacy is the reliability gap that the ITCS seeks to address.

Concepts of **BPS Reliability**:

- **Energy Adequacy** is the ability of the BPS to meet customer demand at all times.
- **Operating Reliability** is the ability of the BPS to withstand sudden disruptions.

The congressional mandate[10] requires NERC to conduct a comprehensive study of existing and future interregional transfer capability between each Transmission Planning Region,[11] make recommendations for prudent additions to the amount of power that can be moved or transferred between neighboring Transmission Planning Regions,[12] and make recommendations on how to meet and maintain transfer capability — to be filed with FERC for public comment and consideration by December 2, 2024.

While an essential component of reliability is ensuring that a planned resource portfolio can deliver an adequate amount of energy at all hours of the year, the interconnected nature of the North American grid often results in

[6] This phrase relates to the replacement of traditional dispatchable resources with a higher percentage of intermittent resources with non-stored fuel sources, such as wind and solar resources.

[7] NERC Reliability Assessments can be found at Reliability Assessments (nerc.com).

[8] The ITCS scope only considers transmission solutions to identified reliability needs per the Congressional mandate, but the team notes that other solutions, such as local resource additions and/or demand response may also address the need.

[9] However, consistent with the limitation in section 215(i)(2), NERC does not seek to order the construction of additional generation or transmission capacity or to set and enforce compliance with standards for adequacy or safety of electric facilities or services.

[10] H.R.3746 - 118th Congress (2023-2024): Fiscal Responsibility Act of 2023 | Congress.gov | Library of Congress

[11] For the purposes of the ITCS, this term refers to the study regions that are described in **Chapter 2** and shown in **Figure 2.2**.

[12] While the congressional mandate applies to the U.S. systems, any analysis of these systems would be incomplete without a thorough understanding of the Canadian system limits and available resources.

various planning regions importing and/or exporting energy with neighboring regions. The ability of the BPS to reliably support these energy transfers is essential during both normal and extreme conditions.

The ITCS will examine the extent of total transfer capability, any prudent recommendations for additional transfer capability to strengthen reliability, and how to meet and maintain such capability as enhanced by any additions. The ITCS is purely focused on reliability and will not include economic justification for new and/or upgraded transmission facilities.

While still in early development stage, preliminary risks identified so far are in line with those detailed in NERC's publicly posted assessments:

- Several regions are at risk of experiencing energy deficiencies due to extreme weather events,
- Under extreme conditions, impacted regions are heavily dependent on transfers from their neighbors, and
- While some regions have additional energy available to support their neighbors, the ability to transfer that energy is at times limited by transfer capability.
- Heavy load growth and/or accelerated retirement scenarios, without mitigation, will further contribute to energy adequacy risks, increasing reliance on transfers.

To keep industry and stakeholders informed throughout the ITCS process, NERC maintains up-to-date information on the ITCS web page and conducts regular project meetings. NERC also formed an Advisory Group[13] with stakeholders that include transmitting utilities across North America. Through these concerted efforts, NERC engages and consults with stakeholders in gathering inputs, assumptions, and scenarios to produce a comprehensive, inclusive study.

To provide further opportunities for stakeholder engagement and consultation, the project is being divided into four documents. This first document, *Overview of Study Need and Approach,* provides background and context regarding transfer capability calculations and the approach for recommending prudent additions, laying the foundation for the ITCS as a whole and its associated methodologies.[14] The three additional documents will include:

- **Transfer Capability Analysis (Part 1):** Description of the total transfer capability between neighboring Transmission Planning Regions (publication in August).
- **Prudent Additions (Part 2) and Recommendations (Part 3):** Identification of "prudent additions" to transfer capability between neighboring areas and the recommendations to meet and maintain transfer capability (publication in November).
- **Canadian Analysis:** A study of transfer capabilities from the United States to Canada and between Canadian provinces. While this part is outside the specific congressional mandate, the interconnectedness of the North American BPS warrants analysis of Canada (publication in Q1 2025).

[13] ITCS_Advisory_Group_Scope.pdf (nerc.com)

[14] See https://www.nerc.com/pa/Stand/Glossary%20of%20Terms/Glossary_of_Terms.pdf for capitalized terms not defined in this report.

Chapter 1: Transfer Capability and Reliability

Recent Extreme Weather Events Show Reliance on Neighbors

Analyses of extreme weather events, such as Winter Storms Uri and Elliott and the heatwave experienced in the Western Interconnection in 2020, as summarized below, have reinforced the critical need for neighboring systems to provide energy exchanges to one another to minimize reliability impacts. During these events, transfer capability, or the lack thereof, had a direct impact on the magnitude and duration of firm load shed. These recent extreme weather events have highlighted the importance of the interregional transmission network in improving reliability by transferring surplus energy from one region to a region experiencing energy shortfalls. In short, these events underscore the types of challenging scenarios that system operators must be equipped to overcome:

- **Winter Storm Uri** impacted the BPS in the Electric Reliability Council of Texas (ERCOT) and Eastern Interconnections during February 8–20, 2021. As noted in the associated report,[15] extreme cold temperatures, freezing precipitation, and generator outages led the ERCOT operators to order firm load shed for nearly three consecutive days, peaking at 20,000 MW on February 15.[16] The Southwest Power Pool (SPP) and Midcontinent Independent System Operator (MISO) also declared transmission emergencies and shed firm load in lower quantities and for shorter durations. Firm load shed during this event was directly related to the transfer capability from regions with surplus energy into the regions with energy shortfalls, as eastern areas of the continent were not experiencing extreme conditions and had surplus energy to provide.
- **Winter Storm Elliott** impacted the BPS in the Eastern Interconnection from December 21–26, 2022. As noted in the associated report,[17] several Balancing Authorities in the Southeast United States shed firm load during the event to maintain reliability. This firm load shed in total (at different points in time) exceeded 5,400 MW, the largest controlled firm load shed recorded in the history of the Eastern Interconnection. Even though interregional transfers were limited by availability of resources in neighboring areas, power transfers from Florida, New York, and the Midwest into the most heavily affected areas almost certainly reduced the amount and duration of firm load shed that would otherwise have been required.
- The **Western Interconnection Heatwave**, from August 14–19, 2020, affected many areas across the Western Interconnection as noted in the associated report.[18] Several Balancing Authorities declared energy emergencies and the California Independent System Operator (CAISO) shed more than 1,000 MW of firm load. In addition to the primary cause of extreme and widespread heat, this report notes two secondary causes related to interregional transfer capability limitations.

Setting the Stage for Transfer Capability Analysis

Recognizing the transforming grid and the reliability impacts of the extreme events summarized above, the Department of Energy (DOE) and FERC have examined transfer capability, each considering a variety of factors. DOE released the *National Transmission Needs Study* (October 2023) as part of its triennial State of the Grid report, which is required by Congress at least every three years to assess national electric transmission capacity constraints and congestion.[19] This DOE study assessed current and near-term transmission needs through 2040 across 13 regions.

In 2022, FERC also initiated a proceeding regarding interregional transfer capability transmission planning and cost allocation, and hosted a staff-led workshop on December 5–6, 2022. The workshop considered whether a minimum

[15] The February 2021 Cold Weather Outages in Texas and the South Central United States | FERC, NERC and Regional Entity Staff Report | Federal Energy Regulatory Commission
[16] Ibid.
[17] Winter Storm Elliott Report: Inquiry into Bulk-Power System Operations During December 2022 | Federal Energy Regulatory Commission (ferc.gov)
[18] August 2020 Heatwave Event Report.pdf (wecc.org)
[19] https://www.energy.gov/gdo/national-transmission-needs-study

requirement for interregional transfer capability should be established and, if so, how to identify the right levels of transfer capability.

Some panelists spoke in favor of a minimum interregional transfer capability requirement for each planning region, such as a percentage of peak load, noting benefits of new transmission beyond pure reliability benefits. Other panelists encouraged a more deliberate approach that would study the needs of each area rather than a one-size-fits-all requirement. The ITCS team took this latter approach to ensure reasonableness of any recommendations, recognizing that a simple percentage requirement may not produce desired outcomes across all Transmission Planning Regions. For instance, some of the considerations lost in the former approach include ignoring dynamic transmission use patterns, varying resource mixes, regional network topology, size of the largest contingency, and periods of stress that do not always correlate to peak demand.

Recently, FERC issued Order No. 1920 “Building for the Future Through Electric Regional Transmission Planning and Cost Allocation” to revise the *pro forma* Open Access Transmission Tariff.[20] In particular, FERC revised tariff requirements pertaining to regional and local transmission planning and cost allocation, including requiring long-term regional transmission planning as well as other reforms to improve the coordination of regional transmission planning and generator interconnection processes. NERC filed comments supporting FERC’s examination of transmission planning under the changing resource mix and stated, “Transmission will be the key to support the resource transformation enabling delivery of energy from areas that have surplus energy to areas which are deficient. The frequency of such occurrences are increasing as extreme weather conditions resulting from climate change impact the fuel sources for variable energy resources. Regional transmission planning can ensure that sufficient amounts of transmission capacity will be needed to address these more frequent extreme weather conditions.”[21]

Both the DOE and FERC analyses were considered when developing the ITCS Framework; however, the ITCS will focus on two key concepts when evaluating BPS reliability: energy adequacy and operating reliability, both of which are related to transfer capability. This is consistent with NERC’s approach to develop Reliability Standards to ensure an Adequate Level of Reliability (ALR).[22]

Since transfer capability is the amount of power that can be reliably transported over a given interface under specific conditions, planning engineers must model elements on the system, simulate how power flow will impact the transmission system, and perform a series of reliability tests. These studies provide assurance that the system is stable and within predefined ranges. As stated in NERC’s 2013 ALR filing, “[a] target to achieve adequate Transmission transfer capability and resource capability to meet forecast demand is an inherent, fundamental objective for planning, designing, and operating the BES [Bulk Electric System].”[23]

Each Interconnection consists of a network of transmission lines for redundancy, avoiding reliance on a single path. Electricity transfers flow over parallel paths, introducing a variety of operating constraints. Consequently, studies such as the ITCS must be performed to ensure that transfers will not jeopardize the reliability of an Interconnection. Additional details regarding the ITCS evaluation of transfer capability can be found in **Chapter 3**.

Finally, recommendations to increase transfer capability, as discussed further in **Chapter 3**, may go beyond what is required to meet current Reliability Standards, but would be what the study finds are prudent to strengthen reliability. These levels will be used in the future to determine areas of risk while performing NERC reliability

[20] Building for the Future Through Electric Regional Transmission Planning and Cost Allocation, Order No. 1920, 187 FERC ¶ 61,068 (2024), at https://ferc.gov/media/e1-rm21-17-000.

[21] NERC Comments, Docket No. RM21-17-000; also Order No. 1920, at page 94 (discussing comments such as NERC’s pertaining to transmission under the changing resource mix); and ibid., at page 586 (referencing NERC comments on potential studies pertaining to transmission)

[22] For more information regarding ALR, see the informational filing on the Definition of “Adequate Level of Reliability” (filed May 10, 2013), at https://www.nerc.com/pa/Stand/Resources/Documents/Adequate_Level_of_Reliability_Definition_(Informational_Filing).pdf.

[23] Ibid. at Exhibit A, page 3

assessments, as the overall system reliability and resilience will be challenged during a number of scenarios with uncertain resource availability. Additional transmission studies will be needed over time once specific projects or other actions are identified to address these recommended increases to transfer capability.

Chapter 2: ITCS Strategy

The purpose of this study is to perform a U.S.- and Canada-wide assessment of the reliable transfer capability of electricity between neighboring Transmission Planning Regions. While the congressional mandate[24] applies to the United States, any analysis would be incomplete without a thorough understanding of the Canadian limits and available resources. The Western Interconnection includes the Canadian provinces of Alberta and British Columbia. Similarly, the Eastern Interconnection contains numerous transmission lines between the United States and Manitoba, New Brunswick, Ontario, and Saskatchewan, plus direct current (dc) connections with Québec.

The ITCS is the first comprehensive study of transfer capabilities between adjacent Transmission Planning Regions, including neighboring Interconnections, making it unique. Further, the study will use 12 years of data, capturing a wide variety of operating conditions and historical weather events to perform the future-looking energy assessment to determine potentially deficient areas. It is also unprecedented in scope, as it will use internally consistent assumptions and modeling approaches for all neighboring interfaces and regions across interconnected North America. This broad view is key in evaluating the support that may be available to an area or areas during anticipated or extreme conditions and considers how this available support may be restricted by transfer capability limitations, thus unavailable to assist in meeting reliability needs. Ultimately, the goal is to incorporate this analysis into future long-term reliability assessments to provide a more comprehensive picture of each region's reliability risks.

Within this strategic context, the key objectives of the ITCS are the following:

- Conduct a comprehensive, repeatable study of existing interregional transfer capability across the contiguous United States and Canada (between each Transmission Planning Region, as defined further below) to assess currently available transfer capability (Part 1) and the future need for additional transfer capacity to ensure reliability under various system conditions, including extreme weather.
- Provide analysis-driven recommendations for additions to the amount of energy that can be transferred between neighboring Transmission Planning Regions (Part 2).
- Recommend approaches to achieve and maintain an adequate level of transfer capability (Part 3).
- Actively engage stakeholders and gather inputs, assumptions, and conditions from Regional Entities, industry, and the Advisory Group to ensure a comprehensive and inclusive study.
- Identify expectations for next steps and continuing analysis of transfer capability to reinforce future NERC *Long-Term Reliability Assessments*, including future trends.

[24] H.R.3746 - 118th Congress (2023-2024): Fiscal Responsibility Act of 2023 | Congress.gov | Library of Congress

Stakeholder Participation

The Fiscal Responsibility Act of 2023 required that NERC, working with the full ERO Enterprise in the performance of the ITCS, consult with each transmitting utility that has facilities interconnected with another transmitting utility in a neighboring Transmission Planning Region. The Federal Power Act defines a transmitting utility as follows:

> *The term ''transmitting utility'' means an entity (including an entity described in section 201(f)) that owns, operates, or controls facilities used for the transmission of electric energy—*
>
> *(A) in interstate commerce*
>
> *(B) for the sale of electric energy at wholesale*

Even though a subset of utilities classified as transmitting utilities were required to be consulted, NERC has adopted a broader approach to consult with and inform all stakeholders, such as Transmission Planners, Planning Coordinators, Transmission Operators, Transmission Owners, state/provincial/federal regulators, and industry trade groups. Due to the sheer size and number of stakeholders involved, as shown in **Figure 2.1**, a comprehensive stakeholder management plan was developed to keep each stakeholder informed and engaged.

Figure 2.1: ITCS Stakeholder Engagement

In particular, an ITCS Advisory Group was assembled with functional and geographic diversity to gather input and ensure a comprehensive study. Participants represent stakeholders including FERC, DOE, National Resources Canada, the Electric Power Research Institute (EPRI), Independent System Operators, and a variety of utilities.[25] The monthly meetings are open with meeting schedules and materials posted publicly. The ITCS Advisory Group's role is to provide input to the ERO Enterprise regarding ITCS design, execution, and recommendations.[26] This group provides insights, expertise, and inputs to the study approach, scope, and results.

In addition, an ITCS letter was broadly distributed to the industry on February 9, 2024, to provide direct outreach to all transmitting utilities, with additional communication planned in the third quarter as preliminary study results become available. Each Regional Entity also works closely with Planning Coordinators and other industry technical groups in their respective regions.

Throughout the ITCS process, NERC continues to review stakeholder comments and adjust where appropriate. Outreach and consulting will continue as the study progresses and preliminary results become available.

Transmission Planning Regions

The Transmission Planning Regions used for this study are shown in **Figure 2.2**. In some cases, traditional planning areas defined in FERC's Order No. 1000[27] have been subdivided to provide more granular analysis of transfer capability limitations, especially under specific weather scenarios. For example, SPP has an expansive geographic footprint stretching from the border of Saskatchewan into parts of Texas. Weather and other operating conditions vary widely over this extended region. Further, construction practices can vary by region based on expected temperatures, as noted in the Winter Storm Uri report. Significant transmission constraints exist within these larger planning areas, and it is important for the ITCS to reflect such limitations to interregional transfer capability. Additionally, this more granular approach allows recommendations at more precise locations. At the same time, the studied areas were large enough to analyze interregional reliability issues and avoid too granular of an analysis of local reliability issues.

Transfer capabilities will be calculated for each pair of adjacent Transmission Planning Regions in the United States, which will be included in the Part 1 report. Transfer capabilities into or between Canadian provinces will be published in the Canadian Analysis. In Part 2 of the study, the team will investigate the potential reliability value of new connections between geographically neighboring Transmission Planning Regions, even if no transmission currently exists. However, no new interfaces will be studied between non-neighboring regions.

[25] A full roster is posted at ITCS_Advisory_Group_Roster.pdf (nerc.com).
[26] ITCS_Advisory_Group_Scope.pdf (nerc.com)
[27] More information can be found on FERC's website at www.ferc.gov.

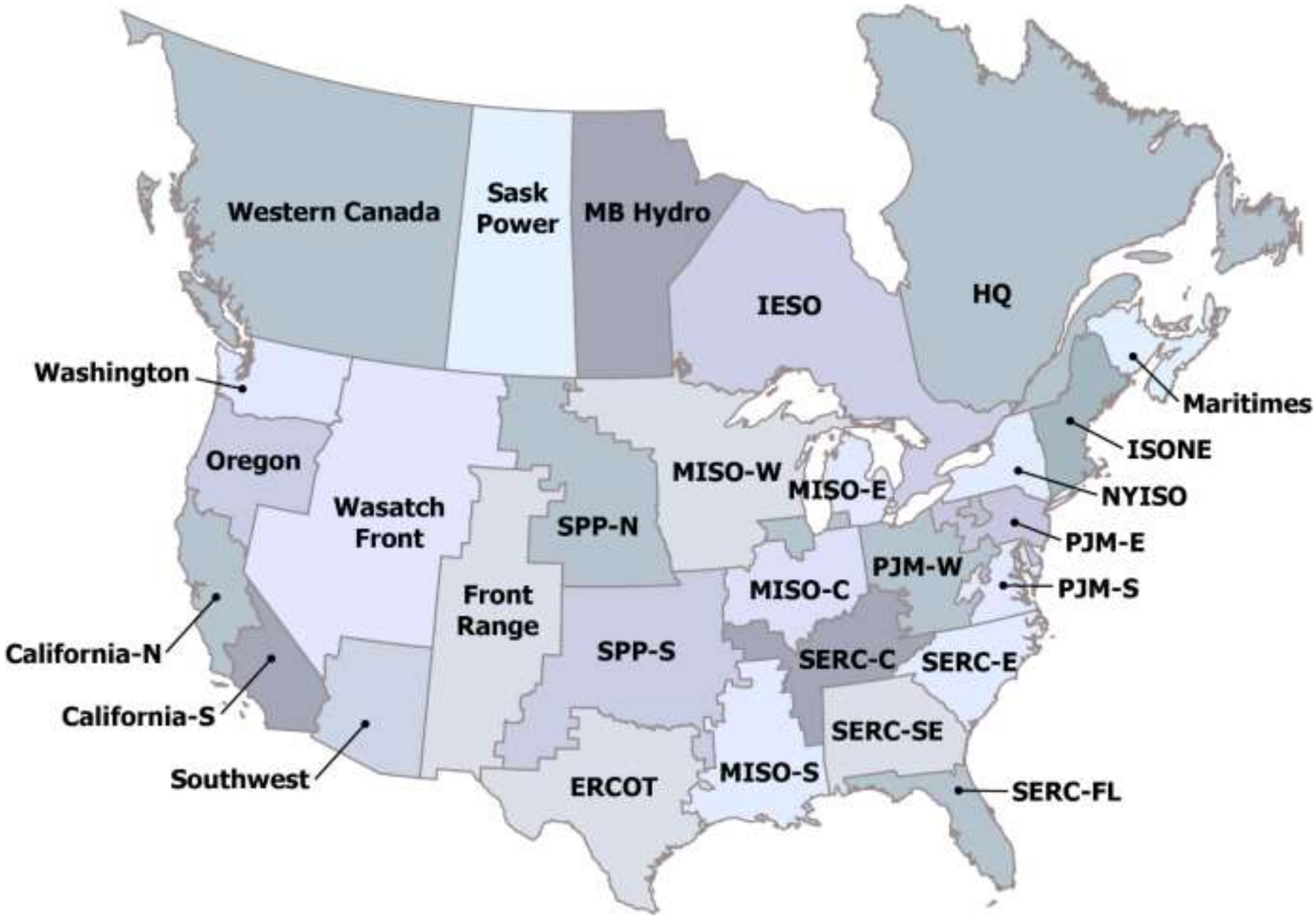

Figure 2.2: Transmission Planning Regions

Important Study Considerations

The ITCS is bound to specific requirements outlined in the Fiscal Responsibility Act, as well as to the scope and obligations of the ERO. Within that context, NERC and the Regional Entities do not plan the BPS.

While the ITCS uses engineering study approaches deployed within industry planning processes, it is not a planning study. Although reliability, in the form of energy adequacy and operating reliability, is an important component in planning, it is the sole focus of the ITCS. More broadly, planning studies ensure that electricity is generated, transmitted, and distributed in a cost-effective, reliable, and sustainable manner, while meeting environmental and regulatory requirements. Planning studies also often involve significant stakeholder input including the analysis of various factors such as population growth, economic development, energy policies, technological advancements, environmental concerns, and regulatory requirements, all to develop a robust plan for the expansion, modification, or improvement of the electrical infrastructure.

Similarly, this reliability-focused study will not provide economic justification for new and/or upgraded transmission facilities. Rather, the study seeks to identify increases in transfer capability that can improve reliability during extreme conditions. NERC recognizes that additional transmission has more quantifiable benefits than purely the reliability benefits referenced in this study. For example, these benefits may include factors such as cost savings between regions by providing access to lower-cost sources of generation, voltage support, blackstart, and policy goal implementation. Nothing in the study is intended to preclude stakeholders and governmental authorities at federal, state, and local levels from evaluating those additional considerations.

Additionally, the Fiscal Responsibility Act specifically requires that prudent additions to transfer capability be recommended. Local solutions, such as additional resources in an energy-deficient area, are not considered in the ITCS. This study also does not recommend any particular transmission or generation projects, which may take the form of, but are not limited to, new ac or dc transmission facilities, upgrades to enable higher ratings, grid-enhancing technologies,[28] or a combination thereof.

The ITCS aims to consider a representative range of scenarios to ensure robust study results. Time permitting, sensitivity analysis will also be performed to programmatically explore underlying risks, such as an accelerated set of generation retirements or higher than expected demand growth. However, the ITCS is not an exhaustive study of all transmission limitations that may occur during real-time operations or under simultaneous transfers across multiple Transmission Planning Regions.

Furthermore, due to the unprecedented scope of this study, efforts were limited in Part 1 to steady-state power flow analysis using P-0 (no contingency) and P-1 (single contingency) scenarios as defined in NERC Reliability Standard TPL-001-5.1.[29] This approach is consistent with many other similar studies and is reasonable to meet the ITCS study needs and timeframe. In addition to the contingency analysis, a voltage screening is performed for each transfer at the valid limit found. This screening for voltage violations is performed using category P-1 contingencies. Notably, the team is not completing short-circuit or stability analysis (i.e., voltage, transient, frequency); however, known stability limits are included. These limitations can be more restrictive than the results presented, which focus primarily on thermal and voltage limits. Further analysis is recommended in the future to determine appropriate solutions after a more comprehensive analysis is performed.

Similarly, in Part 2, a deterministic energy assessment of challenging weather conditions was chosen, rather than a probabilistic resource adequacy assessment. This industry-supported approach enables holistic evaluation of the impacts of actual extreme weather events.

This study does not satisfy any registered entity's obligation to perform studies under approved Reliability Standards. This report also does not attempt to determine load or generator deliverability, available transfer capability (ATC), available flowgate capacity (AFC), the availability of transmission service, or to provide a forecast of anticipated dispatch patterns.

Finally, the ITCS represents a point-in-time analysis using the best available time-synchronized data. Changes to future resource additions, resource retirements, and/or transmission expansion plans have the potential to significantly alter the study results. As such, the study team recommends performing this study, documented in NERC's future LTRA reports, on a periodic basis to identify trends.

[28] This term references advanced technologies that include dynamic line ratings, power-flow control devices, and analytical tools.
[29] TPL-001-5 (nerc.com)

Chapter 3: ITCS Technical Approach

Study Data

NERC worked closely with the Regional Entities and industry to collect necessary data and information. For Part 1 (Transfer Analysis), base cases developed under existing processes were used for the Eastern and Western Interconnections.[30] For Parts 2 and 3 (Prudent Additions and Recommendations), publicly available Energy Information Administration data supplemented by data from NERC's *Long-Term Reliability Assessment* processes and the National Renewable Energy Laboratory were used along with data requests to select Canadian entities.

NERC issued data requests in November 2023 to all Planning Coordinators in the Eastern and Western Interconnections to provide base case updates. These case updates were to include new generation, planned retirements, load forecast updates, anticipated dispatch, rating updates, long-term facility outages, and topology updates. Additional detail was provided in the data requests, and contacts were provided for each Regional Entity.

NERC sent an additional data request to Canadian Planning Coordinators in January 2024 to collect hourly generation and import data for Parts 2 and 3 of the study. This data covers the period 2019 through 2023.

Study Scope

As shown in **Figure 3.1**, the ITCS work is divided into four parts.[31]

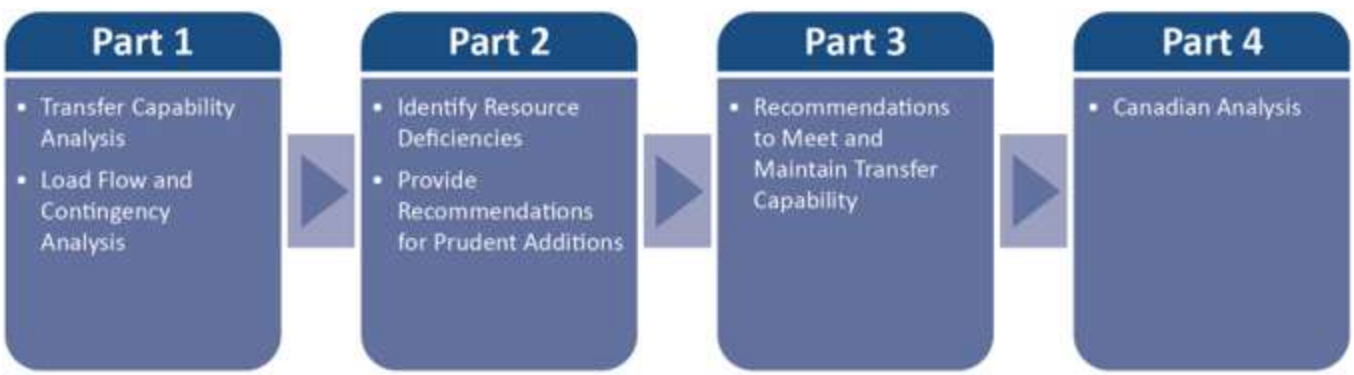

Figure 3.1: Study Parts

Part 1 consists of transfer capability analysis for 2024 (summer and winter) and 2033 (summer and winter). This transfer capability analysis will produce a set of transfer capability limits between each neighboring planning region, which will be used in Part 2 to help determine transfer capability additions that would be prudent to strengthen reliability of areas that are energy deficient under the studied conditions.

As shown in **Figure 3.2**, the Part 1 results are a critical input into Part 2, which will identify regions that are deficient under the study scenarios, including extreme weather events. Regions with an energy deficiency will first be evaluated to determine if there is sufficient transfer capability to cover the deficiency, then prudent additions to transfer capability will be recommended. Part 3 will identify actions needed by policy makers, industry leaders, and NERC to maintain transfer capability. NERC will combine Parts 2 and 3 into one document.

[30] No cases were developed for the ERCOT or Québec Interconnections as these are only connected via dc ties.
[31] For more information on ITCS scope, please see Interregional Transfer Capability Study (ITCS) (nerc.com).

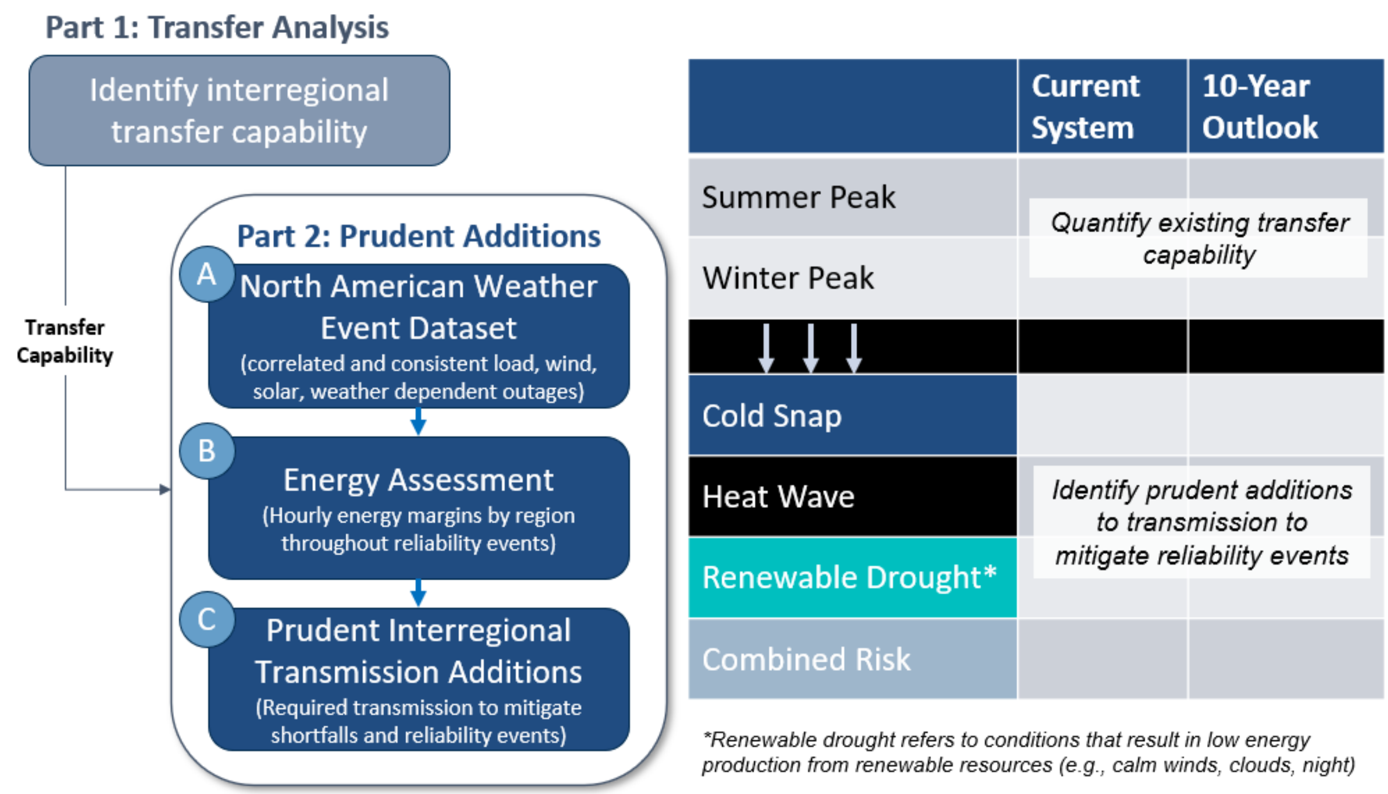

Figure 3.2: Additional Part 2 Details

The Part 2 analysis will represent the transfer capability between electrically neighboring Transmission Planning Regions. The model will also investigate the potential reliability value of new connections between geographically neighboring Transmission Planning Regions. The interfaces to be used in Part 2 are shown below in **Figure 3.33**.

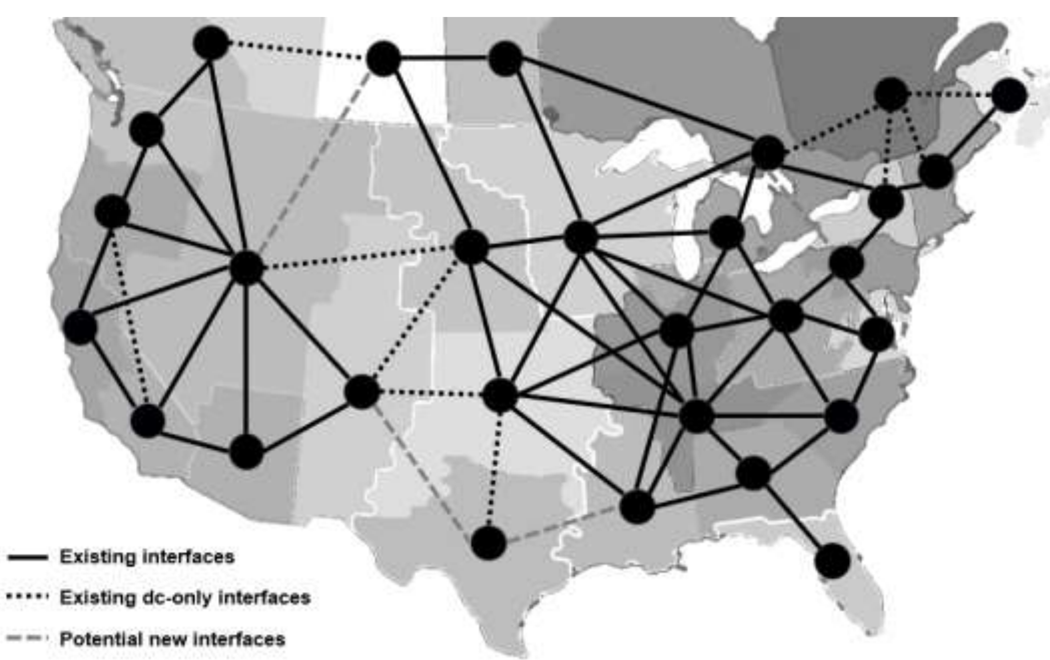

Figure 3.3: Part 2 Study Interfaces

Total Transfer Capability (Part 1)

Transfer capability is the measure of the ability of interconnected electric systems to reliably move or transfer electric power from one area to another area by way of all transmission lines (or paths) between those areas under specific system conditions. The units of transfer capability are in terms of electric power, generally expressed in MW. In this context, area refers to the configuration of generating stations, switching stations, substations, and connecting transmission lines that may define an individual electric system, power pool, control area, subregion, or region, or a portion thereof.[32]

However, while the transfer capability is a measured amount in MW, it does not have a one-to-one correspondence with what new transmission facility (or facilities) should be added. For example, to increase transfer capability by 200 MW between two areas, the areas may evaluate and find that a single new line with a rating of 200 MW would not be the sole change to the network and a combination of facilities near the border may need to be added or improved to support the increase in energy transfers between areas. Determining a solution is complex and may involve additions or modifications to multiple transmission facilities, while taking into account the other planning considerations mentioned previously.

In both the planning and operation of electric systems, transfer capability is one of several performance measures used to assess the reliability of the interconnected transmission systems and has been used as such for many years. System planners use transfer capability as a measure or indicator of transmission strength in assessing interconnected transmission system performance. It is often used to compare and evaluate alternative transmission system configurations. System operators use transfer capability to evaluate the real-time ability of the interconnected transmission system to transfer electric power from one portion of the network to another or between control areas. In the operation of interconnected systems, “transfer” is synonymous with “interchange.”[33]

The intent of a transfer capability calculation is to determine a transfer value with the following general characteristics:

- Represents a realistic operating condition or expected future operating condition
- Conforms with the requirements of the transfer capability definitions
- Typically considers single contingency facility outages that result in conditions most restrictive to electric power transfers[34]

Transfer capability is calculated using computer network simulation software to represent anticipated system operating conditions. Each such simulation reflects a snapshot of one specific combination of system conditions. Transfers between two areas are determined by increasing transfers from a normal base transfer level until a system limit is reached.[35]

The ITCS calculates total transfer capability (TTC) by determining the amount of additional energy transfers that can be added to base transfers already modeled while respecting contingency limits. Reliable operation insists that the grid must be operated to withstand the worst single contingency while remaining within system operating limits, noting that the most severe single contingency may be in a neighboring area. As noted above, category P-1 single contingencies were used in this study, as defined in NERC Reliability Standard TPL-001-5.1.[36]

[32] NERC Transmission Transfer Capability Whitepaper, 1995, at Transmission Transfer Capability May 1995.pdf (nerc.com)
[33] Ibid.
[34] Ibid.
[35] Ibid.
[36] TPL-001-5 (nerc.com)

TTC is the total amount of power that can be transferred between two areas. TTC is made up of two parts:

- Base Transfer Level (BTL): Typically, scheduled power flows between areas in the starting case. These are usually referred to as base flows.
- First Contingency Incremental Transfer Capability (FCITC): FCITC simulates an incremental transfer between areas under a single contingency until a system limitation is reached. In other words, it is the amount of extra power that can be transferred during an unexpected event.

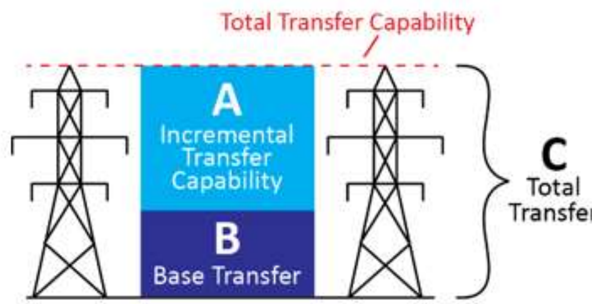

Figure 3.4: Total Transfer Capability

In simple terms, TTC = BTL + FCITC, as shown in **Figure 3.4**.

Prudent Additions to Strengthen Reliability (Part 2)

The Fiscal Responsibility Act of 2023 requires a recommendation of technically prudent additions to transfer capability between neighboring Transmission Planning Regions that would demonstrably strengthen reliability. Reliability is a broad concept, and significant aspects of required reliability are defined by NERC Reliability Standards and continually implemented through entities' planning, investment, and compliance processes. The ITCS examines transfer capabilities between adjacent regions under a variety of weather scenarios and operating conditions that reflect potential extreme conditions, such as those observed during recent events. For this reason, the ITCS goes beyond existing reliability studies and is an avenue to improve the delivery of energy under extreme conditions. In fact, when NERC assesses system reliability, it often reviews capacity and energy scenarios to identify system risk. This is a foundational activity at NERC, as a part of its mandate as the ERO, to assess risks to the BPS in the coming seasons and years.

Determining exactly how much additional transfer capability is "prudent" can depend on the totality of factors and circumstances. FERC precedent reflects that prudence means a determination of whether a reasonable entity would have made the same decision in good faith under the same circumstances and at the relevant point in time. FERC has considered prudence in the context of specific, fact-based scenarios involving rates. For example, as part of examining the totality of circumstances, FERC has considered matters such as whether activities have enhanced the ability to restore service, achieved significant efficiencies, reduced costs or time delays, and/or made efficient use of resources to ensure reliability.[37]

The ITCS seeks to determine whether there are reasonable additions to transfer capability that would be expected to demonstrably improve reliability. This is not intended to preclude entities from considering other factors, such as cost allocation or economic advantages.

To determine prudent additions to transfer capability and maintain focus on strengthening reliability, NERC, working with the ERO Enterprise, developed an approach so that consistent, objective, reasonable criteria could be applied for all areas. This approach involved the following:

- **Determining conditions under which each area might potentially experience energy deficiencies.** This depends on the resource portfolio of each area and the specific conditions being studied. These energy deficiencies will vary in duration, magnitude, and frequency.

[37] See, e.g., *New England Power Co*., 31 FERC ¶61,047 at p. 61,084 (1985); and *Potomac-Appalachian Transmission Highline, LLC,* 140 FERC ¶61,229 at P 82 2012 (Sept. 20, 2012).

- **Identifying needs for prudent additions to interregional transfer capability.** Projected energy deficiencies must be of sufficient severity to justify additions to interregional transfer capability.
- **Prioritizing interfaces for transfer capability increases.** Neighboring regions with the most surplus energy under the studied system conditions will generally be prioritized for additions.
- **Analyzing reliability impacts.** Additional studies will be required by industry to ensure that the additions proposed to achieve the recommended transfer capability increases will adequately address reliability issues without creating other reliability issues, such as system instability under heavy transfer conditions.

The ITCS will recommend additions in the form of a target MW range of interregional transfer capability. These ranges are anticipated to be representative of a variety of operating conditions, ensuring the study presents reasonable, prudent recommendations. However, the actual transfer capability available during real-time operations may be different from the calculated transfer capability. This is because system conditions during actual operation of the system may be different from the studied system conditions.[38]

As noted above, the study team will not recommend actual transmission projects or solutions to achieve target interregional transfer capability.

Meeting and Maintaining Transfer Capability (Part 3)

The final requirement of the Fiscal Responsibility Act of 2023 is to develop a list of recommendations to meet and maintain transfer capability. The types of recommendations that will be considered include the following:

- Recommendations to perform further analysis and studies to ensure that the recommended prudent additions can be maintained reliably and will adequately address reliability issues without creating other reliability challenges. This may also identify further infrastructure upgrades required to reliably maintain transfer capability.
- Recommendations to perform analysis on a periodic basis, measuring progress to address risk and understanding changes in system conditions. This regularity is particularly important during this time of resource transition and planned increases to the transmission facilities. As resource plans, load forecasts, and planned transmission assumptions change, repeated analysis will need to be performed to ensure that the recommended additions are adequate. Future studies, without the time constraints of this initial study, can also include additional analyses.
- Recommendations to address these limitations, including the use of grid-enhancing technologies.
- Recommendations to add resources (e.g., generation, demand response) when interregional transfer capability is available but is not fully utilized due to lack of available resources.
- Recommendations to enhance regulatory mechanisms, policies, or standards.

Results from Part 1 transfer capability analysis and Part 2 energy deficiency analysis will be evaluated to develop recommendations using engineering judgment, planning and operational experience, and collaborative input from the ITCS Advisory Group.

[38] The study team notes that there is a nearly infinite number of scenarios that could be analyzed based on dispatch, topology, weather patterns, outages, etc. There are also a variety of operator actions, including operating guides, generation re-dispatch, transmission system reconfiguration, adjustment of phase angle regulators, and use of ambient adjusted ratings, that operators use to minimize the risks and impacts of challenging operating conditions.

Conclusions

As the ITCS progresses, each interface will be reviewed individually and each area collectively to recommend additions that are likely to provide the highest reliability benefits and to provide information that policymakers need to make informed judgments on this important topic.

Once completed, the ITCS will significantly contribute toward supporting reliability during the ongoing energy transformation. NERC will continue incorporating transmission adequacy in its assessments going forward in support of the grid's reliability and security now and into the future.

Chapter 4: Acknowledgements

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