Eastern Interconnection Planning Collaborative

Technical Considerations for Large Power Transfers Between Regions

EXECUTIVE SUMMARY

The Eastern Interconnection Planning Collaborative (EIPC)[1] provides this analysis for policymakers to outline some of the important technical considerations associated with determining an appropriate level of interregional transfer capability (ITC). Enhancing interregional transfer capability can carry with it many benefits but not without consideration of challenges and costs that can sizably tilt the cost/benefit analysis. It is for this reason that choosing an arbitrary target level of interregional transfer capability is not the best approach. Rather, careful analysis using common metrics can help to provide the information that policymakers need to make informed judgments on a case-by-case basis as to the application of those metrics.

EIPC and its members, who are responsible for planning and operation of the bulk power system for the Eastern Interconnection, stand ready to continue to serve as a resource to policymakers and stakeholders alike as these important issues are discussed and debated to ensure continued delivery of power to meet customers' needs in a reliable and efficient manner into the future.

[1] The Eastern Interconnection Planning Collaborative is an organization that was formed in 2009 by North American Electric Reliability Corporation ("NERC")-registered Planning Coordinators in the Eastern Interconnection ("EI") to perform coordinated interconnection-wide transmission analysis. The EIPC is a "Technical Organization" pursuant to its Mission Statement, which provides a forum for interregional coordination of the combined plans of its regional members (representing both ISO/RTO and non-ISO/RTO regions) to evaluate how well the regional plans mesh to maintain the reliability of the bulk electric system. The EIPC develops transmission system models and performs interregional scenario analysis to identify stress points on the EI-wide system, providing feedback to enhance the regional plans of our members. The EIPC also publishes periodic reports to assess the state of the Eastern Interconnection. By way of example, in 2022 the EIPC published its 'State of the Grid' Report and a White Paper on "Planning the Grid for A Renewable Future" and has published technical reports on other analyses related to planning of the transmission grid in the Eastern Interconnection. For more information, please visit http://www.eipconline.com

OVERVIEW

EIPC is pleased to provide this whitepaper to outline for policymakers and stakeholders some of the key technical issues associated with:

(a) determining an appropriate level of interregional transfer capability between regions within the Eastern Interconnection; and

(b) then expanding the high voltage transmission system to achieve the appropriate level of transfer capability.

The current Eastern Interconnection transmission system reliably enables the delivery of economic transfers, firm transactions and emergency power purchases. A robust transmission system also helps to maintain reliability between regions during extreme events, when reliable power is needed the most. Understanding and planning to an appropriate level of interregional transfer capability will lead to enhanced reliability, enabling the continuous delivery of electric power to customers during extreme weather, fuel supply disruptions and physical or cyber-attacks.

This document has been prepared by the EIPC to ensure awareness for regulators, policy makers, and other interested parties of the technical issues that should be considered when expanding interregional transfer capability (ITC). It is intended to raise awareness of the engineering complexities and technical issues that must be considered when assessing the benefits and costs of committing to any substantial investments required to enhance interregional transfer capability. As with other issues facing the electric grid, regulators and policymakers should consider a measured and informed approach on this complex issue.

ENHANCING INTERREGIONAL TRANSFER CAPABILITY – AN OUTLINE OF THE POLICY DEBATE

A. Activity to Date

Although policymakers have traditionally focused on the planning, cost allocation and siting of specific transmission projects, there has been a suggested movement towards determining an appropriate fixed level of interregional transfer capability and then requiring transmission expansion to meet that pre-determined level.

The Federal Energy Regulatory Commission (FERC) has led this effort through its various notices of proposed rulemaking on transmission planning which have raised specific questions for stakeholder comment as to whether the FERC should mandate such a pre-determined level or otherwise enhance interregional transfer capability both within the nation's interconnections and across the nation's three interconnections. On December 5-6, 2022, the Commission held a Technical Conference on this specific issue which featured a variety of speakers on the topic. The EIPC was represented by PJM's Executive Director of System Planning and EIPC Technical Committee Chairman David Souder who stated:

> *"The EIPC can assist in the development of metrics and a methodology that would be informative to transmission planners to facilitate their determination of the appropriate level of interregional transfer capability (i.e., minimum interregional transfer criteria) between regions under extreme conditions. The resultant minimum interregional transfer criteria would be informative to help ensure adequate transfer capability between regions, enhancing both reliability and resilience as the nation faces more extreme weather and other transmission-related challenges. Although the metrics and analysis should be common across the Interconnection … the application of those metrics and analysis to any particular interregional tie would reflect the specific locational and regional characteristics of the two adjoining regions."*[2]

Mr. Souder went on to note EIPC's intention to examine this issue in greater depth, to identify areas within the Interconnection where interregional transfer capability could be improved and provide input into the determination, ultimately to be made by state and federal policymakers, as to the proper metrics to consider in determining the appropriate level of interregional transfer capability between regions within the Eastern Interconnection.[3]

B. Issues Under Consideration in the Debate

Debate on the issue has been wide ranging. In particular, questions have arisen as to:

- Whether it is prudent as a policy-matter to pre-determine a level of interregional transfer capability among regions and direct transmission enhancements to meet that level?
- Should the level of interregional transfer capability be uniform across an interconnection (and across interconnections), or should the level of transfer capability vary given the differences between regional grid topologies and local considerations?
- What decision-making tools and metrics should be utilized to determine a particular level of interregional transfer capability?

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[2] EIPC Testimony for Interregional Transfer Workshop - December 5 2022

[3] More recently, through H.R.3746, the Fiscal Responsibility Act of 2023, Congress directed the North American Electric Reliability Corporation (NERC) to study various aspects of this issue.

- How to best measure the cost and benefits of an appropriate level of interregional transfer capability and how best to apply that analysis given the different grid topologies within the interconnections?
- Who should ultimately decide the appropriate metrics and weigh the costs vs benefits of such grid enhancements on a case-by-case basis?
- Should the level of interregional transfer capability be driven by reliability needs or should this determination also include a goal of equalizing economics or policy outcomes across regions within an interconnection?
- Which entity is best to perform the detailed analysis to inform policymakers and what should that analysis include?

As noted above, this paper will outline some of the key technical and engineering-related questions associated with determining an appropriate level of interregional transfer capability and in building out the transmission system to meet that level. In the view of the EIPC, these technical considerations and engineering challenges need to be considered as inputs to policymakers' determinations on the above list of issues.

KEY TECHNICAL AND ENGINEERING CONSIDERATIONS

At the outset, it should be noted that interregional transfer capability is not a new concept. From the inception of the electric grid, steps were taken to interconnect regions to reflect the greater reliability value and strength of an interconnected grid. Joint ownership and operating agreements were developed across the country to allow for the sharing of power from jointly developed generators which were sized to serve more than any single region.

Enhancing interregional transfer capability remains a valuable step to help ensure that diversity of both supply and load patterns are reliably managed and to effectuate economic transactions that benefit customers. Nevertheless, enhancing interregional transfer capability is not without its costs and challenges. Nor should it serve as a substitute for individual regions taking responsibility to ensure resource adequacy within their region. With these thoughts in mind, EIPC outlines below various technical challenges that, although not by any means insurmountable, are issues that policymakers should consider when addressing whether they should require additional interregional transfer capability and how the grid should be expanded to enable such increases in transfer capability.

RELIABILITY ISSUES FOR CONSIDERATION

In considering whether to increase interregional transfer capabilities, policymakers need to avoid unintended consequences that could actually result in a degradation of reliability. There are many factors that could increase the reliability risk associated with large increases in interregional transfer capability which include line distance and generation supply.

1. ***Increased exposure to high impact, low frequency events*** – Enhanced interregional transfer capability should not become a substitute for each region ensuring it is meeting its resource adequacy needs, since reliability risks could increase. Specifically, regions will become more impacted by forced outages of major transmission facilities and other high impact events that can now cascade into adjoining regions. Risks associated with dependencies on distant systems become harder to model in transmission planning and resource adequacy analyses as the number of potential outages and the electrical distances that could adversely impact a given system increase exponentially. By way of example, the loss of multiple key transmission lines in one region in conjunction with other lower probability events can now have a much greater interregional impact than might have existed previously.

2. ***Issues associated with long-distance transmission lines*** – To the extent enhanced interregional transfer capability entails the development of more long-distance transmission lines (including High Voltage Direct Current "HVDC") there can be increased reliability risk due to their length and a corresponding increased risk of outage due to severe weather including lightning, hurricanes, tornados, physical attack, wildfires, etc. The probability of a transmission outage is increased as line distances are increased and as such, may not meet the intended level of reliability or resiliency. A recent example occurred on July 5, 2023, when heavy smoke from Canadian wildfires caused the New England electric system to call for emergency measures.[4]

   A special consideration that comes into play with long-distance (also known as "long-haul") HVDC lines is the significant amount of power that can be lost under a single contingency. Most HVDC lines, especially those that have recently been or are planned to be placed in service in the next few years are designed to deliver thousands of megawatts (MW) of

[4] Canada Wildfire Smoke Triggered New England Grid Emergency - Bloomberg

energy on a single connection. Such an HVDC line originates in one Balancing Authority Area and terminates in a separate Balancing Authority Area (BAA), normally hundreds of miles distant from each other. If the line is taken out of service by an event such as a tornado, then the source BAA instantly has an energy surplus and the sink BAA is left with an energy deficit of thousands of MW that must be addressed. For most receiving BAAs, this means that they must account for an HVDC line of this nature to be its most severe single contingency which could require costly mitigation measures to ensure reliability (such as construction of a parallel circuit over a separate route or maintaining higher levels of Contingency Reserves).

3. ***Countervailing Considerations*** – These factors do not mean that enhanced interregional transfer capability should be avoided. By contrast, relying solely on local resources, particularly in small Balancing Authority Areas, exposes that region to greater risk from local weather impacts or fuel supply constraints that can be ameliorated in part through strong ties with larger neighboring regions with surplus capacity to sell and the transmission capacity to deliver that surplus energy to its neighbors. Enhancing interregional transfer capability in those situations can increase the likelihood of reliable operations when local resources are subject to common mode failure risk. As a result, balance is needed and a specific case-by-case analysis, using reliability standards and recognized metrics, can help to better identify those instances when enhanced interregional transfer capability can increase reliability and reduce reliability risk.

4. ***Considerations for the Planning Process*** **–** Existing transmission planning processes already consider a certain degree of transfer capability between adjoining regions. Consideration must also be given to whether regions should modify their existing planning processes to provide a greater degree of interregional transfer capability that a region could normally count on from its neighbors in certain circumstances. Extreme weather events can simultaneously affect several regions within the Eastern Interconnection. These events could include plausible scenarios such as a widespread storm that impacts transmission and generation infrastructure across multiple regions or a physical or cyberattack on infrastructure such as interstate pipelines that serve multiple regions within the Eastern

Interconnection,[5] The end result of this being that in true extreme events generation resources may not be available for transfer between regions.

5. ***Addressing Resource Adequacy Concerns with Remote Capacity*** – Increasing transfer capability needs to be examined as to its impact on retaining needed generation resources in a given region. There needs to be a balance between the appropriate level and types of generation from imports and internal resources both of which need to work together to enhance reliability. Enhancing interregional transmission capability can, for example, vastly increase the ability to transfer renewable generation into a region. This could have the effect of accelerating the pace of retirements of needed conventional generation to supplement the intermittent nature of renewable resources and the increased resources need to manage steeper ramp rates that can occur with increased generation output variability.

   To the extent the pace of retirements of existing generation with attributes needed to reliably manage the grid substantially exceeds the pace of new remote and/or local additions, reliability can be significantly impacted. Here too, a balance is needed between the policy goals of increasing deployment of renewable resources with the realties that reliability can be degraded during those hours when renewable resources are not available to meet the demands. If the pace of premature retirements accelerates, extreme events that impact multiple regions (*e.g.,* winter storms Uri and Elliott, heat dome across the entire south, Superstorm Sandy) there might not be enough excess resources to send to neighboring regions and/or the transmission to transfer the power may be damaged from the extreme event. With increased retirements of local generation, this could cause larger resource adequacy risks for different regions. Regions may need to take actions, potentially out of market, to ensure the continued quantity of resources is available to meet resource adequacy criteria in the future.

6. ***Time Requirement for Construction of High-Voltage Transmission Lines*** – To facilitate a significant increase in the current level of transfer capability between Transmission Planning Regions, a significant number of new, long-distance high-voltage transmission lines will likely be required. An important consideration for regulators and policy makers is

[5] EIPC Testimony, Sec IV, Pg 6
https://static1.squarespace.com/static/5b1032e545776e01e7058845/t/639cd78a50f0d438d326b361/1671223179859/Souder+EIPC+Testimony+for+Interregional+Transfer+Workshop.pdf

the substantial lead time for siting, permitting, and construction associated with high-voltage transmission lines including both AC and DC. On average it can take 8-10 years or more to build a high-voltage transmission line. This timeline includes planning, scoping, routing, environmental review, public comment, project approval, procurement of materials, permitting, land acquisition, and construction. Additionally, if there are multiple lines simultaneously required to increase transfer capability, other issues may come into play that could further increase the timeline including supply chain constraints or the availability of skilled labor.

While Grid Enhancing Technologies (GETs) or alternative transmission technologies such as advanced power flow control devices and synchronous condensers, may have the ability to be more quickly deployed and may provide solutions for issues specific to localized areas, deployment of those technologies will not replace the need for additional transmission lines to support any requirement for large interregional power transfers. Deployment of GETs may provide increased flexibility to real-time operations of the transmission system, however from a long-range transmission planning perspective, the construction of additional transmission lines is likely the better long-term solution to ensure a robust system if the intent is to increase firm interregional transfer capability.

7. ***<u>Delivery Implications and Affected Systems</u>*** – Requirements for increasing the reliable transfer of power go well beyond simply adding a new high-voltage transmission line that connects two regions. Often other components of the system that are involved in the transfer will have thermal constraints near the generation resources that limit the energy that can be sent, as well as constraints near the final load being served, all of which must be addressed to reliably deliver from source to sink. The variety of generation resources that may be required to deliver energy and the combination of loads and sink possibilities within a large region could require many additional transmission improvements to existing facilities or even new transmission lines, which could unintentionally result in significant upgrades to the local transmission systems in order to support interregional deliveries during extreme conditions. By the same token, in analyzing the costs and benefits of new long-distance transmission lines, planners will need to factor in electricity losses which are magnified over lines covering great distances. Losses increase as generation resources are located further away from load centers, which means that more generation is required than would have been needed if the resources were sited closer to the end-use customer.

Given that the Eastern Interconnection is an interconnected network of transmission systems, consideration must also be given to regions that may be impacted by a large amount of interregional power transfer between two other regions. These are known as affected systems and the likely side effects are transmission constraints that may occur and will need to be addressed either through transmission system improvement in those affected systems or thru interchange curtailments.

Here too, these issues are not insurmountable. However, policymakers need to analyze the total impact and resultant costs associated with large interregional transfers as part of a comprehensive benefit to cost assessment.

8. *Transfer Capability Usage*

As new legislation or regulatory requirements are being developed, consideration must be given to the intent of any required increases to interregional transfer capability and how it is intended to be used. For example, if the intent is to hold any portion of the capability for emergency purposes, then limitations would need to be in place on the use in day-to-day economic transfers. Additionally, complications may arise from the use of HVDC given that the flow is scheduled. If a large number of HVDC lines are used to increase interregional transfer capability, enhanced coordination with respect to scheduling flows may be required during emergency or extreme conditions.

9. *Networked HVAC vs Long-Haul HVDC*

As noted elsewhere, HVDC lines can be built with much greater length than HVAC, since AC is limited by the requirements of reactive power. However, the cost and complexity of HVDC terminals mean that HVDC is typically limited to a single terminal at each end of the line. Multiterminal HVDC is technically possible but is uncommon. HVAC lines are commonly built in multiterminal configurations which can provide greater flexibility in integrating and operating new lines.

HVDC transmission offers optionality and values well beyond those of HVAC, when and where required. For example, the flow across an HVDC transmission line is scheduled, while HVAC flow is less controllable. HVDC paths could be built to handle an ultimate capacity level while staging could be applied to local terminal upgrades with minimal impacts to rights-of-way or substations.

CONCLUSION

Enhancing interregional transfer capability can carry with it many benefits but not without consideration of challenges and costs that can sizably tilt the cost/benefit analysis. It is for this reason that choosing an arbitrary target level of interregional transfer capability can create more problems than it solves. Rather, careful analysis using common metrics can help to provide the information that policymakers need to make informed judgments on a case-by-case basis as to the application of those metrics. It is for this reason that EIPC and its members, who are responsible for planning and operation of the bulk power system for the Eastern Interconnection, stand ready to continue to serve as a resource to policymakers and stakeholders alike as these important issues are discussed and debated to ensure the continued delivery of power to meet customers' needs in a reliable and efficient manner into the future.