How Resources Can be Added More Quickly and Effectively to PJM's Grid

PRESENTED BY

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PREPARED FOR

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Pathways to Add Resources More Quickly and Effectively

With FERC Order 2023 guidance and emerging best practices from other regions, the following measures can add resources more quickly and cost-effectively in PJM:

1. Speed up state & local permitting for 44+ GW of projects with signed interconnection service agreements (PJM blog: yet only 2 GW brought online in 2022)
2. Implement fast-track process for sharing and transfers of existing POIs
3. Identify existing "headroom" at possible POIs
4. Fast-track new POIs for "first-ready" projects
5. Allow for GETs and (simple) RAS/SPS to address interconnection needs
6. Simplify ERIS (energy-only) interconnections with option to upgrade to NRIS (capacity) later
7. Proactively and holistically plan for long-term transmission needs

PJM (items 2–7)

2. Fast-track Sharing and Transfers of Existing POIs

Implement new fast-track process for sharing and transferring existing POIs to bypass long interconnection queue for new POIs

- Fast-track sharing of existing POIs (both surplus interconnection capacity & sharing of energy)
- Fast-track the transfers of existing POIs (e.g., POIs of retiring plants; POIs build through SAA)

Why?

- PJM has 40+ GW of existing POIs (with CIRs) at retiring plants! … most of which are in attractive locations for new storage, renewables (e.g., as noted in the ICC draft REAP report), and natural gas plants (Example: client rejected new solar+storage bid at retiring fossil plant because getting ISA would take 5-6 years)
- More quickly assign POIs built under State Agreement Approach to generators procured by states (e.g., NJ)
- Sharing POIs is attractive: many aging resources are rarely dispatched when renewable generation is high

Examples:

- Separate MISO and SPP processes for existing POIs (unlike in PJM, presumes no material impact)
- MISO "energy displacement agreements" (between existing and new resources to ensure that the total amount of shared interconnection service at the POI remains the same)

3+4+5+6. Existing Headroom / First-ready / GETs & RAS / ERIS

- Identify "headroom" (hosting capacity, Order 2023 "heat map" requirement)
  - Example: CAISO identified interconnection requests for which 31 GW of energy-only headroom (23 GW of which are firmly deliverable) already exists without any additional network upgrades
- Fast-track generation resources that can be developed quickly (e.g., "first-ready" projects with minimal POI upgrades … beyond Order 2023 "first-ready, first-served" requirement)
  - Like PJM's "fast-lane" transition process for projects with minimal upgrades, but could be made permanent
  - CAISO's 2023 Interconnection Process Enhancements
- Allow interconnection needs to be addressed by grid-enhancing technologies (GETs) and "simple" remedial action schemes (RAS or system protection schemes, SPS)
  - GETs, such as power flow control devices, only need to be "considered" (but not used) per FERC Order 2023
  - RAS example: CAISO identified 21 GW of energy-only (16 GW of deliverable capacity) interconnection headroom that can be created quickly and inexpensively with RAS
- Simplify ERIS (energy-only) interconnection criteria for new POIs with option to upgrade to NRIS (capacity) later
  - Consider in interconnection studies the ability to manage (e.g., dispatch down) energy resources in nodal market
  - Examples: SPP ERIS, Enel working paper (speeds up energy-only interconnections to slim down the interconnection queue for firm (capacity) interconnections

7. Proactive, Holistic Long-term Transmission Planning

Proactively and holistically planning for long-term transmission needs can reduce total customer electricity costs and speed up interconnection of new resources

- Experience shows that simultaneously addressing all transmission needs (for generation interconnection, reliability, economic, public policy, and interregional needs) reduces costs:
  - CAISO TPP and European ENTSO-E planning and CBA framework, which includes interregional needs
  - MISO LRTP and Australian ISP (which do not consider interregional needs)
  - 2021 PJM study: $3.2b in transmission for 75 GW of clean energy resources -- shows that holistic planning for even just the next decade of generation interconnection needs would offer substantial cost reductions
- Concept: consider all near-term and long-term transmission needs (including public-policy needs through 2040-50) in approving the next decade of transmission upgrades
- Important: immediately reflect approved transmission upgrades in the "base case" for generation interconnection studies (e.g., as MISO did with approved MVPs)
- Include interregional solutions
  - Jointly plan for interconnection needs near seam (e.g., SPP-MISO JTIQ offering documented cost reductions)
  - Additionally: replace ineffective Coordinated Transaction Scheduling (CTS) with intertie optimization to improve utilization of interregional transmission and dispatch efficiency near seams, as recommended by IMM

Thank You!

Additional Slides

About the Speaker

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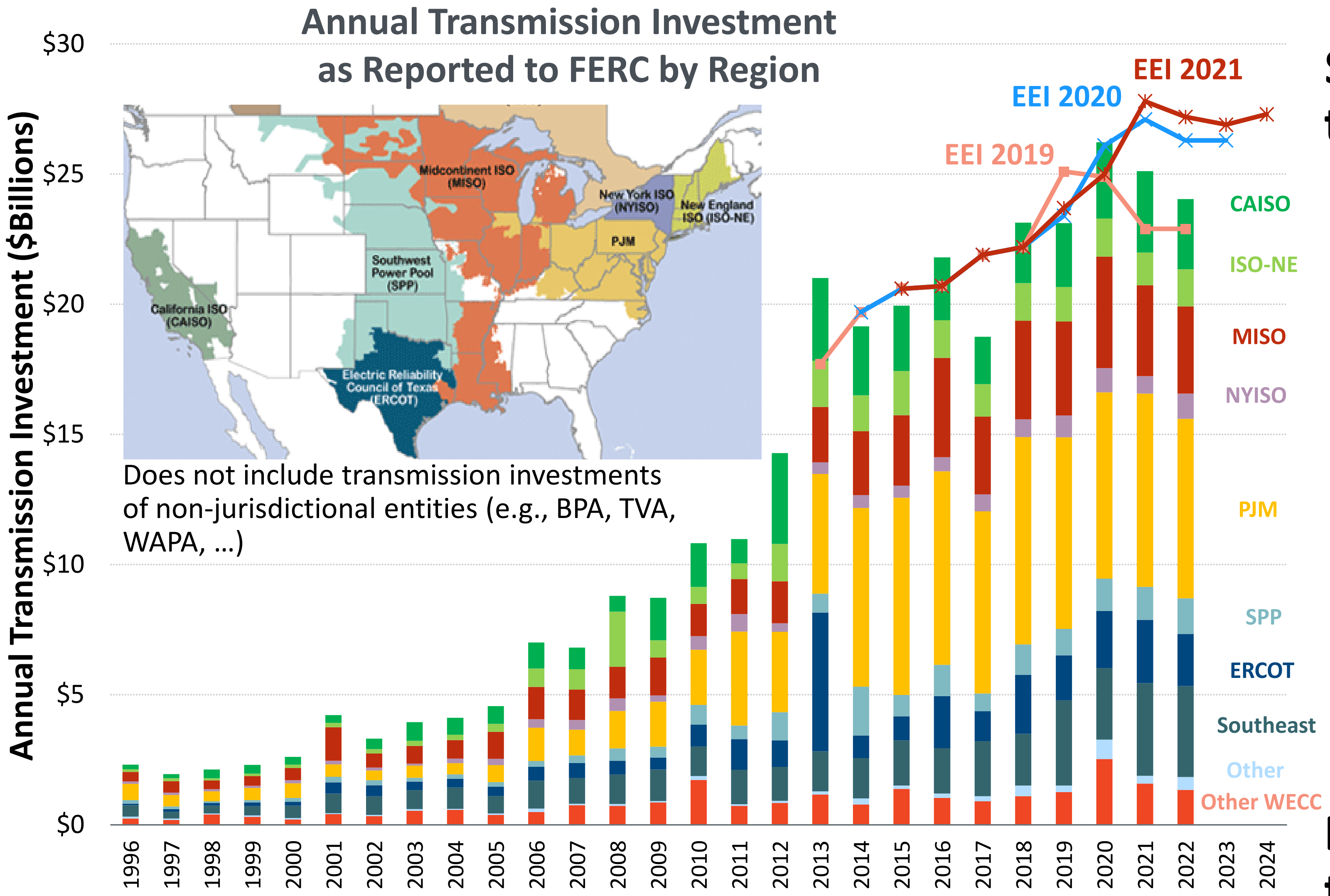
Johannes (Hannes) Pfeifenberger, a Principal at The Brattle Group, is an economist with a background in electrical engineering and over twenty-five years of experience in wholesale power market design, renewable energy, electricity storage, and transmission. He also is a Visiting Scholar at MIT's Center for Energy and Environmental Policy Research (CEEPR), a Senior Fellow at Boston University's Institute of Sustainable Energy (BU-ISE), a IEEE Senior Member, and currently serves as an advisor to research initiatives by the U.S. Department of Energy, the National Labs, and the Energy Systems Integration Group (ESIG).

Hannes specializes in wholesale power markets and transmission. He has analyzed transmission needs, transmission benefits and costs, transmission cost allocations, and renewable generation interconnection challenges for independent system operators, transmission companies, generation developers, public power companies, industry groups, and regulatory agencies across North America. He has worked on transmission matters in SPP, MISO, PJM, New York, New England, ERCOT, CAISO, WECC, and Canada and has analyzed offshore-wind transmission challenges in New York, New England, and New Jersey.

He received an M.A. in Economics and Finance from Brandeis University's International Business School and an M.S. and B.S. ("Diplom Ingenieur") in Power Engineering and Energy Economics from the University of Technology in Vienna, Austria.

Transmission Investments is at Historically High Levels



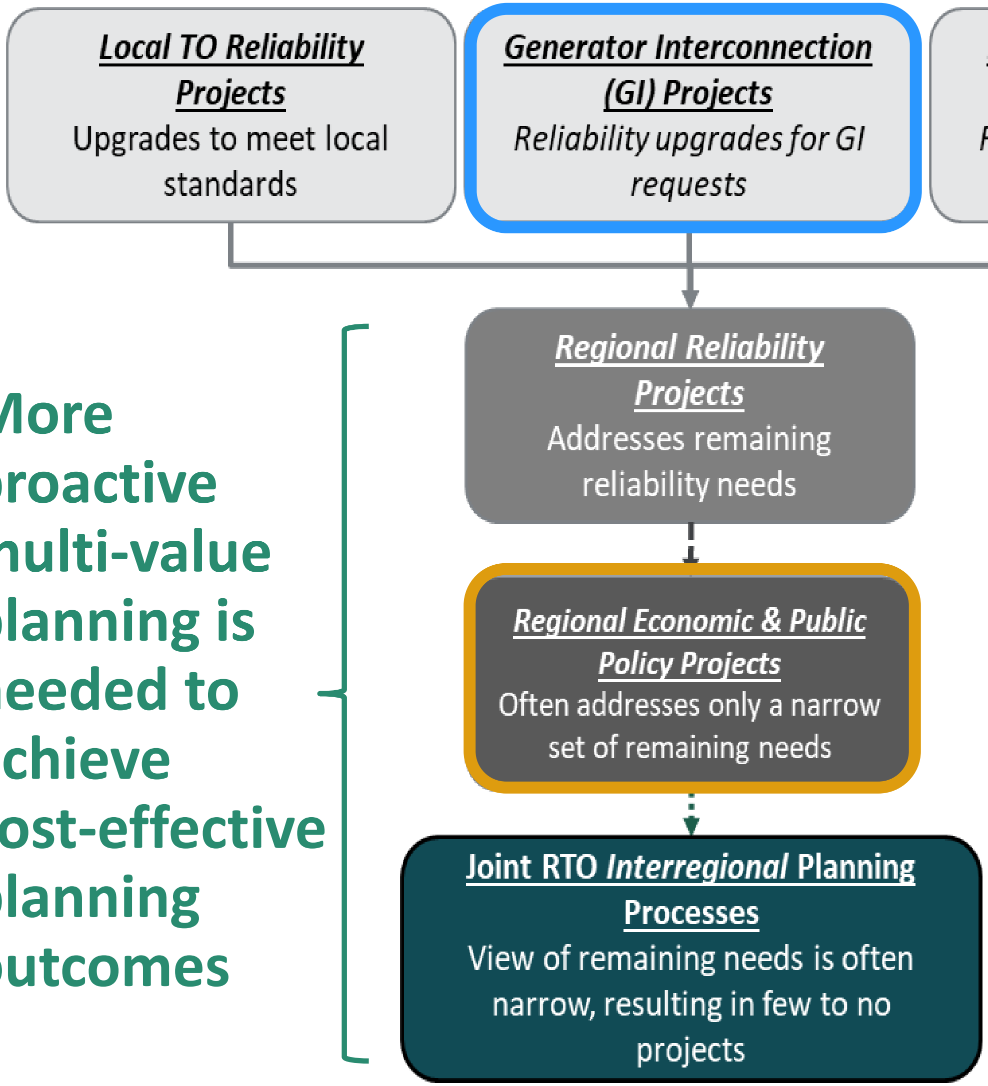
Sources: The Brattle Group analysis of FERC Form 1 Data; EEI "Historical and Projected Transmission Investment" most recent accessed here: https://www.eei.org/resourcesandmedia/Documents/Historical%20and%20Projected%20Transmission%20Investment.pdf

$20-25 billion in annual U.S. transmission investment, but:

- More than 90% of it justified solely based on reliability needs without benefit-cost analysis
  - About 50% solely based on "local" utility criteria (without going through regional planning processes)
  - The rest justified by regional reliability and generation interconnection needs
- While significant experience with transmission benefit-cost analyses exists, very few projects are justified based on economics to yield overall cost savings

Essentially no interregional transmission!

Siloed, Reliability-focused Transmission Planning Cannot Connect Resources Quickly and Identify the Most Cost-Effective Solutions



More proactive multi-value planning is needed to achieve cost-effective planning outcomes

These solely reliability-driven processes account for > 90% of all transmission investments

- None involve any assessments of economic benefits (i.e., cost savings offered by the new transmission)

Incremental generation interconnection has become the primary tool (and efficiency barrier) to support public policy goals

Planning for economic & public-policy needs results in less than 10% of all U.S. transmission investments

Interregional planning processes are large ineffective

- Essentially no major interregional transmission projects have been planned and built in the last decade
- Numerous national studies show that more interregional transmission is needed to reduce total system costs

The Need for and Value Proposition of Interregional Transmission

Existing studies highlight how interregional transmission can provide significant benefits as the grid transitions to clean resources

- **The value proposition (increased reliability, reduced costs, risk mitigation) of interregional transmission defines the "need" for the approval these projects**
- In the last ten years, numerous studies have looked at a wide range of grid transition scenarios—including a "continuation of recent trend" view in which coal is gradually being replaced by renewables to reduce emissions
  - In all instances, **building new interregional transmission reduces overall system costs and reduces emissions** while reducing risk and helping to maintain or increase reliability
- The **need for interregional transmission has evolved** as renewable costs have declined and state clean-energy and decarbonization policies have become more ambitious. It has shifted from transporting (mostly) low-cost wind to load centers to include a broader set of benefits: **interregional transmission improves reliability and protects customers from high-cost outcomes**
- While there is some substitutability between solar, storage, and transmission, the **declining cost of solar and storage has not changed the conclusion that interregional transmission reduces costs**
- The development of **interregional transmission and lower electricity rates also create jobs**; potentially more than many local-only renewables policies
- Particularly as shares of weather-correlated renewable generation increases, **robust interregional transmission** is needed to ensure that the geographic scale of the grid exceeds **the size of typical weather systems**

Framework for More Proactive Transmission Planning*

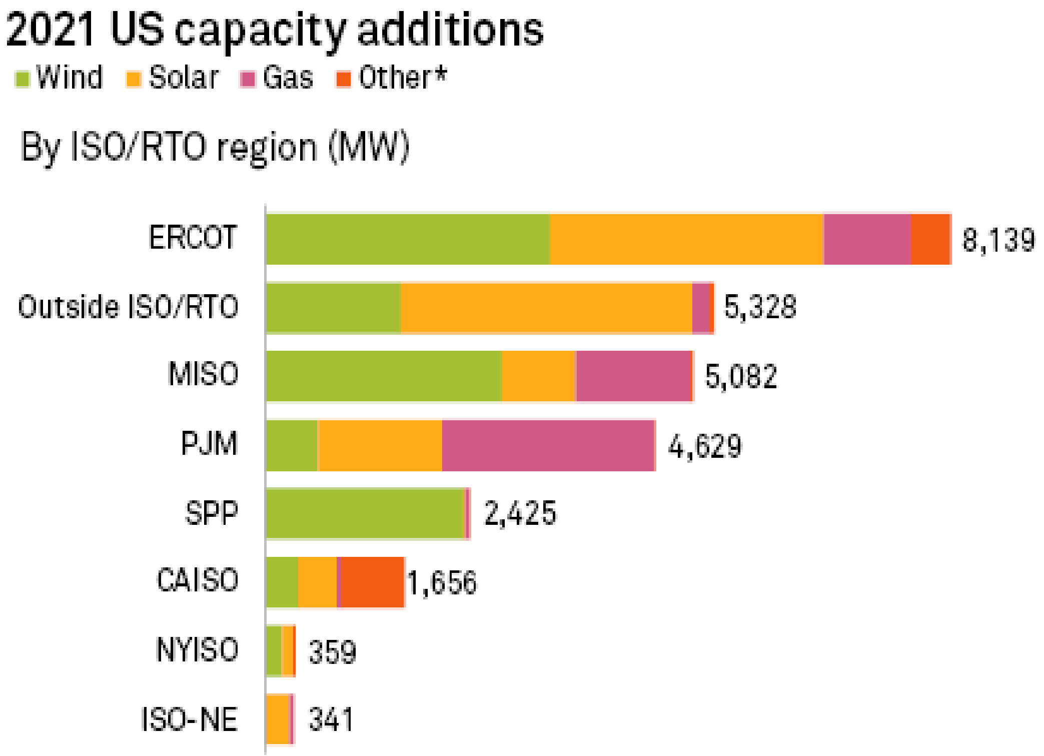
FERC NOPR efforts and available experience point to proven planning practices that can reduce total system costs and risks, but are rarely used today:

1. **Proactively and holistically plan for future generation and load** by incorporating realistic projections of all needs: the anticipated generation mix, public policy mandates, load levels, and load profiles over the lifespan of the transmission investments. Avoid siloed, incremental planning processes.
2. **Account for the full range of transmission needs** and **use multi-value planning** to comprehensively identify investments that cost-effectively address all categories of needs and benefits
3. **Address uncertainties and high-stress grid conditions explicitly through scenario-based planning** that takes into account all transmission needs for a broad range of plausible long-term futures as well as real-world system conditions, including challenging and extreme events
4. **Use comprehensive transmission network portfolios** to address system needs and **cost allocation** more efficiently and less contentiously than a project-by-project approach
5. **Jointly plan inter-regionally across neighboring systems** to recognize regional interdependence, increase system resilience, and take full advantage of interregional scale economics and geographic diversification benefits

* Brattle & Grid Strategies Report: Transmission Planning for the 21st Century: Proven Practices that Increase Value and Reduce Costs, October 2021.

Significant Differences in Generation Interconnection Processes

Some RTOs are able to interconnect disproportionately more generation, and have been able to do so more quickly.



Data compiled Jan. 11, 2022.
* Includes hydro, biomass, oil, geothermal and energy storage capacity.
Source: S&P Global Market Intelligence

RTO Size	Capacity in Queue
80 GW	135 GW
200 GW	330 GW
150 GW	155 GW
180 GW	245 GW
95 GW	100 GW
52 GW	160 GW
42 GW	75 GW
32 GW	30 GW

Planning regions with the most ambitious state clean energy standards (i.e., east and west coast states) are lagging behind regions such as Texas and the Midwest:

- ERCOT: added 10% of system capacity in 2021
- NYISO and ISO-NE: only 1%
- All others: 2-4%

See also: [Generation, Storage, and Hybrid Capacity in Interconnection Queues | Electricity Markets and Policy Group (lbl.gov)]

Five Elements of Generation Interconnection Need to be Addressed

Improving generation interconnection requires addressing all five elements of the GI process. Current discussions focused mostly on Nos. 1 and 5 (NOPR on Nos. 1 and 4)

1. **GI Process and Queue Management:** individual vs. cluster studies, type of studies and contractual agreements, readiness criteria, financial deposits, study and restudy sequences, etc.
2. **GI Scope and "Handoff" to Regional Transmission Planning:** are major ("deep") network upgrades triggered by incremental generation interconnection requests or handled through regional transmission planning?
3. **GI Study Approach and Criteria:** study assumptions, modeling approaches, and specific criteria differ significantly across regions (e.g., ERIS vs. NRIS study differences, injection levels studied, are market-based redispatch opportunities considered?)
4. **Selecting Solutions to Address the Identified Criteria Violations:** most regions select only traditional transmission upgrades to address criteria violations; grid-enhancing technologies, such as power-flow-control devices or dynamic line ratings, are not typically considered or accepted
5. **Cost Allocation:** most regions require the interconnecting generator (or group of generators) to pay for all upgrades identified, even though (a) there may be significant regional benefits to loads and other market participants and (b) more cost effective (multi-value) regional solutions may exist

Option for Improving the Generation Interconnection Process

Reducing the scope of upgrades triggered by generation interconnection processes likely will be necessary to both accelerate and lower the cost of renewable interconnection:

- Attractive: UK "Connect and Manage" (replaced prior "Invest and Connect")
  - Similar to ERCOT; reduced lead times by 5 years; network constraints addressed later (e.g., with congestion management) https://www.gov.uk/guidance/electricity-network-delivery-and-access#connect-and-manage
- ERCOT's generation interconnection process is perhaps most effective in the U.S.
  - Efficient handoff of study roles by ERCOT and Transmission Owners limits restudy needs
  - Projects can be developed and interconnected within 2-3 years; in other regions, the interconnection study process itself may take longer than that
  - Upgrades focused only on local interconnection needs and are recovered through postage stamp
  - Network constraints managed through market dispatch – which imposes high congestion and curtailment risks on interconnecting generators … in part due to ERCOT's insufficiently proactive multi-value grid planning
  - See Enel working-paper.pdf (enelgreenpower.com) [Note: Brattle was not involved]

Generation interconnection based on "connect and manage" when combined with proactive transmission planning offers more timely and cost-effective solutions if:

- Near-term needs are quickly addressed through multi-value planning (beyond reliability)
- Long-term needs are proactively addressed through scenario-based long-term planning

Examples of Brattle Reports on Regional and Interregional Transmission Planning and Benefit-Cost Analyses

Well-Planned Electric Transmission Saves Customer Costs:
Improved Transmission Planning is Key to the Transition to a Carbon-Constrained Future

PREPARED FOR
WIRES

Link: Well-Planned Transmission

PREPARED BY
Judy W. Chang
Johannes P. Pfeifenberger

May 2016

THE Brattle GROUP

Toward More Effective Transmission Planning:
Addressing the Costs and Risks of an Insufficiently Flexible Electricity Grid

PREPARED FOR
WIRES

Link: Effective Transmission Planning

PREPARED BY
Johannes P. Pfeifenberger
Judy W. Chang
Akarsh Sheilendranath

April 2015

The Brattle Group

Link: Transmission Benefits

The Benefits of Electric Transmission: Identifying and Analyzing the Value of Investments

July 2013

Judy W. Chang
Johannes P. Pfeifenberger
J. Michael Hagerty

Link: Diversity Value

BU
Boston University Institute for Sustainable Energy

The Value of Diversifying Uncertain Renewable Generation through the Transmission System

September • 2020

A Roadmap to Improved Interregional Transmission Planning

Link: Interregional Roadmap

PREPARED BY
Johannes P. Pfeifenberger
Kasparas Spokas
J. Michael Hagerty
John Tsoukalis

November 30, 2021

Transmission Planning for the 21st Century: Proven Practices that Increase Value and Reduce Costs

Link: Brattle Grid Strategies

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Johannes Pfeifenberger
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Grid Strategies:
Rob Gramlich
Michael Goggin
Jay Caspary
Jesse Schneider

OCTOBER 2021

Brattle
GRID STRATEGIES LLC

Summarizes proven approaches to quantifying various benefits

Additional Reading on Transmission

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Pfeifenberger, DeLosa, et al., The Benefit and Urgency of Planned Offshore Transmission, for ACORE, ACP, CATF, GridLab, and NRDC, January 24, 2023.
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Pfeifenberger and DeLosa, Proactive, Scenario-Based, Multi-Value Transmission Planning, Presented at PJM Long-Term Transmission Planning Workshop, June 7, 2022.
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Pfeifenberger, The Benefits of Interregional Transmission: Grid Planning for the 21st Century, US DOE National Transmission Planning Study Webinar, March 15, 2022.
Pfeifenberger, 21st Century Transmission Planning: Benefits Quantification and Cost Allocation, for NARUC members of the Joint Federal-State Task Force on Electric Transmission, January 19, 2022.
Pfeifenberger, Spokas, Hagerty, Tsoukalis, A Roadmap to Improved Interregional Transmission Planning, November 30, 2021.
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Pfeifenberger et al., Initial Report on the New York Power Grid Study, prepared for NYPSC, January 19, 2021.
Van Horn, Pfeifenberger, Ruiz, "The Value of Diversifying Uncertain Renewable Generation through the Transmission System," BU-ISE, October 14, 2020.
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Pfeifenberger, "Cost Savings Offered by Competition in Electric Transmission," Power Markets Today Webinar, December 11, 2019.
Chang, Pfeifenberger, Sheilendranath, Hagerty, Levin, and Jiang, "Cost Savings Offered by Competition in Electric Transmission: Experience to Date and the Potential for Additional Customer Value," April 2019 and "Response to Concentric Energy Advisors' Report on Competitive Transmission," August 2019.
Ruiz, "Transmission Topology Optimization: Application in Operations, Markets, and Planning Decision Making," May 2019.
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Pfeifenberger, Hou, "Employment and Economic Benefits of Transmission Infrastructure Investment in the U.S. and Canada," on behalf of WIRES, May 2011.

Brattle Group Practices and Industries

ENERGY & UTILITIES

- Competition & Market Manipulation
- Distributed Energy Resources
- Electric Transmission
- Electricity Market Modeling & Resource Planning
- Electrification & Growth Opportunities
- Energy Litigation
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