Interregional Transmission Needs & the Benefits of HVDC Transmission

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Transmission Investments is at Historically High Levels

$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!

Current U.S. Grid Planning Processes are too Siloed

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)
- Which also means these investments are not made with the objective to find the most cost-effective solutions
- Will yield higher system-wide costs and electricity rates

Planning for economic and public-policy projects: less than 10% of all transmission investments

Interregional planning processes are largely ineffective

- Essentially no major interregional transmission projects have been planned by grid operators in the last decade
- Regional focus on meeting reliability needs leaves no “need” for interregional transmission, even if more cost effective
## Barriers to Interregional Transmission Planning

| A. Leadership, Alignment and Understanding | 1. Insufficient leadership from RTOs and federal & state policy makers to prioritize interregional planning  
2. Limited trust amongst states, RTOs, utilities, & customers  
3. **Limited understanding of transmission issues, benefits & proposed solutions**  
4. Misaligned interests of RTOs, TOs, generators & policymakers  
5. States prioritize local interests, such as development of in-state renewables |
| --- | --- |
| B. Planning Process and Analytics | 6. **Benefit analyses are too narrow, and often not consistent between regions**  
7. Lack of proactive planning for a full range of future scenarios  
8. Sequencing of local, regional, and interregional planning  
9. Cost allocation (too contentious or overly formulaic) |
| C. Regulatory Constraints | 10. Overly-prescriptive tariffs and joint operating agreements  
11. **State need certification, permitting, and siting** |

*Source: Appendix A of [A Roadmap to Improved Interregional Transmission Planning](https://www.brattle.com) (2021)*. Based on interviews with 18 organizations representing state and federal policy makers, state and federal regulators, transmission planners, transmission developers, industry groups, environmental groups, and large customers.
DOE’s National Transmission Needs Study identified significant interregional transmission needs based on 3 groups of scenarios:

1. **Mod/Mod** = status-quo with moderate load and clean-energy shares
2. **Mod/High** = moderate load growth but high clean-energy shares
3. **High/High** = high load and clean-energy shares

“Need” = optimal regional and interregional transmission expansion that minimize total system-wide costs

- Based on six recent national studies, 26 scenarios, and numerous sensitivities
Resource quality varies by region:

- **Onshore Wind**: Interior, TX
- **Offshore Wind**: East coast, TX
- **Solar**: Southwest, TX, FL
- **Geothermal**: CA, NV
- **Hydro**: Western states, imports

Essential to diversify renewables by expanding the grid:

- Reduces generation investment and balancing costs
- Transmission will compete with other approaches to integrating renewables, including storage, distributed resources, and market expansion
MIT Study: Cost Reductions Enabled by Interregional Transmission

Key Result: A more robust national grid would reduce the total cost of decarbonizing the grid ... but (higher-cost) regional and more local solutions may also be feasible

P. R. Brown and A. Botterud, *The Value of Inter-Regional Coordination and Transmission in Decarbonizing the US Electricity System*, Joule, December 11, 2020.
MISO’s new Renewable Integration Impact Assessment (RIIA) improves on many other planning studies by:

- Establishing the need to study both policy goals and reliability goals simultaneously
- Considering diverse future scenarios
- Recommends a “least-regret” transmission plan (but one that does not address possibility of regret from inadequate T)

By design, the scope of study does not address any interregional opportunities:

- Despite modeling five regions in addition to MISO, the study mostly did not consider interregional transmission (see figures)
- Even if “optimal” for MISO, it likely preempts more cost-effective interregional solutions

Example: Prioritizing Regional over Interregional Solutions

How would SPP-MISO-PJM wide planning results differ?

MISO’s projected scope of transmission expansion needs

Source: MISO LRTP Roadmap March 2021
Brattle study found that electrification will drive $3 billion/year of incremental transmission investment over the next decade

- Increases to $7 billion/year between 2030 and 2050
- High electrification sensitivity finds $7 billion/year in near term; $25 billion/year from 2030 to 2050

Quantifying Benefits Beyond “Production Cost” Savings

Relying solely on traditionally-quantified Adjusted Production Cost (APC) Savings results in the rejection of beneficial transmission projects – particularly for interregional planning efforts that consider an even smaller subset of benefits.

Value Consideration for Interregional Transmission

Planning interregional transmission that reduces costs and improves reliability compared to regional or local solutions, the following changes are needed:

- Fully and efficiently **utilize interregional transmission** in energy markets and for resource adequacy
- **Improve planning models:**
  - Improve representation of **neighboring regions** in model footprint to capture diversity
  - Capture impacts of **challenging conditions** and extreme events, such as heat waves or cold snaps
    - Simultaneous spikes in loads, fuel prices, generation and transmission outages, resilience challenges
    - **LBNL study:** 40-80% of annual transmission value is concentrated in top 5% of all hours
  - Integrate/combine all **benefit metrics** of neighboring regions in economic analyses
  - Recognize the full **resource adequacy value** of interregional transfer capability (even if non-firm or not committed to capacity imports) to reflect load and resource diversity
- **Proactively evaluate whether interregional solutions are more cost effective** than regional or local solutions in regional planning processes
  - Recognize regional/interregional benefits, including avoided cost of regional/local solutions
Examples of Brattle Reports on Regional and Interregional Transmission Planning and Benefit-Cost Analyses

The Brattle Group

Link: Transmission Benefits

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

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

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

A Roadmap to Improved Interregional Transmission Planning

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

Summarizes proven approaches to quantifying various benefits
Key Takeaways on HVDC Technology

HVDC transmission technology has evolved dramatically over the last 5-10 years

– HVDC offers higher-capacity, longer-distance, lower-loss transmission on a smaller footprint than AC
– The development of voltage-sourced converter (VSC) technology has also offered dramatic improvements in HVDC capabilities
– These VSC-based capabilities are increasingly needed to enhance the existing AC grid

Internationally, approximately 50 GW of VSC-HVDC transmission projects are in operation today and approx. 130 GW planned or under development through the end of the decade

– North America accounts for only 3% of all VSC systems in operation worldwide and (almost exclusively due to merchant developers) for approx. 30% of planned and proposed VSC systems

U.S. system operators less familiar with HVDC can benefit from the experience gained overseas (particularly in Europe) … but significant planning, supply chain, operational, and regulatory challenges need to be addressed

– The report provides a primer on HVDC technology, documents available capabilities and experience, addresses misconceptions, and offers recommendations to collaboratively address the identified challenges
High Voltage Direct Current (HVDC) technology

A reliable and effective electrical power transmission solution since the late 1890s

- No reactive power $\rightarrow$ Long distance transmission
  - Overhead or underground
- No skin effect $\rightarrow$ Optimal use of conductors
- Converters $\rightarrow$ Power flow control / grid services

Less right of way $=$ Smaller environmental and community impacts
Experience with HVDC transmission in North America

North American HVDC Projects (Existing and Planned/Proposed)

CAISO leads the U.S. in planning and utilizing HVDC transmission:
- First VSC-MMC HVDC line (TransBay, 2013)
- 10 VSC-HVDC systems evaluated in transmission planning; 2 approved
- Full co-optimization of HVDC transmission with generation in day-ahead and real-time markets since 2017
- Interregional optimization in WEIM
- Subscriber PTO proposal (merchant lines)

Most U.S. HVDC transmission projects proposed by merchant and OSW developers (not system operators)
Railroad Right-of-Ways Cover Needed Transmission Corridors

National Network of Class I Railroads

HVDC Use Cases

Optimal use of right-of-way
- Back to back converters
- Oil & Gas platform supply
- Asynchronous connection
- City centre infeed
- Island supply
- Undergrounding
- Water crossings
- Transmission reinforcement between Balancing Areas
- Transmission reinforcement within Balancing Area
- Renewable gen-tie
- Overlay bulk transmission grids
- Asynchronous transmission reinforcement

Controllability
- Transmission reinforcement between Balancing Areas
- Renewable gen-tie
- Overlay bulk transmission grids

Long distance bulk transport
- Transmission reinforcement within Balancing Area
- Transmission reinforcement between Balancing Areas
- Renewable gen-tie
- Overlay bulk transmission grids
- Asynchronous transmission reinforcement

Asynchronous connection
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City centre infeed
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Water crossings
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Thank You!

Comments and Questions?

Additional Slides
Additional Reading on Transmission


Pfeifenberger, Tsoukalis, Newell, *"The Benefit and Cost of Preserving the Option to Create a Meshed Offshore Grid for New York,"* Prepared for NYSERDA with Siemens and Hatch, November 9, 2022.


Newell et al., *"Benefit-Cost Analysis of Proposed New York AC Transmission Upgrades,"* on behalf of NYISO and DPS Staff, September 15, 2015.


Pfeifenberger and Hou, *"Seams Cost Allocation: A Flexible Framework to Support Interregional Transmission Planning,"* on behalf of SPP, April 2012.

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
- Energy Storage
- Environmental Policy, Planning and Compliance
- Finance and Ratemaking
- Gas/Electric Coordination
- Market Design
- Natural Gas & Petroleum
- Nuclear
- Renewable & Alternative Energy

LITIGATION
- Accounting
- Analysis of Market Manipulation
- Antitrust/Competition
- Bankruptcy & Restructuring
- Big Data & Document Analytics
- Commercial Damages
- Environmental Litigation & Regulation
- Intellectual Property
- International Arbitration
- International Trade
- Labor & Employment
- Mergers & Acquisitions Litigation
- Product Liability
- Securities & Finance
- Tax Controversy & Transfer Pricing
- Valuation
- White Collar Investigations & Litigation

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