Solving the Transmission Challenge for Decarbonization

PRESENTED BY

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PREPARED FOR

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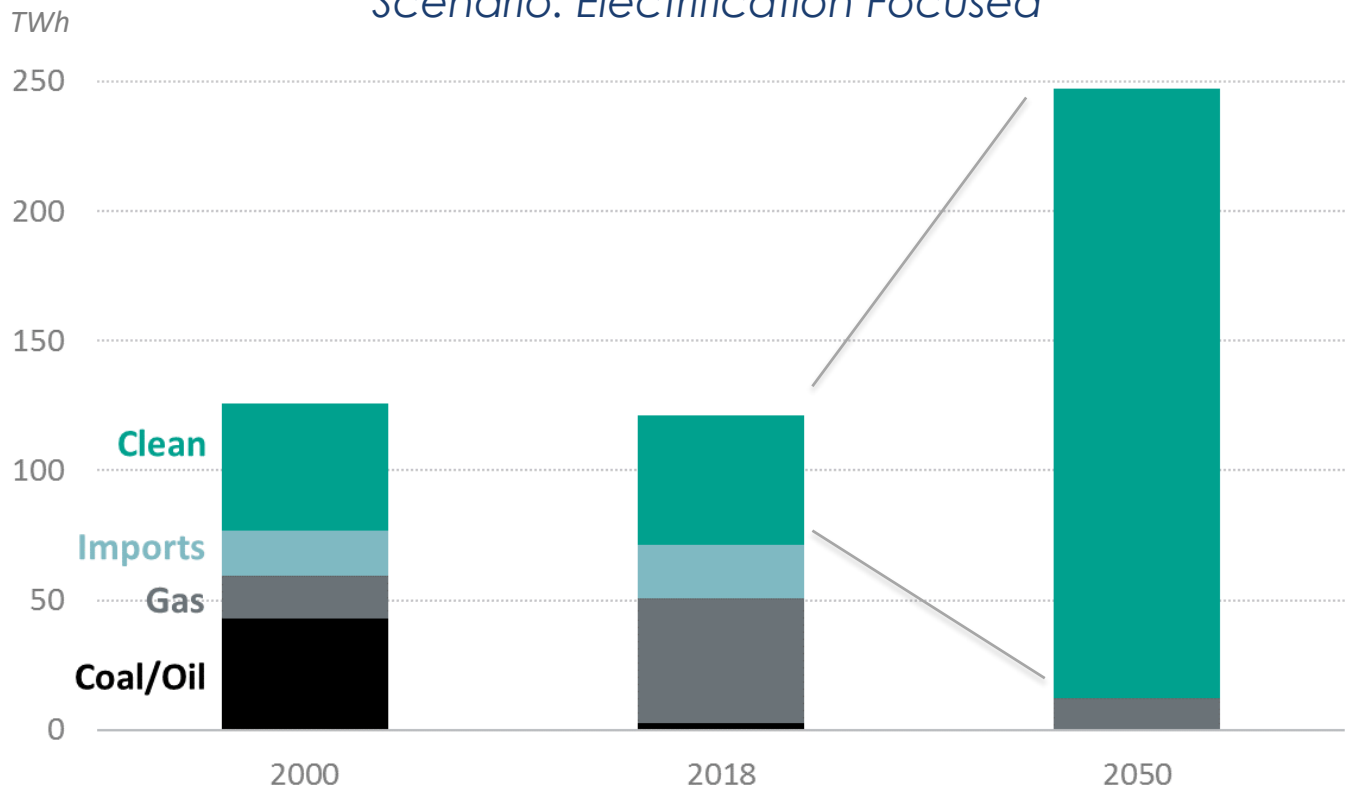
Brattle

Decarbonizing New England will require a massive buildout of clean energy resources

- Replace about **50% of supply** currently from fossil fuel-fired resources
- Supply the approximately **100% increase in demand** from electrification

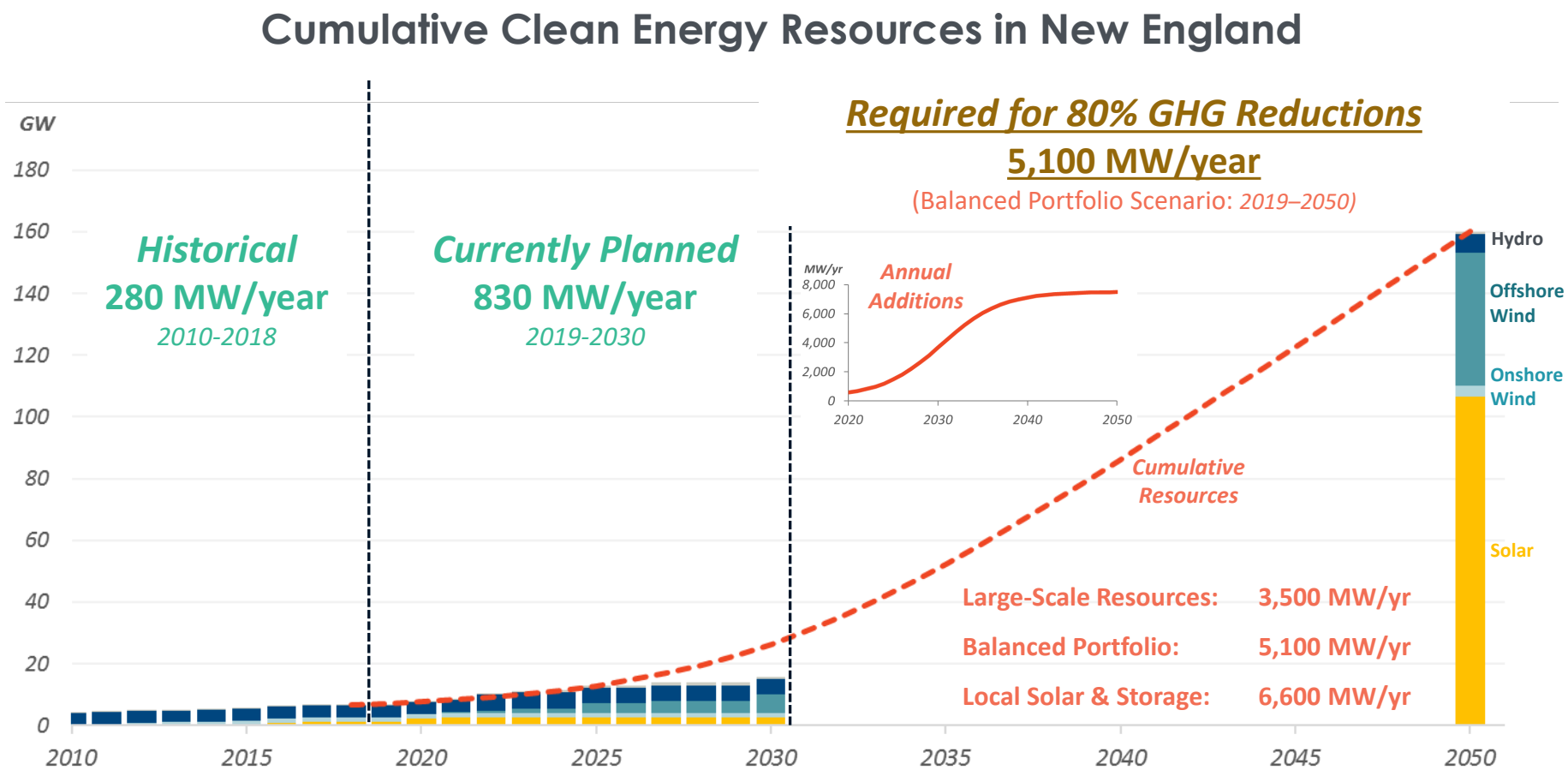
Historical and Projected 2050 New England Generation Mix

Scenario: Electrification Focused



Source: ISO-NE, Key Grid and Market Stats, https://www.iso-ne.com/about/key-stats/, accessed June 28, 2019.

Achieving existing 2050 goals requires significant acceleration of clean-energy investments



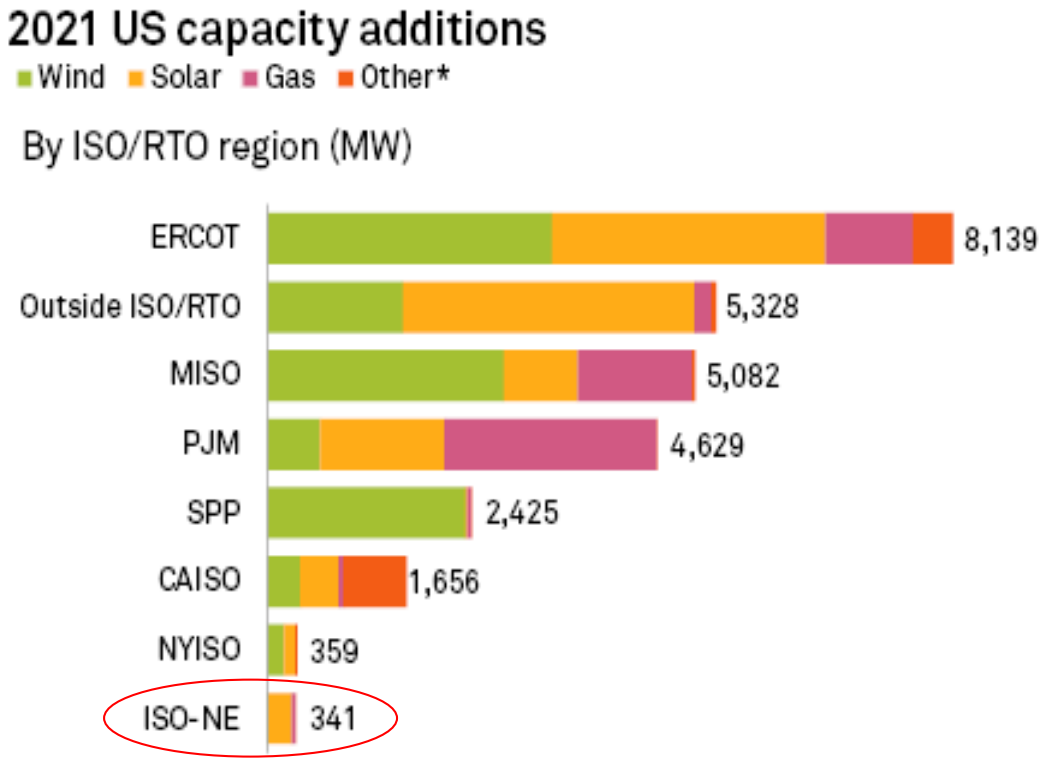
Annual clean energy resource additions need to increase by 4–8x overall

Large-scale solar resource additions will need to increase by 10–25x to meet these goals

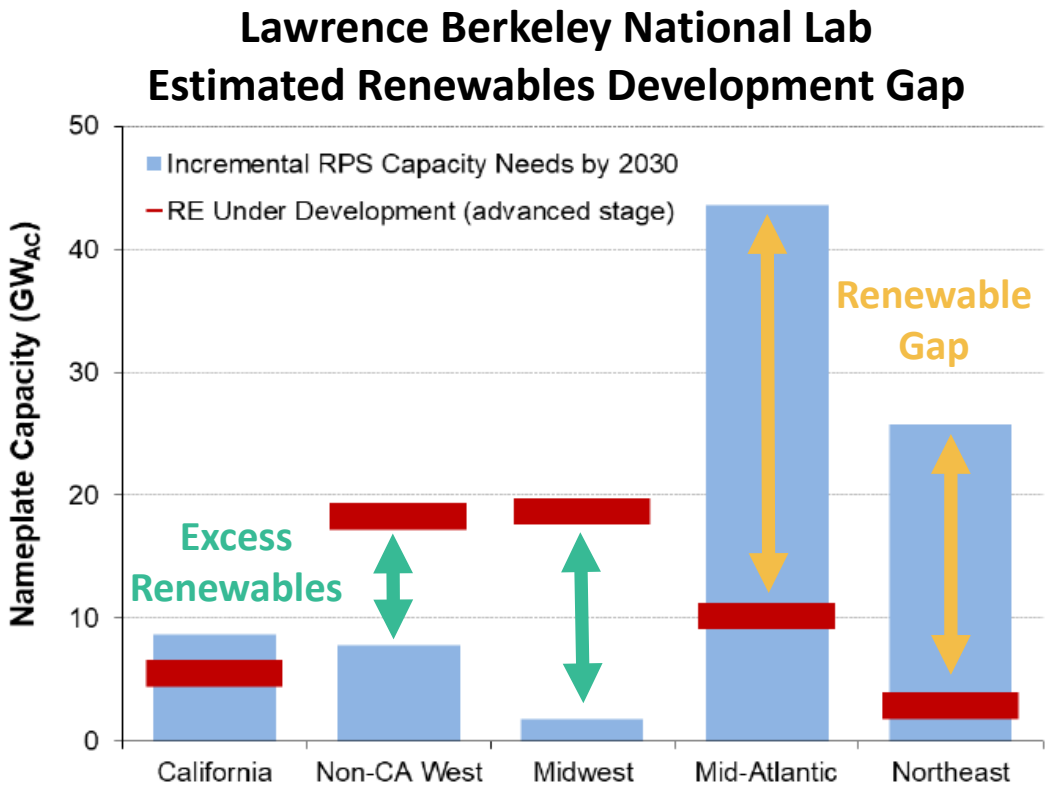
Source: Achieving New England's Ambitious 2050 Greenhouse Gas Reduction Goals - Brattle

Challenge: The Generation Interconnection Process

ISO-NE, NYISO, and PJM have interconnected significantly less renewable generation despite the significant renewable development needed to meet state policies



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



Source: Galen Barbose, "U.S. Renewables Portfolio Standards: 2021 Status Update (Early Release)," Lawrence Berkeley National Lab, Feb 2021. rps.lbl.gov

Solution: Proactive Transmission Planning for the 21st Century*

Available experience already points to proven planning practices that reduce total system costs and risks:

1. **Proactively (rather than incrementally) plan for future generation and load** by incorporating realistic projections of the necessary generation mix, public policy mandates, load levels, and load profiles over the lifespan of the transmission investment
2. **Account for the full range of transmission projects' benefits** 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 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.

Examples of Proactive Multi-value Transmission Planning

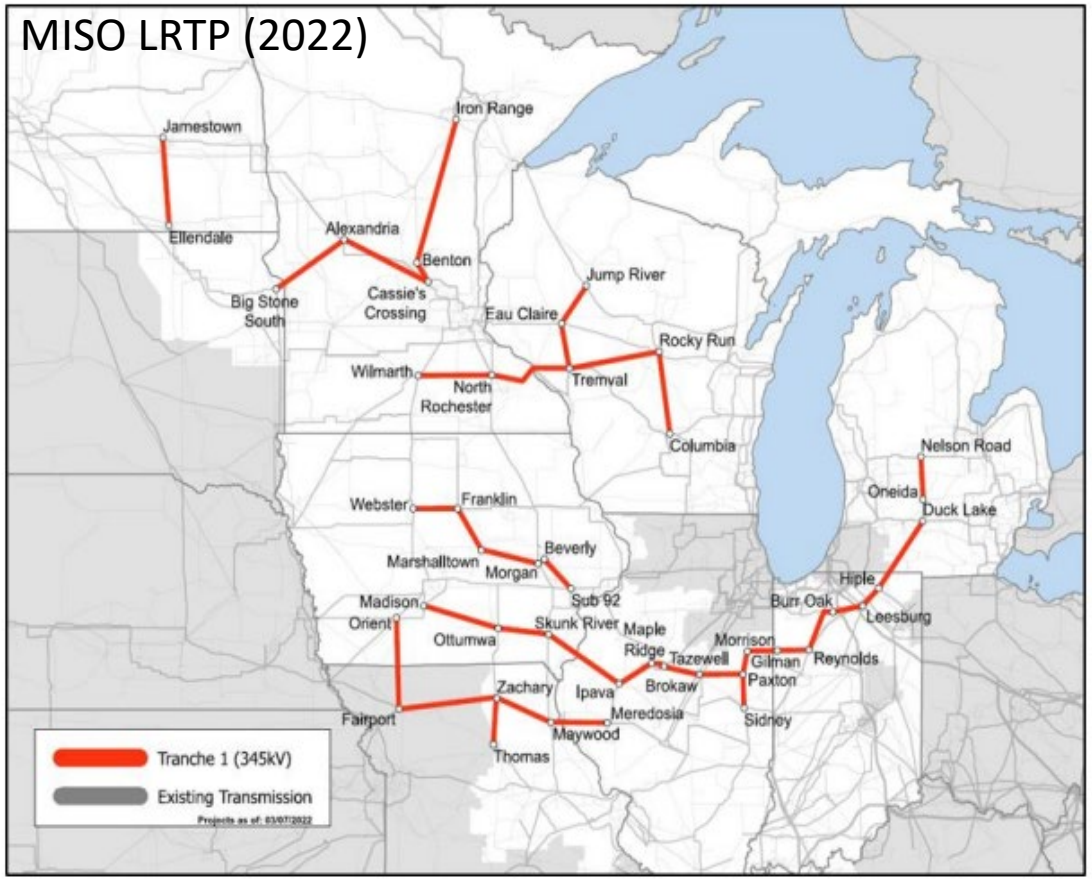
Proactive multi-value transmission planning will be necessary to create a cost-effective grid and to reduce the cost and time required to interconnect renewables at scale

MISO 2022 LRTP results

- Tranche 1: $10 billion portfolio of proposed new 345 kV transmission projects for its Midwestern footprint
- Supports interconnection of 53,000 MW of renewable resources
- Reduces other costs by $37-68 billion

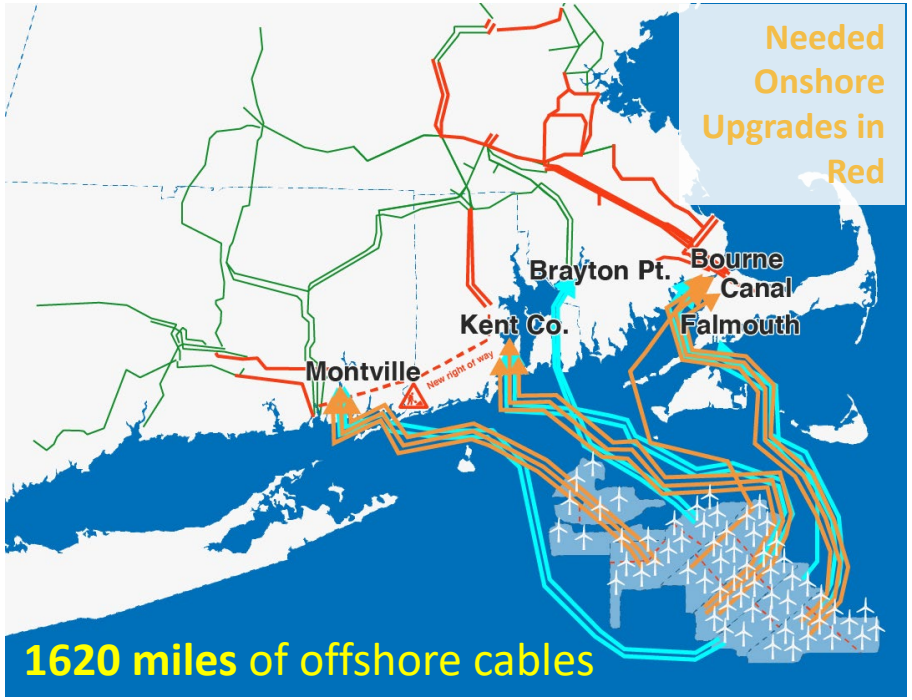
PJM Transmission Study

- Proactively evaluated all existing state public policy needs
- Identified only $3.2 billion in upgrades to integrate 75,000 MW of renewables ($40/kW)
- Would be significantly more cost effective than continued reliance on incremental upgrades through PJM's interconnection process

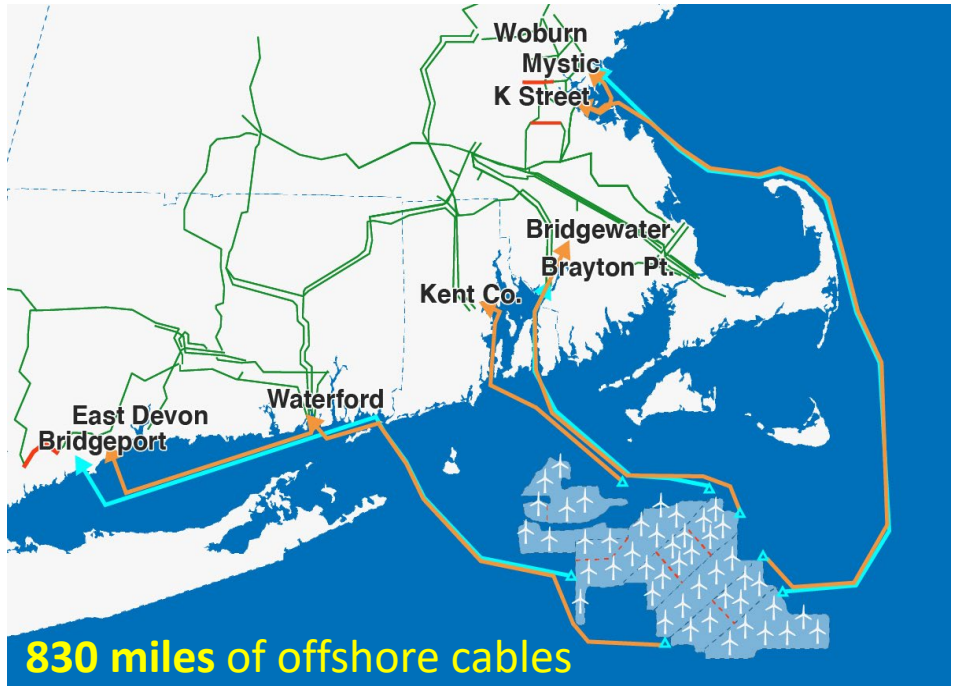


The Benefits of Proactive Planning: OSW for New England

Plausible Gen Tie Approach (for 8400 MW)



Planned Grid Approach (for 8400 MW)



Avoids high-costs of onshore upgrades reduces total costs and risks

Reduces the number of offshore platforms, cabling, seabed disturbance, and cables landing at the coast

Source: Offshore Transmission in New England: The Benefits of a Better Planned Grid - Brattle

Barriers to Better Transmission Planning and Grid Development

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, November 30, 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

About the Speaker

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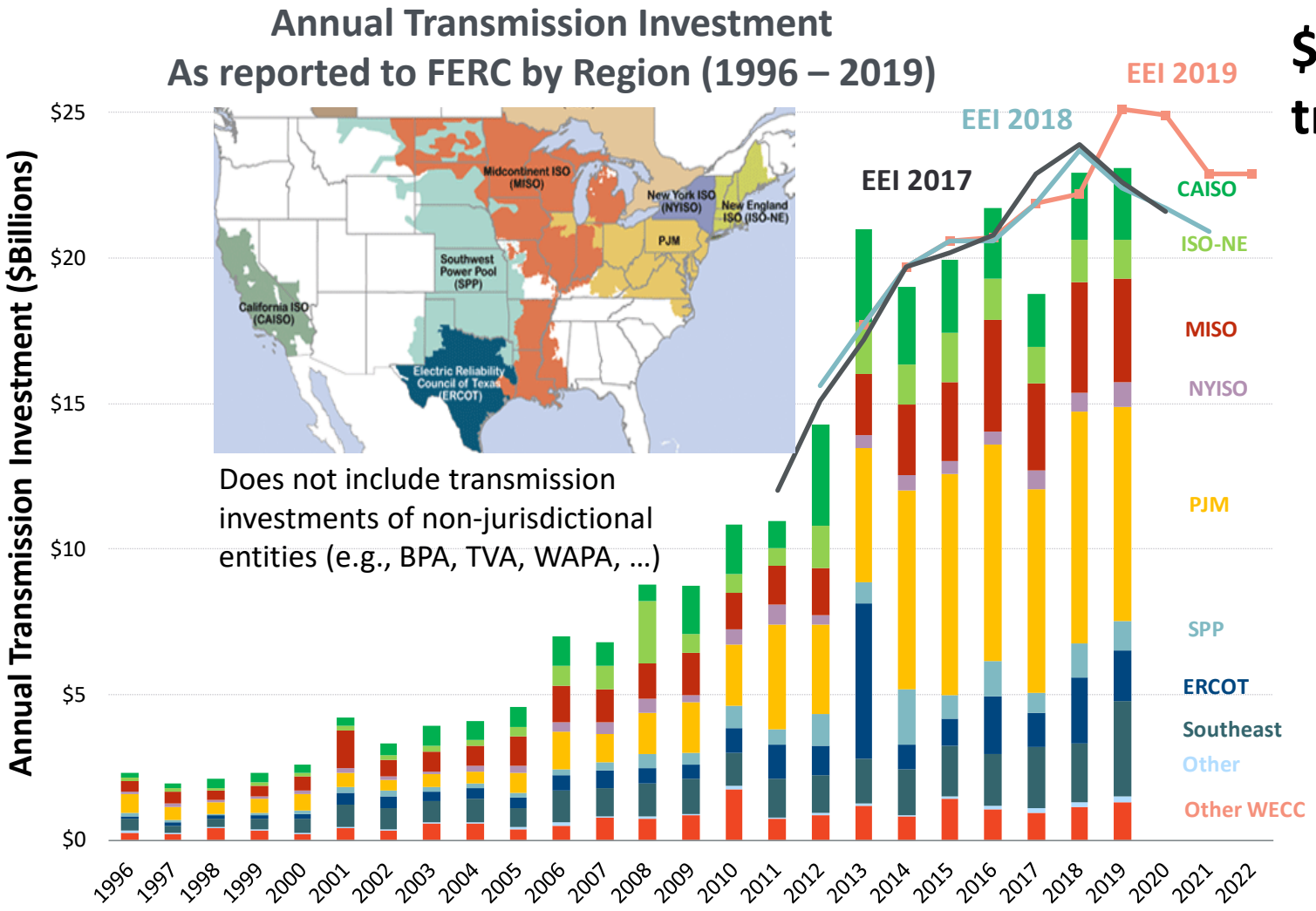
Johannes (Hannes) Pfeifenberger, a Principal at The Brattle Group, is an economist with a background in electrical engineering and over twenty-five years of experience in wholesale power market design, renewable energy, electricity storage, and transmission. He also is a Visiting Scholar at MIT's Center 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 transmission-related renewable generation 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.

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 Investment is at Historically High Levels

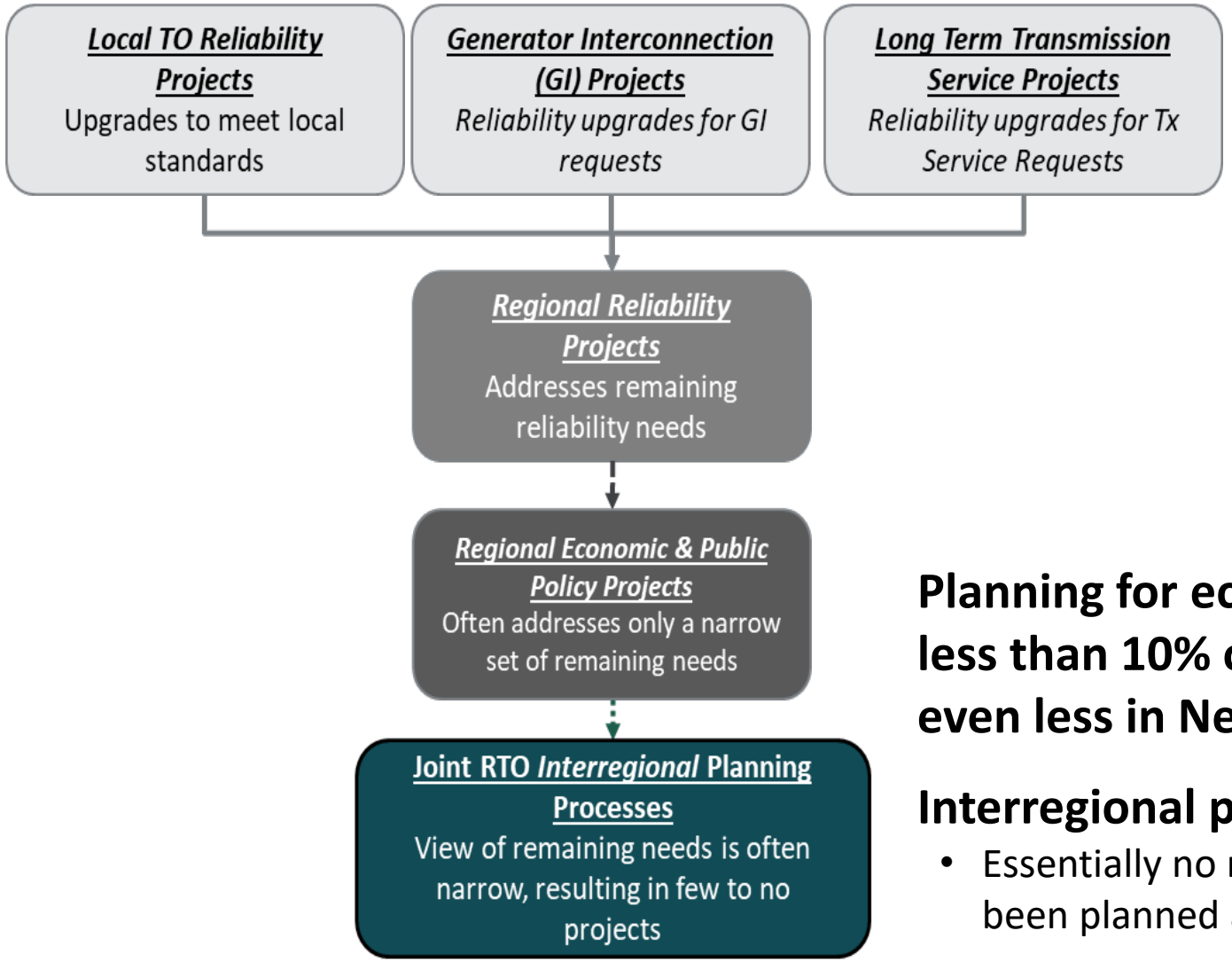


Source: FERC Form 1 Data, EEI "Historical and Projected Transmission Investment" most recent accessed here: https://www.eei.org/resourcesandmedia/Documents/Historical%20and%20Projected%20Transmission%20Investment.pdf

$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
- While significant experience with transmission benefit-cost analyses exists, very few projects are justified based on economics and overall cost savings
- Relative to its size, New England has spent more on transmission than any other region, yet has created little headroom to integrate clean energy resources

Current U.S. Transmission Planning Processes for…



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 U.S. transmission investments; even less in New England

Interregional planning processes are large ineffective

- Essentially no major interregional transmission projects have been planned and built in the last decade

Improving the Generation Interconnection Process

More proactive transmission planning and reducing the scope of upgrades triggered by generation interconnection processes will be necessary to accelerate and lower the cost of renewable interconnection:

- ERCOT's generation interconnection process is generally seen as 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 takes longer than that
  - Upgrades focused more on local needs (similar to ERIS) and are recovered through postage stamp
  - Network constraints managed through market dispatch – which imposes high congestion and curtailment risks on interconnecting generators due to insufficiently proactive multi-value grid planning
  - See working-paper.pdf (enelgreenpower.com) [Note: Brattle was not involved]
- Attractive: UK "Connect and Manage" (replaced prior "Invest and Connect")
  - Similar to ERIS; 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
- Generation interconnection study criteria matter, yet differ substantially across RTOs
  - Overly stringent study criteria can trigger expensive "deep network" upgrades, which increases churn and restudy requirements; congestion management and proactive transmission planning offer more cost-effective solutions

Experience with Proactive & Comprehensive Planning Processes

Although still rarely used, significant experience exists with successful proactive, multi-value, scenario- and portfolio-based transmission planning efforts:

	Proactive Planning	Multi-Benefit	Scenario-Based	Portfolio-Based	Interregional Transmission
CAISO TEAM (2004)[146]	✓	✓	✓		
ATC Paddock-Rockdale (2007)[147]	✓	✓	✓		
ERCOT CREZ (2008)[148]	✓			✓	
MISO RGOS (2010)[149]	✓	✓		✓	
EIPC (2010-2013)[150]	✓		✓	✓	✓
PJM renewable integration study (2014)[151]	✓		✓	✓	
NYISO PPTPP (2019)[152]	✓	✓	✓	✓	
ERCOT LTSA (2020)[153]	✓		✓		
SPP ITP Process (2020)[154]		✓		✓	
PJM Offshore Tx Study (2021)[155]	✓		✓	✓	
MISO RIIA (2021)[156]	✓	✓	✓	✓	
Australian Examples: - AEMO ISP (2020)[157] - Transgrid Energy Vision (2021)[158]	 ✓ ✓	 ✓ ✓	 ✓ ✓	 ✓ ✓	 ✓ ✓

Source: Brattle & Grid Strategies, Transmission Planning for the 21st Century: Proven Practices that Increase Value and Reduce Costs

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

Additional Reading on Transmission

Pfeifenberger, New York State and Regional Transmission Planning for Offshore Wind Generation, NYSERDA Offshore Wind Webinar, March 30, 2022.

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, Prepared for the 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.

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.

Pfeifenberger, Transmission–The Great Enabler: Recognizing Multiple Benefits in Transmission Planning, ESIG, October 28, 2021.

Pfeifenberger et al., Transmission Planning for the 21st Century: Proven Practices that Increase Value and Reduce Costs, Brattle-Grid Strategies, October 2021.

Pfeifenberger, Transmission Options for Offshore Wind Generation, NYSERDA webinar, May 12, 2021.

Pfeifenberger, Transmission Planning and Benefit-Cost Analyses, presentation to FERC Staff, April 29, 2021.

Pfeifenberger et al., Initial Report on the New York Power Grid Study, prepared for NYPSC, January 19, 2021.

Pfeifenberger, Ruiz, Van Horn, "The Value of Diversifying Uncertain Renewable Generation through the Transmission System," BU-ISE, October 14, 2020.

Pfeifenberger, Newell, Graf and Spokas, "Offshore Wind Transmission: An Analysis of Options for New York", prepared for Anbaric, August 2020.

Pfeifenberger, Newell, and Graf, "Offshore Transmission in New England: The Benefits of a Better-Planned Grid," prepared for Anbaric, May 2020.

Tsuchida and Ruiz, "Innovation in Transmission Operation with Advanced Technologies," T&D World, December 19, 2019.

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. "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.

Chang and Pfeifenberger, "Well-Planned Electric Transmission Saves Customer Costs: Improved Transmission Planning is Key to the Transition to a Carbon-Constrained Future," WIRES and The Brattle Group, June 2016.

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

Pfeifenberger, Chang, and Sheilendranath, "Toward More Effective Transmission Planning: Addressing the Costs and Risks of an Insufficiently Flexible Electricity Grid," WIRES and The Brattle Group, April 2015.

Chang, Pfeifenberger, Hagerty, "The Benefits of Electric Transmission: Identifying and Analyzing the Value of Investments," on behalf of WIRES, July 2013.

Chang, Pfeifenberger, Newell, Tsuchida, Hagerty, "Recommendations for Enhancing ERCOT's Long-Term Transmission Planning Process," October 2013.

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

Pfeifenberger, Hou, "Employment and Economic Benefits of Transmission Infrastructure Investment in the U.S. and Canada," on behalf of WIRES, May 2011.