

Offshore Transmission in New England:

THE BENEFITS OF A BETTER- PLANNED GRID

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PRESENTED AT
ESIG Fall
Technical
Conference

Oct 29, 2020



THE **Brattle** GROUP



Presenting today



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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 Senior Fellow at Boston University's Institute of Sustainable Energy (BU-ISE), a Visiting Scholar at MIT's Center for Energy and Environmental Policy Research (CEEPR), and serves as an advisor to research initiatives by the Lawrence Berkeley National Laboratory's (LBNL's) Energy Analysis and Environmental Impacts Division and the US Department of Energy's (DOE's) Grid Modernization Lab Consortium.

Most recently, Mr. Pfeifenberger evaluated offshore wind transmission options in [New York State](#) and [New England](#), discussed role of offshore wind in economy-wide decarbonization on a panel organized by the Atlantic Council, and presented on offshore wind development trends, transmission needs, and renewable integration challenges at a number of industry meetings, including the Harvard Electricity Policy Group.

Mr. Pfeifenberger 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.

Motivation: Substantial off-shore wind development planned in the Northeast

Thousands of MW of new clean-energy resources will need to be built to achieve decarbonization goals of US states.

A key policy challenge is **ensuring a pathway to enable the lowest-cost solutions** for delivering new clean energy from source to population centers.

On the east coast, substantial off-shore wind generation is needed even beyond current commitments. For example:

Region	Already Contracted	Total Committed	Potentially Needed
New England	3,112 MW	5,900 MW	25-40,000 MW by 2050
New York	1,826 MW	9,000 MW	15-25,000 MW by 2040

Sources:

Brattle Study of NE by Jurgen Weiss and Michael Hagerty, "[Achieving 80% GHG Reduction in New England by 2050](#)," September 2019.

Brattle Study for NYISO by Roger Lueken et al., "[New York's Evolution to a Zero Emission Power System: Modeling Operations and Investment Through 2040](#)." May 18, 2020.

E3, "[Electric Reliability under Deep Decarbonization in New England](#)," August 4, 2020.

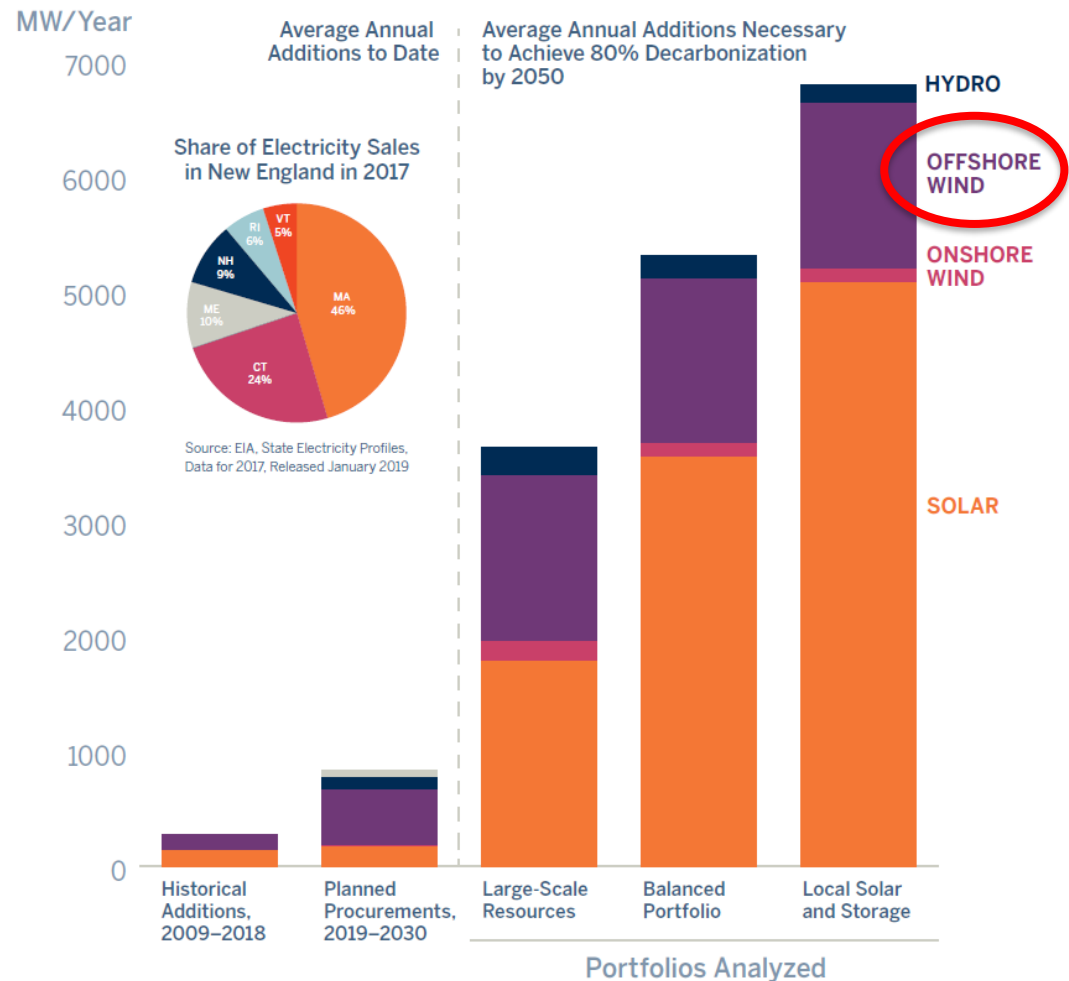
E3, "[Pathways to Deep Decarbonization in New York State](#)," June 24, 2020.

Example: Substantial long-term need for off-shore wind in New England

New England likely would need to add **1,500 MW of OSW every year** through 2050 to achieve “80 by 50” decarbonization goals

Developing these resources and associated transmission efficiently is essential for controlling customer costs

Rapid Development of Renewable Resources Needed in Coming Decades



Project scope and approach

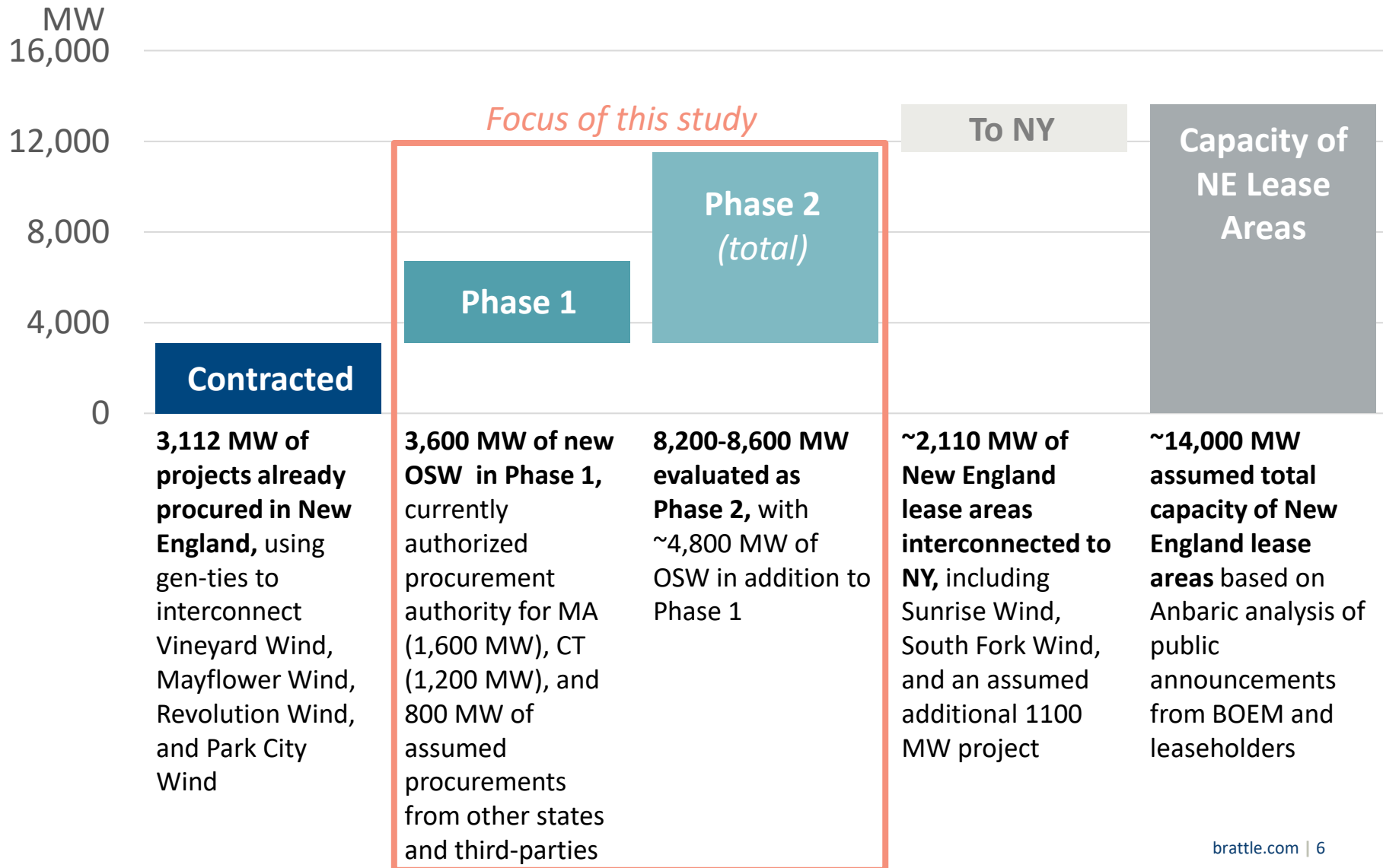
In separate studies of [New England](#) and [New York](#) for Anbaric, we examined approaches to developing offshore transmission and associated onshore grid upgrades to reach stated offshore wind (OSW) development goals

We examined two alternatives:

1. The **“generator lead line” approach**: developers develop incremental amounts of OSW generation with project-specific generator lead lines (GLLs)
2. An alternative **“planned” approach**: Offshore transmission and onshore grid upgrades are planned to minimize overall risks and costs of achieving offshore wind and clean energy goals

The following slides provide an overview of the planned grid approach and summarize results from our New England study

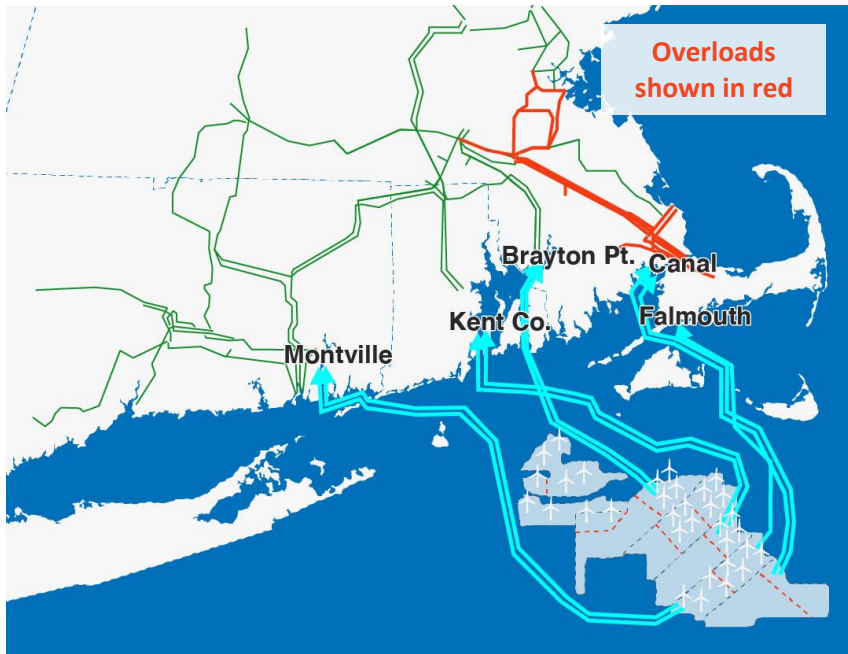
We compare transmission configurations for two additional OSW expansion phases



Phase 1 (add 3,600 MW): Summary of the two transmission approaches

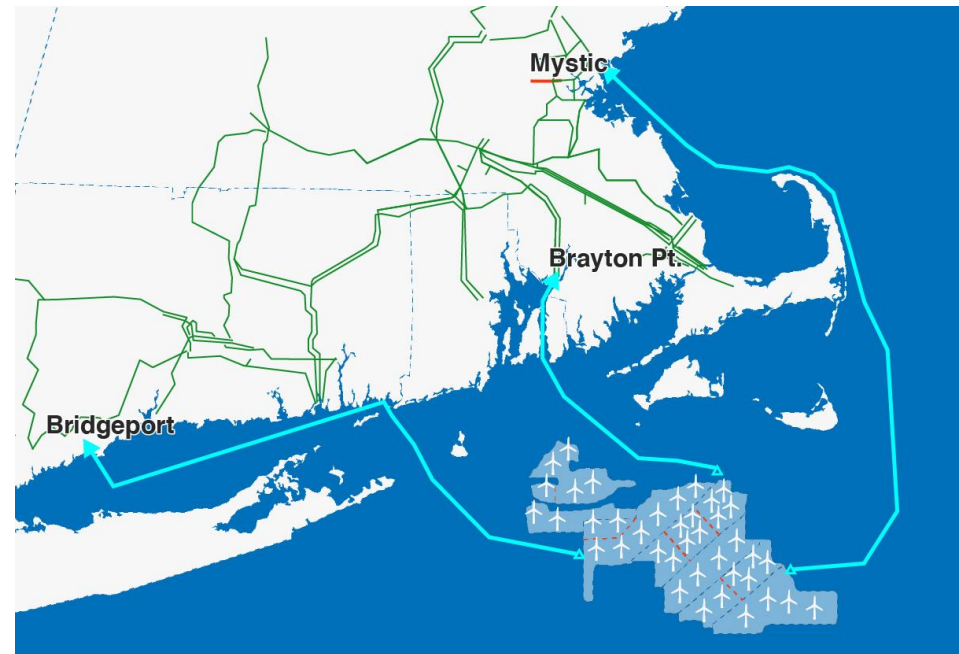
Current GLL Approach

- 9 x 400 MW High Voltage Alternating Current (HVAC) cable bundles:
 - 800 MW each at Montville, Kent Co. Brayton Pt. & Canal
 - 400 MW at Falmouth
- 694 miles of marine cabling
- 4.0% losses
- Significant onshore transmission overloads



Planned Offshore-Grid Approach

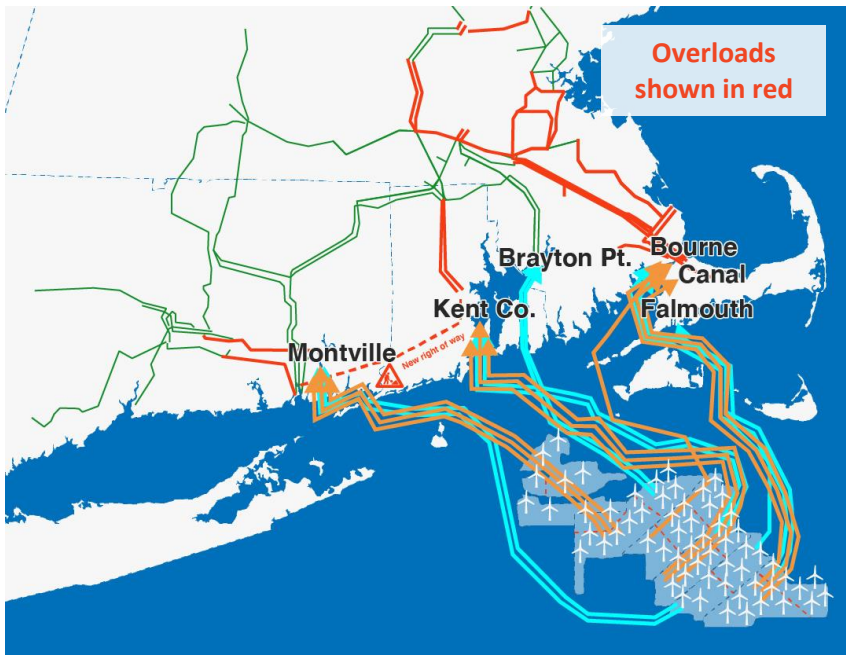
- 3 x 1,200 MW High Voltage Direct Current (HVDC) cable bundles
 - 1,200 MW each at Bridgeport, Brayton Pt. & Mystic
- 356 miles of marine cabling
- 2.4% losses
- Minimal onshore transmission overloads



Phase 2 (add 8,000+ MW): Summary of the two transmission approaches

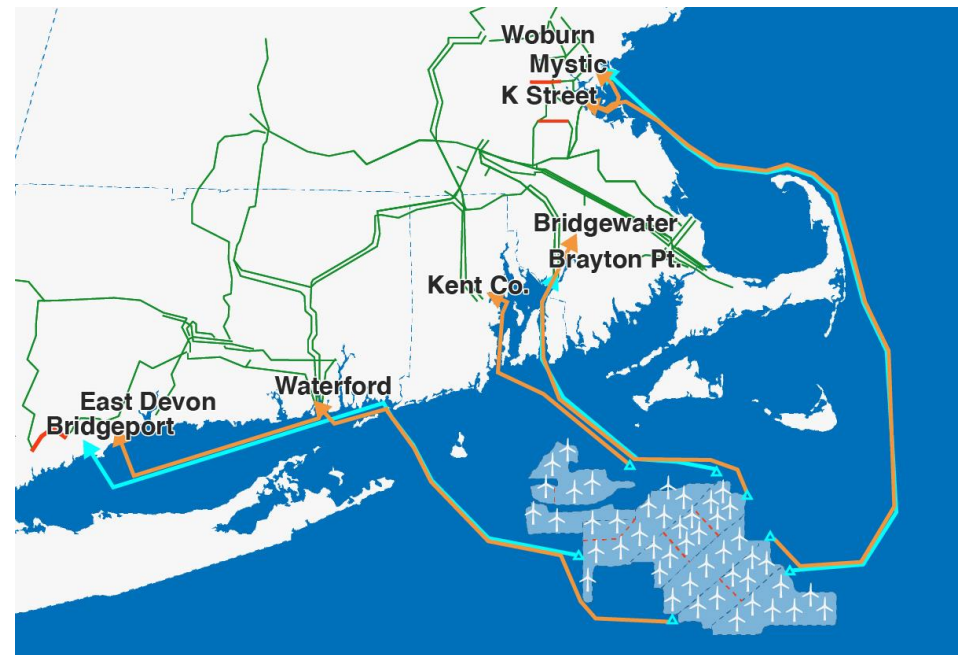
Phase 2, Current Approach (add 8,200 MW)

- 9 x 466 MW HVAC cable bundles
 - 1,400 MW each at Montville, Kent Co., & Canal
- 1 x 400 MW HVAC project
 - 400 MW at Bourne
- 926 miles of marine cabling (1,620 total Phase 1+2)
- Major onshore transmission overloads



Phase 2, Planned Approach (add 8,600 MW)

- 3 x multiterminal HVDC projects
 - 2,000 MW to Waterford (1200 MW) & East Devon (800 MW)*
 - 1,600 MW to K St. (800 MW) & Woburn (800 MW)*
 - 1,000 MW to Bridgewater
 - 400 MW HVAC project to Kent Co. RI
- 474 miles of marine cabling (831 total Phase 1+2)



*Multiterminal HVDC injecting at two locations

Summary of benefits of a planned offshore transmission approach

Elements we examine	Our analysis indicates...
Total onshore + offshore transmission costs <ul style="list-style-type: none"> • Onshore transmission upgrade costs (more risk) • Offshore transmission costs (less risk) 	10% lower under planned approach <ul style="list-style-type: none"> • 65% lower under planned approach • 22% higher under planned approach
Losses over offshore transmission	40% lower under planned approach
Impact to fisheries and environment	49% less marine cable under planned approach
Customer costs of energy, excluding transmission	\$20 million lower annually under planned approach*
Effect on generation and transmission competition	Increased competition under planned approach
Utilization of constrained landing points	Improved under planned approach
Utilization of existing lease areas	Improved under planned approach
Enabling third-party customers	Improved under planned approach

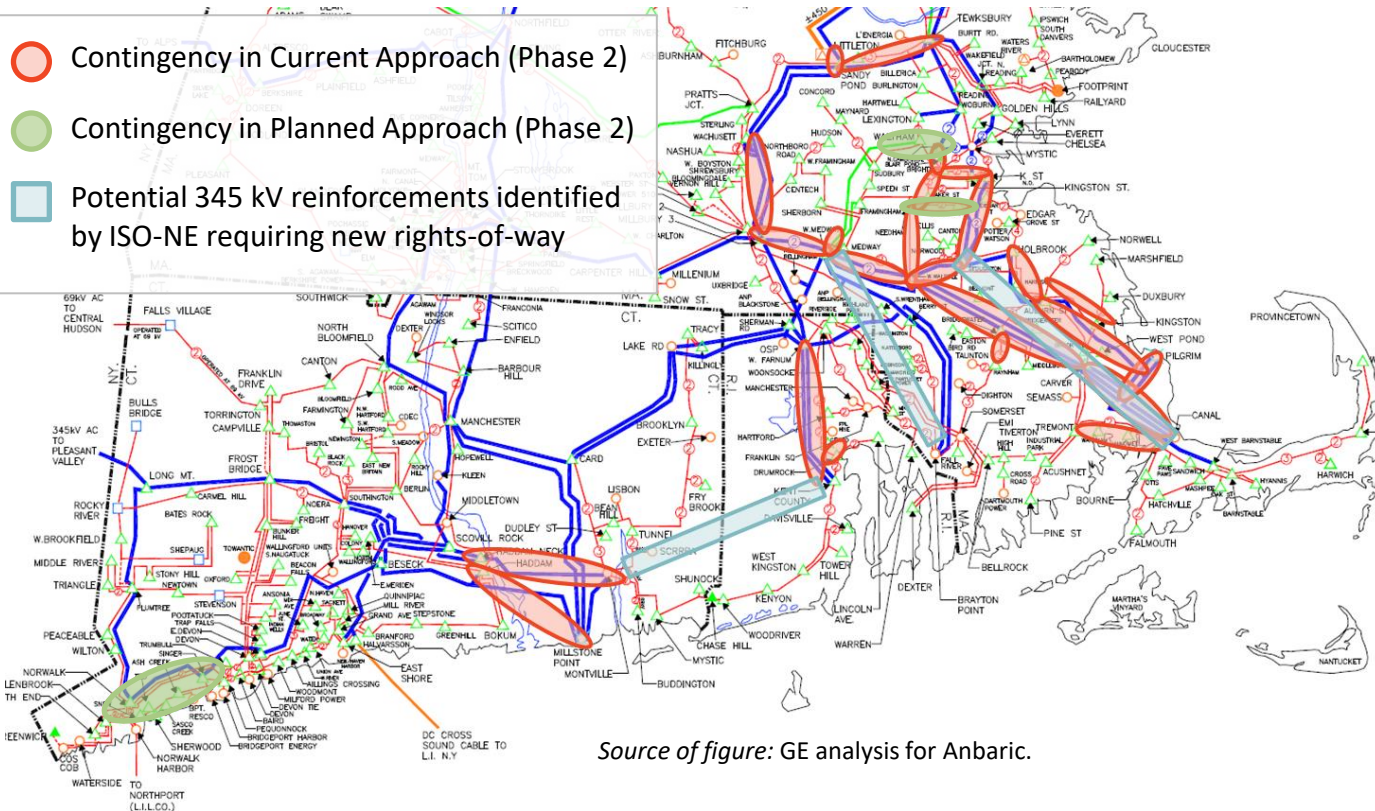
We quantified benefits of the transmission configuration under the planned approach for Phase 1, and also describe several of the qualitative benefits – which exist in Phase 1 and are likely higher in Phase 2

Notes: In this presentation we focus on elements in bold; other elements discussed in [our public study](#)

* GE conducted analysis of production costs and customer costs for Phase 1 for the year 2024; details in full study and GE appendix.

Key observation: onshore costs are large under “current” approach

Already selected projects connecting to Cape Cod face up to \$787 million in onshore transmission upgrades,* and continuing this approach for even the next 3600 MW of procurements could lead to an additional \$1.7 billion in onshore upgrades.



Planned off-shore transmission can significantly reduce the necessary onshore upgrades.

Given the difficulty of permitting and building new onshore transmission, a planned approach also reduces the risk of cost overruns and delays

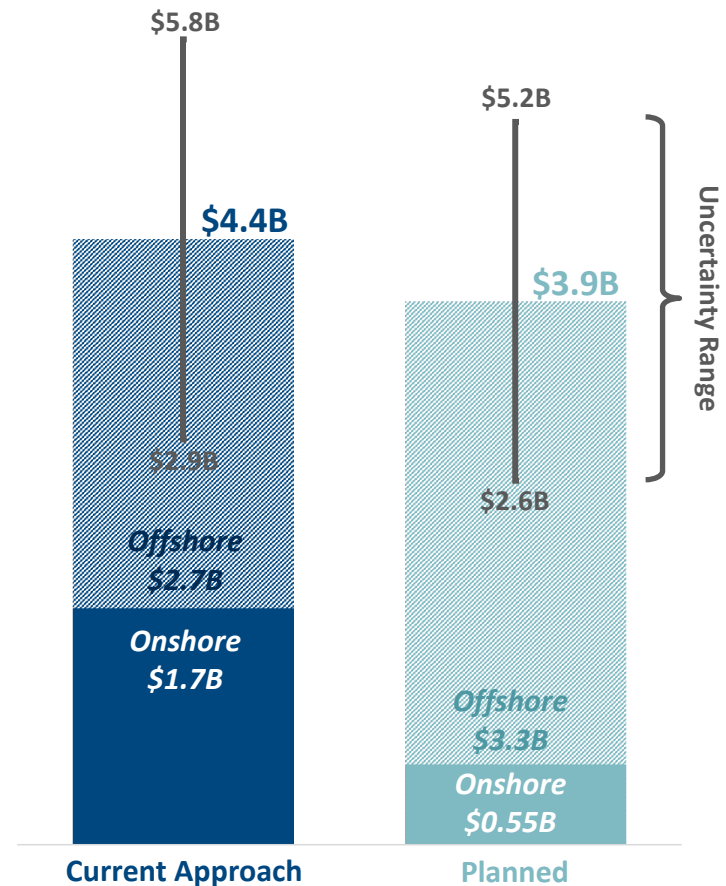
* ISO-NE's Feasibility Study for interconnecting three projects totaling 2,400 MW to Cape Cod (QP 828)

Total costs of transmission are expected to be lower under a planned approach

Even including the more costly offshore transmission equipment, total costs of onshore upgrades plus offshore transmission to enable the next 3,600 MW of OSW are estimated to be lower under a planned than the current gen-tie approach

The planned approach to building offshore transmission can enable significant long-term cost savings and avoid some of the higher risks associated with onshore upgrades

Comparison of Total Onshore Plus Offshore Transmission Costs in Phase 1
(3,600 MW additional OSW)



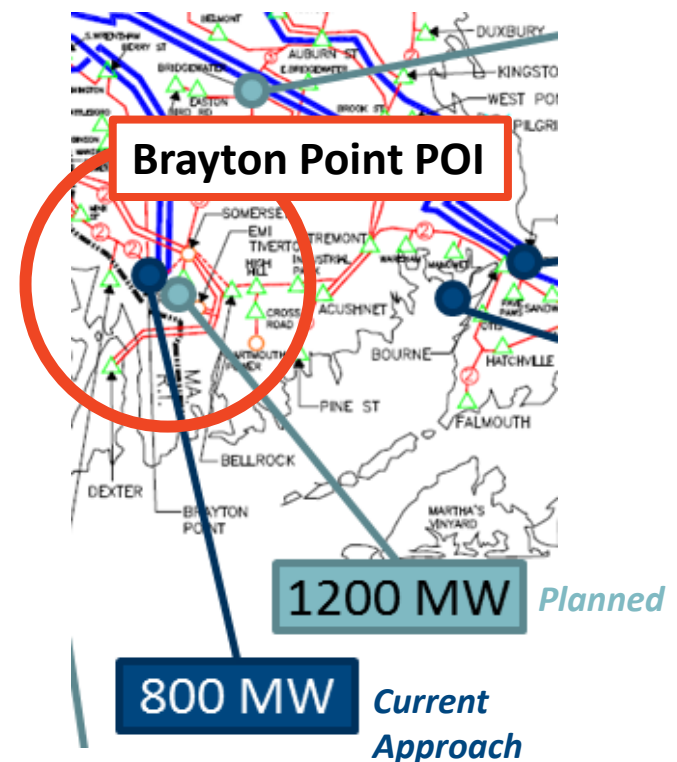
More efficient use of constrained “cable-approach” routes

A planned transmission approach can make better use of limited landing sites.

For example:

- Anbaric’s analysis indicates that access routes to Brayton Point have space for only 2 physical cable bundles. Under the current gen-tie approach this would accommodate 2 x 400 MW HVAC interconnection cable bundles
- A planned approach utilizing HVDC cable bundles can deliver 1,200MW to Brayton Point with room for an additional HVDC cable bundle before reaching spacing constraints

Example: Interconnection Capacity under the Current and Planned Approaches

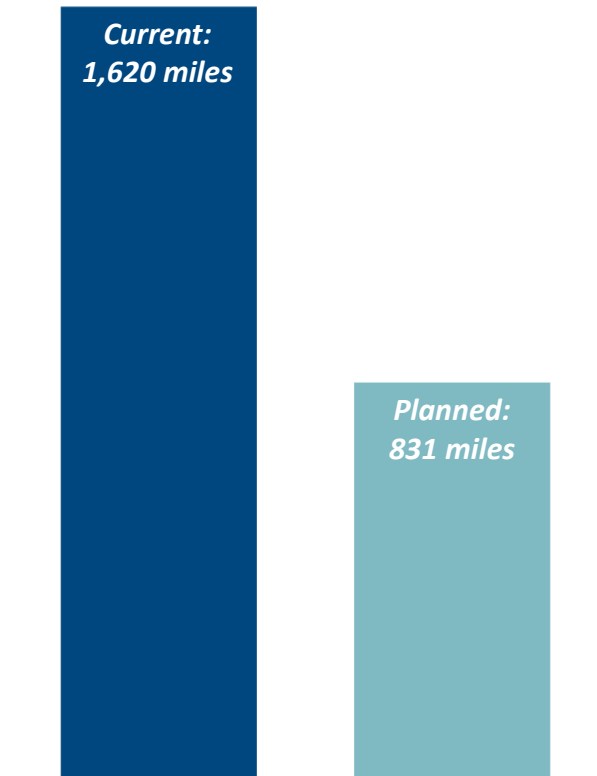


Reduced impacts to fisheries and the environment

Better planning can reduce the cumulative effects of offshore transmission on fisheries and the environment

- Under a planned off-shore-grid approach, marine trenching can be reduced by almost 50%
- Offshore cables can be grouped in transmission corridors to minimize impact; this is not possible to enforce under the current (one-off, unplanned) approach

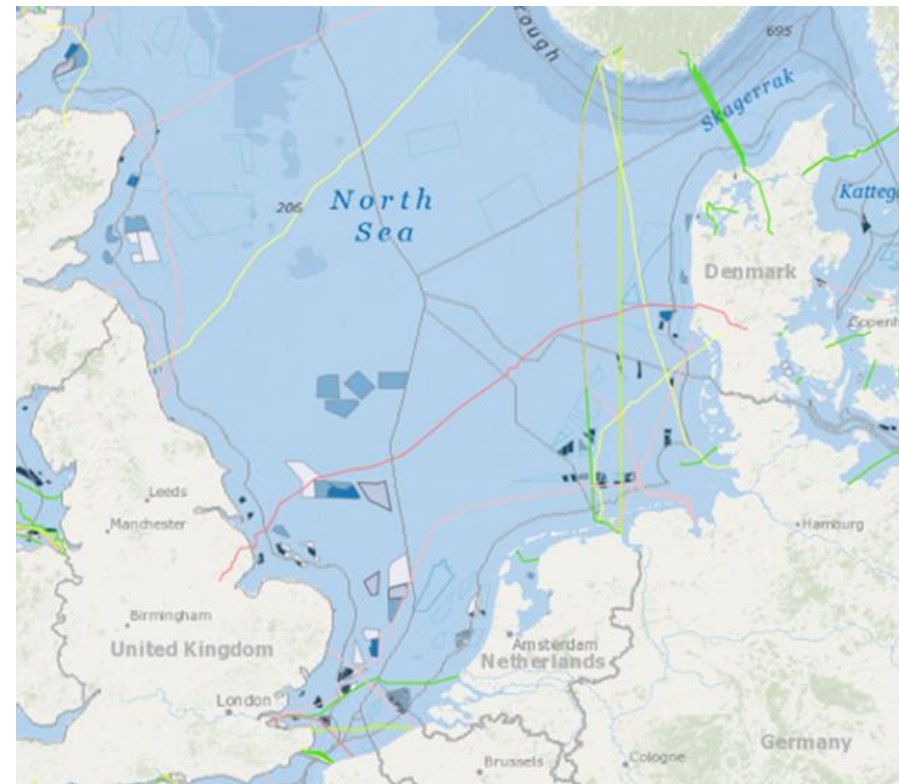
Comparison of Total Length of Undersea Transmission Under Current and Planned Approaches by Phase 2
(8,000 MW + additional OSW)



Offshore transmission in Europe

- Both Germany and the Netherlands have implemented a planned transmission approach, with offshore transmission developed separately and in anticipation of new OSW generation
- Offshore transmission developed by TSO and paid for by electric ratepayers (as with other transmission infrastructure)
- This approach has already enabled 8,600 MW of OSW connected to Germany and the Netherlands to date
- Approach has increased competition among OSW developers. Project costs have declined by over 50% in the last five years, leading to “subsidy free” PPAs for recent OSW in both Germany and the Netherlands

Existing Offshore Transmission Development in the North Sea

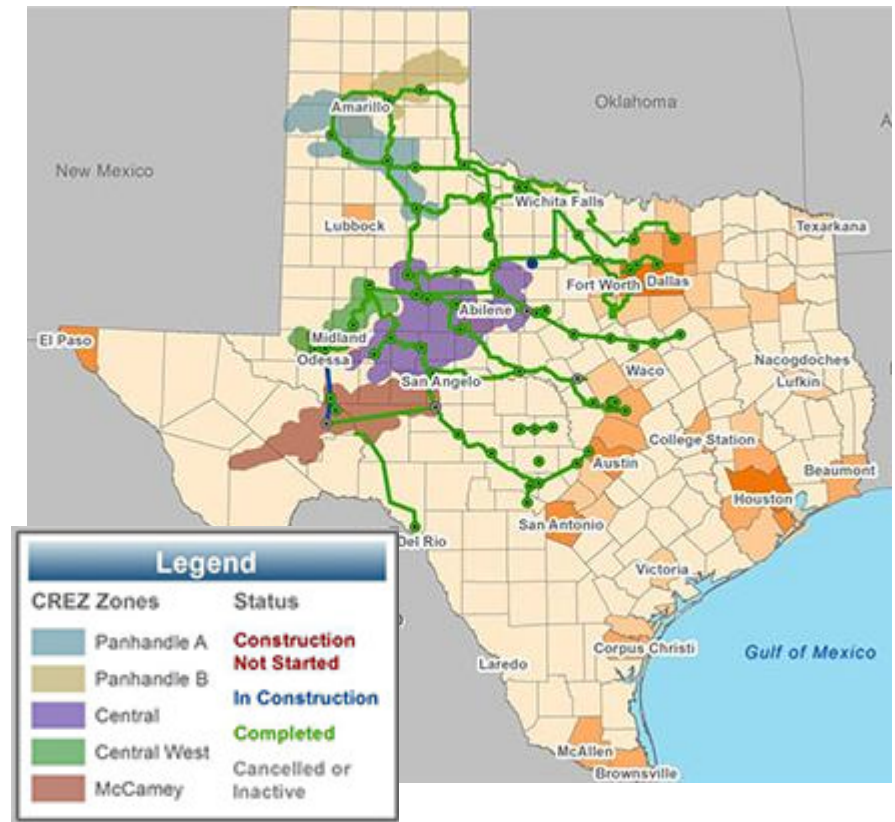


EXAMPLE OF U.S. ONSHORE WIND TRANSMISSION CASE STUDY

Competitive Renewable Energy Zones (CREZ) in Texas

- \$7 billion transmission-first program
- Phased development of transmission enabled 18.5 GW wind from five “competitive renewable energy zones” to rest of state
- Allowed rapid merchant development of wind in W. Texas, reducing electricity costs by \$1.7 billion annually

Texas CREZ Transmission Projects



How might one implement planned OSW transmission procurements

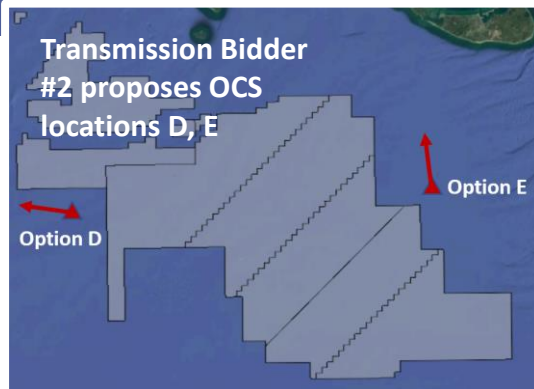
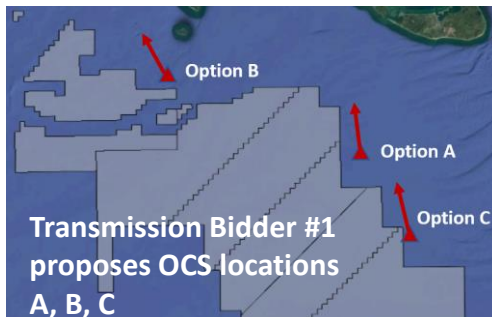
Example Implementation of Transmission and Generation Procurement

1. **Identify preferred onshore POIs** based on long-term plan
2. **Solicit transmission** developers to propose multiple fixed-price options for (bidder-determined) offshore collector station (OCS) locations and POIs
3. Evaluate transmission (Tx) bids considering cost, accessibility to lease areas, impacts on fisheries & environment and select a single winning bidder – but do not yet select final OCS location or POI
4. **Solicit generation** developers to bid to interconnect to any of the OCS locations provided by winning Tx bidder
5. Evaluate OSW generation bids, considering total cost (generation + transmission) and other factors to select generation developer and OCS location

Example of transmission and generation procurement

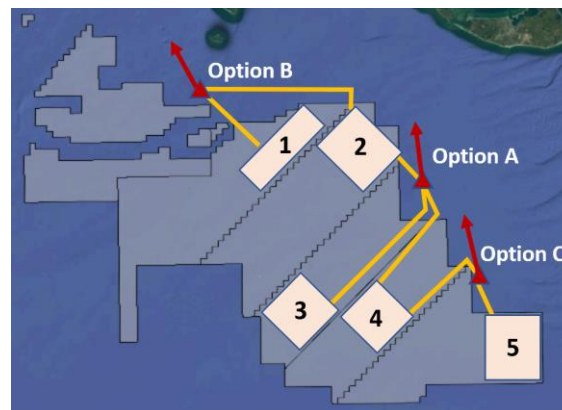
Transmission developers propose collector station locations A - E

Each transmission developer bids a fixed price for one or more collector station locations



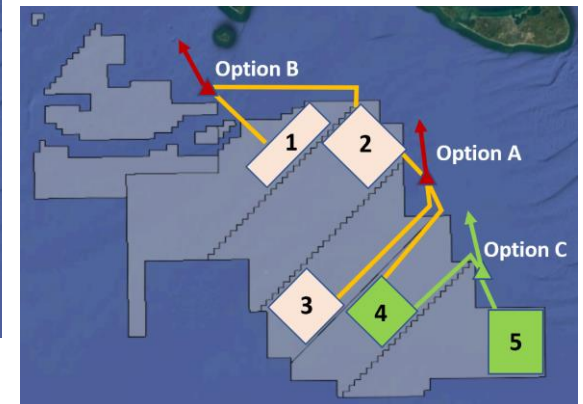
Transmission developer #1 selected; leaseholders bid wind generation 1-5 to collector stations A, B, C

Each generation developer bids a fixed price for one or more collector station locations



Selection of winning configuration

Wind farms 4 and 5 connecting to collector station C minimize costs of procuring specified MW quantity of offshore wind



Mitigating risks of separate generation and transmission development

The current GLL approach places development of generation and offshore transmission under a single developer, but leaves onshore upgrades with incumbent (onshore) transmission owners

- This approach reduces coordination risk between OSW and offshore transmission, but there remains project-on-project risk related to the completion of onshore upgrades

The planned offshore grid model can also address individual project-on-project risk through:

- Strong performance and completion incentives (rewards or penalties) for both transmission and generation developers to meet project deadlines
- Allowing generation developer to participate in transmission procurement, with the condition that the transmission will be open access
- Staggered transmission and generation project completion timelines (e.g., scheduling transmission project completion before generation)

The Bottom Line: We recommend a planned approach to offshore transmission

Utilizing GLLs has distinct disadvantages over planned offshore transmission

- Poorer use of limited onshore POIs
- Increased seabed disturbance
- Reduced competition for transmission and off-shore wind generation
- Higher onshore transmission upgrade costs and higher overall costs in the long run
- Higher risks of delays and curtailments due to challenges of permitting (the likely more substantial) onshore upgrades

But project-on-project risks of separate offshore transmission solutions need to be addressed

Additional Reading

- 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.
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- Newell, Spees, Pfeifenberger, "[Forward Clean Energy Markets: A New Solution to State-RTO Conflicts](#)," January 27, 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.
- Pfeifenberger, "[Improving Transmission Planning: Benefits, Risks, and Cost Allocation](#)," MGA Ninth Annual Transmission Summit, November 6, 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.
- Chang, Pfeifenberger, Hagerty, and Cohen, "[Response to Concentric Energy Advisors' Report on Competitive Transmission](#)," August 2019.
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- 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, and Hagerty, "[The Benefits of Electric Transmission: Identifying and Analyzing the Value of Investments](#)," on behalf of WIRES, July 2013.
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- 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.