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Offshore Transmission in New England:

The Benefits of a Better-Planned Grid

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Prepared for

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The Brattle Group

Project Scope and Approach

Anbaric retained Brattle to compare the potential costs of various offshore transmission options and recommend the most competitive and cost-effective options to enable offshore wind development in New England

We qualitatively and quantitatively examined two approaches to developing offshore transmission and associated onshore upgrades to reach New England's offshore wind (OSW) development goals

1. The **current approach** wherein OSW developers compete primarily on cost to develop incremental amounts of offshore generation and associated project-specific generator lead lines (GLLs)
2. An **alternative "planned" approach** wherein transmission is developed independently from generation. Offshore transmission and onshore upgrades are planned to minimize overall risks and costs.

We conduct analyses of potential OSW-interconnection configurations for two levels of future offshore wind development. While other transmission configurations are possible, those captured here are representative of likely outcomes

- The analyses reflect current trends in how and where developers cite generator lead lines
- We highlight an alternative outcome that is unlikely to occur without a planning process

Executive Summary

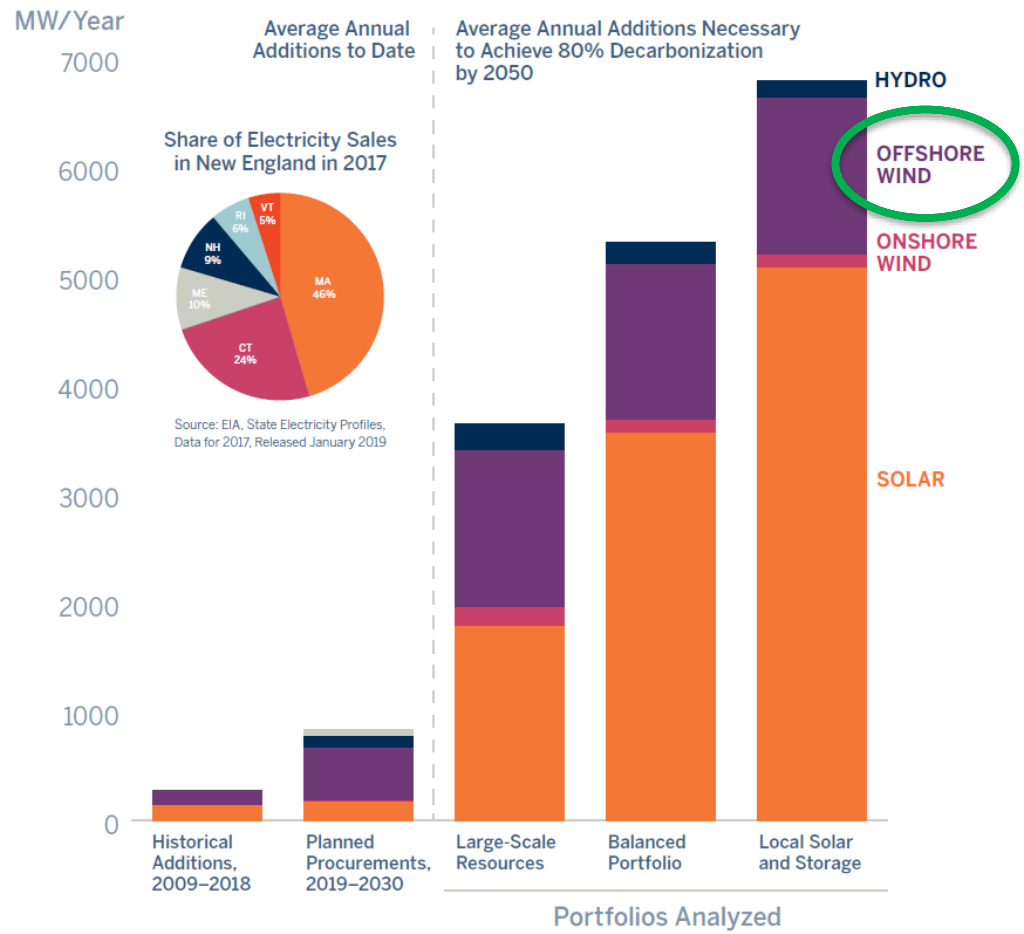
Motivation and policy goals

Thousands of MW of new clean resources would need to be built every year to meet decarbonization goals in New England – **possibly over 40,000 MW of OSW by 2050**

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

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

New England Likely Needs 1,500 MW+ of OSW Additions Every Year to Achieve "80% by 2050" Decarbonization Goals



Source: Brattle Study by Jurgen Weiss and Michael Hagerty, "Achieving 80% GHG Reduction in New England by 2050," September 2019.

The current approach to offshore transmission will incur high costs

New England has already contracted for 3,112 MW of OSW. The next 3,600 MW* of OSW could still be developed under the status quo: with each developer constructing a GLL to an onshore point of interconnection (POI)

- To date, OSW developers have focused on identifying landing sites with the closest access to onshore grid

However, **this existing approach is likely to lead to substantial onshore upgrade needs far sooner than assumed**: already selected projects connecting to Cape Cod face up to $787 million in onshore transmission upgrades and continuing this approach in the next procurements could lead to an additional $1.7 billion in onshore upgrades**

Given the high cost and difficulty of building onshore transmission, **a planned approach to developing the offshore grid can significantly reduce the need and costs for onshore upgrades**, where there is a history of delays and budget overruns in New England

- Since 2002 major onshore transmission projects in New England have on average exceeded budgets by 79% with project duration exceeding five years***

A planned approach is likely to result in lower costs in both the near- and longer-term, by lowering risks and costs of onshore upgrades and increasing competition for both offshore transmission and generation

Estimated Offshore Transmission and Onshore Upgrade Costs Under Current Approach

* Corresponds to currently-authorized procurement authority in MA and CT and potential demand from other states and 3rd parties, beyond the OSW that has already been procured in New England.
**See slides 15-17
*** New Hampshire Transmission, "Greater Boston Cost Comparison," January 2015

Anticipatory planning will lead to lower and more predictable costs

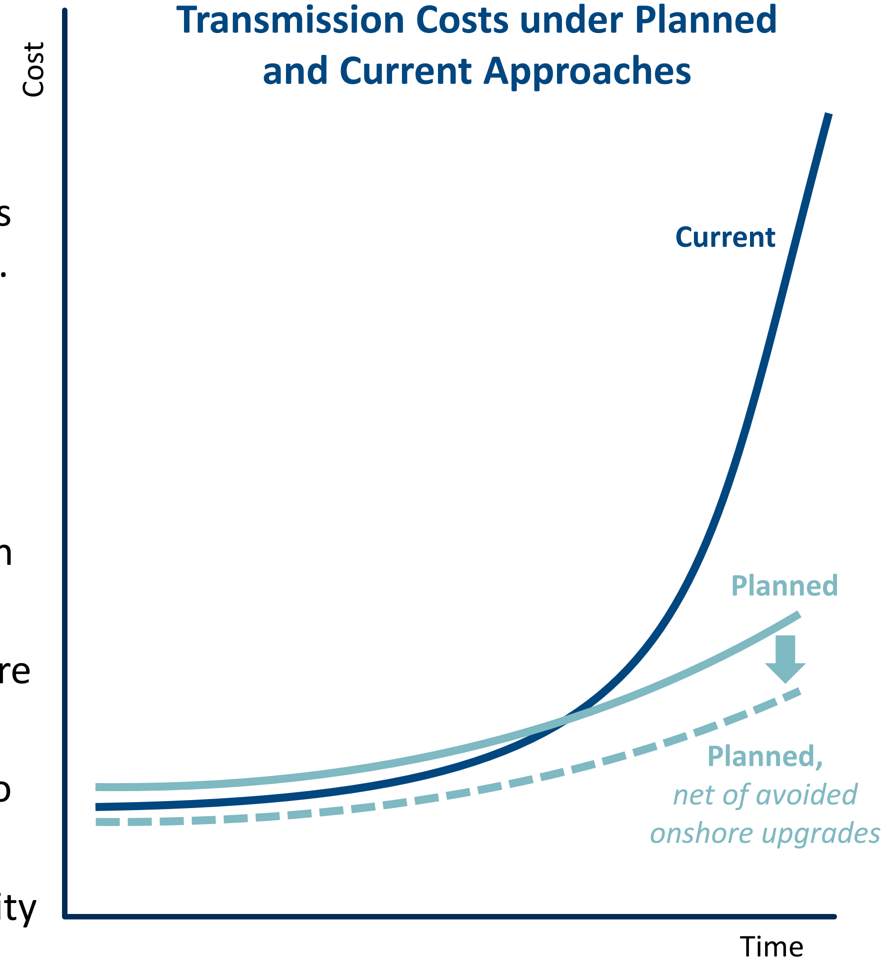
With a well-planned offshore grid, the overall transmission costs can be more closely estimated and phased-in over time

The current GLL approach may appear to have low initial costs but those will likely increase substantially after the "low hanging fruit" is picked, when real costs are revealed through costly onshore system upgrades.

Lack of well-planned transmission to achieve states' objectives has already created barriers for the deployment of clean energy in New England:

- Less than half of the 2,000 MW target Maine established for onshore wind resources have been built, largely due to transmission constraints
- While major new transmission projects for onshore wind were proposed, none have been built
- Five wind projects in Maine were cancelled due to prohibitive transmission upgrade costs
- Lack of a regional plan also imperils hydroelectricity imports from Canada

***Illustration* of Potential Incremental Transmission Costs under Planned and Current Approaches**



Source: Maine Governor's Office of Energy Independence and Security, "Maine Wind Energy Development Assessment," 2012.

Role of public policy in informing regional transmission planning

The growth in offshore wind in New England is driven by state public policy goals and will be achieved through policy mechanisms.

When considering the transmission network needed to support offshore wind deployment, system planning for New England should consider current cumulative goals and a high-OSW future.

Individual states or groups of states can proactively plan for and procure portions of the needed transmission network; such a state-led procurement framework is provided in later slides.

Broader regional coordination among New England states and ISO-NE could help meet the policy objectives of the participating states, including planning and procurement of offshore and onshore transmission systems.

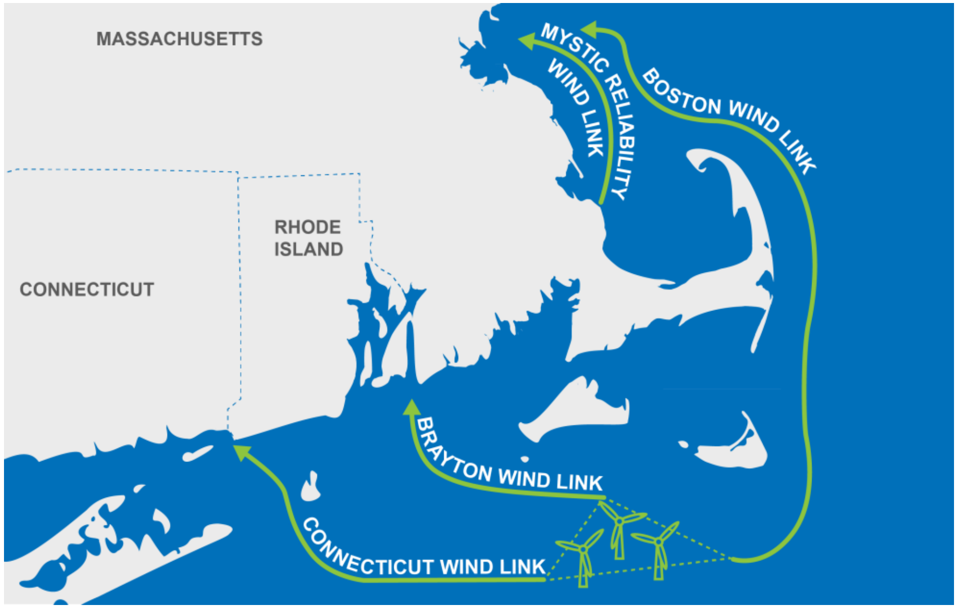
There is precedent for planned development of offshore transmission

Other U.S. jurisdictions have planned transmission infrastructure to develop large-scale onshore renewables. Examples include Texas (CREZ), California (Tehachapi Wind), MISO (Regional Multi-Value Projects), and several European countries. **New England could adopt a similar approach to planning transmission infrastructure to support offshore wind.**

As an example, Anbaric has proposed developing a southern New England OceanGrid that includes a vision to:

- Connect offshore wind directly to load centers and robust grid connections
- Meet needs identified by ISO-NE for new paths for offshore wind to integrate with existing system
- **Avoid more than $1 billion in onshore transmission upgrades**

Schematic of Anbaric OceanGrid Proposal



Source: Anbaric, "Southern New England OceanGrid."

Benefits of a planned offshore transmission approach

A planned transmission approach that jointly coordinates onshore and offshore transmission investments to serve New England's offshore wind needs provides significant benefits for the growing industry and electric customers.

Elements we examine	Our analysis indicates…	*Slides*
Total onshore + offshore transmission costs • Onshore transmission upgrade costs (more risk) • Offshore transmission costs (less risk)	10% lower under planned approach • 65% lower under planned approach • 22% higher under planned approach	*16 & 17*
Losses over offshore transmission	40% lower under planned approach	*12*
Impact to fisheries and environment	49% less marine cable under planned approach	*22*
Generation-related production costs	Reach ~$1 million/yr lower for 3,600 MW of OSW under planned approach	*19*
Customer costs of energy, excluding transmission	Reach $20 million/yr lower for 3,600 MW of OSW under planned approach	*19*
Effect on generation and transmission competition	Increased competition under planned approach	*18 & 20*
Utilization of constrained landing points	Improved under planned approach	*21*
Utilization of existing lease areas	Improved under planned approach	*23*
Enabling third-party customers	Improved under planned approach	*24*

Analytical Approach

We compare transmission configurations for two additional OSW expansion phases

We compare two transmission scenarios representative of configurations achievable under the “current” and “planned” approaches

We assume **3,112 MW of projects already procured** in New England proceed as currently planned with GLLs under both scenarios

We first look at a **<u>Phase 1</u>** to interconnect an additional **3,600 MW** of OSW, corresponding to currently-authorized procurement authority for MA (1,600 MW), CT (1,200 MW), and 800 MW of assumed procurements from other states and third-parties. We necessarily make assumptions about transmission routing and points of interconnection under the planned vs. current approach.

We then look at a **<u>Phase 2</u>** to add a total of **8,000+ MW** of OSW beyond the amount already procured. The total Phase 2 represents the remaining estimated OSW capacity of existing New England lease areas (beyond those already-committed for projects in New England and New York + one additional 1,100MW project to NY)*

Current GLL approach	Planned offshore-grid approach
Gen-ties to interconnect Vineyard Wind, Mayflower Wind, Revolution Wind, and Park City Wind	
Continue GLL approach	Begin planned procurements
Continue GLL approach	Build on Phase 1 planned transmission configuration with additional planned transmission procurements

* 14.5GW assumed total capacity of New England lease areas based on Anbaric analysis of public announcements from BOEM and leaseholders

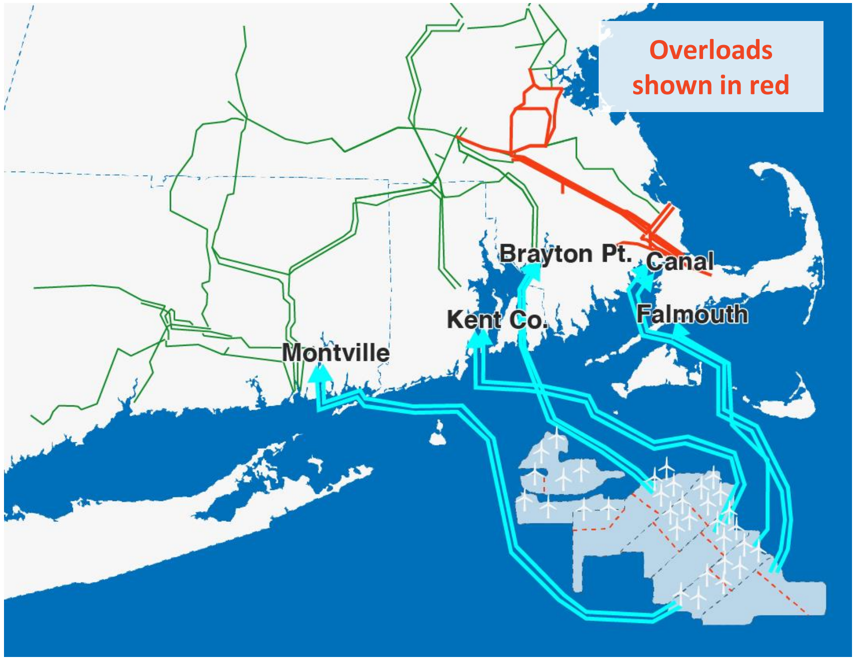
Phase 1 (add 3,600 MW): Summary of the two transmission approaches

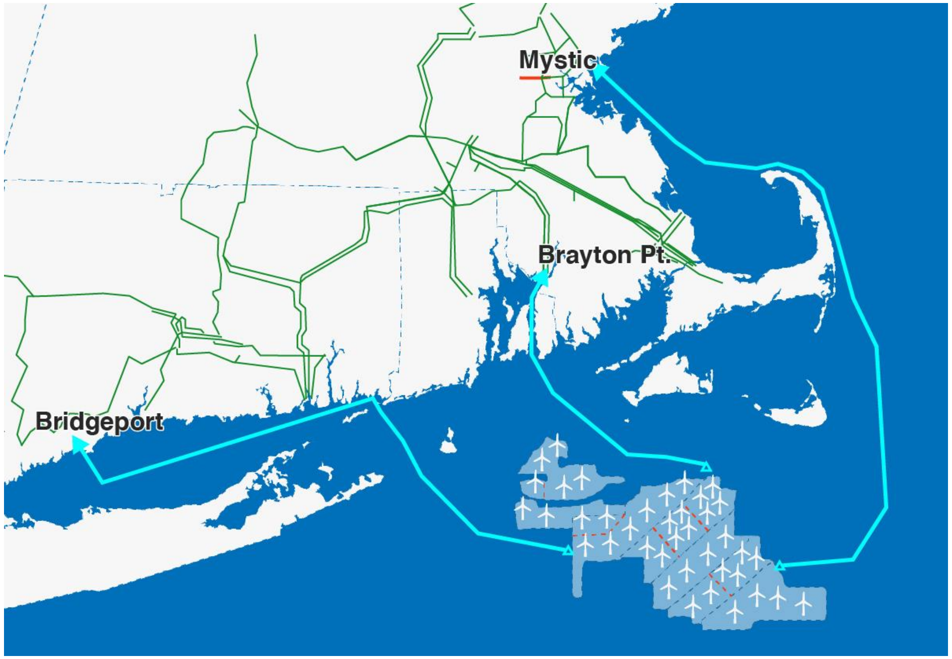
Current GLL Approach

- 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





Sources: Overloads based on GE analysis for Anbaric (Appendix B), which identified numerous within-zone overloads not identified in ISO-NE zonal analysis. Loss estimates based on vendor specifications and third-party sources

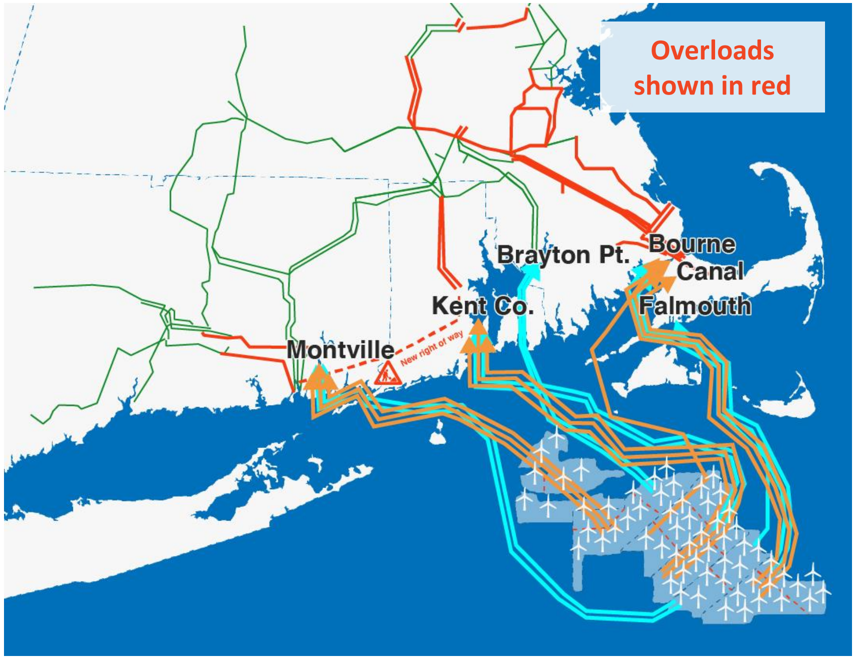
Phase 2 (add 8,000+ MW): Summary of the two transmission approaches

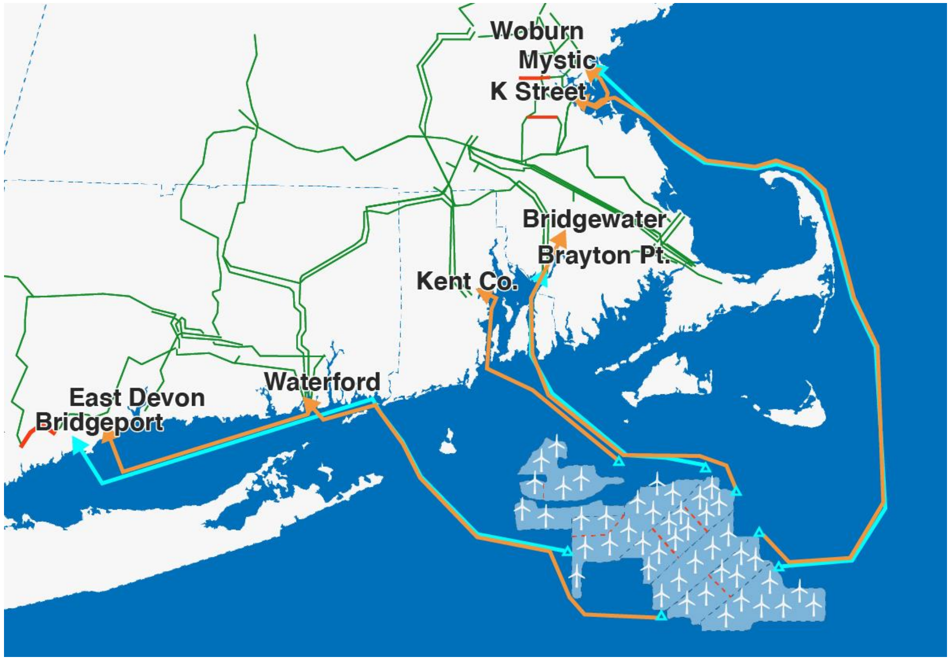
Phase 2, Current Approach (add 8,200 MW)

- 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)*



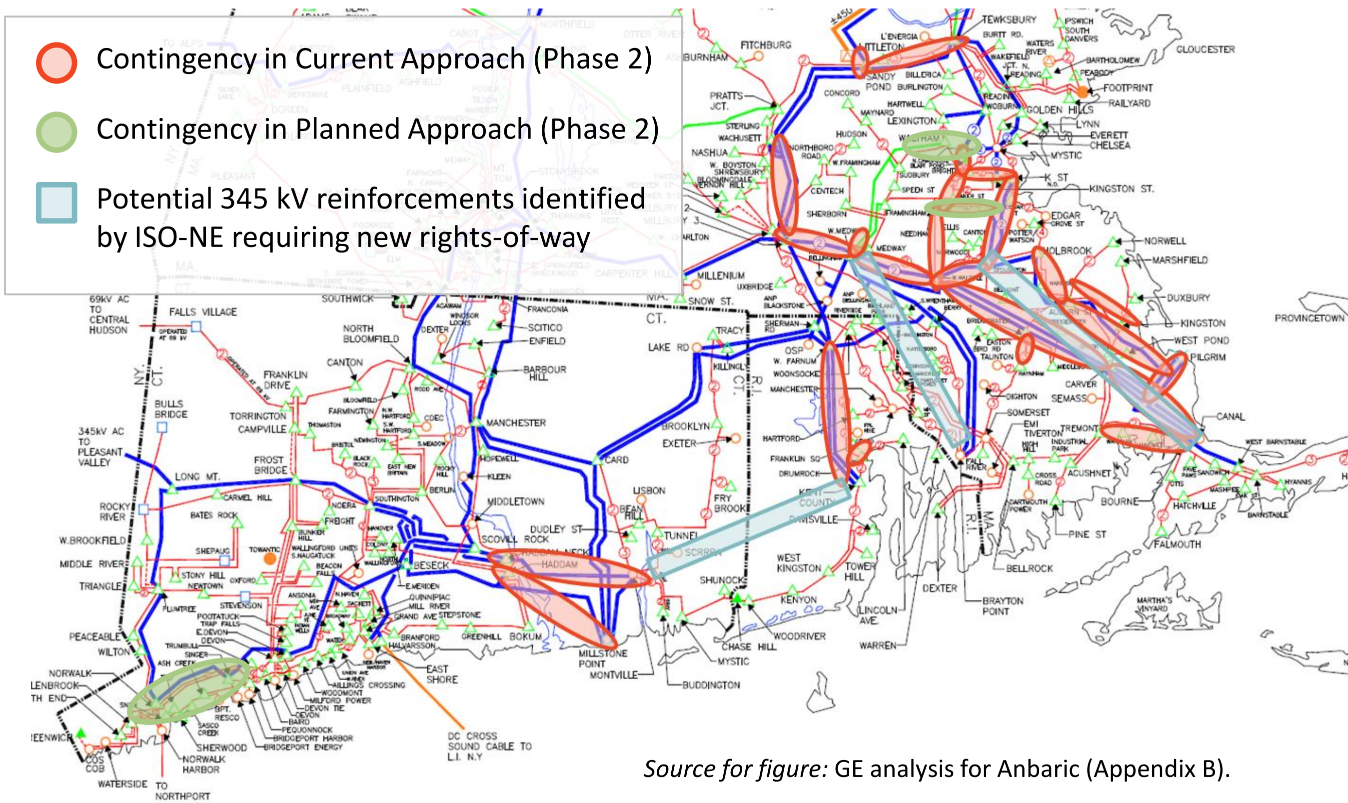


*Multiterminal HVDC injecting at two locations

Benefits of Planned Offshore Transmission

Avoid major overloads of the onshore grid resulting from current gen-tie approach

- To date, OSW developers have focused on landing sites with the closest access to onshore grid
- Already-procured projects connecting to Cape Cod face up to $787 million in onshore upgrades*
- Regional procurement targets exceed available near-shore landing sites**
- Onshore upgrade costs should be included in a generator’s bid, but we anticipate that costs are underestimated, in which case the additional costs could lead to problems completing the projects or increased costs for customers



Source for figure: GE analysis for Anbaric (Appendix B).

* ISO-NE’s Feasibility Study for interconnecting three projects totaling 2,400 MW to Cape Cod (QP 828) identifies $227M in upgrade costs with a -50% to +200% range ($113M to $681M). Interconnecting an additional 400 MW associated with one of these projects (QP829) is estimated to cost an additional $36M with a -50% to +200% range ($18M to $106M).

** ISO-NE has identified 5,800 MW of injection capability in SEMA, RI, and SECT, and existing state procurement targets already equal 5,900 MW

Planning ahead avoids onshore transmission upgrades that otherwise would be needed

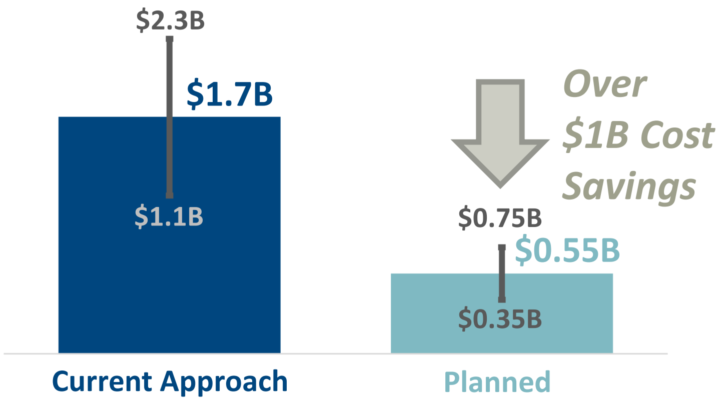
Given the high cost and difficulty of building onshore transmission, a planned offshore grid can significantly reduce need and costs for onshore upgrades, where there is a history of delays and budget overruns in New England

- Major transmission projects in New England since 2002 have averaged budget overruns of 79% with average development times of over five years*
- One recent project in Southern New England – the New England East-West Solution Interstate Reliability Project – took 9 years to complete

Customers benefit from better-planned off-shore transmission through reduced cost and risk of onshore transmission upgrades

- Previous analysis indicates that delays of even one or two years could cost ratepayers $350 to $700 million*
- These uncertainties add substantial risks to the feasibility of the current approach; potentially adding $1.1 billion in costs

The Current GLL Approach Would Require Onshore Upgrade Costs $1.1B Higher Than a Planned Approach in Phase 1
(3,600 MW additional OSW)



Sources: CHA analysis of "Phase 1" transmission upgrade costs for Anbaric included in Appendix C.
*New Hampshire Transmission, "Greater Boston Cost Comparison," January 2015.

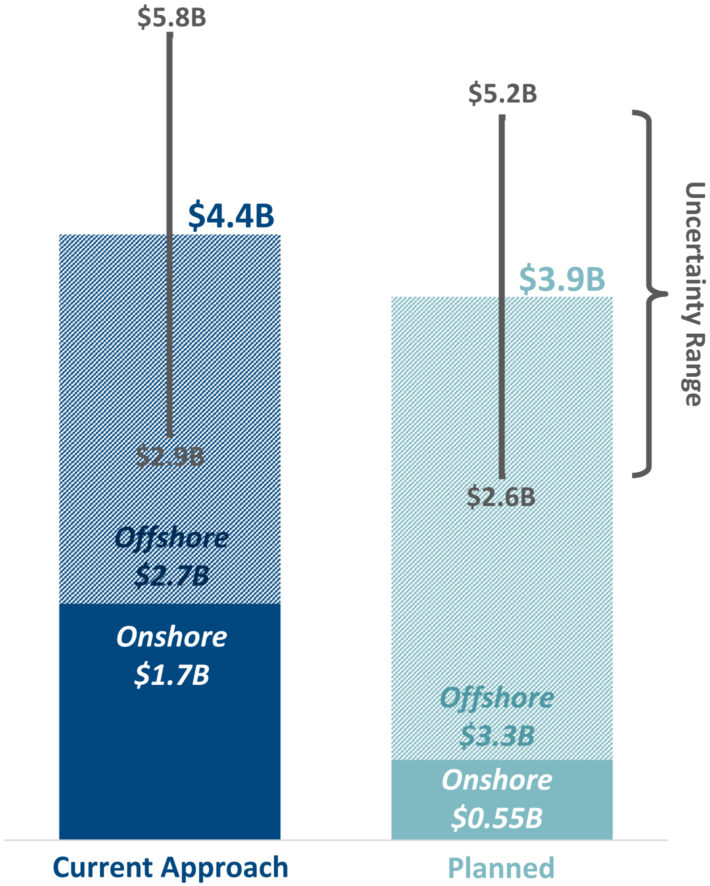
Total costs of transmission are expected to be lower under a planned approach

Even including the more costly offshore transmission equipment ($3.3B vs $2.7B for Phase 1), 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

- Onshore upgrade costs of $0.55B under planned approach vs $1.7B under current 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)



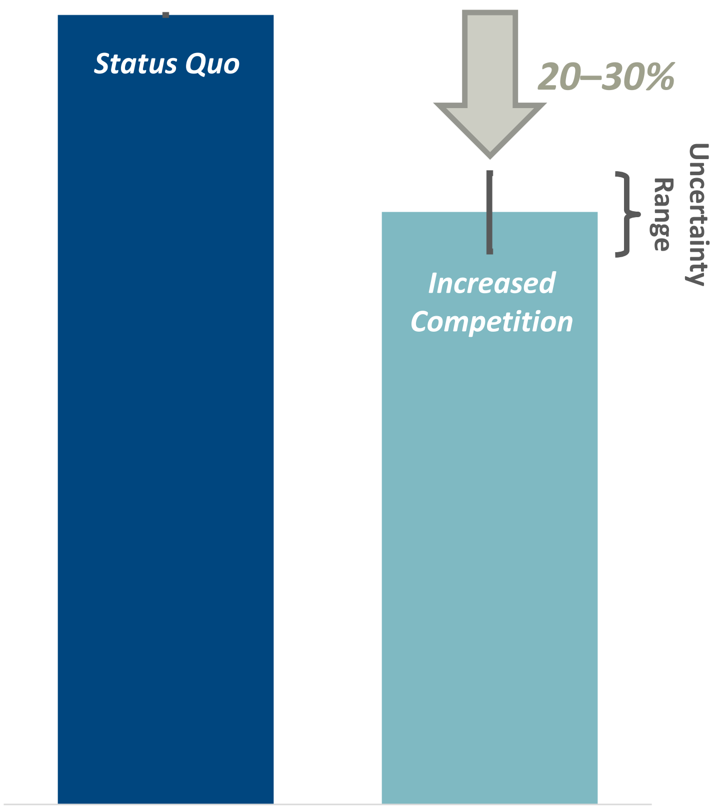
Source for cost data: Onshore upgrade cost estimates based on GE and CHA analysis of "Phase 1" scenarios for Anbaric included in Appendices B and C. Estimate for offshore transmission equipment based on proprietary supplier information provided to Anbaric.

Increased competition among offshore transmission developers

Offshore transmission developers would compete to build planned transmission. This direct competition would put downward pressure on costs to ratepayers (further lowering costs beyond that described on previous slides)

- Studies of onshore transmission indicate that competitive procurement enables "significant innovation and cost savings of 20–30%" relative to the costs incurred by incumbent transmission companies; the costs of conducting the competitive processes are small compared to the savings*
- Studies of offshore transmission costs in the U.K. similarly indicate that competition across independent offshore transmission owners reduced costs 20–30% compared to generator-owned transmission (driven by lower operating costs and financing costs from improved allocation of risk and reduced risk premium)**

Anticipated Cost Impact of Competition to Develop Offshore Transmission



Sources: * The Brattle Group, "Cost Savings Offered by Competition in Electric Transmission: Experience to Date and the Potential for Additional Customer Value," April 2019, Produced for LSP Transmission.
** Cambridge Energy Policy Associates, "Evaluation of OFTO Tender Round 2 and 3 Benefits," March 2016, Produced for Ofgem.

Lower total system-wide generation costs and savings to customers

Based on analyses conducted by GE, the planned approach will yield system-wide generation cost savings, primarily from reduced transmission losses and reduced offshore wind curtailments

- After Phase 2 with an additional 8 GW of OSW in service, curtailments would be reduced from 13% in the current approach to 4% in the planned: equivalent to ~700 MW
- This yields generation cost savings that reach **$55 million** per year-under the planned approach relative to the current approach for Phase 2

The planned approach would inject more of the OSW into higher-priced locations on the grid, further reducing customer costs

- GE's estimated customer savings of the planned approach reach ~$20 million per year in Phase 1 and over **$300 million** per year in Phase 2 in 2028
- Part of this is a value transfer from conventional generators to customers, not necessarily a reduction in total system costs (so is not shown in the chart)

One Year System-wide Generation Cost Savings of Planned Approach Compared to Current Approach

Source: GE analysis for Anbaric included in Appendix B

Increased competition among OSW generation developers

Competition among developers of OSW generation would be enhanced, yielding a range of potential cost savings

Minimum savings → **Higher potential savings**

The planned, competitive approach would simplify a major strategic decision for developers

Today, developers must bid before they have accurate information about their transmission upgrade costs. Removing these risks from the offshore generation procurement should lead to lower bids because of the reduced risk premium alone

Ultimately, it could increase participation and competition in OSW solicitations.

In Europe, planned transmission approaches have enhanced head-to-head competition leading to **zero-subsidy bids** in recent procurements (see case study details in appendix)

We anticipate more willing bidders and more competition with increased access to transmission (though overall still limited by number of leaseholders)

More efficient use of constrained "cable-approach" routes

There are a limited number of landing sites for offshore wind transmission lines in New England

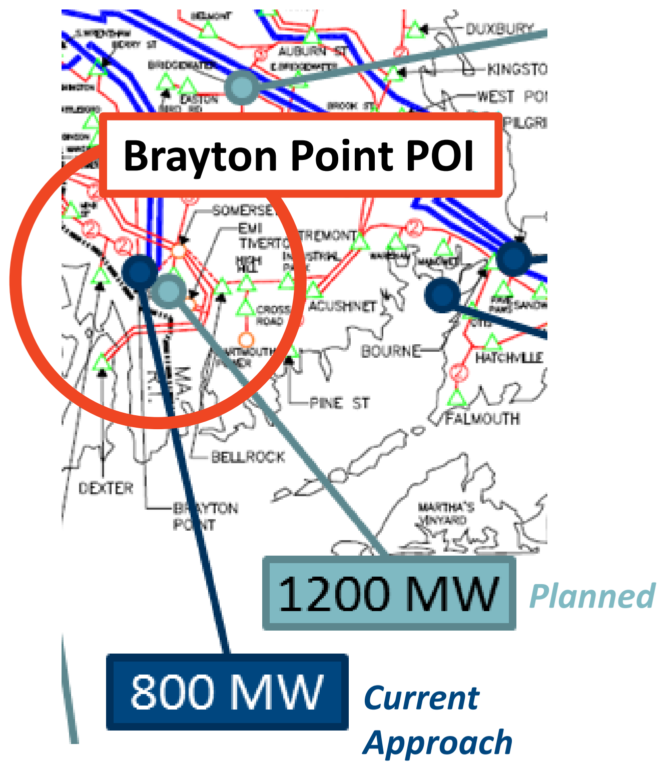
In the longer term, if each OSW project requires a separate cable connection to the onshore transmission system, viable cabling routes become constrained

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



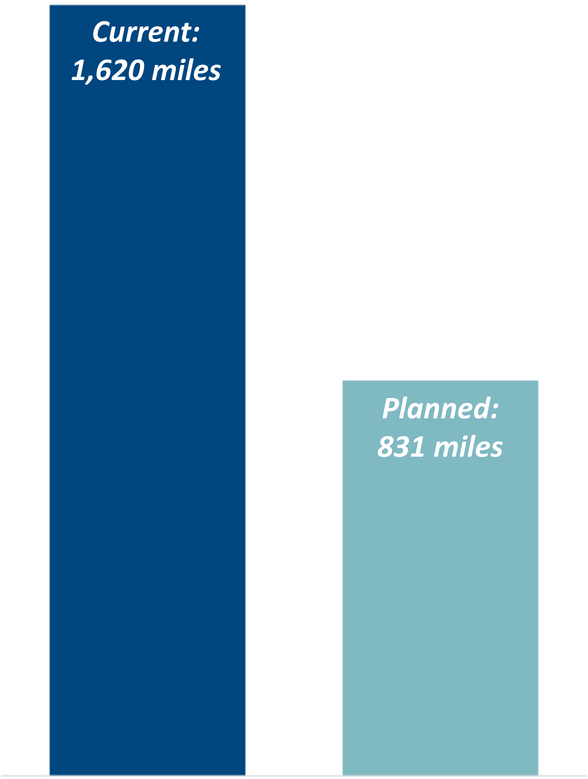
Reduced impacts to fisheries and the environment

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% (based on Anbaric proposed cable routing)
- Offshore cables can be grouped in transmission corridors to minimize impact; this is not possible to enforce under the current (one-off, unplanned) approach

Minimizing the number of offshore platforms, cabling, and seabed disturbance reduces impacts on existing ocean uses and marine environments to the greatest practical extent

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



Source: Slide 13.

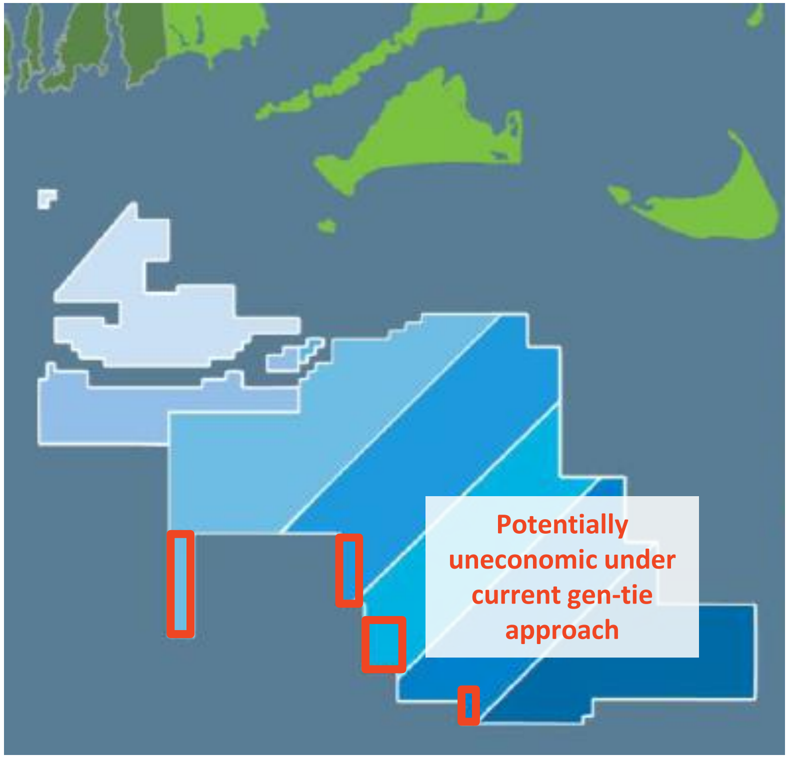
Realize the full potential of existing lease areas

Without a well-planned offshore grid, some of the existing offshore lease sites may not be economic to develop

- After developers interconnect the bulk of their lease sites, it may be cost prohibitive to interconnect the residual areas (of perhaps 50 MW to 250 MW each) using AC generator lead lines sized to carry ~400 MW each
- This increases the risk of inefficient use of lease sites and stranded assets

An offshore grid with well-located offshore collector stations would increase the likelihood that residual lease areas could be developed cost-effectively, and that the full potential of all lease areas can be realized

Developers May Find Residual Areas Uneconomic to Interconnect With Generator Lead Lines



Map Source: Massachusetts CEC, "Massachusetts Offshore Wind Initiatives," EBC Sixth Annual Offshore Wind Conference.

Improved reliability and reduced OSW curtailments

Designing and building the offshore grid with networking capability preserves the option to create a meshed configuration to improve reliability and reduce curtailments in case of transmission outages

- For example: If three 1,200 MW HVDC converter stations were networked offshore, an outage of one line would still allow flowing full power in all hours when the total generation is less than 2,400 MW, resulting in only 4% of energy curtailed relative to no outages
- Under the current (non-meshed) gen-tie approach, an outage in any one of three lines would results in 33% reduction in delivered energy to the onshore system, causing significantly more curtailments than under a meshed configuration

Source: Anbaric analysis.
Notes: Several European countries are studying meshed DC configurations for use interconnecting OSW in the North Sea. Reference materials compiled by Curis et al., "Synthesis of available studies on offshore meshed HVDC grids," 2016.

Enabling third-party customers

An independent, open-access offshore grid can create opportunities for additional (non-mandated) OSW resources to be built at lower cost

- As OSW generation costs decrease, third-party customers have expressed interest in purchasing offshore wind, but even large individual customers are unlikely to purchase sufficient OSW to fully utilize an export cable sized to carry 400 MW of offshore wind. Developing smaller projects with larger export cables would be uneconomical
- An open access transmission system could serve as a platform for individual offshore-wind procurements of smaller sizes, enabling OSW development without state-sponsored contracts
- A generation developer could build surplus transmission capacity into a project but would then likely have market power in selling to third parties, whereas independent transmission would require OSW generators to compete against each other to utilize independent transmission.

Case examples:

Microsoft and Google purchased 90 MW and 92 MW of OSW over independent transmission in the Netherlands and Belgium

The Texas CREZ served as a platform for third-party power purchase agreements (PPAs), enabling over 2 GW of onshore wind PPAs from 22 corporate buyers

In the Southwest Power Pool, ISO-planned transmission investment enabled 2.5 GW of corporate PPAs

Sources: Wind Solar Alliance, "Corporate Renewable Procurement and Transmission Planning," October 2018.

Procurement Approach

We recommend a planned approach to offshore transmission

A planned approach leverages competition among transmission developers to build out a New England offshore transmission grid in a staged manner, enhances competition between off-shore wind generators, and leads to lowest costs

Utilizing GLLs has distinct disadvantages over planned offshore transmission. While the GLL approach may appear to offer* lower costs in the short run, it is not aligned with the public interest in the long run, leading to:

- 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

Under the planned approach, OSW generation developers still will be able to participate in transmission procurements,** but must be willing to develop open-access transmission for other leaseholders when participating in the transmission procurement (even if their generation bid is unsuccessful in the generation procurement)

* Costs of transmission in bundled generation + transmission bids could also appear artificially low if bidders can shift costs from transmission to generation within projects

** This would require functional or physical business separation

Implementing planned transmission procurements

The planned approach can be implemented through joint procurement of transmission and generation. The solicitation can build on prior New England state procurements of transmission for renewable energy, including the 2015 "Three State RFP" issued by MA, CT and RI, which included a Transmission Service Agreement model. The procurement can be initiated immediately, with selection of winning projects by 2021.

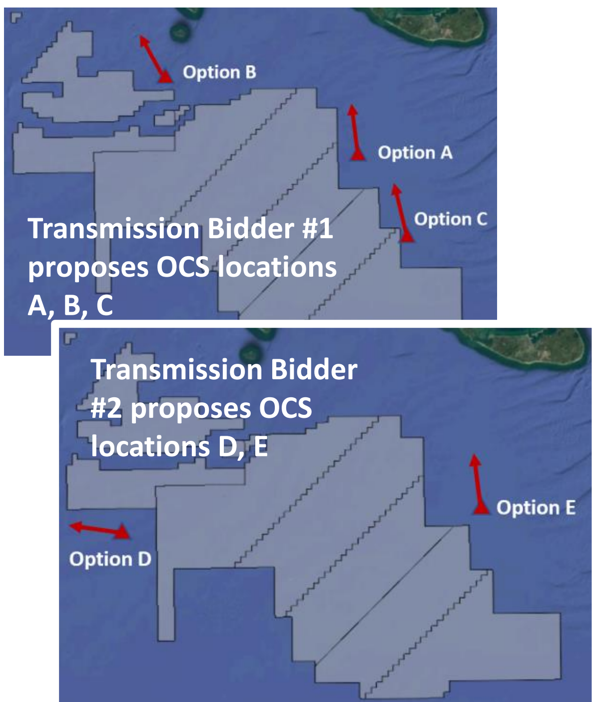
Example Implementation of Transmission and Generation Procurement

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

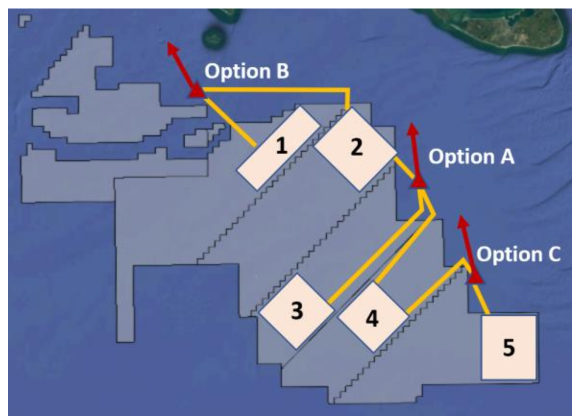
<u>Transmission</u> developers propose collector station locations A - E

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



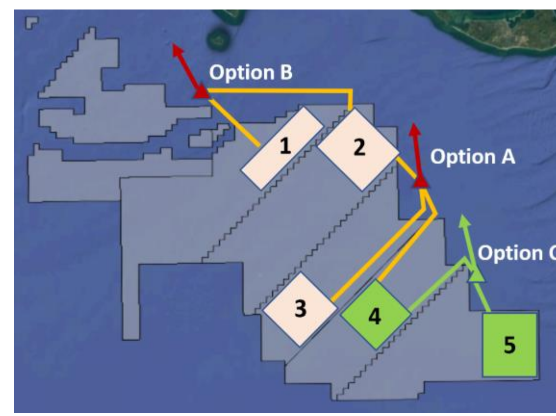
Transmission developer #1 selected; leaseholders bid <u>wind generation</u> 1-5 to collector stations A, B, C

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 risk with separate generation and transmission procurements

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
- Furthermore, the misalignment between generation developer incentives and public policy objectives increase risks to the overall offshore wind development effort (significant onshore upgrades, higher curtailment risk, less competition, and higher long-term costs)

The planned offshore grid model reduces risks that could inhibit achievement of overall OSW development goals, and can also address individual project-on-project risk through:

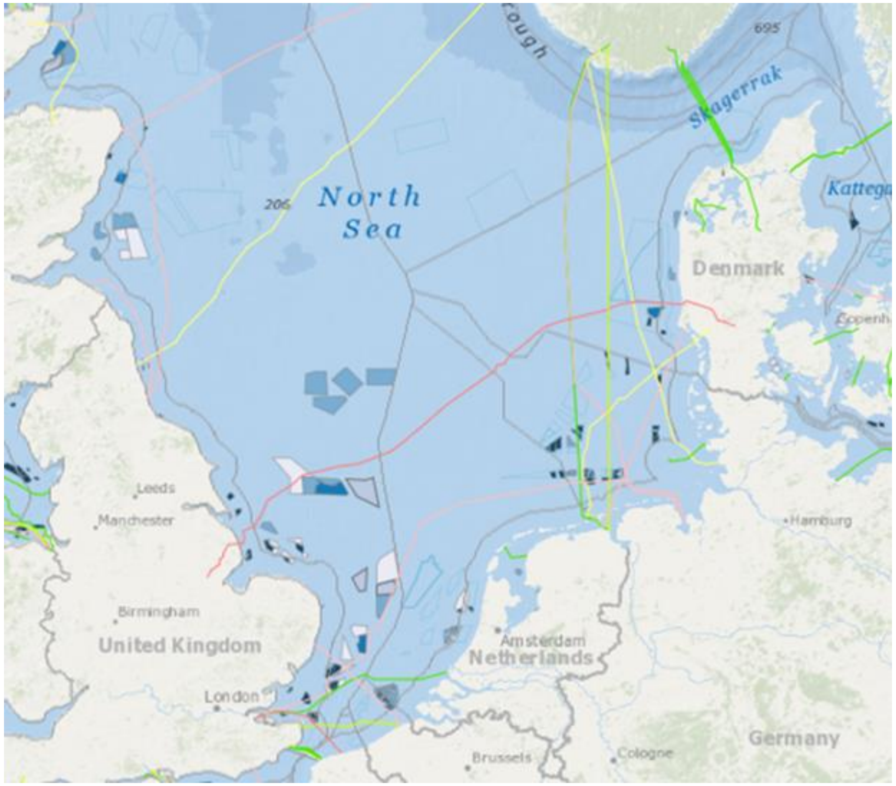
- Strong performance and completion incentives (rewards or penalties) for both transmission and generation developers to meet project deadlines
- Allowing generation developer to participate in transmission procurement, with the condition that the transmission will be open access
- Staggered transmission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

Appendix A:
Case Studies

Offshore transmission network 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

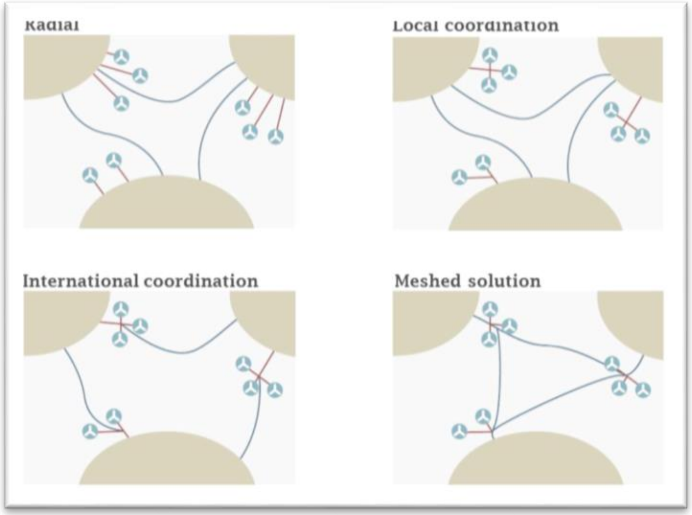


Source: NY Power Authority, “Offshore Wind: A European Perspective,” August 2019.
Wind Europe, “Offshore Wind in Europe,” February 2020.

Planning in the North Sea of Europe

- Planning ahead in the North Sea included analyses of "Radial" versus "Meshed" offshore grid
  - The North Seas Countries' Offshore Grid initiative (NSCOGI), formed in 2010, evaluated and facilitated coordinated development of a possible offshore grid that maximizes the efficient and economic use of renewable resources and infrastructure investments
  - Ten countries were represented by their energy ministries, supported by their Transmission System Operators, their regulators and the European Commission.
- A scenario-based planning approach was initiated in 2012; analysis then already showed benefits of having a planned meshed offshore system*
- More recent 2019 planning and analysis of very high OSW penetration in the North Seas (380 GW by 2050) indicates substantial benefits of meshed offshore grids: lowering the environmental burden, using infrastructure more efficiently, and reducing costs*

Models of Offshore Grid Development Considered



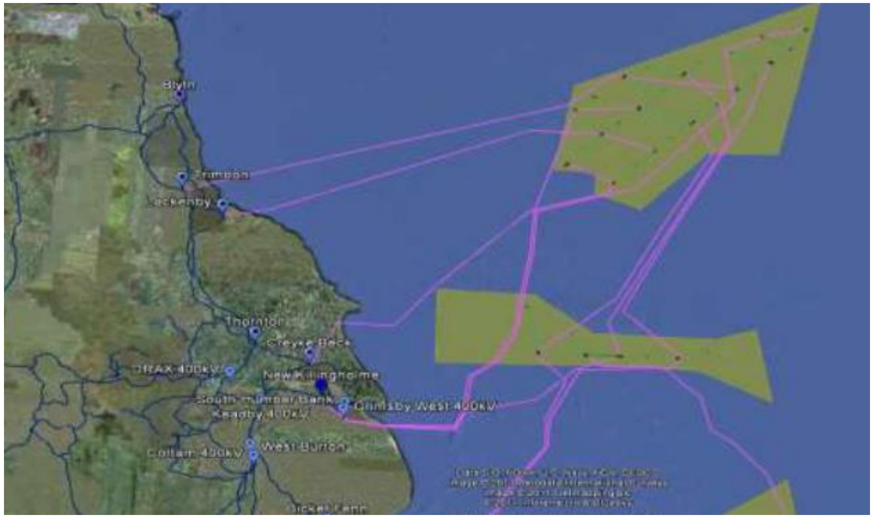
Sources: * The North Seas Offshore Grid Initiative, "Initial Findings," November 2012.
** Wind Europe, "Our energy, our future," November 2019.

CASE STUDIES

Offshore transmission network in the U.K.

- To date, all OSW transmission in the UK has a radial design, with the transmission developed by the OSW developer and then sold to a separate transmission owner
- However, this approach is reaching its limits, as ad-hoc onshore interconnections are pushed further inland with increasing community impacts.
- Ofgem is currently studying and strongly considering implementing an offshore transmission network.

Ofgem Study of Possible Offshore Grid Design



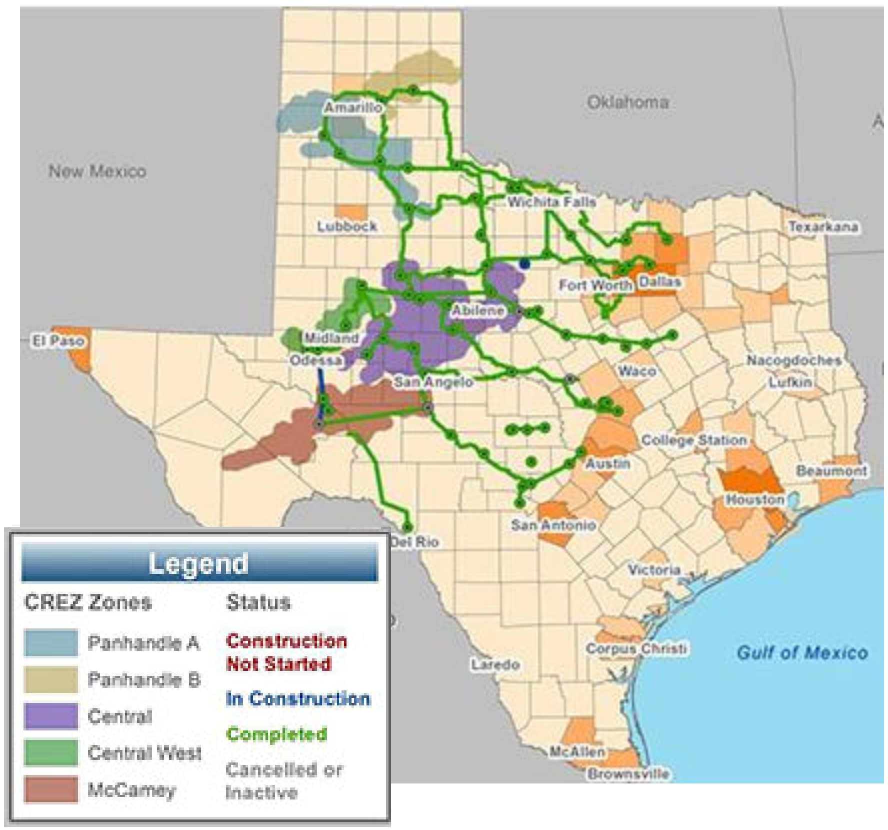
- Various studies conducted by Ofgem, utilities, and industry groups show that such a coordinated design could lower overall transmission costs by 9 to 15 percent.
- An offshore grid to support 34 GW of capacity would cost £24.2 billion ($31.5 billion), equivalent to a transmission cost of £5.36/$6.98 per MWh

Source: NewEnergyUpdate, Reuters Events, February 19, 2020.

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
- Process: ERCOT designed transmission system configurations to integrate each renewable energy zone through a staged, expandable approach. Desired configurations selected by PUC and developed by competitive transmission developers and incumbents

Texas CREZ Transmission Projects



Source: EIA, “Fewer wind curtailments and negative power prices seen in Texas after major grid expansion,” June 2014.

Tehachapi Renewable Transmission Project (TRTP) in California

- Tehachapi was identified as a high wind potential region in southern California almost 20 years ago
- California policy makers solicited interest in building wind in Tehachapi
- California ISO developed a transmission plan for the region
- The transmission enabled 4,500 MW renewable power development
- 250 circuit miles, $2.1 billion cost
- Built by transmission developer, with costs allocated using existing CAISO transmission cost allocation system

CAISO TRTP Transmission Projects

Seg	Description
1	New 500kV line between Antelope and Pardee Substations and Antelope Substation Expansion
2	New 500kV line between Antelope and Vincent Substations
3A	New Windhub Substation and new 500kV line between Windhub and Antelope Substations
3B	New Highwind Substation and New 220kV line between Windhub and Highwind Substations
3C	Upgrades to Antelope, Vincent, Windhub Substations
4	Single-circuit 500kV transmission line between Whirlwind and Antelope Substations
5	Replacement of two 220kV lines with one 500kV line between Antelope and Vincent Substations
6	32 miles of 500kV line from Vincent Substation through the Angeles National Forest
7	Replacement of 220kV line with 500kV line between Angeles National Forest and Mesa Substation
8	Replacement of 220kV line with 500kV line between Mesa and Mira Loma Substations. New and replacement double-circuit 220 kV lines between Chino and Mira Loma Substations
9	New Whirlwind Substation and upgrades to Antelope, Vincent, Windhub, Mesa, Gould, Mira Loma Substations
10	New 500kV line between Windhub and Whirlwind Substations
11	Replacement 500kV line between Vincent and Gould Substations. New 220kV circuit on existing structures between Gould and Mesa Substations

Source: SCE, "Tehachapi Renewable Transmission Project."

Support from Other Stakeholders

"Separating transmission from generation procurement, while complex, has the potential to deliver optimal outcomes for consumers and the environment."

*- Environmental Stakeholders**

"A separate contingent solicitation for structure installation offshore could result in greatly fewer impacts to fisheries, and must have the primary goal of developing a more efficient (less cable used) and better-sited structure in the water."

- Responsible Offshore Development Alliance

"By allowing for more options for consideration and fostering greater competition, a planned transmission system benefits the offshore wind industry, states, taxpayers, local communities, the environment, local businesses, and other stakeholders. To maximize benefits and the opportunities for scaling an offshore wind industry that can create thousands of good sustainable jobs, BOEM should facilitate making open access, planned transmission available as an option [...]"

- International Brotherhood of Electrical Workers

"[…] the size and speed of OSW installations could overwhelm and congest our current land-based coastal grid, damaging the industry's reputation and shortchanging its growth potential."

- Tufts Power Systems and Power Research Group

* Environmental Stakeholders include the National Wildlife Federation, Conservation Law Foundation, Sierra Club (Mass. Chapter), and Acadia Center

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