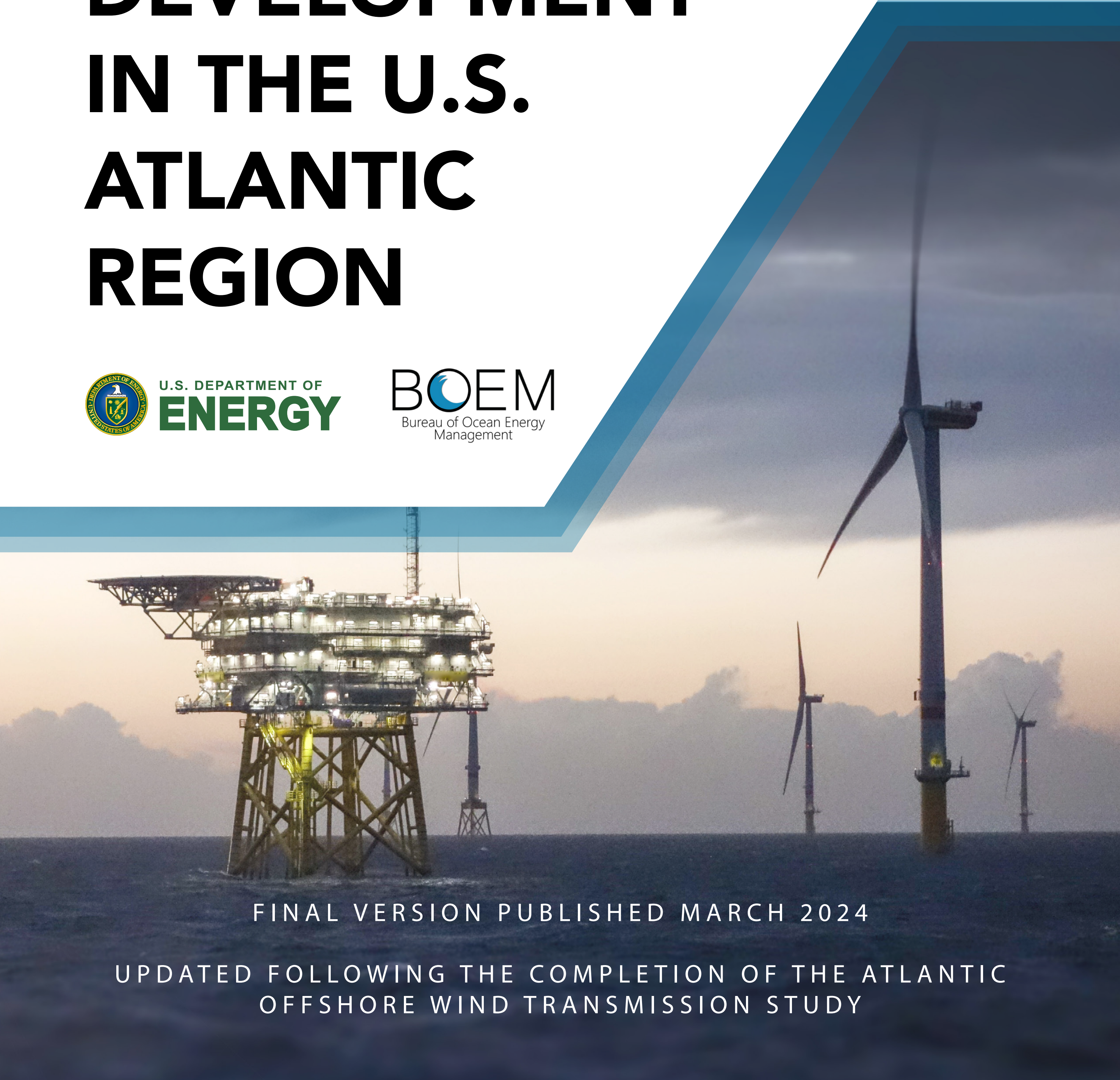
AN ACTION PLAN FOR

OFFSHORE WIND TRANSMISSION DEVELOPMENT IN THE U.S. ATLANTIC REGION

U.S. DEPARTMENT OF ENERGY

BOEM
Bureau of Ocean Energy Management



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UPDATED FOLLOWING THE COMPLETION OF THE ATLANTIC OFFSHORE WIND TRANSMISSION STUDY

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EXECUTIVE SUMMARY

OFFSHORE WIND DRIVERS IN THE UNITED STATES

Offshore wind in the United States is poised to play a critical role in transitioning the nation to a clean energy future while improving the power system's reliability and resilience, as well as providing economic opportunities and American jobs. Offshore wind has enormous potential for generating electricity to meet the needs of the United States.[1] The Atlantic Coast has kick-started the industry with 42 megawatts (MW) of offshore wind generation capacity already installed and two commercial-scale projects in development. State-level clean energy policies are driving a total project pipeline exceeding 50 gigawatts (GW)[i] for the Atlantic Coast region. In 2021, the Biden-Harris Administration announced an inter-agency goal of deploying 30 GW of offshore wind energy by 2030—which would unlock a pathway[2] to 110 GW by 2050—to strengthen the domestic supply chain, create jobs, and reduce carbon emissions while building toward a clean energy future. To realize the enormous potential of the United States' offshore wind, it is imperative to address current and anticipated transmission challenges affecting delivery of this power to the grid.

THE CHALLENGES TO DEVELOPING OFFSHORE TRANSMISSION

As the United States transitions to a clean energy economy, a significant expansion of transmission infrastructure will be needed. This is especially true for the integration of offshore wind because no offshore transmission grid exists. Many offshore wind farms are planned to be located 10 miles or more from shore and may have to deliver power significantly further inland to connect to robust, high-voltage transmission facilities capable of integrating large volumes of offshore wind energy. Developers of offshore transmission infrastructure must also contend with harsh ocean environments; laying cable at depth; shortages of available components, port facilities, and installation vessels; and permitting requirements that span Federal, Tribal Nation, state, and local jurisdictions. Connecting networked transmission (either offshore or onshore) across grid planning regions—referred to as interregional transmission in this action plan—may be beneficial, but it introduces new challenges for planning, ownership, and cost allocation. Stakeholders have expressed uncertainty regarding the tax treatment of transmission projects developed separately from generation by utilities, states, or independent transmission developers, which may create financial disparity between different transmission approaches. There is also a need to ensure appropriate protections for marine environments and coastal communities as well as to address ocean co-use conflicts through avoidance, minimization, and mitigation strategies.

These challenges demonstrate that proactive and coordinated interregional transmission planning is urgently needed to support offshore wind development. Coordinated planning has the potential to minimize environmental impacts associated with cable route development and onshore upgrades, improve timelines associated with permitting decisions and construction, and lower costs by providing increased capacity and stability to the grid.

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[i] See Appendix C: Offshore Wind Procurement Projections

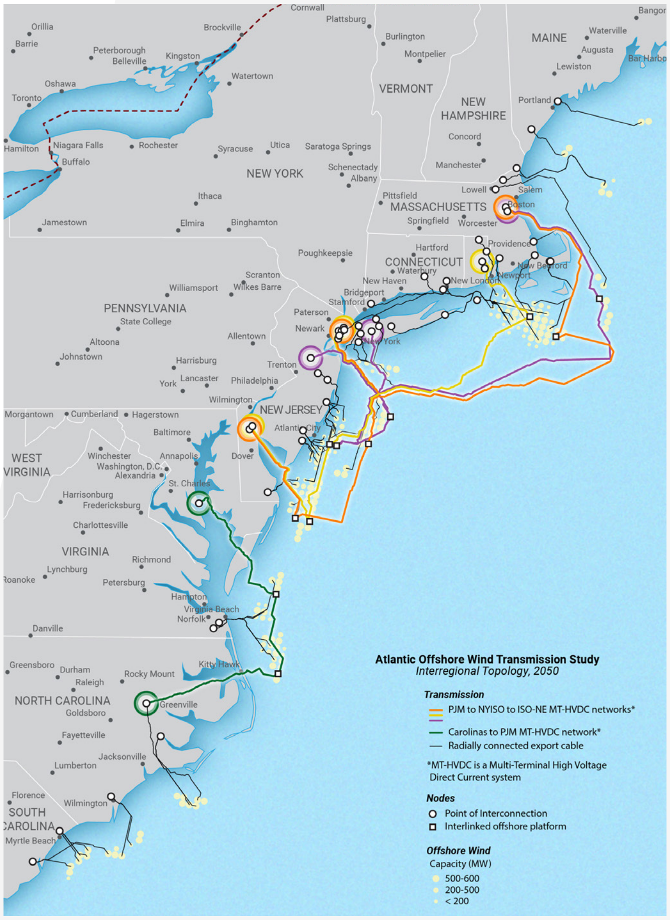
THE ACTION PLAN

The U.S. Department of Energy (DOE) and U.S. Department of the Interior's (DOI) Bureau of Ocean Energy Management (BOEM) jointly developed this action plan, on behalf of the Administration, to address near-, medium-, and long-term offshore wind transmission challenges for the Atlantic Coast of the United States. This work was principally informed by four Federal offshore wind transmission activities: a series of Atlantic Coast scoping conversations held by DOE and BOEM, DOE's *Atlantic Offshore Wind Transmission Literature Review and Gaps Analysis*,[3] DOE's Atlantic Offshore Wind Transmission Study (AOSWTS),[4] and the Convening Workshops hosted in 2022–2023.[ii]

THE OFFSHORE TOPOLOGY PROPOSAL

The AOSWTS final report, which was published in early 2024, found that connecting large volumes of offshore wind along the Atlantic coast over the next several decades will provide a unique opportunity to use interregional transmission links to reduce electricity production costs and bolster reliability onshore. The AOSWTS also incorporated environmental, ocean co-use, and other siting considerations by implementing a path routing methodology.

Figure 1. DOE- and BOEM-recommended offshore wind transmission topology scenario, informed by the Convening Workshops and AOSWTS analysis. The map represents a hypothetical transmission build-out for the 2050 Low Carbon Scenario, as currently analyzed in the AOSWTS.



Although radial generator lead lines and radial shared lines will be essential for the deployment of offshore wind along the Atlantic, the AOSWTS found that expanding those radials into networked configurations adds significant value. All networked topologies studied have benefits significantly outweighing their costs, often by a ratio of 2 to 1 or more. Thus, DOE and BOEM recommend further exploration of interregional offshore HVDC networks identified in the AOSWTS (Figure 1). The interregional interlinks analyzed in the AOSWTS were designed to take advantage of opportunities to maximize production cost savings while attempting to minimize overall cable distances (relative to other potential configurations of interlinks).

Interregional multi-terminal HVDC (MT-HVDC) transmission lines are the most complex transmission build-out option from a technological standpoint, and require extensive planning and coordination; therefore, many of the recommendations that follow are informed by the need for these lines and the expected timelines to develop them. These activities did not seek group consensus, and all recommendations in this action plan were developed internally by DOE and BOEM.

[ii] These activities did not seek group consensus, and all recommendations in this action plan were developed internally by DOE and BOEM.

THE RECOMMENDED ACTIONS

The recommendations support a proposed offshore transmission build-out and fall within four time frames: immediate actions (before 2025), near-term actions (2025–2030), mid-term actions (2030–2040), and sustained actions. Because many of these recommendations will take significant time and effort to establish, including potentially spanning several years, the listed time frame for each action should be interpreted as the year it is in effect or operable rather than the year when efforts are started. Further, although actions have been scheduled based on a perceived need or assumed feasibility, we (DOE and BOEM) encourage earlier implementation whenever possible.

The recommendations are organized into five categories, and each one addresses a specific transmission development need: partnerships and collaborations, planning and operations, technologies and standardization, economics and support initiatives, and siting and permitting. The colors associated with each category, as illustrated below, are also identified on the left of each recommendation.

A criticality rating has been assigned to differentiate recommendations with the greatest potential to enable coordinated offshore transmission development. Recommendations that may be incredibly important to transmission development or ratepayers generally but are not specific to enabling offshore wind deployment have been assigned a lower criticality rating. The numbers in the tables refer to the sections below in which the recommendations are discussed in detail.

The following symbology is used throughout the action plan:

★★★ Critical Path Action

★★ Recommended Action

★ Best Practice

IMMEDIATE ACTIONS

The recommended actions before 2025 are identified as immediate needs. Tackling them now would allow us to leverage the historic Bipartisan Infrastructure Law (BIL) and Inflation Reduction Act of 2022 (IRA) investments and unified political willpower to catalyze change and facilitate collaboration for the decades ahead. As a new industry ramps up, many tasks will need immediate prioritization.

Immediate Actions Before 2025		Reference Section
P & C ★★★	Offshore Wind Transmission State Collaborative	1.1.1
P & C ★★★	Regional Transmission Planning Collaborative	1.1.2
P & C ★★★	Tribal Nation Engagement	1.1.3
P & O ★★★	Systematic Evaluation of Points of Interconnection Capacities and Landfall Locations	2.1.2
P & O ★★★	North American Electric Reliability Corporation (NERC) Reliability Standards Around Offshore Transmission	2.3.1
E & S ★★★	Voluntary Cost Allocation Assignments	4.1.1
T & S ★★	"Network-Ready" Equipment Standards	3.1.1
T & S ★★	Equipment Rating Standardization for Transmission Components	3.1.2
T & S ★★	Research and Development for Offshore Transmission Technology Commercialization	3.3.1
T & S ★★	Expansion of Domestic Supply Chain and Manufacturing	3.4.1
T & S ★★	Skilled U.S. Workforce Development	3.4.2
S & P ★★	Federal-State Aligned Offshore Wind Transmission Siting	5.1.2
S & P ★★	Guidance for Federal Environmental Review and Permitting Requirements and Procedures	5.2.2
T & S ★	Environmental Research & Development for Offshore Wind Transmission	3.3.2

The most critical actions identified for this time frame involve establishing collaborative bodies that span the Atlantic Coast region; clarifying some of the building blocks of transmission planning, including points of interconnection (POI) identification and the North American Electric Reliability Corporation (NERC) Reliability Standards for offshore transmission; and addressing costs through voluntary cost assignments.

Other important work before 2025 includes standardization and research and development (R&D) in the technology and environmental space, support for a growing supply chain and workforce, and siting and permitting improvements.

NEAR-TERM ACTIONS

Actions recommended for the 2025–2030 time frame focus on shifting practices to reach near-term targets. The year 2030 is critical because it coincides with the Biden-Harris Administration's inter-agency offshore wind deployment goal as well as with several Atlantic Coast states that have set procurement goals.[iii] Although analysis from the AOSWTS indicates that 30 GW of offshore wind could be integrated into the grid by 2030 without interregional interlinks or a meshed grid, actions taken during this time will pave the way for the development of an offshore network.

[iii] See Appendix C: Offshore Wind Procurement Projections for a full list of state targets.

The most critical recommendations for this time frame require simultaneous convening and coordination: states coming together to plan for an offshore network; the industry coming together to standardize requirements for HVDC technology; and Federal agencies, Tribal Nations, and stakeholders coming together to identify and prioritize transmission paths on the outer continental shelf.

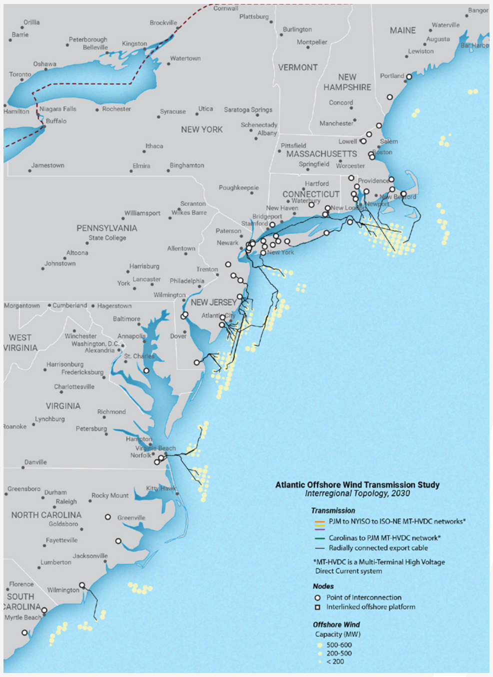
Near-Term Actions for 2025–2030		Reference Section
P & O ★ ★ ★	Interregional Offshore Topology Planning	2.2.1
T & S ★ ★ ★	HVDC Standards Development	3.2.1
S & P ★ ★ ★	Federal Preferred Routes for Transmission in the Outer Continental Shelf	5.1.1
P & O ★ ★	Regulatory Guidance for Ownership of Network-Ready Projects	2.4.2
T & S ★ ★	Data Sharing for Interoperability of HVDC Offshore Systems	3.2.3
S & P ★ ★	BOEM Competitive Right-of-way Grant Issuance Process for Preferred Routes	5.1.3
S & P ★ ★	Multi-state Partnership on Clean Energy Standards and Offshore Wind Goals	5.1.4
P & O ★	Interconnection Queue Process Reform	2.4.1
S & P ★	Community Benefit Agreements	5.2.5

WHAT IS THE INTERCONNECTION QUEUE?

Before a generator can interconnect to the grid and begin generating energy, transmission system operators must first study what system upgrades will be needed for the generator to reliably interconnect, and the generator must pay for any necessary upgrades. The process through which generators request and obtain studies from transmission providers is referred to as the interconnection queue. Queue reform generally refers to changes to transmission providers' interconnection queue processes to reduce the time it takes for a generator to interconnect to the grid.

Other important recommendations focus on providing regulatory guidance and data to decision-making entities, issuing rights-of-way grants, and collaborating among states on clean energy standards and offshore wind goals to help promote holistic transmission design solutions that maximize benefits for the entire region, including the marine environment and ocean co-users. Streamlining generation interconnection through queue reform and strengthening collaboration between developers and local communities are also recommended in this action plan as ongoing activities and practices. Figure 2 is a map of how the offshore transmission system build-out along the Atlantic could look in 2030.

Figure 2. Map of potential offshore transmission development by 2030 for the Low Carbon Scenario, based on analysis of the AOSWTS.



MID-TERM ACTIONS

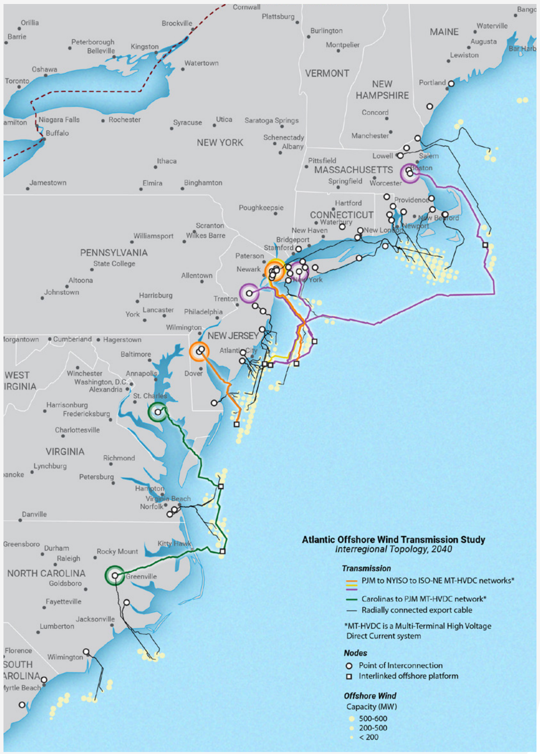
Between 2030 and 2040, we will continue to ramp up for long-term needs. During this decade, we expect interregional offshore transmission will be constructed, ambitious multi-state projects will be developed, and precedent will be set for how our long-term goals will be reached.

Although previously planned infrastructure is under construction, the establishment of a national HVDC testing and certification center will be needed to ensure compatibility of the new MT-HVDC networks being built

	Mid-Term Actions for 2030–2040	Reference Section
T & S ★ ★ ★	Multi-Terminal HVDC Test and Certification Center	3.2.2
P & O ★ ★	Regulated Interregional Joint Planning Processes	2.2.2
P & O ★ ★	Interregional Transfer Capacity Minimums	2.3.2
S & P ★ ★	Assignment of Offshore Cables and Substations for Continued Use as Shared Infrastructure	5.2.3
P & O ★	Enhancement of Existing Market Monitoring Roles	2.4.3

This time frame is also when we look to codify updates to transmission planning through regulated interregional joint planning, transfer capacity minimums, and market monitoring. Further, it is expected that we will start planning for the retirement and repurposing of offshore transmission assets to ensure enduring value to the system in the coming decades. Figure 3 shows a map of how the offshore transmission system build-out along the Atlantic could look in 2040.

Figure 3. Map of potential offshore transmission development by 2040 for the Low Carbon Scenario, based on analysis of the AOSWTS.



SUSTAINED ACTIONS

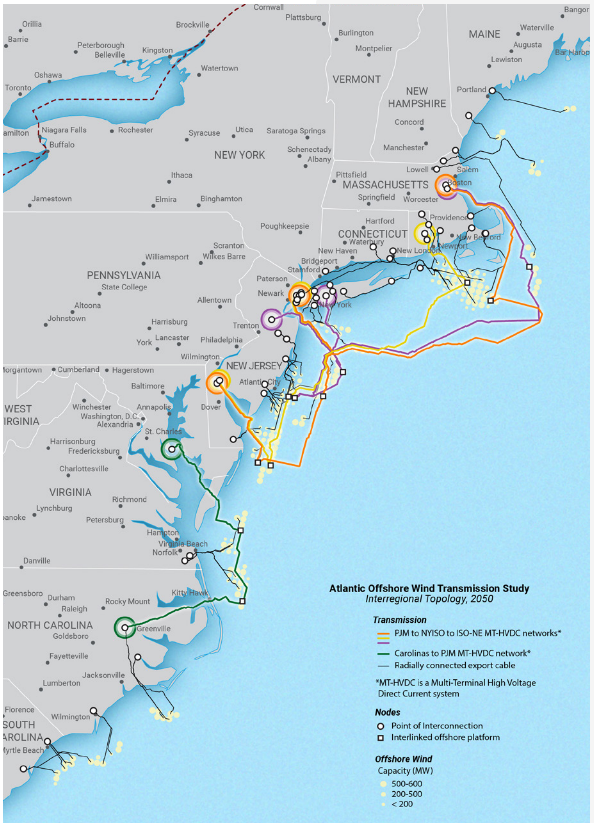
The last set of recommended actions have been identified as tools to achieve development goals for 2050 and beyond. These recommendations generally do not have specific due dates and are seen as tasks that will be consistently important and needed regardless of the year.

Key recommendations involve improved environmental review and permitting frameworks, strong state leadership, empowerment of permitting agencies, thoughtful cost allocation practices, and consideration of the utilization of National Interest Electric Transmission Corridors (NIETCs).

Supporting actions focus on maximizing the use of existing infrastructure and resources. We include communication and information sharing, the use of grid-enhancing technologies to maximize the capacity of the existing onshore transmission grid, and consideration of the utilization of Federal lands. Ratepayer protections feature prominently and focus on benefit valuation practices, ratepayer equity, and consumer advocacy—all intended to ensure that the immense value that offshore wind and a holistically planned offshore grid can provide is delivered back to local communities. Figure 4 shows a map of how the offshore transmission system build-out along the Atlantic could look in 2050.

Sustained Actions for Enduring Growth		Reference Section
S & P ☆ ☆ ☆	Improved Environmental Review and Permitting Frameworks	5.2.1
P & O ★ ★	State-led Transmission Planning	2.1.1
E & S ★ ★	Cost Allocation Methodology	4.1.3
E & S ★ ★	Federally Designated National Interest Electric Transmission Corridors	4.2.2
S & P ☆ ☆	Permitting Agency Resources and Staffing	5.2.4
P & C ☆	International Cooperation	1.2.1
P & C ☆	Communication Practices and Public Engagement	1.2.2
T & S ☆	Transmission Optimization with Grid-Enhancing Technologies	3.1.3
E & S ★	Best Practices for Benefit Valuation	4.1.2
E & S ★	Equity in Ratemaking	4.1.4
E & S ★	Consumer Advocates	4.1.5
E & S ★	Relevant Federal Funding, Financing, and Technical Support	4.2.1
S & P ☆	Utilization of Existing Federal Facilities Along the Coast	5.1.5

Figure 4. Map of potential offshore transmission development by 2050 for the Low Carbon Scenario, based on preliminary findings of the AOSWTS.



OFFSHORE WIND DEPLOYMENT IN THE UNITED STATES

Offshore wind in the United States is poised to play a critical role in the nation's transition to clean energy while improving reliability and resilience of the power system and providing economic opportunity and American jobs. It has the potential to meet the electricity needs of the United States.[5] The Atlantic Coast has kick started the industry, with 42 MW already installed and two commercial-scale projects in development. The Atlantic states are part of a growing number of states with clean energy policies and procurement activities that are driving a total project pipeline exceeding 40 GW.[iv] Federal action is also providing a critical boost alongside state-driven action. In March 2021, the Biden-Harris Administration announced an inter-agency goal of deploying 30 GW of offshore wind energy by 2030—which would unlock a pathway to 110 GW by 2050[6]—to strengthen the domestic supply chain, create jobs, and reduce carbon emissions while building toward a clean energy future. Later that year, BOEM announced that it would ramp up offshore leasing in Federal waters. According to the 2022 Offshore Wind Market Report, actions like these to auction new lease areas and develop wind management areas were influential in the 13.5% growth in the nation's offshore wind project pipeline between May 2021 to 2022.[7] With national leasing plans targeting offshore wind expansion along the Atlantic, Pacific, Gulf of Mexico, and Great Lakes, the domestic industry is experiencing significant growth. Although obstacles to realizing the enormous potential of offshore wind remain, it will be imperative to address the current and anticipated transmission challenges associated with delivering this power to the grid.

CHALLENGES TO OFFSHORE TRANSMISSION DEVELOPMENT AND THE INTEGRATION OF OFFSHORE WIND

As the United States transitions to a clean energy economy, transmission infrastructure will need to be significantly expanded. This especially applies to the integration of offshore wind because there is no existing transmission grid offshore. Most offshore wind farms will be located 10 miles or more from the shore and may have to deliver power significantly further inland to connect to robust, high-voltage transmission facilities capable of integrating such large volumes of offshore wind.

Developers of offshore transmission infrastructure must also contend with harsh ocean environments, laying cable at depth; shortages of available components, port facilities, and installation vessels; and permitting requirements that span Federal, Tribal Nation, state, and local jurisdictions. Connecting networked transmission interregionally may provide significant benefits,

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[iv] See Appendix C: Offshore Wind Procurement Projections.

but it also introduces new challenges for planning, ownership, and cost allocation. Stakeholders have expressed uncertainty regarding the tax treatment of transmission projects developed separately from generation by utilities, states, or independent transmission developers, which may create financial disparity between different transmission approaches. There is also the need to ensure appropriate protections for marine environments and coastal communities as well as to address ocean co-use conflicts through avoidance, minimization, and mitigation strategies. Seven key findings on challenges have been identified:

NEAR-TERM

1. **Initial radial development may limit potential**. First movers may constrain future development. Without a long-term planning vision, near-term transmission solutions may preclude holistic transmission solutions that can facilitate long-term needs, leading to inefficiencies in both economic and environmental outcomes.
2. **Onshore upgrades may be significant**. Coastal transmission systems will need to be reinforced to deliver large amounts of energy from the coast to load centers.
3. **Siting is complex**. Siting of transmission requires enhanced marine spatial planning and holistic siting studies to identify the potential POI and routes to them; avoid, minimize, or mitigate multi-use conflicts; and maximize the throughput capacity of offshore infrastructure.

MID- AND LONG-TERM

4. **Cost allocation mechanisms are inadequate and offshore wind transmission costs are high**. Proactive development challenges conventional processes, particularly for interregional transmission lines. Policy changes are needed, and there is a potential need for Federal/state funding mechanisms or loan guarantees to offset costs.
5. **Reforms may pose project delays**. It takes time to develop new standards, policies, and practices; near-term development will have to proceed in parallel with such reforms.
6. **Current interconnection practices are unsustainable**. Strategic thinking beyond single projects is needed to effectively use cable capacity and landfall locations to minimize environmental and community impacts and to proactively anticipate future system needs.
7. **Proactive development brings project-on-project risk**. The separation of generation and transmission development creates an increased risk that one will be completed before the other, leaving what would be a stranded asset during the lag.

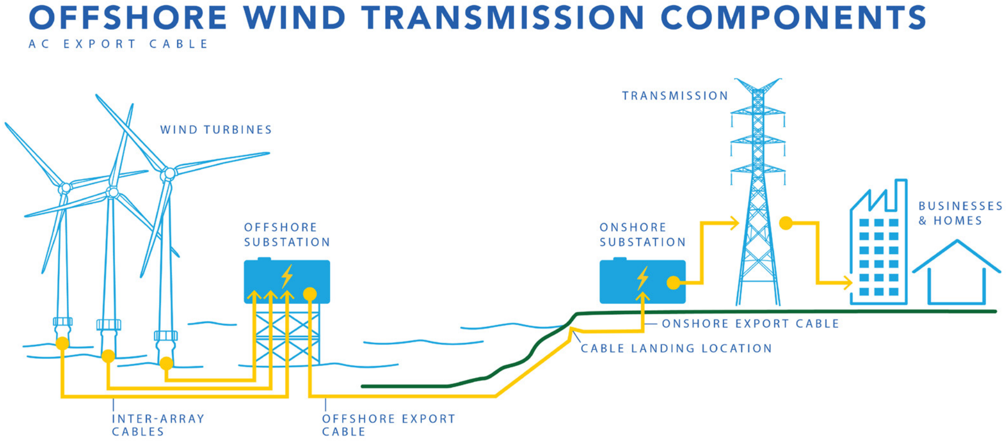
Further regional challenges exist for transmission development along the Atlantic Coast. There are many states and independent transmission planning bodies that have dissimilar or even disparate policies, processes, goals, and priorities. The physical transmission system, although electrically connected, varies in topology and voltage class between regions, and is already vastly oversubscribed, with the capacity in the interconnection queues exceeding the existing transmission network capacity.[8]

OFFSHORE TRANSMISSION TOPOLOGIES AND TECHNOLOGIES

Components of an offshore transmission system

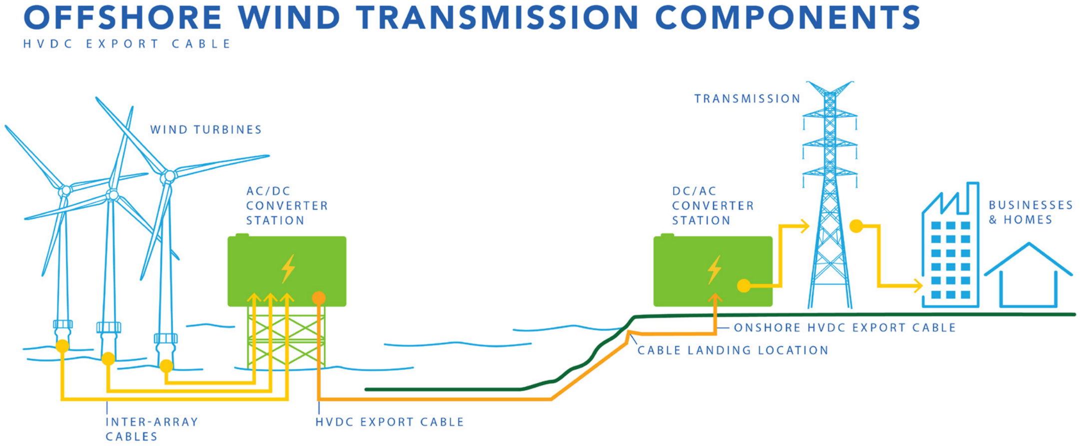
Offshore transmission lines, which may sometimes appear as thin black lines on a map representing the connection of an offshore wind plant to the coast, are complex pieces of infrastructure. Figure 5 illustrates the major components of an offshore transmission system. Each individual turbine in an offshore wind plant has its own collector system cable, or inter-array cable, that carries the power from the generator in the turbine to an offshore substation. That offshore substation performs several key functions: it aggregates all the generated power together so a line to shore for each turbine is not needed, it increases (or "steps up") the voltage so that the power can make it all the way to shore with fewer losses, and it contains all the communications and protection equipment to monitor and control the lines coming into it. After the voltage is stepped up, the power starts its long journey to shore via a high-voltage export cable that is buried in the seafloor. Reaching shore, the export cable is buried under the landfall location and may extend several miles (or more) underground until it arrives at an onshore substation. Once there, the power is transferred to overhead cables so that it can be connected to the existing onshore transmission system for delivery to load centers.

Figure 5. Components of an offshore wind transmission system.



For wind plants that are far from the coast (35 miles or more), using high-voltage direct current (HVDC) transmission cables to carry the power to shore may be most efficient (see Figure 6). HVDC lines lose less power over long distances than the alternating current (AC) lines typically used in the power system in the United States. The HVDC systems require converter stations that are larger and more costly than traditional substations, but with the increase in efficiency and some added technical capabilities unique to HVDC, they may be essential to the future offshore grid.

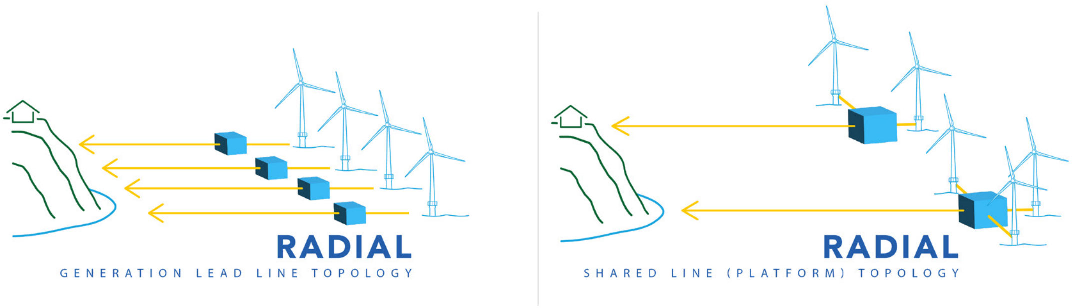
Figure 6. Components of an offshore wind HVDC transmission system.



Conceptual offshore topologies

Many possible configurations may exist for offshore transmission that can be grouped into radial and network topologies. In radial topologies, the power has a single path from the generation to the onshore load. Figure 7 illustrates possible radial connections in which each turbine represents an offshore wind plant. Generation lead lines are the radial configurations most commonly used because they connect a single wind plant to a single point of interconnection onshore. They tend to be the quickest to build and require the least amount of risk for the generation developer. Shared-line topologies differ in that they connect two or more plants offshore through shared export cables. They may require additional coordination but can reduce the number of cables required, which in turn minimizes environmental and community impacts, ocean co-use conflicts, costs, and the number of landfall locations.

Figure 7. Radial transmission topologies (offshore wind plants represented as single turbines).

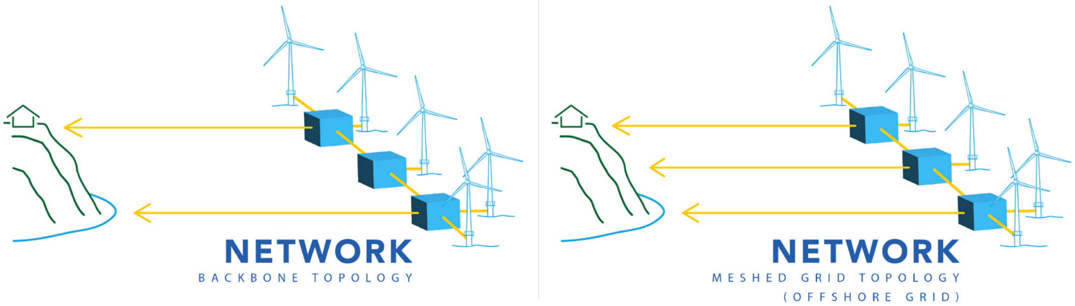


DO ALL OFFSHORE WIND PLANTS UTILIZE A SINGLE CABLE?

The images in Figure 7 show simplified systems to make them easier to understand. In practice, the number of physical cables will depend on the design of those cables, whether multiple phases or poles are bundled into a shared cable jacket, and the power capacity for which they are rated. It may be possible for cables to share trenching or run parallel along a corridor, which here are represented as a single cable path for illustration purposes.

Network topologies build off the radial design but include offshore interlinks to connect multiple cables. These configurations introduce multi-directional power flows and make new options available for system operators to reroute power offshore. Multiple paths, when sized properly, increase system reliability—if a single line is lost, some, if not all, of that power can still make it to shore through an alternate path. Network topologies also may be useful to combat onshore transmission congestion by opening a path offshore for power to flow across the system. Figure 8 illustrates the two kinds of network topologies: backbone and meshed grid. A backbone topology connects a whole string of offshore substations and plants through a single path that connects to two points onshore. A meshed grid, on the other hand, has three or more connections to the onshore system, which increases the resiliency and capacity of the system, as well as the complexity.

Figure 8. Network transmission topologies (offshore wind plants are represented as single turbines).



WHICH TOPOLOGY IS RIGHT FOR THE ATLANTIC?

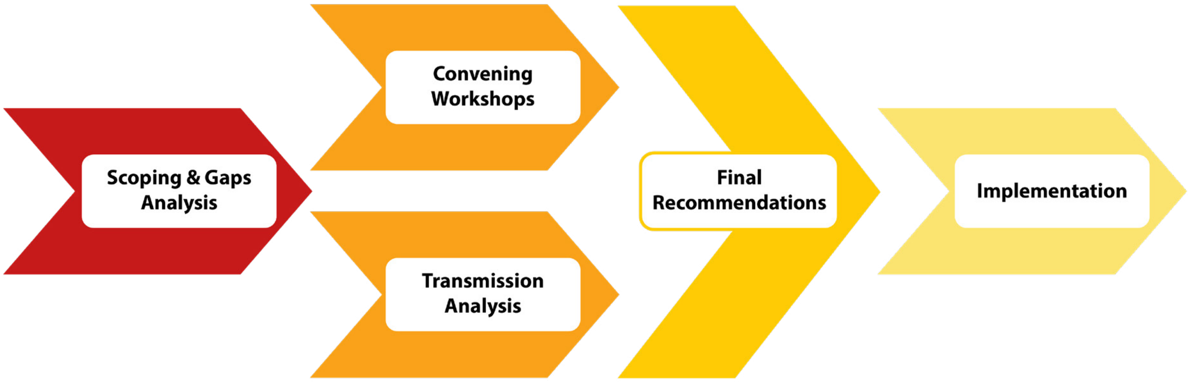
The optimal solution for the Atlantic region is likely going to include all of these transmission topologies. Differences in offshore wind plant location, distance from nearby wind plants, where the power is being used, the timeline for building the project, onshore system needs, and state policies are just some of the factors that will determine the best topology for any given wind plant.

INTRODUCTION TO FEDERAL EFFORTS ON OFFSHORE WIND TRANSMISSION

ABOUT THIS ACTION PLAN

The Federal Government, buoyed by the Biden-Harris Administration's inter-agency goal of deploying 30 GW of offshore wind by 2030, is addressing offshore wind transmission infrastructure challenges in multiple ways. The U.S. Department of Energy (DOE) and U.S. Department of the Interior's (DOI) Bureau of Ocean Energy Management (BOEM), in consultation with the Federal Energy Regulatory Commission (FERC), jointly developed this action plan to address near-, medium-, and long-term offshore wind transmission challenges. This action plan provides time-bound, regionally specific recommendations for offshore wind transmission development off the Atlantic coast of the United States (from Maine to South Carolina) to support the Biden-Harris Administration 2030 deployment target, as well as projections of 85 GW of future deployment,[v] on a pathway to more than 110 GW of deployment by 2050. This work was principally informed by four Federal offshore wind transmission activities: a series of Atlantic Coast scoping conversations held by DOE and BOEM, DOE's *Atlantic Offshore Wind Transmission Literature Review and Gaps Analysis*,[9] the Convening Workshops hosted in 2022–2023, and analysis from DOE's Atlantic Offshore Wind Transmission Study (AOSWTS).[10]

Figure 9. DOE and BOEM Offshore Wind Transmission engagement process for the Atlantic region.



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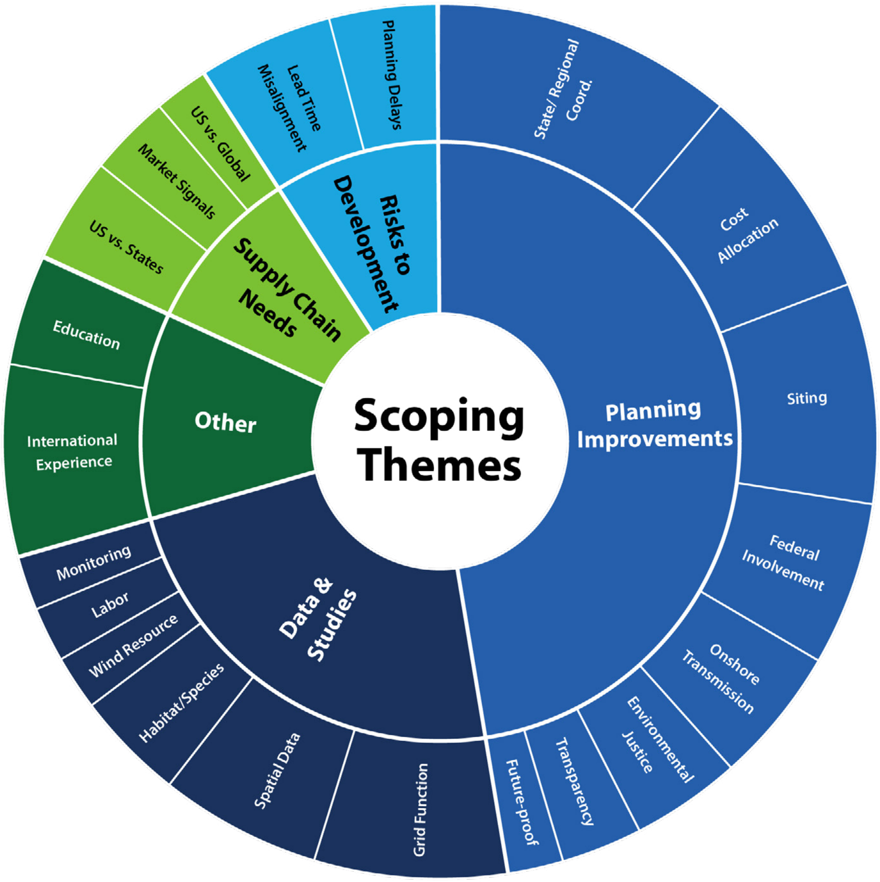
[v] The deployment assumption made in the AOSWTS was 85 GW by 2050 and represents the Atlantic region's contribution toward the national goal of 110+ GW for that time frame, as informed by the Technical Review Committee.

Offshore wind transmission development is complex and requires coordination across many jurisdictions. Input and insight from a broad and diverse group of entities was sought to elucidate transmission challenges and identify potential solutions. Though the development of this action plan was led by DOE and BOEM, it is part of a larger, coordinated, all-of-government approach that includes contributions from Tribal Nations and other decision-makers, as explained below. This action plan is an interim publication that is meant to share initial findings and solicit additional input on these potential solutions. Views expressed and recommendations made are not final and may be revised and republished at the completion of the AOSWTS, slated for late 2023.

Atlantic offshore wind transmission scoping conversations

Between June 21 and August 12, 2021, DOE and BOEM hosted 21 listening sessions to probe and record diverse perspectives on needs, challenges, and opportunities for offshore wind transmission development. More than 100 different entities across the sector were consulted, including Federal agencies, Tribal Nations, state agencies, cable and transmission providers, fisheries organizations, nongovernmental organizations, developers, regional ocean coordinators, unions, and utilities. Recurring themes from these scoping conversations, which are presented by topic area in Figure 10, shaped the investigatory work performed by DOE and BOEM that informed this action plan.

Figure 10. Themes of offshore wind transmission from the Atlantic scoping conversations.



Themes were also organized by near-term (i.e., present to 2030) and mid- to long-term (i.e., through the 2030s and 2040s) time horizons. For the near term, there was concern that first movers would quickly absorb available interconnection capacity with individual project connections and increase the cost and complexity of future development. Conversations also highlighted the challenges associated with connecting new, large, offshore generation to existing low-capacity coastal systems, which could cause coastal power flow reversals and necessitate onshore upgrades. Multi-use conflicts around offshore transmission were also cited. Concerns were raised that many projects are underway and that changes imposed for long-term development should not impede the near-term development of existing projects.

Moving beyond the immediate pace of project development, cost allocation arose as a concern for the mid- to long-term time frame, given the interaction of multiple states and transmission owners required by the industry beyond the initial tranche of radial projects to be developed by the late 2020s. The importance for longer-term process reform to be compatible with ongoing development in a burgeoning industry was emphasized. Some called for reform within established but reactive interconnection processes, particularly as more offshore wind projects enter the queue, to allow for more strategic coordination. Finally, it was indicated that any movement away from the radial interlink model brings project-on-project risk that represents a departure from most electricity generation project development to date. Innovative contractual mechanisms or guarantees may be necessary to mitigate this risk, and there may be learnings from the European experience in this regard.

ATLANTIC OFFSHORE WIND TRANSMISSION LITERATURE REVIEW AND GAPS ANALYSIS

In October 2021, DOE's Wind Energy Technologies Office (WETO) published the *Atlantic Offshore Wind Transmission Literature Review and Gaps Analysis*,[11] which reviewed more than 20 publicly available transmission analyses for the Atlantic Coast region conducted by states, independent system operators (ISOs) and regional transmission organizations (RTOs), industry, and other grid-related stakeholders. The analysis was conducted by WETO and DOE's National Renewable Energy Laboratory and was reviewed by other program offices within DOE as well as DOE's Pacific Northwest National Laboratory, BOEM, and FERC. The analysis summarized key themes across the existing transmission analyses and identified four main knowledge gaps: isolated geographic and oceanic planning, lack of coordination between offshore wind generation and transmission, limited study scope and breadth, and lack of reliability and resilience considerations. To address these gaps, the analysis suggested that stakeholders be convened to evaluate offshore wind transmission options and system impacts and to identify collaborative pathways to achieve Federal, state, and local offshore wind deployment goals for 2030, 2050, and beyond. The analysis concluded that broader, more comprehensive interregional studies of potential offshore wind transmission options are needed. Such studies must be aligned across broader geographies, examine both offshore wind generation and transmission development, and include reliability and resilience considerations. In addition, the need for standards development was discussed.

ATLANTIC OFFSHORE WIND TRANSMISSION CONVENING WORKSHOPS

DOE and BOEM, in consultation with FERC, hosted a series of nine Convening Workshops from April 2022 to March 2023. At these workshops, decision-makers and subject matter experts shared individual ideas about specific technical solutions and regulatory approaches to facilitate proactive and coordinated offshore wind transmission planning and development. Two of the nine Convening Workshops were public, with recordings made available online.[vi] DOE and BOEM also hosted a hybrid (in-person and virtual) Tribal Nation Dialogue at DOI headquarters with Tribal Nations in February 2023. All feedback from the Convening Workshops was heard and thoughtfully considered but may not be reflected verbatim in this action plan; further synthesis and refinement of our learnings is reflected in the recommendations section of this action plan. The workshops sought advice, information, and facts from individual stakeholders rather than a group position or consensus, and all recommendations in this action plan were developed internally by DOE and BOEM. This feedback and insight were instrumental in helping DOE and BOEM think holistically about how to address offshore wind transmission challenges.

The Convening Workshops were organized around three main tracks: technical planning and development, economics and policy, and siting and permitting. At each workshop, subject matter experts presented specific technical topics to set the stage for facilitated discussion among all participants during breakout sessions. Topic areas included collaborative approaches to proactive transmission planning; technology advancement and standardization; economics; environmental impact, siting, and permitting; and policy and regulatory development.

Decision-makers invited to the Convening Workshops varied by the focus of each particular workshop, but included:

- Tribal Nations
- Federal agencies (in addition to DOE, BOEM, and FERC), including the Bureau of Indian Affairs, U.S. Department of Defense, U.S. Department of Transportation, U.S. Environmental Protection Agency, Federal Aviation Administration, Federal Communications Commission, Federal Permitting Improvement Steering Council (Permitting Council), Navy, National Oceanic and Atmospheric Administration (NOAA), National Park Service, U.S. Army Corps of Engineers, U.S. Coast Guard, U.S. Fish and Wildlife Service, and Western Area Power Administration
- State agencies (public utility commissions, state energy offices, state environmental and natural resources agencies, and governors' offices)
- ISOs and RTOs
- Electric reliability organizations
- Consumer advocates
- Existing BOEM leaseholders

The Convening Workshops involved approximately 40 hours of expert presentations and facilitated roundtable discussions. Additional ad hoc meetings with subject matter experts regarding specific technical questions often followed. More than 875 individuals participated in this convening effort, including Tribal Nations, representing 443 entities.

[vi] See June 28, 2022, event at https://www.energy.gov/gdo/events/june-28-offshore-wind-transmission-stakeholder-workshop and March 22, 2023, event at https://www.energy.gov/gdo/events/march-22-atlantic-offshore-wind-transmission-stakeholder-workshop.

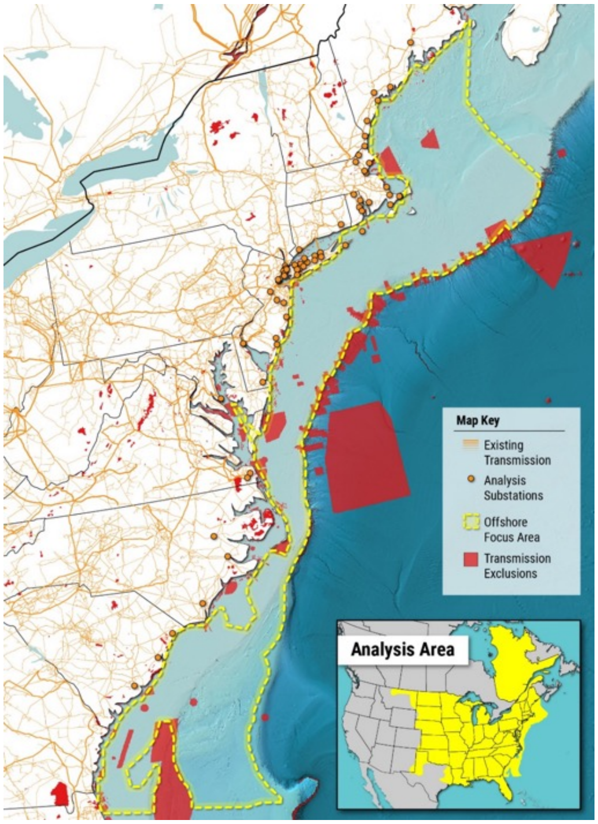
ATLANTIC OFFSHORE WIND TRANSMISSION STUDY

WETO solicited DOE's National Renewable Energy Laboratory and Pacific Northwest National Laboratory to conduct a transmission analysis along the Atlantic coast. The AOSWTS evaluated multiple pathways to enable offshore wind deployment through coordinated transmission solutions for 2030–2050. This transmission analysis examines different transmission technologies and topologies, and compares the costs and benefits of different transmission build-out scenarios under various combinations of electricity supply and demand while considering reliability, resilience, and environmental and siting constraints associated with ocean co-use. The AOSWTS was completed and published in early 2024.[vii]

A Technical Review Committee (TRC), consisting of more than 150 subject matter experts from Tribal Nations and a wide variety of organizations with experience in various aspects of transmission planning, siting, and development, guided the study. The TRC supported the development of the study assumptions, data, and methodologies to address relevant questions. The TRC's goal was to ensure that the study results would be realistic and actionable.[viii]

Figure 11 illustrates the AOSWTS's analysis area, which extends from Maine through South Carolina. The yellow region in the inset map at the bottom right corner represents the Eastern and Québec Interconnections, which is modeled in the grid modeling portions of the study, although analysis is focused on the regions closest to the offshore focus area (the area within the yellow dotted line).

Figure 11. AOSWTS analysis area.



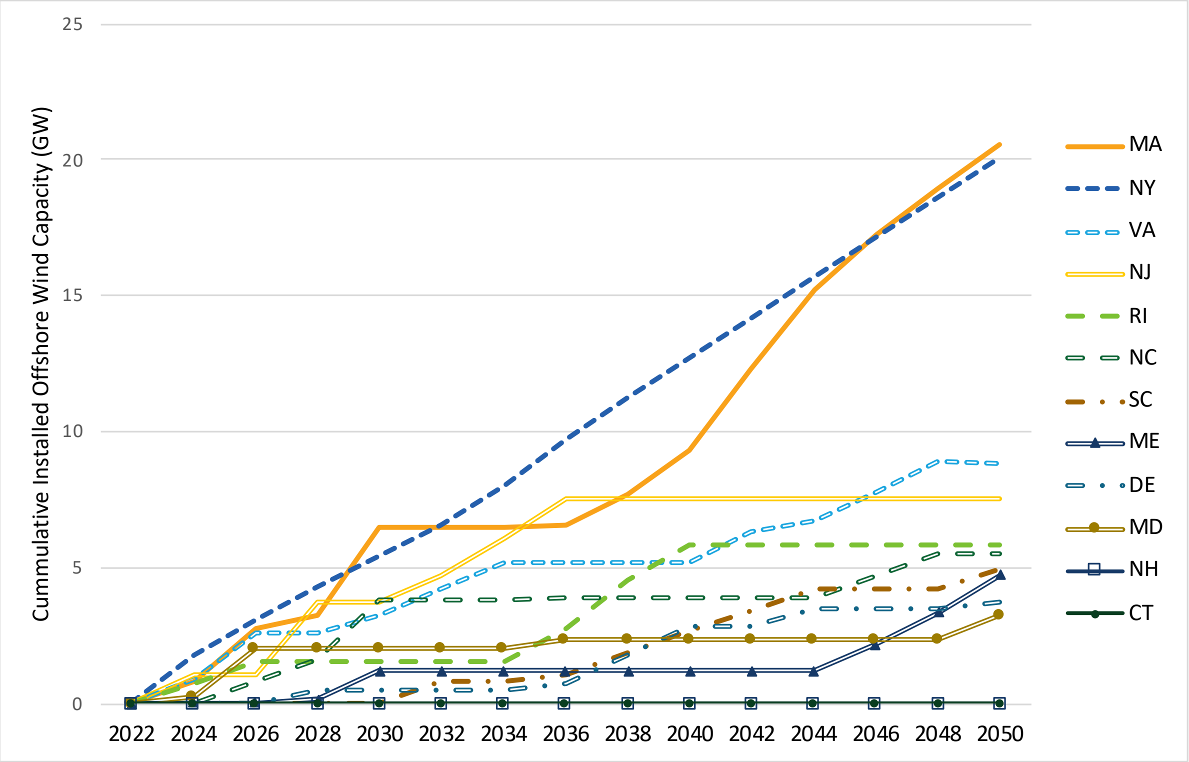
[vii] See AOSWTS at https://www.nrel.gov/wind/atlantic-offshore-wind-transmission-study.html.

[viii] Although the TRC reviewed the analysis of the AOSWTS, it did not review this action plan, so this action plan may not reflect the views or interpretations of any committee member or organization.

The AOSWTS used existing BOEM lease areas in the region to build out an anticipated offshore wind portfolio of 30 GW by 2030 and went beyond existing leases to build out to approximately 85 GW within the Atlantic region by 2050 while considering demand growth, resource mix, cost, policies, and many other factors. The distribution of that wind deployment to the nearest state is shown in Figure 12.

Note that Figure 12 does not imply state procurement or offtake; rather, it shows the offshore wind capacity that could be connected to POI within that state, based on assumptions made to conduct the analysis from the AOSWTS.

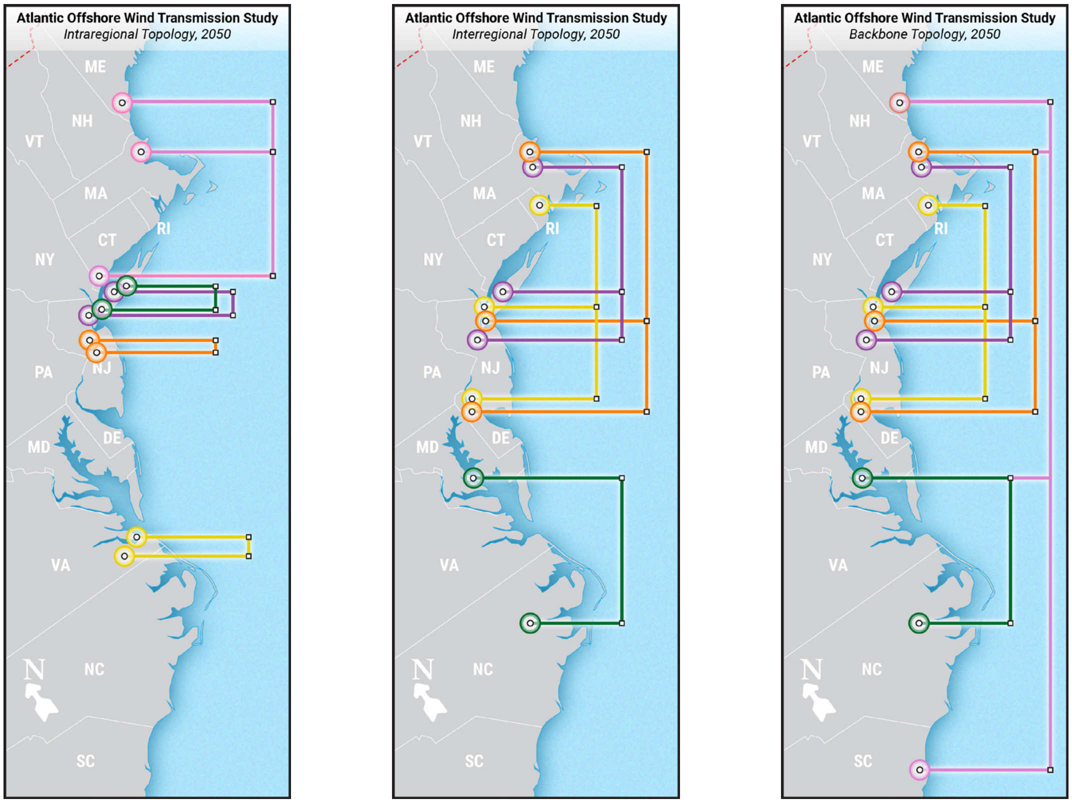
Figure 12. Offshore wind deployment projections for the Atlantic Coast per state through 2050, from AOSWTS.



The AOSWTS analyzed five offshore wind transmission build-out scenarios: radial connections; intraregional connections (i.e., connections within transmission planning regions); interregional connections (i.e., connections among transmission planning regions); intraregional and interregional connections, which combine the prior two; and a backbone connection that extends the interregional connection case along the entire Atlantic Coast of the study region, from Maine to South Carolina.

The AOSWTS found that all networked topologies have benefits outweighing their costs, often by a ratio of 2 to 1 or more. Topologies with interregional components had the most substantial production cost benefits when compared to the radial-only reference case. Table 1 shows a summary of the costs, benefits, and value for each topology scenario studied in the AOSWTS. Although the highest benefit cost ratio is found with the interregional topology, the Incremental benefits of the within region topology are notable and persist even when the interregional topology is included (i.e., the within-region and interregional topology). This finding is significant because it supports the states' ongoing radial and mesh-ready procurement approaches Figure 13 shows the topologies developed for the intraregional, interregional, intraregional + interregional, and backbone scenarios. Because the radial scenario underpins the other scenarios, a radial-only topology map is not provided here.

Figure 13. Intraregional, interregional, and backbone topologies studied in the AOSWTS.



Atlantic Offshore Wind Transmission Study
Intraregional Topology, 2050

Atlantic Offshore Wind Transmission Study
Interregional Topology, 2050

Atlantic Offshore Wind Transmission Study
Backbone Topology, 2050

The radial topology considers the POI and offshore wind connections that attempt to represent an optimal layout for cable costs and lengths, electrical attributes of the POIs, and quality of the connected offshore wind resource. The radial connection topology scenario underpins each of the other topology scenarios; all meshed interlinks connect platforms that exist in the radial topology. The within-region, interregional, and backbone topology scenarios assume that there will still be radial connections to shore; not all offshore platforms are assumed to be meshed into a larger grid.

The AOSWTS found that all networked topologies have benefits outweighing their costs, often by a ratio of 2 to 1 or more. Topologies with interregional components had the most substantial production cost benefits when compared to the radial-only reference case. Table 1 shows a summary of the costs, benefits, and value for each topology scenario studied in the AOSWTS. Although the highest benefit–cost ratio is found with the interregional topology, the incremental benefits of the intraregional topology are notable and persist even when the interregional topology is included (i.e., the intraregional and interregional topology). This finding is significant because it supports the states' ongoing radial and mesh-ready procurement approaches.

Topology	**Total cost ($billion)**	**Additional costs vs. radial ($billion)**	**Annualized offshore transmission costs ($million)**	**Annual gross benefit ($million)**	**Net annual value ($million) [benefits – costs]**	**Benefit–cost ratio [benefits/ costs]**
Radial	$96.3	N/A	-	-	-	-
Intraregional	$99.9	$3.6	$260	$590	$330	2.3
Interregional	$107.7	$11.4	$840	$2,400	$1,560	2.9
Intra–Inter	$111.2	$14.9	$1,090	$2,850	$1,760	2.6
Backbone	$116.3	$20.0	$1,470	$3,940	$2,470	2.7

Note: For a full set of tables and explanation of terms and findings, please refer to the AOSWTS report.

The AOSWTS identified that connecting large volumes of offshore wind along the Atlantic coast over the next several decades provides a unique opportunity for offshore networked transmission. Offshore transmission networks were found to contribute to onshore grid reliability by providing resource adequacy and helping manage onshore contingencies. These findings from the study, as well as learnings from the Convening Workshops, have informed DOE and BOEM's proposed recommendations in this action plan.

THE ACTION PLAN

The recommendations in this action plan support a proposed topology build-out and are organized within five categories: partnerships and collaborations, planning and operations, technologies and standardization, economics and support initiatives, and siting and permitting.

Each category addresses a specific transmission development need and contains multiple recommendations. The recommendations have been further defined by the time frame in which they would be most needed and by how impactful they may be to the national offshore wind deployment goal. The four time frames are divided by immediate actions (before 2025), near-term actions (2025–2030), mid-term actions (2030–2040), and sustained actions. As many of these recommendations will take significant time and effort to establish or may span several years, the listed time frame for each action should be interpreted as the year it is in effect or operable rather than the year the effort starts. Further, although actions have been scheduled based on a perceived need or assumed feasibility, we encourage earlier implementation whenever possible.

A criticality rating has been assigned to recommendations to differentiate those with the greatest potential to enable coordinated offshore transmission development. Recommendations that may be important to transmission development or ratepayers in general but not specific to enabling offshore wind deployment have been assigned a lower criticality rating. However, that description of criticality does not imply that these recommendations are not important or are not supported by DOE or BOEM. The intention is to focus on specific recommendations for offshore wind transmission. The numbers in the tables refer to the sections in which the recommendations are discussed in detail in this action plan.

The following symbology is used throughout the action plan:

★★★ Critical Path Action
★★ Recommended Action
★ Best Practice

RECOMMENDED OFFSHORE TRANSMISSION TOPOLOGY

Based on our learnings from the Convening Workshops; other activities, as previously described; and the analysis of the AOSWTS, the optimal solution for the Atlantic region will likely include a mix of transmission topologies. Some factors that will determine the best grid connection strategy for any given wind plant include its location, its distance from nearby wind plants, where the power will be used, the timeline for building the project, onshore system needs, and state policies (among others).

However, there is a unique opportunity for offshore interregional transmission along the Atlantic coast. DOE and BOEM propose the development of an interregional networked topology for the region, knowing that radial development will happen somewhat organically in parallel. For purposes of the AOSWTS, this proposed interregional topology was specifically configured to take advantage of opportunities to ease congestion while avoiding known areas of co-use conflicts or exclusions in the ocean and attempting to minimize overall cable distances (relative to other potential configurations of interlinks that would be required to achieve equivalent benefits).

HOW WAS THIS INTERREGIONAL TOPOLOGY DESIGNED?

The interregional transmission topology scenario was designed to create a higher benefit-to-cost ratio (relative to other interlink configurations studied) and to enable a variety of benefits to each transmission planning region. The transmission topology was created by simulating the hourly grid operation for a Low Carbon (95% carbon reduction) Scenario with the radial topology, and then by determining how POIs with significant congestion between them could be connected. Electricity price differences (measured by locational marginal price) among regions were more significant than within regions, and interregional interlinks (as illustrated in Figure 13) connect locations with significant price differences to provide maximum congestion mitigation, increase resilience, and improve overall system reliability.

We recognize that other configurations of interregional interlinks could provide similar benefits and that the presence of interregional interlinks should not preclude intraregional networks. However, interregional interlinks seem to be the most optimal solution, providing the largest benefit, based on the existing analysis; as such, this transmission topology informed the recommendations.

Figure 14. Transmission topology maps in five-year increments from 2030 to 2050 for a Low Carbon Scenario from analysis of the AOSWTS.

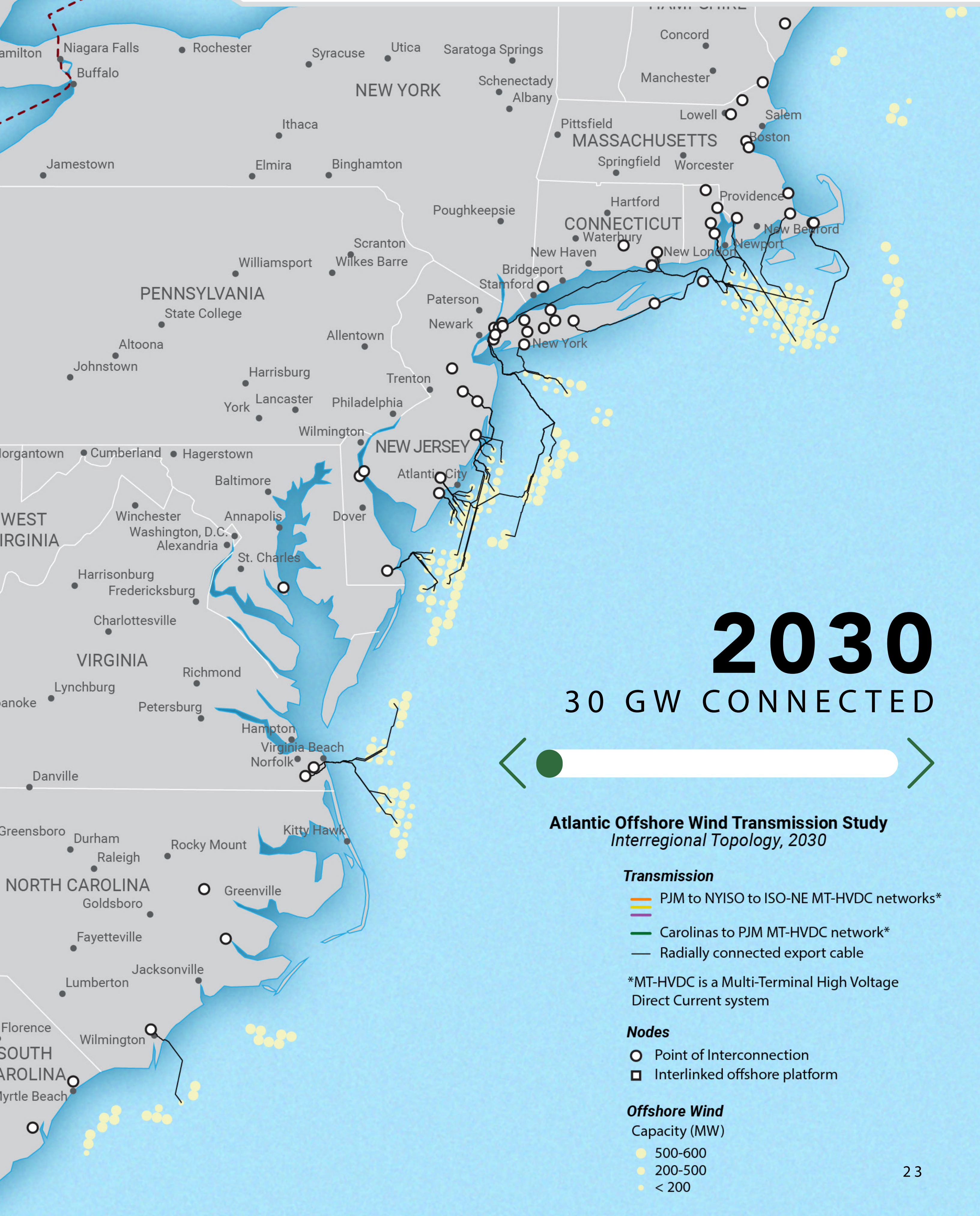


Figure 14. Transmission topology maps in five-year increments from 2030 to 2050 for a Low Carbon Scenario from analysis of the AOSWTS.

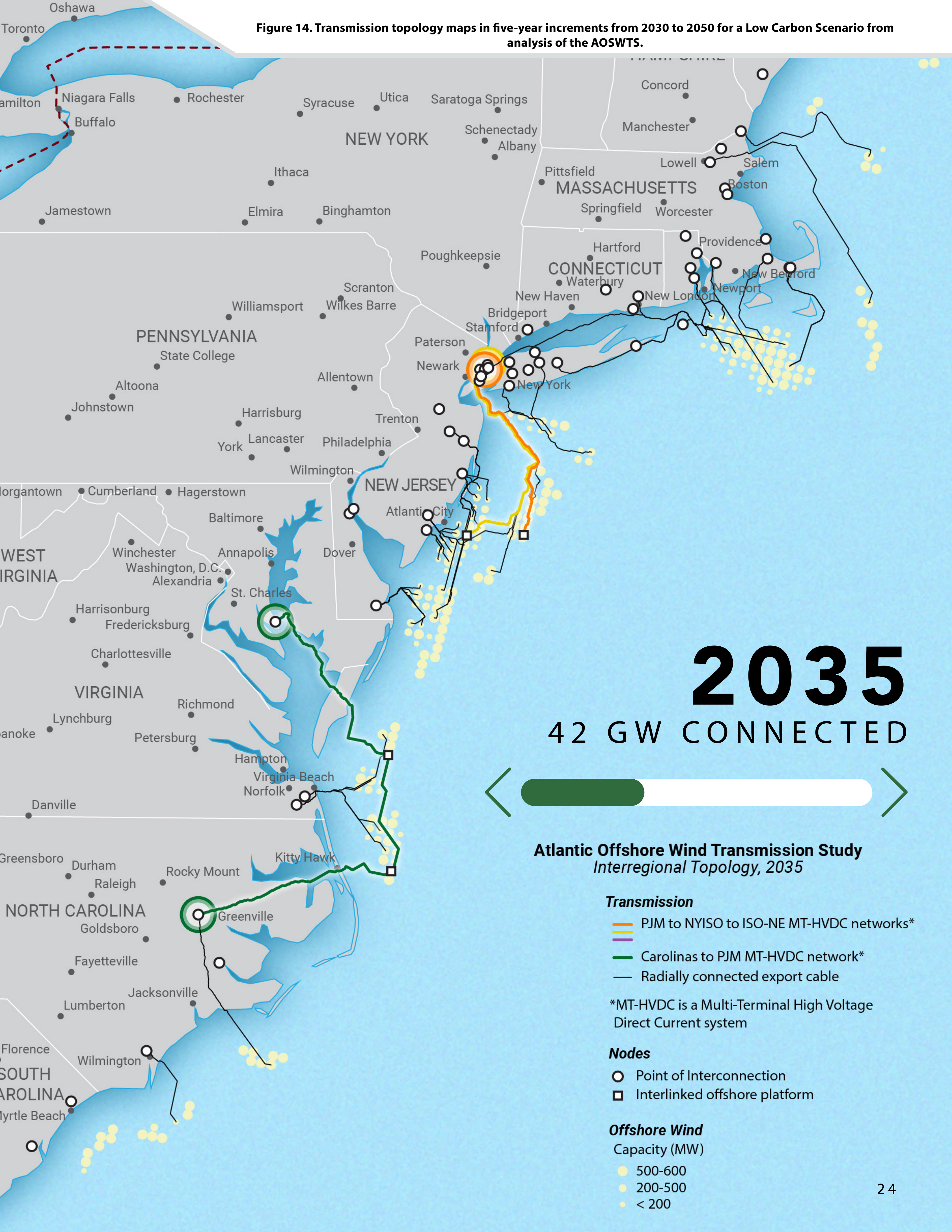


Figure 14. Transmission topology maps in five-year increments from 2030 to 2050 for a Low Carbon Scenario from analysis of the AOSWTS.

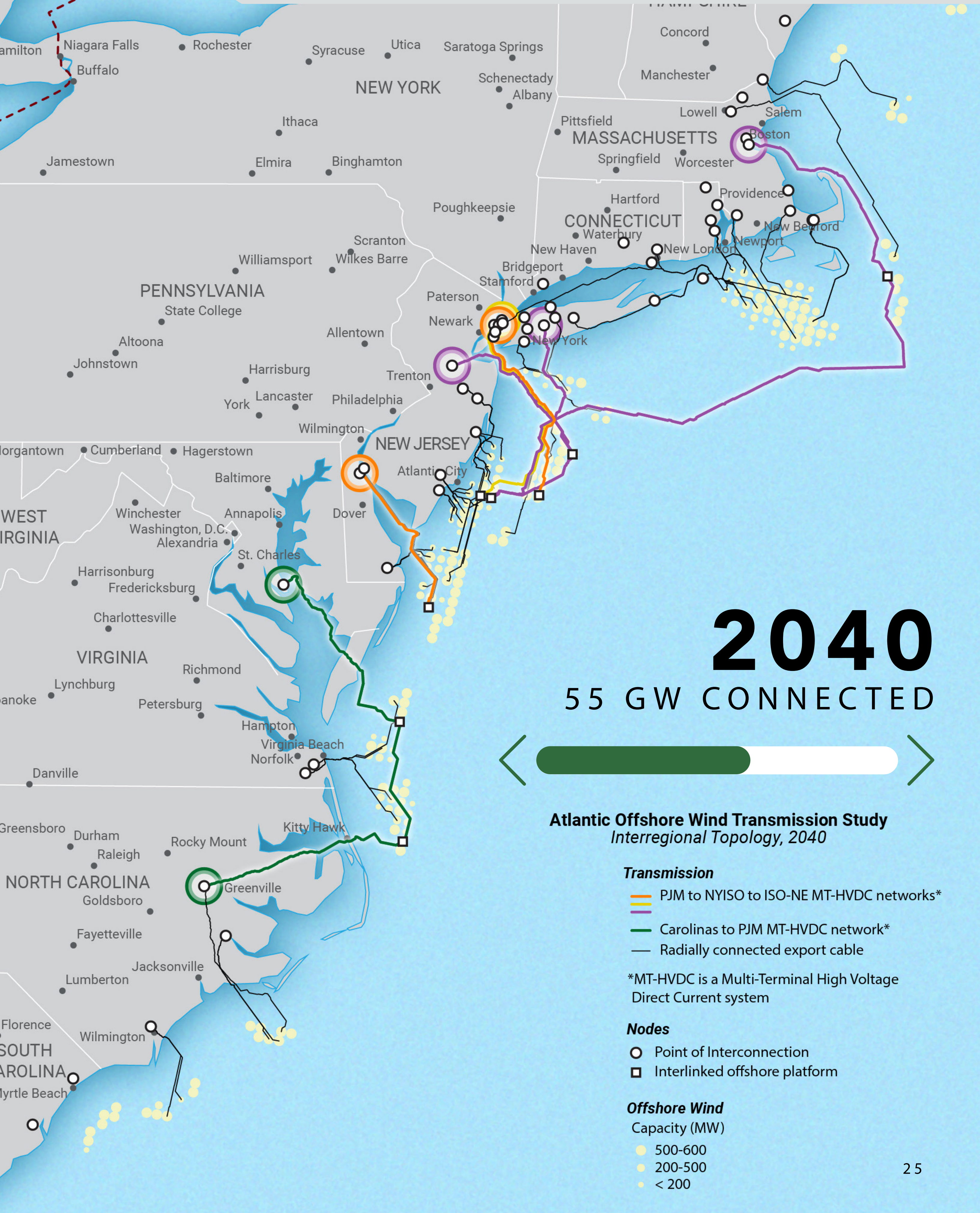


Figure 14. Transmission topology maps in five-year increments from 2030 to 2050 for a Low Carbon Scenario from analysis of the AOSWTS.

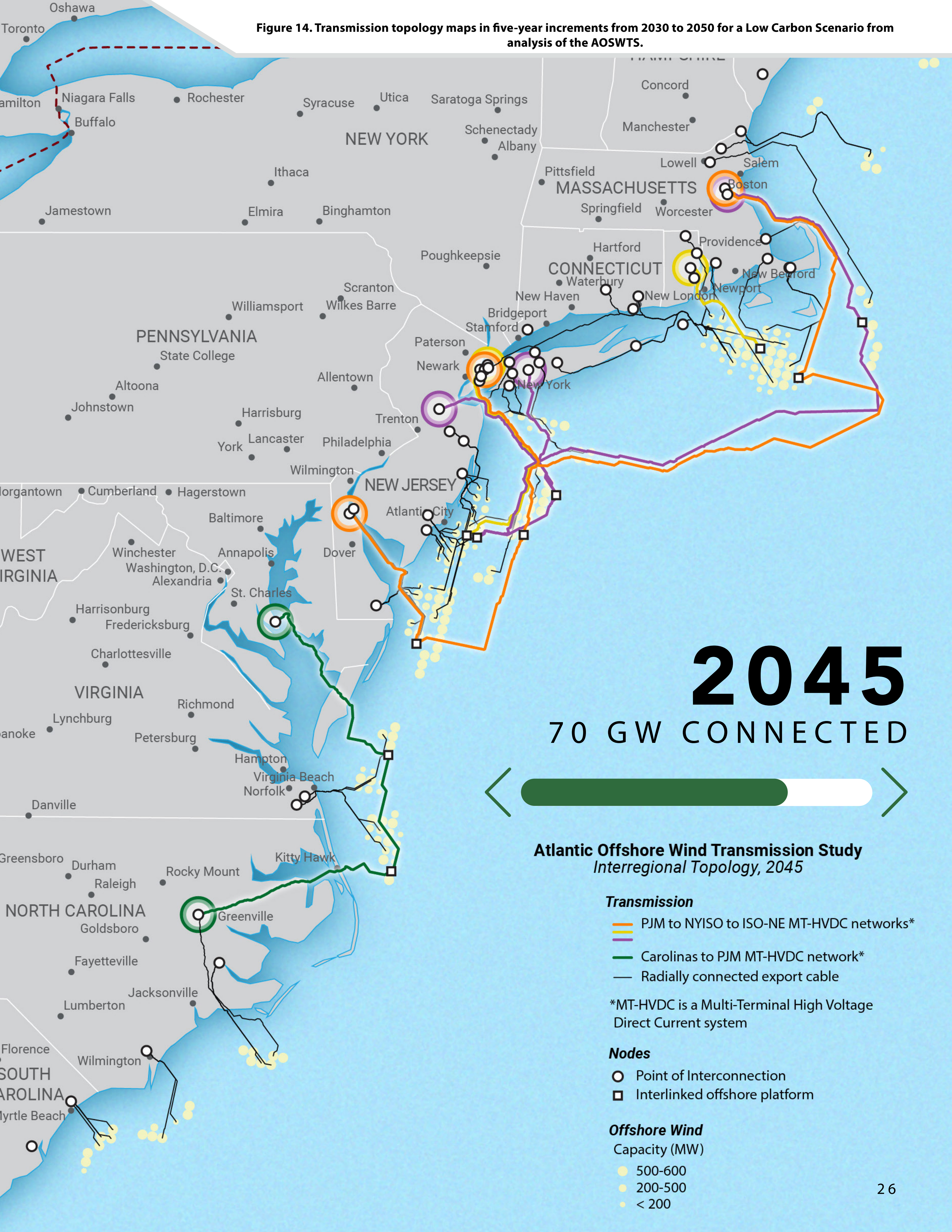


Figure 14. Transmission topology maps in five-year increments from 2030 to 2050 for a Low Carbon Scenario from analysis of the AOSWTS.

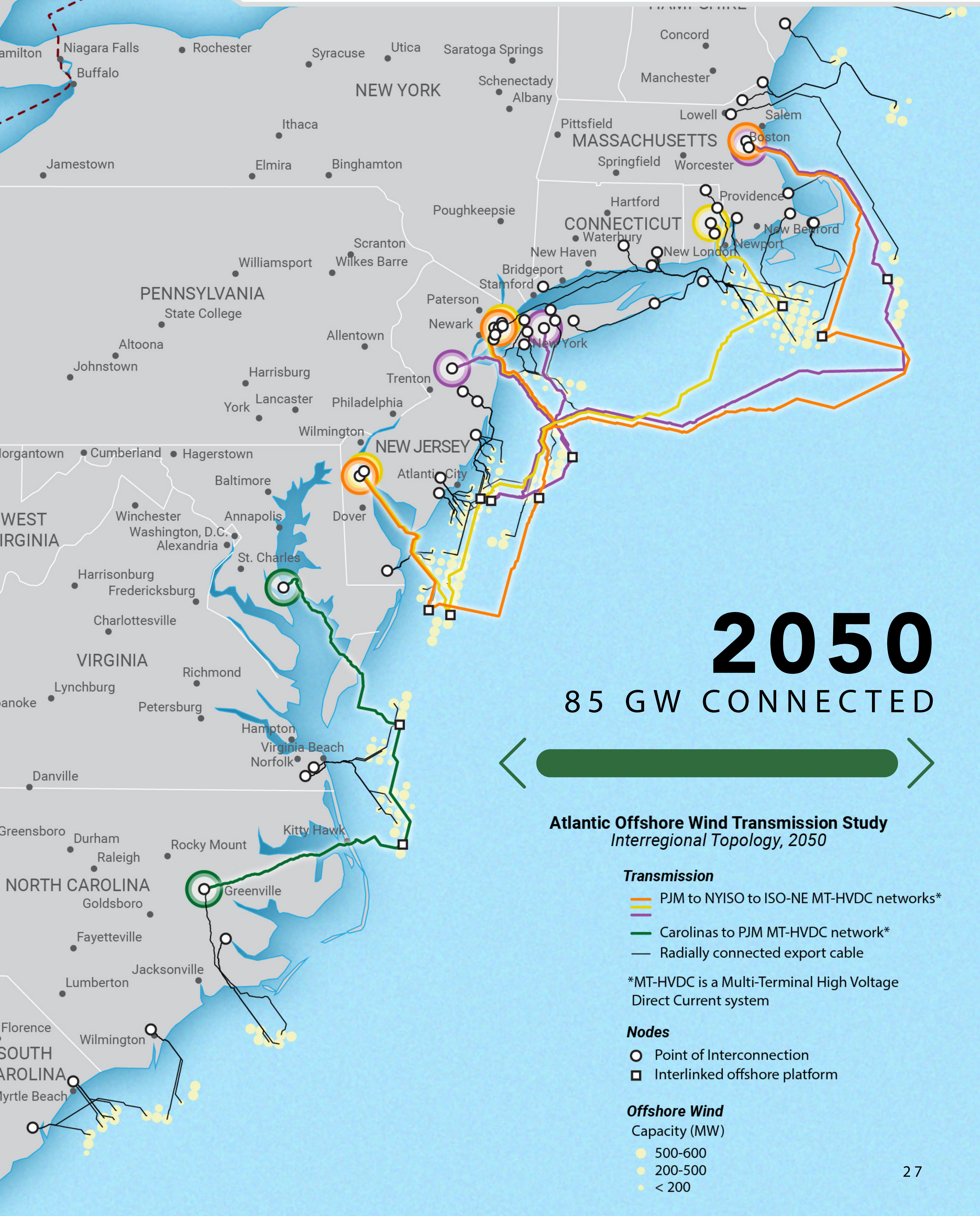


Figure 14 presents a series of maps in five-year increments (from 2030 to 2050) for the proposed interregional transmission build-out recommended by DOE and BOEM. This recommendation is based on the AOSWTS analyses and learnings from the Convening Workshops. As the maps illustrate, many offshore wind projects, particularly those in the near term, will use radial designs. In addition to these near term projects with radial connections, additional offshore wind deployment provides the opportunity to design an interregional set of MT-HVDC interlinks (including HVDC converter stations) that would connect multiple, diverse transmission planning regions and create the capability to transfer power among regions using this offshore network. These interlinks have been specifically designed to maximize production cost savings while attempting to minimize overall cable distances (relative to other potential configurations of interlinks). However, more detailed marine spatial planning will be required to inform transmission siting and translate these potential routes into construction-ready plans.

The three northern MT-HVDC interlinks (shown in red, green, and blue in Figure 15) are independent, multi-terminal lines that connect one POI in each of the three transmission planning regions—Independent System Operator, New England Inc. (ISO-NE), New York Independent System Operator (NYISO), and PJM Interconnection LLC (PJM)—via an HVDC system of subsea cables and offshore platforms. The southern interlink (shown in purple in Figure 15) similarly connects the non-ISO/RTO region of the Carolinas to the PJM region. These interlinks are envisioned to develop incrementally as the offshore transmission system expands over time. These MT-HVDC interlinks, as analyzed in the AOSWTS, account for seven new transmission cables that connect 11 offshore platforms and provide 14 GW of interregional transfer capacity along the coast.

WHAT IS AN MT-HVDC INTERLINK?

HVDC transmission lines use voltage converter stations to change the alternating current used in typical electricity transmission systems to direct current for transfer over the line. An MT-HVDC system consists of more than two HVDC transmission lines connected together to form an HVDC grid through which power can be transferred among multiple possible terminals for use based on current system need.

WHAT ARE THE PRODUCTION COST SAVINGS?

Transmission congestion increases the overall cost of producing electricity because it forces the grid operator to rely on more expensive generation that is close to load centers. Building new transmission lines alleviates this congestion and allows the grid operator to tap into cheaper sources of generation, reducing total electricity production for everyone.

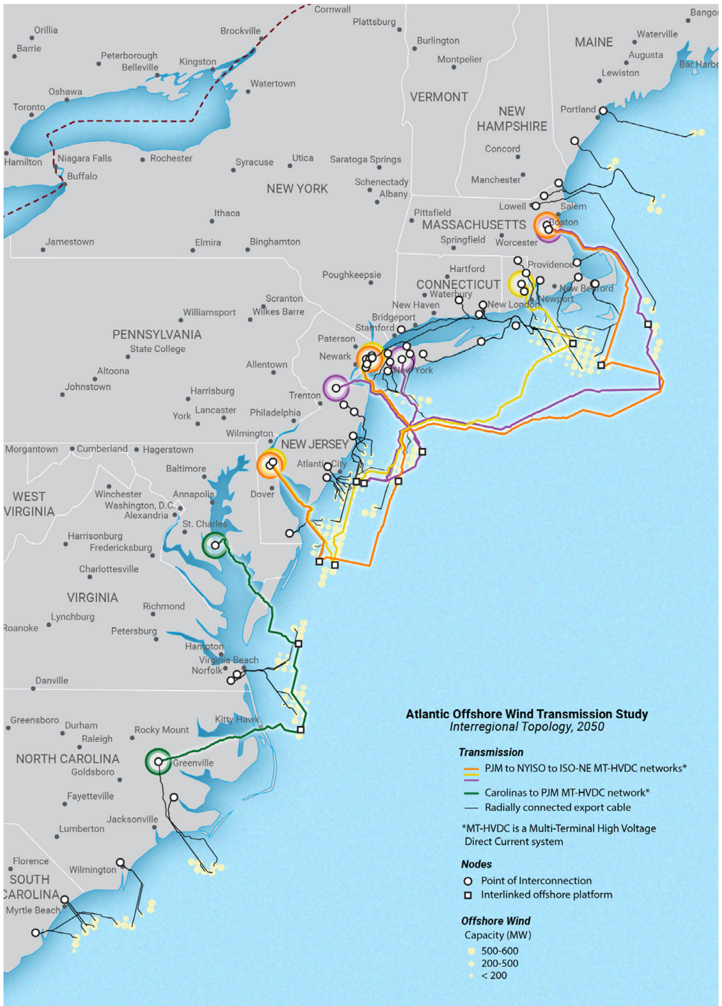
HOW WERE THESE SPECIFIC INTERLINKS SELECTED?

For these proposed interlinks, specific interconnecting POIs were identified for analysis based on assumptions about existing coastal generation plant retirements, but it may be possible to use other nearby POIs and still see similar system benefits regardless of generation retirement schedules. It is important to note that these interlinks were developed for the AOSWTS, which was designed to compare costs and benefits between different transmission topologies.

However, additional analyses will need to be completed by transmission planners and developers to consider alternative POIs, state policies, cable routing and landfall location details, construction plans, facility layouts, and setbacks, among other issues to enable implementation. The AOSWTS will not replace ISO/RTO transmission planning and more detailed siting studies and cannot indicate specifically where infrastructure should be built in the ocean. Rather, the AOSWTS is meant to compare transmission topology options and establish a baseline for this future, more detailed work.

The blue interlink, shown in Figures 14 and 15, illustrates a connection among Massachusetts, New York, and New Jersey that is envisioned to evolve incrementally from 2030 through 2040. For this interlink, the AOSWTS evaluated interconnections at existing substations south of Boston, Massachusetts; on Long Island, New York; and south of New Brunswick, New Jersey.

Figure 15. Map of potential interregional MT-HVDC interlinks identified by the AOSWTS 2050 Low Carbon Scenario analysis.



The red interlink illustrates a connection among Massachusetts, New York, and New Jersey that is envisioned to evolve incrementally from 2030 through 2045. For this interlink, the AOSWTS evaluated interconnections at existing substations north of Boston, Massachusetts; in New York, New York; and south of Salem, Massachusetts.

The green interlink illustrates a connection among Rhode Island, New York, and New Jersey that is envisioned to evolve incrementally from 2030 through 2050. For this interlink, the AOSWTS evaluated interconnections at existing substations near Warwick, Rhode Island; New York, New York; and south of Salem, New Jersey.[ix]

The purple interlink illustrates a connection between Maryland and North Carolina that is envisioned to evolve between 2030 and 2035. For this interlink, the AOSWTS evaluated interconnections at existing substations north of Lusby, Maryland, and in Greenville, North Carolina.

IMMEDIATE ACTIONS

The recommended actions for 2023 and 2024 are identified as immediate needs. By tackling them now, we leverage the historic BIL and IRA investments and unified political willpower to catalyze change and facilitate collaboration for the decades ahead. As a new industry ramps up, many tasks will need immediate prioritization.

Immediate Actions Before 2025		**Reference Section**
P & C ★★★	Offshore Wind Transmission State Collaborative	1.1.1
P & C ★★★	Regional Transmission Planning Collaborative	1.1.2
P & C ★★★	Tribal Nation Engagement	1.1.3
P & O ★★★	Systematic Evaluation of Points of Interconnection Capacities and Landfall Locations	2.1.2
P & O ★★★	North American Electric Reliability Corporation (NERC) Reliability Standards Around Offshore Transmission	2.3.1
E & S ★★★	Voluntary Cost Allocation Assignments	4.1.1
T & S ★★	"Network-Ready" Equipment Standards	3.1.1
T & S ★★	Equipment Rating Standardization for Transmission Components	3.1.2
T & S ★★	Research and Development for Offshore Transmission Technology Commercialization	3.3.1
T & S ★★	Expansion of Domestic Supply Chain and Manufacturing	3.4.1
T & S ★★	Skilled U.S. Workforce Development	3.4.2
S & P ★★	Federal-State Aligned Offshore Wind Transmission Siting	5.1.2
S & P ★★	Guidance for Federal Environmental Review and Permitting Requirements and Procedures	5.2.2
T & S ★	Environmental Research & Development for Offshore Wind Transmission	3.3.2

The most critical actions identified for this time frame involve establishing collaborative bodies that span the Atlantic Coast region; clarifying some of the building blocks of transmission planning, including POI identification and the North American Electric Reliability Corporation (NERC) Reliability Standards for offshore transmission; and addressing costs through voluntary cost assignments.

[ix] The injection near Salem, New Jersey, assumes the retirement of nuclear generation. If this planned retirement does not transpire, then other nearby options for interconnection farther west would likely need to be identified.

Other important work before 2025 includes standardization and research and development (R&D) in the technology and environmental spaces, support for a growing supply chain and workforce, and siting and permitting improvements.

NEAR-TERM ACTIONS

Actions recommended for the 2025–2030 time frame focus on shifting practices to reach near-term targets. The year 2030 is critical for the Biden-Harris Administration's inter-agency offshore wind deployment goal, and several Atlantic Coast states have set procurement goals for this time frame.[x] Although analysis from the AOSWTS indicates that 30 GW of offshore wind could be integrated into the grid by 2030 without interregional interlinks or a meshed grid, actions taken during this time will pave the way for the development of an offshore network.

Near-Term Actions for 2025–2030		**Reference Section**
P&O ★★★	Interregional Offshore Topology Planning	2.2.1
T&S ★★★	HVDC Standards Development	3.2.1
S&P ★★★	Federal Preferred Routes for Transmission in the Outer Continental Shelf	5.1.1
P&O ★★	Regulatory Guidance for Ownership of Network-Ready Projects	2.4.2
T&S ★★	Data Sharing for Interoperability of HVDC Offshore Systems	3.2.3
S&P ★★	BOEM Competitive Right-of-way Grant Issuance Process for Preferred Routes	5.1.3
S&P ★★	Multi-state Partnership on Clean Energy Standards and Offshore Wind Goals	5.1.4
P&O ★	Interconnection Queue Process Reform	2.4.1
S&P ★	Community Benefit Agreements	5.2.5

WHAT IS THE INTERCONNECTION QUEUE?

Before a generator can interconnect to the grid and begin generating energy, transmission system operators must first study what system upgrades will be needed for the generator to reliably interconnect, and the generator must pay for any necessary upgrades. The process through which generators request and obtain studies from transmission providers is referred to as the *interconnection queue*. Queue reform generally refers to changes to transmission providers' interconnection queue processes to reduce the time it takes for a generator to interconnect to the grid.

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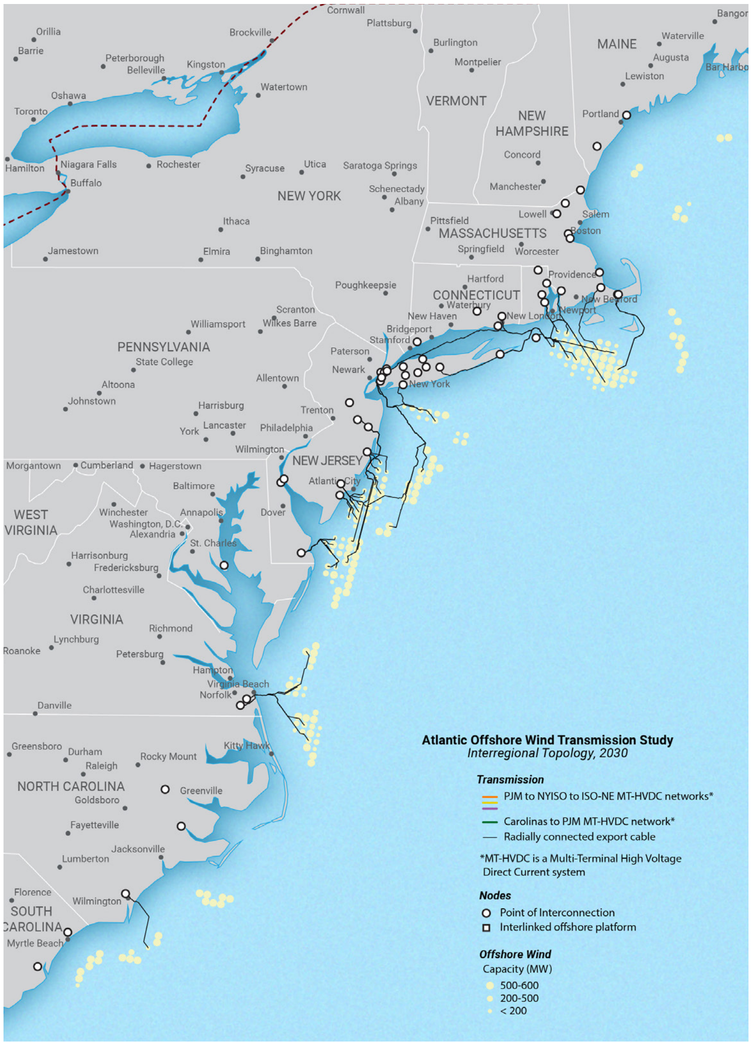
[x] See Appendix C: Offshore Wind Procurement Projections for a full list of state targets.

The most critical recommendations for this time frame require simultaneous convening and coordination: state and transmission planners coming together to plan for an offshore network; the industry coming together to standardize requirements for HVDC technology; and Federal agencies, Tribal Nations, and stakeholders coming together to identify and prioritize transmission paths in the outer continental shelf (OCS).

Other important recommendations focus on providing guidance and data to decision-making entities, issuing rights-of-way grants, and facilitating collaboration between states on clean energy standards and offshore wind goals to promote holistic transmission design solutions that maximize benefits for the entire region.

Streamlining generation interconnection through queue reform and strengthening collaboration between developers and local communities are also recommended in this action plan as ongoing activities and practices. Figure 16 shows a map of how the offshore transmission system build-out along the Atlantic could look in 2030.

Figure 16. Map of potential offshore transmission development by 2030 for the Low Carbon Scenario, based on preliminary analysis of the AOSWTS.



MID-TERM ACTIONS

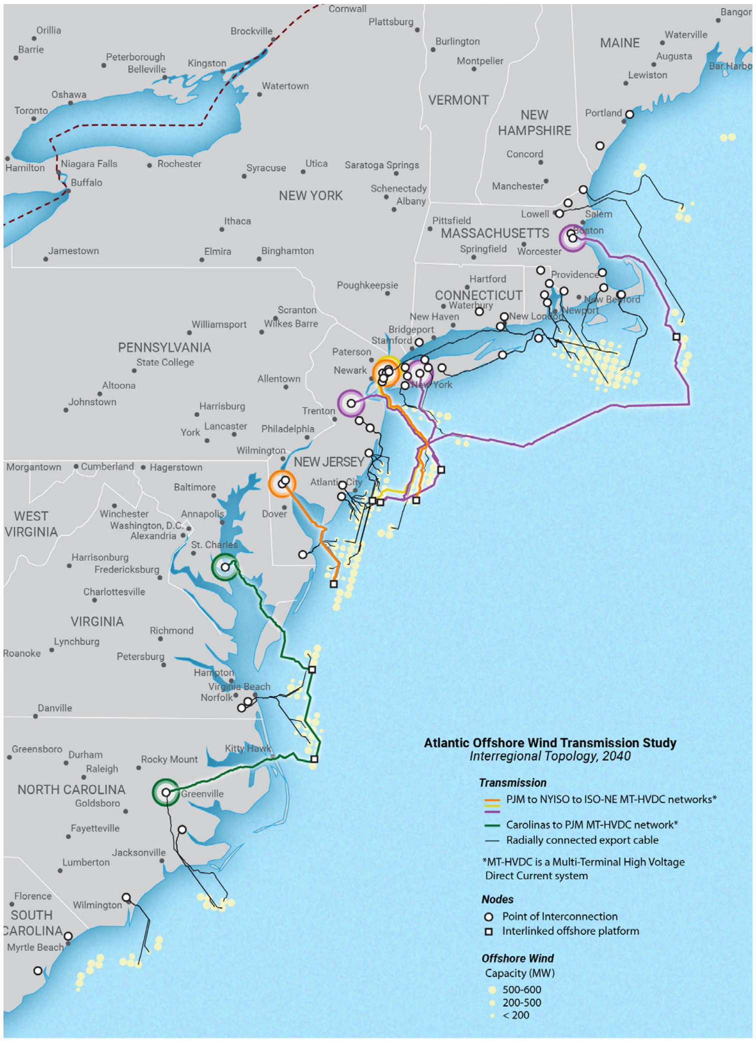
Between 2030 and 2040, we will continue to ramp up for long-term needs. During this decade, we expect interregional offshore transmission will be constructed, ambitious multi-state projects will be developed, and precedent will be set for how our long-term goals will be reached.

Although previously planned infrastructure is under construction, the establishment of a national HVDC testing and certification center will be needed to ensure compatibility of the new MT-HVDC networks being built.

	Mid-Term Actions for 2030–2040	Reference Section
T & S ★★★	Multi-Terminal HVDC Test and Certification Center	3.2.2
P & O ★★	Regulated Interregional Joint Planning Processes	2.2.2
P & O ★★	Interregional Transfer Capacity Minimums	2.3.2
S & P ★★	Assignment of Offshore Cables and Substations for Continued Use as Shared Infrastructure	5.2.3
P & O ★	Enhancement of Existing Market Monitoring Roles	2.4.3

This time frame is also when we look to codify updates to our transmission planning processes through regulated interregional joint planning, transfer capacity minimums, and market monitoring. Further, it is expected that we will start planning for the retirements and repurposing of offshore transmission assets to ensure enduring value to the system in the coming decades. Figure 17 shows a map of how the offshore transmission system build-out along the Atlantic could look in 2040.

Figure 17. Map of potential offshore transmission development by 2040 for the Low Carbon Scenario, based on findings of the AOSWTS.



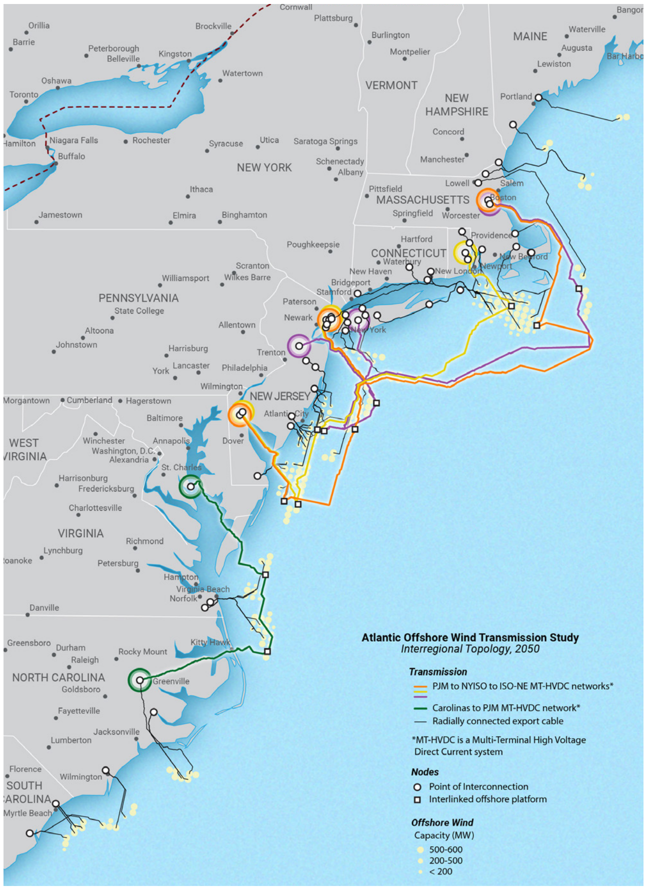
SUSTAINED ACTIONS

The last set of recommended actions have been identified as tools to achieve development goals for 2050 and beyond. These recommendations generally do not have specific due dates and are seen as tasks that will be consistently important regardless of the year.

	Sustained Actions for Enduring Growth	Reference Section
S & P ★★★	Improved Environmental Review and Permitting Frameworks	5.2.1
P & O ★★	State-led Transmission Planning	2.1.1
E & S ★★	Cost Allocation Methodology	4.1.3
E & S ★★	Federally Designated National Interest Electric Transmission Corridors	4.2.2
S & P ★★	Permitting Agency Resources and Staffing	5.2.4
P & C ★	International Cooperation	1.2.1
P & C ★	Communication Practices and Public Engagement	1.2.2
T & S ★	Transmission Optimization with Grid-Enhancing Technologies	3.1.3
E & S ★	Best Practices for Benefit Valuation	4.1.2
E & S ★	Equity in Ratemaking	4.1.4
E & S ★	Consumer Advocates	4.1.5
E & S ★	Relevant Federal Funding, Financing, and Technical Support	4.2.1
S & P ★	Utilization of Existing Federal Facilities Along the Coast	5.1.5

Key recommendations involve strong state leadership, empowerment of permitting agencies, thoughtful cost allocation practices, and thoughtful consideration of the use of national corridors. Supporting actions focus on maximizing the use of existing infrastructure and resources. We include communication and information sharing, the use of grid-enhancing technologies to maximize the capacity of the existing onshore transmission grid, and consideration of the utilization of Federal lands. Ratepayer protections feature prominently and focus on benefit valuation practices, ratepayer equity, and consumer advocacy—all intended to ensure that the immense value that offshore wind and a holistically planned offshore grid can provide is delivered back to the communities that need it. Figure 18 shows a map of how the offshore transmission system build-out along the Atlantic could look in 2050.

Figure 18. Map of potential offshore transmission development by 2050 for the Low Carbon Scenario, based on preliminary analysis of the AOSWTS.



DESCRIPTION OF RECOMMENDATIONS

LEGEND

★ ★ ★
2024

Legend boxes illustrate the proposed criticality level and effective year for each recommendation.

★★★	Critical Path Action
★★	Recommended Action
★	Best Practice

Partnership & Collaborations
P&C

Planning & Operations
P&O

Technologies & Standardization
T&S

Economics & Support Initiatives
E&S

Siting & Permitting
S&P

1. PARTNERSHIPS AND COLLABORATIONS

1.1. STRENGTHENING COLLABORATIVE EFFORTS

Planning, constructing, operating, and maintaining a holistic offshore transmission system for the Atlantic Coast will require an increased focus on cross-jurisdictional cooperation at the Federal, Tribal Nation, regional, state, and local levels. Engaging and partnering with Tribal Nations throughout the process is critical given their proximity, history, and relationship to the land where offshore wind is proposed. It is necessary that states collaborate with one another and with transmission planning organizations, including ISOs/RTOs, to ensure that individual state offshore wind goals and procurement targets are achievable and regional goals (such as economic development and enhanced resiliency) can be advanced. Transmission planning organizations and ISOs/RTOs will be tasked with ensuring technical viability, system efficiency, and overarching reliability. Navigating and coordinating with these various decision-makers is imperative to meet a diverse set of climate, energy, and environmental justice goals.

1.1.1. OFFSHORE WIND TRANSMISSION STATE COLLABORATIVE

★★★ 2023

States are driving offshore wind development through clean energy policies and are instrumental to achieving the national goal of 30 GW of offshore wind deployment by 2030. States are also diverse and bring their own unique experiences, perspectives, goals, policies, and transmission planning processes that are important to align. A new entity with the specific mission of enabling state coordination would unlock offshore wind benefits.

RECOMMENDATION

We encourage the Atlantic states to collectively form an Offshore Wind Transmission State Collaborative. Such a collaborative would offer the Atlantic states the opportunity to establish a shared vision on policy and approach to coordination for offshore transmission development. Given the geographic scope of the Atlantic offshore wind resource, this collaboration should span multiple ISO/RTO footprints as well as non-ISO/RTO footprints.

We recommend that interested states make a commitment to form such a group and launch the initiative. States could sign a cooperative instrument (e.g., a memorandum of agreement) to operationalize the partnership. One state energy office representative and one regulatory utility commissioner from each participating state could be designated to represent the state within the collaborative, with participation from the governor's office and legislative staff at the discretion of the state. Federal agencies could provide technical, convening, and other support as needed and in accordance with Federal and state law.

Alternatively, the Offshore Wind Transmission State Collaborative could be expanded from existing groups, like the New England States Committee on Electricity, or modeled after an existing multi-state cooperation framework. Examples include the Western Interstate Energy Board's Committee on Regional Electric Power Cooperation,[12] which facilitates the examination of electric power system policy issues that require regional cooperation in the West and coordination among western states regarding these issues.

Further support for the Offshore Wind Transmission State Collaborative could be provided by national associations of states—such as the National Association of Regulatory Utility Commissioners (NARUC) and the National Association of State Energy Officials (NASEO)—or regional state associations. DOE could partner with these associations and provide funding to advance the efforts of the collaborative. The collaborative could also be formalized into an official task force similar to the Task Force on Comprehensive Electricity Planning,[13] led by NARUC and NASEO, to develop state-led pathways toward improving grid reliability, resiliency, and affordability under the provisions of Section 209 of the Federal Power Act (FPA).

Such an initiative among the Atlantic states would be well-positioned to coordinate and implement many of the recommendations in this action plan. Principally, organizing and convening an Offshore Wind Transmission State Collaborative could help facilitate the development of offshore wind transmission infrastructure through the following capabilities:

- Providing shared recommendations to transmission providers regarding policies, inputs, scenarios, and other information to be incorporated into interregional transmission planning, regional transmission planning, and/or interconnection processes
- Facilitating agreement on cost allocation for projects that are pursued on a voluntary funding basis, including potential projects to facilitate optimal choice of POI (discussed further in Section 2.1.2)
- Providing input into binding cost-allocation frameworks for use in regional and interregional processes
- Collaborating to improve and better align state solicitation processes
- Providing input to facilitate any necessary improvements to regulatory and contractual frameworks
- Providing specific direction to ISOs/RTOs to plan and fund regional and interregional transmission infrastructure in the long term

RELATED RECOMMENDATIONS:

2.2.1 Interregional offshore topology planning
3.1.1 Network-ready equipment standards
4.1.4 Equity in ratemaking
5.1.4 Multi-state partnership on clean energy standards and offshore wind goals
5.2.1 Improved environmental review and permitting frameworks

This collaborative could facilitate discussions about cost allocation among the states, where appropriate. It could also be leveraged to better assess and minimize impacts on marine environments and coastal communities. Ultimately, such a cooperative could facilitate the issuance of a request for information (RFI) or request for proposal (RFP) to advance interregional transmission objectives by multiple states acting jointly or by multiple ISOs/RTOs.

To successfully implement this collaborative, initial coordination efforts should focus on the near-term challenges to deploying offshore wind transmission, as described in this action plan. This coordination needs to include robust engagement with Tribal Nations, local communities, ocean users, and others, as well as facilitate transparent, sustainable, and equitable transmission planning and siting.

UPDATE ON THE FORMATION OF THE NORTHEAST STATES COLLABORATIVE ON INTERREGIONAL TRANSMISSION

In June 2023, Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New York, and New Jersey submitted a letter to the Grid Deployment Office, requesting support in forming the "Northeast States Collaborative on Interregional Transmission" to enhance system reliability, accelerate offshore wind deployment, and transition to a clean energy future more quickly and affordably. Since June, Maryland and Delaware have joined the Collaborative discussions, bringing the group's size to a total of 10 states. Joint Federal–state meetings have begun, and DOE is working with the states to explore how best to support their engagement through technical assistance in transmission planning and development activities needed to meet their energy policy goals.

1.1.2. REGIONAL TRANSMISSION PLANNING COLLABORATIVE

★ ★ ★
2023

It will take more than coordinated policy and planning decisions from the states to ensure holistic plans are created and executed. The regional transmission entities are responsible for the actual planning, coordination, and operation of the grid, and as such, will have a key role in this transition. Several regional planning forums for stakeholders and interested parties in the Atlantic coastal region already exist. Principally, most prominent are the Joint ISO/RTO Planning Committee (JIPC), which represents NYISO, PJM, and ISO-NE, and the Eastern Interconnection Planning Collaborative (EIPC), which serves the whole eastern interconnection beyond just the Atlantic states (see Figure 19). Due to the geographic scope of the JIPC region with the Atlantic coast, we encourage JIPC to prioritize interregional offshore wind transmission planning needs identified in this action plan and by the Offshore Wind Transmission State Collaborative, and to work with the transmission planning entities in the Carolinas (principally Duke Energy) to include them in these holistic transmission planning efforts.

RECOMMENDATION

We encourage the JIPC to work closely with the new Offshore Wind Transmission State Collaborative and include state policy goals for offshore wind and interregional transmission in its planning work. The findings from the AOSWTS may support these interregional planning efforts.

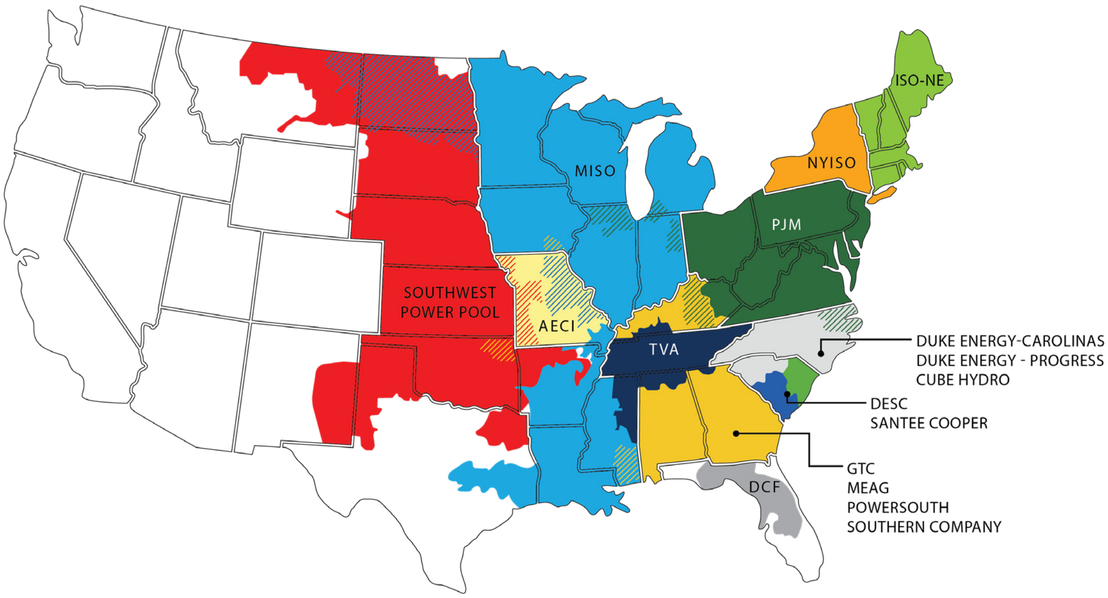
We encourage the ISOs/RTOs to continue supporting the JIPC with the resources and expertise needed to undertake this significant work.

We encourage Duke Energy to participate in JIPC planning conversations, as they relate to offshore transmission near the Carolinas.

Further, we encourage the JIPC to consider the planning needs in adjacent non-ISO/RTO regions, as they apply to offshore transmission system design.

Because JIPC collaborations have not to date resulted in any interregional transmission projects, the implementation of state-led transmission planning (see Recommendation 2.1.1) and recommended reforms to move from interregional coordination to interregional transmission planning (see Section 2.2.2) will be fundamental for success of this renewed focus through the JIPC. The JIPC must be empowered to respond to the requests from states, or to execute joint planning outside of state requests, in a way that consistently values needs, benefits, and costs, regardless of transmission ownership structure. That regional projects do not receive priority over interregional projects, unless the overall benefits are superior, will be key. This benefit calculation would need to be consistent between the interregional and the regional projects in terms of scale and scope (e.g., similar beneficiary communities, which may be a change from how regional projects are currently considered). Interregional projects must not be limited to those first proposed and studied by the regions where the project will reside, a current requirement of JIPC coordination under FERC Order 1000, for a more robust pursuit of interregional benefits.

Figure 19. EIPC Member Regions



Source: EIPC

Note on acronyms: Associated Electric Cooperative Inc. (AECI), Duke Energy Florida (DEF), Dominion Energy South Carolina (DESC), Georgia Transmission Corporation (GTC), Louisville Gas and Electric Company/Kentucky Utilities Company (LGE/KU), Midcontinent Independent System Operator Inc. (MISO), Municipal Electric Authority of Georgia (MEAG), Tennessee Valley Authority (TVA).

WHAT ABOUT CREATING A NEW OFFSHORE PLANNING ENTITY LIKE AN RTO OR POWER ADMINISTRATION?

Although the creation of a new RTO, Power Administration, or other planning organization focused on offshore facilities has been raised as a potential solution to ease planning coordination difficulties for the offshore transmission system, the challenges associated with creating a new planning entity would be significant. We recommend avoiding the introduction of new independent planning institutions for the Atlantic states. Additional process and jurisdictional seams will add further burden and jurisdictional confusion into an already burdened and unclear environment. Further, it would take significant time and cost to stand up an organization, and it would likely be too late to be effective. It has not been demonstrated that any new planning entity would operate in a way significantly different from the existing entities such that it would add value to ratepayers, improve project development timelines, or clarify regulatory processes.

With appropriate reforms that guarantee joint planning (e.g., Recommendations 2.1.1 and 2.2.2), cooperative efforts among existing bodies (including ISOs/RTOs) could achieve similar goals. Although Atlantic Coast ISOs/RTOs may currently be less experienced with offshore than traditional onshore transmission planning, we recommend that they continue to fulfill this planning entity role, working with their partners to ensure the development of sound offshore grid infrastructure, in accordance with any tariff updates that may be necessary to these functions.

RELATED RECOMMENDATIONS:

2.1.1 State-led transmission planning
2.2.1 Interregional offshore topology planning
2.2.2 Regulated interregional joint planning processes
3.1.1 Network-ready equipment standards

1.1.3. TRIBAL NATION ENGAGEMENT

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2023

American Indian and Alaska Native Tribal Nations are sovereign governments recognized under the Constitution of the United States, treaties, statutes, Executive Orders, and court decisions. The Biden-Harris Administration's Memorandum on Tribal Consultation and Strengthening Nation-to-Nation Relationships[14] prioritizes fulfilling Federal trust and treaty responsibilities to Tribal Nations and recommits to Executive Order 13175 (Consultation and Coordination with Indian Tribal Governments), which "charges all executive departments and agencies with engaging in regular, meaningful, and robust consultation with Tribal officials in the development of Federal policies that have Tribal implications." DOE and BOEM further recognize recent commitments made in the Memorandum of Understanding Regarding Inter-agency Coordination and Collaboration for the Protection of Indigenous Sacred Sites,[15] Memorandum on Indigenous Traditional Ecological Knowledge and Federal Decision Making,[16] and Guidance for Federal Departments and Agencies on Indigenous Knowledge,[17] as well as existing requirements under the National Environmental Policy Act (42 U.S.C. 4321 et seq.), National Historic Preservation Act (NHPA; 54 U.S.C. 300101 et seq.), Archaeological Resources Protection Act (16 U.S.C. 470aa-mm), American Indian Religious Freedom Act (42 U.S.C. 1996), Native American Graves Protection and Repatriation Act (25 U.S.C. 3001 et seq.), and all associated implementing regulations.

The Federal Permitting Improvement Steering Council (or Permitting Council), which includes DOE and BOEM, engaged in Government-to-Government consultation with Tribal Nations in development of its Fiscal Year 2022 Recommended Best Practices Report, which included recommended best practices specific to "enhancing early stakeholder engagement, including—engaging with [Tribal Nations] to ensure that project sponsors and agencies identify potential natural, archaeological, and cultural resources and locations of historic and religious significance in the area of the covered project."[18]

Bearing this and agency-specific priorities in mind, DOE and BOEM have sought Tribal Nation input throughout the Federal offshore wind transmission activities to date. Two scoping calls were held with Tribal Nations in July and August 2021 to inform the development of the overall Federal effort on offshore wind transmission. Tribal Nations were invited to all Convening Workshops and were included in the AOSWTS TRC. In February 2023, BOEM and DOE hosted a Tribal Nation Dialogue to provide updates on the AOSWTS' progress, preview the draft recommendations from this action plan, and receive feedback from Tribal Nations.

BOEM released new lease stipulations requiring lessee consultation with Tribal Nations prior to proposing routes and introduced bidding credits in newer lease sales. BOEM's Draft Guidelines and Instructions for Native American Tribes Communications Plan Development Required by BOEM New York Bight Leases (OCS-A 0537–0544) and Carolina Long Bay Leases (OCS-A 0545–0546) provides guidance to comply with the requirements and intent of the lease stipulation for a Native American Tribal Communications Plan and seeks to "ensure early and active information sharing, focus discussion on potential issues, and collaboratively identify solutions . . . to promote the sustainable development of offshore wind energy projects."[19] Tribal Nations are currently members of BOEM's Intergovernmental Renewable Energy Task Forces and engage with BOEM in Government-to-Government and Section 106 of the NHPA (54 U.S.C. 306108) consultations for offshore wind projects. Ensuring effective engagement and consultation with Tribal Nations specific to offshore wind transmission planning is critical.

RECOMMENDATION

We recommend that BOEM leverage its Intergovernmental Renewable Energy Task Forces or establish a new task force focused on transmission siting. This task force would convene Tribal Nations, state and local governments, and Federal agencies to discuss issues surrounding the siting and development of offshore wind and transmission infrastructure.

We recommend DOE funding be directed toward Tribal Nations assistance consisting of three pillars:

- Educational resources—providing training materials on offshore wind and transmission interconnection.
- Expert consultation—providing access to technical expertise to answer questions, conduct research, and produce information and materials in response to Tribal Nation requests.
- Participation support and capacity building—providing funding to support expansion of Tribal Nation engagement on offshore wind transmission issues.
- We recommend that BOEM and DOE continue to assess and improve the effectiveness of existing consultation and engagement mechanisms (e.g., Government-to Government consultations and BOEM Intergovernmental Renewable Energy Task Forces).

RELATED RECOMMENDATIONS:

5.1.2 Federal-State Aligned Offshore Wind Transmission Siting

1.2. INFORMATION SHARING

Offshore wind is a growing industry in the United States that includes partnerships at the Federal, Tribal Nation, regional, state, local, and international levels. Reaching the Biden-Harris Administration's offshore wind deployment goal will require a high level of coordination and proactivity for transmission planning and development, which will not be possible unless there is a shared understanding and incorporation of best practices, transparency, and community engagement. Effective and expedient sharing of information across different organizations, stakeholder groups, and jurisdictions will be paramount for achieving these goals.

1.2.1. INTERNATIONAL COOPERATION

★ All

Although offshore wind generation and its transmission infrastructure are emerging industries in the United States, in several countries across Europe and Asia, the global offshore wind sector has reached maturity. However, even with a higher installed offshore wind capacity than the United States, these countries are facing many similar challenges with respect to transmission planning as in the United States. European countries are evaluating various transmission strategies to optimize the offshore area dedicated to transmission, minimize disruption to the seabed and shoreline, and build interconnection across individual country jurisdictions and energy sectors. In addition to leveraging best practices in these planning efforts, coordination with international partners is also necessary to solve shared roadblocks, such as addressing known challenges in the global supply chain. BOEM and DOE have engaged transmission regulators, planners, and operators in some of the top European markets (as measured by installed offshore wind capacity) to exchange information on their efforts and identify solutions to common challenges.

RECOMMENDATION

We encourage BOEM and DOE to continue to pursue international knowledge exchanges on transmission and consenting best practices with governments, operators, and key decision-makers in other jurisdictions, and to expand this bilateral dialogue to include involvement by key decision-makers in the United States (e.g., ISOs/RTOs, U.S. state regulators, and transmission planners), as well as pursue these exchanges with emerging offshore wind markets that face similar challenges in Asia and Latin America to keep abreast of the latest technological, regulatory, and planning efforts.

We recommend that BOEM continue to work with the international community—through the International Energy Agency Technology Collaboration Programme or other mechanisms—to track and contribute to research to expand the knowledge base and develop best practices. DOE should continue to lend its technical expertise to support these collaboration efforts and other international exchanges.

1.2.2. COMMUNICATION PRACTICES AND PUBLIC ENGAGEMENT

★ All

Offshore wind transmission planning across different jurisdictions, levels of government, and coordinating agencies is diffuse and can be challenging to navigate. As documented in Executive Order 14096 Revitalizing Our Nation’s Commitment to Environmental Justice for All (EO 14096), “all people should be afforded the opportunity to meaningfully participate in agency decision-making processes that may affect the health of their community or environment.” Sharing information at an early stage with the public is critical, especially with communities that may be impacted. These communities should also be engaged well before POI and siting decisions are finalized, as their input may affect siting and other decisions around the project. Municipal representatives, local chambers of commerce, and community-based nonprofits may be willing to help disseminate information and provide input. Affirmative outreach to these communities and other members of the public will be critical and should be guided by several key practices.

RECOMMENDATION

» **Build a website to centralize information:** We recommend creating a regionally focused website that compiles explanations of the different jurisdictions and authorities, links to relevant reports and data sources maintained by different agencies, provides a calendar of upcoming educational or public input opportunities, and shares other relevant information. This website could be maintained by one of the multi-jurisdictional or regional cooperative groups that could collect updates from members and send out regular updates to keep interested parties abreast of new events, studies, projects, data availability, success stories, and best practices.

» **Coordinate early and often:** We strongly encourage early and consistent engagement with Tribal Nations, local governments, and potentially impacted communities. Best practices include working with existing community groups and leaders (which can help to build trust), translating materials into the community s native and other commonly spoken languages, providing information in digital and physical formats, holding public meetings virtually and in person at varied locations and times and providing meaningful access for individuals with disabilities. Providing follow-up meeting notes and explanations of how input was utilized, as well as creating performance metrics and other means of accountability, allows participants to track follow-through on earlier engagement, which may motivate continued involvement. Per EO 14096, we recommend early analysis of disproportionate and adverse health and environmental effects, historical inequities and barriers to the impacted communities related to these effects, and any legal authorities available to address them.

» **Start a public information campaign:** Providing consistent and clear information dissemination from the Federal Government is imperative to improve public understanding and establishing reliable and trusted sources of information. Currently, there is a gap regarding accessible information specific to offshore wind transmission. We recommend that DOE and BOEM lead a Federal effort to address this gap, with DOE's national laboratories and, potentially, other partners. Such an effort should be national in scope and seek to explain offshore wind transmission concepts, including cable technologies; approaches to siting; cable laying, operations, and maintenance; and onshore landfall locations and grid interconnection. We recommend exploring social innovations for engagement, like visual simulations or virtual site visits, and framing offshore wind transmission development as an investment for the common good of the nation to enable the decarbonization of our energy portfolio. DOE and BOEM should also consider providing information to stakeholders in an in-person public forum as part of a technical assistance project. This idea could be explored with a pilot project (e.g., hosting a transmission-specific information-sharing forum with local government officials and community members) and then refined and expanded during a second phase.

FOUR TIPS ON SHARING INFORMATION WITH THE PUBLIC:

1. Provide at minimum a 30-day public notice of upcoming events or convenings, preferably with a "save the date."
2. Clearly explain how any requested feedback will be used or shared, how it will be attributed, and whether a follow-up summary will be provided.
3. When organizing small-group discussions or seeking substantive feedback, consider sending personal invitations or follow-ups or doing pre-interviews to ensure that attendees have the necessary background information and are prepared to participate.
4. Be aware of stakeholder fatigue and, whenever possible, provide context, use existing information-sharing mechanisms, bundle topics, and seek to provide value for participants' time.

For more information on this topic, please see a related recent publication from the Americans for a Clean Energy Grid.[20]

2. PLANNING AND OPERATIONS

2.1. REGIONAL TRANSMISSION PLANNING AND PROCUREMENT

FERC requires that ISOs/RTOs and other transmission providers participate in regional transmission planning processes that identify needs and evaluate solutions. ISOs/RTOs and other transmission providers also administer interconnection queue processes through which network upgrades necessary to integrate new resources into the system, including offshore wind, are identified, funded, and constructed. In addition, transmission projects may be developed on a merchant basis, or pursuant to voluntary funding arrangements, and then integrated into the baseline upon which regional transmission planning is conducted.

State and national offshore wind goals will be achieved most cost effectively using forward-looking, holistic transmission and interconnection planning processes that identify the necessary onshore and offshore upgrades required to facilitate and cost-effectively integrate the offshore wind generation to meet those goals. More work is needed to advance regional transmission planning, forward-looking interconnection processes, and voluntary funding arrangements, and to ensure that these various processes are well-coordinated. Partnerships between ISOs/RTOs and states would also facilitate a more holistic approach to transmission planning that evaluates a wider range of infrastructure alternatives. Long-term, coordinated planning can reduce the costs of network upgrades necessary to accommodate future offshore wind projects.

2.1.1. STATE-LED TRANSMISSION PLANNING

★ ★
All

Developing the necessary transmission infrastructure at the speed and scale needed to achieve state and national goals will require state governments to provide strong leadership as they work with their transmission organizations. State-led transmission planning and procurement done in partnership with ISOs/RTOs can ensure investments meet state goals and help minimize landfall locations and associated environmental impacts, an outcome that would be difficult to achieve with individual project awards.

Ongoing efforts by individual Atlantic states provide useful examples of replicable state-led efforts to develop transmission alongside offshore wind projects. For example, New York's 2022 offshore wind solicitation required proposals to be mesh-ready and to "use HVDC technology for the radial connection between the offshore substation and the cable landfall."[21] New York received more than 100 submissions in January 2023 for its state-run solicitation.[22] New Jersey adjusted the schedule of its forthcoming solicitation to improve alignment with the State Agreement Approach (SAA) process, run by PJM and the New Jersey Board of Public Utilities, to integrate the state's offshore wind plans into PJM's transmission planning process. The SAA received 80 transmission proposals.[23] Revising the solicitation schedule to accommodate the SAA timeline will allow SAA outcomes to inform the next solicitation.

The New England States Transmission Initiative is an example of a multi-state effort to partner with a transmission provider to plan and procure transmission for increased renewable energy development. No multi-state decision-making body yet exists across the Northeast that can guide regional and interregional transmission development in a manner that accounts for all relevant state policies.

State planning leadership may significantly facilitate cost-effective transmission solutions for many reasons. For example:

- States, as offshore wind policymakers, can focus their planning on achieving their long-term goals cost effectively rather than on piecemeal construction that minimizes near-term costs while not necessarily optimizing for overall cost effectiveness in the long term. This approach may include identification of optimal POI anticipatory investments to facilitate savings over the long term, and planning for onshore and offshore upgrades to facilitate broad portfolios of projects.
- States can play an integral role in facilitating agreement on the allocation of costs, which has proven to be a sticking point in the development of forward-looking transmission solutions.
- States can administer procurement processes for offshore wind that could be better aligned with one another to facilitate optimal solutions at the regional and interregional level.

RECOMMENDATION

We recommend that state-led transmission planning be pursued in partnership with regional transmission operators.

An array of near-term and long-term actions can further state-led transmission planning in conjunction with the state actions identified for the Offshore Wind Transmission State Collaborative in Section 1.1.1. States may find the following tasks helpful to support their transmission planning work:

- Pursue state-driven transmission planning and interconnection processes through, for example, PJM's State Agreement Approach process or NYISO's Public Policy Transmission Planning Process.
- Identify and name preferable POIs to better align solutions submitted by developers with state interests.
- Make transmission solicitations modular, similar to the approach taken in New Jersey,[24] to allow companies to prioritize where they feel best positioned to compete.
- Develop and include incremental targets in their transmission solicitations, in addition to final capacity goals, to ensure the construction schedules proposed by transmission developers align with generation investment schedules.
- Modify state-level offshore wind solicitation processes, as needed.

2.1.2. SYSTEMATIC EVALUATION OF POI CAPACITIES AND LANDFALL LOCATIONS

★ ★ ★
2024

Identifying POIs and upgrading onshore infrastructure to connect to the existing grid are critical to delivering the immense offshore wind generation needed along the Atlantic coast. With a limited number of POIs currently available, it is important to maximize their use. The costly and time-consuming interconnection review process could result in near-term development obstructing or increasing the cost of long-term energy goals. Therefore, processes should be put in place to evaluate and plan for infrastructure that minimizes long-run interconnection costs at optimal POIs, to communicate those POIs to applicants, and to factor the cost implications regarding the choice of POI into project selection processes.

RECOMMENDATION

We encourage ISOs/RTOs and transmission planners to systematically identify and prioritize alternatives to each POI requested by interconnection applicants, based on AC power flow characteristics, and to plan for and facilitate construction of infrastructure necessary to facilitate POIs that will most efficiently use landfall locations and minimize long-run costs and environmental impacts.

ISOs/RTOs and transmission planners should also establish communication channels to notify states, other decision-makers (e.g., BOEM), and interested parties about POIs suitable for future shared use (i.e., POIs that would be ideal for connecting offshore grid or interregional transmission). The public interconnection information reform proposed in FERC's interconnection notice of proposed rule making (NOPR)[xi] may give a good template for the kind of information that could be made available. This will help to empower state-driven requests.

Steps to further support this evaluation process include the following:

- DOE can publish the POI identification methods and interregional networking selections from the AOSWTS for transmission planners to consider and build upon in their own study or work going forward.
- Through interregional forums (such as JIPC or EIPC), transmission planners can inform industry and states about the POIs best suited for offshore high-voltage alternating current (HVAC)/HVDC networks, based on the latest alternative POI evaluations.
- States can include ISO/RTO-prioritized POIs in any transmission solicitations for state procurement.

RELATED RECOMMENDATIONS:

2.1.1 State-led transmission planning

2.2. INTERREGIONAL TRANSMISSION PLANNING

Interregional transmission developed across neighboring systems can provide many benefits, including increasing system resilience and taking advantage of economies of scale and geographic diversification for new projects. For an offshore network, interregional transmission also enables

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[xi] Docket No. RM22-14-000. Improvements to Generator Interconnection Procedures and Agreements.

interconnecting different regions offshore to avoid congested POIs and maximize the use of offshore wind generation. However, achieving these benefits through interregional projects will require action from state, regional, and Federal authorities.

2.2.1. INTERREGIONAL OFFSHORE TOPOLOGY PLANNING

★ ★ ★
2025

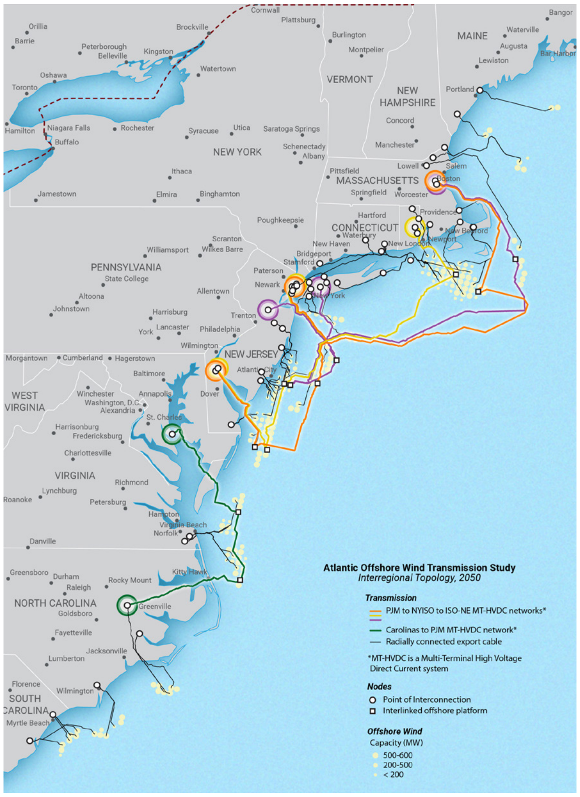
When done well, holistic transmission planning that spans ISO/RTO and state boundaries can add tremendous value to local system reliability and reduce ratepayer costs. However, it requires transmission planners to look beyond their own jurisdiction and into neighboring regions where they may have limited data or a basic understanding of the system. It is often difficult to justify the time and cost to plan transmission outside of one's own footprint, which is why there is a need to establish a common direction and methods to enable transmission planners to do true interregional planning, for which state policy goals are considered an integral part of the planning process. ISOs/RTOs, and planning entities outside of ISO/RTO regions, are key to this effort, but they will need policymakers to set the direction.

RECOMMENDATION

We recommend the Offshore Wind Transmission State Collaborative communicate support for interregional HVDC transmission topology scenarios (such as those identified by the AOSWTS) to their respective transmission planning entities and participate in conversations about benefits evaluation and cost allocation for identified interregional projects.

We recommend that the JIPC conduct a collaborative study process between the ISOs/RTOs and planners in non-ISO/RTO neighboring regions, based on direction of the Offshore Wind Transmission State Collaborative, to include these interregional interlinks in their regional plans.

Figure 20. Map of proposed interregional HVDC interlinks identified by the AOSWTS 2050 Low Carbon Scenario analysis.



Holistic interregional planning would support ISO/RTO authorization of anticipatory investments based on projected state policy needs (i.e., initially build an oversized platform or transmission cable rather than incremental investments). The regulatory criteria for approval could be based on demonstrated long-term savings of anticipatory investment versus incremental additions and demonstrated high likelihood that the asset will be used in the long term. State-driven transmission planning can also reduce project risk for both generation and transmission projects because the grid can be set up to support multiple generation projects and the construction of necessary network upgrades can move forward in advance of generation being awarded. Coordinated transmission development can also minimize environmental impacts and necessary landfall locations. Figure 19 illustrates the type of interregional lines that are envisioned for this kind of planning effort.

HAS THIS BEEN DONE BEFORE?

The Joint Targeted Interconnection Queue Study, undertaken between Southwest Power Pool Inc. (SPP) and Midcontinent Independent System Operator Inc. (MISO), provides a framework for joint planning that can be targeted to meet the needs of specific geographic regions, policy goals, or study periods.

2.2.2. REGULATED INTERREGIONAL JOINT PLANNING PROCESSES

★ ★ ★ 2030

Despite the potential benefits that interregional transmission planning could provide, many barriers and challenges persist, including misaligned interests from ISOs/RTOs and other transmission providers, generators, and policymakers from different regions; disputes over benefit analyses and cost responsibility; and sequencing of local, regional, and interregional planning, permitting, and siting processes, among others. FERC Order No. 1000 sets forth the current generic Federal requirements for considering potential interregional transmission. However, it requires only coordination between regions. Fully integrated interregional planning is allowed but not required and, to date, has not been successfully implemented for any large-scale infrastructure. For a project to be developed under this framework, it must be planned and selected for cost allocation by two or more regions, which are encouraged but not required to harmonize their planning frameworks, such as the data, models, assumptions, planning horizons, and criteria used to study projects. That task has proven difficult considering the varying approaches to transmission planning taken by different regions. Nevertheless, greater transparency in data, assumptions, models, and synchronizing study cycles across regions may help facilitate some interregional development or, at minimum, allow for more cost-effective development of projects on a regional basis.

There is a definite need to enhance the current joint interregional transmission coordination process, to take a broader view of interregional project needs and benefits, and to provide pathways pursuant to which projects can be planned and paid for.

RECOMMENDATION

We advocate for firmer regulation and support FERC's consideration of the issue to provide a ready mechanism by which transmission planners, cooperating with relevant states, can:

- Study collective transmission needs across two or more states that span multiple regions, considering transmission facilities that are already planned in the relevant region or regions (i.e., account for the baseline transmission plan).
- Identify transmission facilities that most efficiently or cost effectively meet those needs.
- Allow a cost allocation method to be voluntarily determined among the participating states, including potentially among states across two or more regions.
- Ensure that the transmission facilities that participating states agree to fund are incorporated into regional transmission plans (i.e., become part of the baseline regional transmission plan) so that subsequent planning studies factor in their existence (e.g., avoiding duplicate transmission facilities or facilities that are less valuable in light of the offshore wind-related transmission facilities).

As this process will take time and effort to establish, the 2030 time frame indicated should be interpreted as the year that it is in effect and enforceable, not the year when efforts are started.

- For an alternative way that interregional transmission lines can be identified and paid for, see Recommendation 2.3.2, Interregional transfer capacity minimums.
- For further discussion on recommended FERC action on interregional cost allocation, see Recommendation 4.1.3, Cost allocation methodology.

2.3. RELIABILITY STANDARDS

The Atlantic Coast's power system is part of the Eastern Interconnection, one of three large power grids in the United States. A large, interconnected network may provide reliable, affordable, and equitable electric service if regulatory, planning, and monitoring standards are established and followed. Under the FPA, one of FERC's roles is to maintain reliability standards for high-voltage interstate transmission projects. FERC has certified NERC as the electric reliability organization to develop mandatory and enforceable reliability standards for the bulk power system, subject to FERC review and approval. A nascent offshore wind industry will need clear standards and guidelines to apply to ocean transmission infrastructure to ensure reliability and resilience while also encouraging interregional transmission planning.

2.3.1. NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION (NERC) RELIABILITY STANDARDS AROUND OFFSHORE TRANSMISSION

★ ★ ★
2024

Application of NERC transmission planning standards to offshore wind generation and transmission could benefit from further clarification and potential modification. Planning entities establish Bulk Electricity System (BES) performance requirements to ensure reliability and resilience of the BES. However, applicable requirements and the standards governing them may need updates to ensure applicability to ocean transmission infrastructure and offshore wind generation tie-lines. Technical clarity is needed in the following three topic areas:

1. Credible multiple contingencies of subsea cables within a common corridor
2. Credible multiple contingencies of HVDC bipole topologies with dedicated metallic return (DMR)
3. Generator definitions for large distributed energy generation plants composed of many individual generators within planning contingency standards.

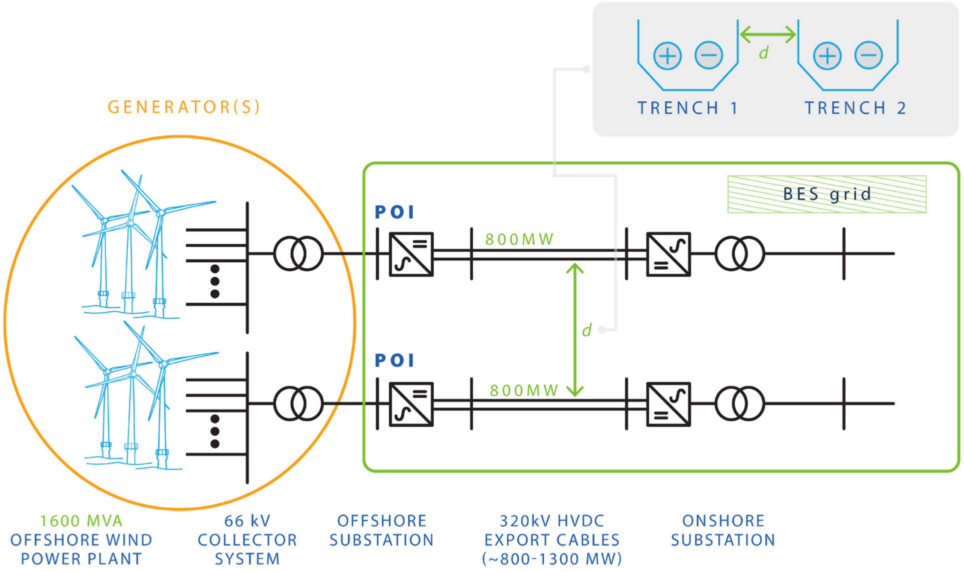
RECOMMENDATION

We recommend that a standard authorization request (SAR) be submitted by industry representatives to NERC on these three topics as soon as possible to address these gaps.[xii] Absent the submission of a SAR by industry representatives to NERC, FERC could also consider directing NERC to submit a proposed reliability standard(s) or modification to a standard(s) to address these issues under FPA Section 215.

Furthermore, we recommend the NERC Inverter-Based Resource Performance Subcommittee and Reliability and Security Technical Committee should consider these findings and integrate them with any ongoing inverter-based resource work.

Topic Area 1. NERC Reliability Standard TPL-001-5 should define a maximum lateral separation distance between buried cables for a common mode of failure, also known as a multiple contingency (N-1-1).[25] Relevant topologies include symmetric HVDC monopoles, as shown in Figure 21; radial AC interlinks along common corridors; and HVDC bipoles with DMR, as indicated in Topic Area #2. Industry standards and experience with onshore AC and DC network design should be leveraged, as applicable. Also, the standard should provide or update definitions of common structure and right of way to include buried and floating subsea cables so that exclusions to N-1-1 apply when cables make landfall or coalesce at a substation (as indicated in NERC TPL-001-5, Footnote 11). Industry may need to submit cable failure data or past cable burial risk assessments that are relevant to this lateral separation distance. These data may include cable failure modes and anchor strike data and may draw upon common burial depths and distances in other countries.

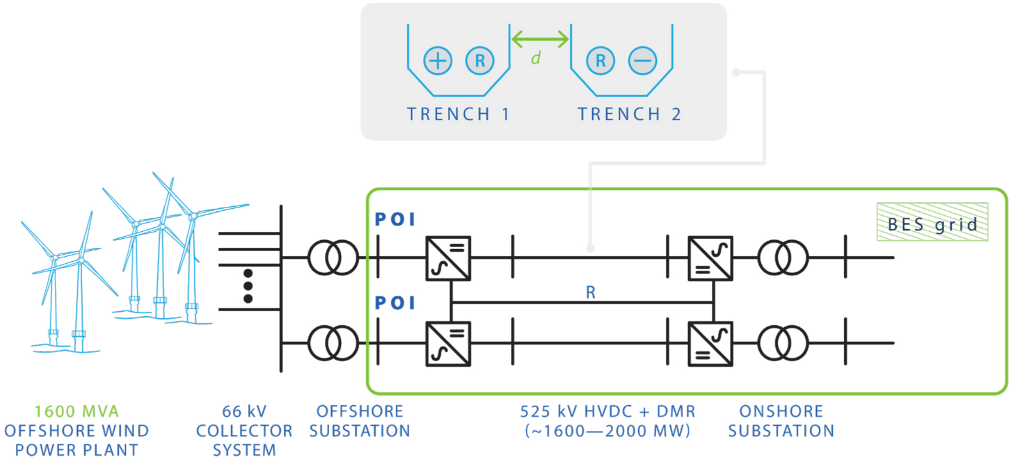
Figure 21. Single-line diagram showing parallel symmetric monopole HVDC cabling along a common corridor. The BES is extended to provide POIs on the AC side of the monopole. The monopole is spaced across two trenches.



[xii] NERC's Standard Process Manual defines the process for developing, modifying, withdrawing, or retiring a reliability standard, which begins with a SAR development. https://www.nerc.com/pa/Stand/Pages/SARs.aspx#:~:text=A%20SAR%20is%20the%20form,or%20more%20approved%20Reliability%20Standards.

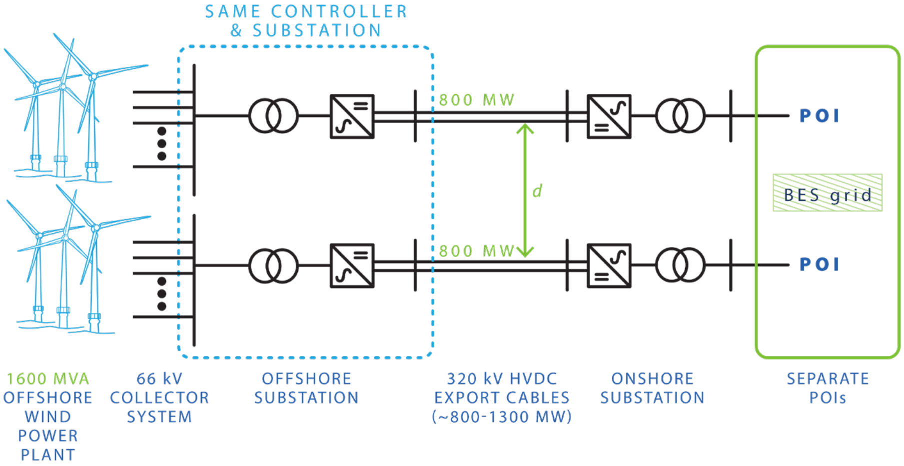
Topic Area 2. The NERC TPL-001-5 definition of P7 (i.e., N-1-1) contingency should be updated to include the maximum lateral separation distance between buried HVDC bipole with DMR cables within which a common mode of failure, multiple contingency (N-1-1), is credible (topology shown in Figure 22). Topologies of HVDC bipole with DMR provide a 50% redundancy to the loss of one pole, so the loss of the entire bipole may not always be considered a credible N-1-1 if properly spaced. Currently, failure of HVDC bipoles is considered under P7 contingencies without exclusion for DMR. Also, the standard should clarify whether the loss of each pole in a bipole system (without DMR) is considered a single (P1) contingency instead of the loss of the entire bipole. Experience with onshore HVDC and other considerations for offshore technology should be leveraged in this regard.

Figure 22. Single-line diagram showing an HVDC bipole with DMR topology within a common corridor. The bipole is spaced across two trenches and the DMR return path is denoted by R.



Topic Area 3. A precise definition is needed in NERC TPL-001-5 for the noncapitalized, undefined term generator within the context of large offshore wind power plants. Further clarification and potential modification may be warranted in regarding whether the planning criteria is intended to assume a single generator (G-1) or multiple generator (G-1-1) loss for projects that connect a common offshore substation to multiple POIs in the Bulk Electricity System (BES), as indicated in Figure 23. In this arrangement, all wind turbines may be controlled by the same power plant controller. Note that in Figure 23, all equipment on the ocean side of the POIs is considered within the generator facility instead of the BES; thus, the loss of all equipment outside of the POIs would be treated as a single generator contingency under TPL-001-5. However, the POIs could be extended to the ocean, and the question of how to consider a generator loss would persist. Clarification may be needed so that collector system and transmission designs may be planned to avoid this contingency.

Figure 23. Single-line diagram illustrating multiple HVDC interlinks connecting from a single offshore substation to two POIs in the Bulk Electricity System. However, this issue would also present if POIs are extended to the ocean.



A NOTE ON SINGLE-SOURCE CONTINGENCY LIMITS

To ensure adequate reserves to compensate for sudden losses of power generation or transmission, system operators establish single-source contingency limits, also known as injection limits, which pose constraints on how much power can flow through any asset on the bulk electric system. As of the publication of this report, ISO-NE has a limit of 1200 MW, NYISO has no limit, and PJM has a limit of approximately 1500 MW. Some developers have articulated that these injection limits, imposed by the ISO/RTOs, restrict the ability to share transmission connecting multiple projects into a single POI. This concern is understandable given that HVDC cable capacities are now exceeding 2000 MW.

However, single-source contingency limits play a valuable role in maintaining stability of the onshore grid. Rather than encouraging system operators to stop setting such single-source contingency limits, we recommend that where practical, these operators reevaluate the limits to confirm their appropriateness and prioritize upgrading network elements as needed to increase system-wide, single-source contingency limits. Ideally, such upgrades should be addressed in the next planning cycle such that developers in the interconnection queue or states proposing shared transmission plans are neither summarily limited nor solely assigned the full cost of correcting the limiting impairment.

2.3.2. INTERREGIONAL TRANSFER CAPACITY MINIMUMS

★ ★
2030

In December 2022, FERC convened a workshop[26] on how it could establish a minimum requirement for interregional transfer capability for transmission planning and cost allocation processes. Interregional transmission projects along coastal states would improve the ability to export offshore wind power inland and help improve overall reliability and resilience. This additional interregional transfer capacity would improve reliability and resiliency for both individual regions and the entire system by moving power from where it is available to where it is needed while also combating extreme locational marginal prices that increase costs for consumers. Interregional lines could take the form of offshore grids or backbones, which would further assist the interconnection of offshore wind, such as the HVDC interlinks identified by the AOSWTS analysis.

RECOMMENDATION

We encourage FERC to continue exploring the establishment of a minimum level of transfer capacity between balancing areas to encourage interregional transmission development.

Entities have suggested several methods of calculating interregional transfer capacity, including uniform bilateral transfer, neighbor-based regional transfer, and uniform regional transfer, but we do not advocate for any one in particular. DOE provided input to FERC on the implications of various calculation methods at its December 2022 workshop.[27] •For more industry perspective on determining the need for interregional transfer capacity, refer to A Roadmap to Improved Interregional Transmission Planning, a report published by the Brattle Group in.[28]

As this process will take time and effort to establish, the 2030 time frame should be interpreted as the year that any interregional transfer capacity minimums are in effect, not the year when efforts are started.

2.4. FEDERAL OVERSIGHT AND REGULATION

As state and regional entities evaluate options to develop offshore transmission in increasingly complex regulatory environments, the need for more Federal guidance emerges. Improvements to the interconnection queue process are needed to ensure generation projects can be connected in a timely manner. Additionally, regions interested in developing offshore networks to realize the operational benefits of these topologies need greater regulatory certainty as to how such networks will be owned and operated.

2.4.1. INTERCONNECTION QUEUE PROCESS REFORM

★ 2026

All offshore wind generation will need to connect to the existing onshore transmission network through the interconnection study process, a complex system of laws, regulations, and administrative steps that have been developed at both the state and the regional levels to ensure fair and open access to the transmission network. Current interconnection procedures were not designed to anticipate the large number of renewable energy and energy storage projects being proposed and developed each year, resulting in long study backlogs, increased queue position gaming, and significant project delays. Improving the interconnection process to increase certainty and reduce study timelines for individual projects while also ensuring that adding new resources to the grid will not result in reliability or safety issues is a multi-disciplinary problem that involves many stakeholder groups at the local, state, and regional levels.

Interconnection queues are a common challenge, both for the developers entering them and the utilities managing them. This is especially true for offshore wind, for which site control is dependent on BOEM lease issuance and where project size and distance from a robust onshore transmission system makes interconnection challenging for utilities. It may be impractical to suggest any queue reforms that target offshore wind over land-based wind or any other generation type, and we recognize that the most significant networked offshore transmission builds will likely not come through the interconnection process; however, the following recommendations may be beneficial for offshore wind as part of a larger system improvement.

DOE’S ONGOING WORK IN INTERCONNECTION QUEUE REFORM

Read more about the Interconnection Innovation e-Xchange[xiii] (i2x) project and subsequent action plan specific to interconnection reform.

RECOMMENDATION

We recommend that FERC and the transmission planning entities prioritize interconnection queue reform in the coming years to foster a working system for all, which will encourage offshore wind deployment to meet state and Federal goals and ensure the costs for network upgrades are equitably allocated across all generation types and transmission system users.

We recommend ISOs/RTOs and transmission planners consider applications for commercial readiness requirements, such as “first-ready, first-served,” to manage their queues.

We recommend ISOs/RTOs and transmission planners consider allowing soliciting entities, such as states with offshore wind procurements, to enter the queue to reserve a queue position on behalf of whatever project(s) wins their solicitation.

State solicitations and the interconnection queue can achieve better alignment by allowing soliciting entities to reserve queue positions. This would also allow the soliciting entity to select winners in a manner that is informed by anticipated interconnection costs and ensures that whichever project wins the solicitation already has a queue position reserved. Such a process should be designed to ensure that it will not disadvantage or delay other interconnection requests not involved in the solicitation. For a case study on how this approach has been successfully implemented, see FERC’s orders on Xcel Energy Order No. 2003 compliance filing.[xiv]

Beyond these reforms, ISOs/RTOs and other transmission providers should explore nondiscriminatory methods to efficiently allocate scarce existing interconnection capacity. Even under a first-ready, first-served framework, several ready projects may compete for a valuable but limited interconnection position.[xv] If, for example, low-cost network upgrades can accommodate only one of the projects, and if the network upgrades to accommodate all of the projects together are cost prohibitive, then a mechanism, such as an auction, to allocate the queue position to a single project, if such a proposal is consistent with existing open access transmission rules, could streamline the process and eliminate delay associated with studying all of the projects together.

In addition, it may be useful for transmission planners managing offshore wind projects (e.g., state utilities) to consider adopting Institute of Electrical and Electronics Engineers (IEEE) 2800 into interconnection requirements. See IEEE Standard for Interconnection and Interoperability of Inverter-Based Resources Interconnecting with Associated Transmission Electric Power Systems[xvi]

2.4.2. REGULATORY GUIDANCE FOR OWNERSHIP OF NETWORK-READY PROJECTS

★ ★
2025

ISOs/RTOs and transmission developers are facing uncertainty around who should ultimately own offshore transmission network assets that are initially constructed by private developers as

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[xiii] See i2X: The Interconnection Innovation e-Xchange at https://www.energy.gov/eere/i2x/interconnection-innovation-e-xchange.

[xiv] *Xcel Energy Operating Companies*, 109 FERC ¶ 61,072 (2004).

[xv] See Initial Comments of the Colorado Public Utilities Commission, Docket No. RM22-14, at 8-14 (filed October 12, 2022), describing circumstances under which scarce interconnection capacity may arise.

[xvi] See IEEE Standards Association at https://sagroups.ieee.org/2800/.

generator lead lines. Frameworks around ownership and shared use are needed to be able to tap into the enormous potential efficiently and effectively.

Once transmission lines become interconnected, they face new NERC compliance requirements that are typically only handled by registered transmission owners. This change may also have implications for ratemaking and cost recovery. As such, ISOs/RTOs have requested regulatory guidance regarding this issue.

RECOMMENDATION

We recommend that FERC, in consultation with ISOs/RTOs and NARUC, investigate the need for and design of specific grid contracts and regulations for offshore networks to cover topics such as shared use and ownership agreements, transmission rights, open access agreements, and cost allocation for shared and networked offshore facilities across multiple POIs

RELATED RECOMMENDATIONS:

2.1.1 State-led transmission planning

2.4.3. ENHANCEMENT OF EXISTING MARKET MONITORING ROLES

★ 2035

Wholesale electricity markets operated by ISOs/RTOs are subject to monitoring to ensure they function efficiently and effectively and protect consumers and market participants from exercises of market power and other noncompetitive outcomes. While a networked offshore grid can provide many benefits in terms of cost savings and environmental benefits, it also presents new challenges in terms of how the grid will be owned and operated. Concerns have been raised about whether existing rules are adequate to prevent market power abuse and encourage efficient use of generation and transmission resources.

RECOMMENDATION

We encourage FERC to review and, if necessary, enhance existing market monitoring roles to ensure efficient use of generation and transmission resources.

Specifically, the review should address whether existing rules will cover congestion management concerns in a future offshore networked grid and how power flows will be managed with respect to individual state renewable goals and targets. A further consideration for FERC is whether a new third-party transmission monitoring role for a networked offshore grid is needed to address these concerns.

3. TECHNOLOGIES AND STANDARDIZATION

3.1. EQUIPMENT STANDARDIZATION

Developing equipment standards cuts costs, ensures a quicker and more efficient transmission installation, and reduces the time to develop and connect a wind farm, which means power can be generated and sent onshore sooner. Europe has been able to build wind farms more cost effectively through equipment standardization, something the United States can also do to bolster the nation's nascent offshore wind industry.

3.1.1. NETWORK-READY EQUIPMENT STANDARDS

★ ★
2024

Although system operators and states plan for long-term transmission networks for 2030 and beyond, immediate development, including development of radial line connections, will need to be standardized as much as practicable to facilitate the efficient interconnection of the larger offshore grid. Given the cost and time associated with even single radial lines, the benefits of coordinated, long-term transmission grids will be expedited through efficient investments in standardized transmission infrastructure in the near term. These standards must strike a balance between preserving options for future growth while mitigating technology risk and supporting profitable project development today.

Novel concepts for preserving options for future interconnectivity while enabling project development to proceed have arisen through New York Public Service Commission's (NYPSC's) Appendix G Meshed Ready Requirements[29] and New Jersey Board of Public Utilities' Offshore Transmission Network Preparation Requirements.[30] An engineering analysis and market simulation[31] guided the development of the NYPSC mesh-ready technical specifications. It concluded that the cost increment for offshore substations to include two 300 MW AC links to neighboring plants is approximately 0.4%, and the future cost of implementing each link between mesh-ready offshore substations would be approximately $120 million to $240 million. Meanwhile, a market simulation was conducted of a 2040 meshed grid linking offshore substations that are each radially interconnected to Long Island and New York City. It suggested payback for this investment in several years.

Given that these network-ready specifications are the first of their kind, perhaps it should not be a surprise that, as drafted, they carry significant ambiguity and raise questions for project developers. Technical challenges, such as frequency and angle synchronization across neighboring platforms, pose future risks. Also, though the specifications seek to maintain flexibility for future development, the degree of reactive power compensation (and its footprint on a substation) varies with cable voltage and distance, and it is possible that a future connection would have inadequate space for the compensation equipment. And, perhaps most important, future ownership and operation of transmission infrastructure as additional plants are connected on the AC side is undefined, which results in risks to the initial project developer.

Some fixes to these shortcomings are straightforward—further equipment definition would preclude the possibility of situations like a developer siting 50-Hz equipment due to a supply chain advantage, and thus limiting the potential for future links. Other changes are more challenging and require legal and regulatory review. Compensatory models, for example, will be needed to ensure that the original project developer investment and net income in future years are not degraded by changes to the mesh.

RECOMMENDATION

We recommend that ISO/RTO groups (e.g., JIPC) design and expand network-ready equipment standards for both HVAC and HVDC subgroups, using NYPSC s standards as a starting point but adding specificity in terms of design requirements. These standards should be in place to enable future expansion as new lease areas are identified.

We recommend that the multi-state collaborative (see Section 1.1.1, Offshore wind transmission state collaborative) take the lead to drive enforcement of standards within member states. Then, states could require projects to comply with specifications or through offshore wind mandates in public service commission transmission permits.

Not every radial line will need to be designed to be network ready. Overbuilding adds cost and increases the complexity of the design. However, for lines that are in close proximity to each other or that are planned to be part of a larger network, it may be prudent to future-proof their design via network-ready standards.

To extend beyond NYPSC’s model, design requirements for standardization and topology compatibility should be prioritized as follows:

1. Standardize rated HVDC voltages to allow interconnections in the future.
2. Coordinate choice of converter configurations (e.g., monopole vs. bipole) and any resulting physical ratings (e.g., frequency and voltage).
3. Coordinate locations of system earthing point, backup locations, and responsibility to provide earthing; also, coordinate the type and size of the earthing impedance and method of system earthing.
4. Design offshore platforms with sufficient space to host equipment necessary for the physical connection of an extension (e.g., additional switchgear bay to add additional cable connection in the future, additional reactive power compensation).

3.1.2. EQUIPMENT RATING STANDARDIZATION FOR TRANSMISSION COMPONENTS

★ ★
2023

When considering the need to interconnect offshore transmission assets and current global supply chain limitations, one-off designs are not going to be viable for meeting our transmission needs. Standardization promotes interoperability and reduces burden on the supply chain. Even when looking beyond U.S. manufacturing capabilities, the global supply chain is not able to accommodate a lot of custom designs. Further, by using only common offshore wind transmission equipment ratings, we minimize the need for transformers and substation equipment on offshore platforms, which will contribute to lower overall system cost.

RECOMMENDATION

As much as possible, we recommend that state solicitations be prescriptive to match the small, medium, and large transmission designs that are already being used for European installations. Establishing equipment standards for transmission cable voltage and current capacity, connectors, and collector stations—as a function of development potential and topology design—will reduce burden on original equipment manufacturers (OEMs) and transmission planners and operators.

Standard rated HVDC packages

The most commonly used HVDC voltages we recommend are ±320 kilovolts (kV) and ±525 kV. There are several major package solutions using these voltages.

- For generating plants of approximately 1.3 GW, a ±320 kV symmetric monopole is recommended.
- For generating plants of approximately 2 GW or more, there are two common package options using ±525 kV: the ±525 kV rigid bipole and the ±525 kV bipole with DMR. Using the rigid bipole is recommended if it is connected to a robust 500 kV AC system onshore. If connecting to a less robust onshore system, it may be important to include a DMR with the ±525 kV bipole to increase reliability.

Updates to NERC reliability criteria definitions (see Section 2.3.1) will influence the potential use of these topologies. Potential outcomes of SAR activities should be considered when formally issuing recommendations for equipment classes.

Standard rated AC packages

While the HVAC supply chain is much more established, with common voltage classes used in the onshore system, we encourage further voltage standardization to reduce the need for transformers and to simplify maintenance and inventory management for offshore systems. The two HVAC design packages that are most prevalent in the market are a 220 kV solution and a 275kV solution. The 220 kV solution offers a capacity of approximately 400 megavolt amperes (MVA) and can be viably used up to about 60 miles offshore. The 275 kV package has an approximate capacity of 450 MVA, but the maximum usage distance is shorter, at about 40 miles. Both require heavy compensation reactor stations on the offshore platform to transfer the electricity over such long distances. Cable ratings and capacities can be assessed through OEM product catalogs and specifications.[32]

3.1.3. TRANSMISSION OPTIMIZATION WITH GRID-ENHANCING TECHNOLOGIES

★ All

Grid-enhancing technologies (GETs), like dynamic line ratings (DLRs) and power flow controls (PFCs), improve the energy transfer capabilities of existing transmission paths. DLRs increase situational awareness and help to manage congestion by providing more detailed information on real-time system conditions. PFCs, which are a family of technologies that can actively manage the way power flows through the transmission system, expand the grid's response capabilities beyond traditional static technologies.

Transmission optimization with GETs could be cost-effective across the United States by avoiding renewable generation curtailment[33] in the short term and by facilitating the future interconnection of additional renewable generation resources while also providing greater situational awareness and flexibility in the long term. ISOs/RTOs and transmission planners can address near-term onshore transmission needs for offshore wind by identifying opportunities for and installing GETs on transmission pathways to cost effectively reduce system congestion and support the interconnection of large amounts of offshore wind along the Atlantic coast.

RECOMMENDATION

We recommend that transmission planners consider using GETs as part of their interconnection transmission studies, if they are not doing so already.

To support this, we recommend that DOE continue to more broadly disseminate published DOE research on Transmission Optimization with Grid-Enhancing Technologies,[34] with an expanded effort to inform the offshore wind transmission community about its potential applications for offshore wind.

DOE should continue to support research that accelerates industry adoption of transmission optimization with GETs, including expanded research required for the potential application of DLRs to subsea cables and the optimization of offshore wind integration into existing onshore grids (which to date has largely been unstudied). Field demonstration and validation should be a continued priority.

DOE IS SUPPORTING FURTHER RESEARCH ON THE BENEFITS OF GETs.

In December 2022, DOE released a notice of intent (NOI) to issue a funding opportunity announcement (FOA) titled "Increasing Utilization and Reliability of Electric Infrastructure With Grid-Enhancing Technologies."[xvii] Released on February 24, 2023, the FOA aims to fill information gaps about the location-specific benefits and use of GETs through field demonstrations across a variety of scales, geographies, and topologies.[xviii] We recommend that DOE consider responses that would demonstrate how transmission optimization with GETs could benefit the integration of offshore wind energy.

3.2. HVDC INFRASTRUCTURE

As offshore topologies become more advanced and need to integrate more resources and connect to multiple points on shore, point-to-point HVDC solutions will have to evolve into MT-HVDC grids—a relatively novel use case within the United States. MT-HVDC introduces several new challenges, principally how to ensure stability and operability between all components.

[xvii] See FedConnect at https://www.fedconnect.net/FedConnect/default.aspx?ReturnUrl=%2ffedconnect%3fagency%3dDOE%26doc%3dDE-FOA-0002947%26utm_medium%3demail%26utm_source%3dgovdelivery&agency=DOE&doc=DE-FOA-0002947&utm_medium=email&utm_source=govdelivery.

[xviii] See FedConnect at https://www.fedconnect.net/FedConnect/default.aspx?ReturnUrl=%2ffedconnect%3fdoc%3dDE-FOA-0002948%26agency%3dDOE&doc=DE-FOA-0002948&agency=DOE.

3.2.1. HVDC STANDARDS DEVELOPMENT

★ ★ ★
2026

Though HVDC transmission infrastructure has been operational in the United States for more than 50 years, updates to equipment and operational standards will have a significant impact on the deployment of critical HVDC technology to support the integration of offshore wind along the Atlantic coast through 2050. To ensure minimum level of performance, all technology used in a system should be qualified to a minimum standard agreed to between all users of the system. It is important that standards allow adequate flexibility for project-specific context.

RECOMMENDATION

We recommend that IEEE, in concert with ISOs/RTOs and the industry, work to develop equipment and operations standards for HVDC transmission infrastructure.

To further this work, we recommend an industry survey be conducted to identify any existing standards and to review common offshore wind transmission equipment ratings to date to identify gaps and any issues of incompatibility.

Equipment standards

Basic requirements are defined by IEEE 1899-2017[35] for control equipment; protection equipment; and auxiliary secondary equipment, with a voltage range of up to 800 kV. However, an effort to consider the functional requirements of HVDC equipment within the context of grid codes encountered by Atlantic Coast offshore wind projects would provide guidance for equipment manufacturers and transmission planners. Further, system-based functionality requirements may also permit interoperability across manufacturers and vintages of equipment.

These functionality requirements should be structured around the grid codes of ISO-NE, NYISO, PJM, and the southeast system operators for the following equipment types:

- HVDC circuit breakers
- DC-AC and AC-DC converter stations
- HVDC subsea cables
- Converter station controls
- DC transformers

Engagement with industry group, IEEE, and RTOs may be effective to further the requirements list.

Operability standards

Like equipment standards, HVDC operability standards are relevant to radial as well as networked topologies. To optimize the flexibility of HVDC networks, topologies that evolve beyond radial interlinks are needed. This means that more than a single offshore and single near-shore HVDC converter station will be required to function in a coordinated fashion. Though single-vendor, MT-HVDC networks are possible, and perhaps even likely early in the development of the supply chain, cost-effectiveness and scale will be best realized through a market-driven model that requires multi-vendor interoperability. Thus, there is a need for radial and networked HVDC operability standards for the following items, in priority order:

1. Protection controls (including circuit breaker opening and closing procedures)
2. DC-AC converter controls
3. Communication interfaces

DOE IS TAKING ACTION TO START ADDRESSING THESE NEEDS.

WETO released a FOA titled Bipartisan Infrastructure Law (BIL) FOA to Address Key Deployment Challenges for Offshore, Land-Based, and Distributed Wind.[36] Topic Area 1, "High-Voltage Direct Current for Offshore Wind Transmission," seeks applications to advance technologies needed to transmit large amounts of electricity from offshore wind over long distances. Subtopics are focused on HVDC standards and benchmark system development, MT-HVDC, and curriculum development for education and workforce training.

The Office of Electricity (OE) has announced an American-Made High-Voltage Direct Current Prize[37] to help resolve technology gaps around HVDC deployment in the United States. OE and EERE are also doing essential work to advance energy-related materials and manufacturing technologies to increase domestic competitiveness, which may be applicable to offshore transmission development.[xix]

GLEANING LESSONS FROM THE INTEROPERA PROJECT.

The InterOPERA consortium of eight European Transmission System Operators, three offshore wind developers, four HVDC equipment manufacturers, two wind turbine manufacturers, two universities, and others was launched in January 2023, with the objectives of improving interoperability of HVDC systems and grid-forming capabilities of offshore and onshore converter stations. The project is co-funded by the European Union and project partners. Standards are a key focus, but procurement, commercial, legal, and regulatory frameworks that will support multi-terminal, multi-vendor, and multi-purpose applications by 2030 will also be products of the effort.[xx]

Though commercial, policy, regulatory, and legal contexts will differ from those of the United States, much of the progress made by InterOPERA will hold implications for U.S. offshore wind. Further, the United States need not wait for InterOPERA's conclusions to launch a companion effort or to assimilate learnings through existing or otherwise recommended collaborative forums. The U.S. Department of Energy should track closely the evolution of InterOPERA and promote relevant findings through U.S. forums, such as DOE research and development plans, DOE funding mechanisms, state-led RFPs, FERC dockets, and NERC and industry standards committees.

3.2.2. MULTI-TERMINAL HVDC TEST AND CERTIFICATION CENTER

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As MT-HVDC grids are developed, it is likely that interactions between HVDC components from different vendors and the interactions with other connected AC devices will need to be studied carefully to assure adequate tuning of controllers and protection device settings. There is currently no testing or certification center in the United States with the capability to test these potential interactions and ensure compatibility before they are installed. This is a national gap, and although

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[xix] See DOE's Funding Opportunity Announcement number DE-FOA-0002864 at https://eere-exchange.energy.gov/Default.aspx#FoaId2e455119-5dd2-4824-876d-f803cea5696c.

[xx] See InterOPERA at https://interopera.eu.

international facilities (e.g., the United Kingdom's National HVDC Centre[xxi]) may initially be used for testing, it is highly recommended that a domestic center of excellence be established. This will be essential for the coordinated control needs of HVAC/HVDC hybrids, like New York's mesh-ready concept and the HVDC mesh proposed for the AOSWTS, which would likely have multi-vendor control components.

RECOMMENDATION

We recommend the establishment of a national HVDC test and certification center in the United States.

The following are essential capabilities for a U.S. HVDC test and certification center:

- Serve as the centralized keeper of control system replicas of the offshore grid (requiring OEM data for mesh components and mesh network control layers) and the onshore grid (requiring coordination with ISOs/RTOs).
- Maintain independence from any one OEM to eliminate any perceived bias and reduce data sharing or competitive market concerns.
- Validate controls and communications for interoperability:
  - » Identify potential performance issues resulting from different digital control systems from different vendors through offline simulations of black-box models supplied by vendors, or hardware-in-the-loop simulations with the control and protection replicas of the vendors' systems. Standardize methods for qualifying dynamic performance of multi-vendor HVDC transmission systems.
  - » Identify communication interface issues. Most HVDC converter and equipment vendors use their own digital communication systems, and they are not typically interoperable. Testing will need to be done to ensure interoperability until there are fully standardized communication interfaces between different vendors' equipment.
- Access and safeguard the proprietary information of multiple OEMs simultaneously.
- Test mesh network control layers with control system replicas, including hardware-in-the-loop, against performance criteria and standards (which have yet to be developed).
- Test control systems for various combinations of HVDC or HVAC/HVDC mesh-ready equipment.
- Test associated protection systems under various fault conditions and different fault clearing strategies. Identify how any differences can be captured in a technology- and OEM-neutral way.
- Certify equipment if system operators or states elect to include certification standards in their interconnection requirements.
- Develop multi-vendor control schemes either based on controller-agnostic interface layers dictated by standards, or through co-development with vendors while maintaining data privacy safeguards.

In addition, the following capabilities for an HVDC test and certification center are recommended unless they become prerequisites to HVDC or MT-HVDC deployments, in which case they should be considered essential:

[xxi] See the National HVDC Centre at https://www.hvdccentre.com/.

- Establish large-scale AC and DC system hardware-in-the-loop simulation capabilities, which are adaptable to different transmission systems. Consider full and hybrid electromagnetic transient simulation approaches based on budgets and technical needs. Test MT-HVDC designs within this broader system simulation.
- Develop and test grid-forming controls through hardware-in the-loop simulations of MT-HVDC networks. Verify response to faults on DC and AC networks.
- Inform the maturation of HVDC and MT-HVDC equipment and operational standards to secure system technical performance (e.g., protection in the case of component failure, power quality output, power flow coordination) and more cost-effective testing, validation, and certification processes.

3.2.3. DATA SHARING FOR INTEROPERABILITY OF HVDC OFFSHORE SYSTEMS

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To ensure sufficient and trustworthy planning, OEMs should be sharing proprietary data/models with ISOs/RTOs, transmission planning entities, and any future established testing centers to ensure proper modeling of HVDC component performance and compatibility with system assets. Those interoperability studies, once complete, should be shared with the larger planning community to promote lessons learned and develop guidance to inform future work.

RECOMMENDATION

We recommend transmission planning entities focus specifically on performing interoperability studies around HVDC and identify modeling and data needs. There will be a need to establish guidelines or even standards for the parameters, models, interface definitions, and other pertinent information that need to be exchanged between vendors for operation of their equipment within the larger system. While working with commercial proprietary data, there may be an additional need to codify the frequency and method of data exchange.

We recommend OEMs provide data to ISOs/RTOs for interoperability studies, lead the legal and contractual work to establish a multi-vendor cooperation framework, and actively look to standardize components when reasonable. There may be a need to address liability in cases of multi-vendor systems, and OEMs may want to offer guidelines for the measures and logs that should be kept in order to do so.

We recommend that the industry at large work to establish common terminology and definitions for HVDC components or functions such that vender-specific branding does not impede our ability to communicate about this technology.

3.3. RESEARCH AND DEVELOPMENT NEEDS

Although we have over 130 years of experience with designing, maintaining, and operating transmission assets in the United States, designing offshore power systems introduces new challenges and scenarios we have not faced before. Energy research and development (R&D) from public and private entities are needed to address current offshore wind transmission technology gaps and support long-term planning. R&D has been a core tenet to DOE's history and work, and particularly through its national laboratories, it remains a priority to advance innovation. Accelerating the commercialization of offshore transmission technology is a key focus area to grow the wind energy industry and ultimately meet critical energy targets and climate goals.

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3.3.1. RESEARCH AND DEVELOPMENT FOR OFFSHORE TRANSMISSION TECHNOLOGY COMMERCIALIZATION

Offshore transmission technology commercialization will help shepherd critical energy technologies to the market, increasing innovation, efficiency, and standardization while reducing costs. HVDC grid-connection technology is a critical area that needs support to tap into the United States' immense offshore wind potential. Floating offshore wind and associated transmission technologies are also important when considering opportunities on both the Atlantic and Pacific coasts.

RECOMMENDATION

We recommend that Federal agencies, consistent with existing authorizations and appropriations, and other scientific and academic institutions fund and perform critical offshore transmission infrastructure research, development, and commercialization.

The following technology gaps have been identified as key enablers of offshore transmission network development and will be essential to meeting our long-term deployment goals.

HVDC R&D needs:

- Mature HVDC circuit breaker technology at 350 kV and higher ratings
- Subsea cable design and increased power capacity for applications in which single-source injection limits allow higher capacity cables
- HVAC-HVDC converter equipment ratings increased beyond 525 kV
- DC/DC converters developed to support connecting HVDC grids
- DC grid protection developed
- DC grid stability standardized
- AC/DC interaction and stability standardized
- Improved modeling of HVDC and offshore wind plants
- Equipment cost reductions, including reducing the physical footprints of offshore converters and breakers

General R&D needs:

- Floating offshore wind and transmission technologies commercially ready
- Technical demonstration of advanced capabilities of inverter-based resources, such as offshore wind, to provide ancillary transmission services such as reactive power support, power oscillation damping, frequency support, and black start operation.

RELEVANT R&D SUPPORT THROUGH DOE AND THE NATIONAL LABS:

Floating Offshore Wind Energy Earthshot[xxii]
Atlantic[38] and West Coast[39] Offshore Wind Transmission Studies
Interconnection Innovation e-Xchange (i2X)xxiii
Wind and MT-HVDC funding opportunity40
MT-HVDC protection and DC breaker requirements
Grid reliability and resilience tools and data sets
2023 Technology Commercialization Fundxxiv

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3.3.2. ENVIRONMENTAL RESEARCH AND DEVELOPMENT FOR OFFSHORE WIND TRANSMISSION

Several research topics were identified during the Convening Workshops, as well as by the U.S. Offshore Wind Synthesis of Environmental Effects Research (SEER) project,[41] which synthesizes key issues, disseminates existing knowledge about environmental effects, and prioritizes future research needs. An Atlantic Offshore Wind Research Recommendations database was created jointly between the Biodiversity Research Institute and SEER; relevant recommendations are discussed below. In addition, BOEM funds and manages scientific research to inform the decision-making process for renewable energy projects on the OCS and maintains a catalog of proposed, ongoing, and completed studies.[42] Many of these studies apply directly to transmission development as well as to offshore wind generation projects.

RECOMMENDATION

Federal agencies and other scientific and academic institutions have invested significant resources in critical scientific research on the environmental effects of offshore wind transmission infrastructure. We recommend that this research continue so it can address remaining information gaps; monitor the effects of infrastructure as it is installed; and keep current as new technology is proposed, reviewed, and deployed.

The examples below are not meant to be a comprehensive list but rather to highlight some of the most pressing research needs (with specific application to transmission cables) known at this time and to recognize that a variety of environmental research topics will require additional investment.

[xxii] See Wind Energies Technologies Office at https://www.energy.gov/eere/wind/floating-offshore-wind-shot.
[xxiii] See About the Interconnection Innovation e-Xchange (i2X) at https://www.energy.gov/eere/i2x/about-interconnection-innovation-e-xchange-i2x.
[xxiv] See Base Annual Appropriations TCF at https://www.energy.gov/technologytransitions/technology-commercialization-fund#:~:text=The%20Base%20Annual%20Appropriations%20TCF,Learn%20more%20here.

WHAT ABOUT ELECTROMAGNETIC FIELDS AND POTENTIAL IMPACTS ON THE MARINE ENVIRONMENT?

During the Convening Workshops, we heard questions on the potential impacts of electromagnetic fields (EMF) from energized cables in the marine environment and recommendations to continue scientific research on this topic. EMF decays quickly with distance from the cable, and cable burial minimizes potential exposure. BOEM has conducted EMF studies[43] and published several white papers.[44] The SEER project's Electromagnetic Field Effects on Marine Life website and associated research brief also provide useful specifics on this topic.[45]

> *"Overall, there is no conclusive evidence that EMFs from a subsea cable create any negative environmental effect on individuals or populations. To date, no impacts interpreted as substantially negative have been observed on electrosensitive or magnetosensitive species after exposure to EMFs from a subsea cable. Behavioral responses to subsea cables have been observed in some species, but a reaction to EMFs does not necessarily translate into negative impacts."*
>
> *— SEER Research Brief on Electromagnetic Field Effects on Marine Life*

New studies may be necessary as new technology is developed for transmission cables to shore, and we encourage that research continue to be pursued as new needs arise.

Post-installation monitoring between transmission infrastructure and marine life

We recommend continued study of impacts and interactions between offshore transmission infrastructure and marine ecosystems. This should include ongoing monitoring throughout the lifecycle of projects, with long-term studies documenting any habitat or behavioral impacts due to introduced thermal or electromagnetic sources, as well as changes and conversion of bottom type due to flow and current changes and introduction of structures. Such studies will build on existing analyses of potential impacts from offshore wind development in the United States.[46] The recovery of the seafloor post-installation should be assessed. Recovery will vary by site because of seabed properties and local hydrodynamics, as well as the specific types of disturbance.

Understanding impacts to archaeological, cultural, and environmental resources in collaboration with Tribal Nations

Ancient, submerged landforms are important to Tribal Nations. Continued research regarding the identification (e.g., high-resolution mapping, verification, and visualization) of ancient, submerged landforms prior to, during, and after offshore wind leasing is necessary. Moreover, there is a need to work collaboratively with Tribal Nations to identify areas of concern that may be impacted by proposed or future development (e.g., transmission cable routes, inter-array cables, offshore service platforms, turbine foundations, scour protection) and develop a prioritized strategy for collecting and analyzing geophysical and geotechnical data to create a regional understanding and representative models of ancient submerged landforms that survived sea-level rise and inundations.

Furthermore, Tribal Nations have concerns related to their relationship with the marine environment. These include physical impacts to the seafloor, alteration of the ecosystem through activities such as silt dispersion and introduction of chemicals, and other activities that may affect the food web and impact tribal sustenance practices (e.g., fishing, shellfish procurement). These concerns should be met with continued collaboration with Tribal Nations, enhanced understanding of the impacts that transmission has on subsistence practices, and the integration of indigenous knowledge into new studies.

Protection materials

The Atlantic Offshore Wind Environmental Research Recommendations Database[47] includes several recommendations related to understanding the environmental effects of protective materials used for transmission. For example, it includes a recommendation for research into ecological function beneath cable protection (e.g., infilling or colonization of rock protection) and whether this can continue while protection measures are in place, as most environmental assessments generally assume total habitat loss.

BOEM and state partners have begun funding research evaluating the effectiveness of materials included in nature-inclusive design for standard cable protection and concrete mattresses. The literature recommends testing scour/cable protection designs to assess the value as an artificial reef; this research could help determine which scour/cable protection design is best for the creation of artificial reefs and for the protection of species. BOEM monitoring studies at Block Island indicate that what the industry is currently using for cable protection may inhibit marine growth, and alternative materials may provide beneficial habitat to marine resources. Expanding on existing knowledge about potential impacts of different types of cable protection material within different habitats will help determine an appropriate or best cable protection to be used within a particular habitat.

Trenching for subsea cable burial

Further research regarding impacts caused by ocean trenching activities for cable installation (e.g., turbidity, noise, anchoring) on marine and coastal environments is necessary. A clearer understanding of the effectiveness of cable protection and of scouring protection materials in providing beneficial habitat to living marine resources, including evaluation of both positive and negative outcomes of habitat promotion, is important. Also, there is a need to understand disturbance levels of different cable installation tools and methods and of how they can be used appropriately in different environments to mitigate seafloor disturbance, where possible. Other topics include understanding the changes that alteration of the seafloor creates and the totality of effects caused by the flow and current changes introduced by the installation of anthropogenic structures (e.g., turbines, electric service platforms). Finally, an assessment of noise created during cable burial operations should be performed. This would include real-time monitoring in different conditions and with different devices. See the Atlantic Offshore Wind Environmental Research Recommendations Database for additional information.[48]

Horizontal directional drilling at cable landfall locations

Additional understanding regarding the impacts on coastal environments of horizontal directional drilling at cable landfall locations is needed. Although materials used during horizontal directional drilling operations are inert, research is needed to examine any lasting effects or habitat loss caused by construction activities.

NOAA fisheries

For the Federal Government to support ongoing and future environmental research, it is necessary to continue efforts to better understand, avoid, and mitigate interactions with NOAA assets and tools (e.g., fisheries surveys, protected species surveys, high-frequency radar systems, meteorological data buoys) so that ongoing ocean observation, monitoring, surveys, and other science continues. Implementation of the NOAA Fisheries and BOEM Federal Survey Mitigation Strategy – Northeast U.S. Region would work toward deconflicting interactions with NOAA assets, and this regional survey mitigation approach could be explored for other regions. Doing so will ensure that the best available resource data is available to inform offshore transmission siting and deconflict areas for development. Additional environmental research could also include exploring opportunities to use offshore infrastructure to enhance data collection wherever possible.

Floating offshore wind

Most of the focus so far has been on fixed-bottom turbines; however, environmental topics specific to the installation of transmission lines associated with floating offshore wind farms must also be considered. These include entanglement, particularly secondary entanglement; that is, when marine debris could get caught on cables in the water column and marine life could consequently get entangled in that debris. There is also potential for noise from thrumming of cables in the water column, especially for mooring lines, which may be an issue with transmission lines in the water column. Continued research into the specific impacts of floating offshore wind farms will become increasingly necessary as they become more widely used.

RELEVANT R&D SUPPORT THROUGH BOEM AND DOE

BOEM conducts environmental research on marine environments, impacted species, electromagnetic fields, acoustics, and other topics. It is available online.[49]

The U.S. Offshore Wind Synthesis of Environmental Effects Research project, hosted through DOE's Pacific Northwest National Laboratory and National Renewable Energy Laboratory, facilitates international information sharing and research and contains an extensive library of research, also available online.[50]

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3.4. SUPPLY CHAIN

Recent industry growth, fueled by national and state goals for offshore wind deployment and a cleaner energy sector, has created huge demand for transmission components and has identified a chokepoint: our domestic supply chain. We are seeing a need to grow supply chains and the trained workforce globally and, more acutely, domestically. These significant shortages will have to be addressed to meet our offshore wind deployment goals.

Several excellent resources exploring supply chain needs and recommending solutions have been published recently. In February 2022, DOE published a comprehensive U.S. government plan to address energy sector supply chain needs titled "America's Strategy to Secure the Supply Chain for a Robust Clean Energy Transition."[51] Key findings pertinent to offshore wind transmission include expanding domestic manufacturing of transmission equipment and cables and developing a skilled U.S. workforce.

3.4.1. EXPANSION OF DOMESTIC SUPPLY CHAIN AND MANUFACTURING

The Supply Chain Deep Dive Assessment for electric grid components[52] further identifies large power transformers and HVDC transmission assets as the primary gaps for transmission equipment in the United States. For large power transformers, shortages exist in raw material supply for grain-oriented electrical steel and in domestic manufacturing for the final transformers. HVDC shortages include converters, DC switchgears (breakers), DC filters, and cable. Historically, low domestic demand for these assets has limited the growth of domestic industry. The recent surge in demand has overwhelmed manufacturing capabilities around the globe so much that some cable manufacturers are no longer responding to requests for information for new projects or may only respond to 25% of requests, and those who do respond have waitlists of five years or more.[xxv]

RECOMMENDATION

We recommend that equipment manufacturers expand domestic facilities to support the demand from offshore transmission projects in the United States, using all financing and technical assistance tools available from the Federal Government.

We recommend that offshore transmission developers reach out to transmission asset manufacturers early both to plan for items with long-lead times in their proposals and to signal market need to the OEMs.

Further recommended steps on domestic supply chain development for offshore wind may be found in *A Supply Chain Road Map for Offshore Wind Energy in the United States* (Offshore Wind Supply Chain Roadmap), published by the National Renewable Energy Laboratory in 2023.[53]

RELATED WORK FROM THE ALL-OF-GOVERNMENT APPROACH TO OFFSHORE WIND SUPPLY CHAIN INCLUDES THE FOLLOWING:

- DOE will complete ongoing work on the national Offshore Wind Supply Chain Roadmap,[54] including the development of a critical materials database and port sufficiency analysis.
- DOE will continue its support of Market Development Cooperator Program[55] grants to support domestic exports to international markets.
- U.S. Department of Transportation will continue investing in port infrastructure needed to transport offshore wind and transmission components via its Port Infrastructure Development Program.[56]
- BOEM will continue to provide early notice of any offshore wind lease activities to give forewarning of new market demand to industry and support state convenings on supply chain collaboration.
- BOEM and the states of New York and New Jersey developed a shared vision on the development of an offshore wind supply chain based on mutual principles.[57]
- DOE, BOEM, and representatives from Atlantic states will continue to meet regularly to coordinate regional approaches to supply chain development as part of the Federal-State Offshore Wind Implementation Partnership.
- Starting with the New York Bight lease sale in 2022, BOEM has incorporated lease stipulations requiring the lessee to establish a statement of goals to describe its plans for the creation of a robust and resilient U.S.-based offshore wind supply chain and provide associated progress updates.

[xxv] Based on feedback gathered during the 2021-2022 Convening Workshops.

3.4.2. SKILLED U.S. WORKFORCE DEVELOPMENT

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A well-trained, diverse, and proficient workforce will be essential for meeting U.S. climate and clean energy goals. Across the nation, there are shortages of experienced transmission engineers, technicians, manufacturing plant workers, and even truck drivers to transport transmission materials. The shortages may be attributed to several factors, including an aging workforce, population decline, training gaps, and the rise of new industry that did not previously exist in force in the United States. Modifying existing training programs and developing new ones to equip and help train workers in offshore wind transmission, including those who might be transitioning from other industries, like oil and gas, is necessary.

RECOMMENDATION

We encourage U.S. employers in the offshore wind and transmission sectors to dedicate specific focus and funding to attract and retain a skilled, trained, and diverse workforce. Offering paid internships and apprenticeships to new workers, students, and recent graduates can increase interest and experience of early career workers and facilitate a pipeline of workers for succession planning.

Expanding and promoting apprenticeship readiness programs can serve a dual purpose. The Offshore Wind Supply Chain Roadmap notes that these programs are a great way to prepare candidates for apprenticeship programs while also demonstrating commitment to diversifying candidate pools.

RECOMMENDATION

We encourage U.S. community colleges, vocational trade schools, graduate, and post graduate educational institutions to offer additional classes and programs focused on transmission and power systems, particularly HVDC and offshore systems, to produce more early career workers.

Building partnerships with labor unions and industry can help aid curriculum development. New York's Hudson Valley Community College offers several associate degrees and certificates in offshore wind manufacturing and partners with manufacturers to build out a workforce.[58] Workforce needs span the industry, and multiple agencies and stakeholders are convening to advance energy workforce development. Strong labor standards and support for organized labor may help enable development of the energy sector industrial base.

DOE EFFORTS TO ADDRESS WORKFORCE TRAINING NEEDS

DOE's Wind Energy Technologies Office released a funding opportunity[59] in December 2022 that includes a specific subtopic for the development of HVDC-focused curriculum for education and workforce training.

BOEM EFFORTS TO ADDRESS WORKFORCE TRAINING NEEDS

In recent lease sales, BOEM used a multi-factor auction format to allow a bidder to receive a credit of 20% of its cash bid in exchange for committing to making a qualifying monetary contribution to programs or initiatives that support workforce training for the offshore wind industry, development of a U.S. domestic supply chain for the offshore wind energy industry, or both.

4. ECONOMICS AND SUPPORT INITIATIVES

4.1. BENEFIT VALUATION AND COST ALLOCATION

In the United States and in Europe, there is general agreement that the development of a coordinated transmission network spanning the needs of multiple offshore wind projects, states, and, potentially, operating jurisdictions can provide many benefits, including significantly reducing overall investment costs, minimizing environmental impacts, and accelerating the ability of states and countries to meet their clean energy goals. A 2023 Brattle report on the benefits and urgency of planned offshore transmission reviews existing offshore wind studies and estimates that coordinated transmission planning for Atlantic offshore wind could result in at least $20 billion in transmission-related cost savings, 60% to 70% fewer shore crossings, and a reduction of approximately 50% in marine transmission cables (2,000 fewer miles) on the seabed.[60]

Despite the clear benefits of coordinated transmission, these projects are notoriously difficult to develop in part because of disagreements on how to allocate project costs among various network users. FERC Order No. 1000 and judicial precedent require that costs be allocated at least approximately commensurate with estimated benefits. However, transmission benefits are difficult to quantify, and the nature and magnitude of benefits may change over the lifetime of the project, making any cost allocation based on estimated benefits potentially highly contentious.

There are multiple efforts underway to address project cost allocation disputes. Individual states and regional system operators are taking action through collaborative planning and voluntary agreements. Meanwhile, FERC has proposed regulatory reforms to provide a consistent framework for the development of long-term scenarios for use in regional transmission planning and to enhance the critical role of states in transmission facility selection and cost allocation.[61] And, as part of the AOSWTS, the study team developed and demonstrated methods to quantify multiple system benefits of offshore wind transmission that could be used to allocate costs fairly and efficiently. These efforts provide useful examples of scalable solutions that could be replicated and showcase areas in which more work is needed on cost allocation, benefit valuation, ratemaking, and engagement with consumers.

4.1.1. VOLUNTARY COST ALLOCATION ASSIGNMENTS

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Transmission cost allocation is a notoriously thorny issue that is intensified by the scale of projects and large price tags associated with interconnecting offshore wind. In fact, the Business Network for Offshore Wind described the issue of who pays as "the hardest single problem for transmission."[62] On June 17, 2021, FERC issued a policy statement[63] addressing state efforts to use voluntary cost agreements for transmission development. In the policy statement, FERC encouraged interested parties to use such agreements and cited the benefits of doing so.

> *"Voluntary Agreements can further those goals by, for example, providing states with a way to prioritize, plan, and pay for transmission facilities that, for whatever reason, are not being developed pursuant to the regional transmission planning processes required by Order No. 1000. In addition, in some cases, Voluntary Agreements may allow state-prioritized transmission facilities to be planned and built more quickly than would comparable facilities that are planned through the regional transmission planning process(es)."*
>
> *—FERC Docket No. PL21-2-000*

In addition to the benefits outlined by FERC, voluntary agreements can help minimize litigation over project cost allocation that could prevent the United States from achieving 30 GW of offshore wind deployment by 2030. Further, voluntary agreements could shorten the timelines for generator interconnection requests. In many regions, interconnecting generators must shoulder a majority, if not all, of the cost for network upgrades that benefit a wide range of network users. When faced with significant and often difficult to predict expenses, they might withdraw from the interconnection queues, which passes the costs onto the next generator in line. Every time a generator drops from the queue, it requires the system operator to conduct a new study of the remaining generation projects and creates cost uncertainty for them. New Jersey's use of the PJM State Agreement Approach provides a useful example of a state pursuing a voluntary cost allocation assignment. Under this approach, the New Jersey Board of Public Utilities asked PJM, on behalf of the state of New Jersey, to solicit transmission solutions to enable the state to meet its offshore wind targets. New Jersey ratepayers will pay the cost of the transmission upgrades, taking advantage of PJM's planning expertise and competitive processes to reduce costs.

RECOMMENDATION

We encourage states to pursue, and ISOs/RTOs and other transmission providers to facilitate, voluntary cost allocation based on a mutually agreed-upon method.

The following best practices have been identified to streamline cost assignments:

- Voluntary funding agreements, through which one or more state regulatory entities and/or public utility transmission providers (at the direction of or in collaboration with state entities) may agree to accept all or part of the cost burden for a specific facility and can provide a mechanism to build beneficial infrastructure that may not otherwise have had a pathway to be planned for and paid.
- System operators should examine the viability of granting priority access to the capacity created on the system as long as it is consistent with open access principles to the state(s) sponsoring a project through a voluntary funding agreement, and possible consequences to market competition and system reliability, particularly during periods of system stress, if such access is given.
- Public utility transmission providers can include in their tariff both a mechanism for voluntary funding agreements and a predefined regional cost allocation method for regional transmission projects.

4.1.2. BEST PRACTICES FOR BENEFIT VALUATION

★ All

Avoiding a cost-allocation methodology that relies solely on a narrow, formulaic approach to quantifying benefits can help shift to a more holistic, multi-value benefit analysis in transmission planning. According to the 2023 Brattle Roadmap, proactive transmission planning can lead to cost-effective outcomes by moving beyond incremental generation interconnection assessments and reliability-driven processes to include a full set of benefits over a longer term.[64] Some of these benefits include economic and public policy needs, environmental benefits, and grid reliability and resilience. This more inclusive approach to evaluating benefits has already been incorporated into some transmission planning by grid operators like MISO and PJM in recent years.

WE RECOMMEND THE FOLLOWING AS BEST PRACTICES TO IMPROVE BENEFIT VALUATION:

» Evaluators could simultaneously assess a portfolio of transmission projects, grouped by project location or implementation timeline, rather than doing individual assessments of each project. This approach, like MISO's multi-value project process, could help alleviate disputes over how benefits—and ultimately costs—are allocated among network users because bundled projects will have a more even distribution of benefits.

» ISOs/RTOs and other transmission providers can enable beneficial projects by simultaneously evaluating multiple benefits beyond reliability or production cost savings. As part of the AOSWTS, DOE will examined a multi-value benefit valuation for transmission investments identified as part of the study.

» FERC can establish a minimum set of benefit categories and methodologies to quantify them to help with cost allocation for new transmission facilities.

» Evaluators can be transparent and consistent when conducting benefit evaluations. This may help prevent disputes over methodologies and future uncertainties that could keep regional and interregional transmission planning solutions from being implemented at the pace necessary to meet state and national goals.

4.1.3. COST ALLOCATION METHODOLOGY

★ ★ All

Many methods for cost allocation rely on various techniques to estimate a subset of project benefits or approximate network usage as a measure of benefits. However, considering the inherent difficulty in defining and quantifying transmission benefits and network usage, no indisputable method exists. The following are best practices for a cost allocation methodology, which may inform mutually beneficial agreements that mitigate litigation risk.

RECOMMENDATION

We recommend that the allocation of interregional transmission costs among regions follow the regional distribution of benefits associated with the project based on a common list of benefits and methods to quantify transmission benefits among regions.

We recommend that ISOs/RTOs and other transmission providers develop novel mechanisms to finance and develop offshore interconnection facilities that can accommodate both near-term and long-term offshore wind development. For example, major new interconnection facilities could be jointly funded by transmission network customers (i.e., load) and initially interconnecting generation, and then costs could be allocated to generation as future generators come online.[xxvi]

[xxvi] California ISO's Location-Constrained Resource Interconnection model illustrates how such a mechanism could be structured. For more information on this model, see 119 FERC ¶ 61,061 and 121 FERC ¶ 61,286.

Project evaluation should include a broad set of benefits to identify projects or portfolios of projects that are beneficial (or at least not disadvantageous) to all states in the region.

Interregional projects are especially challenging to develop due to disputes over cost allocation. The definitions and principles for interregional transmission facility cost allocation outlined in FERC Order No. 1000 were not designed with a networked offshore grid in mind. For example, the existing definition of an interregional transmission facility from Order No. 1000 may not be adequate in a networked offshore grid where cables can connect offshore turbines and substations from different transmission planning regions and where power flows in one region may impact system operations in one or more other regions with no direct interconnection between them.

RECOMMENDATION

In combination with the recommendations for FERC action on interregional transmission planning presented in Section 2.2.2, Regulated interregional joint planning processes, we advocate for firmer regulation and support FERC's consideration of the issue to provide a ready mechanism for:

- States to reach voluntarily determined cost allocation agreements, potentially including states in two or more planning regions.
- Interregional cost allocation principles inclusive of the unique characteristics that a networked offshore grid may provide.
- Default cost allocation methods for interregional transmission facilities to serve as a backstop for cost allocation agreements in cases where transmission planning regions or participating states cannot reach a voluntary solution.

IS THERE A PATHWAY FOR IMPROVED INTERREGIONAL TRANSMISSION PLANNING AND COST ALLOCATION BASED ON INTERNATIONAL EXPERIENCE?

International experience in Europe and in Central and South America points to specific actions that could facilitate greater deployment of interregional transmission. As we consider future transmission and cost allocation paradigms, example actions that may apply to the United States include the following:

- A transparent procedure to determine whether a transmission facility qualifies as a regional or interregional project, based on simulating network flows, is preferable to the current definition, which is based on the physical location of the transmission facility. Simulated network flows under different demand and supply scenarios can be used to calculate the utilization of the line by external network users located outside of the transmission planning region where the line is built.

- Federal agencies, such as FERC, can set a threshold (e.g., 10% of power flows) above which the line would be considered part of the interregional network. The allocation of costs could then be assigned to beneficiaries of the interregional project, as determined based on quantified system benefits, and may not be limited to transmission planning regions in which the transmission facility is physically located. This would require a revision of FERC Order No. 1000 Principle 4 on interregional cost allocation.

- All transmission expenses approved for cost recovery related to interregional transmission could then be recovered through a supplemental interregional tariff schedule. This would have no effect on the recovery of other types of transmission costs. The rate formula for recovering interregional transmission costs could consist of a fixed and adjustable component. The fixed component would be based on benefits other than production cost savings realized by each network user. The adjustable component would be based on production cost benefits revealed by modeling studies and subject to a periodic true-up at predetermined intervals to reflect changing system conditions over the lifetime of the transmission asset.

- The allocation of interregional transmission costs should precede the cost allocation within a region. The allocation of costs within the region among network users can be maintained as a separate process. DOE provided a demonstration of different interregional cost allocation methods applied to transmission investments identified as part of the AOSWTS.

4.1.4. EQUITY IN RATEMAKING

★ All

Energy burden, or the percentage of household income spent on energy costs, disproportionately impacts low-income, Black, Hispanic, Native American, and older adults across the country.[65] Through traditional ratemaking, investor-owned utilities generate revenue based on how much energy is used and, therefore, are disincentivized to implement energy efficiency measures.[66] This exacerbates the situation for low-income residents with high energy burdens, who might be renting and/or living in inefficient housing, and who have fewer means to address high costs. It is imperative that public utility commissions set equitable ratemaking policies to help ensure that as states pursue the reliability and resilience benefits of offshore wind and other new generation sources, households benefit from affordable electricity.

RECOMMENDATION

We recommend that public utility commissions adopt best practice standards to ensure that low-income and vulnerable populations do not continue to be disproportionately impacted by high energy burdens.

Some best practices for public utility commissions to accomplish this goal include:

- Establishing new or reviewing existing low-income discount rates or similar retail rate classification programs to ensure state offshore wind goals do not result in an increased energy burden for disadvantaged communities
- Explicitly considering energy burden, energy security, energy poverty, and other indicators in rate determination, including setting rate caps
- Incorporating performance-based ratemaking practices that leverage performance incentive mechanisms targeted at energy burden or similar indicators

New York is one of several states leading in this area. The state's energy affordability policy of 2016 aimed to limit energy costs for New Yorkers to no more than 6% of their pretax income. In January 2023, Governor Kathy Hochul proposed the Energy Affordability Guarantee to ensure New Yorkers do not pay more than this cap through a host of energy affordability measures, such as a credit to pay high electric bills and a pilot program to modernize low-income homes.[67]

4.1.5. CONSUMER ADVOCATES

★ All

Achieving state clean energy targets for offshore wind will impact a broad range of consumer groups who will want to ensure the rates they pay for electricity are reasonable. Although public rate hearings meet this need in traditional utility planning cycles, these hearings are overly time and resource intensive to be held for every decision needed for developing transmission for offshore wind integration. Including a consumer advocate early in the planning and decision-making process can ensure that ratepayer interests are being considered without having to bring every conversation into a public forum. Consumer advocate engagement can minimize public resistance to transmission projects, increase transparency, and lead to better outcomes that consider the interests of ratepayers. Further, the role of consumer advocates could also provide information and advocacy to Tribal Nations regarding the transmission planning decisions.

RECOMMENDATION

We recommend that ISOs/RTOs establish a designated consumer advocate, starting in 2024, to ensure that the investments in transmission infrastructure needed to support offshore wind are equitably and prudently reviewed with the ratepayer in mind. End-user representatives and municipalities can also provide key inputs in stakeholder processes around cost allocation. The consumer advocate position within PJM can serve as a template for this process. We recognize that designating consumer advocates may require new or additional funding, but the value provided to ratepayers by such a position is often significant.

We recommend that this designated consumer advocate for offshore wind transmission, or at least each state's advocates from the National Association of State Utility Consumer Advocates, be included in key cost allocation and ratemaking conversations happening at the public utility commission regarding large transmission system expansion to accommodate offshore wind deployment.

4.2. FEDERAL SUPPORT

The Biden-Harris Administration has secured historic Federal investments to help achieve bold climate and clean energy goals, including reducing greenhouse gas emissions by 50%–52% below 2005 levels in 2030, reaching 100% carbon pollution-free electricity by 2035, achieving a net-zero emissions economy by 2050, and prioritizing 40% of these climate and clean energy investments for disadvantaged communities.[68] The development of new and upgraded long-distance transmission facilities and distribution systems will be integral to achieving these goals, including for offshore wind. The Building a Better Grid Initiative's focus on developing a reliable and resilient transmission network and launching a proactive, cooperative planning process is a great start. Federal financing support will play a key role in meeting the Biden-Harris Administration's 2030 offshore wind goals.

4.2.1. RELEVANT FEDERAL FUNDING, FINANCING, AND TECHNICAL SUPPORT

★ All

With the Biden-Harris Administration's ambitious clean energy targets and the unprecedented levels of funding support made available by the BIL and IRA, Federal agencies are unifying to support transmission infrastructure development.

Programmatic funds within DOE and BOEM have been directed to support the convening of stakeholders, relevant R&D, and demonstration projects. This historic level of Federal funding support has enabled a plethora of funding and financing opportunities, many of which are competitive and application-based.

RECOMMENDATION

We recommend that developers and states looking to develop offshore wind transmission projects carefully review and apply for existing and upcoming funding programs to access BIL and IRA funding.

Additionally, the Treasury Department continues to develop guidance and rules to provide clarity and certainty about clean energy tax credits that would promote offshore wind development, including the IRA's modified and extended investment tax credit. Under the IRA, the investment tax credit is 30%, provided that prevailing wage and apprenticeship requirements are met, with additional bonuses potentially available.

Appendix B outlines Federal programs and opportunities available as of the publication of this action plan. For the most up-to-date information, please refer to the following DOE websites:

- Office of Energy Efficiency and Renewable Energy Funding Opportunity Exchange[69]
- GDO Grid and Transmission Program Conductor[70]
- Loan Programs Office[71]

RELATED RECOMMENDATIONS:

3.3 Research and development needs

4.2.2. FEDERALLY DESIGNATED NATIONAL INTEREST ELECTRIC TRANSMISSION CORRIDORS

★ ★
All

The FPA directs DOE to routinely study the nation's electric transmission capacity and provide insight into critical areas facing current or future transmission congestion and capacity constraints. The FPA also provides the Secretary of Energy with the authority to designate geographic areas as National Interest Electric Transmission Corridors (NIETCs) where transmission could play an important role in addressing current or future capacity problems.

DOE could designate an offshore NIETC, assuming the conditions for exercising such designations under the FPA are met (see text box). However, an offshore NIETC designation would probably not significantly impact permitting processes for constructing offshore transmission facilities because those facilities are either subject to Federal siting authority managed by BOEM or to state siting authority that is potentially protected from Federal preemption under the Submerged Lands Act.

NIETC designation for onshore transmission facilities associated with offshore energy projects may impact permitting if those onshore facilities are integral to successful offshore development. Onshore facilities associated with offshore energy projects are generally subject to state permitting. Such state permits could include those related to siting and land use rights, health and safety, and environmental protection. Assuming the conditions under the FPA are met, NIETC designation would allow FERC to exercise its backstop siting authority (see text box).

RECOMMENDATION

DOE solicited comments through a Notice of Intent and Request for Information[72] regarding the designation of a NIETC. The finalization of a process for NIETC designation will further inform the extent to which such authority may be useful for transmission development that would support offshore wind deployment. If an offshore NIETC designation is explored by DOE, we recommend that a NIETC not be used as a mechanism to broadly pre-select routes for offshore transmission build-outs.

Whether onshore or offshore, NIETC designation could allow DOE to use its authority to enter public-private partnerships under the Transmission Facilitation Program, and developers could qualify for transmission facility financing through IRA Section 50151.

UNDER WHAT CONDITIONS COULD DOE ISSUE A NIETC DESIGNATION?

In addition to the results from the National Transmission Needs Study,[73] DOE may consider the following additional factors in determining whether to designate a NIETC:

A. The economic vitality and development of the corridor, or the end markets served by the corridor, may be constrained by lack of adequate or reasonably priced electricity.

B. Economic growth in the corridor, or the end markets served by the corridor, may be jeopardized by reliance on limited sources of energy; and a diversification of supply is warranted.

C. The energy independence or energy security of the United States would be served by the designation.

D. The designation would be in the interest of national energy policy.

E. The designation would enhance national defense and homeland security.

F. The designation would enhance the ability of facilities that generate or transmit firm or intermittent energy to connect to the electric grid.

G. The designation maximizes existing rights-of-way and avoids and minimizes, to the maximum extent practicable, and offsets, to the extent appropriate and practicable, sensitive environmental areas and cultural heritage sites.

H. The designation would result in a reduction in the cost to purchase electric energy for consumers.

WHAT IS FERC'S BACKSTOP SITING AUTHORITY?

Section 216(b) of the FPA, as amended by the Infrastructure Investment and Jobs Act, allows FERC to issue permits for the construction or modification of electric transmission facilities within NIETCs when the following statutory conditions are met:

A. A state in which such facilities are located lacks the authority to approve the siting of the facilities or to consider the interstate or interregional benefits expected to be achieved by the proposed construction or modification of transmission facilities in the State.

B. The permit applicant is a transmitting utility but does not qualify to apply for a permit or siting approval in a state because the applicant does not serve end-use customers in the state; or a state commission or entity with siting authority has not made a determination on an application seeking approval of the facilities for more than one year after the later date on which an application was filed and the date on which the designation of the relevant NIETC or the state conditions the construction or modification of the facilities in such a manner that the proposal will not significantly reduce transmission congestion or capacity constraints in interstate commerce or is not economically feasible or has denied an application seeking approval.

Section 216(e) authorizes a permit holder, if unable to reach agreement with a property owner and has made good faith efforts to engage with the property owners and other stakeholders early in the permitting process, to use eminent domain to acquire the necessary right of way for the construction or modification of transmission facilities for which the Commission has issued a permit under Section 216(b). Federal and state-owned land is expressly excluded from the purview of Section 216(e) and thus could not be acquired via eminent domain.

5. SITING AND PERMITTING

5.1. SITING

Building a planned offshore wind transmission system will require careful planning and analysis during the siting process to align requirements across regulatory jurisdictions; ensure appropriate protections; and address ocean co-use through avoidance, minimization, and mitigation strategies. States authorize the routing of export cables in state waters stretching three nautical miles (nm) from shore to the landfall location. BOEM authorizes proposed projects in Federal waters on the OCS, extending out 200 nm, and considers a variety of issues when determining project placement, such as vessel navigation, coexistence with other marine users, and impacts to environmental and cultural resources. The recommendations in this section discuss the sustainable and just development of offshore wind transmission, the creation of benefits for coastal and undeserved communities, and the minimization and mitigation of unavoidable negative impacts.[xxvii]

5.1.1. FEDERAL PREFERRED ROUTES FOR TRANSMISSION IN THE OUTER CONTINENTAL SHELF

★ ★ ★
2025

To meet offshore wind deployment goals through the siting of optimal offshore wind transmission topologies (like the transmission topology strategies analyzed in the AOSWTS), DOE and BOEM, in consultation with other Federal agencies, Tribal Nations, and state agencies with siting, permitting, and related consultation authorities, could identity Federal preferred routes and conduct geophysical surveys, geotechnical investigations, and marine resource assessments to confirm or modify the suitability of the proposed routes. Data collected from this survey work could then be made available to lessees and potential grantees for use in the Federal authorization and permitting process.

RECOMMENDATION

We recommend BOEM continue to work with DOE and other Federal agencies,[xxviii] Tribal Nations, and state agencies with siting, permitting, and related consultation authorities to identify optimal transmission routing paths, based in part on transmission topologies identified in the AOSWTS to accommodate long-term offshore wind deployment goals.

For existing offshore wind leases, BOEM may evaluate existing projects' planned POIs and work with lessees to minimize footprints and/or develop corridors to use as preferred routes, where

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[xxvii] The Council on Environmental Quality's regulations for implementing the National Environmental Policy Act define mitigation as "… measures that avoid, minimize, or compensate for effects caused by a proposed action or alternatives as described in an environmental document or record of decision and that have a nexus to those effects" (40 CFR 1508.1(s)).

[xxviii] This includes coordination with the U.S. Department of Defense to identify and resolve any potential conflicts with military testing, training, or operations.

possible. For future new offshore wind leases offered at auction, BOEM could contemplate offering a potential bidding credit for use of these preferred routes. Bidders could demonstrate eligibility for this credit by committing to design offshore substations that accommodate future expansion and future meshed connections and by allowing use of their substations for this purpose. BOEM could also consider a potential bidding credit for commitment to joint development of shared transmission infrastructure where multiple leases are offered.

RECOMMENDATION

We recommend that BOEM coordinate and oversee prescreening surveys of preferred routes.

Geophysical surveys, geotechnical investigations, and assessments of marine resources could be conducted for corridors and /or routes that are identified as preferred to provide needed data for use in the review and authorization process. These data would be provided to lessees, and potential grantees, for use in BOEM review and authorization of easements and/or rights of way (ROWs). The data would encourage use of the preferred routes by lowering the cost and potentially expediting the timeline for using them.

Potential opportunities for funding the prescreening survey work include:

- Providing funding to conduct the work to offshore wind lessees that are adjacent to the preferred route
- Providing funding to the preferred-route grantee(s) to do the work in a way that allows for future expansion and use of the corridor
- Providing funding to one or more Federal entities (e.g., BOEM, DOE, NOAA, and/or the U.S. Geological Survey) to lead or support the work

These data would be provided to lessees/grantees that would share a corridor for use in BOEM's review and evaluation of easements. Inter-agency collaboration will be required to ensure alignment on the Federal preferred route (e.g., collaboration among BOEM, DOE, NOAA, DOD, U.S. Army Corps of Engineers, USCG, and state agencies, as well as ISOs/RTOs). A memorandum of understanding (MOU) could be supported by a panel that has decision-making authority to identify the preferred routes. BOEM and DOE, along with agency partners, will develop a methodology and timeline for the identification of Federal preferred routes.

Marine spatial planning is a valuable tool that should continue to be used to inform a preferred Federal route or any transmission ROW on the OCS. Partnerships between NOAA and BOEM continue to be beneficial. BOEM's work with NOAA National Centers for Coastal Ocean Science's spatial planning for offshore wind energy and the joint BOEM-NOAA Marine Cadastre authoritative data portal are two examples of important, ongoing joint initiatives.

★ ★
2024

5.1.2. FEDERAL-STATE ALIGNED OFFSHORE WIND TRANSMISSION SITING

Because offshore transmission projects are planned through Federal and state waters, there is an opportunity for Federal and state agencies to work together to implement Federal recommended routes and shared infrastructure.

RECOMMENDATION

We recommend that BOEM either leverage its intergovernmental renewable energy task forces or establish one focused on transmission siting. These task forces would convene Tribal Nations, state and local governments, and Federal agencies to discuss the siting and development of offshore wind and transmission infrastructure.

A new Transmission Siting Task Force would be supported by an MOU among participating parties and a charter establishing expectations. This task force would not be a consensus-seeking body but would allow for the sharing of information that will assist BOEM in the identification and discussion of specific proposals for offshore wind transmission development. It could also inform states' offtake agreements and ISO/RTO planning processes.

RECOMMENDATION

We recommend that DOE and BOEM evaluate opportunities to conduct and publish a detailed siting study, building on the learnings from the AOSWTS and using the principles of marine spatial planning, to share that information with states and transmission operators and further inform other BOEM marine spatial planning activities.

Those findings could be disseminated via the Federal-State Offshore Wind Implementation Partnership or multi-state collaboratives to be included in state planning efforts. Routes identified on the OCS could be further refined and vetted using marine spatial planning approaches during BOEM's grant/lease planning process.

5.1.3. BOEM COMPETITIVE RIGHT-OF-WAY GRANT ISSUANCE PROCESS FOR PREFERRED ROUTES

★ ★
2025

This recommendation expands upon Section 5.1.1 and would further allow specific routes to be designated and ensure the maximum usage of specific POIs. This approach could result in competitive interest and, ultimately, a competitive ROW grant sale, which is a regulatory mechanism that has not yet been used.[xxix] Whether or not the grant(s) would be competitive depends on the response to published requests for competitive interest (RFCIs) and the associated analysis of responses by BOEM. Buy-in from state(s) would be needed for ownership, integration, and operations because any transmission authorized on an OCS grant would inherently need to be continued through state waters and on land to the POIs that would be used. Before issuing any RFCIs, BOEM would consult with Tribal Nations, state governments, and Federal agencies with siting, permitting, and related consultation authorities to deconflict the proposed routes. The area for consideration for the routes should be broad enough to allow for specific siting following the comment period, consultations, and conditions identified by survey work.

[xxix] BOEM's regulations at § 585.308 state that where there is competitive interest, BOEM will conduct a competitive auction for issuing the ROW grant or right-of-use (RUE) grant, following the same process for leases set forth in §§ 585.211 through 585.225. To date, there has not been a competitive grant sale, so BOEM would need to identify the appropriate procedures. For example, BOEM would need to determine whether all lease blocks implicated for such a ROW grant would need to be offered in the sale if competitive interest was only triggered by a portion of a proposed route.

RECOMMENDATION

Assuming the successful identification of preferred transmission routing paths discussed in 5.1.1, we recommend that BOEM issue one or more RFCIs to solicit competitive interest in regional transmission systems that would use ROW and/or right of use and easements grants as needed.[xxx] These RFCIs could be for intra- or interregional systems in which capacity minimums and technology integration requirements are specified. These RFCIs would also include a solicitation for feedback on preferred technology standards and contractual obligations associated with the issuance of the ROW.

By issuing one or more RFCIs, BOEM promotes the identified routes as those that would be supported throughout the Federal review and authorization process. This would deter approaches where industry suggests options that may or may not meet national goals or state-specific needs. The following suggested steps may be useful for BOEM's successful implementation of an RFCI:

- Identify capacity needs for transmission routes and spatial constraints, and specify technology (e.g., HVDC) required for future expansion.
- Incorporate due diligence requirements to ensure grantee progress, including but not limited to requirements and/or associated penalties for failing to progress through BOEM's regulatory framework within a specified schedule. For example, following the issuance of a ROW grant, the grantee is permitted up to one year to submit a General Activities Plan. The deadlines for reaching a complete and sufficient designation by BOEM could be identified at issuance.
- To ensure offshore wind lessee use of independently built transmission infrastructure, BOEM has stated that it may condition Construction and Operations Plan approval for offshore wind leases on the incorporation of a planned approach to siting submarine electric transmission cables on the OCS, including options such as the use of cable corridors, regional transmission systems, meshed systems, and other mechanisms, as appropriate.
- Prioritize intraregional systems (i.e., those within the boundaries of a single Regional Transmission Organization) given that interregional systems could pose more complexities and intraregional systems could be later connected interregionally.

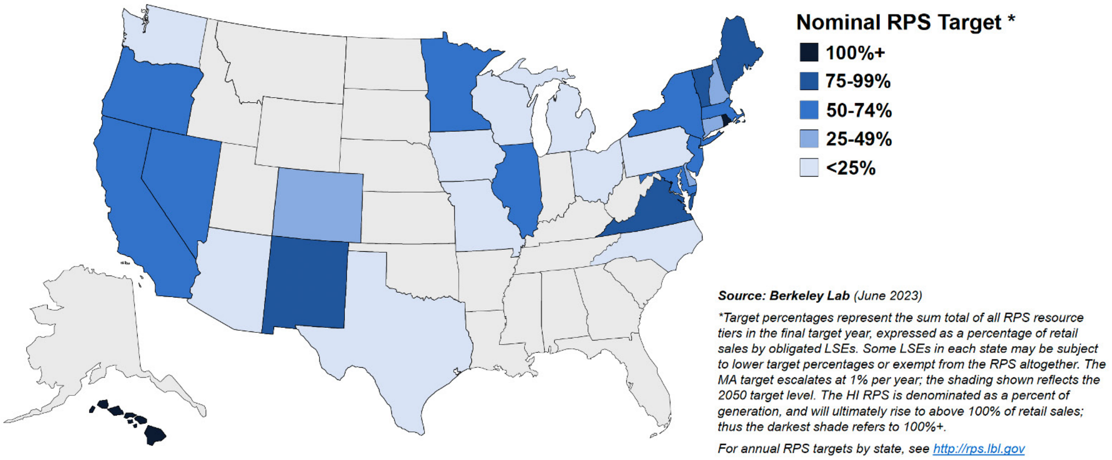
[xxx] The process for issuance of RFCIs could be further clarified through issuance of guidance or regulatory revision.

★★ 2028

5.1.4. MULTI-STATE PARTNERSHIP ON CLEAN ENERGY STANDARDS AND OFFSHORE WIND GOALS

State renewable portfolio standards (RPS) and clean energy standards are fueling the significant decarbonization of electricity on the Atlantic coast. As indicated in Figure 24, most Atlantic Coast states have some degree of RPS, though the timing and scale of the standards vary significantly by state.

Figure 24. Renewable portfolio standards status update[74]



Source: Berkeley Lab (June 2023)
Notes: Target percentages represent the sum total of all RPS resource tiers in the final target year, expressed as a percentage of retail sales by obligated load-serving entities (LSEs). Some LSEs in each state may be subject to lower target percentages or exempt from the RPS altogether. The MA target escalates at 1% per year; the shading shown reflects the 2050 target level. The HI RPS is denominated as a percent of generation, and will ultimately rise to above 100% of retail sales; thus the darkest shade refers to over 100%.
For annual RPS targets by state, see http://rps.lbl.gov

State offshore wind commitments, as summarized in Table 1, fall within these RPS and are driving a total project pipeline exceeding 50,000 MW, as estimated in the Offshore Wind Market Report 2023 Edition.[75] Given this activity and the common link to state RPS, we see additional opportunity that coordinated and cooperative transmission planning can bring to the network of offshore projects.

Along with voluntary cost allocation (see Section 4.1.1), states working with each other can further reduce transmission project costs, facilitate environmental reviews and permitting, and accelerate development timelines. State clean energy standards and offshore energy commitments can be used to incentivize states for this integrated planning instead of posing a competitive framework for offshore wind power. Such collaboration is consistent with the largely uninhibited flow of electrons across state borders. Consideration should be given to whether installed capacity is double counted toward the clean energy standards in multiple states. Some states may accept such double counting without further modification. Other states may accept double counting but then seek to raise their clean energy targets. For others, partnering states will have to arrange a sharing of the RPS credit based on pro-rata share of miles of cable laid in each state, facility construction costs incurred in each state during installation, or some other similar metric.

RECOMMENDATION

We recommend state clean energy standards and/or offshore wind goals be amended to allow for full or partial credit of the installed capacity of an offshore wind plant toward state clean energy standards when an investment in offshore wind infrastructure helps a neighboring state achieve its goals.

Transmission cable siting and landfall

Enabling the siting of cable landfall could reduce state border disputes and competition. By allowing cable landfall or approving onshore transmission within its jurisdiction, one state may enable offshore wind benefits for another state. If RPS or offshore wind credit were received by the hosting state, greater options for offshore wind interconnection would be enabled and a joint pursuit by numerous states of common goals would be more likely. These efforts could be taken up by the Offshore Wind Transmission State Collaborative described in Section 1.1.1, in accordance with Federal and state law.

Distributing financial resources to local communities

The clean energy standards or offshore wind goal credit concept is attractive because it also has equity implications. RPS credit could be tailored around impacts of electricity infrastructure on nearby communities. In place of or in addition to a state receiving partial credit toward its clean energy standards for helping a neighboring state meet its clean energy standards, that neighboring state could make investments, guided by the host state, to mitigate impacts to coastal and ocean co-use communities within the hosting state, including Tribal Nations.

RECOMMENDATION

We recommend an equitable and consistent partial credit among states so that hosting states are not at an extreme disadvantage or advantage. The structure of a consistent credit scheme could be taken up by the multi-state collaborative described in Section 1.1.1, in accordance with Federal and state law.

5.1.5. UTILIZATION OF EXISTING FEDERAL FACILITIES ALONG THE COAST

★ All

Given the immense complexity of siting transmission facilities, it may be prudent to consider the use of existing Federal facilities (and previously developed lands) to simplify the acquisition of land rights, minimize environmental and community impacts, and simplify environmental review and permitting. Coordination and partnership between governmental agencies will be key to determining and assessing suitable land for onshore infrastructure required to support offshore wind development.

RECOMMENDATION

We recommend that offshore wind developers explore the use of U.S. Department of Defense and other Federal installations (e.g., U.S. Navy bases or Coast Guard stations) along the coast for cable landfall locations. Opportunities exist to use dock facilities, laydown yards, and other existing infrastructure to support project development. A similar approach could be applied to state- and locally owned lands, including potentially using existing industrialized areas for brownfield development.

For example, Dominion Energy's Coastal Virginia Offshore Wind project off the coast of Virginia Beach has incorporated this approach in its strategy. The offshore cables will land directly at State Military Reservation (Virginia Army National Guard facility) in Virginia Beach, then proceed underground to the Naval Air Station Oceana before connecting to the existing Fentress Substation in Chesapeake.[76]

Federal sites that host offshore wind transmission facilities may be able to benefit from the installation of said facilities through (1) increased energy resilience through transmission reinforcement, (2) in-kind services for installation facilities, and (3) carbon-free electricity supply through offtake agreements. An enhanced use lease strategy may be a good candidate for structuring a partnership for use of Federal lands and facilities. DOD has pursued a strategy that includes leasing underused real property to gain additional resources for improving installation facilities for other port and energy projects. Section 2667 of Title 10, U.S. Code, provides authority to military departments to lease non-excess real property, subject to several provisions, in exchange for cash or in-kind consideration. According to the military services, some leases, referred to as enhanced use leases, are more complex with long terms and could provide hundreds of millions of dollars for in-kind services to improve installation facilities. However, consideration should be made to ensure no impact to the mission of the facility.

5.2. ENVIRONMENTAL REVIEW AND PERMITTING

The National Environmental Policy Act (NEPA) requires Federal agencies to analyze and disclose the environmental consequences of major Federal actions. In general, NEPA and its implementing regulations require various levels of environmental analysis depending on the circumstances and the type of Federal action being contemplated. States also have a role under existing Federal law in permitting offshore wind energy development, including ensuring that the projects are consistent with their plans for management of coastal zones. The environmental review and permitting process can be time-consuming for both the permitting agencies and the lessee. It is important to optimize this framework to both protect public health, safety, cultural resources, and the environment and to improve overall project timelines for future transmission buildout.

5.2.1. IMPROVED ENVIRONMENTAL REVIEW AND PERMITTING FRAMEWORKS

★ ★ ★
2030

Continued focus on the optimization of environmental review and permitting frameworks across all regulatory jurisdictions can lead to improved environmental and community outcomes, informed by early and meaningful public engagement, and guided by the best available science. Effective, efficient, and transparent processes will inform the public regarding potential impacts, while working toward the avoidance, minimization, and mitigation of these impacts.

Tribal Nations

RECOMMENDATION

We recommend that BOEM and other Federal agency partners afford Tribal Nations an appropriate status as sovereign nations and provide sufficient time for conducting document reviews and providing feedback during all phases of project development.

We further encourage that BOEM, as the lead Federal agency in the review of offshore transmission infrastructure, continue to work closely with Tribal Nations to identify potential natural, archaeological, and cultural resources and areas of historic and cultural or religious significance early on, including through Section 106 of the National Historic Preservation Act consultation and government-to government consultation.

To support this recommendation, it will be key necessary for BOEM to work with Tribal Nations to identify a point of contact within each Tribal Nation to coordinate the appropriate level of review for project design and management in phases of work on transmission projects. It may also be helpful to identify funding mechanisms to support Tribal Nation government review of project documents and ensure that they have meaningful opportunities to provide comments throughout the regulatory process are provided.

Regulatory review and permitting across jurisdictions

The development of offshore wind infrastructure is regulated, permitted, and shaped by many different entities, including Federal agencies, Tribal Nations, state and local authorities, and grid operators. To efficiently and effectively allow transmission infrastructure to develop, all parties must coordinate and align their processes and expectations. This includes project review, NEPA analysis and associated consultations, grid connection studies, and state and local requirements. We recommend establishing clarity among Federal, Tribal Nation, state, and local jurisdictions on roles and responsibilities from the outset of the regulatory process.

RECOMMENDATION

We recommend that BOEM (with the support of other Federal agency partners) continue toencourage and facilitate Tribal Nation, state agency (including state environmental and natural resource agencies and siting bodies), and local agency agreement to participate as cooperating agencies under NEPA. BOEM might seek to establish MOUs with Tribal Nations and state and local agencies that formalize the agreed-upon roles and responsibilities.

We recommend that DOE, BOEM, and the Federal Permitting Improvement Steering Council (the Permitting Council) continue to explore and implement funding mechanisms to support the capacity of often resource constrained Tribal Nations and local governments to meaningfully engage.

The FAST-41 process

Project developers have the option to submit a FAST-41 Initiation Notice[77] to the Permitting Council and BOEM to request that their project be authorized to use Title 41 of the Fixing America's Surface Transportation Act of 2015 (FAST-41) process, including the tracking of milestones on the Federal Permitting Dashboard.[78]

RECOMMENDATION

For offshore wind projects that qualify for FAST-41, we recommend that BOEM and the Permitting Council (with the support of other Federal agency partners) continue to encourage and facilitate Tribal Nations, state agencies, and local agencies to be cooperating or participating agencies in the FAST-41 process.

We recommend that funding mechanisms continue to be explored to support the capacity to meaningfully engage in the FAST-41 process.

We recommend that Federal agencies continue to expand and improve their FAST-41 implementation and compliance capabilities internally. Federal agencies and Tribal Nations can then leverage knowledge and experience gained through the FAST-41 permitting process, including insights gained through data collected on the Permitting Dashboard, to develop recommended permitting timetables for the offshore wind sector.

We recommend that the Permitting Council continually review the implementation of its authority to promote processes that are efficient and effective for other Federal agencies as well as project applicants.

Programmatic environmental impact statements

Strategic use of programmatic environmental impact statements (PEIS) can help streamline the subsequent NEPA review of specific projects that would tier off the already analyzed potential impacts, as well as improve understanding of cumulative regional impacts.

RECOMMENDATION

We recommend that BOEM continue to explore the use of programmatic (regional/multi-project) environmental impact statements for multi-jurisdictional projects to improve the environmental review process under NEPA. In July 2022, BOEM published an NOI to prepare a draft PEIS for the New York Bight Lease Areas[79] and will potentially pursue this approach for other regional lease areas.

Funding opportunities

RECOMMENDATION

We recommend that DOE continue to engage with Tribal Nations, state siting authorities, state environmental and natural resource agencies, and local governments to allow them to fully explore the use of the IRA Section 50152 Transmission Siting and Economic Development Grants program to develop permitting guidance and improve and harmonize permitting frameworks.

HOW DO WE EXPLORE AVENUES TO ALIGN TRANSMISSION PLANNING WITH OFFSHORE WIND LEASING AND PROJECT REVIEW?

In key jurisdictions in Europe, the decision-makers involved in long-term offshore wind and transmission planning, including the transmission system operators and offshore wind regulators, have aligned planning timelines and integrated these two planning processes. In the United States, transmission planning and offshore wind planning are managed by multiple decision-makers using parallel and independent timetables. Synchronizing these efforts in the United States by leveraging existing forums or establishing new coordination mechanisms among the ISOs or transmission system operators, BOEM, and state regulators would provide greater certainty in all areas of offshore wind and transmission planning, including but not limited to interconnection planning, project finance, and supply chain.

5.2.2. GUIDANCE FOR FEDERAL ENVIRONMENTAL REVIEW AND PERMITTING REQUIREMENTS AND PROCEDURES

★★ 2024

There is a need for clearer Federal guidance regarding environmental review and permitting requirements and procedures for intra- and interregional transmission solutions where no precedent exists (e.g., two different wind project developers connecting to a separate transmission asset with a third developer operating the transmission asset).

RECOMMENDATION

We recommend that BOEM, with support from DOE, develop regulatory guidance to address more complicated offshore wind transmission build-out scenarios that would involve complex interactions among lessees and grantees.

It may be helpful, for example, to establish clear guidance to enable the option of offshore transmission infrastructure development without an associated generation project or transmission solutions that connect multiple wind projects to shore. It may also be helpful to further explore the intersection (both in terms of the analyses conducted and the timing of such analyses) of offshore wind transmission planning and NEPA review.

This regulatory guidance should include consideration of the following:

- More complicated NEPA considerations, including connected actions and cumulative impacts
- Incorporation of Indigenous Traditional Ecological Knowledge into environmental and other analyses in accordance with the memorandum on Indigenous Traditional Ecological Knowledge and Federal Decision Making[79] and Indigenous Knowledge Guidance for Federal Agencies[80]
- Consensus-based technical guidance with relevant entities for lessees on the easement authority

BOEM HAS PROVIDED ADDITIONAL GUIDANCE ON THESE TOPICS:

- The identification and evaluation of alternatives conducted under NEPA[81]
- Cable spacing guidance to inform constraints and opportunities for offshore wind transmission siting[82]

5.2.3. ASSIGNMENT OF OFFSHORE CABLES AND SUBSTATIONS FOR CONTINUED USE AS SHARED INFRASTRUCTURE

★★ 2035

BOEM requires offshore wind lessees and grantees to prepare a conceptual decommissioning plan when a project is first proposed, and the Bureau of Safety and Environmental Enforcement (BSEE) requires a more detailed plan prior to the end of the lessee's/grantee's operating term when decommissioning is requested by the lessee or grantee (as early as two years prior to the expiration of the lease or as late as 90 days after expiration). As an offshore grid with shared transmission infrastructure is developed, it may be necessary for transmission infrastructure initially approved as an easement to a specific project to remain in operation beyond the life of the individual wind project for which it was constructed (i.e., the transmission infrastructure will need to not be decommissioned if its continued operation is necessary to support any connected transmission infrastructure).

BSEE’s implementing regulations at 30 CFR 285.900-913 require decommissioning of all facilities at the end of the lease’s/grant’s life unless other arrangements are approved by BSEE. Given that decommissioning would take place more than 25 years after the commercial operation date of a project, independent use of the transmission infrastructure originally approved on an easement to an offshore wind lease may subsequently become integral to a meshed system, or offshore grid. BOEM’s 2022 Supporting National Environmental Policy Act Documentation for Offshore Wind Energy Development Related to Decommissioning Offshore Wind Facilities[83] will be updated over time to reflect the evolution of the state of the science in this area. The associated BSEE regulatory requirements may be updated to clarify processes as well.

RECOMMENDATION

We recommend that BOEM and BSEE develop guidance or—if necessary—regulatory revision for the severability of requirements regarding the decommissioning of offshore wind facility infrastructure from requirements regarding decommissioning of transmission infrastructure (thereby allowing the substations and export cables to remain in use beyond the individual offshore wind lease). Options may include assignment of the easement to another entity or the conversion of the easement to an independent ROW.

To this end, it may be helpful for BOEM and BSEE to remain engaged in the international knowledge exchange agenda as the offshore wind industry matures and projects in other countries address issues associated with different lifespans of project components.

5.2.4. PERMITTING AGENCY RESOURCES AND STAFFING

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All

There continues to be growing attention to improving the environmental review and permitting process for transmission development projects in support of clean energy goals. Another equally important element to support the regulatory sector is ensuring agencies have the staff, resources, and training to review a growing number of projects. Agencies with limited resources lack the capacity to prepare, review, and approve applications, creating bottlenecks when staff cannot meet deadlines. The Brattle Group even recommends that staffing and budgets need to be increased at both the state and Federal levels to accommodate the influx of projects while overhauling compensation structures to attract and retain the professional expertise needed in making regulatory decisions.

Retaining staff is one way to maintain internal expertise and institutional memory. Providing additional resources to agencies through training and education will also help build a robust staff network equipped to prepare environmental compliance documents and navigate complex regulatory processes. Any inexperience or lack of expertise due to insufficient human capital or turnover could result in delays.

We recommend several steps to further equip agency staff to be ready for project authorization and permitting challenges.

RECOMMENDATION

We recommend that state and local agencies with regulatory authority and/or special expertise have the required resources, including staffing levels and technology, to efficiently review an increased number of projects. We encourage increased state funding for these agencies for future year budgets that fully account for their increased environmental review and permitting workload expected for offshore wind transmission development.

We recommend the consideration of funding sources to support Tribal Nation engagement and expert review of offshore wind transmission proposals, such that they may participate meaningfully in consultations on Federal decisions pertaining to the design, direction, and management of proposed transmission.

We recommend that DOE, Interior, Commerce, U.S. Army Corps of Engineers, U.S. Coast Guard, the Permitting Council, and other relevant Federal agencies be resourced adequately to engage in sustained efforts to develop and grow a pipeline of staff with relevant expertise across a variety of disciplines. As needed, agencies should review and make recommendations to Congress on their immediate and long-term Federal agency staffing needs to build a permanent Federal employee workforce with the technical expertise required to keep pace with the growth in the offshore wind sector and meet national offshore wind deployment goals while also working toward the best possible community and environmental outcomes. Incorporating fully funded permanent positions into budget requests and direct-hiring authorities could also be explored as appropriate to address critical immediate staffing needs.

AN ADDITIONAL NOTE ON STAFFING

We acknowledge that there are staffing needs across the growing offshore wind and transmission industry, including in project development, operations and maintenance, manufacturing, construction and installation, research, and training. Particular attention is given in this action plan to addressing staffing and other resources at permitting agencies because these are crucial needs to prevent bottlenecks while ensuring rigorous and thorough environmental review and permitting. See Recommendation 3.4.2, Skilled U.S. workforce development, for additional recommendations on the importance of supporting the training and hiring of a skilled and diverse offshore wind workforce.

★ 2025

5.2.5. COMMUNITY BENEFIT AGREEMENTS

Community benefit agreements (CBA) are one way to help bring local communities into sustained focus and ensure that communities impacted by infrastructure are net beneficiaries, which may positively impact the ability to site and permit transmission infrastructure within the community. CBAs between project developers and impacted communities—such as Tribal Nations, non-Tribal indigenous groups or coalitions, fishing, and other community groups or coalitions—can play a positive role in helping ensure that developers are affirmatively reaching out to communities and committing to provide benefits suited to each community's unique needs. Community coalitions can be composed of impacted stakeholder groups, including neighborhood associations, faith-based organizations, environmental groups, and labor unions.

RECOMMENDATION

We recommend the use of a CBA, signed by impacted communities and an energy project developer, that identifies community benefits that the developer agrees to provide as part of the project’s development in return for the community’s support of the project.

We recommend involvement from Tribal, state, and local leaders to help the process associated with CBA development by ensuring fairness, accuracy in information provided, and adequate outreach. CBAs can provide tangible benefits from transmission project development to local communities. They can be used to establish community development funds, promote training and/or hiring of local residents, establish percentage goals for using local suppliers, encourage the construction of new facilities, stimulate the use of green building techniques, or establish job training centers, among other benefits. The process of negotiating CBAs can be part of the exercise of communicating with and educating local communities about the opportunities and benefits associated with offshore wind development.

CBAs should not ignore communities with environmental justice concerns. These groups are necessary partners for the successful development of offshore wind along the Atlantic coast. Local leaders, along with environmental justice groups, low-income advocates, local chambers of commerce, and other community organizations can help open and maintain diverse channels of communication. Properly designed CBAs can build trust and provide benefits to developers, communities, and local governments.[xxxi]

[xxxi] DOE requires Community Benefits Plans as part of all BIL and IRA funding opportunity announcements. A CBA is not the same as a Community Benefits Plan, though a CBA is one possible outcome as part of a Community Benefits Plan. https://www.energy.gov/infrastructure/about-community-benefits-plans#:~:text=What%20is%20a%20Community%20Benefits,workforce%20availability%20for%20a%20project

APPENDIX A

ACRONYMS AND ABBREVIATIONS

AECI – Associated Electric Cooperative Inc.
AOSWTS – Atlantic Offshore Wind Transmission Study
BES – Bulk Electricity System
BIL – Bipartisan Infrastructure Law of 2021
BOEM – Bureau of Ocean Energy Management
BSEE – Bureau of Safety and Environmental Enforcement
CBA – community benefits agreement
COD – commercial operation date
DEF – Duke Energy Florida
DESC – Dominion Energy South Carolina
DLR – dynamic line rating
DMR – dedicated metallic return
DOE – U.S. Department of Energy
DOI – U.S. Department of the Interior
EERE – Office of Energy Efficiency and Renewable Energy
EIPC – Eastern Interconnection Planning Collaborative
EMF – electromagnetic fields
EO 14096 – Executive Order 14096 Revitalizing Our Nation's Commitment to Environmental Justice for All
FAST-41 – Title 41 of the Fixing America's Surface Transportation Act of 2015
FERC – Federal Energy Regulatory Commission
FOA – funding opportunity announcement
FPA – Federal Power Act
GDO – Grid Deployment Office
GETs – grid-enhancing technologies
GRIP – Grid Resilience and Innovation Partnerships
GTC – Georgia Transmission Corporation
GW – gigawatt
HVAC – high-voltage alternating current
HVDC – high-voltage direct current
Hz – hertz
I2x – Interconnection Innovation e-Xchange
IEEE – Institute of Electrical and Electronics Engineers
IOU – investor owned utility
IRA – Inflation Reduction Act of 2022
ISO – independent system operator
ISO-NE – Independent System Operator New England Inc.
JIPC – Joint ISO/RTO Planning Committee
kV – kilovolts
LGE/KU – Louisville Gas and Electric Company/Kentucky Utilities Company (LGE/KU)

MEAG – Municipal Electric Authority of Georgia
MISO – Midcontinent Independent System Operator Inc.
MOU – memorandum of understanding
MW – megawatt
MT-HVDC – multi-terminal, high-voltage direct current
MVA – megavolt amperes
NARUC – National Association of Regulatory Utility Commissioners
NASEO – National Association of State Energy Officials
NERC – North American Electric Reliability Corporation
NHPA – National Historic Preservation Act
NIETC – National Interest Electric Transmission Corridor
NEPA – National Environmental Policy Act
nm – nautical mile
NOAA – National Oceanic and Atmospheric Administration
NOI – notice of intent
NOPR – notice of proposed rulemaking
NYISO – New York Independent System Operator
NYPSC – New York Public Service Commission
OCS – outer continental shelf
OE – Office of Electricity
OEM – original equipment manufacturer
PEIS – programmatic environmental impact statement
PFC – power flow controls
PJM – PJM Interconnection LLC
POI – point of interconnection
R&D – research and development
RFCI – request for competitive interest
RFI – request for information
RFP – request for proposal
ROW – right of way
RPS – renewable portfolio standards
RTO – regional transmission organization
SAA – State Agreement Approach
SAR – standard authorization request
SEER – Synthesis of Environmental Effects Research
TRC – Technical Review Committee
TSED – Transmission Siting and Economic Development
TVA – Tennessee Valley Authority
WETO – Wind Energy Technologies Office

APPENDIX B

RELEVANT FEDERAL FUNDING OPPORTUNITIES RELATED TO OFFSHORE WIND TRANSMISSION

The following programs and opportunities are available as of the publication of this action plan. For the most up-to-date information, please refer to the following DOE websites:

Energy Efficiency and Renewable Energy Funding Opportunity Exchange[84]
Grid Deployment Office (GDO) Grid and Transmission Program Conductor[85]
Loan Programs Office[86]

A summary of relevant BIL and IRA funding programs through DOE
Search for GDO's transmission and grid resilience financing programs with the Grid and Transmission Program Conductor interactive tool and accompanying guide[87] to help find funding for individual projects. Here is a list of GDO and other DOE offices' current and upcoming opportunities:

- Transmission Programs
  - Transmission Facilitation Program (TFP): This $2.5-billion revolving fund program is to upgrade and build out new, large-scale interregional transmission lines across the nation, as well as support the connection of microgrids in Hawaii, Alaska, and U.S. territories. On October 30, 2023, DOE announced it is entering into capacity contract negotiations with three interregional transmission projects, for a combined total of $1.3 billion. *Status: GDO expects to announce future funding opportunities in spring 2024 (BIL Sec. 40106).*[88]
  - Transmission Siting and Economic Development (TSED) Grants Program: This $760-million grant program is to accelerate and strengthen the electric transmission siting and permitting process, and to support communities along new and upgraded lines. Projects could include improving the efficiency of siting and permitting, increasing stakeholder engagement, and supporting economic development in communities affected by transmission lines. *Status: Concept papers were due November 17, 2023. The deadline for full applications is April 5, 2024, at 5 p.m. ET (IRA Sec. 50152).*[89]
  - Transmission Facility Financing (TFF): This $2-billion direct loan program will finance transmission facilities that are designated to be in the national interest by the Secretary of Energy. On December 19, 2023, DOE released final guidance on designating National Interest Electric Corridors (NIETCs). After a geographic area is designated as a NIETC, transmission facilities in that geographic area will be eligible to apply for TFF funding. *Status: Program is currently under development, and more information is coming soon (IRA Sec. 50151).*[90]
  - Loan Programs Office[91] (LPO): DOE's LPO offers debt financing for large-scale (typically more than $100 million) energy-related projects in the United States. Under the Title 17 Clean Energy Financing Program, LPO can provide Federal financing for projects located in the United States that support clean energy deployment and energy infrastructure reinvestment to reduce greenhouse gas emissions and air pollution. There are $20 billion in loan authority across all Title 17 innovative clean energy technologies. First, the Innovative Clean Energy and Innovative Supply Chain projects can support transmission expansion projects and

deployment of emerging technologies like HVDC and GETs manufacturing and deployment. Second, the Energy Infrastructure Reinvestment project category is created with a total cap on loans up to $250 billion to retool, repower, repurpose, or replace energy infrastructure (including transmission) that has ceased operations. *Status: The application period is ongoing*[92] *and prospective applicants can request a pre-application consultation by emailing LPO@hq.doe.gov with the subject line containing the prospective applicant's name and 'Request for Consultation' (IRA Sec. 1706).*

- Grid Infrastructure Modernization and Improvement Programs
  - » Grid Resilience State/Tribal Formula Grant Program: With this $2.3-billion program, DOE will distribute funds in formula grants over the next five years to states, territories, and federally recognized Tribal Nations to strengthen and modernize the nation's power grid against natural disasters exacerbated by climate change. Eligible projects include utility pole management, relocation of power lines with low sag, adaptive protection technologies, or undergrounding of electrical equipment. Awardees must provide a 15% match of the Federal allocation. From FY22–FY23, DOE awarded 48 states, 53 tribes, three territories, and the District of Columbia a combined total of more than $750 million in formula grant funding. *Status: The application and allocation request period for FY24 opened in January 2024 (BIL Sec. 40101 (d)).*[93]
  - » Grid Resilience and Innovation Partnerships (GRIP) Program: This $10.5-billion program provides funding to enhance grid flexibility and improve the resilience of the electric grid against growing threats of extreme weather. In October 2023, DOE announced the first round of selections for GRIP funding, which included up to $3.5 billion in funding for 58 projects across 44 states. GRIP is divided into three distinct grant programs:
    - » Grid Resilience Utility and Industry Grants: A total of $2.5 billion in funding will be used to modernize the grid and reduce impacts from extreme weather and natural disasters. Disruptive events include wildfires, floods, hurricanes, extreme heat, extreme cold, and storms. Eligible grantees include, but are not limited to, electric grid operators, electricity storage operators, electricity generators, transmission owners or operators, distribution providers, and fuel suppliers. Of the $2.5 billion made available over the next five years, $918 million is included for FY24 and FY25. At least 50% of the project's cost share must come from the grantee, although there is an exception for small utilities (defined as entities that sell no more than 4 million MWh of electricity per year), who must match 1/3 of the Federal grant. *Status: Concept papers for the second round of GRIP funding were due on January 12, 2024, while final applications are due on April 17, 2024, at 5 p.m. ET (BIL Sec. 40101(c)).*[94]
    - » Smart Grid Grants: A total of $3 billion in funding will be used to deploy technologies that increase the flexibility, efficiency, and reliability of the power system, with a particular focus on increasing transmission system capacity; preventing system disturbances, such as wildfires; integrating renewable energy at the transmission and distribution level; and supporting the integration of electrified vehicles, buildings, and other grid devices. There is $1.08 million available for FY24 and FY25. At least 50% of the project's cost share must come from the grantee. *Status: Concept papers for the second round of GRIP funding were due on January 12, 2024, and final applications are due on April 17, 2024 (BIL Sec. 40107).*[95]
  - » Grid Innovation Program: A total of $5 billion in funding will be available to governmental entities (including states and combinations of states, Tribal Nations, local governments, and public utility commissions) to support innovative approaches to transmission, storage, and distribution infrastructure to enhance grid resilience and reliability. Projects similarly are

subjected to a 50% cost share minimum. *Status: Concept papers for the second round of GRIP funding were due on January 12, 2024, and full applications are due on April 17, 2024, at 5 p.m. ET (BIL Sec. 40103(b)).*[96]

- WETO Funding for Offshore, Land-Based, and Distributed Wind Deployment Challenges: In late December 2022, WETO released $28 million as part of BIL to support lowering costs and addressing barriers to wind energy deployment. Topic areas include improving offshore wind transmission technologies—like HVDC standardization, MT-HVDC, and curriculum development for workforce training and development in HVDC transmission deployment—and understanding the impacts of offshore wind development on communities and wildlife. *Status: Applicants must have submitted a concept paper by January 20, 2023, to be eligible to submit a full application. Full applications were due on March 27, 2023 (BIL Sec. 41007(b)(1)).*[97]

- Interregional and Offshore Wind Electricity Transmission Planning, Modeling, and Analysis: Through the IRA, DOE has up to $100 million available for interregional and offshore wind electricity transmission planning, modeling, and analysis to cover two areas of work. First, funding can be used to convene stakeholders to address interregional electricity transmission and offshore wind electricity transmission. Second, funding can be used to execute a variety of other work, including assessing clean energy integration into the electric grid, effects of increased electrification, opportunities for non-wires alternatives, energy storage and grid-enhancing technologies, the value of generator interconnection, and transmission planning process coordination and evaluation of existing rights-of-way and additional transmission corridors *(IRA Sec. 50153).*[xxxii]

- State Energy Program: Under BIL, up to $500 million is provided to state energy offices for eligible state energy program activities between FY22 and FY26. No match is required. The BIL adds a mandatory element of state energy conservation plans to support transmission and distribution planning, including support for local governments and Tribal Nations *(BIL Sec. 40109(a))*.

- Energy Improvement in Rural and Remote Areas (ERA): DOE's Office of Clean Energy Demonstrations (OCED) received $1 billion from BIL to improve resilience, reliability, and affordability of energy systems in communities across the country that have 10,000 or fewer people. Authorized purposes include siting or upgrading transmission and distribution lines, and overall cost-effectiveness of energy transmission or distribution systems. The first solicitation was in 2023, with funding going through 2026. *Status: FOA-0002970 will be announced in early 2024, whereas FOA-0003045 is under review (BIL Sec. 40103(c)).*

A summary of other relevant funding programs through DOE:

- Floating Offshore Wind Shot: This initiative is part of the Biden-Harris Administration's high-profile Energy Earthshots Initiative[98] to address critical technical challenges to reach climate goals. The Floating Offshore Wind Shot looks to drive U.S. leadership in floating offshore wind design, development, and manufacturing while seeking to reduce the cost of floating offshore wind in deep waters by more than 70% to $45 per megawatt-hour by 2035. This initiative was announced in September 2022 and may have relevant funding opportunities in the future. *Status: Concept papers to reduce costs of high-voltage, direct current transmission were due on November 14, 2023, with full applications due by February 5, 2024, at 5 p.m. ET.*[99]

[xxxii] See Public Law 117-169-Aug. 16, 2022, at https://www.congress.gov/117/plaws/publ169/PLAW-117publ169.pdf.

- Increasing Utilization and Reliability of Electric Infrastructure With Grid-Enhancing Technologies (GETs): DOE's Office of Electricity and Office and Energy Efficiency and Renewable Energy launched a funding opportunity to accelerate the development of GETs, such as dynamic line rating and power flow controllers. Funding will support technology development that improves grid reliability, optimizes electricity infrastructure in existing rights-of-way, and facilitates renewable resource interconnection and market access by improving reliability of power transfer. OE and EERE base appropriations for fiscal year 2023 are funding the GETs program for up to $6.5 million, with each award likely receiving up to $2 million. Full applications were due on June 6, 2023.[100] Find the application details at DE-FOA-0002948.[xxxiii]

- Western Area Power Administration (WAPA) Transmission Infrastructure Program: This $3.25-billion revolving loan fund combines WAPA's transmission project development experience with its borrowing authority to support work that expands and modernizes the grid. A key eligibility requirement is to have at least one terminus in the power administration's 15-state territory. *Status: Program is open for applications*[xxxiv]*. Review Project Criteria and email TIP@wapa.gov with any questions or concerns. Recommended Proposal Format and application process are online.*[101]

Relevant financial incentives outside of DOE:

- Offshore Wind Tax Credit Provisions: Of the multiple provisions related to offshore wind through the IRA, tax credits administered through the Internal Revenue Service (IRS) for project developers and manufacturers can be accessed right now. Eligible taxpayers may elect to qualify an offshore wind facility for either an electricity production tax credit (based on the kilowatt-hours produced) or an investment tax credit of up to 30% for projects that begin construction by December 31, 2024. Technology neutral investment of production credits is available for clean electricity-generating projects beginning construction after that date. Offshore wind facilities that qualify for these production or investment tax credits may also qualify for certain bonus credit amounts if additional requirements are met. There is also a production tax credit for the domestic production of eligible wind energy components, which includes blades, nacelles, towers, offshore wind foundations, and related offshore wind vessels.[102] For related offshore wind vessels, the credit is equal to 10% of the sales price of the vessel. For all other eligible wind energy components, the credit amount depends on the type of component and the total rated capacity of the completed wind turbine. *Status: The U.S. Department of Treasury and IRS released new guidance on the investment tax credit in November 2023 for offshore wind energy projects. The 60-day comment period concluded on January 22, 2024.*

[xxxiii] See FedConnect at https://www.fedconnect.net/FedConnect/default.aspx?ReturnUrl=%2ffedconnect%3fdoc%3dDE-FOA-0002948%26agency%3dDOE&doc=DE-FOA-0002948&agency=DOE.

[xxxiv] See Western Area Power Administration, Submission of the Project Proposal at https://www.wapa.gov/transmission/TIP/Documents/2021/ProjectProposal-recommended%20format_Jan2021.pdf.

APPENDIX C

OFFSHORE WIND PROCUREMENT PROJECTIONS

ESTIMATED ATLANTIC OFFSHORE WIND DEPLOYMENT BASED ON STATE GOALS AND PROCUREMENT TARGETS

State offshore wind goals and procurement activity along the Atlantic coast have grown rapidly over the last decade, incentivized by states' policies to support their renewable energy targets. Along with the Biden-Harris Administration's national offshore wind deployment goal and BOEM's growing offshore leasing activity, these policies are driving commercial investment. States are using legislation and executive orders to advance offshore wind procurement and installation targets. Table 1 captures this range of activity for nine Atlantic states, highlighting each state's offshore wind target (and whether that target is for procurement or installation), the target year, the amount of wind generation to be procured (in MW), the underlying authorities that establish each state's goal (e.g., legislation and executive order), and the year that the authority was enacted, and any open procurements currently active for offshore wind energy.

Table 1. State offshore wind procurement activity and authorities

State	Offshore arget (MW)	Goal year	Authorities	Amount procured (MW) as of 10/12/22
Maine	**3,000 MW** Installation	**2040**	An Act Regarding the Procurement of Energy from Offshore Wind Resources (2023)	**155 MW** Monhegan Wind: 11 MW, 2024 Aqua Ventus research array: 144 MW, 2026
Massachusetts	**5,600** Procurement	**2027**	An Act to Promote Energy Diversity (2016) An Act to Advance Clean Energy (2018) An Act Creating Next Generation roadmap for Massachusetts Climate Policy (2021) An Act Driving Clean Energy and Offshore Wind (2022)	**3,241 MW**[xxxv] Vineyard Wind 1: 800 MW, 2023 Mayflower Wind: 804 MW, 2025 Commonwealth Wind: 1,232 MW, 2027 Mayflower Wind Residual: 405 MW, 2027

[xxxv] An RFP was open through January 31, 2024, to procure up to 3,600 MW in aggregate of additional offshore wind capacity for Massachusetts.

State	Offshore arget (MW)	Goal year	Authorities	Amount procured (MW) as of 10/12/22
Rhode Island	**1,030** (Procurement)	–	Affordable Clean Energy Security Act (2022)	**430 MW**[xxxvi] Block Island Wind Farm: 30 MW, 2016 Revolution Wind: 400 MW, 2025
Connecticut	**2,000** Procurement	**2030**	An Act Concerning the Procurement of Energy Derived from Offshore Wind (2019)	**1,104 MW**[xxxvii] Revolution Wind: 304 MW, 2025 Park City Wind: 800 MW, 2025
New York	**9,000** Installation	**2035**	Climate Leadership and Community Protection Act (2019)	**8,494 MW**[xxxviii] South Fork Wind: 132 MW, 2023 Empire Wind 1: 816 MW, 2027 Empire Wind 2: 1,260 MW, 2028 Sunrise Wind: 924 MW, 2025 Beacon Wind: 1,230 MW, 2028
New Jersey	**11,000** Installation	**2040**	Offshore Economic Development Act (2010) Executive Order 8/ AB 3723 (2018) Executive Order 92 (2019) Executive Order 307 (2022)	**3,758 MW** Ocean Wind 1: 1,100 MW, 2024 Ocean Wind 2: 1,148MW, 2028 Atlantic Shores Offshore Wind; 1,510MW, 2026
Maryland	**8,500** Installation	**2031**	Clean Energy Jobs Act (2019) Promoting Offshore Wind Energy Resources Act (2023) Promoting Offshore Wind Energy Resources Act	**2,023 MW** Skipjack 1 & 2: 966 MW, 2026 MarWin: 248MW, 2025 Momentum Wind – 808.5MW- 2026
Virginia	**5,200** Installation	**2034**	Virginia Clean Economy Act (2021)	**2,600 MW** CVOW Pilot: 12 MW, 2020 CVOW Commercial: 2588 MW, 2027
North Carolina	**2,800 MW** **8,000 MW** Installation	**2030** **2040**	Executive Order 218 (2021)	–

[xxxvi] An RFP was open through January 31, 2024, to procure up to 1,200 MW in aggregate of additional offshore wind capacity for Rhode Island.
[xxxvii] An RFP was open through January 31, 2024, to procure up to 2,000 MW in aggregate of additional offshore wind capacity for Connecticut.
[xxxviii] An RFP was open through January 25, 2024, to procure power from individual projects between 800 – 1,400 MW for New York.

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ACTION PLAN DEVELOPED BY:

GDO
GRID DEPLOYMENT OFFICE

U.S. DEPARTMENT OF
ENERGY
Energy Efficiency &
Renewable Energy

BOEM
Bureau of Ocean Energy
Management