The Benefit and Urgency of Planned Offshore Transmission:

Reducing the Costs of and Barriers to Achieving U.S. Clean Energy Goals

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Executive Summary

There is an urgent need to plan the transmission grid necessary for achieving America's increasingly ambitious offshore wind (OSW) and clean energy goals. Proactive and holistic planning for long-term transmission needs offers significant benefits, but unless these planning efforts are started *now*, more attractive near-term transmission solutions will not be identified and the most effective long-term grid development pathways may be foreclosed.

While the most ambitious state and federal clean energy goals will not have to be attained until 2040 or 2050, we project that starting proactive planning for these long-term offshore wind generation needs *now* likely will save U.S. consumers at least $20 billion and reduce environmental and community impacts by 50%. Doing so will also support the timely achievement of policy goals, increase reliability, lower development and investment risks, increase energy independence, and improve climate resilience.

To achieve these benefits, state and federal policymakers, industry regulators, system operators, and market participants must expeditiously address several well-documented challenges. As shown in this analysis, even modest delays in developing and implementing actionable plans for both near- and long-term transmission investments substantially reduces the benefits of such planning efforts.

This report—funded by the Natural Resources Defense Council (NRDC), GridLab, the Clean Air Task Force (CATF), the American Clean Power Association (ACP), and the American Council on Renewable Energy (ACORE)—first lays out in Section I the urgent case for proactively and holistically planning transmission solutions for the nation's increasingly ambitious offshore wind goals. Section II reviews existing studies that document the benefits of proactive planning and quantifies the economic, environmental, and reliability benefits offered by carefully planned offshore wind transmission solutions. Section III summarizes barriers that currently prevent the realization of these benefits. Section IV recommends specific steps that states, grid operators, the federal administration and key federal agencies, and industry stakeholders need to take to create a pathway for no-regrets grid solutions that allows achieving near- and long-term offshore wind goals in a more cost-effective and timely manner. Section V summarizes available federal support for these initiatives—including through the Inflation Reduction Act (IRA), the Infrastructure Investment and Jobs Act (IIJA, which includes the new Transmission Facilitation Program), and U.S Department of Energy (DOE) appropriations—although more dedicated federal funding would likely be necessary to make interregional offshore wind transmission a reality. The remainder of this executive summary briefly discusses each of these points.

THE AMOUNT OF OSW GENERATION THAT NEEDS TO BE INTEGRATED INTO THE GRID

Increasingly ambitious federal and state clean energy goals require comprehensive, coordinated planning for OSW generation. While the most urgent transmission solutions address OSW goals of the next decade, a least-regrets development of these near-term solutions also requires the consideration of long-term goals. Developing transmission plans that are cost-effective in the near-term while creating attractive pathways for addressing long-term goals must start with a clear understanding of both near-term and long-term offshore wind goals.

While most current grid planning is still focused only on meeting state procurements and the federal administration OSW goal of 30 gigawatts (GW) by 2030, the OSW procurements and goals of 11 coastal U.S. states exceed 50 GW through 2035 and reach 77 GW by 2045, as shown in Table ES-1 and illustrated in Figure ES-1.

TABLE ES-1: OFFSHORE WIND PROCUREMENTS, GOALS, AND LONG-TERM NEEDS

State	Already Procured (GW)	Current Goals		Projected 2050 Needs (GW)
		(GW)	Year	
Massachusetts	3.2	5.6	2027	23
Connecticut	1.2	2	2030	9-11
Rhode Island	0.4	1-1.4	2035	5
Maine	0.01			5
New York	4.4	9	2035	14-25
New Jersey	3.8	11	2040	11-26
Maryland	2	2	2030	2
Virginia	2.7	5.2	2034	20-30
North Carolina		8	2040	7-10
South Carolina				
Louisiana		5	2035	5
California		25	2045	25
Washington				4-10
Oregon		3	2030	20
State Total	**17.6**	**77**		**150-197**
U.S. Goal/Need		**110**	**2050**	**220-460**

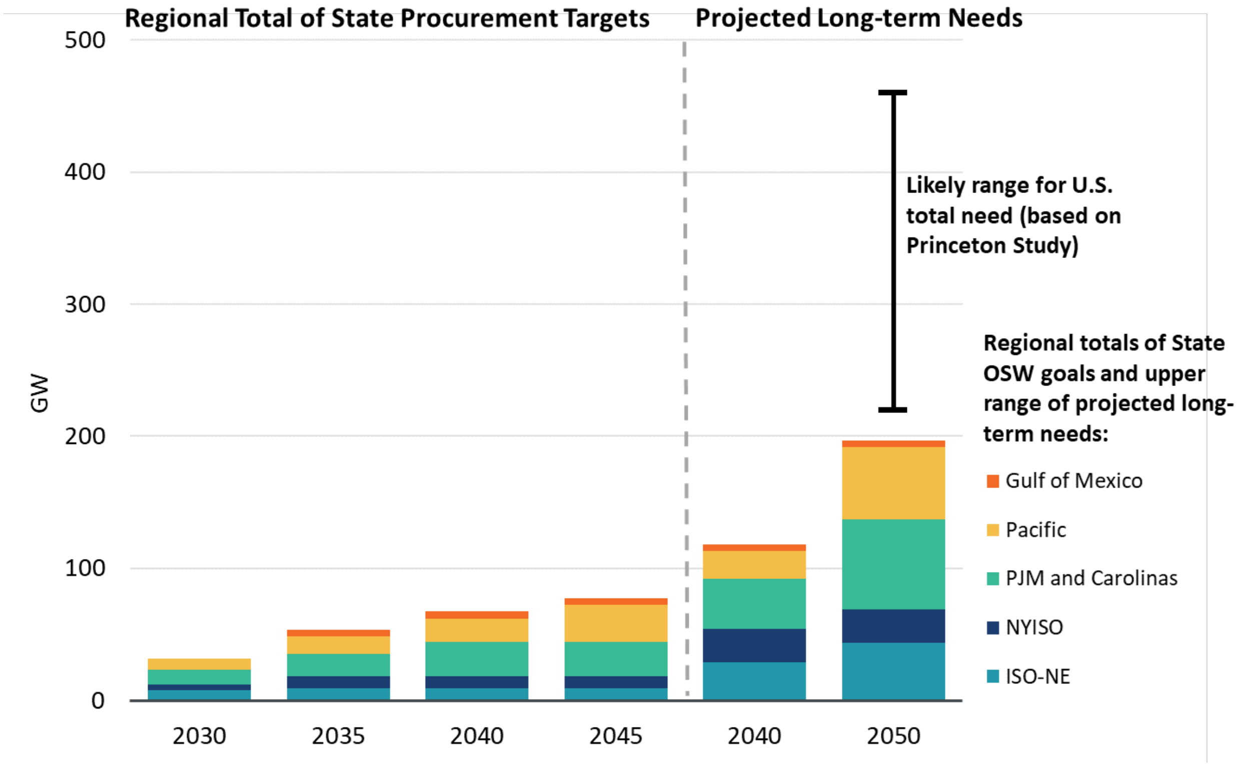
Source: Appendix A.

As Table ES-1 and Figure ES-1 further summarize, state-specific studies of clean energy and decarbonization needs show that close to 200 GW of OSW generation may be required by 2050 to meet the total of state-specific needs in the U.S. While the federal administration's 2050 OSW target is 110 GW, some nationwide analyses (such as Princeton's "Net Zero America" study) project that substantially more OSW will be required to cost-effectively decarbonize the U.S. economy by 2050.

The generation output of most of these OSW projects developed in the Atlantic, Pacific, and the Gulf of Mexico—including floating turbines in deep-water lease areas in the Gulf of Maine and off the Pacific coast—will have to be delivered to the onshore grid and to electricity customers in population centers, recognizing that some may be used to produce hydrogen. Doing so will require a large number of submarine cables buried in the ocean floor, beach crossings, points of interconnection (POIs) to the existing grid, upgrades to the onshore grid near those POIs, and additional transmission to reach various load centers.

To achieve this grid expansion cost effectively requires improved and well-coordinated generation interconnection and transmission planning processes by the regional independent transmission system operators (ISOs). On the East Coast, where OSW development is the most advanced, these system operators are ISO New England (ISO-NE), New York ISO (NYISO), and PJM Interconnection (PJM, which covers the coastline from New Jersey to North Carolina).

FIGURE ES-1: REGIONAL OFFSHORE WIND PROCUREMENT TARGETS AND LONG-TERM NEEDS



As shown in Figure ES-1 above, the existing state OSW goals and projected long-term needs quickly increase beyond near-term grid interconnection requirements. **Through 2050, NYISO likely needs transmission to interconnect up to 25 GW of OSW, ISO-NE may need to interconnect up to 40 GW, and PJM and the Carolinas up to 70 GW**. System operators along the **West Coast may have to develop transmission solutions to interconnect 55 GW** of floating OSW generation.

Given this rapid acceleration of OSW generation, proactive planning of both near-term and long-term transmission needs is essential to create cost-effective options for interconnecting the large amount of OSW generation—along with integrating the necessary land-based clean-energy resources and mitigating any environmental and community impacts from the construction of the necessary onshore and offshore transmission facilities.

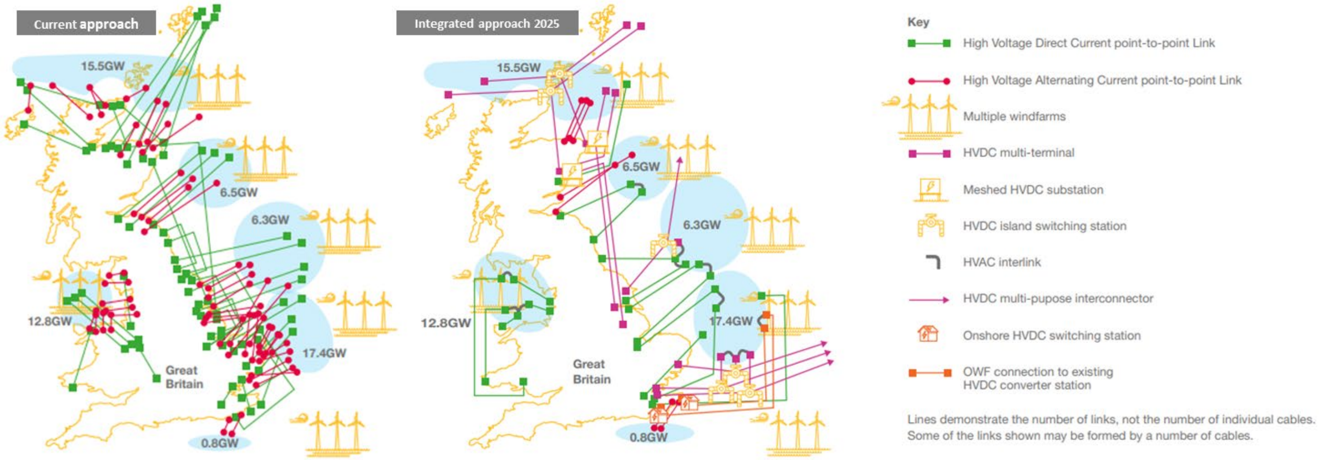
THE BENEFITS OF PROACTIVE OSW TRANSMISSION PLANNING

Starting to plan *today* for the transmission infrastructure development pathway that can integrate this amount of offshore wind generation, and do so cost-effectively over time, will achieve significant economic, environmental, and social benefits. These benefits have been well documented by a wide range of studies and planning efforts. For example:

- A nation-wide study conducted for National Grid UK found that proactively planned offshore and onshore grid investments for approximately 60 GW of OSW generation in the United Kingdom added between 2025 and 2050 would: (1) reduce overall transmission costs by 19% (approximately $7.4 billion); (2) reduce the miles of transmission cables installed in the ocean floor by 35%; (3) reduce onshore transmission line miles by 60%; and (4) reduce the number of beach crossings by 70%. Importantly, the study found that delaying the implementation of a planned solution by only five years (by beginning to address 2050 needs starting in 2030 instead of 2025) would reduce the benefits of a planned 2050 solution by about half. The study's results for 2030 and 2050 are illustrated in Figure ES-2 below. While similar U.S. studies are still ongoing, the insights from the U.K. are directly applicable to the U.S. and consistent with initial U.S. OSW experience to date.
- For example, New Jersey's recently concluded proactive planning effort with PJM for interconnecting an incremental 6.4 GW of OSW generation resulted in cost savings of over $900 million (a 13% reduction of total OSW transmission-related costs) by reducing the cost of upgrades to the existing onshore grid by approximately two thirds. Doing so also reduced interconnection-related risks, created a more competitive environment for future offshore wind procurements, and mitigated environmental and community impacts by consolidating

the number of additional onshore transmission corridors needed from three to one. This was the case even though New Jersey's selected solution focused almost entirely on the *onshore* transmission needs to integrate OSW generation. If the scope of the planning effort had been broader than just for offshore wind and only for New Jersey, the benefits would have been even larger.

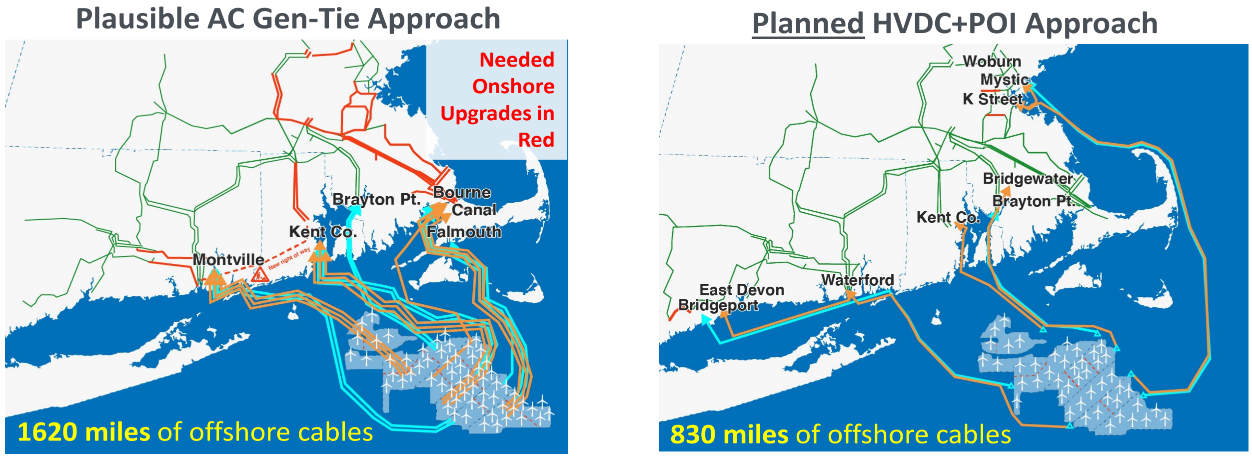
FIGURE ES-2: UNPLANNED VS. PLANNED TRANSMISSION FOR U.K. OFFSHORE WIND IN 2050
(Assuming planning efforts start to be effective by 2025)



Source: National Grid ESO, *Offshore Coordination Phase 1 Report*, December 2020.

- Similarly, two studies by The Brattle Group for Anbaric (an independent transmission developer) found that proactive planning of offshore wind transmission solutions significantly reduces both costs (*e.g.*, by $0.5 billion for an additional 3.6 GW of OSW in New England) and environmental impacts (*e.g.*, reducing the ocean cable miles installed by approximately 50% for an additional 8 GW of OSW, as illustrated in Figure ES-3 below).

FIGURE ES-3: UNPLANNED VS. PLANNED TRANSMISSION FOR NEW ENGLAND OSW



Source: J. Pfeifenberger, S. Newell, W. Graf, The Brattle Group, *Offshore Transmission in New England: The Benefits of a Better-Planned Grid*, May 2020.

- A preliminary study by PJM evaluating the grid upgrades necessary to interconnect 15 GW of OSW generation along with 60 GW of land-based renewable resources also shows the benefits of this type of proactive planning when applied to address the entire region's clean-energy and reliability needs: it would reduce the cost of necessary upgrades to the existing grid by over 80% compared to PJM's existing generation interconnection process.
- Recently completed joint interconnection and long-term transmission planning efforts for onshore renewables by system operators in the Midwestern U.S.—the Midcontinent ISO (MISO) and Southwest Power Pool (SPP)—similarly show that proactive transmission planning can reduce interconnection-related transmission costs by over 50% and provide significant reliability and other grid-wide benefits that reduce total costs.
- A timelier, more cost-effective, and risk-mitigated development of OSW generation through improved transmission planning facilitates significant state and regional employment and economic benefits. Several studies [1][2][3] estimate that approximately 80,000 full-time jobs would be stimulated by the approximately 30,000 MW of OSW construction planned through 2030.

Extrapolating from the consistent set of findings from these studies, and conservatively assuming at least 100 GW of offshore wind generation additions by 2050 (beyond already-ongoing procurements), the U.S.-wide benefits of starting proactive planning efforts for offshore transmission *now* are projected to:

- Lead to at least $20 billion in transmission-related cost savings;
- Result in 60–70% fewer shore crossings and necessary onshore transmission upgrades;
- Reduce marine transmission cable installations on the ocean floor by 50% or approximately 2,000 miles; and
- Significantly accelerate achievement of offshore wind deployment timelines by eliminating transmission-related delays, reducing project-development and cost-escalation risks, reducing community impacts, achieving more competitive procurement outcomes, and facilitating investments in the local clean energy economy.

Planning studies by DNV, PowerGEM, and WSP for NYSERDA further found that networked HVDC offshore transmission grids can deliver significant operational benefits. Going forward, OSW generation should consequently be procured with offshore facilities that are based on a **standardized, modular design** such that can interconnect with a "meshed" or "networked" offshore grid as part of a holistic grid planning process. Achieving such a **networked offshore transmission** system would further:

- Improve the reliability and value of offshore wind generation deliveries;
- Allow for the utilization of new, higher-capacity transmission cables (each able to deliver 2–2.6 GW of offshore wind generation), which further reduces costs and impacts to communities and the environment;
- Improve the utilization and flexibility of the offshore transmission infrastructure;
- Reinforce, avoid upgrades of, and support the existing regional onshore grids, which will improve grid-wide resilience and reduce future congestion costs; and
- Offer unique, cost-effective opportunities to create valuable new transmission links between regions, including addressing system transmission constraints into New York City and New England that reduce system-wide cost and increase interregional grid reliability and resilience.

As summarized in this report, numerous regional and national studies confirm that expanding regional and interregional transmission capabilities offer substantial benefits that increase grid resilience, reduce system-wide costs, and mitigate increases in electricity rates as the U.S. transitions to a more decarbonized electric sector by 2035 and—as called for by state policies and the federal administration—aims to achieve a substantially decarbonized economy by 2050. If planned proactively and holistically, multi-purpose transmission links between OSW facilities can offer the lowest-cost, lowest-impact, and most feasible solutions for adding such regional and interregional transfer capabilities to the existing grid.

THE URGENCY OF STARTING LONG-TERM TRANSMISSION PLANNING FOR OSW NOW

While the nation's mid-century offshore wind goals may appear quite distant, proactive and coordinated planning **efforts must begin immediately to fully realize these planning-related benefits**. Actions taken in the next several years will not only impact the cost and environmental footprint of achieving OSW generation goals for the next decade, but will also pre-determine to a significant extent what is (or is not) possible by 2050.

There are several reasons why it is so urgent to initiate regional and interregional planning for both near-term OSW goals and to create a least-regrets pathway for addressing long-term OSW transmission needs:

- **Long developing timelines**: Transmission facilities for offshore wind will take at least a decade to plan, permit, and construct. This timeline is worsened by supply chain bottlenecks, which necessitate that equipment (such as submarine transmission cables, transformers, and highly specialize installation vessels) be ordered years in advance of installation. As a result, any planning steps taken today are unlikely to yield significant new transmission infrastructure until the early 2030s.

- **Effective use of limited corridors and interconnection points**: The type and location of transmission facilities built to address 2030 or 2035 offshore generation needs will, in turn, directly impact the type and location of transmission facilities that can be built to meet 2040 and 2050 needs. As states continue to procure OSW resources that rely on single-project, radial delivery facilities, the lowest-cost corridors and interconnection points will be utilized first, making it increasingly costly and challenging to find more attractive long-term solutions and reduce environmental community impacts for the substantial OSW additions needed to achieve long-term goals. Both near- and long-term needs have to be considered to specify least-regrets grid expansion pathways that can lead us to more attractive long-term planning outcomes.
- **Technology compatibility**: Unless existing regional transmission planning processes are improved and compatible technology standards are developed *now*, a combination of poor planning and continued reliance on incompatible technologies will make it nearly impossible to realize efficiently integrated regional and interregional grid solutions in the future.
- **Federal support**: Finally, through the Infrastructure Investment and Jobs Act (IIJA) and the Inflation Reduction Act (IRA), the federal government is currently offering support and tax credits to lower costs, address planning, and facilitate contracting for state and nationwide clean-energy needs, including regional and interregional transmission. Some of this support funds may not be available if planning efforts are delayed.

Importantly, as is well documented, identifying the most attractive long-term solutions requires the development of more proactive planning processes that simultaneously consider the full set of transmission needs (*i.e.*, reliability, congestion relief, public policy, and generation interconnection needs) over a long-term planning horizon (*i.e.*, through 2040 or 2050 to consider already-known policy needs). Focusing only on near-term transmission needs and addressing them incrementally will not yield cost-effective solutions in the longer-term.

BARRIERS TO COST-EFFECTIVE, LEAST-REGRETS OFFSHORE WIND TRANSMISSION

The timely development of cost-effective and least-regrets long-term transmission solutions that integrate offshore wind generation holistically in coordination with onshore grid planning faces several distinct challenges. These challenges can be addressed expeditiously and collaboratively as reflected in the recommendations below.

- **Inadequate generation interconnection processes:** The slow, costly, reactive, and incremental generator interconnection processes currently used by regional grid operators are not suitable for optimizing grid interconnection points for the timely and cost-effective integration of renewable generation, including the 30 GW of offshore generation that states will soon have procured to meet their clean energy policy goals over this next decade.
- **Uncertain tax credits**: There is significant uncertainty over the extent to which the availability of federal investment tax credits for offshore wind generators' "wind energy property" applies to the cables and interconnection facilities that deliver the generation to shore and the extent to which these credits are available for such facilities if they are shared by multiple OSW generators or owned by third parties.
- **Siloed transmission planning**: Many existing transmission planning processes do not yet proactively consider long-term public policy needs, nor do so holistically in combination with other transmission needs. Rather, regional grid planning is typically siloed into specific project categories that fail to simultaneously optimize the broad range of reliability, economic, and public policy benefits that can be provided by holistically-planned transmission investments that lower system-wide costs and mitigate increases in customer rates.
- **No effective interregional planning**: The grid planning challenge is even more severe for interregional transmission as these needs are not well defined and no effective interregional transmission planning processes currently exist.
- **HVDC technology integration challenges**: HVDC transmission technology is becoming critical to achieving cost-effective and less environmentally impactful OSW transmission solutions. Yet, the relatively slow adoption and operational integration of advanced HVDC technology in the U.S. creates its own set of unique challenges: (a) the functional requirements of HVDC grids, optimal voltage levels, and transfer capabilities are not yet standardized; (b) equipment from different vendors is not yet compatible or otherwise standardized; (c) critical grid elements (such as DC circuit breakers) are not yet widely commercially available for offshore applications; (d) the large capacity of new HVDC technologies also exceed what many system operators currently view as an acceptable "most severe single contingency (MSSC)"; and (e) the capabilities of advanced technologies—such as voltage support, black-start, fast power-flow control, means to address MSCC concerns, and system-stabilization capability of advanced HVDC converters—are not yet typically accounted for or accepted as solutions in transmission planning.
- **Uncertain offshore network designs**: The optimal choices for technology, grid topology, and cost-effective design of "meshed" or "backbone" offshore grids are still uncertain. While

some studies are underway, detailed benefit-cost cases are not yet available for specific offshore grid designs in the U.S., nor for designs that will likely develop over the coming decades.

- **Regulations and contracts:** The regulatory and contractual frameworks for the shared and networked operation and use of offshore transmission facilities (including procurement method, structure, evaluation criteria, cost allocation, and the inherent tension between open access provisions and priority interconnection rights) are not yet established.
- **Grid operations:** With infrequent exceptions, regional grid operators are not yet equipped to optimize the operations of a regional or interregional offshore grid to take full advantage of networked offshore transmission from a reliability operations and wholesale markets perspective. Transmission tariffs under the jurisdiction of the Federal Energy Regulatory Commission (FERC) do not yet satisfactorily address coordinated operation of existing interregional transmission, which would also make it difficult to capture the full value of new interregional facilities.
- **BOEM transmission permitting**: The Bureau of Ocean Energy Management (BOEM) does not currently have a well-defined or broadly understood maritime spatial planning and permitting process for offshore transmission that is distinct from offshore wind generators' individual interconnection cables. The project-by-project approach to OSW transmission is driven in part by BOEM's regulations, which bundle permitting for radial transmission lines as an easement right associated with the permitting of offshore wind generation in individual wind lease areas. Additionally, BOEM has not clarified how the presence of third-party offshore transmission would affect the right of adjacent leaseholders to utilize their own radial lines if at all.
- **Disjointed lease, procurement, and planning processes**: The processes of lease area auctions, state procurement of OSW generation, and regional transmission planning are siloed and lack coordination. When OSW developers purchase offshore leases that can serve more than one RTO/ISO, it is often uncertain which region they will be connecting into and where the specific points of interconnection might be. When states issue solicitations for OSW generation, they do not know which lease area will serve them (although, realistically, only a few generators with nearby lease areas can effectively compete in those solicitations). And transmission planners attempting to pre-build an offshore grid to address some states' clean energy needs do not know which lease or call areas to target. This separation of leasing, procurement, and planning is inefficient and time consuming because it: (1) creates delays since neither OSW generators nor transmission developers can start planning and permitting the offshore transmission until they know which region they will be

serving as determined by the outcomes of state procurements; (2) challenges the planning and development of efficient transmission solutions, adding costs to any prebuilt transmission since any chosen location of offshore collector stations may turn out to be suboptimal and lead to duplicative offshore substations; (3) can reduce competition in OSW generation procurements since only a limited number of entities with nearby leases can compete; and (4) creates additional barriers for shared offshore transmission.

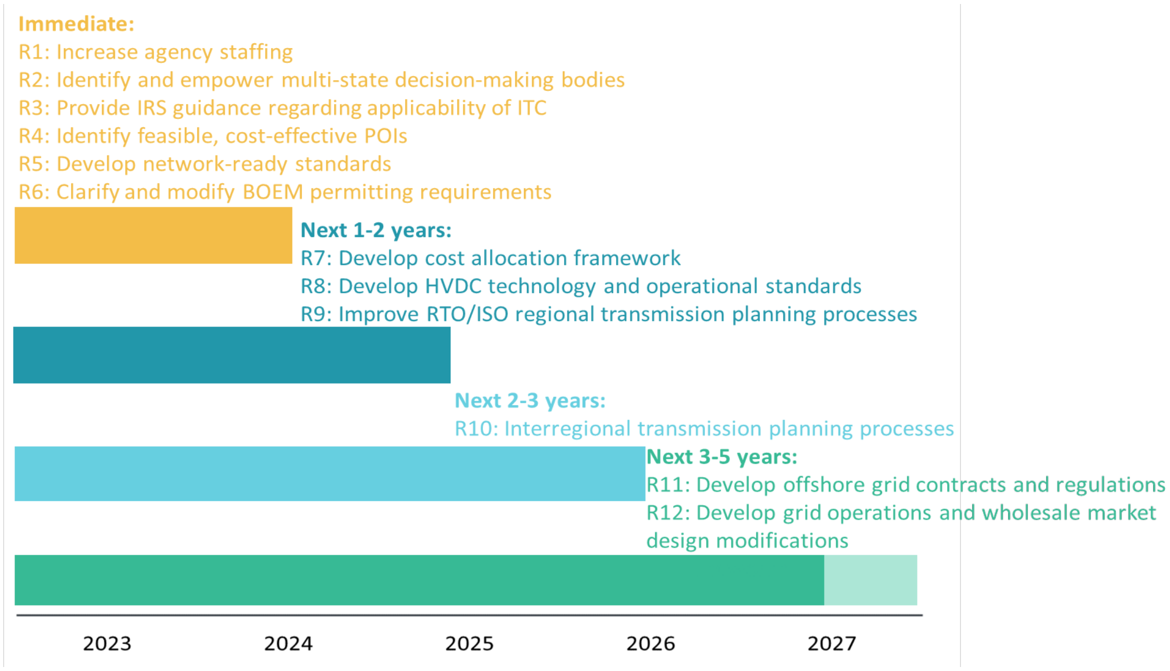
RECOMMENDATIONS FOR ACHIEVING COST-EFFECTIVE REGIONAL AND INTERREGIONAL TRANSMISSION SOLUTIONS WHILE INTEGRATING STATES' ONGOING OFFSHORE WIND PROCUREMENT EFFORTS

We recommend that state and federal policymakers and regulators, federal agencies, regional grid operators, and market participants expeditiously collaborate on the following initiatives to address the challenges discussed above. As summarized in Figure ES-4 below, these recommendations have been grouped into the following four categories:

- **Immediate (this year)**: actions to ensure some of the identified challenges can be addressed expeditiously in states' OSW generation procurements;
- **Near-term (over the next 1–2 years):** actions to ensure that holistic planning of offshore transmission networks can start at the regional grid operator level;
- **Mid-term (over the next 2–3 years):** actions to enable effective interregional transmission planning processes between existing grid operators; and
- **Longer-term (over the next 3–5 years):** actions to develop the necessary grid operations, wholesale market, regulatory, and contractual frameworks, which need to be in place before networked offshore facilities are placed into service.

Brief summaries of each of these recommendations are provided below, including an identification of the relevant entities that should be involved in implementing the recommended actions—many of which can be supported with available federal support and funding.

FIGURE ES-4: TIMELINE OF RECOMMENDATIONS



IMMEDIATE ACTIONS (this year)

1. **Increase staffing at state and federal regulatory agencies involved in OSW planning**: Increased staffing and budgets will be necessary for state and federal regulatory agencies involved in planning for evolving OSW and other clean energy needs to enhance their capabilities to develop, evaluate, and utilize the updated regulatory frameworks necessary to reliably integrate these new facilities in a timely, cost-effective manner while mitigating environmental and community impacts.
   Relevant entities: state governors or senior policymakers, federal policymakers
2. **Create and empower multi-state decision-making entities**: Multi-state entities should be created that are authorized to facilitate planning and procuring of effective regional and interregional transmission solutions to integrate the clean energy resources, including offshore wind, needed over the 2030–2050 timeframe. A multi-state "transmission authority" modeled after the Regional Greenhouse Gas Initiative (RGGI) is one potential option. Governors of adjacent states should immediately begin collaborating to develop a declaration of shared goals for offshore wind transmission and interconnection, create a task force of state agencies to address those goals, and provide dedicated funding. The multi-state task force should then develop a Memorandum of Understanding (MOU) signed by state agencies with specific state goals and a framework for making decisions. This task force would start the work of implementation the recommendations below and identify

what states will need from the regional grid operators, DOE, BOEM, and FERC to accomplish those goals.
Relevant entities: state governors or senior policymakers and state regulatory agencies with support of grid operators, DOE, FERC, BOEM, industry stakeholders, possibly with PMAs

3. **Provide IRS guidance regarding applicability of ITC**: Within the next 90 days, the Internal Revenue Service (IRS) should provide guidance to confirm the applicability of the investment tax credit (ITC) to offshore wind-related interconnection facilities owned by either generators or third parties.
Relevant entities: IRS

4. **Identify feasible, cost-effective POIs**: In collaboration with grid operators and transmission owners, states should immediately begin efforts to proactively identify feasible, cost-effective, and future-proof points of interconnections to the existing grid. POIs should be planned with the necessary transmission corridors and onshore upgrades for all generation interconnection needs associated with existing state OSW and other clean energy goals within each planning region (*e.g.*, initiate efforts similar to New Jersey's recent offshore wind transmission procurement with PJM at full regional scale). These POIs will be needed for both the interconnection of OSW generation with radial export cables and any unbundled networked offshore transmission facilities. POIs for near-term OSW interconnection needs should be selected within a least-regrets pathway to meet likely future OSW transmission needs. Interconnection rights to the specific POIs should be made available to state-procured OSW generation and/or unbundled offshore transmission through a fast-track (*i.e.*, first-ready/first-served) interconnection process.
Relevant entities: states, multi-state entities, DOE, grid operators, FERC

5. **Develop network-ready offshore facility standards:** States and grid operators should immediately develop and implement "network-ready" standards for modular offshore substations and export cables that ensure physical and functional compatibility and expandability of offshore transmission infrastructure. This will enable states to require such network-ready capabilities in all of their upcoming OSW transmission and generation procurements, so that any export links built today can to be integrated into a planned offshore network in the future.
Relevant entities: DOE, states, grid operators with input from OSW generation and transmission developers

6. **Clarify and modify BOEM transmission permitting and lease-process coordination**: BOEM should clarify and modify transmission permitting to add specificity to the permitting process for third-party offshore cable routes between lease areas and to the pre-specified

interconnection points on the existing grid. In addition, DOE, with BOEM, should explore—and evaluate for possible federal legislative action—more effective alternatives to the existing auction, lease, and permitting processes to align them better with state OSW generation procurements.
Relevant entities: BOEM, DOE, OSW transmission developers

NEAR-TERM ACTIONS (1–2 years)

7. **Develop cost-allocation framework**: States should develop an actionable cost allocation framework that covers their OSW commitments within each region. The framework should clearly identify which costs and benefits should be considered, how they should be quantified and monetized to inform cost allocation. Without being formulaically based on quantified benefits, the costs of OSW-related transmission facilities should be allocated in a fair and transparent way that is roughly commensurate with their benefits (*e.g.*, in proportion to their OSW and/or other clean-energy needs).
   Relevant entities: state regulatory agencies, grid operators, FERC
8. **Develop HVDC-technology and operational standards**: A full set of HVDC-technology and operational standards should be developed—beyond network-ready requirements, and in coordination with similar efforts in Europe and elsewhere—to ensure vendor compatibility in offshore transmission procurements and allow for a "future proof" evolution of an offshore transmission network capable of meeting long-term state, regional, and interregional needs.
   Relevant entities: DOE, grid operators, states
9. **Improve regional transmission planning and interconnection processes**: Ongoing efforts to improve transmission planning processes should be continued in coordination with improving generation interconnection processes to address onshore and offshore renewable generation grid integration needs more proactively and from a long-term, multi-value planning perspective that considers the broad range of benefits offered by well-designed transmission networks.
   Relevant entities: FERC, grid operators

MID-TERM ACTIONS (2–3 years)

10. **Improve interregional transmission planning**: It is critical to create effective interregional transmission planning processes with the requisite cost allocation agreements able to identify the needs and approve the investment necessary to capture well-documented benefits of expanded interregional transmission—increased grid resilience, lower system-wide costs, taking advantage of load and resource diversity. The planning processes should

be able to identify where offshore transmission links between regions may be the most feasible and cost-effective way to address the identified (multi-driver/multi-value) interregional needs.
Relevant entities: FERC, grid operators, multi-state entities with input from market participants

LONGER TERM ACTIONS (3–5 years)

11. **Develop offshore grid contracts and regulations**: Before networked offshore facilities are placed in service, offshore grid contracts and regulations—such as shared use/ownership agreements, transmission rights, open access agreements and regulations, liability and decommissioning provisions, cost allocations for shared and networked offshore facilities across multiple POIs—will have to be developed to support the evolving OSW industry and enable a transition from using radial lines to meshed radial lines and (ultimately) fully networked regional and interregional grid solutions.
    Relevant entities: DOE, FERC, states, multi-state entities, grid operators, with input from OSW generation and transmission developers
12. **Develop grid operations and wholesale market design modifications**: Develop recommendations for grid operations and wholesale market design modifications that allow for the regional and interregional optimization of offshore-wind-related transmission including the unique capabilities of HVDC links within and across regions.
    Relevant entities: DOE, FERC, grid operators, transmission owners

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AVAILABLE FEDERAL SUPPORT

As discussed in Section V of this report, substantial technical, regulatory, and financial federal support for these initiatives is available *now* through collaboration with BOEM and the U.S. Department of the Interior (DOI), grid operators, DOE, FERC, and the North American Electric Reliability Corporation (NERC). Federal funding to support implementing these recommendations is available through several avenues, facilitated through DOE's Building a Better Grid Initiative, which coordinates many new programs including the Transmission Facilitation Program, the Grid Resilience Utility and Industry Grants, Smart Grid Grants, and the Grid Innovation Program. Other funding sources include siting facilitation grants, energy infrastructure reinvestment program, and tax credits for certain eligible offshore wind generation property. In addition, the DOE's Wind Energy Technology Office also provides additional funding opportunities, including a recent $28 million opportunity related to addressing key wind energy deployment challenges, along with managing the federal administration's Earthshot™ for floating offshore wind.

The remainder of this report is structured as follows:

- Section I outlines the urgent case for proactively and holistically planning transmission solutions. For this purpose, we identify the substantial and growing OSW goals that will need to be considered and enabled by such planning efforts, driving the urgency to begin planning efforts.
- Section II documents identified benefits of proactive planning and quantifies the economic, environmental, community, and reliability benefits only offered by carefully planned offshore wind transmission solutions.
- Section III summarizes the challenges that currently prevent effective planning, which limit the realization of these identified benefits.
- Section IV provides a roadmap for overcoming these barriers, and recommends specific steps that states, grid operators, the federal administration and key federal agencies, and industry stakeholders need to take immediately and in the near term to create a pathway for no-regrets grid solutions that can achieve OSW goals in the most cost-effective and timely manner.
- Finally, Section V summarizes available federal support for these initiatives, including through the Inflation Reduction Act (IRA), the Infrastructure Investment and Jobs Act (IIJA, which includes the new Transmission Facilitation Program), and U.S Department of Energy (DOE) appropriations.

I. The Urgency of Starting to Plan Offshore Transmission Now

Coordinated planning for transmission to enable OSW is a key element of efficiently achieving state and national clean energy and climate policies. Without a plan and swift action toward identifying and upgrading the limited near-shore grid locations that can accept substantial volumes of OSW generation, achieving state and federal clean energy goals will be more costly, time consuming, and more disruptive to local communities and the environment. Compared to the current process of developing and interconnecting one OSW generation project at time, each with its own cables to shore, a coordinated comprehensive transmission plan could unlock numerous efficiencies and benefits unavailable under current processes. Because state and national goals will require substantial decarbonization efforts over the next decade and beyond, it is of upmost importance to start proactive transmission planning now.

Given both accelerating near-term and challenging long-term infrastructure needs, this planning effort should have been started years ago. At this point, as existing studies show, even modest further delays in starting coordinated planning efforts will lead to higher costs and greater environmental impacts. Currently available federal support and funding options make starting these planning efforts even more urgent and beneficial.

A. Offshore Wind Commitments and Needs

Developing transmission plans that are cost-effective in the near-term while creating pathways for efficiently addressing long-term goals must start with a clear understanding of both near-term OSW commitments and long-term needs.

Many states and the federal government have set ambitious clean energy and decarbonization goals that will require large-scale renewable resource additions, including substantial amounts of OSW generation. This is evidenced by the significant quantities of OSW in resource interconnection queues, the accelerating pace of OSW procurement activities, and the significant OSW development efforts internationally.[1] In addition to individual state goals, OSW generation targets include the Biden Administration's announcement of a 30 GW by 2030 goal, which includes a goal of 15 GW floating OSW by 2035, unlocking a pathway to develop 110 GW in the United States by 2050.[2] The significant OSW resource pipeline demonstrates the urgency of beginning coordinated transmission planning efforts now to identify more cost-effective and lower-impact solutions for integrating these resources into the existing electricity grid.

Table 1 summarizes the current procurements, state and federal policy and planning goals, and projected long-term needs to achieve decarbonization goals.

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[1] W. Musial, P. Spitsen, P. Duffy, *et al.*, DOE, Offshore Wind Market Report 2022, August 2022.

[2] The White House, FACT SHEET: Biden Administration Jumpstarts Offshore Wind Energy Projects to Create Jobs, March 29, 2021; The White House, FACT SHEET: Biden-Harris Administration Announces New Actions to Expand U.S. Offshore Wind Energy, September 15, 2022.

TABLE 1: OFFSHORE WIND TARGETS AND LONG–TERM NEEDS

State	Already Procured (GW)	Current Goals		Projected 2050 Needs (GW)
		(GW)	Year	
ISO-NE	**5**	**8**		**42-44**
Massachusetts	3.2	5.6	2027	23
Connecticut	1.2	2	2030	9-11
Rhode Island	0.4	1-1.4	2035	5
Maine	0.01			5
NYISO	**4.4**	**9**		**14-25**
New York	4.4	9	2035	14-25
PJM	**8.4**	**18.2**		**33-58**
New Jersey	3.8	11	2040	11-26
Maryland	2	2	2030	2
Virginia	2.7	5.2	2034	20-30
SERC		**8**		**7-10**
North Carolina		8	2040	7-10
South Carolina				
MISO		**5**		**5**
Louisiana		5	2035	5
CAISO		**25**		**25**
California		25	2045	25
NWPP				**24-30**
Washington				4-10
Oregon		3	2030	20
State Total	**17.6**	**77**		**150-197**
U.S. Goal/Need		**110**	**2050**	**220-460**

Sources: See Appendix A.

As this table shows, collective procurement goals of the top 11 states now exceed 75 GW by 2045. States have already procured the first 18 GW of this OSW generation, which is projected to be in service by 2035 along the U.S. Atlantic coast from Massachusetts to Virginia. In addition to the offshore wind goals set recently by East Coast states, offshore wind goals now exist along the Pacific Coast with California's recently announced planning goal of 25 GW OSW by 2045. In the Gulf of Mexico, Louisiana set the target of 5 GW OSW by 2035 in its Climate Plan.

Many states with ambitious clean energy and decarbonization goals recognize that OSW will be a substantial part of achieving their long-term goals. Most states have already conducted decarbonization pathways studies that identify likely long-term OSW generation needs that substantially exceed their current OSW goals and targets. As Table 1 above shows, the total projected OSW generation needs based on studies for individual states now range from 150–

200 GW by 2050.[3] Looking beyond state-specific needs, national decarbonization studies have already projected OSW generation developments as high as 460 GW.[4]

As illustrated in Figure 1 below, the individual state and regional decarbonization pathways studies document substantial future generation interconnection needs for the regional grid operators along the U.S. Atlantic Coast. By 2050, ISO-NE will need to interconnect over 40 GW of OSW, NYISO will need to interconnect up to 25 GW, PJM will need to interconnect up to 58 GW, and the Carolinas will need to interconnect up to 10 GW. Full decarbonization roadmap studies often indicate substantial future OSW needs for even individual states, with Massachusetts most recently identifying a goal of 23 GW of OSW generation by 2050,[5] New York identifying 16–19 GW (possibly up to 25 GW) of OSW,[6] New Jersey's 2019 Energy Master Plan envisioning up to 26 GW,[7] studies for Virginia projecting up to 30 GW,[8] and studies for Oregon projecting 20 GW of offshore wind in some 2050 scenarios.[9] Similarly, state decarbonization goals likely mean that system operators on the West Coast will have to interconnect up to 55 GW of floating OSW generation by 2050. On a nationwide basis, these state-specific needs would require 150–200 GW of OSW generation by 2050—with a total possible nationwide need of over 400 GW based on a nationwide study scope. Most of this offshore wind energy will have to be delivered to shore and integrated with the existing grid—recognizing that some of it may be used to produce hydrogen at the offshore plants' locations.

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[3] *See* Appendix A for a complete list of state clean energy transition and decarbonization pathway studies considered in Table 1.

[4] E. Larson, *et al.*, Princeton University, Net-Zero America—National data, January 9, 2022, at 41, Table 42.

[5] Massachusetts Clean Energy and Climate Plan for 2050, December 2022, at 24. See also Massachusetts 2050 Decarbonization Roadmap Study, Energy Pathways to Deep Decarbonization, December 2020, showing a projected range of 11–19 GW for 2050 OSW generation.

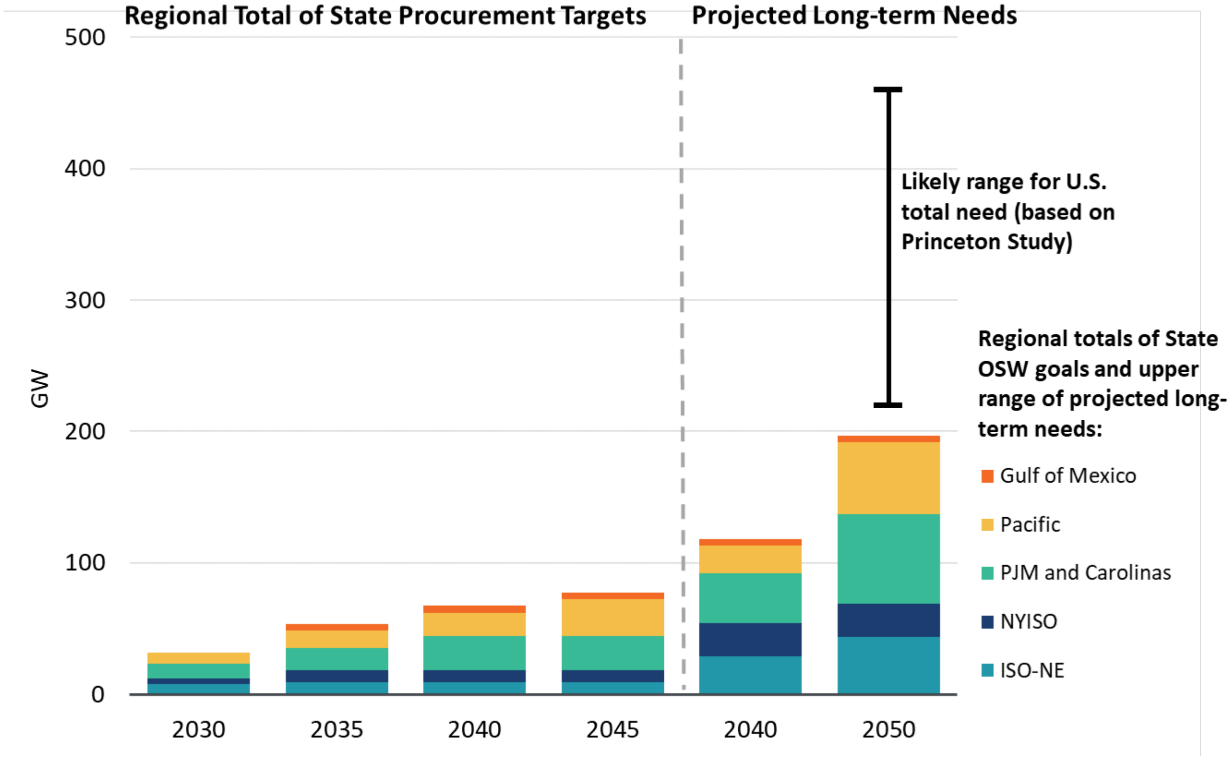
[6] New York State Climate Action Council, Final Scoping Plan, Full Report, December 2022, Table 13. Note that some studies of New York's clean energy needs identify up to 25 GW of OSW generation requirements (see Brattle New York Electric Grid Evolution Study (nyiso.com), pp. 32, 44)

[7] New Jersey 2019 Energy Master Plan, Integrated Energy Plan Technical Appendix, January 2019, at 25.

[8] W. Shobe, *et al.*, Decarbonizing Virginia's Economy: Pathways to 2050, University of Virginia and Evolved Energy Research, January 2021, Fig. 34.

[9] Evolved Energy Research, Renewable Northwest, GridLab, and the Energy Transition Institute, Oregon Clean Energy Pathways Final Report, June 15 and July 2, 2021.

FIGURE 1: REGIONAL OFFSHORE WIND PROCUREMENT TARGETS AND LONG-TERM NEEDS



Available data shows that an OSW development pipeline of 52 GW exists as of December 2022. As shown in Table 2, of the 52 GW of OSW generation under various stages of development, nearly 20 GW have submitted Construction and Operation Plans (COPs) to BOEM, and an additional 24 GW has been made available to developers by BOEM. Table 2 also reflects the updated draft Call Area of 9.9 million acres in the Gulf of Maine that BOEM published in January 2023,[10] the two Wind Energy Areas (WEAs) that BOEM finalized in October 2022 in Texas and Louisiana, enabling at least 8 GW of OSW development[11] and the 373,000 acres BOEM sold in its December 2022 California Lease auction, which is estimated to enable over 8 GW of OSW generation.[12]

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[10] BOEM, Gulf of Maine activities.

[11] BOEM, BOEM Designates Two Wind Energy Areas in Gulf of Mexico, October 31, 2022. (based on BOEM's assumption of 3 MW/km^2).

[12] A. Buljan, offshoreWIND.biz, California Lease Sale Winners Are: RWE, Equinor, CIP, Ocean Winds, and Invenergy. Floating Wind Farm Capacities Higher than Initially Estimated, December 7, 2022. (BOEM estimated a lower 4.5 GW based on 3 MW/km^2).

TABLE 2: OSW DEVELOPMENT PIPELINE AS OF DECEMBER 2022

Status	Description	Total (MW)
Operating	The project is fully operational with all wind turbines generating power to the grid.	42
Under Construction	All permitting processes completed. Wind turbines, substructures, and cables are in the process of being installed. Onshore upgrades are underway.	932
Financial Close	All permitting processes completed. Begins when sponsor announces final investment decision and has signed contracts.	0
Approved	BOEM and other federal agencies reviewed and approved a project's COP. The project has received all necessary state and local permits as well as acquiring an interconnection agreement to inject power to the grid.	0
Permitting	The developer has site control of a lease area, has submitted a COP to BOEM, and BOEM has published a Notice of Intent to prepare an Environmental Impact Statement on the project's COP. If project development occurs in state waters, permitting is initiated with relevant state agencies.	18,581
Site Control	The developer has acquired the right to develop a lease area and has begun surveying the lease area.	24,096
Unleased Wind Energy Area	The rights to a lease area have yet to be auctioned to offshore wind energy developers. Capacity is estimated using a 3 MW/km^2 wind turbine density assumption.	8,290
Total U.S. OSW Pipeline:		51,941

Source: W. Musial, P. Spitsen, P. Duffy, *et al.*, DOE, Offshore Wind Market Report 2022, August 2022, at 8. Updated with the latest activities of BOEM in the Gulf of Mexico and California.

Existing lease areas, identified wind energy areas, and call areas in different regions are shown in Figure 2. BOEM is planning to continue to make available WEAs and award leases through its auction process as shown in Figure 3—with additional lease auctions planned for the Gulf of Mexico, the Central Atlantic, Oregon, and the Gulf of Maine before the end of 2024.[13]

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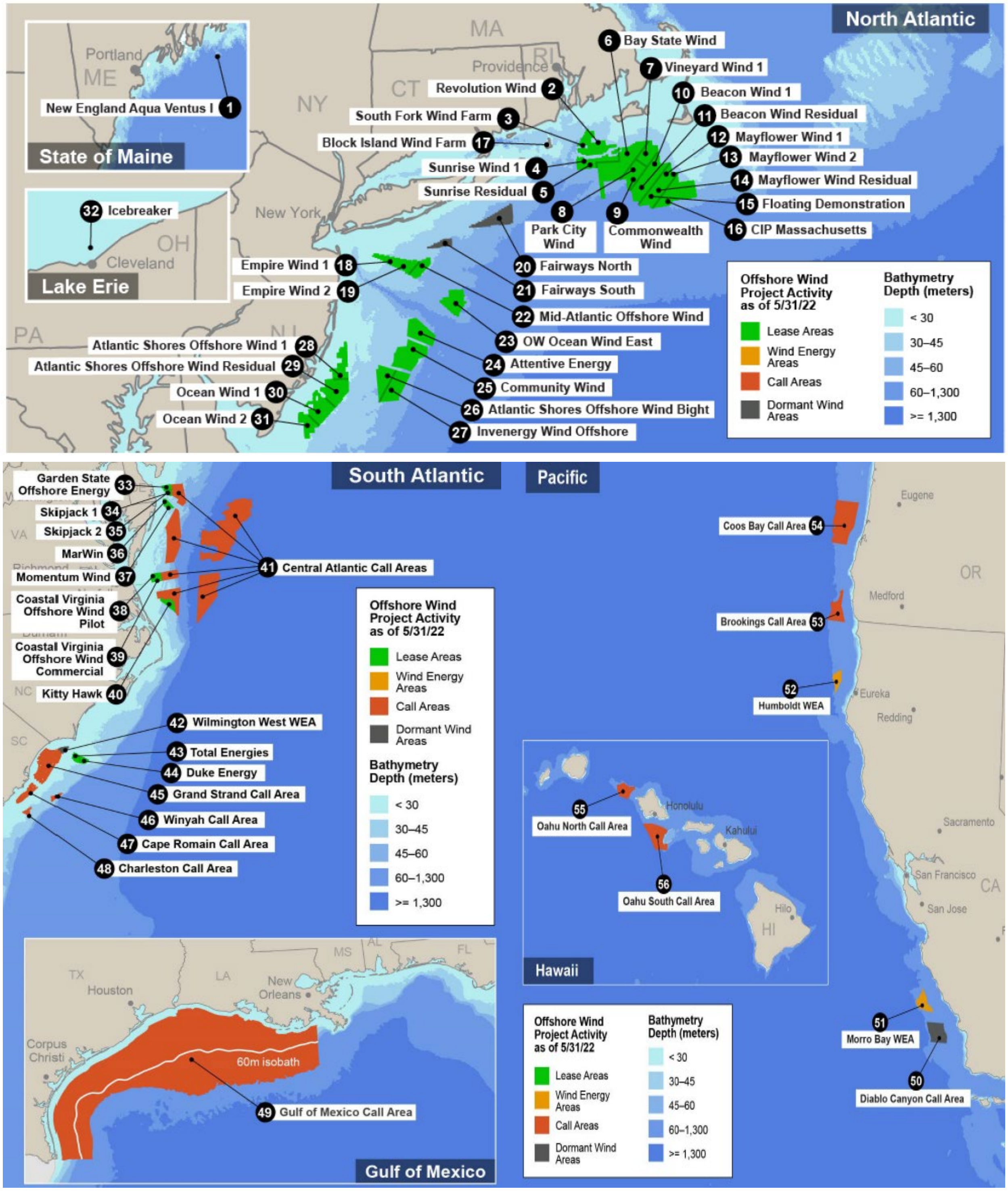
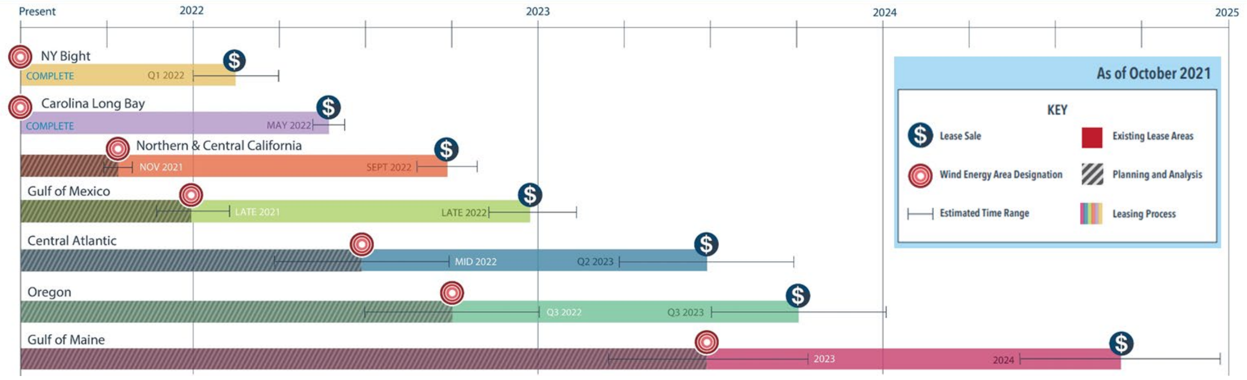
[13] The process to identify and release a new lease area to developers takes several years. For example, BOEM first initiated action in support of the California leases in August of 2016, with a published Request for Interest. BOEM then published a call for information and comment in 2018, another call in 2021, before identifying the wind energy areas in July of 2021, announcing a lease sale in May of 2022, and conducting the lease sale in December of 2022. See BOEM, Request for Interest in California OSW, August 18, 2016; California Activities, History.

FIGURE 2: U.S. OFFSHORE WIND ENERGY AREAS AND CALL AREAS (AS OF 05/31/2022)



Source: W. Musial, P. Spitsen, P. Duffy, *et al.*, DOE offshore wind market report 2022, August 2022, at 12, 14, 18 (BOEM activities as of 05/31/2022). Since May 31, 2022, BOEM updated the draft Call Area of 9.9 million acres in the Gulf of Maine in January 2023; finalized two WEAs in the Gulf of Mexico on October 31, 2022 within the Call Area 49 in the figure above; and sold two lease areas off central and northern California on December 7, 2022 (WEA 51 and 52).

FIGURE 3: BOEM OFFSHORE WIND LEASING SCHEDULE



Source: BOEM, Offshore Wind Leasing Path Forward 2021–2025, October 2021.

Importantly, the ability to develop OSW generation off U.S. coasts through 2050 substantially exceeds the capability of the leases and WEAs BOEM has made available to date or is planning to make available in the near future. For example, NREL’s 2022 study of Offshore Wind Energy Technical Potential found that, after excluding areas unavailable or unsuitable to OSW development, more than 4,000 GW of technical offshore wind resource potential exists off the coasts of the continental United States, as summarized in Table 3 below.

TABLE 3: UNITED STATES’ TECHNICAL OSW RESOURCE POTENTIAL

Region	Total (GW)	Fixed-Bottom (GW)	Floating (GW)	Share of Fixed (%)
California	92	4	88	4%
Great Lakes	575	160	415	28%
Gulf	1,563	696	867	45%
Mid-Atlantic	323	157	166	49%
North Atlantic	706	264	442	37%
Washington/Oregon	216	7	209	3%
South Atlantic	774	188	586	24%
Continental U.S. Total	**4,249**	**1,476**	**2,773**	**35%**

Source: NREL, Offshore Wind Energy Technical Potential for the Contiguous United States, August 15, 2022, at 16.

Without a doubt, sufficient OSW development potential technically exists to meet currently projected state OSW generation needs of over 100 GW by 2040 and state and broader national needs of 200–460 GW by 2050 as summarized in Figure 1 above. The generation output of these OSW plants developed in the Atlantic, Pacific, and the Gulf of Mexico—including floating plants in deep-water lease areas in the Gulf of Maine and off the Pacific coast—will need to be delivered to the onshore grid and to electricity customers in the various population centers. Doing so will require many offshore cables buried in the ocean floor and numerous landfall locations. It will also require points of interconnection (POIs) to the existing grid, and upgrades to the onshore grid to allow for the injection of OSW generation at these POIs and to deliver the energy from there to the various load centers. The development of these OSW-related transmission solutions will have to be coordinated with the existing generation interconnection and transmission planning processes of the regional transmission system operators. On the East Coast, where U.S. OSW development is most active, these system operators are ISO-NE, NYISO, and PJM (which covers the coastline from New Jersey to North Carolina).

B. The Urgency of Starting Proactive Planning

Addressing the interconnection and transmission needs for the substantial amount of U.S. OSW generation development will be challenging. This is particularly the case for meeting the large 2040 and 2050 OSW generation needs, because the transmission grid currently lacks the capability to connect these amounts of new OSW generation and deliver the generation to loads. For example, ISO-NE's 2050 transmission study shows that upgrades will be needed to address 4,500 miles of overloaded onshore transmission lines[14] and several national studies, such as the "Net Zero America" study by Princeton University, project that the capability of today's transmission grid would need to be at least doubled (if not increased five-fold) of this timeframe.[15] It is clear that neither the physical infrastructure nor the current processes of planning and developing the necessary transmission are adequate to meet the challenges presented by the deployment of OSW resources at the already-known scale.

If offshore wind and broader clean energy goals are to be achieved in a timely and cost-effective manner, it is clear that policymakers and the industry must start to reform the transmission planning process and other associated reforms *now*. To cost-effectively and reliably integrate the anticipated new generation and achieve OSW and decarbonization goals, it is essential and urgent to start planning processes that can identify cost-effective and least-regrets transmission development pathways for interconnecting the significant amounts of OSW generation projected to be necessary to meet clean energy goals over the next decades. The immediate challenge is to find solutions that can cost effectively integrate the 30 GW of OSW generation already procured or scheduled to come online over the next decade without

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[14] A. Kniska and R. Collins, ISO-NE, 2050 Transmission Study: Preliminary N-1 and N-1-1 Thermal Results, March 15, 2022, at 18.

[15] E. Larson, *et al.*, Princeton University, Net-Zero America: Potential Pathways, Infrastructure, and Impacts—Final Report Summary, October 29, 2021, at 17.

foreclosing cost-effective pathways towards integrating at least 110 GW (and possibly more than 400 GW) by 2050.

Transmission facilities for offshore wind may take a decade to plan and develop.[16] As a result, any planning efforts started today will not yield significant transmission infrastructure until into the 2030s. Further, because a transmission solution often must be identified significantly in advance of an offshore wind generation solicitation being issued, the lack of a federal or multi-state transmission planning effort risks locking in the current radial tie-line approach.

Integrating a large amount of additional offshore wind energy between 2030 and 2050 will need significant offshore and onshore transmission infrastructure to connect the projects to the existing grid. The ongoing delays in generation interconnection and transmission planning pose a challenge to even the OSW generators procured to meet near-term OSW goals. Any delay in acting to reform transmission and interconnection planning for OSW generation and other clean energy policy needs would only increase the challenge of timely and efficiently realizing long-term state, regional, and national clean energy and decarbonization goals. This is because today's transmission planning and interconnection processes rely on piecemeal and reactive approaches that fail to identify the most cost-effective and lowest-impact transmission solutions to allow for the integration of OSW generation in both the near term but particularly the even larger amounts of OSW generation required by 2040 and 2050.

This planning challenge was analyzed in the United Kingdom, where a study found that the use of proactive national transmission planning could reduce by 19% the costs to integrate an incremental 60 GW of OSW generation needed by 2050 (£5.5 billion or $7.4 billion in capital cost plus £1 billion saving in operational costs), reduce the miles of transmission cables installed in the ocean floor by 35%; reduce onshore transmission upgrades by 62%; and reduce the number of beach crossings by 70%.[17] The study also found that an only 5-year delay of implementing such planning would reduce the benefits of doing so by half. Similarly, NYISO system planning and interconnection studies found that continued reliance on current processes will result in significant OSW curtailments and increase future upgrade costs by hundreds of millions of dollars.[18]

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[16] For example, see J. Saul, N. Malik and D. Merrill, The Clean-Power Megaproject Held Hostage by a Ranch and a Bird, *Bloomberg Green*, April 12, 2022.

[17] NationalGrid ESO, Offshore Coordination Phase 1 Final Report, 2020, at 4, 31, and 34.

[18] Shell, Comments of Shell Energy North America (US), L.P. and Shell New Energies, LLC Addressing Participating New England States Regional Transmission Initiative—Request for Information, 2022, at 6–7.

As described more fully below, many of these long-term planning benefits are reliant on beginning the process for identifying and constructing transmission far enough in advance of OSW project development to enable the necessary level of near- and long-term coordination and planning of transmission solutions. Without such proactive planning, the type and locations of transmission facilities chosen built to address the interconnection of individual OSW generation projects over the next decade will necessarily impact the type and locations of transmission facilities that can be built to meet 2040 and 2050 needs. If transmission technologies, corridors, and grid interconnection points used to address OSW generation interconnection over the next decade do not consider longer-term needs, achieving 2040 and 2050 goals will be more expensive and result in increased environmental and community impacts.

Any delay in starting proactive planning efforts for integrating the large amounts of OSW generation needed over the next decade and beyond will, accordingly, result in suboptimal transmission solutions with higher costs, greater risks and possible delays, and higher environmental and community impacts. If states proceed with OSW procurements that rely on conventional radial interconnection facilities, opportunities to coordinate elements of needed transmission will rapidly shrink; each selected OSW project will utilize a landing point and grid interconnection point in a way that will almost invariably be inefficient in the long term.

If the development of offshore wind transmission solutions continues to be focused solely on near-term needs, it will inevitably lead to technology choices that—while suitable for individual projects—prevent the development of modular transmission solutions that can serve near-term needs while simultaneously creating the flexibility to expand and integrate the facilities into a more beneficial, regionally and interregionally networked offshore transmission solution over time. Thus, even as states proceed with their already-scheduled procurements of OSW generation, there is an opportunity to specify modular transmission designs—such as network-ready offshore substations or higher-capacity high voltage, direct current (HVDC) designs—that create flexibility and preserve the ability to maximize the long-term value of the facilities by being able to integrate them into a networked grid over time. Unless future-proof technology standards are developed *now*, the continued use of incompatible technologies will make it nearly impossible to realize efficient regional and interregional grid solutions in the future.

Reflecting this urgency of more proactive transmission planning for OSW generation, some states have started to procure more comprehensive transmission solutions for meeting their OSW goals. For example, New Jersey has just completed a transmission-only procurement with PJM to address its entire 2035 OSW generation needs, which yielded transmission solutions for

6,400 MW of OSW generation that reduced costs by approximately $900 million and offered significantly lower environmental and community impacts.[19] New Jersey's experience demonstrates vividly that currently used generation interconnection processes are not designed to optimally utilize available POIs and existing transmission capability and yield transmission solutions that could cost-effectively meet the much broader set of future transmission needs. New England states have similarly issued a Request for Information (RFI) to address the regions' current OSW transmission needs.[20] However, while a step in the right direction, the limited geographic scopes and time horizon of these OSW transmission planning efforts will not yield regional and interregional transmission solutions that can most cost-effectively address the full suite of state, regional, and national long-term OSW transmission needs. In contrast, the more holistic planning efforts now underway in the UK have already identified specific transmission projects that will enable the interconnection of 23 GW of OSW resources, while satisfying reliability needs, enhancing OSW availability, reducing environmental impacts by up to 30%, and resulting over £5 billion in customer benefits.[21]

Identifying the most attractive long-term solutions will require the development of more proactive planning processes that simultaneously consider the full set of transmission needs (*i.e.*, reliability, congestion relief, public policy, and generation interconnection needs) over a long-term planning horizon (*i.e.*, through 2040 or 2050 to consider already-known policy needs).[22] Such a long-term, multi-value planning process—which will have to be scenario based to consider long-term uncertainties—will be able to identify least-regrets transmission solutions that (if flexibly developed) can more cost-effectively integrate OSW and other clean-energy resources over time and reduce environmental impacts compared to the currently used incremental generation interconnection and narrowly focused transmission planning efforts.

As discussed further in Section II below, where such proactive, long-term, multi-driver, scenario-based transmission planning processes are already used, they have led to planning outcomes that substantially reduce system-wide costs. In the context of OSW integration, existing proactive studies and planning efforts have shown that proactive planning will reduce the environmental and community impacts through fewer landing points, fewer cable line

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[19] J. P. Pfeifenberger, J. M. Hagerty, J. DeLosa III, The Brattle Group, New Jersey State Agreement Approach for Offshore Wind Transmission: Evaluation Report, October 26, 2022. (BPU SAA Evaluation Report)

[20] See New England States Transmission Initiative.

[21] NationalGrid ESO, Pathway to 2030, July 2022, at 9.

[22] See J. Pfeifenberger, R. Gramlich, *et al.*, Transmission Planning for the 21st Century: Proven Practices that Increase Value and Reduce Costs, the Brattle Group and Grid Strategies, October 13, 2021; J. Pfeifenberger and J. DeLosa, Transmission Planning for a Changing Generation Mix, OPSI 2022 Annual Meeting, October 18, 2022.

miles, and less onshore land use. With fewer facilities built at a larger, more efficient scale, proactive planning will significantly reduce permitting challenges and increase the likelihood of meeting the clean energy and decarbonization goals in a timely fashion.

Many OSW experts and market participants have highlighted the urgency to start proactive planning for offshore wind transmission in their responses to the recent RFI of New England States on regional offshore transmission needs.[23] For example:

- Shell explained that "the need to coordinate the interconnection of [individual offshore transmission] facilities is paramount first on a regional basis and, subsequently, as a critical building block for the development of an integrated interregional transmission network."[24]
- Tufts University noted that "there are many benefits to thinking holistically about transmission landfalls in coordination with port infrastructure, storage, and hydrogen production. A 300 GW OSW build-out represents an approximately $1 [trillion] investment to be made on a very short timeframe (27 years). The U.S. has only one chance to get this right, and it is essential that we view this massive challenge with the respect it deserves. Interregional collaboration and planning with input from state, federal and RTO personnel is essential to working these issues out on a holistic level."[25]
- Anbaric explained that the "radial only" approach that was used to interconnect OSW projects at the inception of these programs is no longer viable. "Moving to a planned approach is a prerequisite to achieving the 30,000 MW of offshore wind needed to achieve 2050 decarbonization goals [in New England]."[26]
- The American Clean Power Association (ACP) and RENEW Northeast (RENEW) highlighted the urgency of initiating planning efforts based on robust long-term goals: "Major transmission projects typically take longer to complete than generation projects, and

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[23] *See Regional Transmission Initiative* (including Connecticut, Maine, Massachusetts, New Hampshire, and Rhode Island), *Notice of Request for Information and Scoping Meeting*, September 1, 2022; For further information, see the New England States Transmission Initiative—New England Energy Vision webpage.

[24] Shell, Comments of Shell Energy North America (US), L.P. and Shell New Energies, LLC Addressing Participating New England States Regional Transmission Initiative—Request for Information, 2022, p.at 2 ("… the need to coordinate the interconnection of these facilities is paramount first on a regional basis and, subsequently, as a critical building block for the development of an integrated interregional transmission network.")

[25] Tufts University, Request for Information: Regional Transmission Initiative Connecticut, Maine, Massachusetts, New Hampshire, and Rhode Island, 2022, at 9.

[26] Anbaric, Scaling Renewable Energy (RFI Comments), 2022, at 1.

proactive development of the near-term transmission projects must start now if growth of renewable energy is to continue."[27]

- Eversource stressed that: "the evolution of policy objectives dictates that the New England region could benefit from a more comprehensive, holistic and forward-looking planning process to identify, with direction from the states, transmission investments that will be needed to integrate the coming influx of renewable resources to achieve state policy goals.… [W]e need to act ***now*** on a set of targeted solutions that address existing interconnection queue backlogs, facilitate near-term clean energy procurements, improve winter reliability, position the region for electrification, and provide financial benefit to customers via DOE funding.… Eversource is concerned that transmission procurements modeled directly on prior RFPs for clean energy generation could result in siloed and chaotic transmission development that results in higher costs to customers, does not comprehensively address the region's reliability and clean energy needs, and indeed puts meeting clean energy goals at risk."[28]

The need to expeditiously address OSW transmission through more proactive planning is particularly pressing because today's generation interconnection processes, which evaluate needs only incrementally (such as one project or one group of projects at a time), have already been stretched well beyond what they have been designed for, resulting in significant delays and unnecessarily high costs of OSW interconnections. As Ocean Winds (OW) has noted in its New England RFI response:

> OW's collective US interconnection experience … has been that the ambiguity and the long duration of existing interconnection practices … have been a challenge for advancing large offshore wind projects. Given the cost, capacity, and temporal uncertainty of the interconnection process, offshore wind developers are effectively and implicitly encouraged to file multiple duplicative interconnection requests in order to de-risk their projects potentially delaying interconnection studies of later interconnection applicants.… As more and more interconnection requests are filed, the self-interest of each developer will further incentivize each developer to file even a higher number of interconnection requests in advance, further hindering

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[27] American Clean Power Association and RENEW Northeast, Comments of the American Clean Power Association and RENEW-Northeast on Changes and Upgrades to the Regional Electric Transmission System Needed to Integrate Renewable Energy Resources, 2022, at 6.

[28] Eversource, Comments of Eversource Energy Service Company on behalf of The Connecticut Light and Power Company, NSTAR Electric Company and Public Service Company of New Hampshire, at 2 [emphasis original].

> the speed of interconnection process for all market participants in a vicious cycle of self-interest of first movers in the interconnection queue. This unintended consequence of the existing interconnection process perpetually increases the number of grid upgrades being cost-allocated, putting an unreasonable price tag and a level of cost-uncertainty in each interconnection application.… Simply limiting speculative, hence risk-mitigating, duplicative interconnection requests and "purging queues" is not the answer. Instead, there is an urgent need for proactive action: a clear policy signal to offshore wind developers that if a state-facilitated offshore wind project is awarded, the State will enable the grid upgrades needed to "beef up" the key coastal POIs that offshore wind projects will need to utilize.[29]

Finally, initiating planning and technology standardization efforts now is particularly compelling since, as discussed further in Section III below, the federal government is offering technical and financial support, including tax credits for generation interconnection facilities, that can be used to address planning challenges, lower costs, and facilitate contracting for the state and nation-wide clean-energy needs, and proactively develop both regional and interregional transmission solutions. Some of this support and funding may not be available if planning efforts are delayed. States need to act quickly to secure available federal funding. For example, DOE issued a Funding Opportunity Announcement (FOA)[30] in November 2022 for the Grid Innovation Program (GIP) as part of the Bipartisan Infrastructure Law (Section 40103(b)) to fund projects that aim to improve grid reliability and resilience and states are eligible to apply. Some states including Massachusetts, Connecticut, Rhode Island, and Maine have started to act and requested notices of interest and draft concept papers from developers for states to consider as part of a GIP funding application.[31]

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[29] Ocean Winds, Comments of OW North America LLC on Regional Transmission Initiative Notice of Request for Information and Scoping Meeting, October 28, 2022.

[30] Opportunity: BIL Grid Resilience and Innovation Partnerships (GRIP)

[31] See the individual states' notices: Massachusetts (responses due December 22, 2022), Connecticut (responses due December 23, 2022), Rhode Island (responses due December 28, 2022), and Maine (responses due December 30, 2022).

II. The Benefits of Proactively Planned Offshore Wind Transmission

The advantages of proactive regional and interregional planning are increasingly well-understood and show that proactive planning offers a wide range of benefits. These benefits include: (1) cost savings; (2) improved grid reliability and resilience; (3) environmental benefits and reduced community impacts; and (4) the employment and economic benefits of developing OSW resources in an efficient and timely fashion. Studies that document these benefits of proactive planning are summarized below. Based on these studies, assuming at least 100 GW of additional U.S. OSW generation procurements between 2030 and 2050, the benefits of proactive planning efforts translate to around $20 billion in reduced transmission costs, 60–70% fewer shore crossings and onshore transmission upgrades, and up to 2,000 fewer miles of marine transmission cable trenches on the ocean floor by 2050. Many of these benefits are reduced considerably if proactive planning efforts are delayed.

A. Cost Savings from Proactive Regional Planning

Proactive long-term planning can reduce the total cost of a clean-energy grid by developing solutions that can more efficiently address multiple transmission needs simultaneously, instead of relying on incremental solutions to many individual needs over time. These proactive planning benefits have been demonstrated through targeted interconnection studies as well as regional multi-value planning efforts.

Benefits associated with proactive planning that includes offshore transmission are likely to increase as technology continues to develop, allowing for the integration of multiple and larger OSW generation projects into networked transmission solutions that add to regional and interregional transfer capability of the existing grid. To enable the benefits, the planning efforts must consider the transition from today's interconnection processes based on radial interconnection facilities to more cost-effective regional and interregional transmission solutions.

Several recent transmission studies document the significant cost savings that proactive planning efforts can achieve:

- ***PJM's Offshore Wind Transmission Study*** highlights the stark difference in generation interconnection costs if long-term interconnection needs are planned proactively. A previous OSW study showed that under the then-current interconnection process, which relied on individual interconnection studies for each queue request, PJM identified $6.4 billion in required upgrades to the onshore grid for 15.6 GW of individual OSW plants,[32] or $413 per kW of renewable generation.[33] In contrast, PJM's 2021 Offshore Wind Transmission Study showed that proactively planning interconnection needs for an estimated 74.5 GW of combined onshore wind, offshore wind, and solar capacity needed to meet the current public policy goals of PJM states would require only $3.2 billion of onshore system upgrades to facilities above 100kV,[34] resulting in interconnection costs of only $43 per kW of renewable generation. If these study results were actually implemented by PJM, it would yield a nearly 90% reduction in the cost of major onshore upgrades (before adding the cost of lower-voltage transmission upgrades) to accommodate interconnection of the resources necessary to meet existing clean energy goals of PJM states.

- The recent ***PJM-New Jersey State Agreement Approach (SAA)*** experience with more proactively addressing the 6,400 MW of additional OSW generation interconnections needed to reach the state's 7,500 MW OSW goal for 2035 similarly showed substantial savings compared to pursuing generation interconnection incrementally through PJM's conventional process. This proactive planning effort, conducted under PJM's never-previously used SAA, was focused only on New Jersey's OSW interconnection needs through 2035, yet yielded substantially lower-cost solutions for the identified upgrades to the onshore grid. In response to the SAA solicitation that received 80 proposals from 13 bidders, PJM and the New Jersey Board of Public Utilities have now approved onshore transmission upgrades to nine companies that will: (1) reduce the total cost of transmission needed to add an additional 6,400 MW of OSW generation by 2035 by over $900 million; (2) significantly reduce schedule and cost uncertainties; (3) utilize the existing grid more efficiently; (4) develop a shared collector substation with sufficient space for the HVDC converter stations of up to four OSW generators that allows for a significant reduction of transmission-related environmental and community impacts; (5) maximize the availability of approximately $2.2 billion in federal tax credits; and (6) allow the state to more cost-effectively reach its new 11,000 MW by 2040 offshore wind goal through future

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[32] Business Network for Offshore Wind and Grid Strategies LLC, Offshore Wind Transmission Whitepaper, 2020, at 11.

[33] See also J. Seel, *et al.*, Interconnection Cost Analysis in the PJM Territory, Berkeley Lab, January 2023. Figure 5 of this study similarly shows approximately $400/kW in average cost for OSW generation in PJM's interconnection queue currently—higher than the interconnection costs of any other resource type and with an uncertainty range of $200/kW to over $500/kW.

[34] PJM, Offshore Wind Transmission Study: Phase 1 Results, 2021, at 14, 18.

procurements.[35] While New Jersey did not select any offshore transmission through this SAA, the state issued its new draft solicitation framework for the next OSW generation procurement with provisions that require both (a) the use of "network-ready" HVDC cables and offshore substation designs and (b) the construction of a shared onshore transmission corridor with the space for HVDC converter stations pre-built conducts and vaults that can accommodate the HVDC cables of up to four OSW generators.[36]

- The benefits of proactive planning—even if focused solely on generation interconnection needs—are similarly documented in ***MISO's and SPP's Joint Targeted Interconnection Queue Study (JTIQ)***. By pooling 5-years' worth of generation interconnection requests on both sides of the MISO-SPP seam, the two RTOs identified $1.6 billion in interregional transmission solutions that facilitate the integration of over 28 GW of generation interconnection at a cost of only $58 per kW of renewable resources, reducing interconnection costs by over 50% (from $117/kW under the system operators' individual interconnection processes), while additionally reducing the congestion and fuel costs of MISO and SPP customers by approximately $1 billion.[37]
- ***MISO's Long Range Transmission Planning (LRTP)*** effort is perhaps the best available example of how scenario-based long-term planning for multiple transmission needs—simultaneously for generation interconnection, regional reliability, congestion relief, and public policy needs—offers substantial overall cost savings to electricity customers. MISO's LRTP effort resulted in the approval of a $10 billion "least regrets" portfolio consisting of 18 multi-value transmission projects in MISO's Midwestern Subregion. In addition to addressing long-term reliability needs throughout the region, the multi-value portfolio of transmission investment will reduce congestion and fuel costs, avoid capital costs of local resource and other transmission facilities, reduce resource adequacy costs and customer load shedding, while also supporting member states' decarbonization policies by helping integrate low-cost wind resources in its footprint. MISO estimated that the transmission investments, which are associated with $14 billion of expenses (including operating costs) over the initial 20 years, will reduce other MISO costs by between $37 billion and $54 billion over the same timeframe—producing significant net benefits that reduce the total costs

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[35] See BPU SAA Evaluation Report. The SAA process identified $575 million in upgrades to the existing grid for 6,400 MW, or $90 per kW of OSW generation. This is approximately 60% less than the $1.5 billion ($234/kW) cost of grid upgrades estimated based on PJM's most recent individual OSW interconnection studies.

[36] New Jersey Board of Public Utilities, Solicitation Documents—NJ Offshore Wind, Attachment 10 (Prebuild Infrastructure Requirements) and Attachment 11 (Offshore Transmission Network Preparation Requirements).

[37] Tsuchida, Proactive Planning for Generation Interconnection A Case Study of SPP and MISO, The Brattle Group, August 17, 2022, at 9.

faced by MISO's customers.[38] Importantly, this portfolio of transmission projects is designed to facilitate a significant shift in MISO's generation mix over the next two decades, including the retirement of about 58 GW of mainly coal-fired power plants, and the addition of about 90 GW of solar, gas, and wind generation by 2039.[39]

- National Grid's ***U.K. OSW study*** analyzed the impact planning would have on the integration of 60 GW of wind generation between 2025 and 2050. The study estimated that, if planning results are implemented starting in 2025, the U.K. could reduce total transmission-related capital costs by 19%, saving approximately $7.4 billion. The estimated savings drop to half that amount if implementation of planning results is delayed by only 5 years, from 2025 until 2030.[40]
- Anabaric's ***New England OSW transmission study*** found that a planned approach based on more expensive high-capacity offshore transmission links to more distant load centers on the existing grid decreases the total combined onshore and offshore transmission costs by $0.5 billion for 3,600 MW of planned additional New England OSW procurements—an 11% reduction of total transmission-related costs.[41]
- A study by the Lawrence Berkley National Laboratory (***LBNL Study***) has analyzed differences in wholesale electricity prices over the last decade to estimate the extent to which expanding transmission capabilities within and between regions could offer significant benefits. The analysis shows that the median price differences across locations within individual regions was $11/MWh in 2021. The analysis also shows that 1,000 MW of expanded transfer capabilities between coastal locations within PJM or CAISO—which may be achievable cost-effectively through proactively planned offshore networks—would have offered benefits of $100–150 million annually in each of 2021 and 2022.[42]

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[38] MISO, LRTP Tranche 1 Portfolio Detailed Business Case, June 25, 2022, at 57–58.

[39] *Id*. at 4. *See* also Utility Dive, MISO board approves $10.3B transmission plan to support 53 GW of renewables, July 26, 2022.

[40] National Grid ESO, Offshore Coordination Phase 1 Final Report, 2020, at 31. National Grid's UK OSW study found that without proactive planning, the best POIs for connecting offshore wind to the UK electric transmission network quickly became saturated, and that additional POIs developed to supplement them were not as ideal, requiring extensive upgrades to the onshore transmission network.

[41] J. Pfeifenberger, Offshore Transmission in New England: The Benefits of a Better-Planned Grid, The Brattle Group, prepared for Anbaric, May 2020, at 17. See also J. Pfeifenberger, *et al.*, Offshore Wind Transmission: An Analysis of Options for New York, The Brattle Group, prepared for Anbaric, August 2020, documenting a similar magnitude of savings for New York.

[42] LBNL, Empirical Estimates of Transmission Value Using Locational Marginal Prices, 2022, at 3 and 18–19.

- The ***Massachusetts Decarbonization Pathways*** report found that to achieve a cost-effective regional electricity system, significant transmission expansions would be necessary within New England and to neighboring regions. For example, between 1.8 GW and 2 GW of additional transfer capability would be cost effective between Maine, New Hampshire, and Massachusetts and approximately 1 GW of additional transfer capability would be cost effective between Connecticut, Rhode Island, and Massachusetts in the study's regional coordination scenario.[43] The study identified even larger interregional transmission needs as discussed below.

As noted in RENEW's "Blueprint for New England" study, interconnection costs are currently rising rapidly for new OSW generation projects. In New England, early OSW projects interconnected at a cost of $10/kW, which has now increased to $275/kW for the most recent projects.[44] Additional attempts to interconnect OSW generation through current interconnection processes will lead to further increases in OSW interconnection costs unless addressed proactively. However, when interconnection requests are addressed proactively and at sufficiently large scale, the average costs of interconnection tend to be lower.[45] The studies summarized above consistently document that these significant increases in interconnection costs that OSW generation faces under the current interconnection processes can be mitigated through more proactive planning of generation interconnection needs, particularly when planned in conjunction with other regional and interregional transmission needs.

Extrapolating from these studies, **proactive planning for** the interconnection of at least **100 GW of additional offshore wind generation** beyond already ongoing procurements would yield at least **$20 billion in transmission-related cost savings**—even before considering risk mitigation, reduced environmental and community impacts, and the broader regional and interregional benefits of a networked offshore transmission grid.[46] Given that incremental offshore wind

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[43] R. Jones, *et al.*, Energy Pathways to Deep Decarbonization: A Technical Report of the Massachusetts 2050 Decarbonization Roadmap Study, Evolved Energy Research, December, 2020, Table 8, p. 64.

[44] RENEW Northeast, Comments of the American Clean Power Association and RENEW-Northeast on Changes and Upgrades to the Regional Electric Transmission System Needed to Integrate Renewable Energy Resources, 2022, at 2.

[45] Compare incremental interconnection costs of $413/kW from previous PJM generation interconnection studies for individual OSW generators, and $275/kW anticipated in the short-term in New England, against costs of proactive planning efforts at $89/kW for Option 1a (interconnection) facilities in New Jersey's SAA (for 6.4 GW of OSW generation), MISO-SPP JTIQ at $58/kW (for 28 GW of renewables), and the PJM Offshore Wind Transmission Study at $40/kW (for 75 GW of renewables, including OSW).

[46] For example, the New Jersey BPU evaluation of transmission alternatives estimated that in the absence of coordinated transmission procurements through the State Agreement Approach, the total cost of onshore and offshore transmission facilities to interconnect 6,400 MW of OSW generation would be $8.9 billion (before

generation needs will likely exceed 100 GW through 2050, and could possibly reach more than 400 GW, the total savings associated with proactively planned transmission solutions will be substantial. Importantly, the planning activities conducted over the next few years will determine if the OSW generation procured for the next decade can be integrated in a timely and cost-effective manner. Because decisions made today will have long-term consequences, they determine the extent to which 2050 OSW generation needs can be integrated cost effectively.

B. Cost Savings and Resilience Value of Expanding Interregional Transmission

Well-planned offshore transmission can integrate OSW generation more cost effectively while also reinforcing the onshore grid, with cost and resilience benefits spread across regions. Interregional benefits include more efficient wholesale market outcomes, reduced congestion, fewer curtailments of renewable generation, reduced costs, improved reliability during challenging market conditions, and resilience benefits during extreme conditions. These benefits are enabled through increased interregional transfer capabilities—some of which may be made feasible and most cost-effectively provided through a well-designed offshore transmission network. In other words, since OSW generation is expected to account for a large share of additional clean energy resources in coastal areas, expanding interregional transfer capability through networked offshore transmission facilities may be a cost-effective way to achieve these benefits.

Several studies document the significant potential cost savings and resilience value associated with expanding interregional transmission:

- The ***LBNL Study*** analyzed regional and interregional price differences in wholesale electricity markets. The study showed interregional price differences offered significantly more

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applying federal tax credits) or $6.7 billion (assuming federal tax credits for generation interconnection facilities). Applying these estimates of OSW transmission costs to 100 GW of nation-wide OSW additions, this translates to $139 billion (before tax credits) and $105 billion (after tax credits) in total OSW transmission costs. A 19% reduction of these transmission costs (as documented in the UK study summarized above) will translate to $20–26 billion per 100 GW of OSW. The estimated $20+ billion (or $200/kW) cost savings estimates exceed the savings realized by the smaller-scale OSW integration studies (such as the Anbaric and PJM SAA studies) but is consistent with savings identified in larger-scale studies—such as MISO LRTP results, which show that $10 billion in proactively planned transmission investments facilitates the integration of 90 GW of new resources, while reducing other costs between $37 billion and $54 billion over the first 20 years. The estimated $200/kW savings in OSW-related transmission cost is consistent with the results of PJM's 2021 study of the grid upgrade costs associated with integrating 75 GW of renewable generation (as discussed above).

opportunities for expanding transmission capabilities, including interregional transfer. For example, the median price difference between regional power markets was $24/MWh in 2021, compared to $11/MWh within regions.[47] While the highest interregional price differences have historically been observed in the interior of the U.S., average 2021 and 2022 price differences between ISO-NE, NYISO, and PJM indicate that expanding interregional transmission capacity between any two of these regions by 1,000 MW would have saved $100–300 million per year in wholesale power purchases. That benefit is anticipated to grow over time as more low-cost clean energy is added to the grid.

- The benefits of planned interregional transmission extend beyond U.S. borders. For example, an ***MIT study of the Northeastern U.S. and Canada*** found that "adding 4 GW of transmission between New England and Canada (Quebec in particular) is estimated to lower the costs of a zero-emission power system across New England and Quebec by 17–28%."[48] The study further notes that "in a low-carbon future, it is optimal to shift the utilization of the existing hydro and transmission assets away from facilitating one-way export of electricity from Canada to the U.S. and toward a two-way trading of electricity to balance intermittent U.S. wind and solar generation. Doing so reduces power system cost by 5–6% depending on the level of decarbonization."[49]
- A ***nationwide MIT study*** found that in a deeply decarbonized U.S. electricity system, an optimally expanded interregional transmission system could reduce the wholesale power price by 20% from $91/MWh to $73/MWh, when compared with a scenario without expanded interregional transmission capacity.[50]
- The ***Massachusetts Decarbonization Pathways*** report found that to achieve a cost-effective regional electricity system, significant transmission expansion would be necessary between New England and its neighboring regions in addition to expanding transmission within New England. For example, for the lower-cost, coordinated scenario, the study estimates that 6 GW of additional transfer capability would be cost effective between New York and PJM, that 2.3 GW of additional transmission would be cost effective between New York and New England (Connecticut and Massachusetts), and that 6.7–6.8 GW of additional transmission would be beneficial between Quebec and each of New York and New England (Maine,

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[47] LBNL, Empirical Estimates of Transmission Value Using Locational Marginal Prices, 2022, at 3 and 18–19.

[48] E. Dimanchev, *et al.*, MIT CEEPR, Two-Way Trade in Green Electrons: Deep Decarbonization of the Northeastern U.S. and the Role of Canadian Hydropower, 2020, at 1.

[49] *Ibid.*

[50] P. Brown, *et al.*, The Value of Inter-Regional Coordination and Transmission in Decarbonizing the US Electricity System, 2021, Figure 2.

Vermont and Massachusetts).[51] At least some of this additional interregional transfer capability may be provided most cost-effectively through a well-designed offshore transmission network.

- A recent General Electric Study for the Natural Resources Defense Council (***GE-NRDC study***) showed that expanding interregional transmission capability by 87 GW on various paths within the Eastern U.S. would provide $83 billion in estimated generation cost savings and avoided customer outage value.[52] The GE-NRDC study specifically concluded that interregional transmission would need to be expanded between New England and New York (by approximately 2 GW), between New York and PJM (by approximately 5 GW), and between PJM and the Southeast (by approximately 8 GW)[53]—all paths for which networked offshore transmission may be the most feasible and/or cost-effective solution.

  The GE-NRDC study illustrated resilience benefits based on system performance during a 2035 Polar Vortex, during which increased interregional transmission capability on the East Coast would provide $1 billion in resilience value (during the single event) by preventing around 2 million customers losing power in Boston, New York City, Baltimore, and Washington, DC. The GE-NRDC study similarly analyzed a heat wave event, during which the added interregional capability provided $875 million of benefits by preventing 740,000 customers from losing power in New York City and Washington, DC.[54] These resilience benefits of interregional transmission have generally been broadly recognized in the industry and by its regulators. As a FERC staff report has emphasized, "[t]he ability to share resources across regions, through use of the high voltage transmission system, provides important reliability and resilience benefits when the resources in one area are impacted due to an unexpected disruptive event."[55]

- Although the resilience value of expanding interregional transmission is difficult to quantify with the simulation models commonly utilized, the **LBNL Study** of historical wholesale energy market price differentials separately analyzed periods of stressed system conditions, which provides a strong indication of the importance of these benefits. The LBNL Study

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[51] R. Jones, *et al.*, Energy Pathways to Deep Decarbonization: A Technical Report of the Massachusetts 2050 Decarbonization Roadmap Study, Evolved Energy Research, December, 2020, Table 8, p. 64.

[52] S. Tandon Manz, *et al.*, Economic, Reliability, and Resiliency Benefits of Interregional Transmission Capacity Case Study Focusing on the Eastern United States in 2035, prepared by General Electric for NRDC, October 17, 2022, at 26.

[53] *Id.*, Figure 15).

[54] *Id.*, at 22.

[55] Report on Barriers and Opportunities for High Voltage Transmission, Prepared by the Staff of the Federal Energy Regulatory Commission, at 8 (June 2020), ("FERC High Voltage Transmission Report").

> documented that 40% to 80% of the energy market value of transmission links is concentrated in only 5% of all hours of a year, reflecting the most challenging system conditions—including storms, cold snaps, and heat waves—that are often not considered in system simulations.[56] LBNL concluded that such spikes in transmission values "occur in different regions in different years" and that "extreme conditions in a single year, or even season, can materially increase the 10-year value of a [transmission] link."[57]

Proactive planning efforts can determine the extent to which offshore transmission networks offer the most feasible and cost-effective solutions to provide valuable additional interregional transmission capabilities between the regions along the nation's coasts. This opportunity to utilize offshore networks to expand interregional transmission capabilities has been broadly recognized. For example, the New York Public Service Commission highlighted that offshore transmission networks may create "additional benefits in terms of trading opportunities and increased reliability by making available alternative delivery routes through a neighboring system in the event offshore outages should affect the direct transmission links."[58] OSW generation developers have similarly noted in their New England RFI comments that "[l]arge-scale OSW project development across the Northeast presents unique opportunities to develop regional and interregional transmission infrastructure."[59]

The recent GE-NRDC study further notes that the additional interregional transmission would preferably be provided by HVDC links due to the additional system control and stability benefits HVDC technology can provide compared to traditional high voltage, alternating current (HVAC) transmission lines.[60] HVDC technology's advantages over traditional HVAC transmission solutions—including frequency response benefits and system stability enhancement,

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[56] LBNL, Empirical Estimates of Transmission Value Using Locational Marginal Prices, 2022, at 28.

[57] *Id.*, at 22.

[58] State of New York Public Service Commission, Order on Power Grid Study Recommendations, January 20, 2022, at 11.

[59] Shell, Comments of Shell Energy North America (US), L.P. and Shell New Energies, LLC Addressing Participating New England States Regional Transmission Initiative—Request for Information, 2022, at 13.

[60] GE-NRDC Study, at 27–28.

particularly when transmitting power over long distances—have long been noted by transmission developers,[61] in FERC reports,[62] and by grid operators.[63]

As Invenergy explains in a recent request for a FERC technical conference on HVDC transmission, the benefits of HVDC lines, which in large part stem from advanced converter technologies, include, in addition to the reliability and resiliency benefits of interregional transfer capability: “(1) dynamic voltage support to the AC system, thereby increasing its transfer capability; (2) frequency support through fast ramp rates; (3) improved transient stability and reactive performance; (4) AC system (oscillation) damping; (5) ‘decoupling’ of the interconnected system so that faults and frequency variations between the wind farms and the AC network or between different parts of the AC network do not affect each other and otherwise providing a ‘firewall’ to limit the spread of system disturbances; and (6) black start capability to re-energize a 100% blacked-out portion of the network.”[64]

FERC staff similarly recognized that grid-forming HVDC designs can provide black start capability by increasing the resilience of the grid by contributing to system restoration process in emergency conditions and reducing impacts of widespread outages[65] as well as ancillary services historically provided by localized dispatchable generation, which will be needed throughout the energy transition.[66]

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[61] Invenergy, Request for Technical Conference of Invenergy Transmission, FERC Docket AD22-13, July 19, 2022 (Invenergy Technical Conference Request).

[62] FERC HV Transmission Report at 10 (“HVDC transmission projects can also provide a variety of system stability benefits. For example, the Pacific DC Intertie is a long distance HVDC line (±500 kV DC, 3100 megawatts (MW)) that is used to transmit electricity from the Pacific Northwest to Los Angeles. Active modulation of real power in this HVDC line has been deployed as an effective strategy to improve system stability by dampening inter-area modes of oscillation in the Western interconnection.)(internal citations omitted)

[63] PJM, 2008 RTEP Reliability Analysis Update, October 15, 2008, at 8–10.

[64] Invenergy Technical Conference Request, at 5.

[65] FERC HV Transmission Report at 10 (“[I]f the system experiences a wide-area blackout, system restoration can be enhanced by using adjoining in-service transmission facilities to restore transmission lines, substations, generating plants, and customers to service. For example, the ability to energize transmission from neighboring systems sped the system restoration following the August 2003 blackout.”)

[66] FERC HV Transmission Report, at 13.

C. Environmental and Community Benefits of Proactively Planning OSW Transmission

Proactive planning of OSW transmission offers the opportunity to select solutions with substantially reduced environmental and community impacts. The current OSW development processes results in separate transmission corridors to deliver the output of individual OSW generation project to shore and the points of interconnection with the existing grid. Coordinated planning and development processes for future OSW integration needs can significantly reduce the number of transmission corridors and construction efforts that result in environmental impacts and community disturbances. The planning for OSW transmission could incorporate the community and equity as core elements. A meshed transmission networks have the potential of realizing higher community and equity benefits.[67] Both U.S. and international studies and procurement efforts have documented these benefits.

- National Grid found that proactive planning of the U.K.'s 2050 OSW transmission needs offers significantly **reduced marine and shoreline impacts**. The study found that the number of beach crossings needed to achieve 2050 OSW goals could be reduced by 70% (from 105 to 30) if implementation of planning efforts starts in 2025; if implementation of planning efforts is delayed to 2030, the number of beach crossings needed by 2050 would increase to 60.[68] The impacts on the marine environment to reach these landing points would be approximately 30% less, with the total length of offshore cable trenches reduced from 5,100 to 3,400 miles.[69]
- The U.K. OSW study similarly found substantially **reduced onshore impacts**. The study shows that proactive planning could reduce the length of needed onshore transmission lines and cable by about 60%, from 2,100 miles to 800 miles.[70] The study similarly found that if coordinated planning (with implementation starting in 2025) would reduce the land needed for onshore substation by 55%, from 953 acres to 427 acres;[71] if implementation of planning efforts is delayed until 2030, 766 acres would be required instead.

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[67] V. Bourg-Meyer, S. Schacht, Clean Energy States Alliance, Offshore Wind and Equity Clean Energy States Alliance State of the States Report, November 2022, at 13-14.

[68] National Grid ESO, Offshore Coordination Phase 1 Final Report, December 16, 2020 (U.K. OSW Study) at 34; based on Offshore Coordination Cost-Benefit Analysis of Offshore Transmission Network Designs, prepared by DNV-GL2020 (DNV OSW Study), at 37.

[69] DNV OSW Study, at 36 (converted from km to miles).

[70] DNV OSW Study, at 36 (converted from km to miles).

[71] DNV OSW Study, at 38 (converted from hectares to acres).

- These findings have also been confirmed in studies by The Brattle Group for Anbaric (an independent transmission developer). For example, proactively planning the use of high-capacity HVDC submarine cables to reach more distant but more robust interconnection points on the existing grid is estimated to **reduce the need for onshore transmission** upgrades by 65%, while simultaneously **reducing the miles of cable trenches** on the ocean floor by approximately 50% for an additional 8 GW of OSW generation.[72]
- The general magnitude of environmental and community impacts estimated by the studies summarized above have been confirmed by **New Jersey's experience** of proactively procuring transmission solutions under PJM's State Agreement Approach—which allowed regulators to consolidate the onshore transmission needs of three OSW generators into a single transmission corridor that could be pre-built, thereby reducing onshore environmental and community impacts by approximately two-thirds.[73]

Based on this experience, proactive planning of OSW transmission **solutions for over 100 GW** of OSW generation would offer substantially reduced environmental and community impact, requiring **60–70% fewer shore crossings and onshore transmission upgrades**, and up to a **2,000 miles (50%) reduction of marine transmission cable trenches** impacting the ocean floor by 2050.[74] Additionally, proactive planning that provides a degree of "future-proofing" would reduce the need for highly expensive, specialized cable-laying and installation vessels to "re-do" offshore transmission facilities, by utilizing a coordinated approach that builds at the appropriate scale at the outset.

D. Employment Benefits of OSW Development

Development of the transmission solutions necessary to integrate OSW generation supports the substantial employment and economic stimulus benefits that OSW development offers to the states and regions. Several existing studies have evaluated the employment benefits of offshore wind development, estimating that the construction of 30 GW OSW would create between 80,000 and 135,000 jobs.

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[72] J. Pfeifenberger, *et al.*, Offshore Transmission in New England: The Benefits of a Better Planned Grid, prepared for Anbaric, May 1, 2020, at 9.

[73] BPU SAA Evaluation Report, at 14 (Scenario 18A).

[74] Assuming an average OSW plant size of 1,200 MW and submarine cable of 50 miles for each plant, over 4,000 miles of submarine cable would need to be installed to integrate 100 GW OSW. Based on the 50% reduction estimated by Anbaric and 35% ocean cable mileages savings estimated in the U.K. OSW Study, the reduction in ocean miles of cable installations would range from 1,500 to 2,000 miles.

- A roadmap study for multi-state cooperation on offshore wind development, commissioned by the **Clean Energy State Alliance (CESA)**, found that the development of 8,000 MW of offshore wind generation is likely to create 36,000 full-time-equivalent jobs in project development and management, supply and installation of electrical substations and subsea cable, wind farm operation and maintenance, and equipment manufacturing. At the current scale of development—30 GW off the U.S. Atlantic Coast by the early 2030s, which greatly increases the likelihood of manufacturing more of the needed equipment locally—this would translate to 135,000 jobs for the region.[75]
- The **American Wind Energy Association** has forecasted that the development, construction, and operation for 20–30 GW offshore wind projects will support between 45,000 and 83,000 jobs by 2030.[76]
- **American Clean Power** estimates that the construction of 23–40 GW offshore wind projects would create 73,000–128,000 jobs, while 28,000 to 48,000 jobs in operations and maintenance roles, in the supply chain, and in surrounding communities could be permanently supported for the life of the projects.[77]

Continued industry growth to meet broader domestic targets are anticipated to foster higher shares of domestic manufacturing, which would further economic growth and employment opportunities. Proactively planned transmission solutions for offshore wind generation will support and enhance these employment and local economic stimulus benefit by reducing OSW development risk and ensuring that state and regional goals can achieved in a more timely and cost-effective fashion.

III. The Challenges and Barriers to Achieving Timely, Cost-Effective OSW Transmission Solutions

The development of more cost-effective long-term transmission solutions to meet state and national offshore wind goals faces several significant challenges that will need to be addressed

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[75] BVG Associates Limited for Multi-State Cooperation on Offshore Wind, U.S. Job Creation in Offshore Wind, Final Report, October, 2017, at S-1.

[76] American Wind Energy Association, U.S. Offshore Wind Power Economic Impact Assessment, March 2020, at 1.

[77] American Clean Power Association, Federal Revenue and Economic Impacts from BOEM Offshore Wind Leasing, December 2021, at 1.

expeditiously and collaboratively to achieve the benefits described above. These challenges include:

1. Slow, costly, reactive, and incremental **generator interconnection processes** currently used by the regional grid operators create delays and increase the cost of integrating clean energy resources.
2. Uncertainty over **federal investment tax credits** for generator and third-party-owned interconnection facilities and other federal funding imposes substantial uncertainty on OSW planning efforts.
3. Siloed **regional grid planning** processes that fail to identify cost-effective solutions that can simultaneously address the broad range of reliability, economic, and public policy transmission needs.
4. The absence of effective planning processes for **interregional transmission**.
5. The lack of HVDC **technology standardization** (*e.g.*, an HVDC grid code) and the slow adoption and operational integration of advanced HVDC technology in the U.S.
6. The lack of a compelling **benefits case** for meshed offshore grid solutions that reinforce the regional grid and provide interregional transmission capability.
7. Undefined **regulatory and contractual frameworks** for the shared and networked operation and use of offshore transmission facilities.
8. Regional **grid operations** that are not yet equipped to optimize fully regional or interregional HVDC links.
9. An unclear and poorly understood **BOEM permitting** process for offshore transmission that is distinct from offshore wind generators' individual interconnection cables.
10. **Uncoordinated processes** for lease-area auctions, state procurement of OSW generation, and regional transmission planning.

Several of these challenges have been highlighted in gaps assessments performed by DOE, including one each for the Atlantic[78] and West Coast[79] regions, and by the Business Network for Offshore Wind in its OSW transmission whitepaper.[80]

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[78] Department Of Energy Office of Energy Efficiency & Renewable Energy, Atlantic Offshore Wind Transmission Literature Review and Gaps Analysis, October, 2021.

[79] Department Of Energy Office of Energy Efficiency & Renewable Energy, West Coast Offshore Wind Transmission Literature Review and Gaps Analysis, September 15, 2022.

[80] B. Burke, M. Goggin, R. Gramlich, Offshore Wind Transmission Whitepaper, Business Network for Offshore Wind, October, 2020.

These challenges are discussed in more detail below. If not addressed expeditiously, they collectively represent a substantial barrier to the timely and cost-effective development of OSW resources.

1. Inadequate Generator Interconnection Processes

The slow, highly-uncertain, costly, reactive, and incremental processes for generator interconnection (GI) currently used by regional grid operators is not suitable to optimize grid interconnection points for a timely and cost-effective integration of the substantial amount of OSW needed to meet even the already-existing state policy goals for the next decade. It will certainly not be able to support the much higher long-term needs through 2040 and 2050. While recent reforms to these GI processes have enabled minor improvements, the siloed structure of generator interconnection processes and their current separation from regional transmission planning processes will not enable the identification of optimal points of interconnections or efficient use of the transmission system.

As the volume of interconnection needs has increased, generation interconnection processes have become a barrier to timely and cost-effectively integrating clean energy into the grid. Historically, generator interconnection processes were designed to evaluate one connection request at a time in a process designed for legacy fossil fuel plants, when far fewer projects were simultaneously seeking to come online. Several regions have somewhat improved on a purely incremental study process[81] by studying "clusters" of several interconnection requests simultaneously, with the goal of speeding up interconnection processes. Unfortunately, these improvements have generally been insufficient to address the substantial backlog and uncertainty associated with the GI processes. Developers continue to identify interconnection processes as a major challenge to the timely and cost-effective development of clean energy resources.[82]

The incremental GI process may also ultimately cause substantial costs for offshore wind project interconnection. As described above, there are substantial benefits to the onshore grid associated with coordinating larger amounts of interconnection requests in a single study

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[81] See, for example, *PJM Interconnection LLC,* 181 FERC ¶ 61,162 (2022).

[82] See, for example, Ocean Wind, Comments of OW North America LLC on Regional Transmission Initiative Notice of Request for Information and Scoping Meeting, October 28, 2022, at 1 ("The ambiguity and the long duration of existing interconnection practices and procedures to identify, optimize, and cost quantify the full nameplate power deliverability at onshore injection points have been a challenge for advancing large offshore wind projects.")

process. These benefits have been demonstrated through the JTIQ, PJM's OSW transmission study, and MISO's LRTP. The downside risks have also been observed, including the substantial growth in interconnection costs in Massachusetts from $10/kW for early projects, to over $275/kW for the most recent.[83] The cost of interconnecting the next wave of OSW to the grid in southeastern New England is anticipated to be well over $1 billion[84] and individual interconnection costs for OSW generation in PJM have grown increasingly uncertain and to a level where they exceed those of any other resource type.[85] Without coordinated planning, this individualized construction will likely prove insufficient to meet wider clean energy goals, increasing the costs of future OSW facilities that may require similar system capability.

Even the new cluster study processes, where GI requests are studied in a group rather than individually, retain large amounts of uncertainty for OSW project developers and are not designed to holistically optimize regional transmission systems considering long-term OSW integration and other system-wide needs. These processes continue to be separate from broader regional transmission planning efforts that, if integrated, would be able to identify more efficient regional transmission solutions that enable the integration of identified clean-energy resources with reliability and market efficiency needs, as discussed further below. Improvements to streamline GI processes also are not designed to proactively identify or optimize limited POIs in a manner that will ensure cost-effective solutions for long-term needs. FERC's recent Notices of Proposed Rulemaking regarding long-term transmission planning and

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[83] American Clean Power Association and RENEW Northeast, Comments of the American Clean Power Association and RENEW-Northeast on Changes and Upgrades to the Regional Electric Transmission System Needed to Integrate Renewable Energy Resources, 2022, at 2. $7.7 million interconnection costs for 800 MW Vineyard Wind 1, $195.5 million for 800 MW Park City Wind and $335 million for the next 1200 MWs.

[84] J. Pfeifenberger, S. Newell, W. Graf, K. Spokas, Offshore Transmission in New England: The Benefits of a Better Planned Grid, The Brattle Group, May 2020.

New 345kV overhead and underground transmission from West Barnstable to K Street in Boston has been estimated to cost $1.4 billion.

[85] See J. Seel, *et al.*, Interconnection Cost Analysis in the PJM Territory, Berkeley Lab, January 2023. Figure 3 of this study shows that average interconnection costs of active projects in PJM's queue have grown from $29/kW to $240/kW, with the average interconnection cost of withdrawn projects (a measure of cost uncertainty faced by generators as they submit interconnection requests) now at $600/kW. Figure 4 shows that the large majority of interconnection-related costs are connected to upgrades to the broader regional network that are triggered by interconnection study criteria—upgrades that can be addressed more cost effectively through holistic planning, rather than incrementally. Figure 5 shows that the average cost of OSW generation in PJM's interconnection queue is now close to $400kW, higher than interconnection costs of any other resource type, and with an uncertainty range of $200/kW to over $500/kW. As discussed earlier, these interconnection costs and cost uncertainties compare to an average cost of proactively-planned onshore network upgrades of less than $90/kW for 6,400 MW under New Jersey's SAA with PJM.

generation interconnection[86] also fall short of requiring necessary improvement to generation interconnection processes and their integration with near- and long-term regional transmission planning processes. While the transmission planning NOPR proposed to add long-term multi-value transmission planning processes, it also does not propose to change the existing planning processes approved by Order 1000.[87] As a result, incremental generation interconnection and near-term transmission needs continue to be addressed first, pre-empting more efficient solutions that could be identified through more proactive planning processes that simultaneously consider multiple longer-term needs.[88]

2. Uncertain Federal Investment Tax Credits and Funding

A source of federal funding is likely to be necessary to promote offshore wind transmission efforts, particularly at the interregional level. The Federal ITC is a key component supporting the capital investment and development of OSW and other clean energy projects. While the Inflation Reduction Act (IRA) renewed provisions for a 30% investment tax credit for OSW generation, there is considerable uncertainty as to whether (a) HVDC transmission facilities from offshore wind generators to the onshore grid qualify for Federal ITC that applies to OSW generators' "wind energy property," including "transfer" and "power conditioning facilities" under Treas. Reg. § 1.48-9(e)(1); and (b) if so, whether those opportunities would extend to comparable facilities that are shared by multiple generators or are independently owned by stand-alone developers. Expeditiously confirming that the ITC is available for OSW generators' and third-party-owned "transfer" and "power conditioning" facilities that include HVDC converters and radial lines to shore is critical to promoting offshore wind transmission.

This uncertainty was specifically referenced in New Jersey BPU's SAA Evaluation Report, noting that:

> In contrast to independently owned transmission assets, the current ITC arguably does apply to "transmission assets" associated with the delivery of offshore wind generation, such as export cables and onshore interconnection

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[86] *Building for the Future through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection,* Notice of Proposed Rulemaking, 179 FERC ¶ 61,028 (2022); *Improvements to Generator Interconnection Procedures and Agreements*, Notice of Proposed Rulemaking, 179 FERC ¶ 61,194 (2022).

[87] *Building for the Future through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection,* Notice of Proposed Rulemaking, 179 FERC ¶ 61,028 at P 3 (2022)("We do not propose in this NOPR to change Order No. 1000's requirements for public utility transmission providers with respect to existing reliability and economic planning requirements.").

[88] For additional discussion of current GI challenges and recommended solutions, see also J. Pfeifenberger, Generation Interconnection and Transmission Planning, ESIG Special Topic Workshop, August 9, 2022.

> assets. In this regard, the Treasury Regulations that define "wind energy property" note that both transfer equipment and power conditioning equipment constitute ITC eligible property, while transmission equipment does not. The IRS has issued guidance on these regulations only once, in the context of an onshore wind farm with a single step-up transformer, and in that guidance demarcated the high side of the step-up transformer as the cut-off point. In contrast to an onshore wind project, we note that offshore wind facilities often must account for commercial and technical considerations when selecting the stepped-up voltage for the export cable. Because that voltage is often again stepped up (or potentially down) to transmission voltage at an onshore substation, many have found persuasive the argument that the export cable and onshore interconnection assets constitute power conditioning or transfer equipment, and not transmission equipment.[89]

Certain precedent potentially allows for ITC eligibility to include wind energy property that is owned by a separate entity. We understand that the Tax Court has rejected arguments that energy property only exists in the context of a "completely functional system,"[90] suggesting that energy property should be eligible for ITC even when only developing a portion of the complete system (*e.g.,* only the offshore transmission). Additional precedent appears to exist that may permit separate ownership of ITC-eligible property under certain circumstances.[91] Developers, such as Anbaric, have submitted comments to seek IRS guidance on the applicability of ITC to export cables and power conditioning equipment.[92]

The Internal Revenue Service (IRS) has not yet ruled on these issues in the context of OSW transmission, which means for OSW generation and (in particular) any independently planned and developed interconnection facilities, ITC eligibility remains uncertain. This uncertainty applies to all segments between the offshore substation (to which cables from each individual wind turbines tie into) and the onshore injection point of OSW energy—including offshore

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[89] BPU SAA Evaluation Report, at Appendix C.3.

[90] See *Cooper v. Commissioner*, 88 T.C. 84, 116–17 (1987) (rejecting an argument that energy property only includes "a completely functional system" in finding that ITC eligibility is not dependent on an individual taxpayer owning a complete system).

[91] See Rev. Rul. 78-268, 1978-2 C.B. 10 (allowing proportionate ITC to co-owners of an electric generating facility despite their owning the facility as tenants in common with tax-exempt and municipally owned entities that are disqualified from receiving the ITC).

[92] Anbaric, Anbaric OSW ITC Comments, December 19, 2022.

cabling, landing infrastructure, and upgrades to existing onshore electrical infrastructure. This has a substantial impact on the extent to which independent offshore transmission solutions are more cost effective than continued reliance on OSW generator-developed radial interconnection facilities. The New Jersey BPU's SAA Evaluation Report found, for example, that foregoing the ITC on facilities that interconnect OSW plants with the onshore grid would increase the cost of achieving New Jersey's offshore wind goals by approximately $2.2 billion.[93]

A successful approach to building interregional transmission facilities likely requires federal cost-sharing beyond the ITC currently available. The full cost of a regional offshore wind transmission network is likely more than any one state's ratepayers can afford to fund, likely requiring both a broad regional cost allocation and federal assistance to buy-down the cost of a full offshore grid. Current federal transmission funding programs, including the GIP and Transmission Facilitation Program, do not have funds specifically directed towards offshore wind transmission, and do not appear well-tailored to provide funding opportunities for offshore wind, although several New England States have requested proposals that would employ these funding streams.[94] Instead, the federal government, either through an existing program or through new legislation, should establish a dedicated "challenge grant" opportunity that would encourage coastal states to come together with a joint proposal to compete for offshore wind grid funding.

3. Siloed Transmission Planning

Many existing transmission planning processes do not yet consider public policy and other transmission needs holistically and proactively. Rather, transmission planning is typically siloed into specific project categories that fail to optimize the broad range of reliability, market efficiency, and public policy benefits that can be provided simultaneously by well-planned regional transmission investments.[95] In addition, generation interconnection-related transmission upgrades and local transmission investments planned by Transmission Owners (often categorized as asset management or supplemental projects)[96] are separated from regional planning efforts that could identify more cost-effective regional solutions. Despite

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[93] BPU SAA Evaluation Report at 52, Table 7.

[94] See New England States Transmission Initiative, December 16, 2022 Update, which includes state notices from Massachusetts, Connecticut, Rhode Island, and Maine.

[95] See, for example, J. Pfeifenberger and J. DeLosa, Transmission Planning for a Changing Generation Mix, OPSI 2022 Annual Meeting, October 18, 2022.

[96] See, for example, *PJM Interconnection LLC,* 172 FERC ¶ 61,136 (2020); see also ISO-NE, Final Asset Condition List, March 2021 (identifying $4.6 billion dollars in ISO-NE Asset management projects as of June 2021); ISO-NE, 2021 Regional System Plan, November 2, 2021, at § 5.8.

differences in the transmission processes across the ISO/RTO regions, similarities exist in this reliance on siloed planning processes for different types of incremental needs, creating a substantial barrier for the identification of more cost-effective transmission solutions for OSW.

Furthermore, while it is critical that the results of offshore wind transmission planning be incorporated into the transmission plans developed by each grid operator, the process for inserting the results of any offshore wind transmission planning process into each planning process differs across regions. States may also need to engage in a coordinated submittal of planning goals into each regional transmission plan to ensure that offshore wind transmission planning has a tangible path forward. FERC initiatives such as the State Agreement Approach in PJM provide a path for individual states to insert their planning priorities into the regional transmission expansion plan,[97] but significant challenges remain.

The three eastern regional system operators—NYISO, ISO-NE, and PJM—will be instrumental to the planning of cost-effective transmission solutions for OSW generation on the Atlantic coast. Yet, all three regions overlook opportunities to more holistically consider a broader range of identified system needs, including for public policy, in their planning process. While the three regions consider public policies as required by FERC Order 1000,[98] these regions do not consistently and comprehensively identify and incorporate all known public policy needs into their transmission planning processes. Instead, each region uses a rather narrow approach to considering public-policy-related transmission needs. While NYISO is addressing some OSW related needs through its Public Policy Transmission Planning Process (PPTPP), and PJM is addressing some of New Jersey's OSW-related needs through its first SAA, ISO-NE has not identified any public-policy-related system upgrades in its most recent regional system plan. Due to concerns of the New England States over the adequacy of the existing planning process, the states did not request[99] that ISO-NE conduct its Public Policy Transmission Studies (PPTS) in either 2017[100] or 2020.[101] This lack of an adequate holistic planning process stands in stark contrast to the substantial transmission investments that will be necessary over the next

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[97] See also *State Voluntary Agreements to Plan and Pay for Transmission Facilities,* 175 FERC ¶ 61,225 (2021).

[98] *Transmission Planning and Cost Allocation by Transmission Owning and Operating Public Utilities,* Order No. 1000, 136 FERC ¶ 61,051 at P 203 (2011) ("The Commission requires public utility transmission providers to amend their [tariffs] to describe procedures that provide for the consideration of transmission needs driven by Public Policy Requirements in the local and regional transmission planning processes.")

[99] NESCOE, Submission Regarding Transmission Needs Driven by State and Federal Public Policy Requirements, May 1, 2017; NESCOE, Submission Regarding Transmission Needs Driven by State and Federal Public Policy Requirements, May 1, 2020.

[100] ISO-NE, 2020 Public Policy Transmission Upgrade Process, June 17, 2020.

[101] ISO-NE, 2017 Public Policy Transmission Upgrade Process, June 21, 2017.

decade to accommodate the 8 GW OSW goal of the New England states and the region's much larger long-term needs. None of the three eastern RTOs currently employ a proactive, scenario-based planning process that, like MISO's LRTP,[102] could simultaneously address long-term reliability, market efficiency, generation interconnection, and state public policy needs. Most recently, California has begun reviewing system needs associated with offshore wind as part of its long-term scenario-based planning outlook, having included 10 GW of offshore wind in its 20-year planning scenarios.[103]

One of the most important steps in building out an offshore wind transmission grid is building a bridge between several recent and ongoing transmission-related "desktop" studies and the transmission planning processes overseen by each ISO and RTO. Currently, many of these studies are academic in nature and divorced from actual ISO/RTO planning processes and planning criteria. Others simply do not involve a comprehensive analysis of the onshore upgrades necessary to support new offshore wind facilities. In addition, there are few effective paths for getting identified large-scale regional and interregional public policy-driven transmission needs integrated with other needs and holistically considered in existing planning processes.

4. Ineffective Interregional Planning

As we have pointed out elsewhere,[104] numerous studies have confirmed the significant benefits of expanding interregional transmission in North America. Building new interregional transmission projects can lower overall costs, help diversify and integrate renewable resources more cost effectively, and reduce the risk of high-cost outcomes and power outages during extreme weather events.[105] Several recent events, including the 2021 winter storm Uri, illustrated the very large potential but thus far unrealized reliability benefits and cost savings that interregional transmission can provide. Yet, despite broad consensus that the benefits and value of expanding interregional transmission capabilities often exceed its costs, thereby reducing overall system-wide costs, these studies are not integrated with any actionable transmission planning processes of the regional grid operators. Not surprisingly, virtually no major interregional transmission projects have been built in the U.S. over the last few decades.

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[102] See MISO, Long Range Transmission Planning.

[103] California ISO, Transmission Planning for Offshore Wind, November 10, 2022, at 15.

[104] J.P. Pfeifenberger, *et al.*, A Roadmap to Improved Interregional Transmission Planning, November 30, 2021 (Interregional Planning Roadmap).

[105] For a summary of interregional transmission studies, see Interregional Planning Roadmap, at 2 (Table 1) and Appendix B.

One of several reasons why interregional transmission is not developed despite the many studies documenting the need for and benefit of doing so is the lack of actionable planning processes that could holistically identify interregional transmission needs, and approve projects that could address such needs.[106] The lack of effective interregional planning processes has been noted in FERC's 2021 Advance Notice of Proposed Rulemaking (ANOPR)[107] and at least 32 reply comments, most of which recommended improving interregional planning processes.[108]

In addition to the near-total absence of actionable interregional planning processes, cost effective interregional transmission solutions are often pre-empted by the design and sequencing of existing transmission planning processes:[109]

- First, since each planning region has to ensure that its own system meets all applicable reliability standards, all of these reliability needs are addressed at the local and regional level. Almost by definition, there is no reliability need for interregional transmission projects left to address.
- Second, many regional planning processes do not account for multiple drivers of the overall need for interregional transmission projects, which means that these processes are not set up to identify interregional transmission project solutions that can simultaneously and more cost-effectively address multiple regional and interregional needs.
- Third, the scope of regional planning processes tends to consider too narrowly transmission-related benefits and their geographic scope, typically quantifying only a subset of transmission-related economic and public policy benefits and considering only benefits that accrue to that particular region without considering the broader set of interregional benefits. This means quantified benefits are frequently understated and even regional projects near regional seams often fail to meet applicable benefit-cost thresholds for regional market efficiency and public policy needs, simply because the planning process ignores the benefits that accrue on the other side of the seam.
- Finally, local and regional reliability needs tend to be addressed quickly and projects are often approved before larger, proactive, and potentially more cost-effective interregional solutions can be considered and approved in a sufficiently timely manner.

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[106] For a survey of interregional transmission planning barriers, see Interregional Planning Roadmap, Appendix A.

[107] *Building for the Future through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection,* Notice of Proposed Rulemaking, 179 FERC ¶ 61,028 (2022).

[108] Interregional Planning Roadmap, at 3.

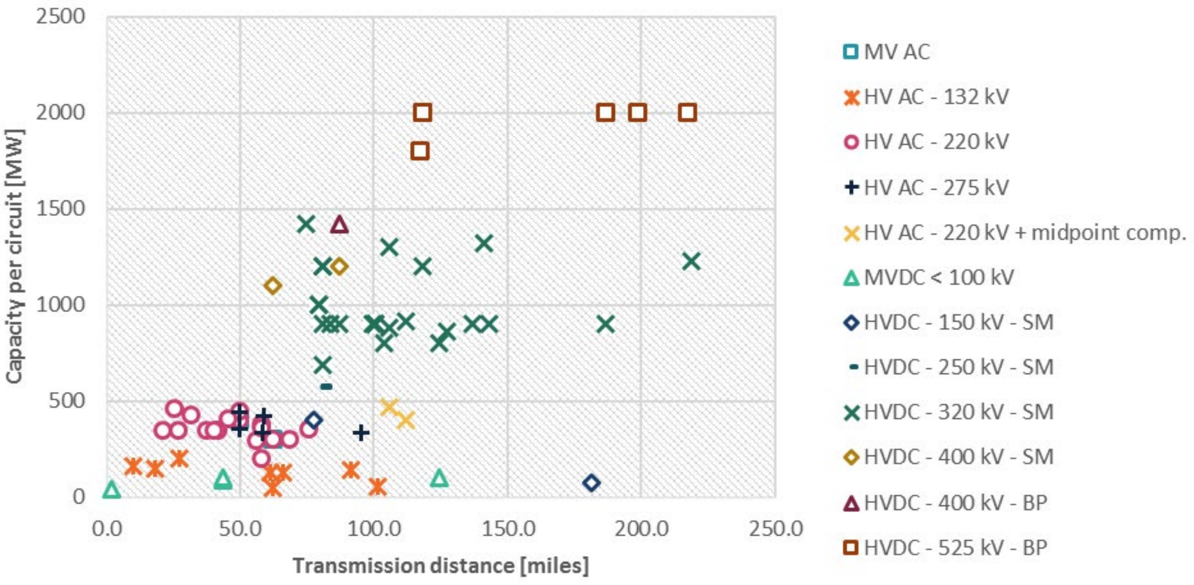
[109] Interregional Planning Roadmap, at 10–11.

Unless these challenges are addressed through improved, actionable interregional planning processes, interregional offshore transmission solutions will not have a feasible development and approval pathway even if additional industry studies, such as DOE's Atlantic Offshore Wind Transmission Study,[110] continue to point out the cost-effectiveness of interregional solutions.

5. Slow Adoption and Lack of Standardized HVDC Technology

HVDC transmission technology has proven to be able to offer more cost-effective and less environmentally impactful offshore wind transmission solutions, particularly as the size of individual OSW plants has increased to 1,200 MW and beyond and distances from onshore interconnection points continue to increase as well. The ability to transmit a substantially greater amount of power over longer distances through a single HVDC cable circuit allows for a significant reduction of offshore cable miles, shore crossings, and onshore impacts. The ability to select more robust, but more distant, grid interconnection points allows for a significant reduction in necessary upgrades to the existing grid.

FIGURE 4: TRANSMISSION TECHNOLOGIES FOR EXISTING AND PROPOSED OSW PLANTS



Source: DNV. The types of HVDC designs shown also distinguishes between "Symmetrical Monopole" (SM) configurations and higher-capacity "Bi-Pole" (BP) configurations.

Proactively designed, mesh-ready HVDC transmission solutions to integrate OSW generation with these technologies can offer attractive options to create regional and interregional multi-terminal offshore HVDC networks that can reinforce the existing grid. For example, as the New

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[110] See US DOE Wind Energy Technology Office and National Renewable Energy Laboratory, Atlantic Offshore Wind Study.

England states have illustrated in their RFI, OSW projects in neighboring wind lease areas near Martha's Vineyard with radial transmission links to Boston, Connecticut, and New York City may provide attractive opportunities to increase the reliability of OSW deliveries and enhance both regional and interregional transmission capabilities through relatively short links between neighboring OSW plants.[111] The U.K. is evaluating multi-purpose interconnector pilot schemes that propose to interconnect to Belgium, Netherlands, and Norway in an offshore wind network to achieve multi-governmental objectives and offshore wind goals.[112]

Integrating radial HVDC links into a networked HVDC offshore transmission system does, however, face several challenges that need to be addressed. First, the still relatively limited global adoption of high-capacity HVDC technologies—such as 525 kV cables capable of delivering between 2 GW and 2.6 GW of OSW generation—creates several challenges for suppliers, developers, network planners, and grid operators. Second, HVDC technologies from different manufacturers are not currently compatible even when operating at the same voltage level. Third, key elements of high-capacity offshore HVDC networks, such as HVDC circuit breakers, are not yet widely available. Fourth, grid operators have very limited planning and operational experience with HVDC technologies necessary to take full advantage of the technology's capabilities. And, finally, for individual HVDC export cables to be networked into a meshed offshore grid, they either need to use the same HVDC voltage level and technology if linked on the DC-side of offshore substations or utilize HVAC links on the AC-side of offshore substations.[113] The different interlink technologies come with different pros and cons, which need to be evaluated carefully in the light of the planned future use of the interlinks.

Commenters in the New England RFI have noted the potential for incompatibility of equipment from different manufacturers, which would create substantial barriers to expansion or modularity benefits associated with coordinated offshore transmission. PPL and WindGrid stated that:

> given the absence of an HVDC standard at this stage, the compatibility between different vendors is not guaranteed by default. For the

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[111] New England Regional Transmission Initiative, Notice of Request for Information, at 11.

[112] The Office of Gas and Electricity Markets, Decision on Multi-Purpose Interconnector Pilot Project Selection, December 15, 2022.

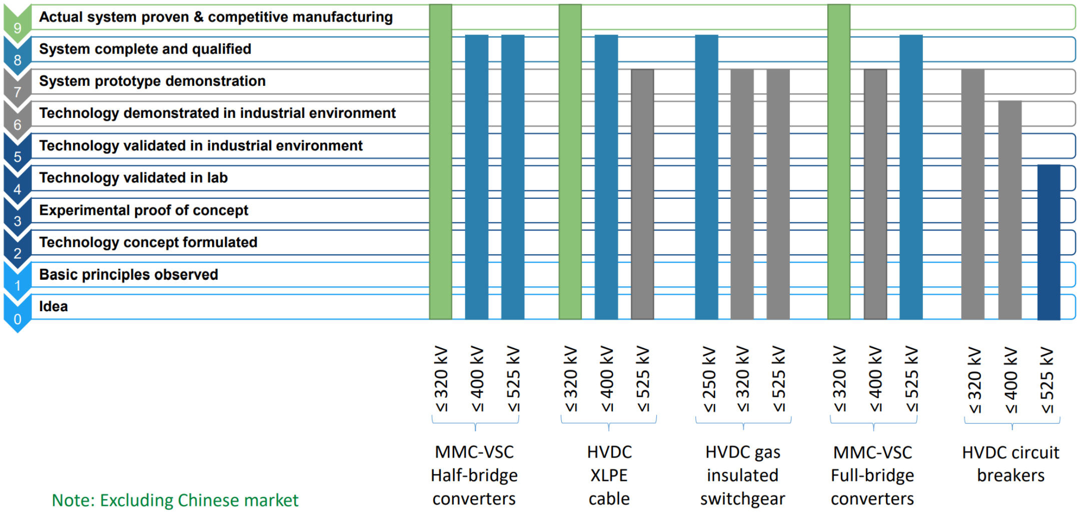
[113] For a summary of offshore transmission designs and the pros and cons of using AC or DC links between OSW export cables, see J. Pfeifenberger, Promoting Efficient Investment in Offshore Wind Transmission, DOE-BOEM Atlantic Offshore Wind Transmission Economics & Policy Workshop, August 16, 2022, at 16–20.

> interoperability of converters from competing manufacturers, the industry has recognized the need for interoperability and multivendor converters.[114]

Multiple initiatives are currently underway in Europe[115] to address the concern over vendor interoperability and will have completed well before any multi-terminal HVDC systems will appear in the U.S.

Figure 5 shows the readiness levels for different technology components required to enable various OSW transmission configurations at different voltages. Notably, HVDC circuit breakers, which would enable multi-terminal HVDC networks, are not yet widely available for offshore applications, even for the lower HVDC voltage levels currently in use.

FIGURE 5: HVDC TECHNOLOGY READINESS



Source: C. A. Plet, Multi-terminal HVDC Transmission Grids: Pros, cons and next steps, IEEE PES GM, 2022, at 17.

The development and standardization of these technologies is being actively pursued in Europe. TenneT has developed a new 2,000 MW, 525 kV HVDC standard that already is planned to be deployed for 13 platform- and 5 island-based offshore 525 kV converter systems, including network-ready OSW connections to support German and Dutch goals of developing an additional 20 GW OSW generation by 2030.[116] Most recently, AMPRION, a transmission system

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[114] PPL TransLink and WindGrid Response to RFI, October 28, 2022, at 11.

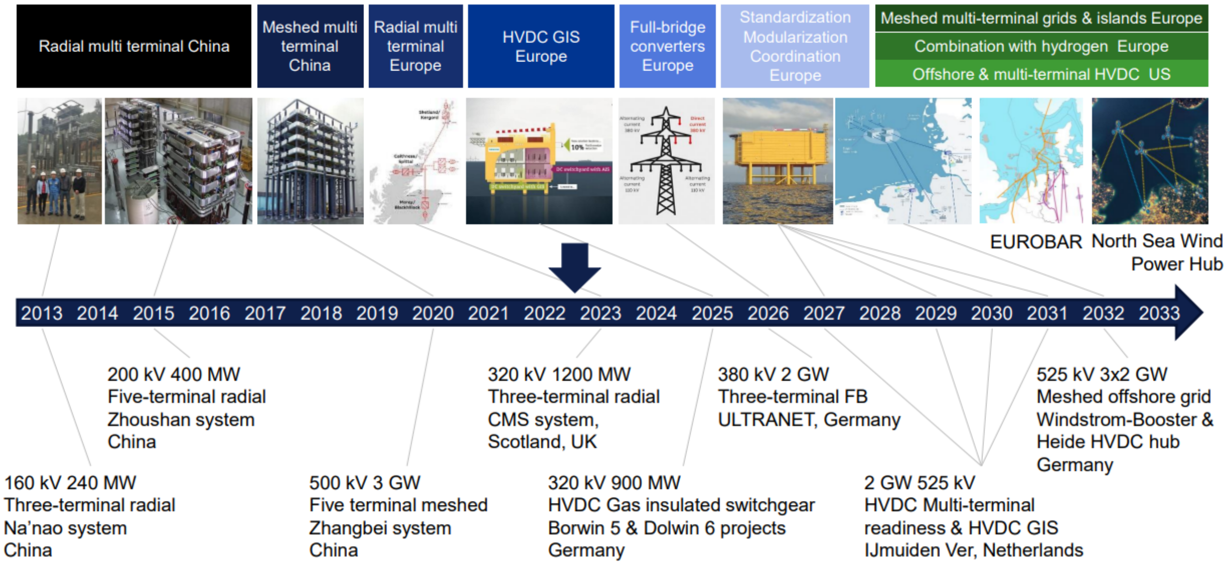
[115] Including Ready4DC and InterOpera.

[116] TenneT, TenneT has opened 2GW Program tender for 525 kV DC offshore Cable manufacturing and installation, July 11, 2022.

See also TenneT Netherlands 8×2 GW (https://www.tennet.eu/projects/offshore-projects-netherlands#9618); TenneT Germany 3×2GW (https://www.tennet.eu/de/unsere-projekte/offshore-projekte-deutschland); Amprion Germany 2×2 GW (https://offshore.amprion.net/Offshore-Projekte/LanWin1-LanWin3/); Belgium's operator in Germany, awarded Siemens Energy and Dragados Offshore to build 2,000 MW converter stations for the LanWin1 and LanWin3 offshore wind connection systems.[117]

As discussed further in Section IV below, the development timeline for use of these advanced technologies in Europe provides an opportunity for the U.S. to participate in the development of technical HVDC standards that would ensure interoperability of various manufacturers HVDC equipment. As shown in Figure 6, these standards are being developed now for development of multi-terminal-ready 525kV HVDC facilities planned for 2027 through 2031 that could be integrated into a meshed offshore grid by 2032.

FIGURE 6: TIMELINE OF FUTURE TECHNOLOGY DEVELOPMENT FOR OFFSHORE WIND



Source: C. A. Plet, Multi-terminal HVDC Transmission Grids: Pros, cons and next steps, IEEE PES GM, 2022, at 14.

Until these (or comparable) types of design and technology standards are developed or adopted for U.S. applications, interoperability of different equipment manufacturers is ensured, and system operators implement HVDC capabilities in their planning processes and operational

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Princess Elisabeth island 2.3 GW (1st phase) multi-terminal connections to UK and Denmark (https://www.oedigital.com/news/499883-belgium-s-elia-presents-plans-for-world-s-first-artificial-energy-island, https://www.elia.be/infrastructure-and-projects/infrastructure-projects/tritonlink, https://www.elia.be/en/infrastructure-and-projects/infrastructure-projects/nautilus); Denmark's North Sea Island 3 GW (1st phase, two converters) multi-terminal connections to Netherlands, Germany (to 50Hertz TSO) and Belgium (via Princess Elisabeth island) (https://ens.dk/sites/ens.dk/files/Energioer/the_energy_island_in_the_north_sea_-_teaser_for_potential_investors_november_2022.pdf); and Denmark's Bornholm Island 3 GW (two converters), multi-terminal connections to Germany (https://en.energinet.dk/About-our-reports/Reports/Business-case-for-Energy-Island-Bornholms-electrical-infrastructure/).

[117] Amprion, Amprion awards converter stations to Siemens Energy and Dragados Offshore, January 10, 2023.

protocols, the development of offshore HVDC networks will remain a challenge. Design and technology standards must be sufficiently flexible (*e.g.*, modular) so networks can be built over time, incorporate evolving technology, while ensuring near-term needs can be met in a timely and cost-effective manner. Work on this issue has been initiated through DOE's recent HVDC standardization efforts, enabled by recent federal funding.[118]

An additional challenge exists as the capacity of new HVDC technologies (2.0–2.6 GW for a bi-pole 525 kV HVDC circuit), which could most effectively deliver the output of several OSW plants to shore, exceeds what system operators view as an acceptable "most severe single contingency (MSSC)."[119] For example, ISO-NE is currently limiting new interconnections to 1,200 MW through its planning procedure which, as several commenters in the New England RFI have pointed out, unnecessarily prevents interconnection of new HVDC technologies with capabilities that exceed the size of the region's single largest contingency.[120] As commenters note, the 1,200 MW limit could be raised if ISO-NE were to accept operational measures to address the current concerns over larger power injections. However, while ISO-NE planning processes are most rigid about limiting interconnection to 1,200 MW, concerns over power injections that exceed the system's current single-largest contingency also exist in other RTOs.

6. Uncertain Design and Benefits of Networked Offshore Transmission

The optimal choices for transmission technology, offshore network configuration, and the design of meshed or backbone offshore links, in particular the offshore hubs/substations, are still uncertain. As shown in Figure 7 below, several offshore transmission configurations are possible, each with its own costs, benefits, and challenges. Radial tie lines, meshed generator ties, shared collector stations, and a full offshore backbone have been identified (and in some

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[118] Department of Energy Wind Energy Technologies Office, WETO Releases $28 Million Funding Opportunity to Address Key Deployment Challenges for Offshore, Land-Based, and Distributed Wind, December 6, 2022.

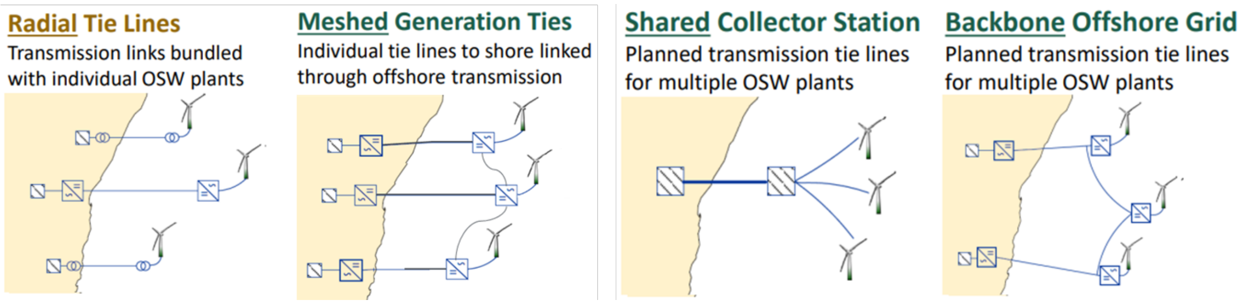
[119] As defined by NERC Standard BAL-002-2, the MSSC is "The Balancing Contingency Event, due to a single contingency, that would result in the greatest loss (measured in MW) of resource output used by the Reserve Sharing Group (RSG) or a Balancing Authority that is not participating as a member of a RSG at the time of the event to meet firm system load and export obligation (excluding export obligation for which Contingency Reserve obligations are being met by the sink Balancing Authority)."

[120] Comments of Hexicon USA, LLC in Response to Request for Information of The New England States Concerning Transmission of Offshore Wind, October 28, 2022, at 7 (referencing Attachment G of the ISO-NE tariff)

See also Anbaric, Scaling Renewable Energy (New England RFI comments), October 28, 2022, at 13.

cases evaluated) as options to deliver offshore generation to the onshore grid.[121] The already-procured OSW projects in the U.S. have all employed radial interconnection facilities, with a new round of solicitations in some regions requiring mesh-ready (or "network-ready") offshore interconnection facilities. Without a selected network design and the further development of standards that ensure of interoperability of technology between different equipment manufacturers, shared or backbone offshore facilities face additional challenges compared to current radial approaches.[122]

FIGURE 7: OFFSHORE TRANSMISSION DESIGN CONCEPTS



Source: J. Pfeifenberger, Promoting Efficient Investment in Offshore Wind Transmission, August 16, 2022, at 16.

Uncertainty in the design, technology type, and cost-benefits case for networked offshore wind transmission systems, particularly as HVDC technology continues to evolve, thus creates a challenge to the development of offshore transmission networks today. The high capital costs associated with nascent technologies create additional challenges in justifying the increase in offshore system capability that would be developed by offshore interlinks. While different designs provide different system benefits and value streams, consensus has not yet emerged in the U.S. as to which system design is preferred. Different transmission designs capable of providing valuable system capabilities—such as voltage support, black-start, power-flow control, and system-stabilization benefits of offshore HVDC networks—are not yet fully understood, accepted, and accounted for by U.S. RTOs in their system operations and

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[121] For an evaluation of these offshore transmission options, see NYSERDA, New York Power Grid Study, Appendix D (Offshore Wind Integration Study), January 2021. The NYSERDA study concluded that "because a meshed configuration can achieve a more reliable and resilient delivery of OSW generation," the State should ensure that new "radial connections are constructed in ways that include the option to integrate the radial lines into a meshed system later." (Executive Summary at 3)

[122] See also J. Pfeifenberger, Promoting Efficient Investment in Offshore Wind Transmission, August 16, 2022, at 17–20. As illustrated in Figure ES-2, the optimal design of an offshore transmission solution for 60 GW is considerably more complex than the concepts illustrated in Figure 7, and vary dependent on the location of wind lease areas, the configuration of the existing onshore grid, the regional resource mix, and numerous other factors. Detailed planning efforts will be necessary to identify the most cost-effective and beneficial combination of onshore and offshore grid configurations and technology choices.

transmission planning efforts. In Europe, however, there is a clear trend towards radial HVDC lines with standardized technology so that they can be connected—through DC interlinks with HVDC circuit breakers—to yield offshore networks, including multi-purpose offshore interconnectors between countries.

Importantly, within the existing actionable planning frameworks that could result in the approval and development of regional and interregional offshore networks, the need for and benefit-cost analyses for creating such networks in the U.S. has not yet been established. While some studies suggest that regional and interregional offshore will be cost-effective in the future,[123] no RTOs have proactively considered networked offshore transmission options in their transmission planning processes. While networked offshore transmission configurations have been solicited by PJM and proposed by bidders in New Jersey's State Agreement Approach, the process did not produce sufficient evidence that, under current planning paradigm, offshore links would benefit the State's OSW procurement.[124] As discussed in the BPU Evaluation Report, SAA bidders did not submit proposals showing that the deliverability advantage (*i.e.*, outage mitigation benefit) of networked offshore configurations justified the cost of the necessary offshore links and did not propose technology solutions with the operational capabilities that would allow these links to be controlled and optimized in real-time to capture market efficiency benefits. Importantly, PJM's market efficiency analysis did not yet document any onshore transmission constraints between POIs that would yield energy and capacity market benefits sufficient to justify offshore links between OSW export cables at this point.

However, acknowledging the future benefits that networked offshore transmission will likely be able to provide, both New York and New Jersey state regulatory commissions have recognized the value of creating the option to integrate radial OSW export lines into an offshore network at some point in the future. In response, both commissions have directed that future procurements of OSW generation include mesh-ready/network-ready offshore substations.[125] The New England states have similarly recognized the likely value of regionally and interregionally networked offshore transmission in their joint Request for Information seeking

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[123] For example, a study for NYSERDA found that linking Long Island and New York City through "meshed" OSW transmission may be attractive at some point in the future (*e.g.*, by 2040), with payback periods for adding links between mesh-ready offshore substations possibly as short as several years. See J.P. Pfeifenberger, *et al.*, The Benefit and Cost of Preserving the Option to Create a Meshed Offshore Grid for New York, November 9, 2021.

[124] BPU SAA Evaluation Report, at 118–122.

[125] See 2022 Solicitation—NYSERDA (Appendix G: Meshed Ready Technical Requirements) and Solicitation Documents—NJ Offshore Wind (Attachment 11: Offshore Transmission Network Preparation Requirements)

comment on an initiative to integrate offshore wind and other resources in a cost-effective, reliable and efficient manner.[126]

7. Undefined Regulatory and Contractual Frameworks

The regulatory and contractual frameworks for the shared use and networked operation of offshore transmission facilities—including procurement methods, procurement structure, evaluation criteria, cost allocation, market operation, and the inherent tension between open access provisions and priority interconnection rights—have not yet been developed. Europe has been addressing this gap for the last few years through "research into the requirements of the legal, economic, and financial framework that could facilitate the cost-effective construction and governance of a [meshed offshore grid]."[127] Initial regulatory work is also underway in Great Britain focusing on regulatory questions related to shared, networked offshore transmission as part of the Offshore Transmission Network Review.[128] In the EU, recent European Network of Transmission System Operators for Electricity (ENTSO-E) work defined and analyzed the various functions necessary to plan, build, own, operate, and maintain interregional offshore transmission networks under various organizational structures.[129] The still undefined nature of these regulatory and contractual elements presents unique challenges in pursuing shared and networked transmission solutions for offshore wind in the U.S.

One potential avenue to address these challenges is through multi-state agreements. However, while such agreements are enabled and encouraged by FERC,[130] no multi-state agreements that could plan and procure effective regional or interregional offshore transmission solutions currently exist. Unanswered regulatory questions associated with multi-state agreements include:

- **Procurement Method:** How would states identify and commit to the amount of public policy transmission to be regionally planned? Would this require state commission orders or new FERC regulations? How would the rights to the capability created by multi-state transmission procurement be apportioned and used? Would capability be preserved in accordance with states' public policy development schedules?

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[126] New England States Transmission Initiative—New England Energy Vision

[127] PROMOTioN, D7.9 Regulatory and Financing principles for a Meshed HVDC Offshore Grid, April 2019, at 4.

[128] See Ofgem, Consultation—Offshore Transmission Network Review—Multi-Purpose Interconnectors: Minded-to Decision on interim framework, April 14, 2022.

[129] ENTSO-E, ENTSO-E Position on Offshore Development: Assessment of Roles and Responsibilities for Future Offshore Systems, November 2022.

[130] State Voluntary Agreements to Plan and Pay for Transmission Facilities*,* 175 FERC ¶ 61,225 (2021).

- **Procurement Structure:** What would be the scope of the procurement? How would shared offshore transmission facilities be planned, identified, selected, and procured? Are separate procurements needed for onshore and offshore transmission components? How will procurement of OSW transmission address project-on-project risks faced by interconnecting OSW generation developers? What type of contracts (*e.g.*, fixed-priced contracts vs. cost-of-service) should be used?
- **Evaluation Criteria:** What project selection criteria are most important to the states? How will these criteria be used in selecting the project? Are there benefit/cost thresholds required to proceed with selection? Which categories of benefits will be considered and how will these benefits be quantified? How should non-monetary considerations (*e.g.*, development schedule, risks, experience, environmental and community impacts) be evaluated? Are there any threshold criteria?
- **Selection Process:** Who will determine which projects should be selected? Should states make a final selection from candidates pre-selected by regional system planners? If so, how? Or should the regional planner make the final project selection?
- **Cost Allocation:** How would costs of selected projects be allocated? Based solely in proportion to the public policy needs of the participating states? Or should some of the costs be allocated to other states in the region as long as such allocation is roughly commensurate with benefits received? Are there federal funds available to buy-down the costs of a project that would help make it more attractive to state regulators?

In addition, the advance planning and reservation of system capability creates inherent tensions with FERC's open-access principles. FERC has already addressed some of these tensions, including noting that capability can be preserved on projects that would "not have been planned but for" a state's decision to pursue policy.[131] FERC has found that generators not "designated" by a state are not similarly situated with respect to the state-selected transmission facilities, which resolves concerns related to undue discrimination between state-selected generators and other generators who would benefit from accessing the transmission facilities.[132] Networked offshore transmission projects that address multiple needs (*e.g.,* a combination of public policy, grid reliability, or market efficiency needs) may require additional regulatory structures to ensure that open access regulations do not prevent the participating states from capturing benefits that are roughly commensurate with their cost responsibility.

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[131] *Order Accepting Agreement,* 179 FERC ¶ 61,024 at P 46 (2022).

[132] *Ibid.*

8. Inefficient Regional and Interregional Grid Operations

With some exceptions, regional grid operators are not yet fully equipped to integrate and optimize regional or interregional HVDC links from either a reliability operations or a wholesale markets perspective. Transmission tariffs under FERC jurisdiction do not yet satisfactorily define or address coordinated operation of interregional facilities that would be required to capture their full value. The inability of grid operators to fully utilize the unique and valuable capabilities of regional or interregional HVDC links creates challenges that need to be addressed before effective HVDC OSW transmission solutions can be planned and operated.

For example, while ISOs/RTOs would be able to optimize the commitment and dispatch of generation resources in both day-ahead and real-time markets to reduce system-wide generation costs, their market design often is not yet able to co-optimize the "dispatch" of HVDC lines within their regions.[133] Similarly, several of the HVDC links currently connecting PJM with New York are not operated optimally from an interregional efficiency perspective. While HVDC technology provides the ability to control flows on a minute-by-minute basis, PJM's Independent Market Monitor has been documenting that real-time flows over the HVDC ties between NYISO and PJM were inconsistent with market price differentials much of the time: during 43.4% of all hours in 2021.[134] In fact, two of the three HVDC tie lines flowed power from PJM to New York during all hours in 2021, regardless of price differences.[135] New York's market monitor has identified a similar issue, identifying a wide range of hours where flows over interfaces with other regions, including to New England and Ontario, are scheduled in an inefficient manner.[136]

The operational limitations that result in inefficient flows on existing interregional ties would prevent the realization of the full benefits of new HVDC links provided through offshore transmission facilities. The regional market monitors have pointed out these inefficiencies for a

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[133] Some regional grid operators have recently started to work on market design modification that would allow them to operationally optimize the use of region-internal HVDC lines. See, for example, NYISO Market Issues Working Group, Internal Controllable Lines, February 3, 2022; DC Line Scheduling Design, March 16, 2022; DC Line Scheduling Design: Two Settlement Examples, April 19, 2022; and Internal Controllable Lines: Market Design Concept Proposal, August 4, 2022.

[134] Monitoring Analytics, 2021 State of the Market Report for PJM, March 10, 2022, at 461.

[135] *Id.* at 460 (Neptune), 465 (Hudson).

[136] Potomac Economics, 2021 State of the Market Report for NYISO, May 2022, at A-95, table A-7.

decade.[137] They have three main causes, all of which could be avoided for interregional HVDC transmission links that are fully controllable during real-time operations:

- **Latency Delay.** The time delay between when flows over a tie are scheduled and when power actually flows (during which system conditions and real-time prices may change).
- **Non-economic Clearing.** The grid operators make decisions about which tie schedule requests to accept without economic considerations, producing inefficient schedules.
- **Transaction Costs.** The fees and charges levied by each grid operator on external transactions serve as a disincentive to engage in trade, impeding price convergence, and raising total system costs.

While some improvements, such as the introduction of coordinated transaction scheduling (CTS) have been implemented in recent years, they have not been effective in utilizing existing interregional transmission capabilities as the regional market monitors continue to show in their state of the market reports. Further enhancements to intertie market and operational protocols—such as market coupling, intertie optimization, or interregional energy imbalance markets—will be needed to take full advantage of the value provided by interregional transmission.[138]

As a result of these continuing inefficiencies, the grid operators' existing energy-market and operational protocols tend to not take advantage of the full operational capability and energy market value provided by new regional or interregional HVDC facilities. In addition, the reliability value of interregional transmission capability often is not appropriately accounted in RTOs' regional resource adequacy evaluations and planning-related determinations, further understating the resource adequacy benefits of these interties.

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[137] For example, PJM's Market Monitor Unit already noted a decade ago that: "In 2012, the direction of power flows at the borders between PJM and MISO and between PJM and NYISO was not consistent with real-time energy market price differences for 53.3 percent of the hours for transactions between PJM and MISO and for 47.2 percent of the hours for transactions between PJM and NYISO. The MMU recommends that PJM continue to work with both MISO and NYISO to improve the ways in which interface flows and prices are established in order to help ensure that interface prices are closer to the efficient levels that would result if the interface between balancing authorities were entirely internal to an LMP market." 2012 State of the Market Report for PJM—Volume 2, Section 8 (monitoringanalytics.com) at 225.

Similarly, New York's Market Monitor similarly pointed out over $300 million in annual costs related to inefficient use of existing interregional transmission capabilities between New York and other regions. See Patton (2010), Analysis of the Broader Regional Markets Initiatives, presented to Joint NYISO-IESO-MISO-PJM Stakeholder Technical Conference on Broader Regional Issues, September 27, 2010, at 13.

[138] For a discussion of intertie scheduling enhancements, for example, see Pfeifenberger, *et al.*, The Future of Ontario's Electricity Market: A Benefits Case Assessment of the Market Renewal Project, April 20, 2017, at 53 (Figure 9).

9. Untested BOEM Permitting Process for Third-Party Transmission

BOEM does not currently have a well-defined or broadly understood permitting process for offshore transmission that is distinct from offshore wind generators' individual interconnection cables. The project-by-project approach with radial OSW interconnection facilities developed by OSW generators is driven in part by BOEM's regulations, which bundle permitting for radial export lines into the easement associated with the permitting of offshore wind generation in the respective wind lease areas.

In particular, the relationship between independent transmission and BOEM leases remains uncertain. For example, although BOEM has a permitting process for transmission in federal waters, it is not clear how BOEM could implement its regulatory process for siting rights-of-way (ROWs) for backbone transmission or meshed offshore networks, particularly from the view of states and leaseholders. For instance, BOEM has not signaled whether it will simply process unsolicited requests by issuing Requests for Competitive Interest (RFCIs)—which it has previously done with Anbaric's NY Bight proposal[139]—or whether it will drive a centralized planning process similar to how it operates lease sales for wind energy areas.

While BOEM does have a process for permitting separate transmission facilities, there is substantial regulatory uncertainty about how the leases would interact with these coordinated transmission approaches, particularly as coordination requirements increase over time in the transition to a full offshore backbone. Further, it is not clear how the presence of a separately approved ROW for transmission adjacent to a particular lease area would affect the ability of the WEA leaseholder to develop a radial export line, including whether there would be a requirement on the WEA leaseholder to utilize the independent transmission solution. For mesh-ready substations currently required in New York's and New Jersey's OSW generation solicitations, it remains unclear whether neighboring WEA leaseholders have the presumptive right to interconnect to these mesh-ready facilities or if they must go through a separate permitting process. We note, however, BOEM has already made initial steps toward revising these regulations through a recent Notice of Proposed Rulemaking, which focuses in part modernizing the regulations governing offshore transmission to facilitate a wide range of

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[139] Request for Competitive Interest on Anbaric's request for a ROW grant offshore NY and NJ, Docket No. BOEM-2018-0067.

offshore transmission solutions, including meshed systems or a full offshore grid, while "maximiz[ing] the utility of land-based points of interconnection."[140]

10. Uncoordinated Processes for Lease Area Auctions, State Procurements, and Transmission Planning

The processes of lease area auctions, state procurement of OSW generation, and regional transmission planning are siloed and lack coordination. When OSW developers purchase offshore leases, it is still unknown to which state or region they will be connecting, or the size or operation date of the specific project, as several wind energy areas can be used to deliver OSW generation to several states and more than one region. When states issue solicitations for OSW generation, they do not know which lease areas will serve them (realistically, only a few generators with nearby lease areas can effectively compete in those solicitations). Any attempts to pre-build an offshore grid to address states' clean energy needs are challenging because it is not known which lease areas to target prior to states completing their OSW solicitations. This separation of leasing, procurement, and planning is inefficient and time consuming by:

- Creating delays, since neither OSW generators nor transmission developers can start planning and permitting the transmission connection until they know which region they will be serving, as determined by the outcomes of state procurements;
- Introducing challenges in planning and developing efficient transmission solutions, and adding costs to any prebuilt transmission since any chosen location of offshore collector stations may turn out to be suboptimal and lead to duplicative offshore substations; and
- Reducing competition in OSW generation procurements by limiting the number of generators that can compete in state solicitations, and potentially resulting in prebuilt collector stations that may advantage some lease areas over others;
- Limiting the opportunities for reducing the amount of offshore cabling needed by bundling multiple adjacent OSW onto fewer large shared offshore transmission links.

Addressing these challenges and inefficiencies will require a fundamental redesign of how wind energy areas are leased by BOEM, how OSW generation is procured in the U.S. by individual states, and how transmission solutions for OSW can be planned by the grid operators. These

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[140] BOEM, Notice of Proposed Rulemaking, 30 CFR Part 585, un-dated pre-publication BOEM Docket No. 2022-0019, Federal Register Docket No. BOEM-2023-0005, released January 12, 2023, at 104.

efforts will also likely require new federal and state enabling legislation to fully and efficiently coordinate WEA lease auctions with state procurements.

IV. Recommendations for Planning Cost-Effective Regional and Interregional OSW Transmission that Supports States' Ongoing Procurement Efforts

This section of our report provides of roadmap of twelve specific initiatives to address the identified challenges to achieving more timely, cost-effective, and environmentally acceptable OSW transmission solutions. We recommend that state and federal policymakers, state and federal regulators, regional grid operators, and market participants collaborate on the following initiatives:

1. Increase staffing and budgets for state and federal agencies
2. Empower regional, multi-state decision-making bodies
3. Confirm the applicability of tax credits to offshore wind-related interconnection facilities
4. Proactively identify feasible, cost-effective POIs in conjunction with fast-track generation interconnection processes
5. Develop and implement network-ready standards for use in OSW procurements
6. Clarify and streamline BOEM permitting for third-party transmission and, if possible, better coordinate lease processes with state procurement and transmission planning
7. Agree on actionable cost-allocation frameworks for planned OSW transmission
8. Develop HVDC technology, operational, and compatibility standards for transmission procurements
9. Continue to improve regional transmission planning and generation interconnection processes
10. Develop effective and actionable interregional transmission planning processes
11. Develop offshore grid shared-use contracts and open-access regulations
12. Improve grid operations and wholesale market designs to take full advantage of regional and interregional HVDC capabilities

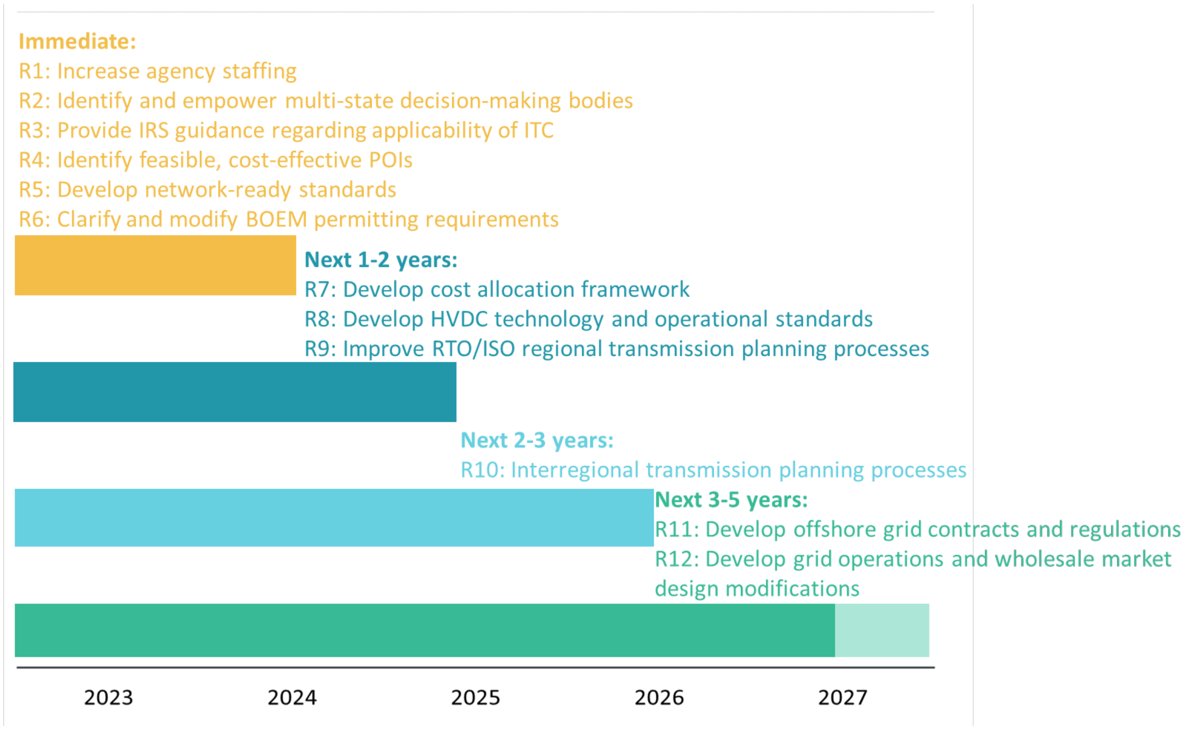
As shown in Figure 8 below, Recommendations Nos. 1 through 6 are the most urgent next steps that should be addressed **immediately within the next year**. These are all items that would make ongoing state procurement of OSW generation more future proof from an offshore transmission network development perspective.

Recommendations Nos. 7 through 9 are initiatives that should be completed **over the next one to two years** to facilitate the cost allocation of offshore transmission, the standardization of networked offshore transmission technology, and the already ongoing efforts to improve regional planning and generation interconnection processes.

The scope of Recommendation No. 10 (interregional planning) goes well beyond offshore transmission needs to include improved transmission planning between regions and nation-wide, which will realistically require **2–3 years** to develop.

Finally, Recommendations Nos. 11 and 12 focus on offshore grid usage and operational aspects, which do not need to be finalized until networked and shared-use offshore HVDC transmission facilities are placed in service. However, to provide sufficient clarity to industry participants, these items should be addressed over the next **3–5 years**.

FIGURE 8: TIMELINE OF RECOMMENDATIONS



1. Increase Staffing and Budgets for State and Federal Agencies

To address the significant number of challenges created by the ongoing clean energy transition and implement the OSW transmission-related recommendations discussed below, regulatory agencies with oversight, planning, implementation, and/or policy development responsibilities must have their funding substantially increased. This is consistent with recent recommendations by MIT researchers evaluating the regulatory challenges of the transition to a clean energy grid.[141]

Today, state and federal energy regulatory staff are subject to outdated compensation structures that do not allow states to attract or retain the necessary expertise to provide comprehensive guidance to state policymakers and effectively regulate the industry. These challenges are compounded by the lack of similar restrictions on market participants, who retain a commercial interest in attracting these staff to address the challenges, including

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[141] Gruenspecht, *et al.*, Electricity Sector Policy Reforms to Support Efficient Decarbonization, MIT Center for Energy and Environmental Policy Research (CEEPR), April 2022, at 14. ("Staffing and budgets for state and federal regulatory agencies should be substantially increased to enhance these agencies' capabilities to design and implement regulatory mechanisms that can guide the transition to least-cost high-VRE systems with storage.")

through regulatory and legislative means, by acting in their own interests and not necessarily for the benefit of ratepayers.

Many of the recommendations set out below rely directly on the ability of state and federal agencies to participate in complex and often multi-state collaborations to tackle the complex challenges of achieving clean energy policies and decarbonization goals. State policy makers, legislators, and regulators will need to be at the heart of this effort. States not only drive clean energy policies in the U.S., but they also have primary responsibility under current regulatory constructs for identifying and selecting which OSW projects will be built. These OSW generation selections have historically been bundled with all necessary transmission facilities and grid upgrades, including identification of the radial export lines to shore and the funding of associated onshore upgrades. In addition, although legislation may be required, states are uniquely situated to arrange for the recovery of transmission-related costs (which already occurs for costs allocated for regional reliability and market efficiency investments). FERC's recent NOPR on transmission planning specifically identifies the ongoing and growing importance of state involvement:[142]

> "We believe that providing an opportunity for state involvement in regional transmission planning processes is becoming more important as states take a more active role in shaping the resource mix and demand, which, in turn, means that those state actions are increasingly affecting the long-term transmission needs for which we are proposing to require public utility transmission providers to plan in this NOPR."

To take on this role, state policymakers and regulators require the support of experienced staff—a scarce and valuable resource. While outside experts can assist states, internal expertise will substantially enhance the ability to engage in technical discussions and arrive at well-informed regulatory decisions. DOE, grid operators, and market participants should stand ready to provide the technical information not readily available to state agencies, but this assistance is no substitute for appropriately experienced internal staff. Without development of the relevant internal capabilities, state and federal agencies will not be effective in supporting the recommendations outlined below—to the detriment of achieving OSW and other clean energy goals and decarbonization objectives.

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[142] *Building for the Future through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection,* Notice of Proposed Rulemaking, 179 FERC ¶ 61,028 at P 301 (2022).

RECOMMENDATIONS FOR ACTION

- **State governors or senior policymakers** should make necessary changes, including passing appropriate legislation, to ensure that regulatory staff charged with leading ambitious energy and environmental policies can be retained. This may require conducting an analysis of similar compensation packages at private firms regulated by the state.
- **State agencies** should identify areas where expertise is needed and create procedures to identify, attract, and retain top talent, including from industry, to improve states' ability to develop, implement, and monitor both the programs under their direct supervision and federal regulations that directly impact the achievement of state goals.
- **The Department of Energy** should, wherever possible, utilize funding to support state agencies in their efforts to either develop, attract, and maintain key staff and internal expertise or contract to obtain the necessary expertise. For example, section 40109 of the Infrastructure Investment and Jobs Act provides $500 million in funding to state energy offices through the State Energy Program through 2026, and section 50153 provides $100 million for expenses and planning for interregional and offshore transmission lines.

2. Identify and Convene Multi-State Decision-Making Bodies

Identifying and empowering regional, multi-state decision-making bodies authorized to effectuate the development of effective, proactively planned regional and interregional transmission solutions is a critical first step toward supporting state and national offshore wind goals over the 2030–2050 timeframe. With support from the federal government, relevant state policymakers and grid operators should immediately convene to identify existing entities capable of assisting states in grid planning, or develop a new decision-making body to guide regional and interregional transmission development to address public policy and other transmission needs.

At first, these efforts will likely focus on individual regions until interregional transmission planning processes are improved to evaluate multi-value needs across regions, as discussed further in Recommendation 11. Enabled by the governors, state agencies involved in OSW generation procurement and transmission planning, including one agency for each of these purposes per state as necessary, should begin these convenings—with technical support and funding available from DOE—as soon as possible. Grid operators would be expected to provide technical expertise, including providing planning-related information unavailable to other parties, to assist states in these deliberations. States without offshore wind goals but with other public policy interests in transmission expansion should also be invited to join the regional collaborations.

These convenings will serve multi-fold purposes and provide a forum for action on many of the recommendations below. States should proceed, ideally, with support from DOE and a facilitator, to develop a binding process that would enable interested states to (1) identify policy needs to inform public policy transmission planning; (2) approve the development of identified transmission solutions; (3) agree on contracting for or cost allocations to enable the financing of the transmission investments; and (4) agree on the sharing or allocations of the clean-energy interconnection capabilities and other benefits created through the transmission planning and development effort. At a minimum, this will require multi-state agreements along with the necessary authorizations for state agencies to enter such agreements.

This effort may also benefit from the creation of regional or interregional **multi-state transmission authorities**, authorized to work directly with grid operators to procure transmission solutions and recover the cost of procured facilities, either through contracts with the transmission developers or through RTO tariff provisions. Such a multi-state transmission authority—distinct from an offshore ISO/RTO (which we caution against)[143]—could possibly be modeled after the 11-state Regional Greenhouse Gas Initiative (RGGI).[144] A multi-state decision-

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[143] We caution against the creation of a new ISO or RTO for only offshore transmission because: (1) the new ISO/RTO would create additional market seams, which would make optimal use of the infrastructure even more difficult; (2) the offshore ISO/RTO would not serve any loads but would simply export all power generated to the existing ISOs/RTOs, which could prevent a reasonable market-wide optimization of generation dispatch and flows and exacerbate issues associated with offshore cost recovery; and (3) to interconnect its transmission facilities, the offshore ISO/RTO likely would still need to go through the generation interconnection process of the existing RTOs (*e.g.*, similar to merchant transmission lines interconnecting NYISO and PJM), which would make proactive planning for the combined onshore and offshore transmission needs even more challenging.

ENTSO-E recently assessed possible solutions and roles to address OSW transmission needs, similarly concluding that independent offshore transmission operations likely are less beneficial than integrated onshore-offshore operations of the transmission grid. See ENTSO-E, ENTSO-E Position on Offshore Development: Assessment of Roles and Responsibilities for Future Offshore Systems, November 2022, at 4–5.

In contrast, a multi-state transmission authority would only facilitate the development of OSW-related onshore and offshore transmission infrastructure that is regionally (and possibly interregionally) planned and operated to yield the most cost-effective solutions to support state, regional, and national clean-energy policies. The offshore facilities of the various transmission owners would still be operated independently by the respective ISO/RTO to ensure the offshore network is fully integrated with the onshore grid and offshore generation resources are optimally dispatched to yield the most cost-effective outcomes from a regional perspective.

[144] See https://www.rggi.org/. RGGI is administered by RGGI Inc, a 501(c)(3) non-profit corporation created to support development, implementation, and operations of RGGI. Other commenters have raised the idea of an interstate compact under 16 U.S.C. 824p(i), although these compacts would appear to be limited to the exercise of existing “electric energy transmission siting responsibilities of those States.” 16 U.S.C. 824p(i)(1)(B).

making body could be developed by building upon and enabling the Organization of PJM States (OPSI), Independent State Agencies Committee (ISAC) in PJM, New England States Committee on Electricity (NESCOE), in collaboration with federal Power Marketing Agencies (PMAs), or through other similar state-led governance models.

These multi-state convenings could begin with a declaration of shared values and goals from participating state governors, and assign a task force of relevant state agencies, as well as outlining designated resources, state legislation, or funding to address these goals. This declaration could form the basis for beginning the convenings, where a formal multi-state memorandum of understanding (MOU) with specific goals and commitments, as well as a framework for making joint decisions, could be developed. This approach could be modeled after similar agreements reached in Europe which guide international coordination on transmission system development issues enabling OSW integration and the broader energy transition.[145] In addition, the federal administration has developed a federal-state OSW partnership[146] and FERC has created a Joint Federal-State Task Force on Electric Transmission,[147] both of which could also serve as to support a multi-state offshore transmission entity.

These authorized multi-state decision-making bodies would enable alignment of state-specific needs with regional and interregional transmission planning and development efforts, making actionable many of the recommendations underlying this effort, including: providing and certifying planning scenarios that would form the basis of developing onshore POIs (Recommendation 4); collaborating on the design of mesh-ready standards (Recommendation 5); developing a binding cost-allocation framework among states with OSW commitments (Recommendation 7); providing input to regional (Recommendation 9) and interregional (Recommendation 10) transmission planning; as well as providing input to enable the necessary improvements to regulatory and contractual frameworks (Recommendation 11) as well as grid operations and market design (Recommendation 12).

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[145] See Letter of Intent Between the German Federal Minister of Economic Affairs and Energy and The Minister of Climate, Energy, and Utilities of the Kingdom of Denmark on Cooperation on Jointly Analyzing Joint and Hybrid Offshore Renewable Energy Projects Between the Countries; The Declaration of Energy Ministers on The North Sea as a Green Power Plant of Europe.

[146] The White Hours, FACT SHEET: Biden Administration Launches New Federal-State Offshore wind Partnership to Grow American-Made Clean Energy, June 23, 2022.

[147] FERC Joint Federal-State Task Force on Electric Transmission, available at: https://www.ferc.gov/TFSOET

RECOMMENDATIONS FOR ACTION

- **State governors or senior policymakers** should identify the urgency of immediate coordinated planning for state policy including OSW through a shared declaration, and charge lead regulatory agencies with participating in a collaborative fashion with other states to accomplish this directive by collaborating on development of a statement of shared values to initiate multi-state planning convenings through a memorandum of understanding (MOU). State policy makers should also promptly identify and enact any additional authority needed (including through legislation, if necessary) to grant agencies authority to submit public policy transmission needs into a multi-state regional planning process, procure transmission needed for development of OSW and other public policy resources, and allow cost recovery of these facilities. Existing constructs for multi-state collaboration, including RGGI, the Organization of PJM States (OPSI), Independent State Agencies Committee (ISAC) in PJM, New England States Committee on Electricity (NESCOE), or others could serve as potential organizational and governance models, including for voting structures, for such multi-state efforts.
- The **Department of Energy** should convene lead regulatory agencies from each state with the goal of identifying and empowering regional multi-state decision-making bodies and developing a specific milestone schedule for future work items for the decision-making bodies. DOE studies, including the National Transmission Planning Study,[148] Transmission Needs Study,[149] and Atlantic Offshore Wind Transmission Study[150] can provide valuable insights and support to participating states as they proceed through the milestone schedule.
- **Grid Operators, FERC, BOEM, industry stakeholders** and others, possibly including federal PMAs, should be ready to provide support as necessary the multi-state decision-making effort, including by conducting planning studies and incorporating recommended OSW injections into their transmission planning processes.
- **Lead state regulatory agencies** should actively participate in these convenings with the goal of identifying, developing, and formalizing cooperation among states, including a governance or voting process to make decisions, identify transmission needs, and endorse cost allocations, wholesale market designs, planning decisions, or other recommendations.

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[148] US DOE Grid Deployment Office, Building a Better Grid, National Transmission Planning Study.

[149] US DOE Grid Deployment Office, National Transmission Needs Study.

[150] US DOE Wind Energy Technology Office and National Renewable Energy Laboratory, Atlantic Offshore Wind Study.

3. Clarify Applicability of the Investment Tax Credit to Offshore Wind-Related Interconnection Facilities

The IRS should expeditiously provide guidance to confirm the applicability of the ITC to offshore-wind related interconnection facilities that deliver to shore the output of one or more offshore wind generating plants, including those under independent third-party ownership.[151] We understand that there may be authority under the existing rules that already permits separate ownership of ITC eligible property,[152] and provides ITC eligibility in joint ownership circumstances.[153] In addition to immediate action from the IRS, Congressional action may be necessary to more explicitly expand the ITC to infrastructure necessary to bring offshore wind-generated energy to a specific point on the onshore grid, including links between offshore wind collector stations.

RECOMMENDATIONS FOR ACTION

- The **Internal Revenue Service** should provide guidance on the applicability of the ITC to all property, including export lines and other conditioning equipment, in connection with one or more offshore wind facilities in a manner consistent with CCA 201122018 (May 4, 2011) and the Bluebook released by the Joint Committee on Taxation (JCS-1-22). This guidance should make the ITC available for property necessary to deliver and condition electricity for use on the grid, such as subsea cables and voltage transformers, and for eligible equipment owned by a third party consistent with current tax authorities. The guidance should also make clear that interconnection facilities that are sized to enable future project expansion, or connection with an adjacent OSW project, are ITC-eligible; similarly, any equipment required at onshore or offshore interconnection substations to enable future meshing should also be ITC-eligible.
- If IRS guidance is insufficient, the **U.S. Congress** may need to explicitly expand the ITC to infrastructure necessary to bring offshore wind-generated energy to a specific point on the onshore grid, including links between offshore wind collector stations.

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[151] For a discussion of applicable IRS rules, see Appendix C.3 of the BPU SAA Evaluation Report.

[152] See *Cooper v. Commissioner,* 88 T.C. 84, 116–17 (1987) (rejecting an argument that energy property only includes “a completely functional system” in finding that ITC eligibility is not dependent on an individual taxpayer owning a complete system);

[153] See Rev. Rul. 78–268, 1978-2 C.B. 10 (allowing proportionate ITC to co-owners of an electric generating facility despite their owning the facility as tenants in common with tax-exempt and municipally owned entities that are disqualified from receiving the ITC).

4. Optimize Onshore Interconnection Points for Delivering Offshore Wind

States, in collaboration with grid operators and DOE, should immediately start efforts to proactively identify feasible, cost-effective POIs with the necessary transmission corridors and onshore upgrades for all generation interconnection needs associated with forecasted new generation within each FERC-jurisdictional planning region. This work could be facilitated through the multi-state decision-making body described above. These efforts would be similar to New Jersey's recent offshore wind transmission procurement with PJM that identified POIs and necessary upgrades for an additional 6,400 MW of OSW generation but at a full, multi-state regional scale. Five New England states' recently begun transmission RFI could serve as the foundation for such coordination and optimization in the region.

Development of adequately robust POIs—and selecting POIs that reduce the necessary upgrades to the onshore grid with lower total OSW-related transmission costs—will be needed for both the interconnection of OSW generation with radial tie lines and any networked offshore transmission facilities. Interconnection rights at any state-funded POIs should be made available for state-procured OSW generation and/or transmission through a fast-track (*i.e.*, first-ready/first-served) RTO interconnection process that takes account of any state (or multi-state) investment in a particular location, similar to that already identified through FERC's generator interconnection NOPR.[154] Moreover, expeditiously incorporating these POIs into each regional transmission planning model is critical to ensuring that planning entities produce POIs that remain feasible and do not become obsolete as the grid evolves.

In addition, this effort may need to evaluate rules surrounding grid operators' single largest contingency, to determine transmission designs and operational protocols that enable reliable operations with higher-capacity HVDC-cables and injection amounts.

FERC's recent NOPR on long-term transmission planning, if finalized, would require regional planners to implement long-term planning for multi-value needs, but these long-term planning efforts would not result in sufficiently timely transmission upgrades to facilitate the development of POIs needed for the interconnection of OSW generation coming online within the next decade. This is because a final rule approved by FERC in 2023 will require years of compliance filings and planning studies before the first transmission investments would be

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[154] *See Improvements to Generator Interconnection Procedures and Agreements,* Notice of Proposed Rulemaking, 179 FERC ¶ 61,194 at P 260 (2022).

identified and approved. Further, the additional long-term planning processes specified in the NOPR add a 20-year long-term time horizon to regional and interregional plans, but are not intended to change the existing, near-term planning processes.[155] Additional near-term efforts, such as multi-state versions of the SAA process PJM has just completed in collaboration with New Jersey, would therefore be necessary to identify the best POIs to interconnect OSW generation needs over the next decade, while longer-term needs are identified proactively through new regional and interregional long-term planning efforts, as discussed in Recommendations Nos. 11 and 12.

Importantly, any such efforts to identify and possibly build out an optimal set of POIs to integrate the necessary amounts of OSW generation over time—to accommodate state procurement targets and the entire generation in BOEM lease areas, and considering long-term OSW needs to meet decarbonisation goals—would also need to be associated with: (1) providing interconnection rights to the specific states that fund the transmission upgrades necessary to enable the specified injections at the selected POIs; and (2) providing a fast-track path through generation interconnection processes (*e.g.*, under a first-ready/first-served framework), so generators can be interconnected at those state-funded POIs more quickly.

RECOMMENDATIONS FOR ACTION

- **States, in collaboration with grid operators and DOE** should immediately start efforts to proactively identify feasible, cost-effective POIs (with feasible transmission corridors) for all generation interconnection needs associated with existing state OSW and other clean-energy goals within each FERC-jurisdictional transmission planning region.
- The identified **multi-state decision-making entity** (possibly a multi-state transmission authority) should procure the transmission solutions (with the necessary land, transmission corridor infrastructure, and onshore upgrades) necessary to enable cost-effective POI development to support short-term goals and obtain long-term benefits of coordinated transmission.
- **Grid Operators** should, in collaboration with the states or multi-state entity, expedite the analyses necessary to identify the best set of POIs that can integrate the generation procured and projected over the coming decades, as states develop the regulatory pathways to request, allocate, select, and recover the costs of the needed transmission

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[155] *Building for the Future through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection,* Notice of Proposed Rulemaking, 179 FERC ¶ 61,028 at P 3 (2022) ("We do not propose in this NOPR to change Order No. 1000's requirements for public utility transmission providers with respect to existing reliability and economic planning requirements.")

upgrades. This analytical initiative would be similar to PJM's effort in the New Jersey SAA, PJM's Offshore Wind Study (studying the integration of 75 GW of renewables needed to meet the public policy needs of PJM states),[156] and ISO-NE's Pathways Study.[157] As was the case in New Jersey's selection of POIs to meet its 7,500 MW OSW goals for 2035, these RTO-level studies will identify POI options and associated onshore network upgrade costs that will serve as the necessary input to the decision-making of states, which may then select OSW generators or independent transmission developers to use the most cost-effective and least environmentally impactful POIs for the purpose of integrating the planned amounts of OSW generation.[158] Grid operators would additionally need to streamline generation interconnection processes to make sure that generators ultimately selected through state procurements would be able to use the pre-built POIs through a fast-track (first-ready/first-served) process.

- **DOE** should continue to refine and share detailed results and insights of its ongoing studies, such as the Atlantic Offshore Wind Transmission Study[159], with states, FERC, and grid operators to assist with identification and analysis of potential POI locations from a broader interregional perspective.
- Building on its approval of the New Jersey State Agreement,[160] the policy statement on voluntary transmission development and cost allocation,[161] and provisions in the transmission planning NOPR, **FERC** should continue its efforts to enable:
  - Voluntary cost allocations agreed to by states to enable public policy transmission procurement and selection (Recommendation 6).
  - The expedited integration of public policy needs or transmission projects identified by states into grid operators' regional transmission plans under approved voluntary cost allocation provisions, prior to additional long-term transmission planning reforms being adopted under Recommendation 10.
  - Access to proactively planned and pre-built POIs provided in a fair and expedited fashion such as through approval of state agreements on preservation and utilization of created

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[156] PJM, Offshore Wind Transmission Study: Phase 1 Results, 2021.

[157] ISO-NE, 2050 Transmission Study Revision 2, November 17, 2021.

[158] See I.M.O. Offshore Wind Transmission, NJBPU Order, October 26, 2022, at 20–21.

[159] See US DOE Wind Energy Technology Office and National Renewable Energy Laboratory, Atlantic Offshore Wind Study.

[160] 179 FERC ¶ 61,024 at P 46 (2022); Rate Schedule FERC No. 49.

[161] *State Voluntary Agreements to Plan and Pay for Transmission Facilities,* 175 FERC ¶ 61,225 (2021).

POI capability funded by states through public policy transmission investments (Recommendation 9).

- **FERC** should similarly continue to pursue reforms to generator interconnection processes to create a fast-track option (*e.g.*, based on the generator interconnection NOPR's proposed first-ready/first-served approach[162]) for OSW generators assigned to the pre-planned POIs. Ideally, FERC should go beyond the NOPR's currently proposed reforms in the following areas:
  - Encourage grid operators to plan for generation interconnection needs more proactively; and
  - Encourage migrating to a "connect and manage" approach, similar to approaches adopted in the United Kingdom and Texas,[163] to address any distant network upgrades currently identified through interconnection studies through a combination of congestion management (in the short term) and multi-value transmission planning, including the use of advanced, grid-enhancing technologies (GETs) (in both the medium and long-term).

5. Develop and Implement Network-Ready Standards for Use in OSW Generation Procurements

To avoid losing the opportunity to integrate these offshore facilities into a planned grid in the future, we recommend that state procurements for OSW generation and transmission mandate “network-ready” designs for all offshore facilities—in particular, for OSW generation procurements with generator-owned radial links to shore.

A broadly accepted and future-proof network-ready standard should thus be developed immediately for standardized, modular offshore substations. This will create flexible, low-cost options to integrate radial offshore export links into a networked offshore grid in the future. This network-ready standard could then be used by states in all their future OSW generation and transmission solicitations such that the option to integrate these radial facilities into a linked offshore grid can be exercised if and when the benefit of doing so is confirmed through regional and interregional planning efforts. Offshore wind generation development will not pause until a regional or interregional offshore transmission network can be planned—which is

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[162] *See* Improvements to Generator Interconnection Procedures and Agreements, Notice of Proposed Rulemaking, 179 FERC ¶ 61,194 at PP 37-160 (2022).

[163] *See* J. Pfeifenberger, *Generation Interconnection and Transmission Planning*, ESIG Workshop Presentation, (August 9, 2022) at 15.

why ensuring network-ready designs that are modular and future proof (*i.e.*, able to accommodate the still uncertain future selections of evolving HVDC technologies) is critical to capture the full benefits of coordinated long-term transmission plans for 2030–2050.

This standardization effort should clearly define technical requirements that will allow the potential for future interconnections between offshore transmission platforms to enable additional benefits. The choice of technology should take into account the envisaged purpose of the future interconnections, required upfront investment, required total investment and operational costs.[164] These efforts should be aligned with similar efforts ongoing in Europe[165] and can begin domestically with technical specifications that New York and New Jersey have already identified for mesh-ready/network-ready offshore substations and that New England is exploring through its RFI.[166] However, while New York and New Jersey's mesh-ready standards are limited to HVAC links between offshore platforms, the technical specifications should be sufficiently flexible to allow for future HVDC links—although that would require standardized HVDC voltage levels and equipment to be included in mesh-ready designs as well (as discussed in Recommendation 8).

RECOMMENDATIONS FOR ACTION

- **DOE** should sponsor the selection of technical experts (such as a qualified engineering firm, or a National Lab) to develop of necessary technical standards for network-ready solutions.[167] This effort would build upon existing work on network-ready standards in Europe, New York, and New Jersey to ensure broad technical compatibility. DOE and the selected leads of this effort should work closely with an advisory committee composed of state, FERC, NERC, other relevant national lab, grid operators, utility, and OSW transmission and generation developer participants.
- Once standards are developed, **states** should expressly require the use of the jointly developed network-ready design standards for offshore substations and export cables in generation solicitations as an eligibility requirement to secure OSW contracts. State OSW

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[164] See C.A. Plet, *et al.*, Offshore substation platform expandability, 2021 Cigre Canada Conference, Toronto.

[165] See PROMOTioN—Progress on Meshed HVDC Offshore Transmission Networks, D12.3—Draft Deployment Plan, February 26, 2020, at Table 2, Figure 1-1, 33.

[166] See 2022 Solicitation—NYSERDA (Appendix G: Meshed Ready Technical Requirements); Solicitation Documents—NJ Offshore Wind (Attachment 11: Offshore Transmission Network Preparation Requirements); and 2022 New England States Transmission Initiative Request for Information (Question 3).

[167] Work on this issue has been initiated in the U.S. through DOE's HVDC standardization efforts, enabled by recent federal funding. See Department of Energy Wind Energy Technologies Office, WETO Releases $28 Million Funding Opportunity to Address Key Deployment Challenges for Offshore, Land-Based, and Distributed Wind, December 6, 2022.

procurement contracts will also need to allow for adding shared-use and open access provisions in the future (see Recommendation 9).

6. BOEM Transmission Permitting and Leasing

BOEM should clarify and modify its permitting processes quickly to provide additional specificity to enable pursuit of coordinated offshore transmission, including third-party use of offshore cable routes. This effort should include BOEM permitting of transmission, (1) between lease areas and pre-specified POIs on the existing grid and (2) between existing or newly assigned lease areas. It should also include the potential for BOEM to review and approve general activity plans to allow construction of cables in advance of offshore wind project permitting to reduce project-on-project risk, incentivize lessees to participate in offshore networks, and allow for coordination of resources such as cable-laying vessels. Permits may specifically include rights-of-way to construct competitively awarded cables by one or more entities selected by one or more states. In an encouraging first step, BOEM has recently sought industry comment on how to revise transmission permitting and leasing regulations through a recent Notice of Proposed Rulemaking, including the potential for exploring coordinated approaches to transmission, shared cable corridors, meshed systems, or the development of the offshore grid.[168]

In addition, DOE and BOEM should explore and evaluate, for possible future federal legislative action, more effective alternatives to the existing auction, lease, and permitting processes for possible future federal legislative action for better alignment with OSW generation procurements. Current processes can impede the development of coordinated transmission and more cost-effective OSW solutions because states and system planners do not know which lease areas will serve their policy needs, as discussed above. While modification to BOEM lease auction processes would likely require federal legislation and additional analysis beyond the scope of this paper, substantial incremental benefits of coordinated planning may remain unavailable without improving the coordination of wind area designations, lease area auctions, state OSW generation procurement, and BOEM generation and transmission permitting.

RECOMMENDATIONS FOR ACTION

- **BOEM** should immediately begin a planning process to identify and analyze feasible regional offshore cable routes, including to pre-specified interconnection points on the existing grid. This planning process should include development of a defined process to advance existing

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[168] BOEM, Notice of Proposed Rulemaking, 30 CFR Part 585, un-dated pre-Federal-Register-publication, BOEM Docket No. 2022-0019, Federal Register Docket No. BOEM-2023-0005, released January 12, 2023, at 104.

stand-alone transmission proposals in coordination with other siting agencies, FERC, and relevant state agencies. This effort should develop a review and approval process for general activities plans to allow construction of offshore cables *in advance* of OSW projects, including multi-use ROWs and transmission facilities, to reduce project-on-project risk and incentivize lessees to participate in offshore networks. Additionally, **BOEM** should issue a request for information and/or call for information on proposed cable routes, accounting for state and federal needs, identified interconnection points, specified lease areas, environmental factors, and ocean-user conflicts (*e.g*., fisheries, other seabed infrastructure, *etc.*). This request should build on BOEM's recently issued Notice of Proposed Rulemaking,[169] and would likely occur after onshore POIs are identified as part of Recommendation 4.

- **DOE** should engage BOEM, FERC, the Congressional Research Service, or other relevant government agencies to explore alternatives to existing lease process and any necessary federal administrative or legislative actions to allow for the planning and permitting of transmission solutions to those lease areas to start immediately, and for coordination with state solicitations of generator bids for developing the lease areas designated for such state procurement.

7. Develop an Actionable Cost Allocation Framework

States with OSW commitments should, in concert with implementing Recommendation 2, develop a methodology to allocate the costs of OSW-related transmission investments, which include onshore upgrades for multi-state generation interconnection efforts and shared radial export facilities. This methodology should ensure that allocated costs are roughly commensurate with the benefits states receive (*e.g.*, in proportion to their OSW and/or other clean energy needs). This framework can then also serve as the basis for developing cost allocations of networked regional and interregional offshore transmission, as discussed further in Recommendations 9, 10, and 11.

As a potential starting point, RENEW Northeast together with Brattle authors have developed a voluntary multi-state cost allocation framework as part of a Northeast Transmission Blueprint.[170] The recommended approach relies on simple beneficiary-pays principles and applies cost responsibility in proportion to incremental transmission capability requested by

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[169] *Ibid.*

[170] RENEW Northeast, A Transmission Blueprint for New England: Delivering on Renewable Energy, May 23, 2022 (Appendix contributors, J. Pfeifenberger and J. DeLosa III).

each state in support of its public policy needs and accounting for avoided costs.[171] Any developed cost allocation frameworks should enable a wide range of potential use cases, including contemplating clean energy resources likely needed by those states that may participate in public policy planning efforts but do not have offshore wind goals, as discussed further in Recommendations 9 and 10. We recommend cost allocation frameworks that apply to portfolios of transmission projects, rather than individually to each project. While it is critical that benefit-cost-analyses used to evaluate alternative transmission solutions consider and (if possible) quantify the full set of benefits transmission investments can provide, we recommend *against* the development of cost allocations that are formulaically based on such quantified benefits, since quantified benefits depend on study assumption and change over time—which tends to make the allocation process more contentious than simpler, voluntary cost allocation frameworks that meet the "roughly commensurate" standard.[172]

RECOMMENDATIONS FOR ACTION

- **State regulatory agencies**, as part of a multi-state decision-making entity in Recommendation 2, should develop a binding multi-state cost allocation agreement, to be filed with FERC, which enables continued discussion of procurement frameworks and selection criteria among participating states. These discussions should be informed by grid operators' analyses demonstrating that the benefits of proactive coordinated planning are roughly commensurate with allocated costs. States should also apply for transmission grants, loans, and loan guarantees from DOE to reduce costs to customers, and help to ease any cost allocation disputes.
- **FERC** should encourage this multi-state effort and provide guidance on acceptable cost-allocation frameworks. Building upon the approved New Jersey State Agreement Approach,[173] the policy statement on voluntary transmission development,[174] existing cost allocation frameworks for multi-value transmission projects,[175] and cost-allocation

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[171] *Id.* at 15.

[172] See J. Pfeifenberger and J. DeLosa III, Transmission Planning for a Changing Generation Mix, OPSI Annual Meeting, October 18, 2022, at 17, 23.

[173] 179 FERC ¶ 61,024 at P 46 (2022); Rate Schedule FERC No. 49.

[174] *State Voluntary Agreements to Plan and Pay for Transmission Facilities,* 175 FERC ¶ 61,225 (2021).

[175] For example, cost allocations used for MISO MVPs, SPP's highway/byway approach, and NYISO' Public Policy Transmission Planning Process (PPTPP) may provide good starting points. See also 181 FERC ¶ 61,219 at P 50 (2022) ("…cost allocation does not need to be undertaken with exacting precision in order to be roughly commensurate with benefits … the use of a portfolio approach will help ensure that the benefits of each MVP portfolio are distributed broadly across the subregion") (citing *Illinois Comm'n I,* 576 F.3d at 477; 178 FERC ¶ 61,087 at P 30 n.42 (2022) ("Courts have held that the cost causation principle does not require costs to be allocated with exacting precision, but rather requires that costs be allocated in a manner 'roughly commensurate' with the benefits received.")).

provisions in the transmission planning NOPR, FERC should quickly approve voluntary cost allocations that enable coordinated public policy transmission development.

- **DOE** should identify funds that can be made available to facilitate the construction of coordinated offshore wind transmission facilities, either by opening a TFP solicitation dedicated to each coast's offshore wind transmission needs or otherwise identifying funding opportunities well-suited to offshore wind transmission.

8. Develop HVDC Technology and Operational Standards

Within 1–2 years, following the development of network-ready standards in Recommendation 5, DOE should develop rigorous HVDC technology compatibility and operational standards that allow for a "future proof" evolution of the offshore transmission network to meet state, regional, and interregional needs. These standards can be informed by similar work underway in Europe[176] and build on initial efforts by DOE.[177] Ahead of a national adoption of any standards, state procurements can drive standardization through collaboration and by adopting standards in their OSW procurements.

These compatibility standards should cover, at a minimum, the following aspects: system requirements (*e.g.*, voltage level, converter configuration, system protection, fault clearing strategy); functional requirements (*e.g.*, operational switching sequences, control modes, fault response, *etc.*); vendor interoperability requirements (*e.g.*, communication interface, transient and harmonic stability, *etc.*); procurement requirements (*e.g.*, responsibility for system integration, liability, performance guarantees, information exchange, *etc.*); and operational requirements.[178]

Additional challenges will be presented by the need for **floating offshore wind generation** required as the demand for OSW continues to grow and new lease areas are in deeper waters and often more distant from shore. Given the federal administration's goal of 15 GW of OSW by

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[176] See PROMOTioN—Progress on Meshed HVDC Offshore Transmission Networks, D12.3—Draft Deployment Plan, February 26, 2020.

[177] Department of Energy Wind Energy Technologies Office, Bipartisan Infrastructure Law (BIL) FOA to Address Key Deployment Challenges for Offshore, Land-Based, and Distributed Wind, December 6, 2022, at 10.

[178] The lack of an "HVDC grid code" that specifies how an offshore network should be operated, also is probably one of most important missing technical elements towards achieving interoperability of different HVDC facilities that could be integrated into a linked network. One step in this direction would be to revisit the existing NERC standards and assess to what extend and how they are applicable to DC systems, and adapt those standards where necessary.

2035[179] and the fact that state OSW generation commitments already include more than 50 GW of floating offshore wind generation,[180] technology development and standardization will have to address additional design considerations relevant to floating applications. While many of the components of the electrical design will be the same, cables connected to floating platforms must handle dynamic stresses not imposed on fixed-bottom offshore equipment due to repetitive wave motion and extreme events such as storms. A joint industry project focused on this matter is currently in early stages of developing pre-standardization requirements[181] and a number of development efforts for floating equipment have been initiated,[182] although technology maturity is still low.[183]

RECOMMENDATIONS FOR ACTION

- As a follow-on to the work in Recommendation 5, **DOE** should continue efforts, including developing the process to identify necessary technical and operational standards for HVDC technology. The continuity of this effort would ensure compatibility with any previous mesh-ready guidance developed by DOE and adopted by states. DOE and the selected technical leads should work closely with an advisory committee composed of members from states, FERC, NERC, relevant national labs, grid operators, utilities, and OSW

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[179] See White House, "Fact Sheet: Biden-Harris Administration Announces New Actions to Expand U.S. Offshore Wind Energy" at https://www.whitehouse.gov/briefing-room/statements-releases/2022/09/15/fact-sheet-biden-harris-administration-announces-new-actions-to-expand-u-s-offshore-wind-energy/

[180] See Table 1 offshore wind goals and needs for California, Oregon, Washington, and Maine—with additional floating OSW plants likely off other Atlantic-coast states.

[181] DNV, 30 Partners Join DNV to Start Joint Industry Project for Floating Offshore Wind Substations, May 31, 2022.

[182] Pre-standardization for design and testing is in place since last year (*e.g.*, Cigre—TB 862—Recommendations for mechanical testing of submarine cables for dynamic applications). See also:

Hitachi ABB, "Hitachi ABB Power Grids launches new transformers for floating offshore wind power" *power transformer news*, June 8, 2021 at https://www.powertransformernews.com/2021/06/08/hitachi-abb-power-grids-launches-new-transformers-for-floating-offshore-wind-power/

Nevesbu, "Concept design of a floating offshore substation," May 10, 2022 at https://www.nevesbu.com/insights/floating-offshore-wind-substation-concept-design/

Splash 247, Saipem and Siemens Energy to design new floating substation," *Transformers Magazine,*, September 7, 2022 at https://transformers-magazine.com/tm-news/saipem-and-siemens-energy-to-design-new-floating-substation/

Ocean Grid, Floating HVDC platform at https://oceangridproject.no/research/floating-hvdc-platform

D. Cole, "Thinking inside the box with HVDC for floating offshore wind," *LinkedIn* at https://www.linkedin.com/pulse/thinking-inside-box-hvdc-floating-offshore-wind-david-cole/

Petrofac, Design, Floating substation concept development at https://www.petrofac.com/services/our-work/concept-design-floating-offshore-wind/

[183] In particular, developing and qualifying "dynamic" 525 kV HVDC cables—such that floating offshore transmission substations could be interconnected with stationary 525kV HVDC facilities (which are increasingly more likely to become an industry standard)—will be challenging and may take up to a decade to reach full maturity.

transmission and generation developers to develop these HVDC and offshore network standards.

- Once standards are developed, **states** (*e.g.*, through multi-state agreements) should utilize these standards in any coordinated onshore or offshore procurement for public policy transmission that may include HVDC facilities.
- **DOE**, with Congressional authorization if necessary, should financially support pilot projects and testing centers to demonstrate technology maturity and the economic and operational capabilities of HVAC-meshed and multi-terminal HVDC designs, including HVDC circuit breakers and vendor compatibility, to demonstrate commercial readiness of standardized technologies for use in competitive processes by offshore wind generators and transmission developers for both fixed-bottom and floating offshore wind plants. These pilot demonstration projects could rely on the advisory committee as discussed in Recommendation 5, and include engineering experts such as IEEE, and build on recent standardization efforts in Europe and conducted by the DOE described above.

9. Improve Regional Transmission Planning and Interconnection Processes

Ongoing efforts to improve regional transmission planning processes (over the next 1-2 years) to proactively address onshore and offshore renewable generation grid integration needs from a long-term, multi-value planning perspective will be key to meeting the ongoing and evolving needs of the nation's clean energy future. Initial reform efforts are already underway as part of FERC's transmission planning NOPR,[184] but that effort has not yet resulted in a final rule nor any resulting reforms. In addition, the NOPR does not propose to reform the existing near-term regional transmission planning processes, which create several challenges to efficient regional planning as discussed above, including an accelerating volume of incremental transmission investments and siloed, single-driver planning processes that pre-empt more cost-effective solutions.

Reforms to improve regional transmission planning require the review of siloed existing processes that are not sufficiently coordinated with each other to yield cost effective regional planning solutions. More holistic planning and simultaneous identification and consideration of multiple transmission needs will also be necessary to reduce the cost of necessary network upgrades triggered by generation interconnection requests. When considering a broad range of

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[184] *Building for the Future through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection,* Notice of Proposed Rulemaking, 179 FERC ¶ 61,028 (2022).

local, reliability, market-efficiency, public policy, resilience, and other drivers at the same time, regional planning processes will be able to address both near-term and long-term needs in a more cost-effective manner. A major focus should be for states and regional grid operators to formally incorporate the transmission needed to incorporate these generation resources into each region's planning process and ensure that any planning effort actually has a path to implementation within each planning region and that any future onshore grid expansion planning is integrated with OSW transmission planning.

A comprehensive framework for cost-benefit analysis needs to be adopted to ensure that all costs and benefits (system-wide cost savings and reliability improvements) of different transmission solutions can be identified and quantified transparently to inform the evaluation and selection of both regional and interregional transmission solutions.[185] Several U.S. grid planners already have significant experience with the quantification of multiple transmission-related benefits in long-term planning efforts.[186] In Europe, ENTSO-E has developed a framework with common principles and procedures for multi-criteria cost-benefit analysis for its network development plan projects.[187]

RECOMMENDATIONS FOR ACTION

- **FERC** should continue efforts in its transmission planning NOPR toward longer-term, multi-value, scenario-based proactive transmission planning, and ensure that facilities identified to meet these needs are part of least-regrets, system-wide solutions.
- **Grid Operators** should provide robust compliance filings to any final regional planning rule, including to ensure planning processes will be more responsive to the state public policy needs within their region and provide a clear path to actionable inclusion of offshore wind transmission needs into the existing transmission planning efforts.[188] Grid operators should

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[185] As noted earlier, we do not recommend that cost allocations are formulaically based on quantified benefits. Rather, the costs of OSW-related transmission facilities should be allocated in a fair and transparent way that is roughly commensurate with their benefits (*e.g.*, voluntarily in proportion to states' OSW and other clean-energy needs, but considering system-wide benefits that may accrue to all loads in a region or across neighboring regions).

[186] See Pfeifenberger, Gramlich, *et al.*, Transmission Planning for the 21st Century: Proven Practices that Increase Value and Reduce Costs, the Brattle Group and Grid Strategies, October 13, 2021.

[187] ENTSO-E, 3rd ENTSO-E Guideline for Cost Benefit Analysis of Grid Development Projects, January 28, 2020.

[188] For instance, while the NOPR provides for proposed requirements that planning regions include "transparent and not unduly discriminatory criteria, which seek to maximize benefits to consumers over time…" these provisions only require "*potential selection in the regional transmission plan,*" likely allowing compliance filings that do not mandate such selection. *Building for the Future through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection,* Notice of Proposed Rulemaking, 179 FERC ¶ 61,028 at pro-forma Attachment K (2022).

also provide more robust frameworks to work directly with states, as envisioned in the NOPR,[189] to participate in development of selection criteria for proactive, multi-value transmission planning.

- **FERC** should monitor the results of regional planning reforms to evaluate whether the revised planning processes result in identification of cost-effective solutions to address multiple transmission needs and reduce the amount of siloed planning performed in the various planning regions.
- The contemplated creation of an **Independent Transmission Monitor** could assist FERC in the ongoing evaluation and analysis of transmission needs and advise on the effectiveness of and necessary further improvements to transmission planning reforms.[190]

10. Create Effective Interregional Transmission Planning Processes

Over the next 2–3 years, efforts should continue toward improving interregional planning processes as contemplated in FERC's 2021 ANOPR,[191] including evaluating fundamental reforms to the timing and sequencing of interdependent regional and interregional transmission planning processes. While the benefits of interregional transmission have been broadly identified, critical barriers exist preventing the identification of interregional transmission needs and solutions that could more cost-effectively provide solutions to needs across regions. FERC has made initial strides in improving interregional coordination as part of ongoing efforts in the NOPR to adopt long-term transmission planning scenarios, but these coordination processes do not address interregional needs, nor do they try to evaluate whether more cost-effective interregional solutions should displace higher-cost regional solutions.[192] These efforts could be aided by DOE exercising existing authority to identify National Interest Electric

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[189] *Building for the Future through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection,* Notice of Proposed Rulemaking, 179 FERC ¶ 61,028 at P 245 (2022).

[190] See, for example, States press FERC for independent monitors on transmission planning, spending as Southern Co. balks | Utility Dive (October 27, 2022); FERC, state regulators consider independent monitors as way to boost transmission oversight 'gap' | Utility Dive (November 16, 2022); and Item No. 5 of Notice Inviting Post-Technical Conference Comments - Docket No. AD22-8-000 | Federal Energy Regulatory Commission (ferc.gov) (December 23, 2022).

[191] *Building for the Future through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection,* Notice of Proposed Rulemaking, 179 FERC ¶ 61,028 (2022).

[192] For a discussion of interregional planning challenges and proposed solutions, see Interregional Planning Roadmap.

Transmission Corridors, which would create additional federal interregional planning and development authorities.[193]

Building on the refinements to FERC's transmission planning NOPR, additional interregional planning reform efforts should seek to improve grid resilience, lower system-wide costs, take advantage of load and resource diversity, evaluate if interregional solutions can more cost-effectively address regional transmission drivers, and analyze if offshore transmission links between regions offer the most feasible and cost-effective way to address these identified interregional needs. Existing and currently contemplated new interregional coordination efforts do not attempt to pursue this degree of planning or operational coordination between regions that could offer substantial additional system benefits.

RECOMMENDATIONS FOR ACTION

- **FERC** should continue ongoing efforts set out in its ANOPR and transmission planning NOPR that seek to improve interregional coordination. **FERC** should additionally consider future reforms to regional and interregional planning processes that would address sequencing of near- and longer-term transmission planning processes to ensure that incremental investments based on siloed existing planning processes do not preempt more cost-effective interregional transmission solutions.
- **Grid Operators** should respond to FERC's guidance with a robust interregional need identification process, including identifying needs on a multi-value basis, evaluating whether interregional solutions are more cost-effective in addressing regional needs, and if offshore transmission links offer the most cost-effective solutions to address identified needs.
- The contemplated creation of an **Independent Transmission Monitor** (as already noted in Recommendation No. 9) could effectively assist FERC in the ongoing evaluation and analysis of interregional transmission needs and advise on interregional planning reforms.

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[193] 16 U.S.C. § 824p. The DOE's only designation of National Interest Electric Transmission Corridors occurred in 2007 with the designation of the Mid-Atlantic Area and the Southwest Area, see *Order Denying Rehearing,* 73 Fed. Reg. 12959 (March 11, 2008). These Corridor designations were vacated by the Ninth Circuit in *California Wilderness Coalition v. Dept. of Energy,* 631 F.3d 1072 (9th Cir. 2011); see also A. Zevin, S. Walsh, *et al.*, Building a New Grid Without New Legislation: A Path to Revitalizing Federal Transmission Authority, Columbia University Center on Global Energy Policy, December 14, 2020.

11. Develop Offshore Grid Regulations and Contract Structures

Over the next 3–5 years, and before networked or multi-use offshore facilities are placed into service, appropriate regulatory and contractual frameworks will need to be developed to enable the commercial use of shared offshore and onshore transmission facilities that are built for the purpose of enabling OSW goals.

Some progress has already been made in New Jersey's effort to develop an avenue, as recently approved by FERC, to preserve and assign POI capability created by state-sponsored network upgrades for the purpose of integrating OSW generation.[194] However, the PJM-New Jersey agreement contemplates preservation of the capability created at specific onshore POIs for one state that are then assigned to specific individual OSW generators. As ongoing efforts in the U.K. show, many additional regulatory and contractual matters will need to be addressed once offshore facilities are designed to (1) be coordinated to address the needs of multiple generators and states,[195] and (2) are linked into a shared, multi-purpose offshore network with multiple POIs in one or more market areas.[196] Offshore wind integration efforts in Ireland have addressed similar issues.[197]

These contractual and regulatory frameworks also need to be developed in the U.S. for multi-purpose use, allowing for both the delivery of OSW generation to shore and expansion of the transmission capability of the integrated grid. They should also facilitate both regional and interregional operations. While networked connections between radial transmission facilities may initially create a meshed network configuration within one region, underlying regulatory constructs should be created such that these networks can be readily expanded to enable interregional connections. This will likely require additional and related RTO market design work, including engagement with workstreams contemplated under Recommendation 12 below. These regulatory frameworks should also seek to mitigate project-on-project risks of separating offshore wind transmission development and operations from offshore wind generation development and operations, by preserving (or otherwise identifying) the capability

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[194] 179 FERC ¶ 61,024 at P 46 (2022).

[195] See National Grid ESO, Offshore Coordination: Early Opportunities Update, May 2022 (to increase coordination for projects already under way), including discussion of "multi-purpose interconnectors" (at 9) and "next steps timeline" (at 16) of codes and standards, industry processes, stakeholder engagement, and grid operations processes.

[196] See Ofgem consultation and stakeholder survey: Update following our consultation on changes intended to bring about greater coordination in the development of offshore energy networks, January 26, 2022.

[197] S. Boeve, B. Vree, *et al.*, Final Report: Offshore Grid Delivery Models for Ireland, Navigant, March 31, 2020.

to be used by facilities subject to coordinated interconnection and enabling application of revised ITCs implemented under Recommendation 3.

Development of such a regulatory and contractual framework will require close collaboration among grid operators and states, possibly supported by DOE's transmission contracting capability. This framework must support evolving system designs, supporting the transition from radial tie lines to meshed radial tie lines and towards broader regional and interregional grid solutions. In addition, state engagement is critical to ensure that the ultimately developed contractual provisions can be used to enable networked offshore transmission through state-driven OSW generation and transmission procurements.

RECOMMENDATIONS FOR ACTION

- **DOE** should develop a technical forum of East Coast RTO/ISOs to begin development of regulatory and contractual models for intra- and inter-regional networking and multi-purpose use of offshore transmission facilities. This technical forum would include FERC as a critical member advising on open access precedent, states (possibly through a multi-state entity), NERC, relevant national labs, OSW generators, transmission developers, and other parties DOE finds appropriate.
- Once regulatory frameworks are developed, **FERC** should provide guidance on how RTO/ISO tariffs may need to be modified to support the necessary regulatory frameworks, encouraging or requiring **Grid Operators** to adopt these standards in compliance filings.

12. Improve Grid Operations and Wholesale Market Designs for HVDC networks

Within the next 3–5 years, and certainly before networked or multi-use offshore facilities are placed into service, DOE, in coordination with grid operators, should develop wholesale electricity operations and market design modifications that allow for the regional and interregional optimization of HVDC transmission networks.[198] These revisions to RTO operations and markets should consider the need to optimize both regional and interregional HVDC interties and the accelerated utilization of advanced technologies to address reliability needs (including MSSC concerns) and provide market benefits.

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[198] As noted, NYISO has already started to work on market design modification that would allow them to operationally optimize the use of region-internal HVDC lines. See Internal Controllable Lines: Market Design Concept Proposal, August 4, 2022.

Importantly, these improvements should take full advantage of the unique capabilities of HVDC technology as discussed earlier, utilize advanced technologies and operational tools to address concerns over largest single contingencies described above, and more fully and optimally utilize both existing and new interregional transmission capability. Once fully enabled, the benefits of optimized market operations enabled by appropriately-designed regional and interregional HVDC networks—such as interregional energy transfer value, grid congestion relief benefits, the resource adequacy value of broader interregional diversification, the interregional resilience value enabled by the improved grid operations and RTO/ISO market design, and reliability benefits such as black start capability—should also be considered in the benefit-cost analyses employed in regional and interregional transmission planning processes.

RECOMMENDATIONS FOR ACTION

- Following efforts in Recommendation 8, **DOE** should continue the technical forum of East Coast RTO/ISOs to build on existing experience (*e.g.*, current NYISO efforts) and develop best practices in grid operations and market design that allow for the optimization of offshore wind-related HVDC transmission links within and across regions and the consideration of these benefits within planning processes. This technical forum would include FERC, states (possibly through the multi-state entities), NERC, other relevant national labs, and would be expanded to include market participants likely to be impacted by pricing outcomes.
- Once the improved grid and market operations standards are developed, **FERC** should encourage **Grid Operators** to adopt these improved operational, reliability, and planning frameworks in their tariff and business practices.

V. Available Federal Support

Federal support for these recommendations is now available through several funding options and programs that are relevant to evaluating, analyzing, and planning the onshore or offshore grid to enable injection of offshore wind resources. DOE administers several of these funding streams under its Building a Better Grid Initiative, which includes the Transmission Facilitation Program, the Grid Resilience Utility and Industry Grants, Smart Grid Grants, and the Grid Innovation Program, described further below.[199] In addition, DOE's Wind Energy Technology

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[199] Department of Energy Grid Deployment Office, Building a Better Grid Initiative.

Office provides further funding opportunities,[200] including a recent $28 million opportunity related to address HVDC Standardization and other key wind energy deployment challenges,[201] and managing the federal administration's Earthshot™ for floating offshore wind.[202] While federal funding is very limited compared to offshore transmission investment needs—and investment tax credits are not broadly available to support offshore transmission—the available support can facilitate initiative to address the recommendations discussed above:

- Up to $100 million is available for funding for planning, modeling, and analysis is available under section 50153 of the Inflation Reduction Act (IRA),[203] including for specific purposes such as: (1) paying expenses associated with convening relevant stakeholders to address the development of transmission of electricity associated with OSW;[204] and (2) evaluating integration of clean energy into the grid, including cost methodologies to facilitate the expansion of the bulk power system, impacts of increased electrification, benefits of coordination between generator interconnection processes and transmission planning, evaluation of rights-of-way and existing transmission corridors, benefits of additional interregional or inter-interconnection transmission links, and opportunities for use of non-transmission alternatives.[205]
- Up to $760 million is available to facilitate the siting of certain interstate and offshore electricity transmission lines under section 50152 of the IRA, including for analyzing a transmission project, examining alternate siting corridors, participating in regulatory proceedings, and supporting economic development in affected communities.[206]
- Up to $2 billion is available for transmission facility financing under section 50151 of the IRA, including loan guarantees to certain transmission facilities designated by the Secretary of Energy to be in the national interest.[207]

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[200] Department of Energy Wind Energy Technologies Office.

[201] Department of Energy Wind Energy Technologies Office, WETO Releases $28 Million Funding Opportunity to Address Key Deployment Challenges for Offshore, Land-Based, and Distributed Wind, December 6, 2022.

[202] Department of Energy Wind Energy Technologies Office, Floating Offshore Wind Shot.

[203] 42 USC § 18715b.

[204] 42 USC § 18715b(b)(1).

[205] 42 USC § 18715b(b)(2)(A)–(L).

[206] 42 USC § 18715a.

[207] 41 USC § 18715.

- Up to $250 billion is available for energy infrastructure reinvestment loan financing under section 1706 of the IRA, including to retool, repower, or repurpose energy infrastructure, including transmission, to avoid or reduce greenhouse gases.[208]
- Up to $5 billion is available for resilience grants under section 40101 of the Infrastructure Investment and Jobs Act (IIJA), intended to reduce the likelihood and severity of grid disruptions, including for purposes such as weatherization technologies, monitoring and control technologies, equipment undergrounding, utility pole management, reconductoring or relocating power lines, and others.[209] Of this amount, up to $2.5 billion is available for Grid Resilience Utility Grants under section 40101(d) through Formula Grants for states, Tribes, and territories, and $2.5 billion is available for Grid Resilience Industry Grants under section 40101(c) through competitive grants and federal financial assistance.[210]
- Up to $5 billion is available under section 40103(b) of the IIJA, the Grid Innovation Program, providing states groups of states, Indian Tribes, local governments, or Public Utility Commissions funding opportunities for innovative approaches to transmission, storage, and distribution infrastructure.[211]
- Up to $3 billion is available for Smart Grid Grants under section 40107 of the IIJA, allowing for enhanced deployment of technologies to enhance grid flexibility.[212]
- Up to $2.5 billion is available on a revolving basis is available under section 40106 of the IIJA, which establishes the Transmission Facilitation Program.[213] This program allows DOE to engage in various ways to assist in the facilitation of transmission, including assisting in design, construction, operation, as well as issuing loans related to eligible projects and entering into contracts for up to 50% of the capacity of an eligible transmission project.[214]

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[208] 42 USC § 16516; 42 USC § 16517; see also Department of Energy Grid Deployment Office, Bipartisan Infrastructure Law and Inflation Reduction Act Program and Opportunities, October, 2022, at 4.

[209] 42 USC § 18711.

[210] Department of Energy Grid Deployment Office, Bipartisan Infrastructure Law and Inflation Reduction Act Program and Opportunities, October, 2022, at 5.

[211] 42 USC § 18712(b).

[212] The IIJA amended and made additional appropriations for 42 USC § 17386(a), the existing Smart Grid Investment Matching Grant Program established under the Energy Independence and Security Act of 2007, see IIJA § 40107.

[213] 42 USC § 18713.

[214] 42 USC § 18713(e)–(f).

- Up to $500 million is available for state energy offices, including for collaborative transmission siting and energy conservation plans under section 40109 of the IIJA, via DOE's State Energy Program extending to 2026.[215]
- The IRS administers several tax credits for project developers, including a 30% investment tax credit for offshore wind projects beginning construction before January 1, 2026, including direct pay provisions. Section 13502 of the IRA also includes additional tax credits for domestic manufacturing of components and installation vessels for offshore wind facilities.[216]

As several respondents to the RFI of the New England States have noted in specific recommendations for obtaining federal support and funding, these options are suitable to support offshore wind transmission efforts.[217] Four of the five New England states participating in the multi-state RFI have already sought input on how these funding opportunities may enable regional transmission goals. [218]

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[215] The IIJA amended and made additional appropriations for 42 U.S.C. § 6322(c), the existing Energy Policy and Conservation Act, see IIJA § 40109.

[216] Congressional Research Service, Offshore Wind Provisions in the IRA, September 29, 2022, at 2.

[217] For example, see Anbaric, Scaling Renewable Energy (RFI Comments), October 28, 2022, at 3-4, and 6 and Eversource, Comments of Eversource Energy Service Company on behalf of The Connecticut Light and Power Company, NSTAR Electric Company and Public Service Company of New Hampshire, October 28, 2022, at 6-9.

[218] See New England States Transmission Initiative, Five New England States Announce New Regional Energy Transmission Infrastructure Initiative – Request for Information to Integrate Clean Energy Resources, December 16, 2022 Update.

Appendix A

Table A-1 provides the details of offshore wind procurements, procurement targets of the states, and projected long-term needs. The projected long-term needs are based on state or regional clean energy and decarbonisation pathways studies.

TABLE A-1: OFFSHORE WIND COMMITMENTS AND FUTURE NEEDS

Region/State	Already Procured	State Goals					Projected Long-Term Need (GW)	
	2022	2030	2035	2040	2045	2050	2040	2050
ISO-NE (MW)	**4,841**	**8,042**	**8,642-9,042**	*8,642-9,042*	*8,642-9,042*	*8,642-9,042*	**23-29**	**42-44**
Massachusetts	3,241	5,600	*5,600*	*5,600*	*5,600*	*5,600*	6.7-11	23
Connecticut	1,158	2,000	*2,000*	*2,000*	*2,000*	*2,000*	9.1-11.1	*9.1-11.1*
Rhode Island	430	*430*	1,030-1,430	*1,030-1,430*	*1,030-1,430*	*1,030-1,430*	2.7	5
Maine	12	*12*	*12*	*12*	*12*	*12*	5	5
NYISO (MW)	**4,362**	*4,362*	**9,000**	*9,000*	*9,000*	*9,000*	**9-25**	**14-25**
New York	4,362	*4,362*	9,000	*9,000*	*9,000*	*9,000*	9-25	14-25
PJM (MW)	**8,432**	**8,432**	**14,722**	**18,222**	*18,222*	*18,222*	**13-30**	**33-58**
New Jersey	3,758	*3,758*	7,500	11,000	*11,000*	*11,000*	3.5-13.5	11-26
Maryland	2,022	*2,022*	*2,022*	*2,022*	*2,022*	*2,022*	*2.0*	*2.0*
Virginia	2,652	*2,652*	5,200	*5,200*	*5,200*	*5,200*	8-15	20-30
SERC (MW)		**2,800**	*2,800*	**8,000**	*8,000*	*8,000*	**8**	**7-10**
North Carolina		2,800	*2,800*	8,000	*8,000*	*8,000*	8	7.2-10
South Carolina								
MISO (MW)			**5,000**	*5,000*	*5,000*	*5,000*	**5**	**5**
Louisiana			5,000	*5,000*	*5,000*	*5,000*	5	*5*
CAISO (MW)		**5,000**	*10,000*	*15,000*	**25,000**	*25,000*	**15**	**25**
California		5,000	*10,000*	*15,000*	25,000	*25,000*	*15*	*25*
NWPP (MW)		3,000	*3,000*	*3,000*	*3,000*	*3,000*	**2-6**	**24-30**
Washington							0	4-10
Oregon		3,000	*3,000*	*3,000*	*3,000*	*3,000*	2-6	20
Atlantic Total (GW)	**17.6**	**23.6**	**35.2-35.6**	**43.9-44.3**	**43.9-44.3**	**43.9-44.3**	**54-93**	**96-137**
Gulf of Mexico Total (GW)			**5**	*5*	*5*	*5*	**5**	**5**
Pacific Total (GW)		**8**	**13**	*15*	**28**	*28*	**17-21**	**49-55**
US Total from State and Regional Studies (GW)	**17.6**	**31.6**	**53.2-53.6**	**66.9-67.3**	**76.9-77.3**	**76.9-77.3**	**76-119**	**150-197**
Federal U.S. Total (GW)		**30**				**110**	**40-100**	**224-458**

Notes: Values in italics and grey shading are based on previous years' stated procurement targets (and linearly interpolated for CAISO).

Sources for State Procurement Targets:

Massachusetts, Bill H.5060: An Act Driving Clean Energy and Offshore Wind, July 2022, at 58.

Connecticut, House Bill 7156: An Act Concerning Procurement of Energy Derived From Offshore

Wind, 2019.

Rhode Island, S 2583 Affordable Clean Energy Security Act, 2022.

New York, New York's Climate Leadership and Community Protection Act, 2019.

New Jersey, New Jersey Executive Order No. 307, September 21, 2022.

Maryland, OSW goal see 2019 Clean Energy Jobs Act; current procurement see Maryland Offshore Wind Overview (2022). As specified in its 2019 Clean Energy Job Act, the target of Maryland is to reach 1.6 GW offshore wind by 2030 but Maryland has already procured (2022.5 MW) more than the target.

Virginia, HB1526 Virginia Clean Economy Act, 2020.

Louisiana, Louisiana Climate Action Plan, February 2022.

Oregon, House Bill 3375, 2021.

California, Offshore Wind Energy Development off the California Coast: Maximum Feasible Capacity and Megawatt Planning Goals for 2030 and 2045, August 2022.

Sources for Long-Term Needs:

Massachusetts, Clean Energy and Climate Plan for 2050, December 2022, at 24.

A. Kniska and R. Collins, 2050 Transmission Study: Preliminary N-1 and N-1-1 Thermal Result, ISO-NE, March 16, 2022, at 12.

New England for Offshore Wind - NE4OSW: States Overview.

R. Jones, *et al.*, Energy Pathways to Deep Decarbonization: A Technical Report of the Massachusetts 2050 Decarbonization Roadmap Study, Evolved Energy Research, December, 2020.

Connecticut Department of Energy and OC Environmental Protection, Integrated Resources Plan: Pathways to achieve a 100% zero carbon electric sector by 2040, October 2021.

State of Maine Governor’s Energy Office, State of the Offshore Wind Industry: Today through 2050, January 28, 2022, at 27.

R. Lueken, S. A. Newell, J. Weiss, J. Moraski, S. Ross, The Brattle Group, New York’s Evolution to a Zero Emission Power System, May 18, 2020, at 44 (14-25 GW by 2040).

New York State Climate Council Scoping Plan, December 19, 2022, at 221, Table 13 (16-19 GW by 2050).

N. Bouchez, *et al.*, Grid in Transition Study: Phase 1 Analysis, NYISO, June 28, 2022.

PJM, Energy Transition in PJM: Emerging Characteristics of a Decarbonizing Grid, May 17, 2022.

Evolved Energy Research, New Jersey 2019 IEP Technical Appendix, November 29, 2019, at 20 and 25.

W. Shobe, *et al.*, University of Virginia and Evolved Energy Research, Decarbonizing Virginia's Economy: Pathways to 2050, January 2021, at 40, Figure 34.

B. Sergi, *et al.*, Duke Energy Carbon-Free Resource Integration Study, National Renewable Energy Laboratory, 2022, at 32.

Washington State Department of Commerce, Washington 2021 State Energy Strategy Transitioning to an Equitable Clean Energy Future, December 2020, at 37.

Evolved Energy Research, Renewable Northwest, GridLab, and the Energy Transition Institute, Oregon Clean Energy Pathways Final Report, June 15 and July 2, 2021.

Source for Federal U.S. Total:

E. Larson, *et al.*, Net-Zero America—National data, January 9, 2022, Princeton University, at 41, Table 42.

List of Acronyms

AC	Alternating Current
ACORE	American Council on Renewable Energy
ACP	American Clean Power Association
ANOPR	Advance Notice of Proposed Rulemaking
BOEM	Bureau of Ocean Energy Management
BP	Bi-Pole
BPU	Board of Public Utilities
CAISO	California Independent System Operator
CATF	Clean Air Task Force
CEEPR	Center for Energy and Environmental Policy Research
CESA	Clean Energy State Alliance
COP	Construction and Operation Plan
CTS	Coordinated Transaction Scheduling
DC	Direct Current
DOE	U.S Department of Energy
DOI	U.S. Department of the Interior
ENTSO-E	European Network of Transmission System Operators for Electricity
ESO	Electricity System Operator
EU	European Union
FERC	Federal Energy Regulatory Commission
FOA	Funding Opportunity Announcement
GE	General Electric
GET	Grid-Enhancing Technology
GIP	Grid Innovation Program
GW	Gigawatt
HVAC	High Voltage, Alternating Current
HVDC	High Voltage, Direct Current
IESO	Independent Electricity System Operator
IIJA	Infrastructure Investment and Jobs Act
IRA	Inflation Reduction Act
IRS	Internal Revenue Service
ISAC	Independent State Agencies Committee
ISO	Independent System Operator
ISO-NE	ISO New England
ITC	Investment Tax Credit
JTIQ	Joint Targeted Interconnection Queue Study
kV	Kilovolt
kW	Kilowatt
LBNL	Lawrence Berkley National Laboratory

LMP	Locational Marginal Pricing
LRTP	Long Range Transmission Planning
MISO	Midcontinent Independent System Operator
MIT	Massachusetts Institute of Technology
MOU	Memorandum of Understanding
MSSC	Most Severe Single Contingency
MVP	Multi-Value Project
MW	Megawatt
MW/km2	Megawatt per square kilometer (wind energy generation density)
NERC	North American Electric Reliability Corporation
NESCOE	New England States Committee on Electricity
NJ	New Jersey
NOPR	Notice of Proposed Rulemaking
NRDC	Natural Resources Defense Council
NREL	National Renewable Energy Laboratory
NYISO	New York Independent System Operator
NYSERDA	New York State Energy Research and Development Authority
OPSI	Organization of PJM States
OSW	Offshore Wind
OW	Ocean Winds
PJM	PJM Interconnection
PMA	Federal Power Marketing Agency
POI	Point of Interconnection
PPTPP	Public Policy Transmission Planning Process (of NYISO)
PPTS	Public Policy Transmission Study
RENEW	RENEW Northeast
RFI	Request for Information
RFCI	Request for Competitive Interest
RGGI	Regional Greenhouse Gas Initiative
ROW	Right-of-Way
RTO	Regional Transmission Organization
SAA	State Agreement Approach
SM	Symmetrical Monopole
SPP	Southwest Power Pool
TFP	Transmission Facilitation Program
UK or U.K.	United Kingdom
U.S.	United States
WEA	Wind Energy Area