The Benefit and Urgency of Planned Offshore Transmission:

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

EXECUTIVE SUMMARY

PREPARED BY

Johannes P. Pfeifenberger
Joe DeLosa III
Linquan Bai
Cornelis Plet (DNV)
Carson Peacock
Ryan Nelson

PREPARED FOR

Natural Resources Defense Council
GridLab
Clean Air Task Force
American Clean Power Association
American Council On Renewable Energy

JANUARY 24, 2023

Brattle

ACORE
AMERICAN COUNCIL ON RENEWABLE ENERGY

NRDC

CATF
CLEAN AIR TASK FORCE

GridLAB

AMERICAN CLEAN POWER

ADVISORY PANEL

STUDY SPONSORS

Cullen Howe, NRDC

Ric O'Connell, GridLab

Nicole Pavia, CATF

Gabe Tabak, ACP

Kevin O'Rourke, ACORE

RTOS

Suzanne E. Glatz, PJM

Robert Ethier, ISO-NE

NYISO (invited)

CAISO (invited)

STATES AND REGULATORY EXPERTS

John Bernecker, NYSERDA

Robert Snook, CT DEEP

Abraham H. Silverman, Esq., NJ BPU

Suedeen Kelly (former FERC Commissioner)

ACADEMIC AND INDUSTRY EXPERTS

Prof. Eric Hines, Tufts

Robert Gramlich, Grid Strategies

Beverly Bendix, RMI

Christina Hayes, Americans for a Clean Energy Grid

Lopa Parikh, Orsted

Shaela Collins, Shell

Peter Shattuck, Anbaric

Dave Effross, AFL-CIO

William Magness, DNV

Kevin Knobloch, National Offshore Wind Research and Development Consortium

NOTICE AND DISCLAIMER

This report was prepared for the named clients in accordance with The Brattle Group's engagement terms and is intended to be read and used as a whole and not in parts. It reflects the analyses and opinions of the authors and does not necessarily reflect those of The Brattle Group's clients, Advisory Panel members, or other consultants.

Advisory Panel members provided input and guidance related to study design and evaluation, but the contents and conclusions of the report, including any errors and omissions, are the sole responsibility of the authors. Advisory Panel member affiliations in no way imply that those organizations support or endorse this work.

There are no third-party beneficiaries with respect to this report, and The Brattle Group does not accept any liability to any third party with respect to the contents of this report or any actions taken or decisions made as a consequence of the information set forth herein.

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.

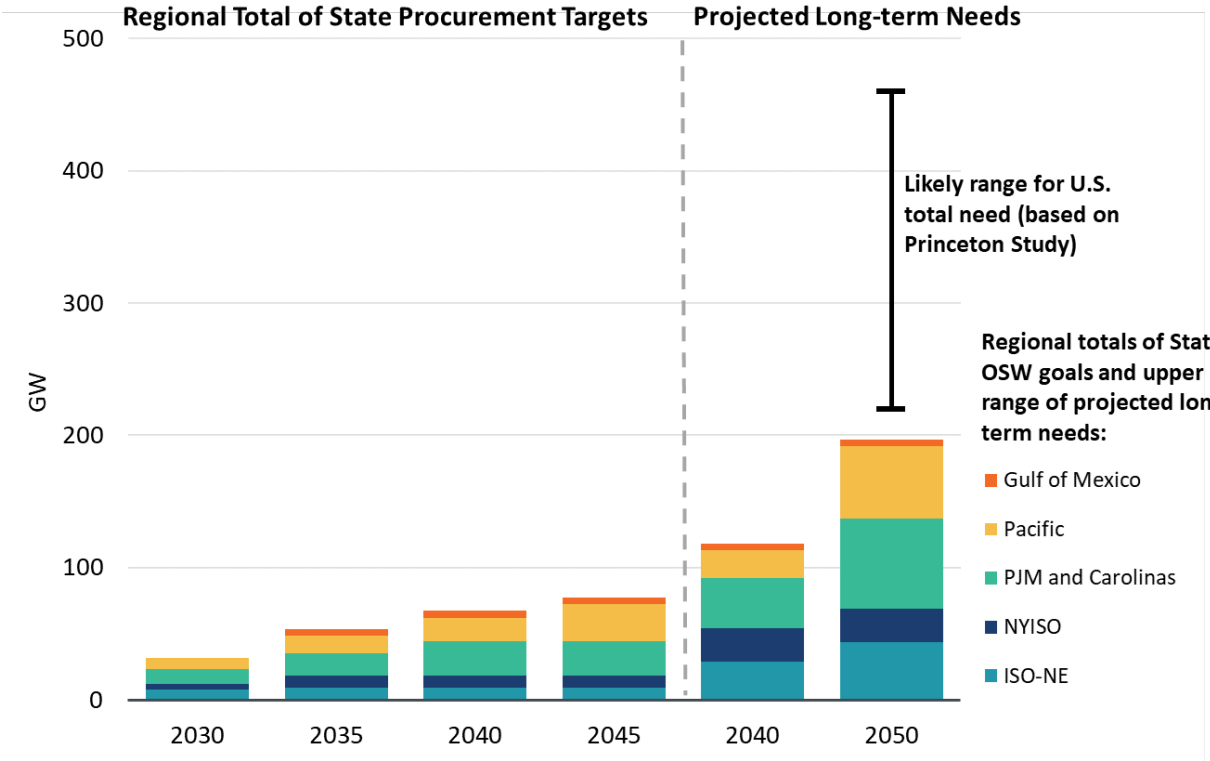
As Table ES-1 and Figure ES-1 further summarize, state-specific studies of clean energy and decarbonization needs show that close to 200 GW of OSW generation may be required by 2050

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.

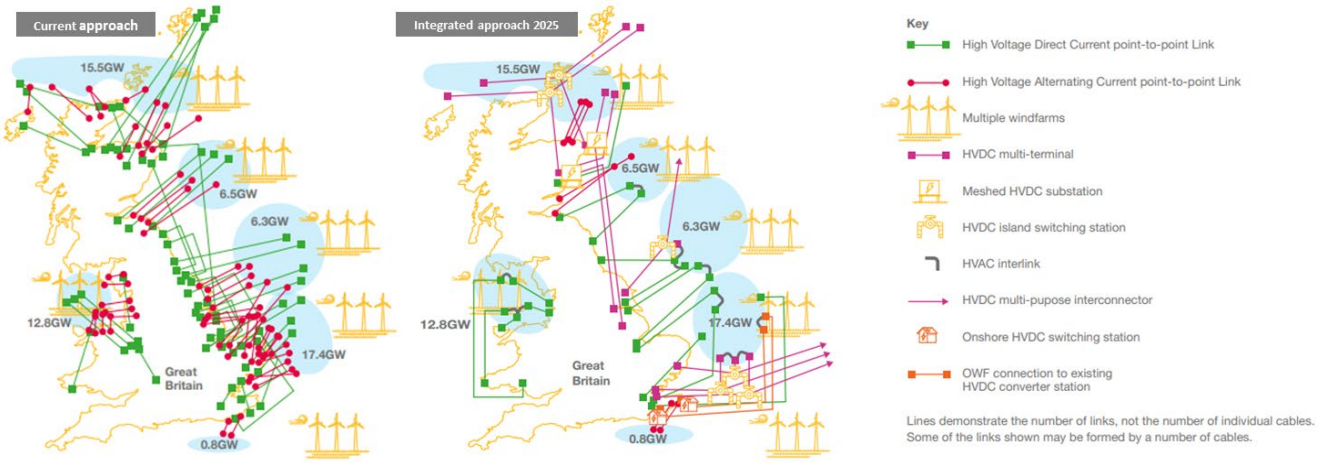
THE BENEFITS OF PROACTIVE OSW TRANSMISSION PLANNING

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.

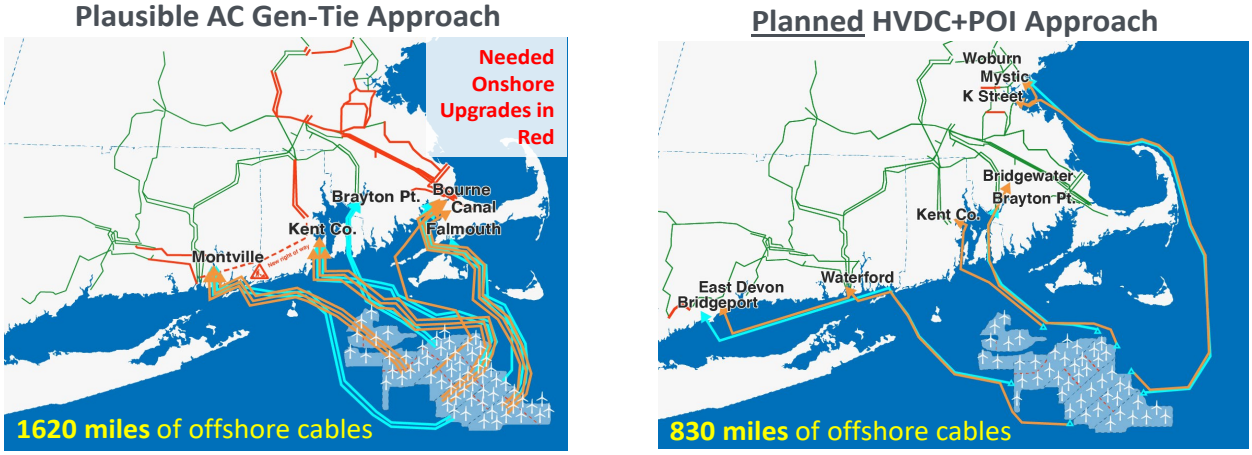
FIGURE ES-2: UNPLANNED VS. PLANNED TRANSMISSION FOR U.K. OFFSHORE WIND IN 2050
(Assuming planning efforts start to be effective by 2025)



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.

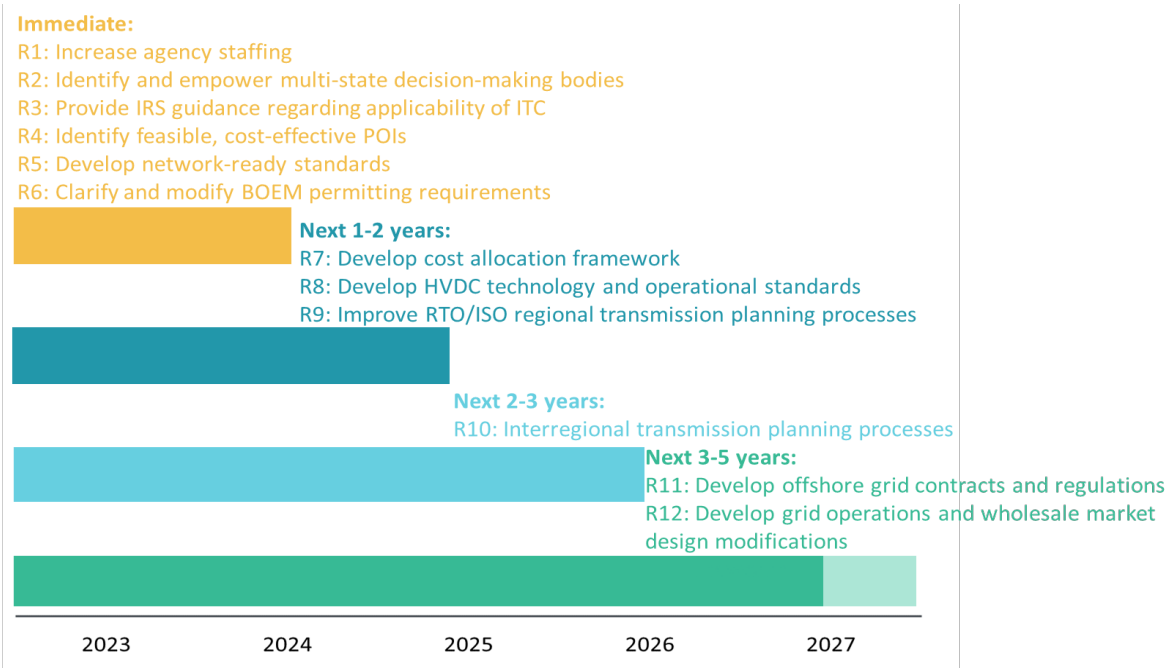
RECOMMENDATIONS FOR ACHIEVING COST-EFFECTIVE REGIONAL AND INTERREGIONAL TRANSMISSION SOLUTIONS WHILE INTEGRATING STATES' ONGOING OFFSHORE WIND PROCUREMENT EFFORTS

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

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.