AN ACTION PLAN FOR

Offshore Wind Transmission Development in the U.S. West Coast Region

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U.S. Department of ENERGY | Grid Deployment Office

BOEM BUREAU OF OCEAN ENERGY MANAGEMENT

Acknowledgments

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Executive Summary

This *Action Plan for Offshore Wind Transmission Development in the U.S. West Coast Region* (Action Plan) outlines recommendations to achieve effective offshore wind transmission development on the U.S. West Coast through 2050. The recommendations are intended to inform how Federal agencies, Tribes, states, transmission planners, private industry, and other groups approach transmission for offshore wind on the West Coast. Implementation of these recommendations will unlock significant opportunities to foster domestic energy production and enhance the region's energy grid. The West Coast has an opportunity to demonstrate leadership in floating offshore wind development. A successful approach can be accomplished through phased, flexible transmission development that maximizes economic benefits, enhances grid reliability, and minimizes environmental impact.

Deployment Pathway: Findings from the forthcoming West Coast Offshore Wind Transmission Study (WOW-TS), published by the Pacific Northwest National Laboratory (PNNL) and the National Renewable Energy Laboratory (NREL), support a two-phased deployment approach, where an initial radial transmission topology configuration for 2035 could be expanded into a larger interregional transmission network by 2050.[1] An interconnected system would optimize power flow, enabling sharing lower-cost generation between regions. While networked topologies within regions (i.e., intraregional) also offer significant benefits, modeling from the WOW-TS indicates that connecting California and the Pacific Northwest with an interregional approach unlocks greater economic potential, possibly exceeding $25 billion in net system-wide benefits.[2] The phased approach to transmission development minimizes the risk of underutilized assets, ensuring a smooth and efficient scale-up. Technological advancement, particularly in floating substations, dynamic cables, and high-voltage direct current (HVDC) systems, will be crucial to support this expansion. This Action Plan contains recommendations to enable phased transmission build-out.

Key Opportunities Enabled by Recommendations:

Coordinated efforts can achieve an offshore wind energy system that introduces economic opportunity, improves regional grid reliability, and prioritizes environmental stewardship. Recommendations provided in this Action Plan will open opportunities in three areas:

- **Economic Growth**: The interregional transmission network would dramatically increase economic benefits across different states and the broader region through avoided fuel costs and increased availability of offshore wind generation during cable outages. The significant cost savings across the electrical system projected by the WOW-TS would stimulate private investment and job creation across multiple sectors, including manufacturing, construction, operations, and maintenance.
- **Enhanced Grid Reliability**: The interconnected nature of the 2050 interregional transmission network would significantly improve grid resilience and reliability. The ability to share power across regions would mitigate disruptions caused by extreme weather events, transmission congestion, localized transmission outages, or fluctuations in generation.
- **Environmental Stewardship**: Early and comprehensive consultation and engagement, coupled with environmental research and analysis, are likely to minimize impacts to Tribes, fisheries, and coastal communities. Careful siting using advanced technologies and strategic cable placement would reduce environmental disturbance.

Recommended Actions

Achieving this vision will not happen with business-as-usual approaches and will require significant effort and collaboration across multiple sectors. The Action Plan recommendations are organized into five categories that each address a specific offshore and coastal transmission development need:

- **Planning and Operations:** A long-term plan using a phased and flexible approach for transmission development would achieve the greatest economic benefit while making the best use of early transmission investments. Fair and transparent cost allocation mechanisms would ensure that transmission costs are appropriately shared and ratepayer benefits are maximized.
- **Partnerships, Collaboration, and Community Benefits:** Federal, Tribal, state, and local government agencies must work collaboratively to ensure that transmission planning, supply chain development, and permit reviews occur effectively while protecting key values and rights. Strong partnerships with industry, fishing communities, and other ocean co-users are vital.
- **Opportunities and Support for Tribes:** Several Tribes have expressed concerns about the offshore wind development process as it relates to their sovereignty, sacred sites, and cultural ties to the land and ocean. Some Tribes have also noted a lack of resources and capacity to fully engage in input opportunities, consultations, or other forums to provide feedback. Federal and state governments can continue to address these concerns through early communication with Tribes, supporting opportunities that build Tribal Nation capacity, funding Tribal Nation-led research, and upholding existing policies that support collaborative agreements.
- **Technology Advancement and Standardization:** Investment in research, development, demonstration, and standardization of key technologies, including floating substations, high-voltage dynamic cables, and advanced HVDC systems, would accelerate the commercialization of floating offshore wind transmission infrastructure.
- **Environmental Review, Siting, and Permitting:** Research, analysis, data collection, and cross-agency collaboration can help avoid environmental conflicts related to the siting and permitting of new transmission infrastructure. Agencies with regulatory authorities, in partnership with Tribes, should guide specific environmental efforts that address knowledge gaps.

Public and private sector implementation of recommendations in this Action Plan will enable benefits from West Coast floating offshore wind, providing a secure, reliable, and economically beneficial energy future.

Introduction

The West Coast of the United States is poised to serve as a global leader in floating offshore wind technology. Offshore wind energy provides benefits such as cost savings,[3] improved grid reliability through higher and more stable capacity factors,[4] local energy resilience,[5] and substantial job creation.[6]

The U.S. Department of the Interior's (DOI) Bureau of Ocean Energy Management (BOEM) leased five areas off the coast of California to private companies in December 2022 for potential development of commercial-scale floating offshore wind power plants. These five leases, located at least 20 miles off the coast of Morro Bay and Humboldt Bay, California, have the potential to provide up to 4.7 gigawatts (GW) of offshore wind energy generation capacity.[7]

On the West Coast, a range of activities are underway across the region related to potential floating offshore wind development. In 2024, California developed a strategic plan through Assembly Bill 525 and set a goal of developing 2 to 5 GW of offshore wind capacity by 2030 and 25 GW by 2045;[8] Oregon is developing an Offshore Wind Energy Roadmap through House Bill 4080;[9] and Washington is supporting a public–private initiative to explore opportunities in the offshore wind supply chain.[10] Tribes[i] have engaged in BOEM's Renewable Energy Intergovernmental Task Force meetings and other working groups, and some Tribes have expressed concern about offshore wind development. To connect new offshore wind generation to the transmission grid, the California Independent System Operator (CAISO) Board recently approved a transmission plan to procure 400 miles of new transmission on California's North Coast that interconnects 1.6 GW of offshore wind generation and can be expanded for future offshore wind generation in line with their 20-year Transmission Outlook.[11]

Floating Offshore Wind

Approximately two-thirds of the United States' offshore wind energy potential exists over waters too deep for fixed-bottom wind turbine foundations to be installed in or on the seabed.[12] Instead, floating turbine platforms, which are stabilized with mooring lines and anchors, are needed to harness the high wind speeds blowing above these deep seas. To seize these opportunities, DOI set a goal to deploy 15 GW of floating offshore wind capacity by 2035—enough to power more than 5 million American homes.[13] Given the bathymetry of the ocean areas off the West Coast, offshore wind development there will require floating technology.

[i] The terms *Tribes* and *Tribal* are used throughout this document to refer to Indigenous nations, groups, or organizations regardless of Federal recognition. The term *Tribal Nations* is used throughout to refer specifically to federally recognized Tribal Nations. Other terms, such as *Indian Tribes*, are used only when included in a title or law, for example, Executive Order No. 13175—Consultation and Coordination With Indian Tribal Governments.

Floating Offshore Wind Shot. To achieve the goal of 15 GW of floating offshore wind, the Biden-Harris Administration launched an interagency Floating Offshore Wind Shot, which seeks to reduce the cost of floating offshore wind energy by more than 70% by 2035.[14] The Departments of Energy, the Interior, Commerce, and Transportation have already achieved more than 50 milestones and dedicated more than $950 million to advance the Floating Offshore Wind Shot and American competitiveness on floating offshore wind.[15] This Action Plan supports the Floating Offshore Wind Shot.

Transmission Topologies

Interconnecting large wind farms to coastal substations and transmission infrastructure poses technical, economic, and policy challenges that need to be considered alongside the development of new offshore turbines. Developers of offshore transmission infrastructure must contend with harsh ocean environments while installing cables in deep water; shortages of available components, port facilities, and installation vessels; and permitting requirements that span Federal, Tribal, state, and local jurisdictions that may have dissimilar or even disparate policies, processes, goals, and priorities. The physical transmission system varies in configuration (or topology) between regions and is already oversubscribed, with significant new generation capacity in the interconnection queues waiting to connect.

Onshore transmission upgrades are key to harnessing the potential offshore resource and moving power through sparse coastal grids to high-voltage, inland transmission corridors. Significant reinforcements are needed in specific areas, including the Humboldt County region of Northern California and parts of Southern Oregon, to both accommodate increased generation from offshore wind and provide long-needed improvements in overall grid reliability to reduce outage risks for communities. Onshore transmission upgrades must be completed concurrently with, or in advance of, any new offshore wind farm construction.

Alternating Current (AC) and Direct Current (DC) Transmission for Offshore Wind. Electric transmission involves transmitting electrical power at high voltages from generating plants to substations in which electricity can be stepped down in voltage and sent through the distribution system that connects to households and businesses. Most transmission lines utilize AC power, which is also used on distribution circuits and delivered to electric customers. HVDC transmission is used in specific circumstances, particularly for very long distances, because HVDC systems experience lower transmission losses per unit length. However, HVDC transmission requires more costly converter stations to convert power between AC and DC at both ends. The choice between AC and HVDC transmission is determined by a cost-benefit analysis considering distance, cost of converters, power requirements, and grid characteristics.

For offshore wind turbines, which produce AC power, export cables that connect the wind plant to the onshore cable landing location can be either AC or DC (Figure 1). These export cables, whether AC or DC, are submerged and typically buried 3-6 feet in the seabed or are protected with rocks or concrete mattresses. For AC export cables, an offshore substation is used to collect power from rows of turbines and to adjust the voltage before flowing to an onshore substation that connects to the larger onshore grid. For DC export cables, AC/DC converter stations are used both offshore, to convert AC power from the turbines to DC, and onshore, to convert DC power back to AC. Selecting the most cost-effective export cable requires balancing the higher cost of AC-DC converter stations with the reduced losses from a DC system, which are proportional to distance. DC systems start becoming cost-competitive when export cable lengths are approximately 50 miles.[16] Further, offshore HVDC systems offer

technical capabilities unique to HVDC that may be essential to the operation of a future offshore grid, including the ability to precisely control power flows to multiple output locations.

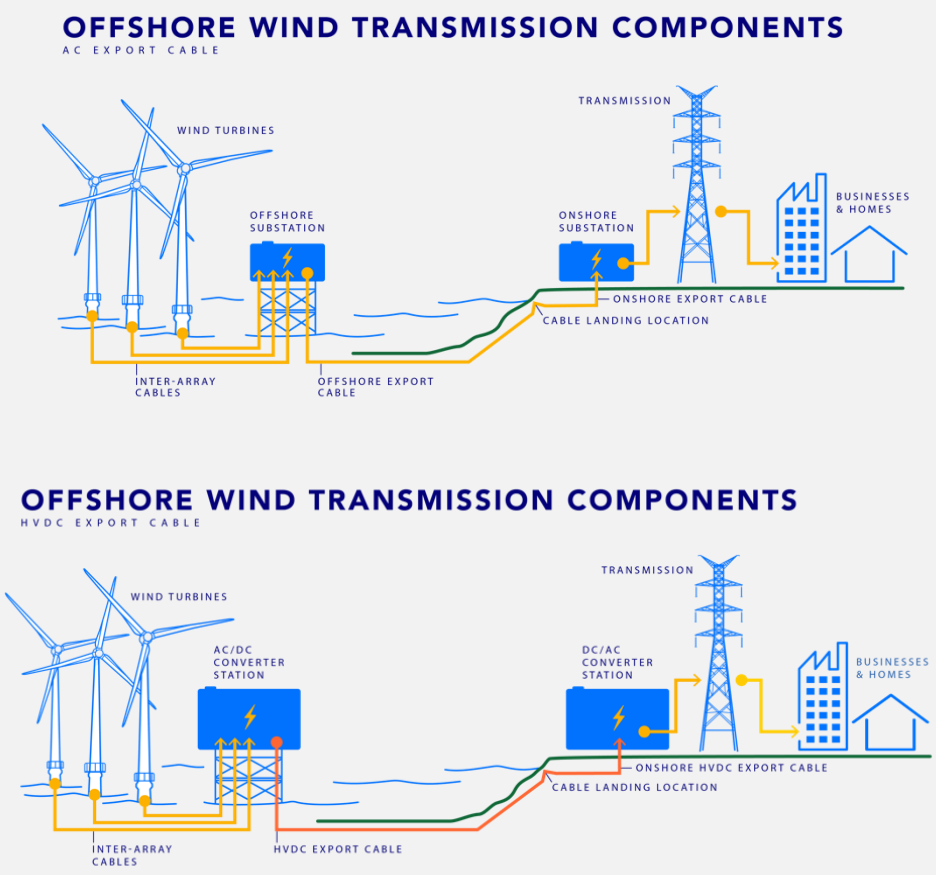


Figure 1. Offshore wind transmission components for an AC system (top) and DC system (bottom).

Offshore transmission configurations are grouped into radial and network topologies. For radial topologies, power follows a single path from the generation to the onshore point of interconnection (POI). Radial topologies are most common, tend to be the quickest to build, and require the least risk for the generation developer. Network topologies expand on the radial design by including offshore interlinks to connect multiple cables. These configurations introduce multi-directional power flows and make new options available for transmission system operators to reroute power offshore. Multiple paths, when sized properly, increase system reliability—if a single line is lost, power can still make it to shore through an alternate path. Network topologies can combat onshore transmission congestion and outages by opening a path offshore for power to flow across the system, thus improving reliability and reducing costs.

For the West Coast, transmission topologies are categorized into four potential interconnection approaches (Figure 2). *Radial concentrated* uses radial interconnections from individual wind plants to a few onshore POIs. *Radial distributed* uses the same approach of radial interconnection but connects to

more onshore POIs, thereby distributing the geographic location of power injection points. *Intraregional* topologies use a radial and/or network approach to connect multiple offshore wind plants to POIs within regions but do not create any new transmission paths between regions. Lastly, *interregional* topologies include a multi-terminal backbone that connects multiple offshore wind plants to POIs in two regions. An interregional topology allows offshore wind power to selectively flow to multiple regions and creates a new transmission path for power from other generation resources to flow between regions (e.g., between California and the Pacific Northwest).

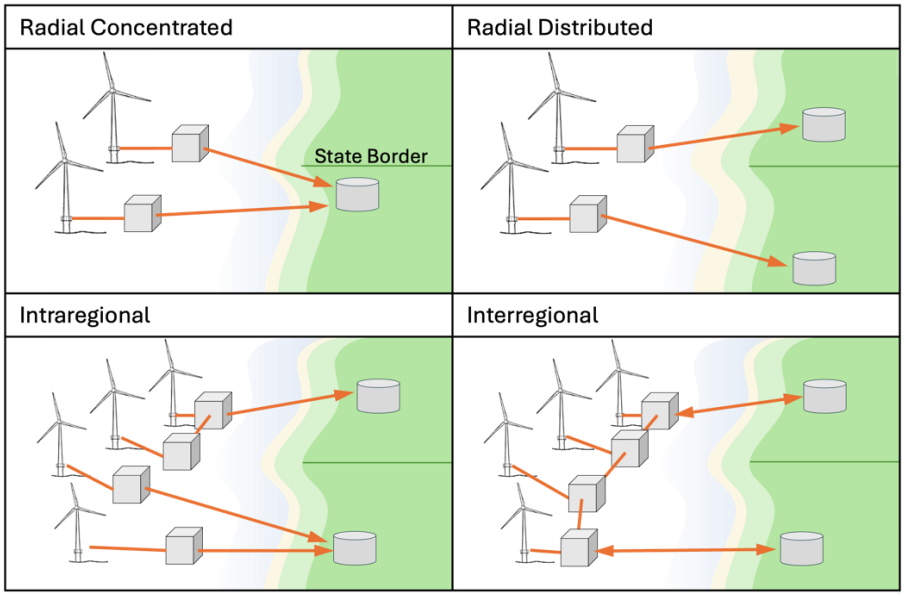


Figure 2. Transmission topology grouping for West Coast offshore wind generation.

Who makes transmission decisions? Transmission planning and siting is a multi-faceted process involving several key players, with no single entity holding complete authority. The U.S. Department of Energy (DOE) plays a significant role in supporting research and analysis but does *not* directly make transmission decisions. Instead, responsibility is divided, in general, as follows:

- **Federal Government:** BOEM is responsible for permitting offshore transmission infrastructure, including cables and substations, located on the Federal outer continental shelf (OCS). Along the West Coast, this generally covers areas beyond the 3-nautical-mile state limit out to 200 nautical miles. Other Federal agencies are involved in the siting, review, and permitting process. For example, the Federal Energy Regulatory Commission (FERC) regulates interstate electricity transmission and is responsible for ensuring that the rates, terms, and conditions that apply to the transmission of electricity in interstate commerce are just, reasonable, and not unduly discriminatory or preferential. FERC also has limited back-stop siting authority over certain onshore transmission facilities.
- **State Governments:** Once transmission lines reach state waters (within 3 nautical miles of the coast) and landfall points, permitting responsibilities shift to the respective state government agencies. State regulations vary but typically involve environmental impact assessments and approvals from coastal resource agencies. Public utilities commissions, with structure varying by state, oversee the interconnection of the transmission facilities to the onshore grid built solely within that state. They review applications from transmission owners, assess the impacts of planned infrastructure, and ensure compliance with state regulations.
- **Transmission Planners:** Organizations like regional transmission operators (RTOs), independent system operators (ISOs), and utilities operate the regional grid and identify transmission needs to maintain a reliable grid and ensure adequate power supply. Transmission planners carry out the interconnection process for new generation assets connecting to their transmission grid.
- **Transmission Owners:** These entities, such as utilities and private transmission companies, are responsible for the construction, operation, and maintenance of transmission facilities and substations. Their proposals for new infrastructure or upgrades are subject to review, permitting, and approval by the relevant Federal and state authorities.
- **Local Governments:** Local governments may have a role to play through zoning regulations, land use planning, and public hearings.
- **Tribal Nation Governments:** The United States recognizes the right of Tribal governments to self-govern and supports Tribal sovereignty and self-determination. Tribal cultural resources are protected under a variety of Federal laws. Some Tribal Nations also have treaty-reserved rights to harvest fish and other species in areas outside of their present-day Tribal lands, and some Tribal Nations have Federally reserved fishing rights. Transmission built onshore on Tribal land requires Tribal consent, while Federal involvement in projects occurring outside of Tribal lands that may affect Tribal rights and interests may require government-to-government consultation and consideration of potential effects on those Tribal rights and interests.[17]

These collaborative processes ensure that transmission projects undergo thorough environmental review, address public concerns, and meet regulations before construction can begin. The interactions

between these entities frequently involve complex negotiations and approvals at multiple levels of government. See Appendix A for an overview of permitting roles.

Determining the number of transmission cables. It is not yet possible to answer questions about how many cables will be needed per project or on the West Coast in total. There are no definitive numbers of transmission cables yet because cable arrangements depend on several factors that have not been decided, including capacity of lease areas, cable technology and voltage choices, and cable landing sites. Many of these decisions will be made by offshore wind developers when future wind farms are designed. It will be at least several years before enough information is gathered through site surveys to design the cable routes.

This Action Plan

This *Action Plan for Offshore Wind Transmission Development in the U.S. West Coast Region* (Action Plan), produced in concert by DOE's Grid Deployment Office (GDO) and DOI's BOEM, is an expansion of Federal offshore wind transmission planning efforts, serving both as a follow-up to the *Action Plan for Offshore Wind Transmission Development in the U.S. Atlantic Region*[18] and as a tool for addressing the unique challenges of deep-water transmission needed for the floating offshore wind farms anticipated on the West Coast. This document provides regionally specific recommendations for potential future offshore wind transmission development off the West Coast of the United States (from California to Washington).

West Coast Offshore Wind Transmission Study

Results from the West Coast Offshore Wind Transmission Study (WOW-TS)[19] underpin, and are intended to complement, this Action Plan and will allow for comparison of cost and benefits between potential transmission topologies. The WOW-TS, produced by the Pacific Northwest National Laboratory (PNNL) and the National Renewable Energy Laboratory (NREL), modeled future generation and transmission in the Western Interconnection to study different interconnection topologies for offshore wind development. The WOW-TS will be published in January 2025.

> **West Coast Literature Review and Gaps Analysis.** In February 2023, DOE published a literature review and gaps analysis[20] summarizing the methods and findings from 13 past and ongoing offshore wind transmission analyses focused on the West Coast. The gaps identified in this review were used to inform the scope of the WOW-TS to address existing knowledge gaps without duplicating past research.

The WOW-TS found that offshore wind generation will play an important role in meeting future electrical demand across the West, particularly for coastal regions. Capacity expansion modeling in the WOW-TS found that 15 GW of offshore wind generation by 2035 and 33 GW by 2050 were needed to meet policy goals and load growth at the lowest cost.[21] The study compared system-wide costs and reliability of different transmission topologies to interconnect this amount of offshore wind generation (Figure 3).[22] In 2035, the scenarios included radial concentrated with five POIs and radial distributed with nine POIs.[23] In 2050, three scenarios shared the same set of POIs and power injection capacities but took different approaches for transmission coordination.[24] The 2050 topologies included radial (no connection between wind plants), intraregional (networked transmission within regions), and interregional (networked transmission between and within regions).

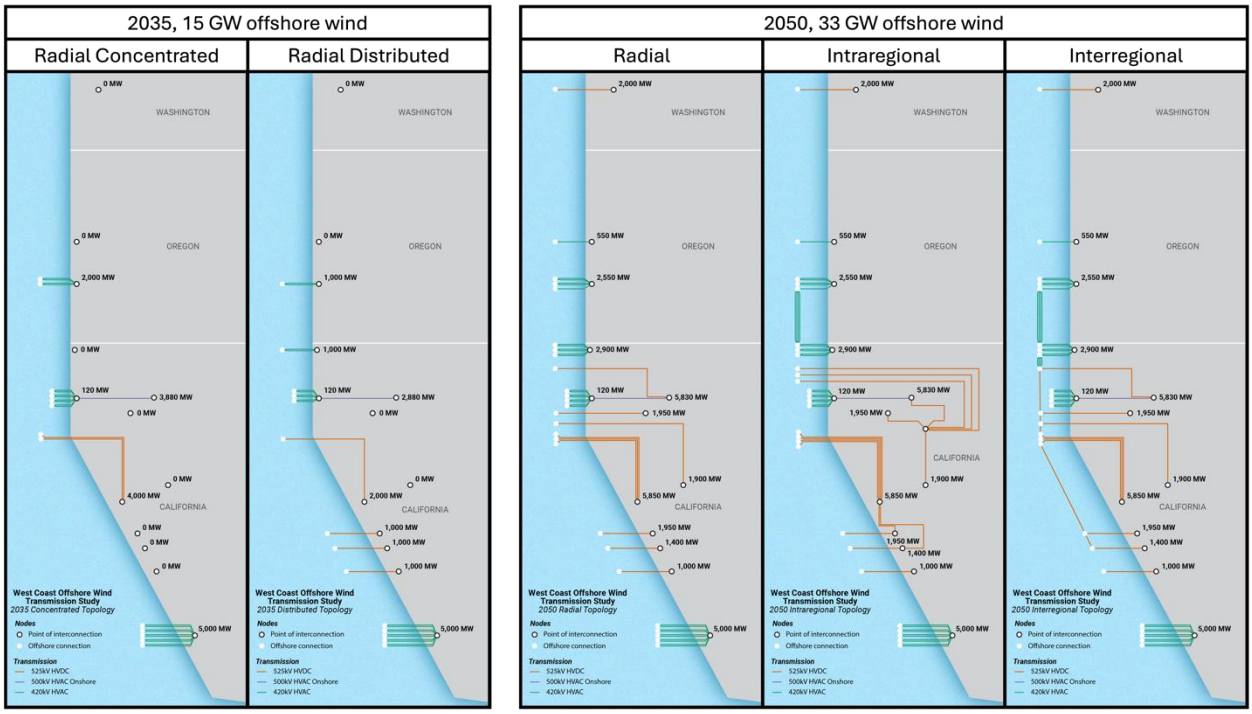


Figure 3. Transmission topologies for WOW-TS.[25]

After modeling and analyzing all topologies, the WOW-TS found the following:

Phased Development

- In 2035, both radial concentrated and radial distributed offer similar benefits but with different cost structures. Concentrated power injections drive the need for more onshore upgrades for reliability than distributing them. Distributed injections incur greater build costs in the ocean to reach more POIs than concentrating them. However, given comparable total costs, a distributed approach may offer greater resilience and broader geographic distribution of benefits.[26]
- The most cost-effective pathway starts with the 2035 radial distributed topology and builds to the 2050 interregional topology. However, both interregional and intraregional topologies offer similar benefits in terms of avoided system-wide fuel costs and increased availability of offshore wind generation during cable outages.[27]
- Using a phased approach to transition from 2035 to 2050 is feasible by expanding either one of the 2035 topologies to build the future 2050 topology with no stranded assets. Designing near-term transmission investments for 2035 that can be used as part of a longer-term vision allows the greatest system-wide economic benefit.[28]

Economic Benefits and Costs

- Interconnected offshore wind transmission systems (both intraregional and interregional) offer substantial economic advantages over the radial system in 2050, with net, system-wide benefits potentially exceeding $15 billion for intraregional and $25 billion for interregional topologies.[29]

- The benefits from networked transmission accrue not only due to the ability to move offshore wind power flows to the location with the highest need, but largely because networked offshore transmission enables sharing of lower-cost generation between otherwise isolated load areas.[30]
- The magnitude of these benefits is highly sensitive to other assumptions about the future electrical grid; for example, including the price of hydrogen, where modeling lower hydrogen costs reduces the value of networked offshore transmission.[31]
- WOW-TS results also show that the distribution of economic benefits from networked offshore wind transmission can be unevenly distributed across regions and between network users (i.e., generators, transmission owners, load purchasers) if transmission in one region causes congestion in another region. Therefore, transmission planning should consider power flows in adjacent regions to avoid unexpected impacts.[32]
- The capital investments to build a transmission system that meets future needs are significant and comparable between the different topology sets. Networked transmission systems modeled in WOW-TS were used by all generation assets, not just offshore wind, and proper cost-allocation mechanisms should be developed to fully utilize the benefit of networked offshore transmission.[33]

Reliability

- Transmission expansions and reinforcements to support offshore wind and avoid overloads in the Western Interconnection create a system that is largely reliable and stable in 2050. Production cost savings afforded through coordinated transmission designs justified the costs of reinforcements to enable coordinated transmission. Special mitigation strategies need to be developed to ensure dynamic stability under all identified major disturbances.[34]

Community Values

- An evaluation of community values found that careful planning and siting is needed to balance the energy resilience benefits from offshore wind transmission with potential impacts on fishing and coastal communities.[35] Some of the coastal communities most likely to see fishing impacts are those most in need of the energy benefits.

West Coast Offshore Wind Transmission Convening Series and Action Plan

Five research and engagement tracks inform this Action Plan, including a January 2023 scoping meeting facilitated by DOE and BOEM; DOE's *West Coast Offshore Wind Transmission Literature Review and Gaps Analysis*;[36] the WOW-TS,[37] led by PNNL and NREL from 2023 through 2024; the West Coast Convening Series, which included 12 convening workshops in 2024; and a public Request for Information.[38] From January to November 2024, DOE and BOEM held a Convening Series[39] to gather advice, information, and facts from Tribes,[40] state governments, individuals, and organizations rather than group consensus.[ii] The Convening Series included five Tribal workshops, four state government and transmission planner workshops, two public workshops, one Federal agency workshop, and several opportunities for technical input through WOW-TS meetings led by PNNL and NREL.

[ii] Some of the Convening Workshops were public and some were invitation-only for certain decision-makers, such as Tribal or state governments.

Recognizing the need for alternative methods to collect feedback, the authors of this Action Plan solicited input via email; during existing meetings and conferences, to reduce scheduling burden; and at ad hoc meetings for specific questions.

All feedback from the Convening Series, Request for Information, and other sources was thoughtfully considered but may not be reflected in this Action Plan. All recommendations in this Action Plan were developed internally by DOE and BOEM. Feedback and insight were instrumental in helping DOE and BOEM think holistically about how to address offshore wind transmission challenges. The feedback covered various topics, including collaborative approaches to proactive transmission planning; technology advancement and standardization; economics; environmental impact, siting, and permitting; and policy and regulatory development.

More than 560 individuals from 296 entities participated in the West Coast Convening Series, including representatives from Federal agencies, Tribal governments, state agencies (i.e., public utility commissions, state energy offices, state environmental and natural resources agencies, and governors' offices), ISOs and RTOs, and existing BOEM leaseholders.

DOE and BOEM offer these recommendations to foster responsible offshore wind transmission development on the U.S. West Coast. This collaborative effort provides actionable strategies for a variety of entities, including industry, non-profits, Tribes, and state governments. Not all recommendations fall under Federal purview, and the recommendations are not binding or enforceable. They are not regulatory or siting decisions. These recommendations are meant to advance conversation and highlight opportunities for improvement as the transmission planning process takes shape.

Atlantic Coast Recommendations to Consider for the West Coast. The West Coast Action Plan builds on lessons learned from the Atlantic Coast. In March 2024, DOE and BOEM published *An Action Plan for Offshore Wind Transmission Development in the U.S. Atlantic Region*,[41] which outlined 41 recommendations to support offshore wind transmission development off the Atlantic Coast. Some recommendations are not region-specific and are applicable to the West Coast as well. Rather than repeat these recommendations, they are listed below for reference. Additional recommendations are referenced in sections throughout this Action Plan.

- 1.2.1 International Cooperation
- 1.2.2 Communication Practices and Public Engagement
- 2.1.1 State-led Transmission Planning
- 2.1.2 Systematic Evaluation of POI Capacities and Windfall Locations
- 2.3.1 North American Electric Reliability Corporation (NERC) Reliability Standards Around Offshore Wind
- 2.4.2 Regulatory Guidance for Ownership of Network-Ready Projects
- 3.1.1 Network-Ready Equipment Standards
- 3.1.3 Transmission Optimization with Grid-Enhancing Technologies
- 3.2.1 HVDC Standards Development
- 3.2.2 MT-HVDC Testing and Certification Center
- 3.3.2 Environmental Research and Development for Offshore Wind Transmission
- 3.4.1 Expansion of Domestic Supply Chain and Manufacturing
- 3.4.2 Skilled U.S. Workforce Development
- 4.1.4 Equity in Ratemaking

- 4.1.5 Consumer Advocates
- 5.1.1 Federal Preferred Routes for Transmission in the Outer Continental Shelf
- 5.1.5 Utilization of Existing Facilities Along the Coast
- 5.2.1 Improved Environmental Review and Permitting Frameworks
- 5.2.4. Permitting Agency Resources and Staffing
- 5.2.5 Community Benefit Agreements

Recommendations

West Coast offshore wind transmission recommendations are organized into five categories (Figure 4).

Figure 4. Recommendation Categories.

1. Planning and Operations

This section examines the need for improved transmission planning to effectively integrate offshore wind into the electricity grid. We present recommendations to improve modeling and implement cost allocation strategies across regional and state boundaries.

1.1 Phased, Flexible Approach for Regional Transmission Development

Transmission development to support offshore wind interconnections will occur over multiple phases as new offshore wind generators have potential to come online in the 2030s and subsequent decades. Building radial interconnections for early offshore wind projects that can be integrated into either intra- or interregional transmission topologies in the future would lead to the highest system-wide cost savings in the long term. The WOW-TS findings suggest that a phased, flexible approach, incorporating initial investments into a long-term vision, yields the greatest system-wide cost savings, with interregional topologies displaying more cost savings than intraregional topologies, depending on sensitivities related to distribution, fuel cost, and capacity of other generating resources, including hydrogen.[42]

A phased approach, prioritizing low-regret investments adaptable to various future scenarios, is optimal. This allows for re-evaluation of cost-benefit analyses as uncertainties resolve. CAISO's plan for the North Coast transmission development exemplifies this approach: building HVDC infrastructure from Humboldt to Collinsville, but initially operating it as a 500 kilovolt (kV) AC line until higher capacity and HVDC converter station costs are justified. To realize all potential benefits of an interregional topology, a phased and flexible approach can accommodate voluntary collaboration among states, planners, and regulators

needed to address challenges due to varying state timelines, complex cost allocation, and differing policies and planning processes while respecting individual state priorities and conforming to the FERC cost causation principle.

- **We recommend** a *phased* approach in which transmission planners begin planning with a 20-year vision of future transmission development, then design near-term interconnection investments that can be implemented with least regrets to multiple future outcomes. To develop a long-term plan, transmission planners need information from states and industry to help them forecast future energy needs.
- **We recommend** state integrated resource plans (IRPs) identify expected capacity and location of offshore wind generation, alongside other new and retired generation.
- **We recommend** a *flexible* approach in which transmission planners re-evaluate costs and benefits of the long-term transmission strategy based on up-to-date economic and power system data every few years or based on certain triggering events, like delays in project development, significant cost increases, or other changes. As future fuel costs, resources, and loads become more certain, transmission planners can adapt their long-term strategy to make best use of least regrets investments.
- **We recommend** regional transmission planners evaluate costs and benefits of transmission investment on a system-wide scale across FERC Order No. 1000 transmission planning regions within the Western Interconnection. Planners should also aim to disaggregate costs and benefits by balancing authority and network users (i.e., generators, transmission owners, and load purchasers) to inform equitable cost allocation processes.

1.2 Supporting Tools and Analysis for Modeling Future Grids

Effective long-term transmission planning is critical for maintaining grid stability and achieving national energy security goals. The energy sector is undergoing a period of rapid transformation, driven by technological innovation, cost reductions, and evolving demand patterns. The increasing electrification of various sectors and the potential for significant demand increases driven by artificial intelligence further underscore the urgency of comprehensive and forward-looking transmission planning to accommodate the resources necessary for a reliable and resilient grid. Successfully navigating this transformation requires incorporating realistic projections of future scenarios into transmission planning tools. This is particularly true for emerging energy resources such as floating offshore wind in which the long lead times for deployment and the significant potential for cost reductions and technological maturation must be carefully considered. Failure to accurately account for these factors in long-term planning increases the risk of grid instability, unexpected curtailment of new energy generation, and, ultimately, delays in meeting broader energy security objectives.

- **We recommend** existing transmission planning efforts (e.g., the Western Transmission Expansion Coalition, WestTEC, and California's Renewable Energy Transmission Initiative, RETI)[43] include offshore wind in their assumptions, integrating realistic offshore wind development scenarios, alongside expected capacity expansions, plant retirements, and demand changes. Planning exercises should include sensitivities to cost and production assumptions within the bounds of expected uncertainty.
- **We recommend** a robust set of offshore wind cost curves and power curves be developed that can be incorporated into a variety of capacity expansion models, such as PLEXOS,[44] ReEDS,[45] and

RESOLVE.[46] Offshore wind assumptions should be time-bound and include uncertainty levels. Assumptions should be verified for accuracy with the energy industry, utility, government, and financing sectors.

- **We recommend** comprehensive offshore wind transmission feasibility studies of potential onshore transmission routes that address environmental impacts, permitting, land ownership, right-of-way acquisition, and military mission compatibility (like RETI) for both new transmission corridors and expansions of existing corridors. Planners should consult resources like the California Military Energy Opportunity Compatibility Assessment Mapping Project[47] to identify compatibility between transmission plans and military operations.
- **We recommend** incorporating offshore wind into long-term resource adequacy plans and long-term regional transmission plans that reflect Federal leasing timelines, industry investments, and state or Federal goals. In particular, we recommend offshore wind generation be included in state IRPs to the extent applicable. It is important that the contributions of geographically diverse offshore wind resources to resource adequacy are fully considered in CAISO transmission planning, Western Power Pool transmission planning, and integrated resource planning processes through at least a 20-year time horizon.

1.3 Cost Allocation and Reducing Ratepayer Impacts

When new transmission infrastructure is built, ratepayer impacts are determined by cost allocation methods either for individual transmission facilities or portfolios of transmission facilities. Transmission facilities that only fall in one utility's jurisdiction are more straightforward for cost allocation, but the processes for cost allocation under regional transmission planning and interregional transmission coordination are complex and vary by transmission planning region. However, FERC requires that transmission providers, such as ISOs, RTOs or utilities, ensure that cost allocation methods are just, reasonable, and consistent with the cost causation principle, which for regional transmission facilities, means that the costs of transmission facilities must be allocated in a manner that is at least roughly commensurate with estimated benefits. This principle is often referred to as *beneficiary pays*. Benefits received may be quantified for each customer base, which can be based on utility service territory, planning region zones, or geographic location, and are then allocated to ratepayers via electric bills.

> **Western Region Transmission Planning**. Existing transmission planning coordination efforts in the Western Interconnection can be leveraged to address interregional transmission, related cost allocation, and offshore wind specific transmission planning to meet current and future needs. Existing coordination bodies include WestTEC, the Western Transmission Coalition, and individual state coordination on transmission facilities (such as the Oregon and Washington partnership on the Cascade Project).

FERC has jurisdiction over the rates for transmission facilities that operate in interstate commerce and must approve cost allocation methods submitted by transmission providers, which are included in transmission providers' tariffs. State agencies (public utility commissions, state electricity consumer advocates, and energy offices) often file comments and participate in FERC ratemaking proceedings and hearings, representing interests such as retail electric service customers. Although phased and flexible offshore wind transmission expansion can benefit customers and will require fair and equitable cost allocation according to these regulations, additional considerations could reduce ratepayer impacts.

- **We recommend** convening discussions on system-wide cost allocation for future interregional transmission facilities, using existing forums to ensure equitable distribution of costs and benefits across transmission planning regions.
- **We recommend** that transmission planners and operators consider alternative financing methods to reduce the burden on ratepayers, such as by leveraging public funding sources like California's Greenhouse Gas Reduction Fund;[48] or leveraging public loan funds to incentivize private or other investment into needed transmission that otherwise may not be built, such as DOE's Transmission Facilitation Program,[49] or the Climate Catalyst Revolving Loan Fund.[50]

FERC Order No. 1920. FERC Order No.1920,[51] issued in May 2024 and supplemented by Order No.1920-A[52] in November 2024, contains multiple reforms, including, but not limited to the ones enumerated below, that will impact long-term regional transmission planning processes and cost allocation, requiring transmission providers to:

- Conduct long-term regional transmission planning over at least a 20-year time horizon
- Develop long-term scenarios for use in planning and use seven enumerated reliability and economic benefits for evaluating transmission facilities
- Include a process giving states and interconnection customers the opportunity to fund all, or a portion, of the costs of a selected transmission facility that otherwise would not meet selection criteria
- Submit a cost allocation method(s) for allocating the costs of long-term regional transmission facilities
- Modify interregional transmission coordination procedures to align with long-term regional transmission planning

Transmission providers are in the process of complying with FERC Order No. 1920 requirements. The resulting long-term regional planning processes and cost allocation methods will affect long-term regional transmission planning, interregional transmission coordination, and cost allocation methods for transmission facilities, including facilities that support offshore wind.

For more ideas about equity in ratemaking and consumer advocacy, see *An Action Plan for Offshore Wind Transmission Development in the U.S. Atlantic Region* recommendations 4.1.4 and 4.1.5.[53]

2. Partnerships, Collaborations, and Community Benefits

This section recognizes the need to enhance multi-state collaboration, create innovative revenue-sharing models, improve inter-agency coordination, and mitigate potential impacts of the development process on local communities, the fishing industry, and ocean co-users. Recommendations are outlined across two categories in this section: (i) interagency and intergovernmental coordination, and (ii) benefits to ocean co-users and local communities.

Interagency and Intergovernmental Coordination

2.1 Forming a Multi-State Collaborative to Advance Interstate Coordination

Multiple regional models and frameworks for Federal–state partnerships exist, but there is not one central planning entity leading regional conversations among the three West Coast states and their varying offshore wind development timelines. The creation of a regional collaborative to represent all interests could better serve the planning process to realize benefits of a future offshore transmission system.

Regional collaborative entities have formed to help support and advance offshore wind generation and transmission development on the Atlantic coast. In 2023, 10 East Coast states formed the Northeast States Collaborative on Interregional Transmission (Collaborative),[54] in partnership with DOE, to coordinate and develop solutions to build an onshore and offshore transmission grid. The Collaborative coordinates with the Federal Government, ISOs/RTOs, and other stakeholders on transmission priorities.

- **We recommend** establishing a multi-state working group to advance interregional offshore wind transmission supply chain coordination and collaboration. This entity could be state led and operate as a sub-group in a broader West Coast offshore wind supply chain collaborative. The working group could initially focus on the transmission supply chain—including transmission-specific vessels and sub-sea cable manufacturing—given the different offshore wind planning timelines for California, Oregon, and Washington. Formation of the working group would be most effective when at least two West Coast states have active offshore wind lease plans. Tribal Nations may also wish to participate in certain aspects of the supply chain. Including Tribes early in discussions, particularly on topics about planning, ownership, and economic opportunities from building out a domestic supply chain, could yield enhanced collaboration.

Supply chain. Supply chain development is a pillar of DOE's Floating Offshore Wind Energy Earth Shot™ and a critical piece of the agency's offshore wind work. DOE has released resources to start addressing these challenges for floating and fixed-bottom offshore wind.

- NREL's Supply Chain Road Map for Offshore Wind Energy in the United States[55] outlines the necessary steps to build a robust and competitive U.S. offshore wind supply chain, focusing on domestic manufacturing and workforce development.
- NREL's September 2023 report, *The Impacts of Developing a Port Network for Floating Offshore Wind Energy on the West Coast of the United States*,[56] describes a strategy to develop West Coast ports.
- In February 2022, DOE published *America's Strategy to Secure the Supply Chain for a Robust Clean Energy Transition*,[57] which is part of a whole of government approach to revitalize the U.S. economy and domestic manufacturing.

Continuing to expand the domestic supply chain, scaling up domestic manufacturing, and developing and maintaining a skilled workforce are prerequisites for the floating offshore wind industry. Although technologies and development timelines will be different for the West Coast and the Atlantic Coast, DOE and BOEM cover these matters in more detail in *An Action Plan for Offshore Wind Transmission Development in the U.S. Atlantic Region* sections 3.4.1 and 3.4.2.[58]

2.2 Federal Coordination

Coordination among Federal agencies is central to ensuring sustainable planning outcomes. For example, in October 2024, BOEM and the U.S. Department of Defense (DOD) signed an interagency memorandum of understanding (MOU) on offshore wind development.[59] The MOU establishes a framework for enhanced collaboration between the agencies and aims to streamline the permitting and siting processes, improve communication and information sharing, and minimize potential conflicts between offshore wind projects and national security interests. The agreement focuses on identifying and resolving potential challenges early in the development process. In alignment with the DOD–BOEM MOU, early and ongoing coordination is a primary goal of the DOD with any transmission-related agreements.

Other MOUs between Federal agencies around offshore wind transmission development can be used to coordinate offshore wind transmission implementation.

- **We recommend** that Federal agencies explore similar MOUs for offshore wind transmission planning, such as coordinating subsea cables, sharing siting information between agencies, and/or engaging and consulting with Tribes.
- **We recommend** development of a webpage directory that describes different Federal and state agency roles in offshore wind transmission planning and permitting and that lists contact information for designated representatives and Tribal liaisons at each agency. This information could, for example, be included on the U.S. Bureau of Indian Affairs' Offshore Wind Resource Page.[60]

2.3 Building Capacity for Local Governments

Local governments (such as cities, towns, and counties) often lack the capacity to effectively engage in offshore wind transmission planning. Specifically, local governments struggle with negotiating community benefits agreements (CBAs), conducting thorough environmental reviews and developing protection measures, and effectively mitigating potential negative impacts. States can empower local governments to participate effectively in the offshore wind process, ensuring that projects are developed responsibly while maximizing community benefits.

- **We recommend** that states explore targeted funding and technical assistance for local governments. This support could include financial resources, technical assistance, training and workshops, template agreements, and best practices guidance.

Please see Section 3.50 for a similar recommendation regarding Tribal Governments.

Benefits to Ocean Co-Users and Local Communities

2.4 Electrical System Benefits for Local Communities

Potential POIs for offshore wind in coastal California and Oregon are located within counties that experience more frequent and longer duration power outages than other communities.[iii] Disruptions in electricity service can lead to food spoilage and can limit access to critical services for vulnerable populations who live below the poverty line or have health issues. Interconnecting offshore wind generation at coastal substations could improve electric service reliability if the region is resource constrained. To provide local benefits near an offshore wind POI, the CAISO approved inclusion of a phase shifting transformer for new offshore wind transmission on California's North Coast that will control power flow from a new 500 kV Humboldt substation to the existing 115 kV Humboldt substation to improve resilience in the area. Innovative approaches, such as the example from CAISO, should be explored to identify pathways to provide local electrical system benefits to communities, including Tribal communities, near offshore wind POIs or along inland transmission developed for offshore wind energy.

- **We recommend** that transmission providers identify solutions to improve local electric service reliability at the POI and along the path of any onshore transmission reinforcements or upgrades to

[iii] In particular, Humboldt County (CA), Mendocino County (CA), and Lane County (OR), based on analysis conducted through WOW-TS.

provide local benefits to communities, including Tribal communities. This will be achieved through engagement with local communities and utilities during the planning stages to ensure that any benefits will adequately address real local needs.

2.5 Improved Fisheries Data

Although Federal efforts to characterize fishery impacts and data are underway,[61] more accurate and comprehensive information on fish populations, distributions, migration patterns, fishing activity, and projected latitudinal shifts is essential to minimize potential conflicts between offshore wind energy projects and the valuable West Coast fishing industry and the surveys used to collect fisheries data.[iv] Critical data gaps exist, particularly regarding recreational and subsistence fishing locations, increasing high-resolution sea floor surveying areas to detect potential sensitive benthic habitats,[v] and consideration of where future fisheries may operate, underscoring the need for improved data collection and collaboration among regulatory agencies and fishing sectors.[62] The National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) published a strategic science plan that identifies research priorities for West Coast offshore wind, including research on fish, fisheries, protected species, habitats, and ecosystems.[63] Gathering and incorporating robust fisheries data into analyses prior to siting and permitting decisions ensures that transmission is sited to avoid or mitigate negative impacts on fish stocks, habitats, and fishing livelihoods.[64]

- **We recommend** collaboration between BOEM, state agencies, Tribes, NOAA and other Federal wildlife management agencies, the Pacific Fishery Management Council, and commercial and recreational fishing sectors to address existing data gaps and incorporate information on key fishing grounds to identify cable siting areas with the least conflict. Parties could use a comprehensive, port-specific temporal analysis of fisheries using logbook or other appropriate information beyond Vessel Monitoring System data, to be agreed upon with the fishing industry, to inform the siting of offshore wind transmission cables. Siting should consider Tribal usual and accustomed fishing areas and options to reduce impact, such as horizontal directional drilling in certain areas.

2.6 Fisheries Agreements

Fisheries agreements describe guidelines for shared use of ocean space between infrastructure developers and fishermen to clarify expectations about reporting, liability, monitoring, and dispute resolution, among other topics. These agreements aim to create a cooperative relationship that permits development while protecting fishermen's livelihoods and marine ecosystem health. They can also create guidelines for compensatory strategies where applicable.

[iv] NOAA's National Centers for Coastal Ocean Science used fisheries data from NMFS and Oregon and California's fish and wildlife agencies to develop a spatial suitability model. Further data collection is underway for future model iterations. In August 2024, BOEM released its Socioeconomic Characterization of West Coast Fisheries in Relation to Offshore Wind Energy Development, which includes an overview of fisheries and fishing communities, relevant sources of socioeconomic information for West Coast fisheries, and relevant examples of socioeconomic methods. Recognizing the importance of fisheries analysis to offshore wind transmission planning, the WOW-TS includes a Community Values analysis and considers impacts to fisheries.

[v] Datasets on sensitive benthic habitats and designated habitat areas of concern should be obtained directly from Federal and state agencies, academic institutions, and various mapping collaborations like the California Sea Floor Mapping Program, since not all datasets are available from online portals.

Fisheries compensatory mitigation. Eleven East Coast states are exploring a regional approach to fishery compensatory mitigation for offshore wind through a request for proposals issued by New York State Energy Research and Development Authority.[65] A third party would lead the initiative and disburse funds from a shared source, reducing conflict and improving fund management consistency. Funds can help fishermen adapt to fishing within wind farms and in surrounding areas (e.g., gear or monitoring modifications). Compensation is just one of many tools available. Although BOEM can develop guidance for a mitigation initiative, it cannot manage or disburse funds.

If constructed, offshore wind transmission cables would not be the first subsea cables installed off the West Coast; telecommunications cables span vast distances on the seafloor and make landings onshore. Successful precedents exist in cooperative agreements between telecommunications companies and fishermen.[vi] These agreements prioritize cable burial, set guidelines for monitoring, and establish clear reporting and dispute resolution procedures to minimize conflicts.

- **We recommend** that West Coast fishing organizations and developers consider existing subsea telecommunication cable agreements as a template for potential transmission cable agreements.
- **We recommend** that any future West Coast mitigation programs consider transmission-related compensatory mitigations and physical mitigations, like cable burial and modified gear, and that the findings of the California Coastal Commission (CCC) Offshore Wind Energy Fisheries Working Group[66] are incorporated into any avoidance and minimization measures.[vii]

2.7 Community Benefits Frameworks

Communities and Tribes hosting onshore transmission infrastructure can secure various benefits through agreements with developers. Several frameworks exist, including CBAs, host community agreements, and cable landing agreements, each offering different structures and benefits. There are multiple successful examples of host community agreements, which include local government as the primary signatory, with offshore wind developers in East Hampton, New York,[viii] and

[vi] For example, the Oregon Fishermen's Cable Committee (OFCC), established in response to telecommunications cable projects, provides a framework for compensation claims and dispute resolution, fostering communication and trust (OFCC; ofcc.com). Similarly, the Central California Joint Cable/Fisheries Liaison Committee, created through an agreement between fishermen and cable companies, details mitigation measures, monitoring programs, and compensation mechanisms for gear damage (http://www.cencalcablefishery.com/uploads/2/2/6/5/22655546/140519_final_agreement_as_amended.pdf).

[vii] The Working Group is formed in accordance with California's Senate Bill 286 and CCC's conditional concurrences with BOEM's consistency determination. The CCC is tasked with the development of a statewide strategy to minimize offshore wind impacts on fisheries, including fair compensation for economic losses and prioritizing mitigation measures. Bill Text - SB-286 Offshore wind energy projects.

[viii] A host community agreement and an Easement Agreement between South Fork Wind (the developer) and the Town of East Hampton, New York, permits the developer to install the project's export cable beneath Town-owned roads and land in exchange for a $29 million payment to the Town over 25 years. Upon completion of construction, South Fork Wind repaved and restored Town roads and replanted grass along road shoulders.

Barnstable, Massachusetts.[ix] By establishing agreements with developers, local governments can secure benefits and address local concerns regarding onshore infrastructure installation.[67] These agreements can encompass job training; municipal infrastructure improvements, like sewer upgrades; and environmental protections tailored to specific community needs.[68] These types of agreements can also create commitments between a developer and community for a duration longer than an individual project's life cycle. In addition, CBAs can play an important role in ensuring that Federal investments benefit communities as required by DOE's Community Benefits Plans for nearly all Bipartisan Infrastructure Law and Inflation Reduction Act funding opportunity announcements and loan applications.[x]

Tribes can also be affected by transmission infrastructure landing points and cables and have specific concerns that may be addressed by a benefits framework created with developers,[xi] such as those created with the Mashpee Wampanoag Tribe[69] and the Santa Ynez Band of Chumash Indians.[70] These concerns include, but are not limited to, environmental monitoring, job creation, cultural sensitivities, electricity reliability, and the potential for any large influx of transient workers to strain local resources and contribute to the Missing and Murdered Indigenous People crisis. While DOE has an existing CBA Toolkit[71] that provides resources for creating CBAs, there is opportunity to expand these resources to ensure they meet Tribes' needs.

Transmission Siting and Economic Development Grants. In July 2024, DOE announced project selections through the Inflation Reduction Act's Transmission Siting and Economic Development grants, which included more than $5 million for the Santa Ynez Band of Chumash Mission Indians to establish the Santa Ynez Chumash Oceanographic Institute.[72] The Oceanographic Institute will train Tribal members to advise and staff government agencies and companies that oversee ocean and coastal activites and site, permit, and develop offshore wind and transmission projects.

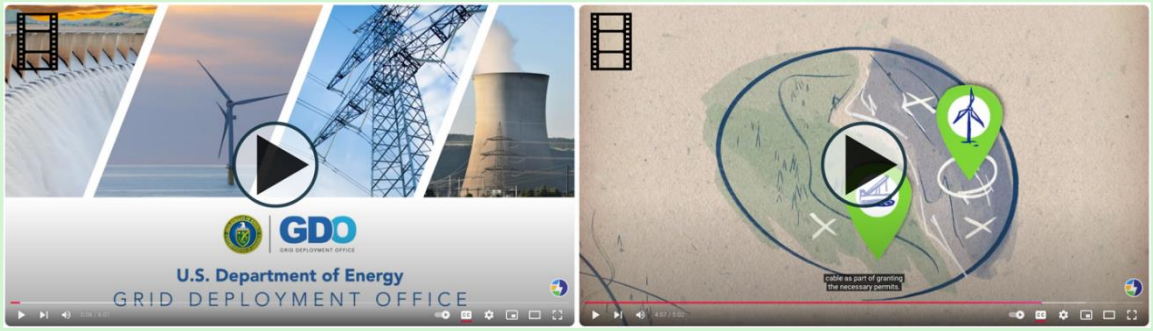
- **We recommend** that local governments that host future POIs develop host community agreements (or similarly structured agreements) in collaboration with offshore wind developers. DOE's CBA Toolkit provides guidance and examples in negotiating such agreements.

For more recommendations about community benefit agreements, please see *An Action Plan for Offshore Wind Transmission Development in the U.S. Atlantic Region*[73] section 5.2.5.

[ix] Barnstable, Massachusetts, received at least $16 million from Vineyard Wind in a host community agreement that also included community-specific terms, like commitments for magnetic field monitoring, improvements to a bathhouse, new sewer infrastructure, and stronger environmental protections than state standards.
[x] For more on DOE's Community Benefits Plan framework and requirements, see About Community Benefits Plans | Department of Energy.
[xi] A Tribal Benefit Agreement between the Mashpee Wampanoag and Vineyard Offshore creates a Mashpee Wampanoag Tribe Offshore Wind Community fund to support Tribal initiatives while enhancing collaboration. In California, a CBA between the Santa Ynez Band of Chumash Indians and CADEMO Corp. supports the creation of a Tribal research institute, a community college partnership for educational and apprenticeship programs, Tribal-led studies, collaborative environmental reviews, and more.

2.8 Education and Outreach

Educational Resources. Whether you are new to transmission or looking for a refresher, we invite you to check out two short educational videos from GDO: Transmission 101 and Siting and Permitting of Offshore Wind Transmission.[74]



Successful deployment of offshore wind projects hinges on public acceptance, yet significant gaps exist in public understanding of the technology, environmental impacts, and regulatory processes. This lack of understanding directly impacts the planning and construction of associated transmission infrastructure, potentially leading to delays, increased costs, and ultimately hindering the achievement of energy security and grid modernization goals. Trustworthy information sources about transmission technology are needed to support public understanding and address misinformation.

- **We recommend** a comprehensive education and outreach strategy that includes accessible educational resources and on-the-ground community engagement, targeted public education campaigns, and partnerships with relevant organizations. Trusted entities like the National Labs can serve as important partners to increase education about offshore wind.
- **We recommend** utilizing diverse communication channels, including in-person events, online resources, social media, and culturally appropriate materials, to reach diverse audiences and overcome language and accessibility barriers.

2.9 Educating and Training an Energy and Grid Workforce

Offshore wind generation and transmission buildout on the West Coast will require development of a skilled and extensive workforce. The California Energy Commission's (CEC) Assembly Bill 525 Offshore Wind Energy Strategic Plan noted that 74 different occupations[75] make up the industry, requiring a broad range of skillsets, but a total of 1,088 offshore wind workers in 2023 shows the industry is still taking off. According to NREL's *U.S. Offshore Wind Workforce Assessment*, an estimated 14,000 to 57,000 more employees, depending on domestic content scenarios, are needed to meet a target of 30 GW of U.S.-installed offshore wind capacity by 2030.[76]

Working with union training programs can help meet growing demand and create employment opportunities in local communities. The International Brotherhood of Electrical Workers' (IBEW) Outside Lineman apprenticeship program as well as joint labor-management apprenticeships administered by IBEW Local Unions and utility industry partners are existing pathways for on-the-job training to build and maintain the transmission grid. Additional training specific to working in the offshore environment can provide specialization opportunities.

- **We recommend** that offshore wind developers help identify any certifications required to work offshore on wind energy transmission projects. Once unions know the required certifications, they can identify what trainings need to be added to apprenticeship programs.
- **We recommend** that industry and workforce trainers continue collaborating to understand how potential technology can influence training needs. Understanding the exact technology used (such as floating technology) will determine whether members train in multiple technologies or one single standardized technology.

Project labor agreements (PLAs) can provide economic and social benefits, including pathways to hiring for individuals with limited opportunities to participate in the workforce. While PLAs are a useful starting point, more can be done to improve access to job opportunities. For example, earlier this year, Oregon took an innovative step by passing House Bill 4080, which ensures strong labor standards for all developers and contractors involved in the construction, operation or maintenance of offshore wind energy projects. The Bill also establishes a plan for outreach, recruitment and retention of women, minority individuals, and veterans.[77]

Tribes, academic institutions, and local communities also all have roles in training workers to build, maintain, and operate transmission. For example, Bristol Community College in Massachusetts established the National Offshore Wind Institute (NOWI) to offer trainings and certifications for the maritime and offshore wind industry.[xii] The Massachusetts Maritime Academy also offers various offshore wind trainings.[xiii]

- **We recommend** that community colleges and Tribal Colleges and Universities (TCUs) develop educational programs related to transmission and energy. Creating more long-term, stable careers in the grid and energy space would benefit a wide range of job seekers and young people. These skills are transferrable to a wide array of careers.
- **We recommend** creating transmission-related apprenticeship and training or upskilling programs in local communities. Training programs that partner with local organizations allow communities to take on a greater responsibility to lead some of their own training programs.

For more recommendations about workforce, please see *An Action Plan for Offshore Wind Transmission Development in the U.S. Atlantic Region* section 3.4.2.[78]

3. Tribal Opportunities and Support

Throughout the development of the offshore wind industry in the United States, Federal agencies have taken steps to improve and enhance communication and collaboration with Tribes.[xiv] The following

[xii] NOWI offers Basic Safety, Advanced Rescue, Enhanced First Aid, Basic Technical, and Slinger Signaler, with Helicopter Underwater Escape coming soon.
[xiii] Massachusetts Maritime Academy's trainings include First Aid, Fire Awareness, Working at Heights, and Sea Survival.
[xiv] The terms 'Tribes' and 'Tribal' are used throughout this document to refer to Indigenous nations, groups, or organization regardless of Federal recognition. The term 'Tribal Nations' is used throughout this document to refer specifically to Federally recognized Tribal Nations. Other terms, such as 'Indian Tribes', are used only when included in a title or law, for example, Executive Order 13175 Consultation and Coordination with Indian Tribal Governments.

section includes recommendations to continue and expand those efforts and ensure that decisions related to offshore wind respect Tribal sovereignty and Tribal rights, honor the United States' trust responsibility, and incorporate Tribal expertise.[79]

Throughout the convening process for this report, DOE and BOEM invited all Tribes within California, Oregon, and Washington to participate in listening sessions and workshops throughout 2024. We received input from Tribes during these convenings, including several responses from Tribes through the public Request for Information. Perspectives and input from Tribes were incorporated into DOE and BOEM's independent process of developing the recommendations below. DOE and BOEM also engaged throughout this process with non-federally recognized Tribal groups.

Examples of Federal Resources Available to Tribes.

- Tribal Nation Transmission Program: GDO developed this program based on direct input from Tribes. It offers capacity building through funding, educational resources, training, and on-call assistance from technical experts and researchers.[79]
- BOEM Support for Tribal Government Document Review: BOEM has contracted three Indian Small Business Economic Enterprises to support Tribes' review of environmental documents. The contractors will work with Tribes to discuss interests and concerns, review documents, and support Tribes' responses.
- Environmental Review Improvement Fund Tribal Assistance Program: The Federal Permitting Council[80] has funding available to support Tribal Nation engagement in the environmental review and authorization process for infrastructure projects covered under Title 41 of the Fixing America's Surface Transportation Act (FAST-41).[xv]
- Energy Innovator Fellowship: DOE pairs recent graduates and energy professionals with host institutions, including Tribal entities, to provide workforce development and support for critical energy organizations. Multiple Tribal entities are currently hosting fellows to support energy infrastructure development and grid modernization in Tribal communities.[81]
- Capacity Accelerator for Tribal Offshore Wind Engagement: DOE is developing a program to support the vital role of Tribal Nations and Tribal collaboratives in decision-making processes.

3.1 Tribal Nation Treaty Rights Related to Offshore Wind Transmission

The United States has a trust responsibility to protect treaty rights, lands, assets, and resources of Tribal Nations. Tribal Nation treaties are legally binding agreements between the Federal Government and Tribal Nations. Some Tribal Nations hold treaty rights to harvest fish and other species outside of their present-day Tribal lands, and some Tribal Nations have Federally reserved fishing rights.

[xv] For more information about the Federal Permitting Improvement Steering Council (Permitting Council) and FAST-41, visit FAST-41 Program | Permitting Council.

- **We recommend** that Federal agencies affirm their commitment to protect Tribal Nations' treaty rights, reserved rights, and similar rights, and demonstrate their commitment through proactive integration of treaty and reserved rights considerations into all decision-making and regulatory frameworks.
- **We recommend** that Federal agencies collaborate whenever feasible to share information about Tribal treaty and reserved rights and help ensure that rights are respected in all agency decisions.

3.2 Elevating Indigenous Knowledge for Environmental and Cultural Data Collection and Monitoring Through Research Opportunities

Areas of Tribal cultural importance,[xvi] along with resources that are vital for Tribal economic, subsistence, and cultural use, extend across the land and underwater.[82, 83] In many cases, Tribes hold unique knowledge about these areas and resources, and are willing to share that information with Federal agencies to help ensure that the agencies act to protect the Tribes' lands, assets, resources, and treaties. In 2022, the White House Office of Science and Technology Policy and the Council on Environmental Quality issued guidance for Federal agencies to recognize that Indigenous Knowledge[xvii] is a valid form of evidence that can be used in their research, policy, and decision-making.[84] In accordance with this guidance, Federal agencies are expected to consult and collaborate with Tribal Nations to include Indigenous Knowledge in decision-making and build relationships with Tribal Nations that support Indigenous Knowledge.

- **We recommend** that Federal agencies work with Tribes to create opportunities for Tribes to share Indigenous Knowledge to inform environmental analysis, siting, and permitting decisions related to transmission facilities for offshore wind through the implementation of relevant statutes and

[xvi] For example, some historical, archeological, and cultural resources are documented through California's Office of Historic Preservation/California State Parks, State of California Native American Heritage Commission and through other resources, but some if not all culturally significant data may be held sacred and privately by Tribes.

[xvii] *Indigenous knowledge is defined by 36 C.F.R. § 219.19 as, "*A body of observations, oral and written knowledge, innovations, practices, and beliefs developed by Tribes and Indigenous Peoples through interaction and experience with the environment. It is applied to phenomena across biological, physical, social, cultural, and spiritual systems. Indigenous Knowledge can be developed over millennia, continues to develop, and includes understanding based on evidence acquired through direct contact with the environment and long-term experiences, as well as extensive observations, lessons, and skills passed from generation to generation. Indigenous Knowledge is developed by Indigenous Peoples including, but not limited to, Tribal Nations, Native Americans, Alaska Natives, and Native Hawaiians. Each Tribe or Indigenous community has its own place-based body of knowledge that may overlap with that of other Tribes. Indigenous Knowledge is based in ethical foundations often grounded in social, spiritual, cultural, and natural systems that are frequently intertwined and inseparable, offering a holistic perspective. Indigenous Knowledge is inherently heterogeneous due to the cultural, geographic, and socioeconomic differences from which it is derived, and is shaped by the Indigenous Peoples' understanding of their history and the surrounding environment. Indigenous Knowledge is unique to each group of Indigenous Peoples and each may elect to utilize different terminology or express it in different ways. Indigenous Knowledge is deeply connected to the Indigenous Peoples holding that knowledge."

policies.[xviii] Agencies should develop frameworks, in consultation with Tribes, to guide how to include Indigenous Knowledge in rulemaking and permitting processes, and how to establish and uphold data sharing or privacy agreements that protect Indigenous Knowledge, in accordance with the Office of Science and Technology Policy and Council on Environmental Quality's "Guidance for Federal Departments and Agencies on Indigenous Knowledge", as appropriate.[85]

- **We recommend** that agencies allocate research funding to programs that provide capacity to Tribal Nations to explore unanswered questions about the effect of onshore and offshore transmission on Tribal resources, including environmental, cultural, and archaeological resources, through baseline data collection prior to siting or permitting, pre-construction surveys, or post-construction monitoring.[86] In accordance with Executive Order 14112,[87] agencies should identify funding programs that may allow for Tribal set-asides or other similar resource or benefits prioritization measures and, where appropriate, establish Tribal set-asides or prioritization measures that meet the needs of Tribal Nations, and should provide ongoing outreach and technical assistance to Tribal Nations throughout the application and implementation process.

3.3 Tribal Collaborative Agreements

As transmission facilities are developed, transmission corridors may impact land that is significant to Tribes, contains resources essential to the exercise of Tribal treaty rights, or is adjacent to Tribal land. Tribes are seeking meaningful roles in decision-making about management of lands and waters related to offshore and onshore transmission expansion. Agencies should seek to enter into collaborative agreements that would include Indigenous Knowledge in decision-making processes and enable shared decision-making, which can take a wide range of forms.[xix] Whether through co-stewardship, co-management, or other shared decision-making, land and resource management that recognizes Tribal sovereignty and prioritizes Tribal leadership and Indigenous Knowledge both safeguards Tribal interests and improves resource management.

- **We recommend** continued commitment to executive orders, joint secretarial agreements, memorandums of understanding, and policies that support collaborative agreement approaches, such as (but not limited to):
  - Executive Order 13175: Consultation and Coordination With Indian Tribal Governments.[88]

[xviii] Relevant statutes may include, but are not limited to, National Environmental Policy Act (NEPA; 42 U.S.C. §4321 et seq.), Endangered Species Act (ESA; 87 Stat. 884, as amended; 16 U.S.C. §1531 et seq.), National Historic Preservation Act (NHPA; 54 U.S.C. §300101 et seq.), Marine Mammal Protection Act (MMPA; 16 U.S.C. §1361 et seq.), Magnuson-Stevens Fisheries Conservation and Management Act (MSA; 16 U.S.C. §1801 et seq.). Relevant policies include the Advisory Council on Historic Preservation's Policy Statement on Indigenous Knowledge and Historic Preservation.

[xix] There are numerous examples of collaborative agreements currently in place or being developed that can serve as examples for land and waters impacted by transmission, including, but not limited to, Chumash Heritage National Marine Sanctuary (collaborative co-stewardship), Bears Ears National Monument (cooperative management), Pacific Northwest land management (co-stewardship), and Molok Luyuk in Berryessa Snow Mountain National Monument (co-stewardship).

- DOI Secretarial Order 3342: Identifying Opportunities for Cooperative and Collaborative Partnerships With Federally Recognized Indian Tribes in the Management of Federal Lands and Resources.[89]
- DOI, U.S. Department of Agriculture, and U.S. Department of Commerce Joint Secretarial Order 3403 A1: Fulfilling the Trust Responsibility to Indian Tribes in the Stewardship of Federal Lands and Waters.[90]
- Best Practices Guide for Federal Agencies Regarding Tribal and Native Hawaiian Sacred Sites: Guidance issued by a Federal agency working group.[91]
- California AB 1284: Tribal Co-Governance and Co-Management of Ancestral Lands and Waters Act.[92]

3.4 Tribal Nation Government Communication and Coordination

Federal and state agencies should engage early and meaningfully with Tribal governments as part of the decision-making process for siting and permitting new or upgraded transmission infrastructure. This engagement should include, depending on the context, government-to-government consultation consistent with Executive Order 13175,[93] Memorandum on Uniform Standards for Tribal Consultation,[94] and Memorandum on Tribal Consultation and Strengthening Nation-to-Nation Relationships;[95] consultation pursuant to 54 USC § 302706(b) of the National Historic Preservation Act;[96] and invitation to serve as cooperating, participating, or joint lead agencies pursuant to the 40 CFR § 1501.9(a) and (c)(1) of the National Environmental Policy Act.[97]

Federal agencies should also coordinate between themselves to minimize the burdens on Tribal staff and leadership, and to ensure that the appropriate Tribal leaders, staff, and/or representatives are engaged.

- **We recommend** creating a single, centralized contact directory for Tribal representatives that can be accessed and updated directly by Federal agencies, Tribes, and state agencies to reduce burden and redundancy. Several directories already exist and could be leveraged to inform a centralized directory, including the U.S. Bureau of Indian Affairs' Tribal Leaders Directory,[98] among others. The contact list should include contact information for Tribal government leaders but have the ability to be expanded to include Tribal Historic Preservation Officers and additional staff for specific issues (e.g., energy, natural resources, fisheries, etc.). The contact directory should also allow Tribes to request recipients for certain types of communications and their preferred communication method.
- **We recommend** that Federal agencies include designated Tribal liaisons in all Tribal engagement requests so that meeting requests or written questions can be coordinated and consolidated, as appropriate.[xx] Requests to Tribal Nations should avoid engagement during times or seasons that

[xx] Communication and consultation with Tribal Nations is recognized, but not limited to, the commitments described in Memorandum on Tribal Consultation and Strengthening Nation-to-Nation Relationships, Memorandum of Understanding Regarding Inter-Agency Coordination and Collaboration for the Protection of Indigenous Sacred Sites,

conflict with Tribal events or culturally significant periods. If multiple Federal and/or state agencies are engaging with Tribes, the agencies should coordinate their outreach together to the extent practical. Agencies should provide information to Tribes to clarify Federal agency jurisdiction, roles, and timeline so that Tribes understand when, why, and with whom engagement will occur.

- **We recommend** that Federal agencies, Tribal governments, and state agencies consider forming joint committees for information sharing and collaboration on offshore wind transmission issues.
- **We recommend** using multiple methods to contact Tribes, by email, phone, written correspondence, and in person, through continuous outreach. If a response is not received through one method of communication at one stage in the process, subsequent outreach should be conducted to make contact, establish a relationship, and build trust through actions over time.

3.5 Capacity Building for Tribal Governments

Some Tribes report that they are overburdened with requests for engagement and face serious capacity constraints that prevent them from engaging in issues of importance, including offshore wind transmission. Tribes have articulated a need for support to ensure that they have a seat at the transmission decision-making table.[99] This support can come in multiple forms, including direct funding to enable engagement, technical assistance to review or prepare documents, and funds to increase hiring to make sure Tribes have adequate staff coverage. Actions outlined in Executive Order 14112 help address these constraints by directing agencies to increase accessibility, equity, flexibility, and utility of Federal funding and support programs for Tribes.[100] Building long-term capacity also includes supporting TCUs. One existing example is DOE's Tribal Nation Transmission program, which provides capacity-building resources in the form of technical assistance.

- **We recommend** streamlining transmission-related grant applications by minimizing paperwork, providing direct application assistance, extending response deadlines to allow more response time, and acknowledging the competing demands on limited staff to reduce administrative burdens.
- **We recommend** providing support for transmission-related programs at TCUs to cultivate a long-term workforce capable of managing energy projects and advocating for Tribal interests.

4. Technology Advancement and Standardization

This section addresses the technological distinctions between West Coast floating offshore wind and the fixed-bottom technology prevalent on the Atlantic Coast. Coordinated efforts by government and industry should focus on equipment standardization to support domestic manufacturing supply chains and incorporate geographic considerations, such as seismic needs, into design specifications.

(cont. [xx]) Memorandum for the Heads of Departments and Agencies: Indigenous Traditional Ecological Knowledge and Federal Decision-Making, and Guidance for Federal Departments and Agencies on Indigenous Knowledge, as well as existing requirements under the National Environmental Policy Act (42 U.S.C. §4321 et seq.), National Historic Preservation Act (NHPA; 54 U.S.C. §300101 et seq.), Archaeological Resources Protection Act (16 U.S.C. §470aa–mm), American Indian Religious Freedom Act (42 U.S.C. §1996), Native American Graves Protection and Repatriation Act (25 U.S.C. §3001 et seq.), and all associated implementing regulations.

4.1 Technology Development Timeline, Standardization, and Certainty

Offshore wind development in the United States up until this point has used fixed bottom technology, so floating offshore wind technologies are still comparatively nascent. This means that challenges from immature technology, long lead times due to a lack of standardization, and potential incompatibility issues exist. Addressing these challenges requires standardization of transmission components to streamline design, reduce costs, minimize environmental effects, and ensure interoperability, as highlighted by recent government and industry initiatives, like the Northeast States Collaborative white paper[101] on HVDC technology standards and the CEC study[102] on existing and emerging technologies. Continued government-industry collaboration and research and development funding is crucial to accelerating floating offshore wind deployment and developing market certainty that will facilitate industry planning for future investment.

- **We recommend** increased investment in the research, development, and demonstration of key floating offshore wind transmission technologies, including floating offshore substations, dynamic and HVDC cables, and HVDC breaker technologies. This should be accompanied by an industry roadmap outlining commercial availability, testing, and certification timelines to enhance planning and market certainty. Specific research priorities may include developing improved materials for all floating components (e.g., deep-water cables and anti-calcification coatings), exploring monitoring technologies for transmission cables, addressing entanglement issues, and providing resources to support emerging technologies.
- **We recommend** that public and private entities begin considering standardized testing procedures that account for ocean movement. This could involve research funding or a public–private partnership to propose procedures. Eventually, standards for dynamic cable and substation equipment could address the movement inherent in floating offshore wind platforms, which potentially impacts equipment lifespan and reliability.
- **We recommend** that states consider possibilities for voluntary equipment standardization in their solicitations to support coordinated procurement. Lessons may be learned from the Standardization for Interregional Offshore Wind Transmission funding opportunity DOE launched in 2024 for the Atlantic Coast.[103] This project aims to develop guidance on best practices, including standard-sized and network-ready designs, and provide technical assistance to states to address coordinated transmission solutions.
- **We recommend** that West Coast developers consider the Det Norske Veritas (a technical classification foundation) Floating Substation Joint Industry Project's findings to ensure that floating substation suppliers meet or exceed the latest industry standards, including exploring a standardized 525 kV DC cable voltage and seeking policy and economic support for its adoption.[104]

For more recommendations about equipment standards and HVDC infrastructure, please see *An Action Plan for Offshore Wind Transmission Development in the U.S. Atlantic Region* sections 3.1 and 3.2.[105]

4.2 Seismic and Hazard Planning for Offshore Transmission

The West Coast faces seismic hazards—such as earthquakes, landslides, and tsunamis—and other natural hazards, like wildfires. Onshore and offshore transmission equipment and related facilities, like substations, need to be designed for extreme conditions.

- **We recommend** that transmission planners and operators consider requiring seismic standards at POIs and along transmission routes to ensure reliability.

- **We recommend** that siting studies consider implications of natural disasters. Siting analyses should account for the potential resilience benefits that additional transmission can provide in an emergency event; for example, infrastructure could allow remote areas to have power restored more quickly or to not lose power in the first place.
- **We recommend** that original equipment manufacturers and standards development bodies establish testing and operation standards for offshore floating equipment and guidelines for cable installation in seismic zones.
- **We recommend** that the offshore wind industry standardize the inclusion of DOD-compatible sensors in new offshore wind transmission projects. Incorporating sensor technologies into transmission cables (e.g., fiber optic cables for distributed sensing) could provide valuable real-time, early warning seismic data and provide information about cable conditions to allow for monitoring and maintenance of underwater infrastructure.

5. Environmental Review, Siting, and Permitting

The responsible development of transmission infrastructure requires a strong foundation of environmental research and development. This includes conducting surveys and studies to inform the siting of offshore transmission corridors; minimizing impacts during project planning, construction, operation, and decommissioning; and establishing effective long-term monitoring.

In existing permitting processes, Federal agencies, including BOEM, analyze the environmental impacts of offshore wind projects under the National Environmental Policy Act (NEPA). States also play a role, often coordinating reviews (e.g., the California Environmental Quality Act and NEPA) and through Federal consistency as part of the Coastal Zone Management Act. BOEM is using a new, regional approach, creating a Programmatic Environmental Impact Statement (PEIS) for California's offshore wind lease areas (draft released in November 2024).[106] This PEIS outlines potential mitigation measures that might be applied to any projects proposed in the existing leased areas offshore California. Individual project-specific analyses will also be conducted once existing lessees submit completed Construction and Operations Plans, and these analyses would affirm the suite of measures required to avoid, minimize, and mitigate any potential environmental impacts.[xxi] See Appendix A for an overview of permitting roles.

Environmental Data Portal. The West Coast Ocean Data Portal provides detailed biological, human, and physical data for the region and was assembled by Federal, Tribal, and state governments and non-government organizations.[102] Additionally, BOEM and the State of California assembled publicly available data on ecological and natural resources, commercial and recreational ocean uses, community values, geology and geospatial information, and more, available from the California Offshore Wind Energy Gateway.[107] Explore the data and spatial models in greater detail through the California Offshore Wind Energy Modeling Platform.[108]

[xxi] Public comment is due February 12, 2025, and BOEM is holding two virtual public meetings: January 28, 2025, at 5:00 p.m. and January 30, 2025, at 12:00 p.m. Pacific time. Visit https://www.boem.gov/caoffshorewindpeis for registration and additional information.

5.1 Environmental Research Prioritization

Environmental reviews are conducted as part of the permitting process for both onshore and offshore transmission projects, leveraging existing data from decades of similar projects. However, the development of transmission infrastructure in novel or ecologically sensitive areas may necessitate additional research to fully assess potential impacts on unique species and habitats. For example, NMFS, a key partner in BOEM's siting process, has highlighted critical research needs in its *West Coast Offshore Wind Energy Strategic Science Plan*, focusing on habitat impacts, physiological and physical effects on marine life, and species abundance and distribution.[109] This research could involve various approaches, such as baseline population surveys, laboratory and field studies examining stressor-receptor relationships, and the development of advanced monitoring and mitigation technologies. Mapping and biological surveys could also follow existing guidance for the Atlantic region, modified as needed with input from West Coast habitat scientists, to further delineate and classify West Coast habitat features.[110]

The scope and design of any new research should be directly informed by the needs of regulatory agencies to support robust decision-making. Effective prioritization requires strong coordination among multiple agencies and scientists across the West Coast. While some collaborative efforts have begun,[xxii] a clearly defined and synthesized vision of research needs and priorities would help maximize resources. See recommendation 3.2 for a discussion of incorporating Indigenous Knowledge.

- **We recommend** that regulatory agencies coordinate to identify and prioritize necessary research or data collection efforts to inform decision-making for offshore and onshore transmission development. This coordination could identify priority research needs, a timeline for results, and a pathway for funding research.

***Tethys* Knowledge Base.** Knowledge and information exchange about the environmental effects of offshore energy is documented through the Tethys program,[111] which is supported by DOE, and includes the following resources:

- Knowledge Base—a database that organizes and provides access to primary literature.[112]
- Pacific Offshore Wind Environmental Research Recommendations—an online tool that synthesizes environmental research recommendations as identified in literature.[113]
- Pacific Coast Offshore Wind Environmental Research Project Finder—an online tool that provides links to studies and publications associated with environmental research about offshore wind on the U.S. West Coast.[114]
- Wind Energy Monitoring and Mitigation Technologies Tool—an online tool that provides information about environmental technologies for monitoring and mitigation.[115]
- Offshore Wind Environmental Monitoring Metadata—a collection of environmental documentation associated with domestic and international offshore wind projects, including regulatory documents and environmental research reports related to each project.[116]

[xxii] For example, the California Marine Renewable Energy Working Group, the Pacific Offshore Wind Consortium, the West Coast Ocean Alliance, a project led by California Marine Sanctuary Foundation funded by California Ocean Protection Council, and California Assembly Bill 80 proposed in 2023–2024 session but not passed.

5.2 Studies for Siting Offshore Transmission Corridors

Assessing transmission routes and evaluating shared corridors can optimize the siting of offshore wind transmission by reducing the number of routes and avoiding sensitive habitats. A proactive, planned, and coordinated approach among Federal agencies, Tribes, and state agencies to deconflict transmission routes can lead to a more efficient siting process than relying solely on a developer to drive the process. Identifying and conducting geophysical surveys, geotechnical investigations, and marine resource assessments for preferred areas can confirm or modify the suitability of the proposed routes and help identify sea space for subsea cables. Cable and environmental studies can also complement the corridor assessment process and help resolve any potential conflicts. For example, incorporating cable spacing guidance, design standards, and geologic impediments early in the siting process can yield better siting decisions.

Routing Studies and Analysis. Additional work is ongoing at the state and Federal levels. The California Energy Commission (CEC) is exploring how it may use its authority to designate suitable transmission corridor zones for high-voltage transmission that considers sea space, locations of canyons, and sensitive species, among other topics.[117] BOEM, in partnership with NOAA's National Centers for Coastal Ocean Science, is working to develop decision support tools to assess transmission suitability in the Atlantic.

- **We recommend** that lessees; potential grantees; and Federal, state, and Tribal governments partner to identify potentially sensitive biological communities, areas of cultural significance, or other suitability concerns for cable routing prior to assessment surveys for use in the permitting process.
- **We recommend** continued research to help inform cable best practices and design standards. This could include working with the Bureau of Safety and Environmental Enforcement to update its 2014 cable study[118] and helping to advance research in the understanding of cable spacing dynamics for the expected cable types in deeper waters. Collaborative efforts could draw on existing standards (like those detailed by the SMART Cables initiative)[119] and expertise from relevant agencies and industries to compile and research best practices for cable spacing and design standards, particularly in deep waters and areas with high seismic activity.

For more recommendations about environmental research and development, please see *An Action Plan for Offshore Wind Transmission Development in the U.S. Atlantic Region* section 3.3.2.[120]

5.3 Best Practices for Siting and Permitting

Offshore wind transmission will require careful planning and analysis during the siting process to align requirements across regulatory jurisdictions; ensure appropriate protections; and address ocean co-use through avoidance, minimization, and mitigation strategies. States authorize export cable routing in state waters stretching 3 nautical miles from shore to the landfall location. BOEM authorizes proposed projects in Federal waters on the OCS, extending out 200 nautical miles, and considers a variety of issues when determining project placement, such as vessel navigation, coexistence with other marine users, and impacts to environmental and cultural resources. Transmission permitting may take several years. Intentional and proactive coordination can reduce permitting times without compromising input processes.

- **We recommend** leveraging existing rights-of-way and infrastructure as well as prioritizing these options when siting onshore transmission infrastructure. Opportunities may exist to utilize existing

pipelines, railways, transportation corridors, or other rights-of-way to site new transmission.[xxiii] Planners could also investigate the feasibility of reconductoring or upgrading existing onshore transmission facilities or using grid enhancing technologies to increase capacity before constructing entirely new infrastructure.

- **We recommend** that states create and maintain a document describing their permitting processes and authorities so that interested parties can better understand how to participate. A document could be similar to CEC's Permitting Roadmap, which was produced prior to, and helped inform, California's AB525 Strategic Plan.[121] California's Strategic Plan provides a comprehensive overview of marine environments, fisheries, sea space, transmission technology and implementation, and permitting processes. Oregon is in the process of creating an Offshore Wind Energy Roadmap, which will outline standards the state should consider in offshore wind energy development and approval, including protection of environment and marine species and Tribal cultural and archaeological resources, among other topics.[122]

For more recommendations about siting and permitting, including additional information about the FAST-41 process, please see *An Action Plan for Offshore Wind Transmission Development in the U.S. Atlantic Region*, sections 5.1.1, 5.1.5, and 5.2.1.[123]

5.4 Coordinated Government Transmission Siting and Permitting

West Coast offshore and onshore wind transmission development will benefit from early, collaborative landscape-scale planning involving all relevant jurisdictions, stakeholders, and Tribes. Formal frameworks, such as California's successful Renewable Energy Action Team (REAT),[124] can streamline permitting, clarify siting processes, and ensure timely development while protecting environmental and cultural resources. REAT's collaborative approach, exemplified by the Desert Renewable Energy Conservation Plan, demonstrates how coordinated planning can balance renewable energy with ecosystem and recreational preservation.

For lease areas and transmission corridors on the OCS, BOEM establishes Intergovernmental Renewable Energy Task Forces as a key mechanism to help shape the agency's approach to offshore renewable energy development. The Intergovernmental Task Forces currently include representation from Tribal Nations, Federal agencies, states, and local governments and may be used to inform ISO and RTO transmission planning processes.

- **We recommend** that BOEM continue to leverage its Intergovernmental Renewable Energy Task Forces throughout project development and include meetings that focus on OCS transmission siting and permitting as the process takes shape.
- **We recommend** that Federal and state agencies with authorities in transmission siting and permitting consider establishing a framework to coordinate transmission corridor development to the extent practicable. Creating formal agreements (either through MOUs or other mechanisms)

[xxiii] In some cases, existing infrastructure will prevent the placement of transmission infrastructure in a particular area. Siting authorities are encouraged to utilize existing resources, like the public GIS site and Online System for Customer Applications and Records maintained by the California State Lands Commission.

could clarify roles in the offshore wind siting and permitting process and could be useful to identify gaps that need specific coordination, especially for land and waters not on the OCS.

- **We recommend** that ISO and RTO transmission planning processes include coordination with all relevant governments (Tribal, Federal, and state agencies).

5.5 Environmental Monitoring During and Post Construction

To fulfill environmental permitting requirements, offshore wind transmission cable routes require detailed site-specific surveys to assess geological, biological, and habitat conditions. Construction and Operations Plans inform project modifications and address environmental and technical concerns before installation. Comprehensive environmental monitoring of transmission activities and infrastructure, including cables and substations, is crucial—from construction to operation—to assess and mitigate potential impacts on marine ecosystems. Monitoring provides valuable data to inform adaptive management strategies, ensuring the long-term health of the environment and responsible project operation.

- **We recommend** that government agencies (Federal, Tribal, and state), academic and/or research institutions, ocean co-users, and private developers collect and share baseline data to inform comparisons to conditions during and after construction and operation, conduct regular monitoring and assessments of transmission infrastructure, and follow procedures to address environmental changes promptly, according to adaptive management best practices.
- **We recommend** that government agencies and academic and/or research institutions support research, development, and demonstration of cost-effective and comprehensive monitoring technologies, including autonomous inspection systems, subsea monitoring, and environmental monitoring.
- **We recommend** that developers work with Federal, Tribal, and state agencies to develop best management practices and minimization measures to reduce impacts from displacement, entanglement, habitat alteration, and other potential impacts.

Appendix A—Summary of Permitting Roles

The agencies involved in permitting offshore wind energy projects vary depending on the specific location and project details, but Table 1 provides a general overview. Please note that this is not intended as an exhaustive list, and the involvement of specific agencies can change based on the location and specifics of the project. Some agencies have primary permitting authority while others play a more advisory or coordinating role.

Table 1. Summary of Permitting Roles

Government/Agency	Primary Responsibilities	Level of Government
Bureau of Ocean Energy Management (BOEM), U.S. Department of the Interior (DOI)	Leases the seabed, leads environmental and technical reviews, permits construction and operation of offshore wind facilities, oversees lease compliance	Federal
Bureau of Safety and Environmental Enforcement (BSEE), DOI	Reviews facility design reports and other operations plans, oversees offshore construction and operations, ensures safety of offshore operations	Federal
U.S. Fish and Wildlife Service (USFWS), DOI	Oversees enforcement of several Federal laws[xxiv]	Federal
U.S. Department of Defense (DOD)	Coordinates with agencies on lease conditions and survey and construction plans to identify and mitigate impacts to military activities through the DOD Clearinghouse[125]	Federal
U.S. Army Corps of Engineers (USACE)	Permits construction activities impacting navigable waters (e.g., Section 408 Civil Works Projects, which include Federal navigation channels)	Federal
National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce (DOC)	Conducts fisheries management, marine mammal protection, habitat conservation, and environmental review; implements Endangered Species Act through National Marine Fisheries Service, along with USFWS	Federal
U.S. Coast Guard (USCG)	Oversees navigation safety, vessel traffic management, and security; produces Pacific Coast Port Access Route Study[126]	Federal
Federal Energy Regulatory Commission (FERC)	Regulates rates, terms, and conditions of transmission of electricity in interstate commerce; holds limited back-stop siting authority over certain onshore transmission facilities	Federal
U.S. Environmental Protection Agency (EPA)	Issues air and water quality permits	Federal

[xxiv] Including the Migratory Bird Treaty Act (MBTA; 16 U.S.C. §703 et seq.); the Bald and Golden Eagle Protection Act (BGEPA/Eagle Act; 16 U.S.C. §668-668c.); the MOU under EO 13186 dated September 12, 2013; consultation under the Endangered Species Act (ESA; 87 Stat. 884, as amended; 16 U.S.C. §1531 et seq.); Marine Mammal Protection Act (MMPA; 16 U.S.C. §1361 et seq.); recommendations under the Clean Water Act (CWA; 33 U.S.C. §1251 et seq.); and the Fish and Wildlife Coordination Act (FWCA; 48 Stat. 401, as amended; 16 U.S.C. §661 et seq.).

Government/Agency	Primary Responsibilities	Level of Government
Tribal Nations	Govern Tribal lands, resources, and citizens; represent Tribal interests through consultation and potential co-stewardship of resources located outside of Tribal lands, or acting as a co-lead agency on permitting decisions. Conduct approvals if infrastructure crosses Tribal Nation land, with BIA involvement	Tribal Nation
State agencies (e.g., California Coastal Commission, Oregon Department of Land Conservation and Development)	Engage in coastal zone management, permit onshore infrastructure, and implement other state-level regulations	State
Pacific Fishery Management Council	Manages fisheries in Federal waters for marine and anadromous species; prepares Fishery Management Plans; identifies Essential Fish Habitats	Multiple (Federal, Tribal, state, and citizen representation)

Appendix B—List of Acronyms

AC	alternating current
BOEM	Bureau of Ocean Energy Management
CAISO	California Independent System Operator
CBA	community benefits agreement
CCC	California Coastal Commission
CEC	California Energy Commission
DC	direct current
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
FERC	Federal Energy Regulatory Commission
GDO	Grid Deployment Office
GW	gigawatt
HVDC	high-voltage direct current
IRP	integrated resource plan
ISO	independent system operator
kV	kilovolt
MOU	memorandum of understanding
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOWI	National Offshore Wind Institute
NREL	National Renewable Energy Laboratory
OCS	outer continental shelf
OFCC	Oregon Fishermen's Cable Committee
PEIS	Programmatic Environmental Impact Statement
PLA	project labor agreement
PNNL	Pacific Northwest National Laboratory
POI	point of interconnection
REAT	Renewable Energy Action Team
RETI	Renewable Energy Transmission Initiative

RTO	Regional Transmission Operator
TCUs	Tribal Colleges and Universities
USFWS	U.S. Fish and Wildlife Service
WestTEC	Western Transmission Expansion Coalition
WETO	Wind Energy Technologies Office
WOW-TS	West Coast Offshore Wind Transmission Study

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