Advancing Offshore Wind Energy in the United States

U.S. Department of Energy Strategic Contributions Toward 30 Gigawatts and Beyond

HIGHLIGHTS

30 GW 2030

110 GW 2050

U.S. DEPARTMENT OF ENERGY

Photo by Lyfted Media for Dominion Energy

The Strategy

The U.S. Department of Energy (DOE) has been a global leader in supporting critical wind energy research, development, demonstration, and deployment (RDD&D) for decades, helping usher in commercial wind energy production.

These investments have contributed to the rise of today's wind energy sector. This offshore wind energy strategy outlines DOE's approach for accelerating the development of U.S. offshore wind to deploy 30 gigawatts (GW) by 2030 and establish a pathway to deploying 110 GW or more by 2050.[1] As a critical part of this pathway, this strategy seeks to also support the deployment of 15 GW of floating offshore wind capacity by 2035, as announced by the Biden administration in September 2022.[2] In January 2022, DOE issued a nationwide strategy[3] that outlined broad priority areas for accelerating the sustainable development of offshore wind energy in the United States. This strategy document outlines DOE's contributions to meeting the challenges indicated in the nationwide strategy, including the need to reduce the levelized cost of energy; expand predictable leasing and permitting processes; develop the domestic supply chain; and expand transmission. DOE's efforts form a part of a broader all-of-government approach to advancing offshore wind energy and strengthening the U.S. transmission grid as part of our nation's clean energy future.

Photo by Helena Pound, DOE

DOE's Role

For more than a decade, DOE has led a robust portfolio of RDD&D, analysis, and stakeholder engagement to advance offshore wind energy in the United States and support the transmission system upgrades that enable it. DOE supports the development of critical technologies through research, innovation, coordinated planning efforts, technical assistance programs, community engagement, demonstration projects, and federal loans for clean energy deployment, transmission buildout, and supply chain development. DOE regularly partners with numerous federal, state, local, and tribal government agencies and organizations; domestic and international private and public energy entities; and its national laboratories. DOE collaborates with U.S. agencies such as the Bureau of

[1] The White House. 2021. "FACT SHEET: Biden Administration Jumpstarts Offshore Wind Energy Projects to Create Jobs." *https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/29/fact-sheet-biden-administration-jumpstarts-offshore-wind-energy-projects-to-create-jobs*.

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

[3] U.S. Department of Energy (DOE). 2022. *Offshore Wind Energy Strategies*. *https://www.energy.gov/sites/default/files/2022-01/offshore-wind-energy-strategies-report-january-2022.pdf*.

Ocean Energy Management to help inform siting and leasing and coordinates efforts closely with the U.S. Department of Commerce, U.S. Department of Transportation, and others to advance offshore wind energy while protecting biodiversity and ocean co-use. Through this strategy, DOE outlines a plan to bring its complement of programs and resources to bear to support offshore wind, in partnership and collaboration with the parties mentioned above, as the agency seeks to steward its annual appropriations and new resources under the Bipartisan Infrastructure Law and Inflation Reduction Act.

The Vision

Together with its federal partners, DOE envisions a future in which offshore wind energy is not only a critical part of the nation's decarbonized economy and climate solution, but is developed in a way that is economic, reliable, sustainable, just, and timely (Figure H-1).

Vision

A FUTURE IN WHICH OFFSHORE WIND IS A CRITICAL PART OF THE NATION'S DECARBONIZED ENERGY SECTOR AND CLIMATE SOLUTION. A FUTURE IN WHICH OFFSHORE WIND PROMOTES:

Economic

- **Cost-competitive generation** and a **high-value energy option**
- Lasting, good-paying, and meaningful **employment**
- The **global export** of components and services
- **U.S. leadership** in design, manufacturing, and deployment of **floating offshore wind**.

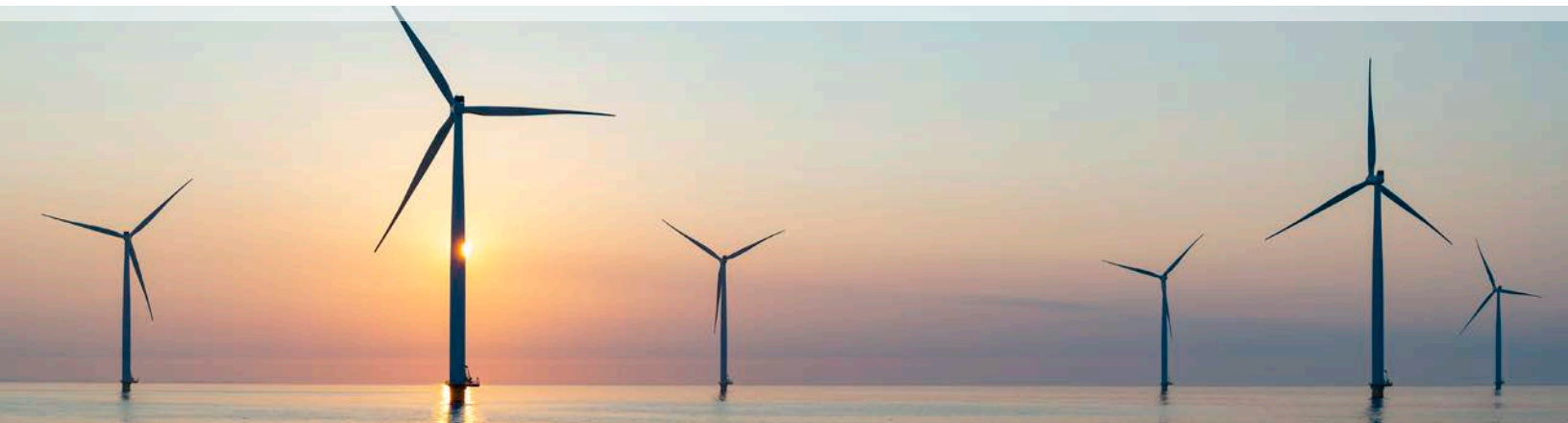
Reliable

- **Utility-scale power production** in proximity to coastal load centers
- Resilient and reliable **transmission infrastructure**
- Carbon-free production of **alternative fuels** and energy storage systems.

Sustainable, Just, & Timely

- **Reductions in greenhouse gas emissions, air** pollution, and **water consumption**
- Development that **avoids, minimizes, and mitigates impacts** on living marine resources and habitats.
- Design for **circular economy** practices that use recyclable materials
- Financial and employment benefits and decision-making **opportunities for local and underserved communities**
- **Maximized ocean co-use** that considers other economic and environmental needs, including fisheries and tribal interests
- **Coordinated and efficient permitting** and expanded leasing opportunities.

Figure H-1. All-of-government offshore wind energy vision. *Illustration by John Frenzl, National Renewable Energy Laboratory (NREL)*



The Opportunity

Offshore wind is a growing source of reliable and clean energy around the world, with over 50 GW installed across more than 250 projects, as of mid-2022. The United States has just begun to tap the vast resource potential along its coasts with seven wind turbines (42 megawatts [MW]) installed off Rhode Island and Virginia as of 2022, but has a project pipeline of 40 GW planned.[4] In addition to the federal offshore wind target of 30 GW by 2030 and 15 GW of floating offshore wind by 2035, individual U.S. state policies aim to procure at least 39 GW by 2040.[5]

With over 4,200 GW of technical resource potential, offshore wind could meet today's U.S. electricity demands by more than three times.[6] [7] A single offshore wind power plant can deliver a significant amount of energy to coastal load areas, which tend to suffer from transmission congestion and limited siting options for large-scale, land-based renewable energy generation. The potential scale of offshore wind energy's deployment and its access to the nation's highest and most reliable wind speeds make this generation source a crucial infrastructure investment, and one that can help revitalize coastal communities, including ports and manufacturing facilities. Achieving the administration's goal of 30 GW by 2030 would translate to more than 77,300 employed workers in jobs induced by offshore wind activity, capital investments in offshore wind energy projects of more than $12 billion per year, and 5–10 new manufacturing plants (for producing wind turbine nacelles, blades, towers, foundations, and subsea cables).[8] Infrastructure investments also include marshaling ports, fabrication ports, and large installation vessels for a total of approximately $11 billion needed by 2030 to support the manufacture, transport, and installation of major offshore wind energy components.[9]

National Offshore Wind Energy Priority Needs

This strategy builds on the 2022 *Offshore Wind Energy Strategies* report[10] published by DOE, in coordination with other federal agencies, that outlines the following regional and national challenges and strategies to accelerate offshore wind energy deployment in the United States (Figure H-2):

- **Reducing offshore wind energy costs.** The average cost of offshore wind energy generation in the United States is above that of many other generation sources. Additionally, at the time of publication, offshore wind projects are facing challenges associated with rising costs due to inflation and rising cost of capital. Reducing the generation cost is a need for both fixed-bottom and floating offshore wind systems, though it is a particular area of emphasis for floating offshore wind. Floating offshore wind systems are at an earlier commercial and technological stage with costs that tend to be above those of fixed-bottom offshore wind systems.
- **Supporting optimized siting and regulation.** The extent of lease areas available for offshore wind energy development will need to grow considerably

[4] Musial, W., P. Spitsen, P. Duffy, P. Beiter, M. Marquis, et al. 2022. *Offshore Wind Market Report: 2022 Edition*. *https://www.energy.gov/sites/default/files/2022-08/offshore_wind_market_report_2022.pdf*.

[5] Musial, W., P. Spitsen, P. Duffy, P. Beiter, M. Marquis, et al. 2022. *Offshore Wind Market Report: 2022 Edition*. *https://www.energy.gov/sites/default/files/2022-08/offshore_wind_market_report_2022.pdf*.

[6] Lopez, A., R. Green, T. Williams, E. Lantz, G. Buster, B. Roberts. 2022. "Offshore Wind Energy Technical Potential for the Contiguous United States." *https://www.nrel.gov/docs/fy22osti/83650.pdf*.

[7] U.S. Energy Information Administration. 2022. *Annual Energy Outlook 2022*. *https://www.eia.gov/outlooks/aeo/narrative/pdf/AEO2022_Narrative.pdf*

[8] Lantz, E., G. Barter, P. Gilman, D. Keyser, T. Mai, et al. 2021. *Power Sector, Supply Chain, Jobs, and Emissions Implications of 30 Gigawatts of Offshore Wind Power by 2030*. *https://www.nrel.gov/docs/fy21osti/80031.pdf*.

[9] Shields, M., J. Stefek, F. Oteri, M. Kreider, E. Gill, et al. 2023. *A Supply Chain Road Map for Offshore Wind Energy in the United States*. *https://www.nrel.gov/docs/fy23osti/84710.pdf*.

[10] DOE. 2022. *Offshore Wind Energy Strategies*. *https://www.energy.gov/sites/default/files/2022-01/offshore-wind-energy-strategies-report-january-2022.pdf*.

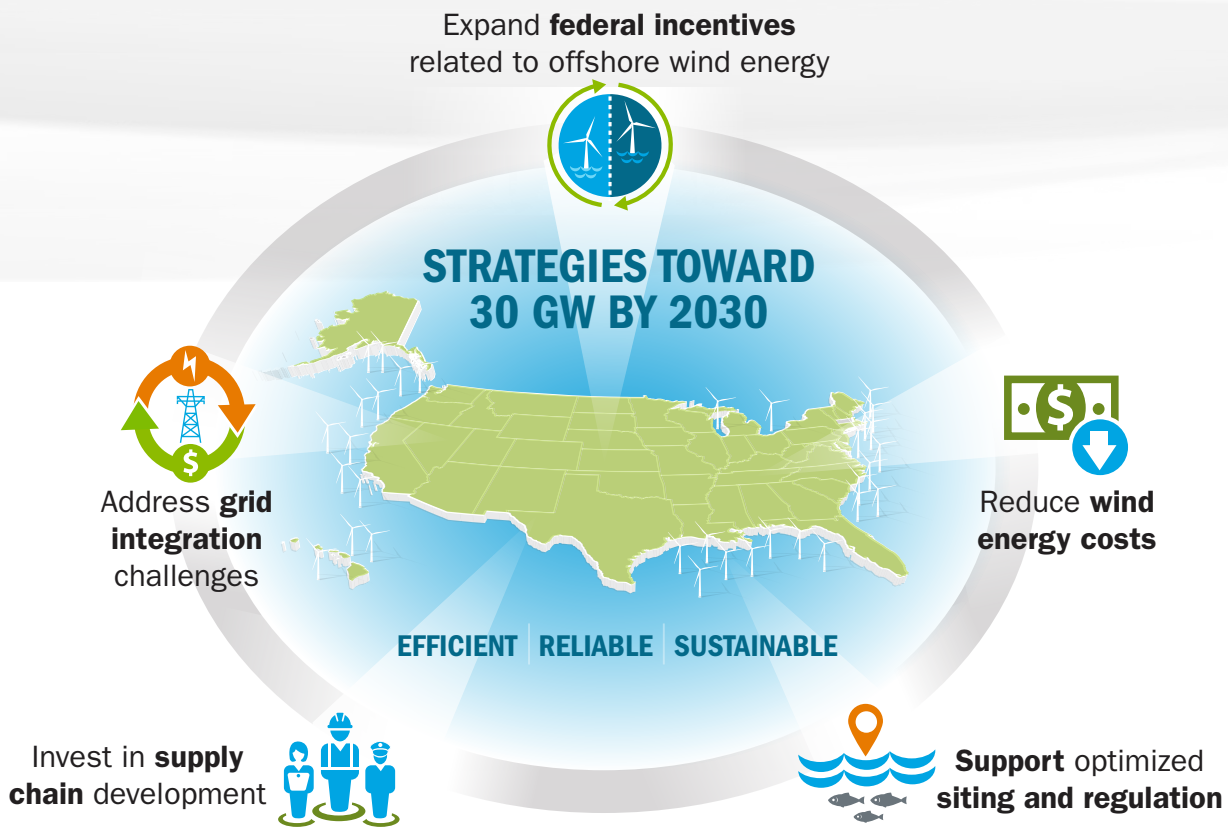


Figure H-2. Key needs for meeting 30 GW by 2030 (DOE 2022). *Illustration by John Frenzl, NREL*

in the coming decades to meet longer-term state and federal deployment goals. Future offshore wind leasing also requires increased certainty in timing and processes, and careful consideration of ocean co-use, environmental sustainability, benefits to underserved communities, and energy justice.

- **Investing in supply chain development.** The nation is readying for its first commercial-scale offshore wind energy projects, yet the domestic supply chain is not yet mature enough to manufacture all key components needed to reach the Biden administration goals, as well as serve global markets.
- **Planning the grid integration of offshore wind energy.** Most U.S. coastal areas lack adequate transmission capacity to bring gigawatt-scale production from offshore wind turbines to coastal load centers. Therefore, there is a need to deploy offshore and onshore transmission networks to deliver offshore wind power and improve reliability and resilience and enable dynamic cable solutions for floating offshore wind energy.

The 2022 *Offshore Wind Energy Strategies* report also identified expanded federal incentives related to offshore wind energy as a challenge area.[11] Since the publication of that report, the Inflation Reduction Act of 2022 was passed,[12] which extends tax credits for clean energy and manufacturing. These tax credits have the potential to support both offshore wind market growth, as well as the development of a

[11] DOE. 2022. *Offshore Wind Energy Strategies*. *https://www.energy.gov/sites/default/files/2022-01/offshore-wind-energy-strategies-report-january-2022.pdf*

[12] Inflation Reduction Act of 2022. H.R.5376. 117th Congress. 2022. *https://www.congress.gov/bill/117th-congress/house-bill/5376/text*

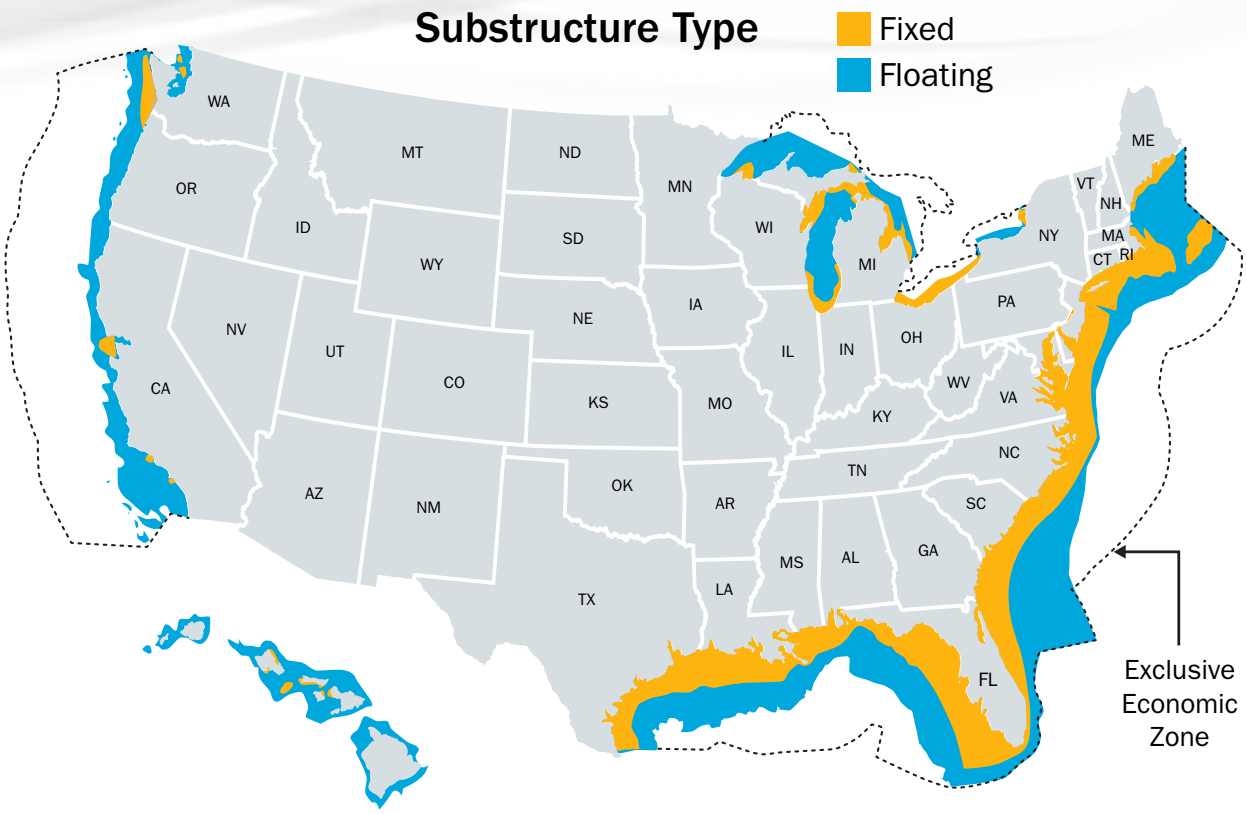


Figure H-3 Offshore wind substructure type by water depth (60 m). *Image from NREL.*

domestic supply chain[13] and may help address some of the challenges associated with rising project costs.

Offshore Wind Energy Technology Types

Offshore wind turbines are the largest rotating structures ever built and are highly complex systems. These systems can be broadly categorized into fixed-bottom and floating offshore wind systems. Deployment of offshore wind energy across all major U.S. coastal areas requires using both fixed-bottom and floating substructures because of varying water depths. Fixed-bottom substructures are secured in the seabed by monopiles, "jacketed" lattice-type frames, or gravity or suction bucket anchors and are typically deployed in water depths of 60 meters (m) or less. Floating wind turbines are mounted on buoyant platforms or substructures and connected to the seabed using mooring lines and anchors, typically in water depths exceeding 60 m.[14] From the total offshore wind resource potential of 4.2 GW, more than 65% is in deep waters, requiring floating platforms (Figure H-3).[15]

[13] The White House, "Building A Clean Energy Economy: A Guidebook to the Inflation Reduction Act's Investments in Clean Energy and Climate Action," January 2023, *https://www.whitehouse.gov/wp-content/uploads/2022/12/Inflation-Reduction-Act-Guidebook.pdf.*

[14] This water depth is not a hard limit and floating substructures might get deployed in water depths shallower than 60 meters (m) depending on economic feasibility and siting considerations.

[15] Lopez, A., R. Green, T. Williams, E. Lantz, G. Buster, B. Roberts. 2022. "Offshore Wind Energy Technical Potential for the Contiguous United States." *https://www.nrel.gov/docs/fy22osti/83650.pdf.*

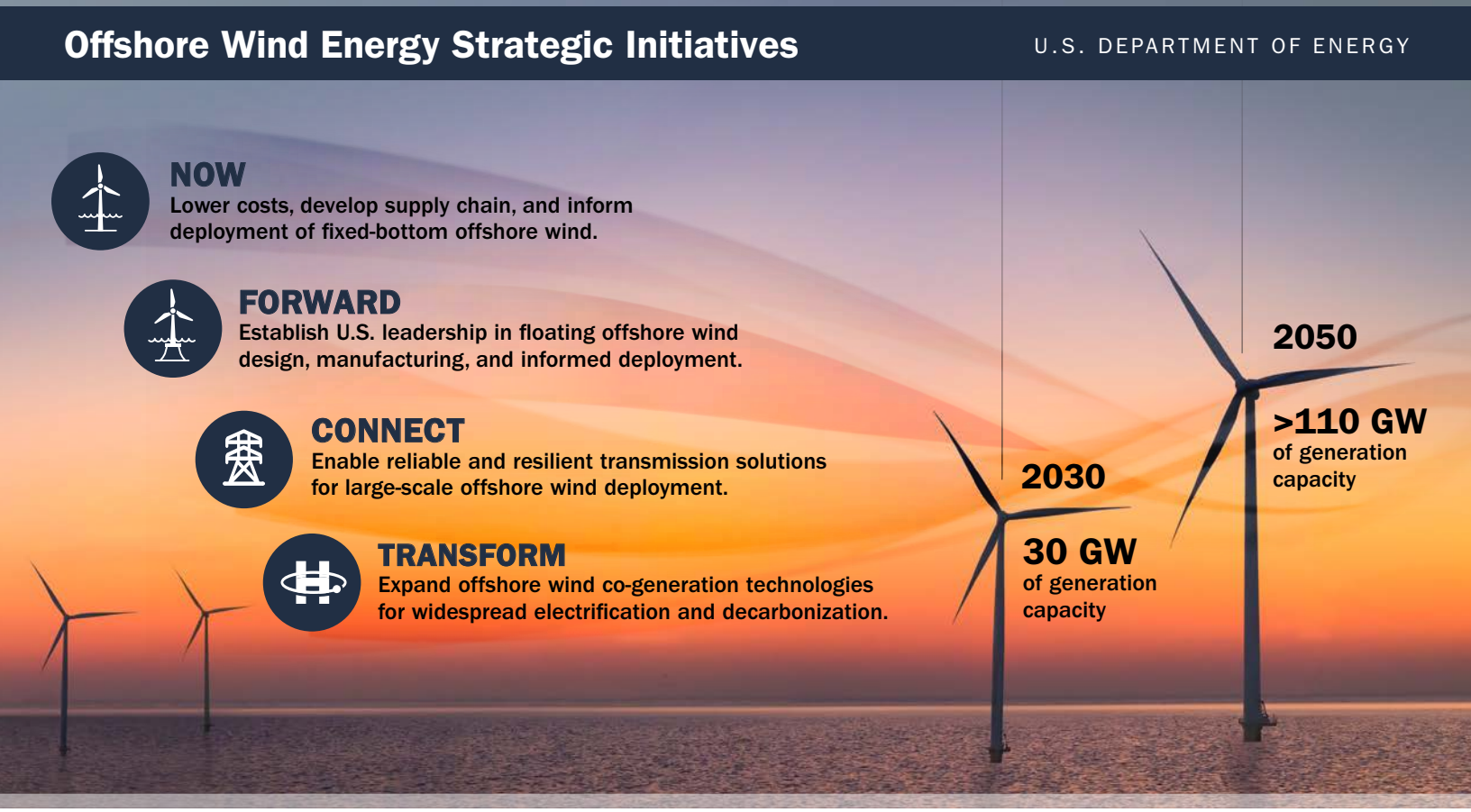


Figure H-4. Strategic initiatives for offshore wind energy to become a critical part of the nation's decarbonized energy sector and climate solution. *Illustration by John Frenzl, NREL*

Floating offshore wind energy development is anticipated to take place along the Pacific Coast, Gulf of Maine, Hawaii, and deeper water areas off the entire U.S. coastline. Furthermore, it is at an earlier technological and commercial stage, and more research, development, and demonstration (RD&D) is needed to lower costs to the point where the technology can be widely cost competitive across coastal regions. More work is also needed to expand coastal infrastructure for floating offshore wind, advance manufacturing practices, and build a domestic supply chain to pave the way for widespread deployment.[16] Because there have only been a small number of floating offshore wind energy projects deployed, more research is needed to characterize potential impacts of floating systems on the marine environment, and to design systems to maximize the potential for ocean co-use.

The Initiatives

This strategy proposes to advance offshore wind energy deployment through four major initiatives, each using DOE's broad portfolio of resources and capabilities to catalyze the technology's development in the near and long terms and establish the United States as a global leader in this space. These DOE initiatives (shown in Figure H-4) address the specific research and development (R&D), supply chain, and deployment needs associated with offshore wind technologies, transmission, and co-generation.

[16] Shields, M., J. Stefek, F. Oteri, M. Kreider, E. Gill, et al. 2023. *A Supply Chain Road Map for Offshore Wind Energy in the United States. https://www.nrel.gov/docs/fy23osti/84710.pdf.*

> economic, reliable, sustainable, just, and timely development

Photo by Helena Pound, DOE

NOW

NEAR-TERM OFFSHORE WIND DEVELOPMENT

Photo by Gary Norton, NREL 41188

To meet the Biden administration's 30-GW-by-2030 goal and unlock a pathway to 110 GW by 2050, DOE is establishing the Near-term Offshore Wind (NOW) initiative.

This initiative promotes the development of fixed-bottom offshore wind energy by lowering costs, spurring supply chain development, and informing expanded, sustainable, and just deployment. NOW features the following R&D efforts to:

- Reduce the cost of fixed-bottom offshore wind to $51/megawatt-hour (MWh) by 2030 from 2021's level of $73/MWh[17] by:
  - Optimizing the design of wind turbines and wind plant layouts through enhanced understanding of the short- and long-term U.S. offshore wind resource and meteorological, ocean, and geophysical characteristics; this optimization would reduce costs through higher energy production, longer wind turbine system lifetimes, and lower development expenses and material use.
  - Upscaling of wind turbines through systems engineering and testing, validating, and demonstrating the many innovations that will enable larger, more powerful turbines (e.g., superconducting generators, active turbine controls) while exploring the need for, costs and benefits of, and pathways to standardizing turbine sizes.

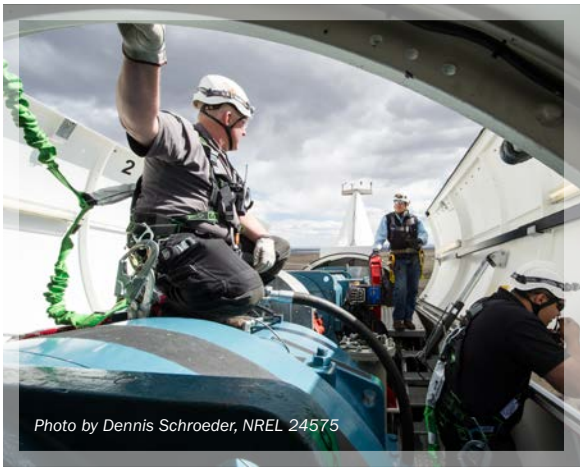


Photo by Dennis Schroeder, NREL 24575

  - Developing installation, operations, and maintenance strategies that reduce complexity and labor at sea while mitigating adverse impacts on the ocean environment (e.g., remote maintenance, noise mitigation measures during installation).
- Support the development of a robust domestic offshore wind supply chain to grow to more than 30 GW of fixed-bottom installations and operations by:
  - Publishing road maps of offshore wind supply chain needs, including ports, manufacturing, and Tier 2 (subassemblies) and Tier 3 (subcomponents) suppliers, informed by holistic analysis.
  - Convening and coordinating with stakeholders to advance effective and efficient supply chain planning and development.

[17] Stehly, T. and P. Duffy. 2022. "2021 Cost of Wind Energy Review." *https://www.nrel.gov/docs/fy23osti/84774.pdf.*

- Promoting the development and adoption of serial production practices in domestic manufacturing facilities through dedicated design studies and sector coordination efforts.
- Supporting the development of construction, operations, and maintenance vessels by assessing needs and gaps, conducting R&D to advance and demonstrate clean-fuel vessels, and facilitating access to financing to fill critical vessel needs.
- Facilitating the deployment of offshore wind power plants through federal financing.
- Supporting the development of a diverse, equitable, and inclusive future offshore wind energy workforce by analyzing the timing and geography of future workforce needs and establishing a network to ensure coordinated development of programming and expanded training programs to fill key workforce gaps.

• Inform just, sustainable, and timely development of fixed-bottom offshore wind energy by:

- Supporting community engagement and social science to understand impacts on communities and economies and work to ensure that underserved communities benefit from offshore wind energy development.
- Supporting research to evaluate, avoid, minimize, and mitigate impacts on ocean co-uses, including fishing, tribal equities, and other federal missions.
- Developing technologies and practices to reduce radar system interference from offshore wind turbines.
- Supporting research to understand and reduce environmental impacts of fixed-bottom offshore wind energy deployment in the United States, including developing monitoring and impact mitigation technologies that will help inform project design and operation as well as reduce environmental impacts on marine ecosystems and wildlife.
- Collecting and analyzing data for informed decision-making about offshore wind energy lease area delineation for fixed-bottom facilities. Through these activities, DOE could support the Bureau of Ocean Energy Management's decision-making through analysis, resource and physical data collection activities, and techno-economic tools.

> Reduce the cost of fixed-bottom offshore wind to $51/MWh by 2030 from 2021's level of $73/MWh

FORWARD

FLOATING OFFSHORE WIND ADVANCED RESEARCH AND DEVELOPMENT

Photo by Brent Rice, NREL 52802

To unlock a pathway to 110 GW by 2050, U.S. offshore wind energy must extend into deeper waters, comprising about two-thirds of the nation's potential.

In September 2022, the Biden administration announced a goal of deploying 15 GW of floating offshore wind capacity by 2035.[18] Floating offshore wind will enable the U.S. West Coast, Gulf of Maine, and deeper waters offshore all U.S. coasts to tap into this powerful resource. Because the floating offshore wind energy industry—and related technologies—are relatively new, the United States can assume a leadership role in commercializing these technologies on a large scale. The Floating Offshore Wind Advanced Research and Development (FORWARD) initiative establishes U.S. leadership in floating offshore wind design, manufacturing, and deployment by addressing the most urgent RD&D, supply chain, and siting needs. In recognition of its great potential and the critical need to address RD&D challenges, DOE, the U.S. Department of the Interior, U.S. Department of Commerce, and U.S. Department of Transportation launched the Floating Offshore Wind Shot™ (Box H-1) in September 2022.[19] This Energy Earthshot combines FORWARD with the floating activities from CONNECT and TRANSFORM for a holistic and impactful push to bringing floating offshore wind to U.S. waters (Figure H-5). For instance, developing critical transmission technologies (CONNECT), such as dynamic cables for floating offshore wind applications, is part of the Floating Offshore Wind Shot™.

Illustration by Josh Bauer, NREL

FORWARD, with support from DOE, aims to:

- Reduce the cost of floating offshore wind energy in deep waters to $45/MWh by 2035 from today's estimated $150/MWh[20] by:
  - Enabling use of increasingly more efficient and larger wind turbines through integrated turbine and floating platform system designs, components,

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

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

[20] This RD&D cost goal was formulated in the Floating Offshore Wind Shot for a deep-water site (1,000 m) and 125 kilometers from the point of interconnection.

Floating Offshore Wind Shot™

In September 2022, the Floating Offshore Wind Shot was announced to drive U.S. leadership in floating offshore wind design, development, and manufacturing. This is an interagency effort led by DOE, the U.S. Department of the Interior, U.S. Department of Commerce, and U.S. Department of Transportation. Achieving the Energy Earthshot targets will help America tackle the remaining technical challenges to address the climate crisis and more quickly reach the Biden administration's goal of equitably reaching net-zero carbon emissions by 2050 while creating good-paying jobs and growing the economy.[21] The Floating Offshore Wind Shot includes an ambitious goal to reduce the cost of floating offshore wind energy by at least 70%, to $45/MWh by 2035 for deep sites far from shore.[22]

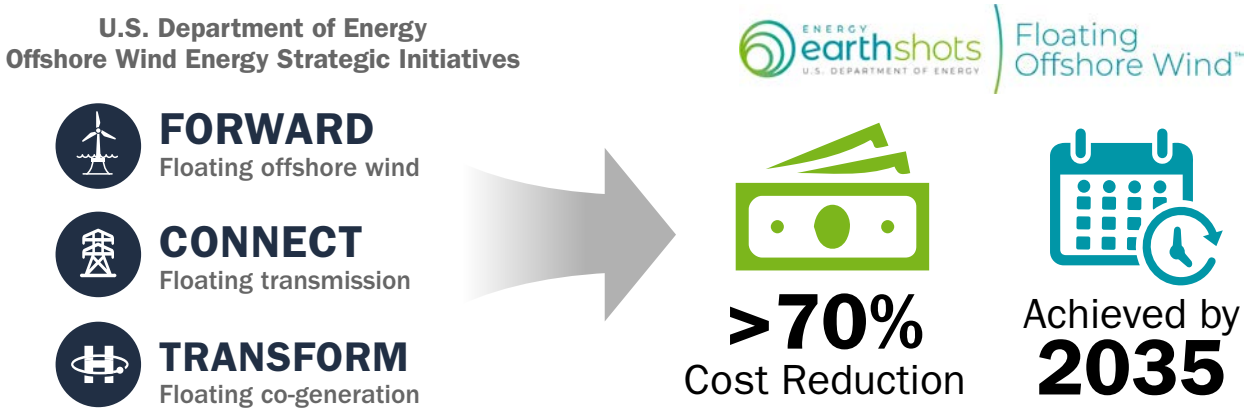


Figure H-5. Alignment of the DOE offshore wind energy strategy with the Floating Offshore Wind Shot. *Illustration by John Frenzl, NREL*

[21] The White House. 2021. "FACT SHEET: President Biden Signs Executive Order Catalyzing America's Clean Energy Economy Through Federal Sustainability." *https://www.whitehouse.gov/briefing-room/statements-releases/2021/12/08/fact-sheet-president-biden-signs-executive-order-catalyzing-americas-clean-energy-economy-through-federal-sustainability*.

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

and controls while evaluating and exploring pathways to increase wind turbine size and improve floating system design standardization.

  - Developing serial manufacturing practices in domestic manufacturing facilities.

  - Advancing systems engineering and controls co-design to reduce weight, increase efficiency, and reduce costs.

  - Supporting the development of new mooring, anchoring, dynamic cables, and floating substation concepts for deep-water deployment.

  - Developing operations and maintenance strategies and increasing wind turbine reliability to reduce periods of non-operation and reduce labor at sea through remote system health monitoring, inspection, and maintenance capabilities incorporating artificial intelligence and predictive maintenance.

- Support the development of a domestic supply chain to facilitate deployment of 15 GW or more by 2035 by:

  - Developing analyses and road maps of manufacturing, port, and supply chain investment needs along the West Coast, Gulf of Maine, and other U.S. regions.

  - Convening stakeholders and collaborating with federal agencies, states, and the floating offshore wind energy industry to develop and execute plans to fill high-priority supply chain gaps in alignment with analyses and road maps.

  - Advancing serial manufacturing for a range of wind turbine components, with an initial emphasis on turbine platforms.

  - Tailoring design of floating systems, installation, and manufacturing practices to align with U.S. infrastructure and manufacturing capabilities.

  - Filling critical gaps in U.S. vessels, manufacturing facilities, and floating offshore wind plants through federal financing.

  - Identifying and supporting the workforce needed to install and operate floating offshore wind facilities while promoting workforce diversity, equity, inclusion, and accessibility.

- Inform just, sustainable, and timely development of floating offshore wind energy in deep waters by:

  - Leveraging lessons learned from fixed-bottom development to ensure underserved communities benefit from floating offshore wind development.

  - Supporting community engagement in floating offshore wind development planning and conducting social science and socioeconomic research to understand the impacts of offshore wind energy on coastal communities and economies.

  - Funding research to characterize, avoid, minimize, and mitigate potential environmental impacts and promote co-use of ocean space, including for fisheries, tribal equities, and other federal missions, with a focus on the unique impacts and geographies of floating offshore wind energy development.

  - Developing technologies and practices to reduce radar interference from floating offshore wind turbines.

  - Supporting research to inform the siting, development, and operations of floating offshore wind systems in deep-water habitats in coordination with federal and state agencies, with a near-term focus on the West Coast.

CONNECT

TRANSMISSION SOLUTIONS FOR LARGE-SCALE OFFSHORE WIND ENERGY DEVELOPMENT

The coastal bulk transmission systems in most U.S. regions are currently not equipped to accommodate large amounts of new offshore wind energy and developing transmission offshore is complicated and largely uncharted territory for the United States.

Developing transmission infrastructure introduces a wide range of technical, regulatory, social, and environmental issues falling under many jurisdictions at the federal, state, and regional levels. Collaborative, proactive, and long-term transmission planning and phased grid development is vital to the increased certainty and pace of offshore wind energy development. Transmission solutions must not only be cost-effective, but also reduce environmental and ocean co-use impacts. As a result, the CONNECT initiative aims to facilitate the development of and investment in transmission infrastructure solutions for large-scale offshore wind deployment and enhanced grid reliability and resilience through key partnerships, analysis, planning, R&D, and transmission infrastructure. The goals of CONNECT are to:

- Coordinate and inform planning for a transmission system that integrates offshore wind energy with the U.S. electricity grid by:
  - Convening and coordinating planning efforts for the design and construction of an offshore wind transmission network that serves individual projects and regional power markets and is integrated into the onshore transmission system.
  - Conducting analyses to inform regional transmission development, including analysis of future offshore wind transmission topologies, the benefits and costs of transmission options, identification of routing trade-offs, and spatial analysis to reduce use conflicts.
  - Providing technical assistance for regional planning entities and communities.
- Support technology innovation to increase offshore grid reliability, resilience, and interoperability by:
  - Facilitating R&D on cybersecurity, control systems, and power electronics to reduce energy losses and increase the value of offshore wind to the power system.
  - Developing or refining technologies to increase the performance, reliability, and interoperability of offshore wind transmission such as high-voltage direct current (HVDC) applications, improved electrical hardware for reliable operations in harsh ocean environments, dynamic power cables and floating substations, and interoperable controls, communications, and protection equipment.
- Support expansion of reliable and resilient grid infrastructure by:
  - Coordinating with federal and state agencies to identify the investment priorities for transmission manufacturing facilities to enable more than 110 GW of offshore wind capacity by 2050.
  - Supporting critical investments in transmission infrastructure through federal loan guarantees, grants, and other mechanisms as part of the Building a Better Grid Initiative.[23]

[23] DOE. Building a Better Grid Initiative. *https://www.energy.gov/gdo/building-better-grid-initiative#*

TRANSFORM

EXPANDED OFFSHORE WIND CO-GENERATION

TRANSFORM aims to support the technical innovation of clean energy solutions needed to decarbonize all segments of the economy.

The TRANSFORM initiative will advance offshore wind co-generation technologies, also known as wind-to-X technologies, which use offshore wind energy to produce another energy solution, such as hydrogen co-generation, in support of widespread electrification and a net-zero economy. Offshore wind energy can be a key enabler of this transition because it can be deployed at utility scale, mitigates the land-use requirements of other generation sources, and can be coupled (on land or offshore) with other clean energy technologies. TRANSFORM will fund technology R&D activities, establish demonstration projects to prove technical viability, and facilitate DOE loans that support investments into co-generation from offshore wind. Specifically, the goals of TRANSFORM are to:

- Promote storage and wind-to-X technologies from offshore wind energy by:
  - Advancing coupled wind-storage systems to enable their widespread adoption and address intermittency challenges associated with variable renewable energy generation; this effort includes techno-economic analysis of offshore storage to inform its economic deployment and R&D to advance coupled offshore wind-storage systems to extend their use cases and performance in different power markets.
  - Optimizing clean-fuel co-generation technologies to transition the transportation and agriculture industries to full decarbonization (e.g., clean hydrogen[24]); this includes conducting techno-economic analysis of hydrogen and other clean fuels to inform economic deployment and hybridization strategies and R&D to advance safe hydrogen and other clean-fuel production technologies.
  - Supporting research and demonstration of wind co-generation, also known as wind-to-X technologies, including energy storage and clean-fuel production, and the establishment of offshore energy hubs as a center for operations, transmission, and storage facilities.
- Support the development of offshore wind energy hubs by:
  - Investigating the potential for offshore wind energy hubs to serve as important multisector tools in a net-zero economy; this includes analyzing techno-economic feasibility and regional needs for offshore wind hubs to evaluate trade-offs and coordinate planning.
  - Conducting R&D to lower the cost and increase the efficiency of hubs to incorporate wind energy with other technologies to optimize energy and space use and avoid, minimize, and mitigate any adverse environmental effects.
  - Establishing and coordinating offshore wind energy hubs to demonstrate their technical feasibility and support financing to facilitate offshore wind energy hub development.

[24] Efforts are coordinated with activities outlined in the *DOE National Clean Hydrogen Strategy and Roadmap*, which responds to legislative language set forth in Section 40314 of the Bipartisan Infrastructure Law and was published in September 2022 as a draft for public comment. *https://www.hydrogen.energy.gov/clean-hydrogen-strategy-roadmap.html*.

DOE CONTRIBUTING

Offices

DOE seeks to build on the expertise, capabilities, and resources across a range of its offices to promote offshore wind energy (Figure H-6). This document identifies the many opportunities for DOE action, including the many offices that might engage in the focus areas of this strategy. These areas include R&D to lower costs; efforts to promote just, sustainable, and timely deployment; transmission research and coordination; stakeholder engagement; supply chain development; and many other key facets of offshore wind energy deployment. Each office contributes to one or more critical areas of need.

	NOW			FORWARD			CONNECT	TRANSFORM
	Cost Reductions	Domestic Supply Chain Development	Expanded, Just, & Sustainable Deployment	Cost Reductions	Domestic Supply Chain Development	Expanded, Just, & Sustainable Deployment	Transmission Development	Co-Generation Applications
Advanced Materials and Manufacturing Technologies Office	●	●		●	●		●	●
ARPA-E	●			●			●	●
Grid Deployment Office							●	●
Hydrogen and Fuel Cell Technologies Office		●			●			●
Loan Programs Office	●	●	●	●	●	●	●	●
Office of Clean Energy Demonstrations	●			●			●	●
Office of Cybersecurity, Energy Security, and Emergency Response							●	
Office of Economic Impact and Diversity		●	●		●	●	●	●
Office of Electricity							●	●
Office of Manufacturing and Energy Supply Chains	●	●		●	●		●	●
Office of Science	●			●				
Vehicle Technologies Office		●			●			
Water Power Technologies Office	●	●	●		●	●	●	●
State and Community Energy Programs			●			●	●	●
Wind Energy Technologies Office	●	●	●	●	●	●	●	●

Figure H-6. Alignment of DOE office expertise and potential engagement with strategic initiatives
Note: ARPA-E = Advanced Research Projects Agency-Energy

Advancing Offshore Wind Energy in the United States

U.S. Department of Energy Strategic Contributions Toward 30 Gigawatts and Beyond

HIGHLIGHTS

Read the full report.

30 GW 2030 **110** GW 2050

U.S. DEPARTMENT OF ENERGY

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