

OFFSHORE WIND MARKET REPORT

2024 EDITION

EXECUTIVE SUMMARY





Offshore Wind Market Report: 2024 Edition Executive Summary

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Cover Photo by Joe DelNero: NREL 90979. Wind turbine construction in October 2023 at Vineyard Wind 1 off the coast of Massachusetts.

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Executive Summary

The *Offshore Wind Market Report: 2024 Edition* provides detailed information on the U.S. and global offshore wind energy industries to inform policymakers, researchers, and analysts about technology, economic, and market trends. The report provides the status of more than 322 operating offshore wind energy projects in the global fleet through Dec. 31, 2023, as well as the broader global pipeline of projects in various development stages. To provide current information and discussion on the emerging offshore wind industry in the United States, this report tracks significant U.S. domestic progress and events from Jan. 1, 2023, to May 31, 2024. Maps of the U.S. pipeline activity and Call Areas are shown in Figure ES-1.

U.S. Offshore Wind Energy Market

The first commercial-scale¹ offshore wind power plant in the United States, the 132-megawatt (MW) South Fork Wind Farm off Rhode Island, began delivering power to New York in November 2023 and was fully commissioned on March 14, 2024. Another commercial-scale offshore wind power plant, the 806-MW Vineyard Wind 1 project, also achieved first power in January 2024 with the installation of several operating turbines and remained under construction through the publication of this report (August 2024).² As of May 31, 2024, there were 174 MW of offshore wind power in operation.

The U.S. offshore wind energy pipeline had 4,097 MW under construction as of May 31, 2024. Three projects contribute to this total: Vineyard Wind 1 (806 MW), Revolution Wind (704 MW), and Coastal Virginia Offshore Wind (2,587 MW). This is an increase of more than 300% from the 938 MW under construction reported in the *Offshore Wind Market Report: 2023 Edition* (Musial et al. 2023).

By May 31, 2024, the U.S. offshore wind energy project development and operational pipeline reached a potential generating capacity of 80,523 MW. The U.S. offshore wind energy pipeline grew 53% (27,836 MW) from the previous edition of this report. Notable additions include the following: Eight proposed lease areas in the Gulf of Maine provided 15,702 MW of pipeline growth, two proposed lease areas in the mid-Atlantic provided 4,499 MW, two proposed lease areas off the coast of Oregon provided 3,156 MW, and four proposed lease areas in the Gulf of Mexico added 6,638 MW. Finally, one research lease area in the Gulf of Maine contributed 144 MW in potential capacity to the U.S. offshore wind industry pipeline.³

¹ In this report, projects greater than 100 MW are considered commercial scale.

² Projects that have not placed all turbines in service are categorized as under construction for the purposes of this report.

³ Note that the listed developments add up to more than the total pipeline growth because of recalculations of other project capacities in the pipeline from changes to or the loss of offtake agreements.

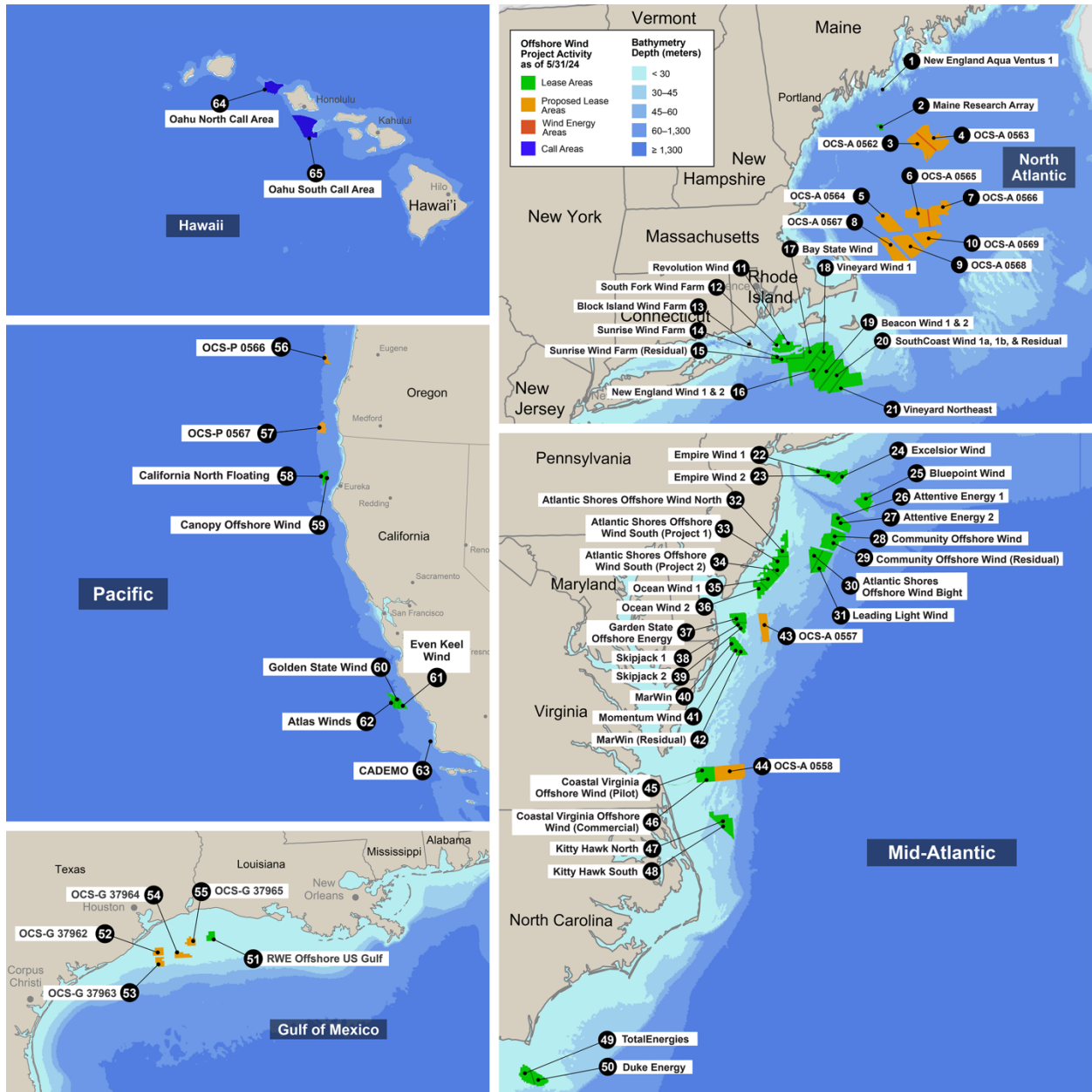


Figure ES-1. Locations of U.S. offshore wind energy pipeline activity and Call Areas as of May 31, 2024.

Maps created by John Frenzl, National Renewable Energy Laboratory

The U.S. floating offshore wind energy market has approximately 25,116 MW in the pipeline as of May 31, 2024, which includes lease areas and proposed lease areas on the west and east coasts. Of the 25,116 MW floating total, 6,042 MW of floating offshore wind potential are in the “site control” phase following the December 2022 auction of five lease areas in California. The remaining 19,074 MW are in the planning phase, including the Gulf of Maine where a May 2024 proposed sale notice published by the Bureau of Ocean Energy Management (BOEM) identified eight floating offshore wind energy lease areas for an auction planned in October 2024. On April 24, 2024, U.S. Secretary of the Interior Deb Haaland announced the new

BOEM leasing plan through 2028 (U.S. Department of the Interior 2024), with 7 of the 12 new proposed offshore wind energy auctions in deep water suited for floating offshore wind technology.

On March 22, 2024, the Internal Revenue Service issued guidance that updated the eligibility criteria for offshore wind projects seeking the Energy Communities Bonus Credit⁴ passed under the Inflation Reduction Act. Offshore wind projects with multiple points of interconnection may benefit from bonus credits if they locate any power conditioning and transfer equipment at one of their points of interconnection within an energy community. Also, projects may now qualify for bonus credit benefits if their supervisory control and data acquisition system is situated at an “eligible project port” within an energy community.

The U.S. Department of Energy (DOE) estimates that \$10 billion has been announced or invested in the U.S. offshore wind supply chain since the beginning of 2021. This \$10 billion figure includes \$2.1 billion in 2023 alone for port development, vessel orders, workforce development, research, and other supply chain investments in the U.S. offshore wind energy market (DOE 2024). The National Renewable Energy Laboratory estimates that an investment of at least \$22 billion in ports, large installation vessels, and major manufacturing facilities will be needed to establish the U.S. offshore wind supply chain (Shields et al. 2023).

The Bureau of Ocean Energy Management advances leasing in 2024. BOEM held a competitive lease auction in August 2023 for the Gulf of Mexico and awarded one lease area. New lease activity has advanced in four regions where proposed sale notices have been issued, and lease areas are being prepared for auction in 2024. The proposed wind energy lease sales in 2024 are the Central Atlantic (Aug. 14, 2024), the coast of Oregon (October 2024), and the Gulf of Maine (October 2024) (BOEM 2024a).

Eight states have set procurement mandates that total 45,730 MW of offshore wind capacity by 2040. The U.S. offshore wind energy market continues to be driven by state-level offshore wind procurement, planning activities, and energy policies. As of May 31, 2024, state mandates totaled 45,730 MW from eight states. Five other states have set formal planning targets that, when combined with the state mandates, total 115,130 MW by 2050. While planning goals do not require agencies to take direct action for offshore wind, procurement mandates are statutory requirements for the state to achieve a predetermined quantity of offshore wind generation on a scheduled timeline.

As of May 31, 2024, 15 contracts to purchase 12,378 MW of electricity from offshore wind power plants have been signed. Multiple state procurements were open as of May 31, 2024. This total does not include projects for which offtake agreements have been canceled.

In 2023, increased costs driven by macroeconomic pressures, market volatility, and limited hedging made many projects with existing fixed-price power offtake contracts financially nonviable. Eight projects canceled their offtake contracts: SouthCoast Wind 1, New England

⁴ Energy communities are located at sites that are historically affected by industrial pollution, communities affected by closed coal mines or coal-fired power plants, or communities that had a dependence on fossil fuel industries (through jobs or tax revenues) that are now facing higher than average unemployment. For more information, refer to <https://energycommunities.gov/energy-community-tax-credit-bonus/>.

Wind 1 and 2, Empire Wind 2, Beacon Wind 1, Ocean Wind 1 and 2, and Skipjack Wind. Challenges such as cost increases driven by inflation and rising interest rates impacted developers with signed offtake agreements who were attempting to bring projects online before 2030. Figure ES-2 summarizes state planning goals, procurement mandates, and offtake contracts awarded in the U.S. offshore wind energy market.

States have quickly responded to economic headwinds and power contract cancellations. Most states have reaffirmed their original offshore wind commitments and timelines. Multiple states have restructured their procurement strategies and opened new solicitation rounds to enable canceled projects to re-bid with updated offtake prices, such as by introducing inflation indexing. Most projects with canceled offtake agreements are still in active development and are seeking new offtake opportunities.

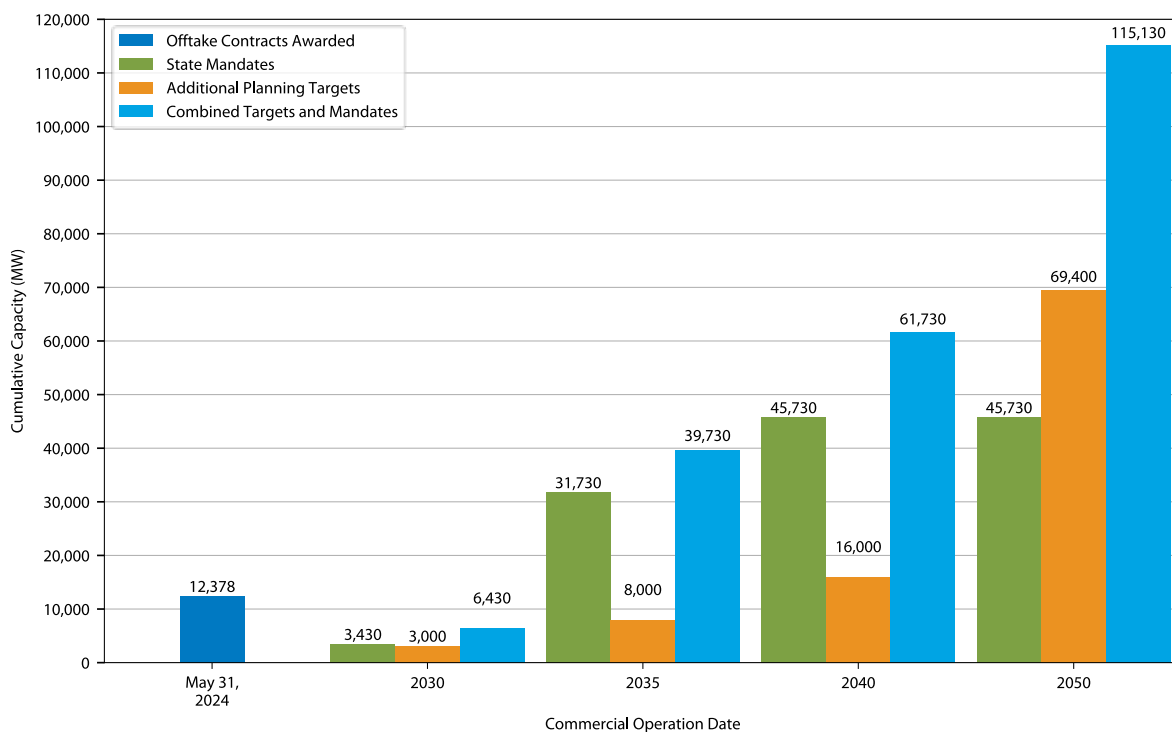


Figure ES-2. Cumulative capacity of U.S. offshore wind energy state planning goals, procurement mandates, and offtake agreements awarded

Global Offshore Wind Energy Market

In 2023, 6,326 MW of offshore wind energy were deployed globally, bringing total installed capacity to 68,258 MW as of Dec. 31, 2023. More than 13,096 operating offshore wind turbines in 319 operating projects contributed to this total installed capacity. The capacity installed in 2023 represents the fourth largest capacity installed in a single year.

The global generating capacity potential in the pipeline for all offshore wind energy projects reached 453.6 gigawatts (GW) by the end of 2023 for both installed and planned projects. European projects dominate the future project pipeline. Most projects in advanced

development stages are in Europe and China, but a significant portion of projects in the development pipeline are also moving forward in the United States and Oceania.

The global pipeline for floating offshore wind energy increased 1.8% to 104,399 MW. This increase is one of the lowest percentage changes observed since the annual report started tracking global pipeline growth in floating offshore wind. Since the publication of the *Offshore Wind Market Report: 2023 Edition* (Musial et al. 2023), 10% of the capacity was delayed and recharacterized in the planning stage. The growth is attributed in part to the Gulf of Maine lease area announcements.

New capacity for global floating offshore wind energy projects nearly doubled in 2023, bringing the total global capacity to 231.4 MW. The 88-MW Hywind Tampen floating offshore wind plant in Norway was fully commissioned in 2023 and is the largest operational floating offshore wind plant in the world (Equinor 2023). Other floating offshore wind energy projects came online near Marseille, France (25 MW) (SBM Offshore 2023); Bilbao, Spain (2 MW) (RWE 2023); Longyuan Nanri Island, China (3.6 MW) (Shanghai Electric 2023; M. Lewis 2023); and on the Wenchang oilfield off the coast of China (7.25 MW) (Buljan 2023a; China National Offshore Oil Corporation 2023).

Offshore Wind Energy Technology Trends

Larger offshore wind turbines are advancing toward commercial production. Offshore wind turbines have grown substantially over the past decade. The average installed turbine rating grew from 7.7 MW in 2022 to 9.7 MW in 2023 as developers began shifting to the new 15-MW turbine technology platform. Some original equipment manufacturers (OEMs), such as Vestas, and other industry experts have expressed a hesitation to continue increasing turbine size to allow supply chain and R&D investments to be paid off and to allow the benefits of industrialization, standardization, and industry learning to lower costs. This hesitation became apparent when General Electric dropped plans for an 18-MW turbine and announced a shift to its new 15.5-MW turbine. Vestas secured the first orders of its 15-MW turbine model and plans to make the first deliveries in 2025 (Vestas 2024) but has been steadfast in its position to remain at this scale. Siemens Gamesa has secured grants to develop and deploy what was announced as the “world’s most powerful” offshore wind prototype and plans to start operations in early 2025 (European Commission 2023). Chinese OEMs have also announced plans to develop 18-MW to 22-MW turbines.

Offshore Wind Energy Cost and Price Trends

Rising interest rates, supply chain constraints, and higher commodity prices during 2021–2023 have led to higher offshore wind energy costs globally and in the United States. Rising costs affect projects planned for commercial operation between 2023 and 2026 the most because of a lag of at least 1–3 years between the placement of supply chain orders and the start of commercial operations. Projects planned for later commercial operation might be less affected because of the actions taken at the state and federal levels and may have time to wait for macroeconomic conditions to return to prior levels.

Reporting by a set of consultancies and research entities⁵ suggests an unsubsidized levelized cost of energy for a hypothetical, commercial-scale offshore wind project in the United States of \$125 per megawatt-hour (MWh) in 2023 (on average and using mid-case estimates).⁶ The same sources report a wide range of \$75/MWh to \$149/MWh across scenarios (due to, for example, favorable siting conditions, closer proximity to port and grid infrastructure, varying financing assumptions, and other factors). These costs represent an average increase of more than 45% when compared to the 2023 edition of this report (Musial et al. 2023).

Future Outlook

The U.S. offshore wind energy pipeline grew to almost 81 GW. Forecasts from 4C Offshore (2024) and Bloomberg New Energy Finance (BNEF) (2023) estimate that U.S. offshore wind energy deployment could reach 40 GW and 42 GW, respectively, by the end of 2035.

Forecasted global projections for offshore wind energy indicate strong market growth with more than a fivefold increase in offshore wind energy projected over the next decade.

Forecasts from BNEF (2023) indicate that global offshore wind energy will reach 492 GW by 2035, and 4C Offshore (2024) forecasts 422 GW by 2035. The most prominent trend in the 2035 forecast is the estimated growth of China's market (from 52.2 GW to 188.9 GW by 2035). U.S. installed capacity is forecast to be 9% (4C Offshore 2024; BNEF 2023) of the global total by 2035.

In the United States, key offshore wind energy market indicators, such as permitting, interconnection, commercial leasing, state energy planning targets, procurement policies, offtake agreements, and federal support for U.S. jobs and supply chain development, point toward sustained, long-term market growth when viewed together. But the macroeconomic hurdles facing the first generation of commercial offshore wind energy projects continue to linger, and ongoing challenges with the deployment of those first projects make the prospects for long-term growth of offshore wind in the United States more uncertain.

⁵ The consultancies and research entities referenced include those cited with Figure 28 in Section 5.2.1: Bloomberg New Energy Finance (2024b), the U.S. Energy Information Administration (2023), DNV (2023), the International Energy Agency (2023), Lazard (Bilicic and Scroggins 2023), and the National Renewable Energy Laboratory (2024).

⁶ Mid-case estimates refer to a baseline, business-as-usual or “most likely” scenario.

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