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Floating Wind Farms

Climate-Tech to Watch

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WHAT ARE THEY?

A floating wind farm is exactly what it sounds like—an array of wind turbines on floating platforms instead of fixed foundations rooted to the seabed. Each floating platform is tethered to the seabed with mooring lines and anchors that prevent it from drifting off. Floating wind turbines are important because they can be installed in deep waters where much of the world's wind energy lies.

FLOATING WIND FARMS IN THE ENERGY TRANSITION

To achieve net-zero greenhouse gas emissions in the world energy system by 2050 and avert the worst impacts of climate change, countries must deploy a wide range of low-carbon energy technologies. The International Energy Agency's "Net Zero by 2050" report estimates that around 150 gigawatts (GW) of offshore wind capacity additions will be needed by 2050. That's about 25 times as much capacity as the world has today.[1] However, almost 99 percent of today's capacity is fixed-bottom wind farms in waters less than 50 meters (m) deep. Floating wind farms have the potential to provide over half of the needed capacity in the coming decades, expanding development to areas with stronger, more consistent winds over deeper waters.

Figure 1: Floating wind turbine

Despite its promise, floating wind technology is expensive. The levelized cost of energy (LCOE) for commercial-scale floating projects was between $110 per megawatt hour ($110/MWh) to $175/MWh in 2019. But cost reductions could come quickly with technological innovations in turbine platforms and size. The National Renewable Energy Laboratory estimates that the LCOE for floating projects could fall to around $60/MWh by 2032, which would be competitive with fixed-bottom projects.[2]

FLOATING WIND PLATFORMS

Floating wind platforms are engineering marvels, balancing building-sized wind turbines as tall as 800 feet with wingspans longer than the largest commercial jet. Three major types of floating platform have been used in demonstration projects: spar-buoys, semi-submersible, and tension leg platforms (shown from left to right in figure 2).

Figure 2: Floating turbine platforms[3]

Spar-buoys rely on a weight installed below a buoyancy tank to achieve stability. But their deep drafts and slender structure mean they must be installed in deeper water depths (>100m) than other platform concepts. They are also difficult to transport and require heavy-lift installation vessels, making them more costly.[4]

Semi-submersible platforms, which are commonly used in oil and gas exploration and production, make up 90 percent of global installed and planned floating wind farms today.[5] These platforms distribute buoyancy at the water plane through a set of three columns connected to submerged horizontal pontoons. They are easier to assemble and transport without the use of heavy-lift installation vessels.[6]

Tension leg platforms have submerged buoyancy tanks that are moored to the seabed by vertical tethers. The excess buoyancy from the platform creates rigid tension on the tethers, which reduces vertical motion and creates stability. Tension leg platforms are costly to assemble because they have higher installed mooring costs and are highly unstable during installation.[7]

GLOBAL PROGRESS

There are currently no operating commercial-scale floating offshore wind farms. Most projects installed to date are small arrays or single-unit demonstration projects. Hywind Scotland, a 30-megawatt (MW) demonstration project offshore Peterhead in Aberdeenshire, is the world's first floating offshore wind demonstration project (figure 3). Commissioned in 2017, it comprises five Siemens 6-MW turbines mounted on spar-buoy substructures. WindFloat Atlantic 2, commissioned in 2020 off the Portuguese coast, is a 25-MW demonstration project with three Vestas 8.4-MW turbines on semi-submersible platforms.

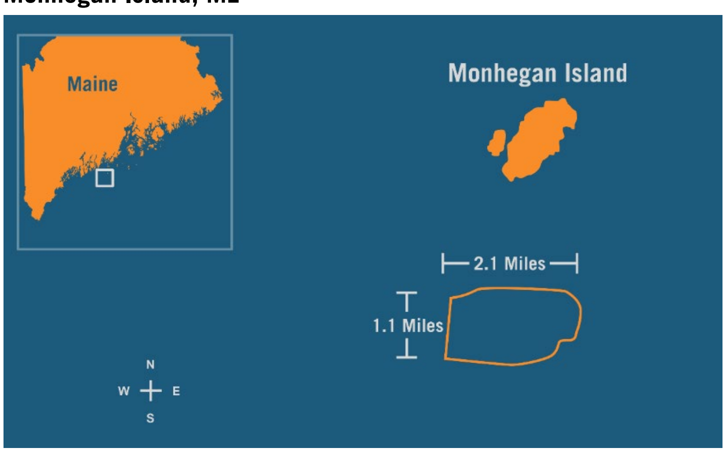
Figure 3: Hywind Scotland[8]

Although only 84 MW of floating offshore wind capacity has been installed to date, the pipeline includes 44 projects totaling 7,663 MW.[9] More large-scale demonstration and commercial-scale projects are essential to further bring down the cost of this important technology.[10]

PROGRESS IN THE UNITED STATES

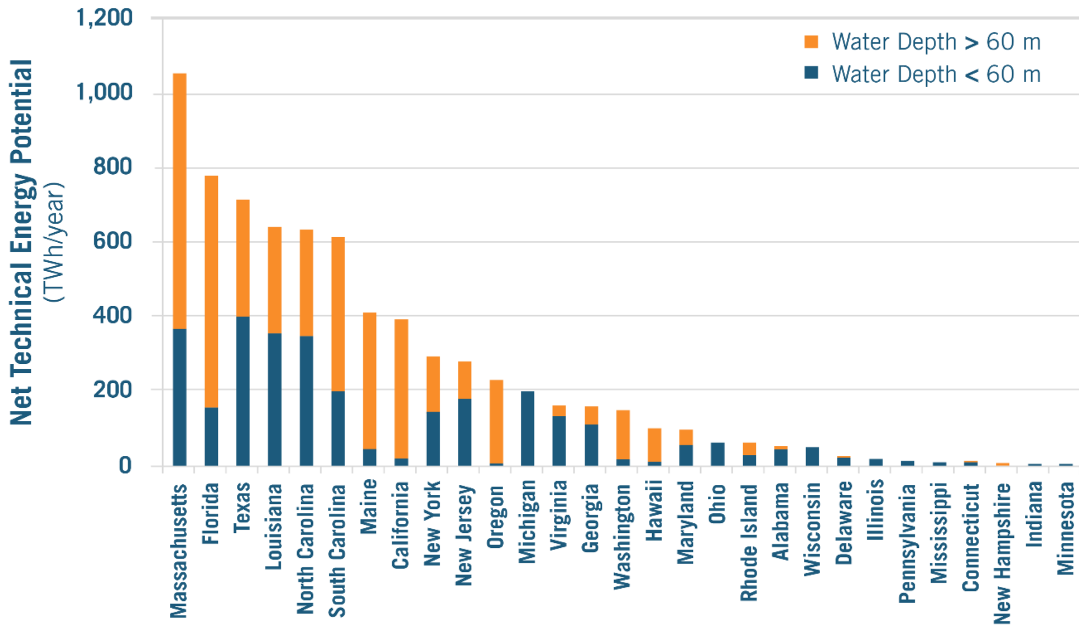
The floating wind industry is just kicking off in the United States. The U.S. Department of Energy's (DOE) Offshore Wind Advanced Demonstration Program is funding the University of Maine's New England Aqua Ventus I, the nation's first floating wind demonstration project, which will begin operating in 2023 (shown in figure 4). Aqua Ventus I will be approximately 12 MW in size and use concrete semi-submersible platforms.[11] Much larger projects are planned. Of the 28.5 GW in the U.S. offshore wind project pipeline at the end of 2019, 2.75 GW were from floating projects.[12]

Figure 4: Aqua Ventus I is located nearly 3 miles southwest of Monhegan Island, ME



In March 2021, the Biden administration announced new deployment targets for offshore wind: 30 GW by 2030 and 110 GW by 2050. To reach these targets, floating wind technologies will be necessary. Over 58 percent of offshore wind resources in the United States are in deep waters. States like California, Hawaii, and Maine, where wind farms must be located in water that is 60 or more meters deep (shown in figure 5), will benefit particularly from these innovations.

Figure 5: Offshore wind net technical energy potential by state for depths more than and less than 60m[13]



KEY POLICY ISSUES

The Department of Interior's Bureau of Ocean and Energy Management (BOEM) is responsible for managing and permitting offshore wind farms in U.S. federal waters on the outer continental shelf. The process can be quite complex and time consuming, requiring developers to acquire a lease in a BOEM auction, complete a site assessment plan, and submit a construction and operation plan for BOEM to then conduct an environmental impact statement as directed by the National Environmental Policy Act. While BOEM has mostly focused on permitting sites off the Atlantic coast, it recently announced commitments to expand development to California's Pacific coast, where deep waters would require floating offshore wind farms.[14]

DOE also plays a critical role in accelerating floating wind innovation by bridging funding gaps and backstopping risks that private investors are unwilling to bear. DOE's budget for these activities was $63 million in FY 2021, a 20 percent increase from FY 2020, including funding for projects like Aqua Ventus I.[15] DOE has also set up a National Offshore Wind Research and Development (R&D) consortium to work with states and private companies, and the Advanced Research Projects Agency-Energy (ARPA-E) supports a robust portfolio of floating wind projects as well.[16]

A growing number of states are looking to install floating wind farms, too. Oregon has a target of building 3 GW off the state's coast by 2030.[17] Maine's Ocean Energy Task Force proposes installing 5 GW of offshore wind capacity by 2030 and emphasizes the state's need for floating wind technology.[18] Although the governor of Maine signed legislation to prohibit offshore wind installations within state waters, the law would allow them to be sited in federal waters.[19]

LOOKING FORWARD

With the administration's ambitious target and the global effort to reach net-zero emissions by 2050, floating offshore wind should be the next big thing in the wind industry. Large-scale demonstration of floating wind technology is needed to increase confidence from investors that the technology works as intended, catalyzing greater private investment, and reducing costs.

FURTHER READING

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ENDNOTES

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