OFFSHORE WIND POWER

In the U.S., total potential capacity for offshore wind is estimated at 4.2 TW,[1] and current installed capacity is only 29 MW,[2] indicating that there is a lot of room for this technology to grow. All U.S. coasts, including the Great Lakes, have significant technical potential for offshore wind power (see Figure 1). Wind speeds off the East Coast and in the Gulf of Mexico are lower than off the West Coast, but the presence of shallower waters in these regions makes them more attractive for development. Hawaii accounts for roughly 17% of the entire U.S. annual technical potential for offshore wind.[3] Despite an abundant wind resource, Alaska faces significant challenges that inhibit large-scale offshore wind, such as the remoteness of the resource, its distance from load centers, and the large amount of land available for onshore wind development in the state.[4]

Offshore wind has the potential to produce large amounts of renewable energy in locations near coastal urban centers which require large amounts of electricity but have limited space for utility-scale renewables on land. As a result, coastal states have committed to purchasing a total of 39 GW of offshore wind by 2040, and they are banking on these projects to provide tens of thousands of high-paying jobs as well as investments in port infrastructure, supply chain development, vessel construction, and onshore assembly facilities.[5] Similarly, the Biden administration has a goal to deploy 30 GW of offshore wind capacity by 2030. At this rate, the country could have as much as 110 GW of offshore wind capacity by 2050, supplying 6% of the nation's electricity supply.[6]

Given these commitments, a significant ramp-up of offshore development in the next decade is expected. But there are a number of challenges that need to be overcome. First, offshore wind is currently more expensive than onshore wind and utility-scale solar. The global weighted average cost of offshore wind power is \$0.115/kWh,[7] which is more than other renewable

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[1] IRENA. 2021. *Renewable capacity statistics 2021.* https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Apr/IRENA_RE_Capacity_Statistics_2021.pdf
[2] IRENA. 2021. *Renewable capacity statistics 2021.* https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Apr/IRENA_RE_Capacity_Statistics_2021.pdf
[3] NREL. 2012. *U.S. renewable energy technical potentials: A GIS-based analysis.* https://www.nrel.gov/docs/fy12osti/51946.pdf
[4] NREL. 2017. *Offshore wind energy resource assessment for Alaska.* https://www.nrel.gov/docs/fy18osti/70553.pdf
[5] The White House (January 22, 2022). "Fact sheet: Biden-Harris administration races to deploy clean energy that creates jobs and lowers costs." https://www.whitehouse.gov/briefing-room/statements-releases/2022/01/12/fact-sheet-biden-harris-administration-races-to-deploy-clean-energy-that-creates-jobs-and-lowers-costs/
[6] The White House (March 29, 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/
[7] IRENA. Wind power. https://www.irena.org/costs/Power-Generation-Costs/Wind-Power

energy technologies. However, costs dropped by 28% to 51% between 2014 and 2020[8] as installed capacity increased across the globe, and they are expected to continue falling.[9]

Second, offshore wind is challenging from an engineering perspective. Components and cables must withstand the harsh marine environment, and construction and maintenance at sea requires specialized equipment and skills. Some technology is still nascent, such as the floating foundations that will be required to develop offshore wind in deep waters. The DOE identifies five strategic priorities that can accelerate development of offshore wind energy: increasing demand through targeted (not technology-neutral) federal incentives; reducing costs by fostering research and development in site characterization and technology advancement, especially for floating turbines; improving siting and regulatory processes by increasing transparency and stakeholder engagement, auctioning new lease areas, and facilitating ocean co-use through careful planning; investing in supply chain development, including offshore wind ports and logistics networks; and planning efficient and reliable grid interconnection to deliver offshore wind energy at scale.[10]

The forecasted buildout of offshore wind capacity is likely to proceed before critical questions about the ecological impacts of offshore wind can be fully answered. There are many unknowns about the impacts of offshore wind turbines, cables, and pre-construction and construction activities on marine life, avian life, and even wind and hydrographic patterns. Many recreational fishermen expect turbines to have a net positive impact by creating artificial reefs, while many commercial fishermen fear displacement from traditional fishing grounds, risks to vessel transit, increases in insurance costs, and impacts to the resources they depend on.

Gill et al. (2020)[11] state that the possible impacts of offshore wind on fisheries fall into four buckets:

- Energy landscape effects: Potential impacts may be driven by: the emission of electromagnetic fields (which are most likely to affect species that migrate using magnetic cues and species that orient and/or forage using electric and/or magnetic fields); underwater sound (e.g., during pile-driving activities); and changes to the physical environment caused by the alteration of water currents and wind wakes (which may alter hydrodynamic patterns and vertical stratification, potentially over large spatial scales). These changes may affect fish (re)production, migration, and/or distribution. These effects can take place during the construction and operations phases, and potentially during decommissioning as well.

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[8] Wiser, R., *et al.* 2021. "Expert elicitation survey predicts 37% to 49% declines in wind energy costs by 2050." *Nature Energy* 6: 555–565. DOI:10.1038/s41560-021-00810-z

[9] DOE. 2021. *Offshore wind market report: 2021 edition.* https://www.energy.gov/sites/default/files/2021-08/Offshore%20Wind%20Market%20Report%202021%20Edition_Final.pdf

[10] US Department of Energy (2022). *Offshore wind energy strategies.* https://www.energy.gov/sites/default/files/2022-01/offshore-wind-energy-strategies-report-january-2022.pdf

[11] Gill, Andrew B. et al. 2020. Setting the context for offshore wind development effects on fish and fisheries. *Oceanography* 33 (4): 118-127. DOI:10.5670/oceanog.2020.411

- Artificial reef effect: Addition of hard structures (e.g., turbine towers, scouring protection) may give rise to reef effects, which may cause some species to concentrate in wind farm areas. It is not known how these effects could play out at the population or community levels or whether species that benefit from these effects might be desirable or undesirable (e.g, predators, competitors, invasive species) from a commercial or recreational perspective. These effects can take place during the operations phase and potentially during decommissioning as well.
- Fisheries exclusion effect: Development of large-scale wind farms may result in a loss of or restricted access to some traditional fishing grounds but may also provide new opportunities to specific types of fisheries. These effects can take place at the construction and operations phases, and potentially during decommissioning as well.
- Fisheries displacement effect: If fishing vessels are excluded from a wind farm area due to regulatory restrictions, safety concerns, or changes in resource abundance, they may shift to other fishing grounds, leading to possible concentration of fishing effort in these areas and impacts to other fishermen fishing in these areas. These effects can take place at the operations phase and potentially during decommissioning as well.

Offshore wind power produces about 1.6 times as many lifecycle emissions as onshore wind,[12] but lifecycle emissions for both are far lower than fossil fuel energy and even solar PV. Like offshore wind and solar PV energy, onshore wind requires various minerals (e.g., aluminum, chromium, copper, iron, lead, manganese, molybdenum, neodymium, nickel, and zinc) and it is important to consider environmental, social, and geopolitical aspects associated with sourcing these minerals. Due to the length of the sub-sea cables that are needed to connect wind energy generation farms to shore, offshore wind uses more copper than any other renewable energy technology (8,000 kg/MW, compared to 2,900 kg/MW for onshore wind, 2,822 kg/MW for solar, and around 1,100 kg/MW for conventional fossil fuel energy).[13] If released into the environment, copper can have negative effects on aquatic and marine life, including fishery resources.[14]

- Fishery friendliness: Arguably, offshore wind stands to impact fishery ecosystems and resources more than any renewable energy technology, especially when scaled up at the buildout rates currently projected by the White House and Department of Interior. Additionally, offshore wind is largely incompatible with commercial fishing activities and is expected to have downstream effects on fishermen, coastal communities, and regional food systems.

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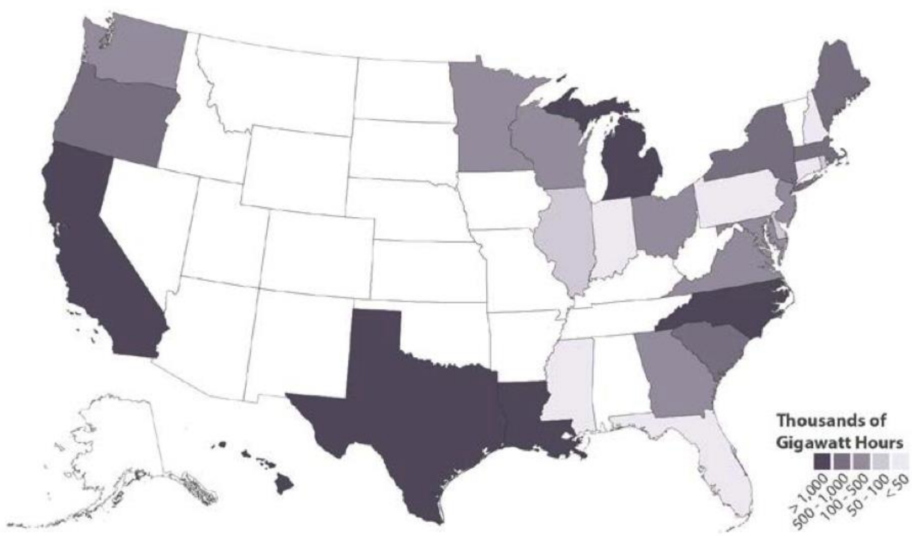
[12] Wang, S. and Jinxiang, L. 2019. Life-cycle green-house gas emissions of onshore and offshore wind turbines. *Journal of Cleaner Production,* 210, 804-810. DOI:10.1016/j.jclepro.2018.11.031.

[13] IEA. 2021. *The role of critical minerals in clean energy transitions.* https://iea.blob.core.windows.net/assets/24d5dfbb-a77a-4647-abcc-667867207f74/TheRoleofCriticalMineralsinCleanEnergyTransitions.pdf

[14] Woody, Carol Ann and Sarah Louise O'Neal. 2012. *Effects of copper on fish and aquatic resources.* Prepared for The Nature Conservancy. https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/alaska/sw/cpa/Documents/W2013ECopperF062012.pdf

- Co-benefits: Development of offshore wind is thought to hold promise for economic development in coastal areas.
- Environmental externalities: In addition to potential impacts to fishery resource via reef effects and alterations to the energy landscape, there are concerns about the impacts of offshore wind on birds and marine mammals, including endangered species.
- Policy catalysts: Offshore wind development can be promoted through production tax credits, state purchasing agreements, public investment in research and permitting, port development, and grid expansion and interconnection.
- More information:
    - Drawdown: Offshore wind turbines
    - Department of Energy (2022). *Offshore wind energy strategies.*
    - Bureau of Ocean Energy Management. Renewable energy on the outer continental shelf.
    - Responsible Offshore Science Alliance: Resources

Figure 1. Total estimated technical potential for offshore wind power in the U.S. Source: NREL 2012. [15]



Continue reading at https://fisheryfriendlyclimateaction.org/solutions

[15] NREL. 2012. *U.S. renewable energy technical potentials: A GIS-based analysis.* https://www.nrel.gov/docs/fy12osti/51946.pdf