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Markets to Watch:
Offshore Wind

Executive Summary

Though still in early development stages in the U.S., the global offshore wind market is poised to grow 15-fold over the next two decades, turning it into a $1 trillion business.[i] Interest in offshore wind, like other renewable energy technologies, is being driven in part by concern over climate change and a desire by governments, consumers, and companies to move to low-carbon sources of power. Relative to land-based wind developments, offshore developments have the benefit of faster and more consistent wind speeds, bigger and more efficient wind turbines, and fewer land use constraints. Offshore wind may even overtake onshore wind as a crucial energy source to meet global decarbonization goals.

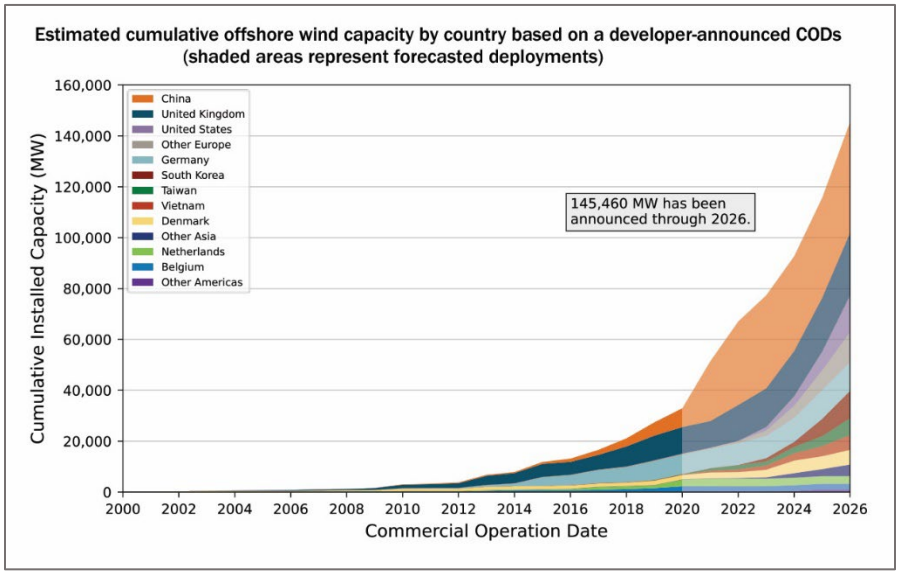
Wind turbine technology continues to advance with top equipment manufacturers vying for tallest turbine and largest market share. Joint ventures between cash-rich oil majors and experienced renewable developers compete for demand that is often determined by state policy incentives.

The Market

Since the first offshore wind project was installed in Denmark in 1991, the offshore wind industry has slowly gained ground. By 2020, 33 gigawatts (GW) of offshore wind capacity had been installed globally. The International Energy Agency (IEA) projects that figure to increase 15-fold over the next two decades, turning it into a $1 trillion business.[ii] Offshore wind financings in the first half of 2020 totaled $35 billion, up 319% year-on-year, according to BloombergNEF.[iii]

It's worth noting that offshore wind is still a relatively expensive energy source. Its levelized cost of electricity (LCOE) is significantly higher than onshore renewables (land-based wind and utility-scale solar) as well as fossil fuels like coal.[iv] However, it is attractive as a power source for a number of reasons. Offshore wind speeds are typically higher and more consistent than onshore wind speeds, with averages greater than 7.5 m/s along most of the U.S. coastline. Bigger and taller wind turbines can be installed offshore, which increases the capacity and efficiency of offshore generation (generation capacity increases exponentially with the size of the rotor diameter). Offshore wind also has a locational advantage over onshore wind. Whereas onshore wind projects are often located in less densely populated, rural areas, offshore wind can be located directly off the coast from major cities where electricity load is concentrated.

To build an offshore wind project off the U.S. coast, developers begin by winning a lease auction from the Bureau of Ocean Energy Management (BOEM). Developers



Source: U.S. Department of Energy, Offshore Wind Market Report: 2021 Edition.
https://www.energy.gov/eere/wind/articles/offshore-wind-market-report-2021-edition-released

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then complete local, state, and federal permitting. If the project is in federal waters, this process culminates with a BOEM Construction and Operation Plan (COP) review.

Two early pilot projects in the U.S. include the 30 megawatt (MW) Block Island Wind Farm project constructed in Rhode Island by **Deepwater Wind**, and the 12 MW Coastal Virginia Offshore Wind pilot project constructed by **Ørsted** and owned by **Dominion Energy** (which will pave the way for a larger, 2,600 MW project). In May 2021, BOEM announced approval for the 800 MW Vineyard Wind project in Massachusetts, a joint venture between **Avangrid Renewables** and **Copenhagen Infrastructure Partners (CIP)**, the first fully approved commercial-scale project in the U.S.[v] Several other projects have either been approved or are pending COP approval.

European and Asian offshore wind markets are significantly more advanced. In 2020, 2,197 MW of offshore wind was installed in China and 3,238 MW installed in Europe. Key developers include **Avangrid**, **Equinor**, **Ørsted**, **CIP**, and **EDF Renewables**. Joint ventures (JVs) between wind developers and oil majors are common. Due to the high capital costs associated with offshore wind and their expertise in offshore development, oil majors have seen this as an opportunity to participate in the renewable transition. **Shell** and **Equinor** have made the largest entrance into offshore wind, though **BP**, **Chevron**, **Total**, and **Eni** have all followed suit.

Trends & Uncertainties

Several considerations and developments could shape the future of the offshore wind market.

Policy incentives

In the U.S., offshore wind development is tied closely to state policies and incentives. Several states including Massachusetts, New York, Connecticut, and Maine have enacted legislation that mandates the development of offshore wind projects. For instance, New York has mandated the development of 9,000 MW of offshore wind by 2035.[vi] In a different approach, Maryland is incentivizing offshore wind development by providing offshore renewable energy credits (ORECs) for up to 2.5 percent of the state's renewable portfolio standard. Other states are considering policies as well; California's Governor signed a law in 2021 requiring the California Energy Commission to establish offshore wind procurement mandates from 2030 to 2045.[vii]

New lease sales

In March 2021, the Biden Administration announced a target of adding 30 GW of offshore wind by 2030 and directed BOEM to advance new lease sales and complete review of at least 16 COPs by 2025.[viii] This includes plans to auction off leases to developers for up to seven new areas by 2025.[ix]

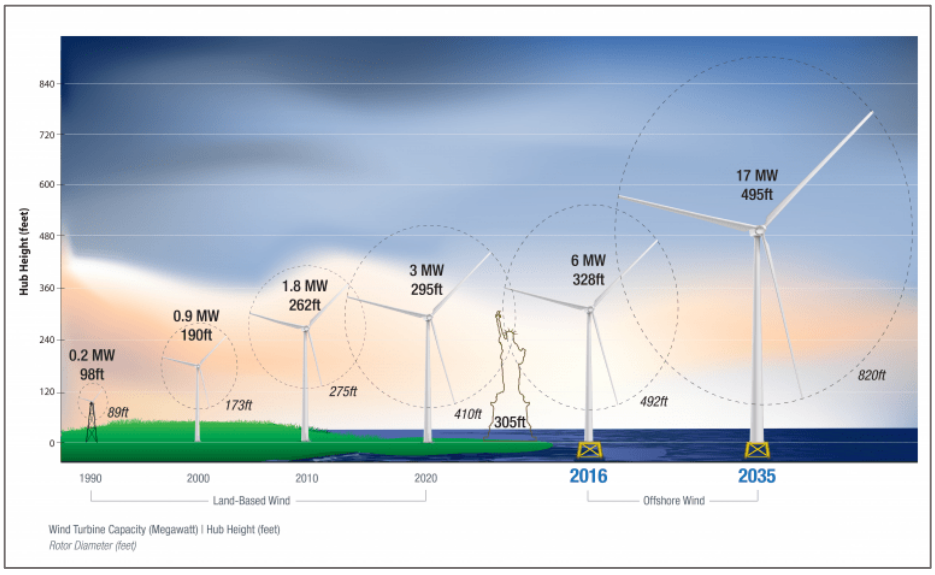
High upfront capital costs

With a long development timeline and significant capital expenditures to maintain project viability throughout development, high upfront capital costs limit the number of players in the market, beginning with the acquisition of BOEM leases, which are auctioned off to the highest bidder. In a 2018 solicitation, three lease areas were won at a total price of $405 million by **Equinor**, **Vineyard Wind**, and **Mayflower Wind** (a JV between **EDP Renewables** and **Shell**). This averages to over $1,000 per acre (by comparison, offshore drilling leases in the U.S. have averaged only $222 per acre).[x] Development costs also include extensive environmental studies, interconnection studies, and permitting, resulting in total development costs potentially exceeding $100 million.

Technology advancements

As lease areas are snatched up in regions with shallow waters, development will move into deeper waters. Unlike shallow water turbines (which are fastened to the sea floor with underground piles), wind turbines in deep water float, with a tether to the sea floor. Floating offshore wind is expected to grow from approximately 100 MW today to 10 gigawatts (GW) in 2030 and then 250 GW in 2050[xi]. Advancements in technologies and construction practices that enable new projects in deeper waters could increase offshore wind expansion significantly in the future.

Turbine manufacturers also continue to push the limits of turbine size. **Vestas**, **GE**, and **Siemens Gamesa** have been vying for the title of largest wind turbine since they entered the offshore market. In October 2021, **Vestas** announced plans to install a prototype 15 MW turbine with a height of 280 meters.[xii]



Source: U.S. Dept. of Energy, Office of Energy Efficiency & Renewable Energy , "Wind Turbines: the Bigger, the Better," 2021. https://www.energy.gov/eere/articles/wind-turbines-bigger-better

Jones Act considerations

The Jones Act, a 1920 law requiring goods shipped between U.S. ports to be transported by U.S.-built, owned, and operated ships, presents a hurdle for offshore wind developers. Currently, only a small number of ships exist in the world that are capable of installing the next generation wind turbines—far fewer than will be needed to meet demand in the coming decade. Some companies are investing in building new Jones Act-compliant wind turbine installation vessels, or are considering the use of "feeder" vessels to bring components to foreign installation vessels stationed at sea.

Local content requirements

As part of their approval of offshore wind projects, some U.S. states and some countries are requiring or incentivizing developers to use local content (e.g., manufacturing turbines and creating jobs in their own jurisdictions). Developers and turbine manufacturers worry that this has the potential to make supply chains less efficient and add costs to projects; the extent will depend on how far-reaching and stringent the local content requirements are.

Transmission systems requirements

Offshore wind projects are often 500 to 1,000 MW in size, larger than most onshore power plants. Interconnecting such a large project to the grid is challenging and further exacerbated by the condensed interconnection points for offshore wind. In New York, for example, the state's 9 GW offshore wind goal will be met entirely by projects interconnecting on Long Island and New York City. Interconnection upgrade costs—the fees required to upgrade the transmission grid so that a project is able to safely interconnect—can be hundreds of millions of dollars,[xiii] and it may take three or more years to obtain the full cost estimate.

Stakeholder concerns

Commercial fishers, the shipping industry, and local communities have historically been the strongest opponents to offshore wind development. Cape Wind, a proposed development off Martha's Vineyard, was scrapped after 16 years of work and $100 million in development expenses due to well-funded opposition from residents and government officials. Some stakeholders worry about environmental impacts of projects, with concerns ranging from habitat disturbance to underwater noise impacts.

Addressing stakeholder concerns is essential to the success of new offshore projects. Today's proposed offshore projects, for instance, are typically sited at a further distance from shore than Cape Wind. Vineyard Wind, in another example, agreed to pay $21 million to compensate fishers impacted by their project and amended project design to reduce impacts to the fishing community.[xiv]

Business Opportunities

The growth of the offshore wind energy market creates opportunities not only for developers, but also for other stakeholders in the energy, construction, and manufacturing industries.

New offshore wind development: U.S.

Offshore wind development in the U.S. has primarily been focused in the Northeast to date and expansion is expected to continue there with new projects gaining COPs. Expansion in other regions is underway and expected to increase as the BOEM auctions leases in new areas, starting with NY Bight, Carolina Long Bay, and Northern & Central California.

In the Carolinas and Mid-Atlantic region, most of the power markets are regulated utility markets, meaning that state mandates will likely be required to incentivize the purchase of offshore wind power. North Carolina recently took a step to address this challenge with an executive order establishing a goal of 2.8 GW by 2030 and 8 GW by 2040 (though this alone is not as strong as a mandate).[xv]

Offshore wind projects in California are much anticipated. Developers are working to strike offtake agreements with community choice aggregators (CCAs), which procure power for municipalities. The passage of AB 525, a law mandating a strategic plan to facilitate offshore wind development, will likely broaden offtake opportunities.[xvi]

New offshore wind development: Global

In 2021, China reportedly overtook the UK as the country with the most installed wind capacity.[xvii] Forecasts predict China will deploy between 45 to 52 GW by 2030[xviii]—all of which will be captured by Chinese companies, as foreign developers are not allowed to participate.

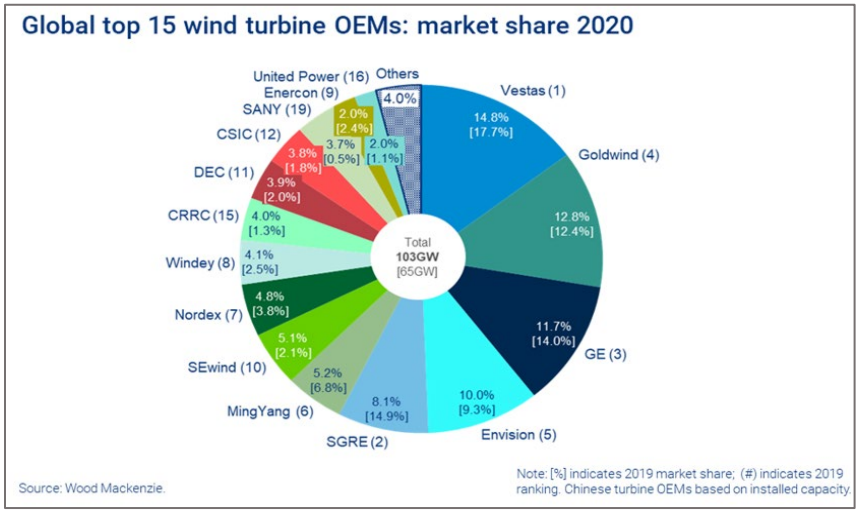
European developers will continue at their current strong development pace, holding 45% of the total installed global offshore wind capacity by 2030. In particular, the U.K., Denmark, and the Netherlands have significant projects underway. New installations in Europe are expected to hold at around 5 GW per year for the next five years.[xix]

Offshore wind development is forecast in other Asian countries, like Taiwan and South Korea, as well as Brazil, where the industry is working to meet the government's goal to install 16 GW by 2050.[xx] Argentina and Australia may emerge as new offshore markets in coming years; both have strong wind resource potential, but are taking the first steps towards developing an offshore wind market.

Because offshore wind comes at such a premium to other power generation options, it is less likely—for now—to be a priority investment in less developed markets where costs heavily outweigh environmental concerns.

Turbines & components

Turbine manufacturing is led by Vestas (Denmark), GE (U.S.), and Siemens Gamesa, (Spain)—together holding a 35% market share of the global turbine market,[xxi] while Chinese companies Goldwind and Envision Energy serve the China market exclusively. Growth in the offshore wind market is likely to support continued advancements in turbine design and manufacturing. The market for floating turbines, still relatively nascent, has also created opportunities for new entrants like Ocergy and Stiesdal Offshore Technologies.



Source: Wood Mackenzie, "Global wind turbine market: state of play," April 14, 2021
https://www.woodmac.com/news/opinion/global-wind-turbine-market-state-of-play/

Offshore grid connectors

While offshore wind has primarily connected to the grid through individual project points of interconnection (POIs), the risk of receiving expensive transmission upgrade requirements that are uneconomical is driving a new business model—offshore transmission. Anbaric has turned their focus to creating transmission networks that are open access to offshore developers. In a recent proposal to PJM for their Boardwalk Power Link, Anbaric argued that this transmission network model would optimize use of available coastal POIs and minimize landing points onshore for electric cables.[xxii]

Energy storage

Because wind energy is intermittent, integrating energy storage (which could include batteries, green hydrogen, or other storage technologies) into offshore wind projects may be a common feature of future developments. Baystate Wind, a JV between Eversource Energy and Ørsted, has included a 55 MW battery with their 800 MW wind project for capacity firming and energy time shifting.[xxiii]

Port and shipping upgrades

To facilitate the manufacturing, installation, and operation of offshore wind plants, significant port upgrades are required. This is in part due to the large size of the offshore wind turbines (they must be manufactured adjacent to the port because they are too large to transport). In Europe, port upgrades to meet new installation demand will cost an estimated $7.9 billion by 2030.[xxiv] In the U.S., the federal government is providing grants up to $230 million for port upgrades,[xxv] creating opportunities for construction firms and shipping companies, as well as new jobs in port cities.

Takeaways for MBAs

1. The offshore wind market is expected to triple in year-over-year installations by 2030, reaching over 200 GW, resulting in significant opportunities in the U.S. and global markets. Several joint ventures and turbine manufacturers are vying to gain control of the market.
2. Investment in offshore wind is being driven in part by global interest in low-carbon energy. Policy mandates and financial incentives play, and will continue to play, a large role in the pace of investment.
3. Offshore wind development represents not only business opportunities for wind developers and turbine manufacturers, but may also bring opportunities in port upgrades, new shipping infrastructure, and grid and battery storage technologies.

Further Reading

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