NREL
NATIONAL RENEWABLE ENERGY LABORATORY

NREL is a national laboratory of the U. S. Department of Energy (DOE),
Office of Energy Efficiency and Renewable Energy,
operated by the Alliance for Sustainable Energy, LLC.

2014 U.S. Offshore Wind Market Report: Industry Trends, Technology Advancement, and Cost Reduction

Aaron Smith,
Tyler Stehly,
Walt Musial

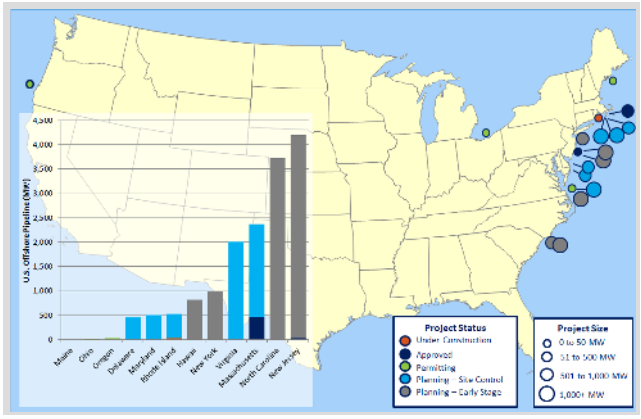
Global Market Trends

- The global offshore wind industry is set to reach a deployment record with 4,000 megawatts (MW) expected to come online in 2015, bringing the cumulative market to 11,800 MW.
- The announced project pipeline totals nearly 250,000 MW. The pipeline is led by Europe (63%), but development seems to be accelerating in Asia (23%), North America (9%), and the rest of the world (5%). Projects totaling 37,000 MW have announced that they will begin operations by 2020.

U.S. Market Trends

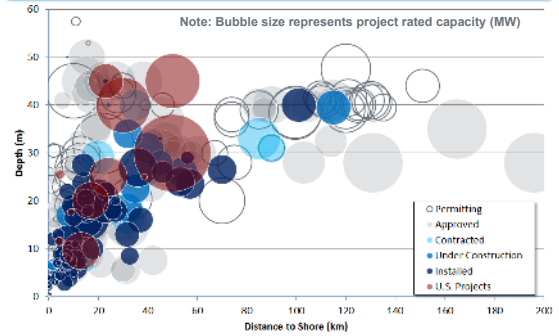
- The U.S. offshore wind development pipeline contains 21 projects (15,654 MW), and developers have obtained site control for 13 projects that could support up to 5,930 MW (Figure 1).
- The 30-MW Block Island Wind Farm (BIWF) off the coast of Rhode Island started construction in April 2015 and will be the first offshore wind project in the United States.
- The industry also experienced some setbacks in 2015, as projects in the pipeline have encountered a range of political, legal, and economic issues. The slow start to the industry is not without precedent: each European country began with proof-of-concept projects before eventually moving to larger, commercial-scale installations.
- The main focus for projects in the U.S. development pipeline is currently on obtaining viable power offtake mechanisms and completing the permitting process.

Figure 1. U.S. offshore wind development pipeline



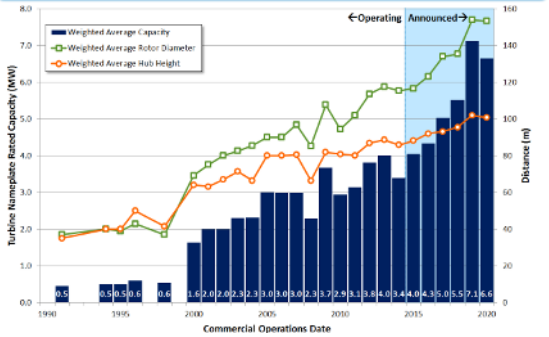
Note: Map is limited to the contiguous United States and does not show two projects (816 MW) proposed in Hawaii

Figure 2. Project size, water depth, and distance from shore



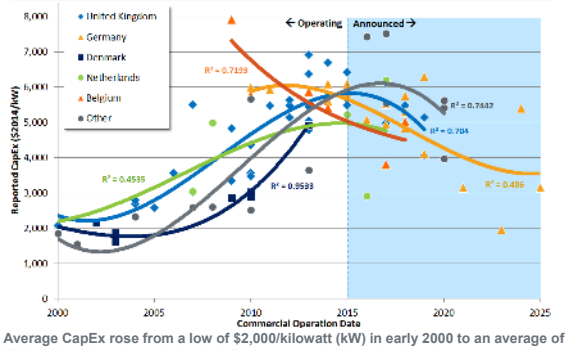
Projects are being installed at sites that have deeper water and are located further from shore, which, all else equal, increase the cost of construction/operation. U.S. project attributes vary, but are expected to be more similar to projects in the European pipeline than to operational projects.

Figure 3. Turbine rating, rotor diameter, and hub height



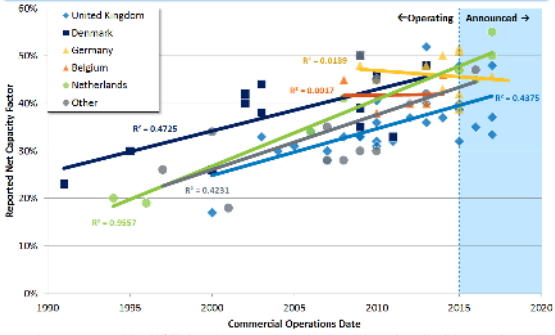
Growth in turbine rating plateaued from 2011 to 2015; however, the industry is rapidly adopting the new generation of 6 MW+ turbines. Larger turbines deliver LCOE benefits by lowering balance-of-system requirements, reducing the requisite number of marine operations, and increasing performance.

Figure 4. Capital expenditure (CapEx) trends by country



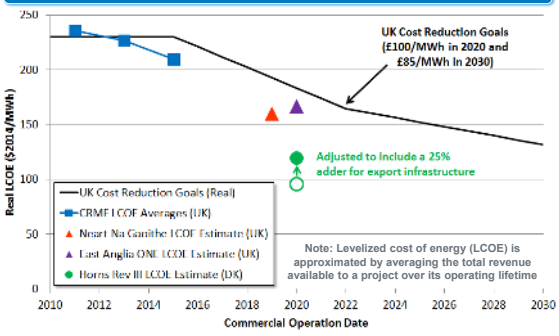
Global Average CapEx rose from a low of $2,000/kilowatt (kW) in early 2000 to an average of nearly $5,925/kW in 2014 driven by technical challenges, supply chain bottlenecks, et cetera. However, the industry expects that the average CapEx will broadly decline through 2020 in all major markets.

Figure 5. Net capacity factor (NCF) trends by country



Performance (as measured by NCF) has improved markedly, driven by: 1) siting projects in locations that are farther from shore, which typically have higher wind speeds, and 2) improvements in offshore wind turbine technology (e.g., increased rotor-to-generator ratio and taller hub heights).

Figure 6. Progress towards levelized cost of energy reduction



The UK Cost Reduction Monitoring Framework (CRMF) and recent competitive subsidy auctions (DK, UK) provide some empirical evidence that the industry is reducing LCOE and may be in advance of the trajectory required to meet 2020 cost reduction goals.

Conclusions

- Start of construction on the 30-MW BIWF is a key milestone for the U.S. offshore wind industry. Completion of the project will provide a concrete showcase that illustrates the potential of offshore wind to contribute to state, regional, and federal goals for clean, reliable power and lasting economic development.
- The BIWF and the DOE's Advanced Technology Demonstration Projects program are expected to enable the U.S. industry to gain valuable experience by using the best available European technology, and applying other project-specific innovations to adapt to U.S. siting challenges.
- Demonstration-scale projects are expected to help streamline and reduce the risk of offshore wind investment in the United States by exercising the permitting process, generating information about U.S. operating conditions, and showcasing the capabilities of the U.S. supply chain.
- Experience gained through the initial projects is expected to enable the U.S. industry to reduce LCOE for the next generation of commercial-scale projects. Cost reduction will make offshore wind more competitive with other sources of low-carbon generation and could simplify the process of working with stakeholders to define the viable power offtake mechanisms that are necessary to launch a domestic industry.

Contacts: aaron.smith@nrel.gov; tyler.stehly@nrel.gov; walter.musial@nrel.gov
Report available: http://www.nrel.gov/docs/fy15osti/64283.pdf

OFFSHORE WINDPOWER 2015
Baltimore, Maryland
September 29—30, 2015
NREL/PO-5000-64958