Bloomberg Environment

Daily Environment Report™

Renewable Energy

INSIGHT: Unleashing the Potential of Offshore Wind

BY ROBERT A. JAMES, ANDREW D. WEISSMAN AND BRYAN M. STOCKTON

The next revolution in global energy production may be one you have to squint to see.

Over the last several years, large-scale deployment of offshore wind has emerged as a significant resource. This acceleration is spurred by experience in Northern Europe where continued improvements in turbines and other technology, learning-curve benefits, and economies of scale have slashed costs per megawatt hour by more than 50 percent over the past five years. In some circumstances, projects are being launched without explicit price subsidies. Turbines are being installed farther and farther offshore, where visual impacts (a frequent impediment to wind development) are reduced and winds are stronger and steadier.

Underscoring these benefits, a recent government-funded study by Lawrence Berkeley National Laboratory concludes that the total value in the northeast U.S. of potential offshore wind projects exceeds that of land-based wind. Some analysts forecast global deployment to increase fivefold over the next decade.

To realize the potential of this resource, policymakers and stakeholders must recognize and overcome its unique challenges. This article highlights siting, entitlement, infrastructure, transmission, development, and financing issues that are distinctive for offshore wind, when compared with onshore wind or with other marine projects. We contrast Northern Europe with two frontier regions: the United States, where a number of competing states have launched ambitious efforts, and Taiwan, which has a centralized plan to develop resources off its western coast.

Entitled Location, Financeable Project: A Tale of Three Regions All energy project developers set out to acquire both a suitable site with all necessary government approvals and a long-term power purchase agreement (PPA) with financeable terms. But the differences for these objectives between onshore and offshore wind can be striking.

Land-based U.S. projects typically are built on privately owned property or on public lands slated for energy uses. Nationwide, there are hundreds or even thousands of suitable locations. For sites built on agricultural land located near existing transmission lines, the uncertainties associated with environmental reviews can be confined. Given the comparatively low costs of onshore wind power and the standardized process, a developer that acquires a suitable site has a good chance of being able to obtain a PPA.

American offshore wind development has proven decidedly more challenging. To achieve economies of scale, the individual project size will be much larger, limiting the number of PPAs that will be awarded. Because projects are now being sited 10 to 20 miles from shore and national governments lay claim to territorial waters for many purposes besides energy, such as fishing, navigation and national security, the sovereign's role in leasing is much greater and nuanced than for onshore projects. When the military signals that large swaths of offshore locations may be off limits, as was suggested by the Navy for the U.S. West Coast in February 2018, many otherwise suitable options may be unavailable.

The Northern European experience can be profitably compared. Nations bordering the North Sea have established predictable regulatory frameworks for offshore development. Governments are increasingly awarding PPAs and site control concurrently. This enables the pursuit of ambitious programs in which the state not only acts as commercial lessor but also offers long-term policy and financial support through the form of aggressive renewable energy targets and, where necessary, price support mechanisms.

An instructive intermediate case is taking shape in Taiwan. Offshore wind is being encouraged in an initiative to switch from nuclear and coal generation. As part of a comprehensive plan for the Taiwan Strait, multiple zones have been designated for development. Potential developers are responsible for entitling sites before they may compete for PPAs. Projects must navigate multiple phases, including obtaining Environmental Protection Administration approval and securing consents from local authorities. If the project is selected, it can obtain a construction permit and an electricity license, and a PPA can be executed.

With the national government acting as a gatekeeper to both zonal leases and a generous feed-in tariff, Taiwan hopes to provide developers with a predictable path forward. The government has recognized that its current nine-year lease term for onshore wind would create serious financing problems if applied to offshore projects, where the duration of non-resource financing and PPAs will need to be much longer. According to letter guidance, the National Property Administration will extend the lease for the period of the electricity license (so long as the conditions that were satisfied in obtaining the license remain in effect).

Streamlining Siting and Economic Review Opportunities for improvement in the U.S. development review process stand out. First, the steps required to obtain site control can be streamlined. Currently, for a developer to acquire a site, the Department of Interior's Bureau of Ocean Energy Management (BOEM) must decide to offer to sell a lease for the site, and the developer must be the successful bidder in a competitive auction conducted by BOEM (if competitive interest exists, as has been the case for the most recently announced lease areas). A multiyear environmental assessment is required before a construction plan can be submitted and reviewed for approval. As the Department of Energy has acknowledged, ''[t]he number of permits and authorizations required for the realization of an offshore wind project can be daunting for developers.''

Nongovernmental organizations and other stakeholders often intervene aggressively in the BOEM review process and object to issuance of a lease, creating additional uncertainty and delay. A different set of interests exists for offshore wind, including fishing, trawling, tourism, and shipping, than is the case for onshore projects. BOEM evaluated a potential New York lease for nearly five years before concluding its area identification process in 2016 and issuing its Final Sale Notice. The process at least for initial projects has stretched out over the better part of a decade, although that time frame is shrinking for newer proposals.

Second, greater coordination among BOEM, state governments, and electricity authorities will help rationalize the connection of the site review process to the sale of power. The responsibility for leasing tracts and the selecting projects to be awarded PPAs is presently divided among agencies. That division impairs an integrated determination of which tracts will be offered for sale and when and whether power sales contracts will be awarded.

As the New York State Energy Research and Development Authority (NYSERDA) has recognized, developers must grapple with two ''distinct and de-coupled actions[:] . . . acquiring a site lease that allows for project development on federal underwater lands, and securing an agreement for power purchase.'' This bifurcated process ''creates substantial risk for developers who pursue leasing at great financial risk and uncertainty without the stability of power purchase agreements.''

The multiple-stage, multiple-agency approach can lead to long periods of delay and create mismatch between the sites offered for sale and state energy goals. Still, there are encouraging signs. It is no surprise that the region with most leasing activity—New England—is also the region in which the states have committed the most to financing offshore wind. BOEM is prioritizing its leasing to align with the state policies.

BOEM also is starting to explore ways to streamline the federal licensing process, in part by consolidating multiple agency reviews into a single document and record of decision. Further, a Department of Interior Secretarial Order issued in August 2017 establishes a target for BOEM to complete environmental impact statements within one year and with no more than 150 pages (300 pages for complex projects). For offshore wind, it remains to be seen whether such arbitrary limits will be sufficient to ensure the ''hard look'' at environmental impacts required by federal law.

Another regulatory development that may offer greater flexibility involves preparation of a Construction and Operations Plan (COP). Under draft guidelines proposed in January 2018, developers would be allowed to prepare a COP for BOEM's review that includes ''a reasonable range of design parameters'' but permits the developer to submit final design decisions (such as micro-siting of turbines) in later stages of the process if they fall within a design envelope specified in the COP. BOEM based this change on the approach to permitting offshore development used by the U.K. and other European countries.

The BOEM initiative—while welcome—addresses only part of the problem. A comprehensive development plan is desirable, one that simplifies the site evaluation process and integrates it with the process for selecting projects to receive PPAs. Until this occurs, development of offshore wind in the U.S. is likely to fall short of its potential.

Fostering Local Specialized Infrastructure A second major difference between onshore and offshore wind is the nature and scale of the necessary human and physical infrastructure. Offshore wind draws on a hybrid of the traditional marine services industry, the wind power generation industry, and combinations that are unique to the application.

Specialized skills and equipment are, of course, also required for land-based projects, but much of the work can be performed using readily available equipment and local qualified technicians. Transporting and installing turbines on land is significantly easier than constructing foundations and installing turbines at sea—and offshore turbines are becoming much larger.

The need for a resilient logistics capability for offshore projects is comparatively greater. This stems from the massive scale and size of offshore projects, the need to work in a highly corrosive marine environment under variable conditions, and the difficulty of installing foundations for large turbines in locations in which the seabed is 35, 50 or more meters below sea level. Performing this work in a cost-effective manner requires a specialized physical port infrastructure, logistics services providers, construction and maintenance vessels, helicopters and related aviation resources, and other assets. General marine facilities must be strengthened and otherwise upgraded to handle large turbines and foundations.

Customized expertise is required in supply chain management, information technology, human resources and knowledge management, marine engineering, sub-sea engineering, bonding and insurance, and marine environmental assessment. The Jones Act's requirement of U.S.-flagged vessels for most transport between U.S. ports and other legal and regulatory features of the maritime field further affect the selection and deployment of resources available to the offshore developer, compared with its onshore counterpart.

This need for specialized resources creates interesting synergies for firms with offshore oil and gas expertise, such as those on the U.S. Gulf Coast. Some of this knowledge base can also be brought in from abroad. Northern Europe has developed these resources over many years. Two U.S. offshore oil and gas related companies have announced partnerships with European offshore wind companies. Taiwan is also encouraging alliances or joint ventures with experienced foreign firms, and a number of local and foreign-affiliated firms have sprung up.

The initial influx of overseas assistance will be useful. In the long term, creating domestic supply chains and developing a cadre of engineers with the required expertise physically based in the area in which projects are located is likely to prove more effective. One of the most important lessons learned in Northern Europe is the importance of developing a robust local infrastructure in order to reduce project costs and lower risks. Analysts have opined that the learning-curve benefits of scale achieved by building a large number of projects in the same geographic region are the important factor driving down costs in Europe.

Developing large numbers of offshore wind projects concurrently may provide the critical mass that will best foster this infrastructure. Such a concentration may be possible in Taiwan, whose plan contemplates installing assets in a compressed time frame to achieve a ''1000 Wind Turbine'' goal. It is less clear that it can be achieved in the U.S. where projects are being built on a one-off basis without a comprehensive plan and where the development timetable is uncertain.

Creating an Efficient Offshore Transmission System Offshore wind development has unique transmission concerns. Offshore projects can be located relatively close to large, coastal population centers where energy demand is highest (and where onshore sites are comparatively hard to acquire). U.S. developers have to date typically been responsible for building transmission to interconnect with the contracted utility. This differs from the U.K. and Germany, where a separate transmission operator is responsible for offshore transmission assets and may charge the wind project owner fees to transmit power.

Pioneer projects in frontier regions may establish a local interconnection point, which may not be optimal for the projects that follow. Stakeholders may debate whether an incremental approach will be inefficient after more projects are built in a region, assuming the best interconnection points may not be able to handle additional loads without significant upgrades. Transmission hubs, rather than separate lines running out to each and every project, might be more efficient in some instances in the long term. They may be less likely to be built in the U.S. in the short term so long as individual offshore developers remain responsible for transmission investment, and development timing hinges on state incentives rather than on national infrastructure priorities.

Plans for a high-voltage direct current transmission line running offshore Virginia to New Jersey were targeted at solving this issue, along with relieving regional transmission congestion and reducing transmission losses. Investors including Google and Marubeni proposed the Atlantic Wind Connection in 2010 to provide this backbone. However, there were not enough credible wind farms far enough along in development at the time for this venture to advance on its original schedule and basis. Today, smaller proposed regional transmission links in New England may be a way for offshore wind not only to deliver power but also to straddle electricity markets and efficiently move power between regions.

In Taiwan, the government-owned power entity (Taiwan Power Company) has present authority over transmission. Because the company is also currently responsible for purchasing the power production, it will influence whether single or multiple offshore hubs or radials will be employed. Depending on the location and construction timetables, some developers could be exposed to delays in completion and the specter of planned or forced outages.

The integration of generation with the grid involves more than just cables. Capabilities must be established for reactive power and back-up generation. Some offshore wind developers may look to pumped storage or battery storage to supply electricity when most needed. The transmission system operator must manage system operating limitations and balancing requirements.

Delayed or interrupted power sales, with or without a contractual right of curtailment in the PPA, could be highly adverse to affected projects, particularly those relying solely on energy sale revenues. Because the risks are even greater for first-movers, developers will initially strive for greater responsibility for and control over transmission and interconnection. One possible approach is to split revenues into energy payments and infrastructure and generation capacity payments, with capacity payments continuing even when electricity output is curtailed.

Managing a Hybrid of Maritime and Energy Project Risks Offshore wind entails navigating a host of developmental and operational risks over the life of the project different in character or quality from onshore counterparts. Operations and maintenance expenses for an offshore wind energy facility may account for about a quarter of the total costs over the life of the project. Experience from Europe suggests that each offshore wind turbine currently requires at least one annual maintenance visit and three to five additional minor repair visits during the year.

Offshore projects are vulnerable to different types of severe weather events and acts of God than are typically seen onshore. Risk management and insurance programs will need to address the prospect of earthquakes and typhoons in Taiwan and nor'easters in New England. Construction and maintenance time windows will be limited by weather and wave conditions. The corrosive marine environment in which offshore projects operate can wear on turbines and cables. The ocean terrain can shift due to natural events or trawling, potentially exposing a buried cable and increasing risk of damage or shorter useful life.

Building an onshore wind farm usually entails a turbine supply agreement and a single balance of plant (BOP) engineering, procurement, and construction (EPC) contract. Offshore projects, by contrast, can involve multiple contractors handling separate segments for the turbine foundation and jackets, the cabling, the substations, and the onshore facilities. This structure demands close coordination and formal interfaces across all design, construction, and management professionals.

Foundation technology is under evolution for offshore wind. Anchored foundation options include monopoles, jackets akin to those on oil platforms, and concrete gravity bases. Floating foundations are making rapid progress; by the end of 2018, Japan will have 14 megawatts and Europe 88 megawatts of projects utilizing floating turbines. The laying and maintenance of cables between turbines, substations and landfall also involve a choice of techniques and a weighing of associated costs, benefits, and risks.

As has occurred with renewable generation of all types, all of these challenges are likely to become more manageable over time, as experience is gained. Unless they are addressed adequately in PPAs, however, early-mover projects could face costs that can impair their viability or impose unexpected costs in the delivery of electricity to the grid.

Financially Supporting Frontier Projects Development of offshore wind is progressing rapidly, now including regions in which large-scale deployment is just beginning. Those frontier locations are at a stage comparable to onshore wind and photovoltaic solar until recently, where financial support to ensure adequate cash flow will be essential to achieve economies of scale and learning-curve benefits. This is particularly true given the importance of developing robust infrastructure, which cannot be accomplished without achieving critical mass in the areas where wind farms are being built.

Numerous mechanisms can be used to provide the required support. The simplest approach currently being pursued in Taiwan, and previously used in Europe, is to provide feed-in tariffs for the first wave of projects, taking into account the heightened costs and risks associated with early-stage projects and the need to develop the required infrastructure.

A number of other approaches is possible. In the U.S., for example, tax benefits for renewable energy can be maintained and extended. There is also the prospect of long-term tariff bonds that amortize investments in transmission over an extended period. Project equity can be sourced from green energy funds, which often can raise and offer capital on favorable terms. Hedging instruments can move commodity, currency, and macroeconomic risks to counterparties that will bear them for consideration.

Experience points to some level of risk that governments may seek to retract long-term incentives at some point during the life cycle of renewable energy projects. Financial support mechanisms for initial offshore wind projects are critical; unlike some sources, offshore wind in a frontier region like the U.S. or Taiwan has a cost that is not yet at grid parity.

Incentive policies are inherently political, and a future administration or legislature may attempt to terminate or pull back previous terms. The wind industry in the U.S. has experienced this with Congress phasing out the production tax credit and modifying a loan guarantee program. These concerns are heightened for the emergence of offshore wind, and all those interested in the development of this resource should be vigilant in identifying and responding to proposed changes.

Conclusion Lessons learned from the Northern European experience may be supplemented, or modified, by experience in the new locations. Offshore wind in the U.S. and Asia has a long way to catch up to Europe's large-scale capacity. But with pro-development policies in place and attention being paid to the distinctive challenges, significant growth in these regions is no longer over the horizon.

—The authors thank Stephanie McClellan for reviewing an earlier version of this article.

Rob James is a partner in the San Francisco and Houston offices of Pillsbury Winthrop Shaw Pittman LLP. With over 35 years at Pillsbury, he co-leads the firm's Projects team, focusing on energy project development, complex commercial agreements, and engineering, procurement and construction contracts, including public-private partnerships. In the electricity sector, in addition to conventional power generation and storage, he advises on solar, wind and geothermal projects. He is the editor and principal author of U.S. Energy: Regulation, Development & Finance (second edition), covering American electricity, oil and gas markets and projects.

Pillsbury senior counsel Andrew Weissman has been at the forefront of high-stakes, cutting-edge issues impacting the energy industry for more than three decades. Andy has helped to transform federal and state energy and environmental policy, assisting in the development of major energy regulatory programs as well as energy and environmental legislation. He is the leader of EBW Analytics Group, which provides independent expert analysis of natural gas, electricity and crude oil markets.

Bryan Stockton, a Pillsbury senior associate, helps clients navigate permitting processes for the construction of new wind, solar, and natural gas power plants; negotiate with regulatory agencies; resolve claims and litigation arising from environmental laws; identify and mitigate liabilities related to complex corporate and real estate transactions; contribute to the rulemaking process in advance of the promulgation of new federal air, water and fuels regulations; and resolve complex compliance issues.

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