



U.S. OFFSHORE WIND POWER: AN INDUSTRY IN MOTION

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PREFACE

THIS REPORT IS THE SECOND IN A SERIES OF THREE KLEINMAN CENTER FOR ENERGY POLICY PUBLICATIONS EXPLORING OFFSHORE WIND POWER. The first piece, entitled “Tilting at Windmills: The Emerging U.S. Offshore Wind Energy Industry,” presented an overview of offshore wind, noted the opportunities and challenges associated with harnessing this renewable energy source, and observed

that several states along the U.S. Eastern Seaboard appear to be competing to lead this emerging domestic industry. This report takes a closer look at the federal regulatory environment governing offshore renewable energy development; examines offshore wind progress in Massachusetts, Rhode Island, New York, New Jersey, and Maryland; and touches upon fledgling offshore wind developments in other American states.

ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

AS OF JUNE 2018, THE BLOCK ISLAND WIND FARM—A FIVE-TURBINE, 30-MEGAWATT OFFSHORE WIND ARRAY LOCATED 3.8 MILES OFF OF BLOCK ISLAND, RHODE ISLAND—IS THE ONLY INSTALLATION OF ITS TYPE IN AMERICAN WATERS. Based on March 2018 data, offshore wind presently constitutes less than 0.003% of the United States’ total in-service utility-scale electricity generation capacity (U.S. Energy Information Administration, 2018).

By comparison, at the end of 2017, European sea basins (the North, Irish, and Baltic Seas; and the Atlantic Ocean) held 4,149 grid-connected offshore wind turbines, with a cumulative capacity of 15,780 megawatts (WindEurope, 2018). In fact, during 2017 alone, the 25-year-old European offshore wind industry installed a record 3,148 megawatts (560 new turbines). Contrast Europe’s extraordinary 2017 with the same year in American offshore wind—**zero** American installations commenced construction, completed construction, or were connected to the grid during 2017.

The U.S. offshore wind sector continues to lag behind its European counterpart. The domestic industry faces some of the same barriers encountered in Europe—relative high costs, supply chain constraints, potential impacts to fishing, visibility concerns, and NIMBYism¹ issues. However, offshore wind developers in the U.S. must also carefully navigate the uniquely American legal “shoals” occasioned by idiosyncratic state-level energy policies; the federal Jones Act; and the intricacies of securing not only approvals from local, state, and federal governments, but also the necessary coordination and agreement between those governmental actors.

Since 2010, multiple Atlantic coast states (Massachusetts, Rhode Island, New York, New Jersey, and Maryland) have taken concerted legislative or executive action to advance offshore wind development. Several other East Coast states—Connecticut, Delaware, Virginia, and North Carolina—are themselves currently engaged in early-phase offshore wind efforts. California and Hawaii, with abyssal Pacific Ocean waters a short distance offshore, are conducting preliminary activities in anticipation of deploying floating offshore wind turbines.

America’s inaugural offshore wind effort, Cape Wind, ultimately proved unsuccessful, and there is a pronounced current disparity between the European and American industries in terms of installed capacity. Nonetheless, 2018 may prove to be the foundational year for offshore wind in the United States. On May 23, 2018, Massachusetts and Rhode Island selected bids for projects sized at 800 megawatts and 400 megawatts (respectively); three weeks later, Connecticut selected a bid for 200 megawatts of offshore wind capacity. These projects may be the first utility-scale American offshore wind farms.

Although the granular implementation details of each state’s offshore wind strategy vary, a confluence of factors, including the gradationally intensifying national interest in offshore wind, could mean that the American offshore wind industry may be poised to surge, particularly along the Atlantic Coast.

1 “Not In My Back Yard”

INTRODUCTION

RELATIVE TO EUROPE'S MATURE INDUSTRY, AMERICAN OFFSHORE WIND APPEARS POSITIVELY EMBRYONIC.

At the close of 2017, European offshore wind capacity totaled 15,780 megawatts (WindEurope, 2018). By contrast, America's present offshore wind capacity (the five turbines of the 30-megawatt, pilot-scale Block Island Wind Farm, located off of Rhode Island) comprises less than 0.003% of the United States' total utility-scale electricity generation capacity (1,081,509 megawatts, based upon March 2018 data) (U.S. Energy Information Administration, 2018).

Originally proposed in November 2001, Cape Wind, a 468-megawatt array planned for waters off Cape Cod, Massachusetts, was touted to be America's first offshore wind installation (Bureau of Ocean Energy Management, 2018a). However, after "relentless opposition from a mix of strange bedfellows"² drawn from across the American political spectrum, Cape Wind's developers essentially abandoned the project in 2015 (Eckhouse & Ryan, 2017). Cape Wind's offshore lease remains suspended at present, but the 2016 completion of the Block Island Wind Farm brought a glimmer of hope to the industry. Yet, as of June 2018, Block Island remains America's solitary offshore wind installation.

Nevertheless, it appears that the American offshore wind industry is steadily consolidating. Along with mounting state-level interest, offshore wind experts³ highlight several crucial elements that explain why offshore wind power along the Atlantic coast of the United States may be approaching critical mass in terms of utility-scale commercial viability. These factors include:

1. The abundant and consistent offshore wind resource;
2. Favorable seabed conditions;
3. Dramatically declining technology costs, as shown by decreasing European offshore wind project costs; and

4. Dense and ever-swelling coastal populations—which can increase demand and exacerbate land-use and transmission constraints, but also create attractive electricity markets favoring generation in close proximity to demand centers.

This report will first explore the federal regulatory framework and legal considerations that govern American offshore renewable energy projects. Next, it will examine state-level commitments to offshore wind by Massachusetts, Rhode Island, New York, New Jersey, and Maryland. The report closes by touching upon some initial activities occurring in other states, and offering some concluding observations.

The appendices are as follows: Appendix 1 illustrates the general areas along the Atlantic coast of the United States that might see wind project development in the coming years, and provides, for comparison, an average offshore wind speed map from the National Renewable Energy Laboratory. Appendix 2 presents, in spreadsheet format, the current status of U.S. Atlantic Coast offshore wind leasing. Appendix 3, drawing upon a similar figure in New York's Offshore Wind Policy Options paper, outlines various subsidy models that could be applied to offshore wind projects. The figures in Appendix 4 are collective representations of the data presented in Figures 6, 7, 8, 10, and 11.

² A colloquialism within the American offshore wind industry admonishes developers not to attempt to site offshore wind projects in locations visible from the "porches of the vacation homes" of both the Kennedys and the Koch Brothers.

³ Since February 2018, the author of this report has conducted ten interviews with stakeholders in the American and European offshore wind power industries. These include the Bureau of Ocean Energy Management; offshore wind developers (in both the United States and Europe); and government officials from Germany, Denmark, and Ireland.

FEDERAL FRAMEWORK FOR OFFSHORE DEVELOPMENT

ENABLING LEGISLATION

The Submerged Lands Act of 1953⁴ granted states title to the seafloor and natural resources within three nautical miles⁵ of their coastlines. Also enacted in 1953, the Outer Continental Shelf Lands Act,⁶ preserved federal jurisdiction over and ownership of all submerged lands and natural resources (including hydrocarbons, sand, gravel, and other minerals) located more than three nautical miles from shore. Approximately 50 years later, the Energy Policy Act of 2005 amended the Outer Continental Shelf Lands Act, and expanded the Secretary of the Interior's oversight responsibilities to include offshore renewable energy projects.⁷ In 2009, the Department of the Interior issued final regulations⁸ implementing its Renewable Energy Program. These regulations outline a framework for issuing leases, easements, and rights-of-way associated with offshore wind, ocean wave, and ocean current energy projects (Bureau of Ocean Energy Management, 2017b). Regulatory authority was later delegated to the Bureau of Ocean Energy Management (formerly known as the Minerals Management Service).

BUREAU OF OCEAN ENERGY MANAGEMENT

The Bureau of Ocean Energy Management (“BOEM”), a subsidiary bureau of the United States Department of the Interior, directly oversees development of renewable energy projects on the Outer Continental Shelf.⁹ BOEM is assisted in its regulatory oversight mission by the Bureau of Safety and Environmental Enforcement, “the lead federal agency charged with improving safety and ensuring environmental protection related to the offshore energy industry, primarily oil and gas, on the U.S. Outer Continental Shelf”¹⁰ (Bureau of Safety and Environmental Enforcement, 2018).

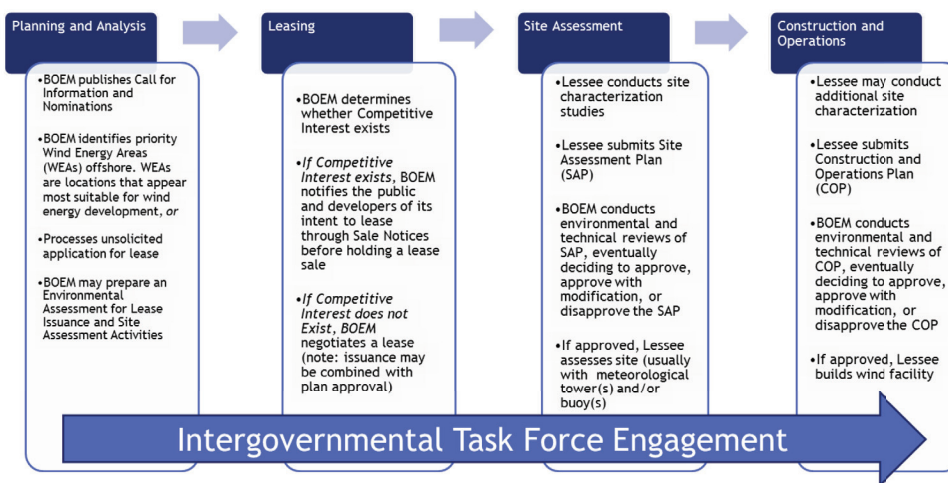


FIGURE 1: BOEM OFFSHORE WIND ENERGY COMMERCIAL LEASING PROCESS

(BOEM, 2017c)

4 43 U.S.C. § 1301, *et seq.*

5 For the Gulf Coasts of Texas and Florida, this distance is “three marine leagues” (about 9 nautical miles).

6 43 U.S.C. § 1331, *et seq.*

7 43 U.S.C. § 1337(p)(1)(C).

8 30 C.F.R. § 585.

9 See Appendix 1 for an illustration of areas of the Outer Continental Shelf along the Atlantic Coast that may see offshore wind development.

10 Prior to 2011, the Bureau of Ocean Energy Management and the Bureau of Safety and Environmental Enforcement formed a single combined entity called the “Bureau of Ocean Energy Management, Regulation and Enforcement.”

BOEM's offshore wind energy program proceeds in four phases: planning and analysis, leasing, site assessment, and construction and operations (BOEM, 2017c). The horizontal arrow across the bottom of Figure 1 denotes BOEM's continuous interaction, throughout all phases of the development process, with Intergovernmental Renewable Energy Task Forces.¹¹ The task forces serve as forums to coordinate planning, educate about BOEM's processes, and exchange scientific and other information (BOEM, 2018l). These task forces are intended to promote partnerships and facilitate the exchange of information between representatives from federally recognized tribes, federal agencies, states, and local governments. Task forces have helped identify Wind Energy Areas, and have "provided early identification of, and steps towards resolving, potential conflicts" (BOEM, 2017c).

In February 2018, BOEM published a report, entitled "Strengthening the Intergovernmental Renewable Energy Task Forces," which identifies the task forces as a "key mechanism" shaping BOEM's offshore renewable energy development process (BOEM, 2018l). This report also pinpoints five action items to further enhance task force efficacy:

- Strengthen task force dialogs to improve the quality and depth of discussions;
- Integrate regional perspectives into the state task forces;
- Customize post-leasing task forces by working with states;
- Enhance stakeholder engagement by building on and expanding the task force approach;
- Increase transparency of decision making (BOEM, 2018l).

BOEM's decision to incorporate regional perspectives into the state task forces may prove prescient. This is because offshore wind development activities in one state have "the potential to trigger concerns in neighboring states, from fishing and shipping impacts to view-shed considerations" (BOEM, 2018l). For that reason, as American offshore wind makes headway into the hitherto uncharted waters of constructing and

operating utility-scale installations, the Intergovernmental Renewable Energy Task Forces—and industry as a whole—must remain conscientious of the regional and multi-state impacts of offshore wind development.

PHASE ONE: PLANNING & ANALYSIS

During phase one, BOEM engages with the Intergovernmental Task Forces. One objective of this collaboration is to generally identify tracts¹² of the Outer Continental Shelf that may have offshore wind development potential. For leasing purposes (phase two), more refined "Wind Energy Areas" are designated. These are plots "that appear most suitable for commercial wind energy activities, while presenting the fewest apparent environmental and user conflicts" (BOEM, 2012).

Following the November 2010 launch of "Smart from the Start"—a coordinated Department of the Interior initiative designed to facilitate siting, leasing, and construction of offshore wind projects on the Atlantic Outer Continental Shelf—Wind Energy Areas were identified off the coasts of Maryland, Delaware, New Jersey, Virginia, Rhode Island, and Massachusetts (Office of the Secretary, 2010). Note that some Wind Energy Areas are further subdivided into multiple leasing areas.

In 2013, in furtherance of developing an auction process for offshore renewable energy lease sales, the National Renewable Energy Laboratory issued a series of studies analyzing various options for delineating non-overlapping leasing areas within each Wind Energy Area (Musial et al., 2013; Musial, Elliott et al., 2013; Musial, Elliott, Fields, Parker, & Scott, 2013; Musial, Parker et al., 2013). These reports concluded that the subdivision of Wind Energy Areas "provides ample development potential to allow for a commercial-scale project in each leasing area with a maximum potential for the greatest diversity of developers" (Musial et al., 2013). The rationale for partitionment is that the totality of a Wind Energy Area might be developed more rapidly if multiple developers work simultaneously on separate leases.

11 The following 14 states have BOEM task forces: California, Delaware, Florida, Hawaii, Maine, Maryland, Massachusetts, New Jersey, New York, North Carolina, Oregon, Rhode Island, South Carolina, and Virginia.

12 These general areas have various titles, including "Area for Consideration" or "Area of Mutual Interest" (the latter designation being used when more than one state expresses interest in a particular offshore parcel).



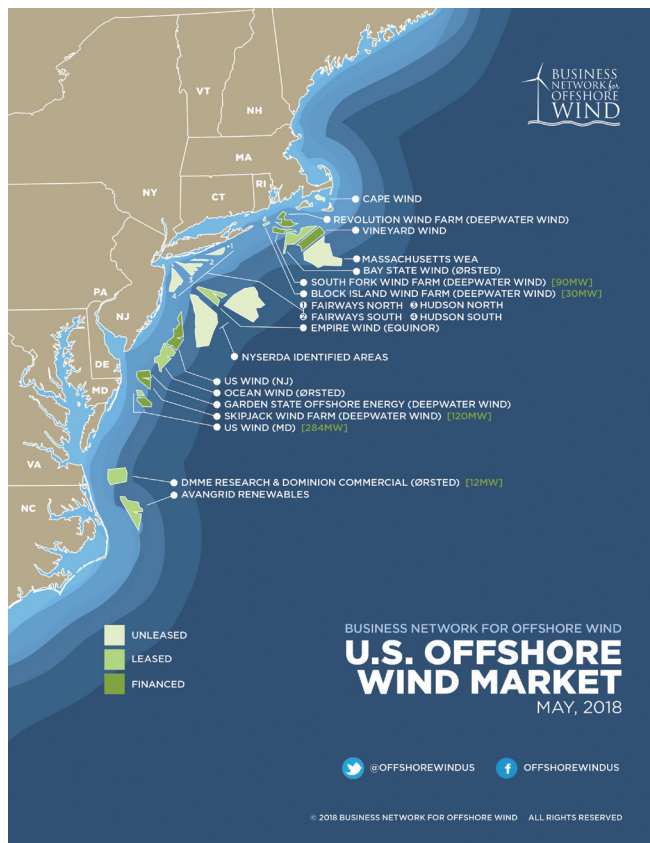


FIGURE 2: U.S. OFFSHORE WIND MARKET AS OF MAY 2018

(Business Network for Offshore Wind, 2018)

Figure 2 depicts the U.S. offshore wind market as of May 2018, and illustrates how Wind Energy Areas can be partitioned into smaller lease areas. For example, the New Jersey Wind Energy Area is made up of separate two lease areas, which are owned by Ørsted (this project is called Ocean Wind) and U.S. Wind, respectively. The Massachusetts Wind Energy Area is observed to be even further subdivided.

Figure 2 is perhaps best understood by cross-reference with Appendix 2. Appendix 2 exemplifies the intricate patchwork of leases and projects that make

up the current American offshore wind industry. This phenomenon is particularly pronounced in the Rhode Island/Massachusetts offshore area. There, Deepwater Wind—developer of the Block Island Wind Farm—holds lease OCS-A 0486. From that single (but nearly 100,000 acre) lease parcel: (1) the South Fork Wind Farm secured approval from the Long Island Power Authority for offtake of 90 megawatts (January 2017); (2) Rhode Island selected 400 megawatts from the Revolution Wind project for negotiation (May 23, 2018); and (3) Connecticut opted for 200 megawatts, also from Revolution Wind (June 13, 2018).

Similarly, on lease OCS-A 0500, an Ørsted/Eversource partnership has outlined future projects (Bay State Wind and Constitution Wind). Another interesting aspect is the fact that the Maryland Public Service Commission approved the Skipjack Wind Farm—sited on a lease (OCS-A 0482) that is considered part of the Delaware Wind Energy Area—for subsidy by Maryland ratepayers.

As part of phase one, BOEM released two environmental assessments: one for the Wind Energy Areas off of Maryland, Delaware, New Jersey, and Virginia, and a second pertaining to Rhode Island and Massachusetts (Bureau of Ocean Energy Management, 2013; Bureau of Ocean Energy Management, 2012). These assessments, required by the National Environmental Policy Act,¹³ analyze the environmental impact of lease issuance, site characterization (underwater surveys), and site assessment activities (installing equipment for measuring meteorological conditions). BOEM concluded that, for all Wind Energy Areas, leasing and related activities would have no significant environmental impact.

PHASE TWO: LEASING

During phase two, BOEM issues Outer Continental Shelf renewable energy leases. The program has proven successful, with more than 1.4 million offshore acres currently leased for wind energy development (NYSERDA, 2018a). Leases are awarded in accordance with the framework outlined in federal regulations.¹⁴ Crucially, these federal Outer Continental Shelf leases do not themselves confer construction rights; rather, the lease grants the lessee **only** the exclusive right to develop its plans and seek subsequent BOEM approval prior to commencing construction.¹⁵ Leases can be issued competitively or non-competitively.

BOEM initiates the competitive leasing process by publishing a public notice of Request for Interest in the Federal Register.¹⁶ The responses received allow BOEM to determine whether competitive interest exists with respect to the offshore parcel(s) in question. Once BOEM has determined that such interest does exist, it uses auctions to award leases on a competitive basis.¹⁷ Details for each auction are published in the Federal Register in the form of Proposed Sale Notices and Final Sale Notices. The

auctions proceed in one of several formats, including sealed bidding, ascending bidding, two-stage bidding, and multiple factor bidding.¹⁸ Minimum bids, and the bidding system to be utilized, are specified in the Proposed Sale Notice and Final Sale Notice.¹⁹

By contrast, the noncompetitive leasing process commences when a developer submits an unsolicited request to lease a portion of the Outer Continental Shelf.²⁰ BOEM considers these inquiries on a case-by-case basis, and must first assess whether competitive interest exists with respect to the lease area in question.²¹ If competitive interest does exist, BOEM adheres to the competitive leasing process outlined in the federal regulations.²² If, however, BOEM determines there is no competitive interest with respect to a particular parcel, it will publish a notice of Determination of No Competitive Interest in the Federal Register.²³ Under these circumstances, BOEM may decide to offer a developer a noncompetitive lease.²⁴

¹⁴ 30 C.F.R. § 585.

¹⁵ 30 C.F.R. § 585.200.

¹⁶ 30 C.F.R. § 585.210.

¹⁷ 30 C.F.R. § 585.211.

¹⁸ 30 C.F.R. § 585.220.

¹⁹ 30 C.F.R. § 585.221.

²⁰ 30 C.F.R. § 585.230. Also see Appendix 2. Two offshore wind developers submitted unsolicited requests to lease two discrete areas offshore Massachusetts. As a result, BOEM concluded that competitive interest exists with respect to the two parcels, and, in April 2018, announced that the two offshore areas in question would be auctioned (competitively leased).

²¹ 30 C.F.R. § 585.231(b).

²² 30 C.F.R. § 585.210–585.225.

²³ 30 C.F.R. § 585.231(c).

²⁴ 30 C.F.R. § 585.231(f).



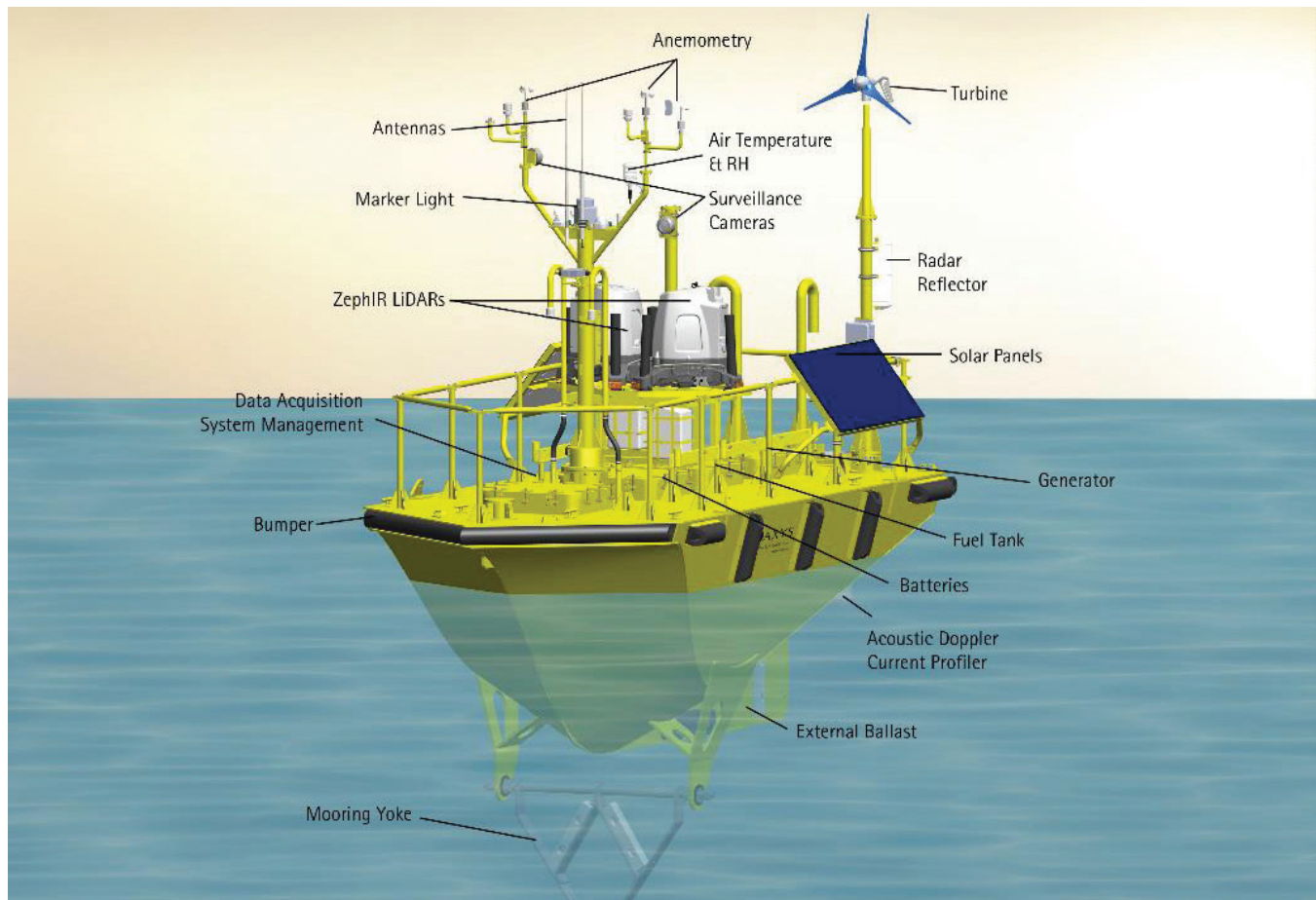


FIGURE 3: METOCEAN BUOY

(Bureau of Ocean Energy Management, 2018k)

PHASE THREE: SITE ASSESSMENT

After obtaining an Outer Continental Shelf lease, an offshore developer must submit, during phase three, a Site Assessment Plan for BOEM's approval. In this plan, the developer outlines the methodology and means by which it intends to assess the meteorological and oceanic (commonly referred to collectively as "metocean") conditions of the leased offshore parcel,²⁵ as well as data from physical characterization surveys (geological or hazards surveys) and baseline environmental surveys (biological or archaeological surveys). BOEM may approve, approve with modification, or disapprove a lessee's Site Assessment

Plan.²⁶ Assessment activities cannot commence until BOEM has approved the Site Assessment Plan.²⁷

After BOEM has authorized a Site Assessment Plan, site conditions for marine renewable energy projects are typically evaluated by deploying buoys and/or constructing an offshore tower. These sophisticated installations, adorned with thermometers, anemometers, sensors to measure wave height and direction, and barometric pressure gauges, provide developers with crucial information about metocean conditions within the leased parcel. Figure 3 is a computer-generated depiction of one type of metocean buoy.

²⁵ 30 C.F.R. § 585.605(a)(1).

²⁶ 30 C.F.R. § 585.613.

²⁷ 30 C.F.R. § 585.605(c).

PHASE FOUR: CONSTRUCTION & OPERATIONS

Phase four begins when an offshore wind developer submits a Construction and Operations Plan to BOEM. This detailed document sets forth the developer's construction, operations, and conceptual decommissioning plans, and must encompass all onshore and support facilities and anticipated easements.²⁸ BOEM conducts environmental and technical reviews of the Construction and Operations Plan, and, where necessary, solicits input from relevant federal, state, and local agencies and affected tribes.²⁹ As with the Site Assessment Plan, BOEM may approve, approve with modification, or disapprove a lessee's Construction and Operations Plan. Even after BOEM has approved the Construction and Operations Plan,³⁰ construction cannot commence until a facility design report, fabrication and installation report, and safety management system have been submitted.³¹

BOEM recognizes the “project complexity, the unpredictability of the environment in which [offshore wind projects] will be constructed, [and] the rapid pace of technological development” within the offshore wind industry (Bureau of Ocean Energy Management, 2018e). Thus, in January 2018, BOEM released draft guidance

regarding the use of a Project Design Envelope approach when submitting an offshore wind Construction and Operations Plan. The purpose of the Design Envelope approach is to grant developers flexibility to accommodate final design decisions—like the specific turbine model to be deployed—at more commercially advantageous times (later in the project development process), and to serve as a mechanism for phased offshore wind development.

Figure 4 aids in visualizing the overall timeline of the federal Outer Continental Shelf renewable energy development process. According to BOEM, the four phases are expected to last:

- Phase One: Planning and Analysis—two years
- Phase Two: Leasing—one to two years
- Phase Three: Site Assessment—five years
- Phase Four: Construction and Operations—two years (plus lease term)

By way of example, the Block Island Wind Farm, America's first—and, at present, only—operational offshore wind farm, was under development for more than eight years before it generated any electricity (Tabb, 2017).

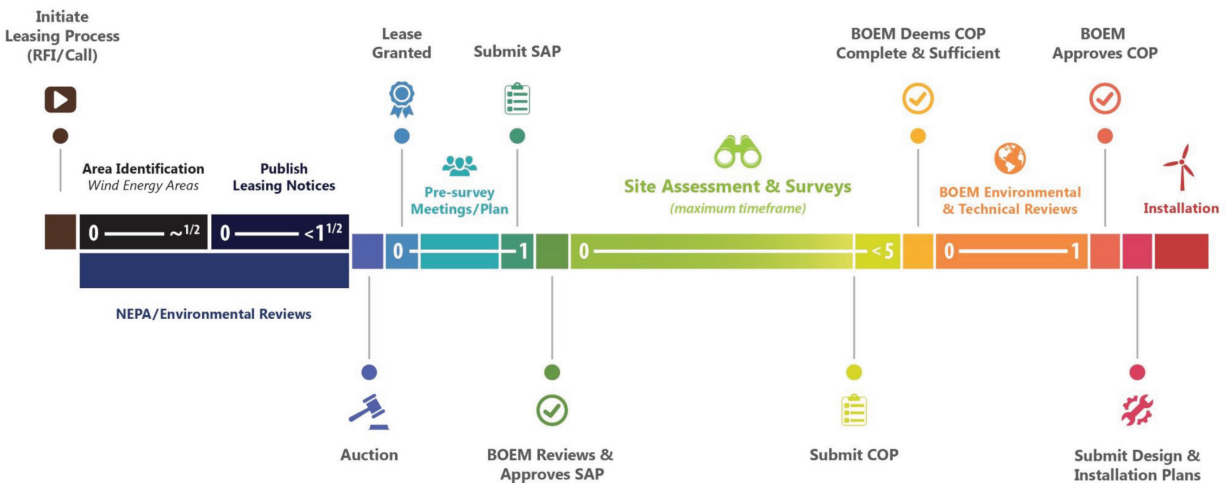


FIGURE 4: BOEM PROJECT DEVELOPMENT TIMELINE

(Feinberg, 2017)

28 30 C.F.R. § 585.620.

29 30 C.F.R. § 585.628.

30 30 C.F.R. § 585.628.

31 30 C.F.R. § 585.632.

In comparison, although development timelines for individual onshore wind projects vary,³² the American Wind Energy Association observes that onshore wind developers will “conduct wind resource assessment, siting and permitting, and transmission studies over a period of several years” (American Wind Energy Association, 2017). Infinity Renewables, a developer of American wind projects, estimates that onshore wind construction takes 8 to 18 months, depending on project size and seasonal conditions (Infinity Renewables, 2018).

The purpose of the Design Envelope approach is to grant developers flexibility to accommodate final design decisions—like the specific turbine model to be deployed—at more commercially advantageous times (later in the project development process), and to serve as a mechanism for phased offshore wind development.

32 The majority of onshore wind projects in the United States are sited on land leased from private owners, while offshore wind leases in federal waters must be obtained from BOEM.

OTHER FEDERAL AGENCIES IN OFFSHORE WIND DEVELOPMENT



Block Island Wind Farm by Val Stori, Clean Energy Group (Flickr)

Although BOEM is primarily responsible for regulating and managing the nation's offshore renewable energy resources (with assistance from the Bureau of Safety and Environmental Enforcement), other federal entities are involved in American offshore wind development. For instance, the 2016 National Offshore Wind Strategy report was the product of a collaborative effort between the U.S. Department of Energy ("DOE") and U.S. Department of the Interior (U.S. Department of Energy & U.S. Department of the Interior, 2016).

The stated objective of the Department of Energy with respect to offshore wind is to "reduce the levelized cost of energy through technological advancement to compete with local electricity costs" (U.S. Department of Energy & U.S. Department of the Interior, 2016). To that end, DOE's Wind Energy Technology Office

has "allocated about \$200 million since 2011 for competitively-selected offshore wind research, development, and demonstration projects" (U.S. Department of Energy, 2018c). The research focuses on technology development,³³ market acceleration,³⁴ and advanced technology demonstration.³⁵ The Department of Energy is also investigating how to make offshore wind turbines more resilient to hurricanes (U.S. Department of Energy, 2018e).

Other federal agencies that may be involved in American offshore wind projects include the Army Corps of Engineers, U.S. Coast Guard, National Oceanic and Atmospheric Administration, U.S. Department of Defense, Federal Aviation Administration, and the National Park Service (U.S. Department of Energy & U.S. Department of the Interior, 2016).

³³ This category of research is intended to "develop the engineering modeling and analysis tools required to lower overall offshore facility costs and to design the next generation of innovative large-scale turbines optimized for installation and operation in the marine environment" (U.S. Department of Energy, 2018d).

³⁴ This research, which examines offshore wind supply chain-related issues, is "aimed at understanding and mitigating market barriers to the development of the U.S. offshore wind market" (U.S. Department of Energy, 2018b).

³⁵ These demonstration projects "will help address key challenges associated with installing full-scale offshore wind turbines, connecting offshore turbines to the power grid, and navigating new permitting and approval processes" (U.S. Department of Energy, 2018a).

THE JONES ACT

The Merchant Marine Act of 1920 also impacts the offshore wind development process. Commonly called the Jones Act, this cabotage law³⁶ guarantees U.S. citizen participation in domestic coastwise maritime trade by limiting competition from foreign shipyards and merchant vessels (Sohn & Lewkowicz, 2018). This is accomplished by requiring vessels carrying merchandise between U.S. ports to be: (1) owned by U.S. companies controlled by U.S. citizens, with at least 75% U.S. ownership; (2) at least 75% crewed by U.S. citizens; (3) built (or rebuilt) in the United States; and (4) registered in the United States (Transportation Institute, 2018).³⁷



FIGURE 5: HEAVY-LIFT JACK-UP VESSEL IN OPERATION

(Krabbendam, 2017)

Under the Jones Act, “merchandise” includes “goods, wares and chattels of every description” and “valueless material.”³⁸ Offshore wind turbine and foundation components fall within the Jones Act’s broad definition of merchandise. Once “permanently or temporarily affixed to the seabed,” an offshore wind turbine monopile³⁹ is considered, under the Jones Act, the equivalent of a U.S. port (Sohn & Lewkowicz, 2018). The Jones Act thus prohibits a foreign-flagged heavy-lift jack-up vessel from itself transporting offshore wind

turbine and foundation components from a U.S. port to the offshore installation site. At present, the United States possesses no Jones Act-compliant heavy-lift jack-up vessels, which are necessary to install offshore wind turbines.

The domestic lack of heavy-lift jack-up vessels is not insurmountable. In 2010, U.S. Customs and Border Protection, the agency responsible for Jones Act enforcement, ruled that the utilization of a stationary foreign-flagged heavy-lift jack-up vessel to drive “a monopile foundation into the seabed and then [add] a platform deck, anemometer tower, and other components” does not violate the Jones Act (U.S. Customs and Border Protection, 2010).

In 2016, the Block Island Wind Farm successfully employed this work-around strategy. A foreign-flagged vessel, the *Brave Tern*, transported five turbine nacelles from Europe, across the Atlantic Ocean, and directly to the installation site off the coast of Block Island (without making an interim stop at any U.S. port of call). U.S.-flagged vessels then ferried tower sections and blades to the offshore installation site from nearby Newport, Rhode Island. Consistent with the 2010 Customs and Border Protection ruling, the *Brave Tern*’s transferring and assembling the tower sections and blades via crane does not constitute “transportation” within the ambit of the Jones Act.

Although this protocol was successful for the pilot-scale (30-megawatt) Block Island project, Sohn and Lewkowicz note that “[b]y some estimates, the use of foreign-installation vessels may increase project costs by as much as \$20 to 40 million for a 100-turbine development” (Sohn & Lewkowicz, 2018). They propose several alternatives, which range from amending the Jones Act to include a waiver for renewable energy projects, to, in the longer term, constructing Jones

³⁶ 47 nations have cabotage laws, which, generally speaking, restrict foreign access to domestic trade (Transportation Institute, 2018).

³⁷ See also, 46 U.S.C. § 55102.

³⁸ 19 U.S.C. § 1401(c).

³⁹ A monopile is one type of offshore wind turbine foundation.

Act-compliant heavy-lift jack-up vessels. Other market observers espouse similar positions, and identify the Jones Act as “the largest barrier to accelerating growth” in U.S. offshore wind (Hill, 2018).

Projected growth in the pipeline of U.S. offshore wind projects is expected to trigger construction of Jones Act-compliant vessels. In June 2017, a partnership of Zentech, Inc. and Renewable Resources International unveiled plans for the first Jones Act-compliant heavy-lift jack-up vessel (*OffshoreWIND.biz*, 2017). Delivery of that vessel is expected “no later than fourth quarter of 2018” (MarineLog, 2017). As of August 2018, no announcement has been made regarding completion of such a vessel.

The Jones Act prohibits a foreign-flagged heavy-lift jack-up vessel from itself transporting offshore wind turbine and foundation components from a U.S. port to the offshore installation site. At present, the United States possesses no Jones Act-compliant heavy-lift jack-up vessels, which are necessary to install offshore wind turbines.

FEDERAL TAX INCENTIVES, LEGISLATION, AND SUPPORT

Federal tax incentives, like the Renewable Electricity Production Tax Credit (“Production Tax Credit”) and the Business Energy Investment Tax Credit (“Investment Tax Credit”), have contributed to growth in domestic renewable energy technologies, like solar and onshore wind (U.S. Department of Energy, 2016). The Production and Investment Tax Credits are after-tax, dollar-for-dollar incentives (Schwabe, Feldman, Fields, & Settle, 2017).

The Production Tax Credit⁴⁰ is an inflation-adjusted, per-kilowatt-hour federal tax credit available to facilities using qualified energy resources.⁴¹ Installations harnessing wind (on- and offshore) and marine and hydrokinetic⁴² renewable energy qualify for this incentive.⁴³ One potential disadvantage of the Production Tax Credit—compared to the Investment Tax Credit—is its volumetric nature. Because the magnitude of the Production Tax Credit is positively correlated to the quantity of electricity a facility produces, it could be argued that this incentive scheme amounts to doubling-down on risk. In other words, both commodity revenues⁴⁴ and tax credits will decrease if a project taking the Production Tax Credit has a lower-than-expected output.

By contrast, the Investment Tax Credit is a 30% federal tax credit tied to the dollar amount of the energy investment in question.⁴⁵ Some view one-time incentives—like the Investment Tax Credit—as preferable, particularly in intricate tax equity transactions (Davis & Maron, 2017). However, large wind generation projects, though eligible for both incentive schemes, typically opt for the Production Tax Credit. This may be because, historically, the combined benefit of the Production Tax Credit and accelerated depreciation

(see footnote 46) have afforded tax savings in excess of 50% of a project’s initial capital costs (Bolinger, 2014).

The federal tax reform bill passed in December 2017 largely preserved the Production and Investment Tax Credits (Plumer, 2017). An analysis of the “Tax Cuts and Jobs Act of 2017” by law firm Nixon Peabody noted that most changes to renewable energy tax credits are “due to the incidental effects of changed depreciation rules,^[46] or new rules regarding the deduction of interest” (Milder, 2018). After adjusting for inflation, the 2018 Production Tax Credit is valued at \$0.024 per kilowatt-hour.

The 2017 tax legislation did preserve the planned step-down of both tax credits, with the Production Tax Credit and Investment Tax Credit ending in 2020 and 2022, respectively (Alta Energy, 2018). Nonetheless, some observers argue that developing a robust and efficient U.S. offshore wind supply chain could trigger project cost declines sufficient to offset the low-cost tax equity financing that will be lost upon the expiration of the Production and Investment Tax Credits (Lillian, 2018).

In response to the planned phase-outs of the federal tax credits, two pieces of federal legislation have been introduced. The Offshore Wind Incentives for New Development Act, if adopted, would extend the Investment Tax Credit to all offshore wind projects commencing construction before January 1, 2026 (Markey & Whitehouse, 2017). Sponsor Senator Edward J. Markey (D-Mass.) has stated that this legislation provides the nascent U.S. offshore wind industry “the long-term certainty in the tax code that it needs” (Markey, 2017).

40 26 U.S.C. § 45(a).

41 “Qualified energy resources” include wind, closed-loop biomass, open-loop biomass, geothermal energy, solar energy, small irrigation power, municipal solid waste, qualified hydropower production, and marine and hydrokinetic renewable energy. 26 U.S.C. § 45(c)(1).

42 For the purposes of the Production Tax Credit, the Internal Revenue Code defines marine and hydrokinetic energy as energy derived from waves, tides, and currents in oceans, estuaries, and tidal areas; free flowing water in rivers, lakes, and streams; free flowing water in irrigation systems or canals; or differentials in ocean temperature (i.e. ocean thermal energy conversion). 26 U.S.C. § 45(c)(10)(a).

43 26 U.S.C. § 45(c)(1).

44 Depending on the procurement scheme, revenues could include income from sales of Renewable Energy Credits, generation capacity, and commodity electricity. See, e.g., Appendix 3, outlining New York State’s offshore wind procurement options.

45 26 U.S.C. § 48(2)(a).

46 Wind generation projects also benefit from the Modified Accelerated Cost Recovery System, which provides accelerated depreciation tax offsets (Schwabe, Feldman, Fields, & Settle, 2017). This is considered a before-tax incentive, as it provides a reduction in taxable income.

Another bill, the bipartisan⁴⁷ Incentivizing Offshore Wind Power Act, employs a different structure, proposing that the Investment Tax Credit be extended to the first 3,000 megawatts of qualifying offshore wind facilities placed into service (Carper & Collins, 2017a; U.S. Senate Committee on Environment and Public Works, 2017). According to the bill's sponsors, Senators Tom Carper (D-Del.) and Susan Collins (R-Maine), linking the allocation of the Investment Tax Credit to a capacity quota (rather than a fixed date) accounts for "the longer start-up time for offshore wind facilities as compared to onshore wind facilities" (Carper & Collins, 2017b). At best, these pieces of federal legislation have an uncertain future.

To date, the Trump Administration has appeared indisposed to promote policies supporting renewable energy, but offshore wind seems to be the exception. In May 2016, the United States and Denmark entered into a Memorandum of Understanding intended to "promote mutually beneficial cooperation in the field of offshore wind energy" (Government of the Kingdom of

Denmark & Government of the United States of America, 2016). Denmark—ranked third worldwide in offshore wind behind the United Kingdom and Germany—had 1,266 megawatts of installed offshore wind capacity at the end of 2017 (WindEurope, 2018). Although it was the Obama Administration that entered into this Memorandum of Understanding with Denmark, offshore wind engagement between the two nations has continued under the Trump Administration.

In April 2018, Secretary of the Interior Ryan Zinke announced the proposed sale of two additional offshore wind lease areas in waters off Massachusetts. In fact, Secretary Zinke stated that the responsible development of offshore wind projects within the proposed Massachusetts lease areas will "play a big role in the Administration's America-First Offshore Energy Strategy" (U.S. Department of the Interior, 2018).

47 Sponsored by Senators Carper and Collins, and supported by Senators from Delaware, Hawaii, Maryland, New York, and Ohio, and both Senators from Maine, Massachusetts, New Jersey, and Rhode Island.



OFFSHORE WIND'S FEDERALISM IMPLICATIONS

In *Federalist Paper* No. 39, published in 1788, James Madison reasoned that the American federal and state governments are to be considered “coequal bodies politic” occupying “distinct and independent portions of the supremacy” that constitutes American democracy. This axiomatic dogma, commonly referred to as “federalism,” is enshrined within American jurisprudence to this day. “Cooperative federalism”⁴⁸ is a related concept often encountered in American energy and environmental policy; it refers to regulatory environments in which the various levels of government (local, state, and federal) share regulatory responsibilities, and cooperate in achieving unified goals (Wisemann, 2018). The unique and idiosyncratic nature of offshore wind projects, which are subject to regulation by local, state, and federal authorities, presents an ideal case study of American federalism in practice.

Although the electricity-generating components (the turbines themselves) of an offshore wind farm may be sited on the federally-owned Outer Continental Shelf, the investment will never be profitable if electricity cannot be delivered to the onshore grid. It is expected that the transmission infrastructure for the majority of American offshore wind projects will need to traverse state coastal zones (NYSERDA, 2018b). Among other considerations, this unavoidable geographic circumstance may explain BOEM's recent recommitment to optimizing Intergovernmental Renewable Energy Task Force engagement. See the “Federal Framework” section. Given their intergovernmental design, these task forces could reasonably be viewed as the “trenches” or “front lines” of cooperative federalism in the offshore wind context.

Beyond merely serving as a conduit through which electricity generated offshore is physically delivered to serve onshore load, state involvement is critical

to offshore wind project development. Once the electricity—after traversing state waters—is delivered onshore, it must be safely injected⁴⁹ into the grid infrastructure, in compliance with the regulatory framework of the state and/or regional transmission organization/independent system operator (“RTO”/“ISO”) in which the injection occurs.

Moreover, setting aside the aforementioned federal tax incentives, many renewable energy subsidies (such as renewable portfolio standards and associated renewable energy credits/certificates)⁵⁰ are wholly driven at the state level. Although renewable energy subsidy schemes and procurement frameworks are generally enacted by way of state legislation, state public utility commissions must also promulgate rules and regulations to implement the legislation. These subsidies, regulatory environments, and related energy policies can vary considerably from state to state—an inevitable product of federalism, perhaps. Thus, although BOEM has exclusive control over federal offshore renewable energy leasing, a lack of decisive and consistent state-level support for offshore wind would likely paralyze the American industry.

Finally, offshore wind projects affect local stakeholders, and these impacts must not be overlooked. These include visibility concerns, which can generate significant and vitriolic opposition (à la Cape Wind), and local zoning issues (the landfall location of the export cable, siting the onshore components of the offshore wind farm). Economic considerations implicate tourism, local port redevelopment, and access to fishing grounds, and the latter two can have concomitant significance on the state level.

⁴⁸ Sometimes referred to as “marble cake federalism,” because these regulatory frameworks tend to blur the delineations between the several levels of government.

⁴⁹ This is no small feat at the scales proposed (up to 2,400 megawatts in New York State, and up to 3,500 megawatts in New Jersey).

⁵⁰ See footnote 59.

STATE-LEVEL DEVELOPMENTS IN OFFSHORE WIND

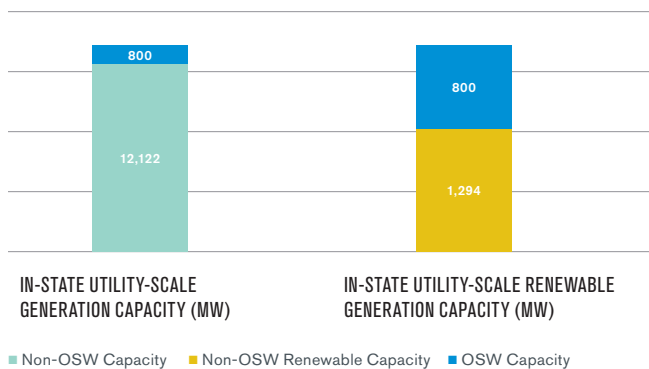
MASSACHUSETTS & RHODE ISLAND

As mentioned in the introductory section of this report, the Cape Wind project, slated to be America's first offshore wind project, was ultimately scuttled after more than a decade of continual opposition. Undeterred, Massachusetts pressed on, with unmistakable results. Scarcely three years after the final capitulation of Cape Wind's developers, the Commonwealth has helped firmly establish the initial foundation of the utility-scale American offshore wind industry.

On May 23, 2018, Massachusetts selected Vineyard Wind to negotiate a contract with state utilities for an 800-megawatt offshore wind farm (Massachusetts Clean Energy, 2018d). As of March 2018, Massachusetts had a net summer capacity (for all utility-scale assets) of 12,122 megawatts (U.S. Energy Information Administration, 2018). Using these capacity figures, the output of the Vineyard Wind project would itself represent just over 6% of the Commonwealth's overall electricity generation capacity. In terms of Massachusetts' March 2018 total renewable capacity (1,294 megawatts), Vineyard Wind would comprise approximately 38% (U.S. Energy Information Administration, 2018). Figure 6 graphically represents these amounts.

FIGURE 6: OFFSHORE WIND COMPARED TO MASSACHUSETTS' UTILITY-SCALE GENERATION CAPACITY AND RENEWABLE CAPACITY

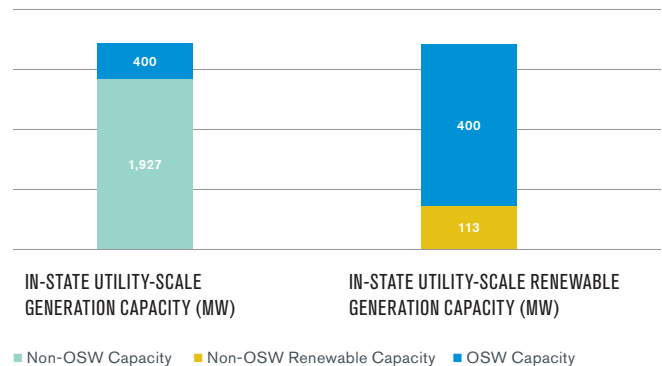
(U.S. Energy Information Administration, 2018)



Also on May 23, 2018, Rhode Island—home to Deepwater Wind's Block Island Wind Farm—announced that Deepwater was selected to negotiate a contract for the 400-megawatt Revolution Wind project (McDermott, 2018). This capacity addition dramatically impacts Rhode Island's modest generation fleet, which, in March 2018, had a net summer capacity of just 1,927 megawatts (U.S. Energy Information Administration, 2018). As a result, Revolution Wind would constitute about 17% of Rhode Island's overall utility-scale generation capacity. However, the completion of the Deepwater project would nearly quadruple Rhode Island's total utility-scale renewable generation capacity (113 megawatts) as of March 2018 (U.S. Energy Information Administration, 2018). The addition of this offshore wind capacity to Rhode Island's generation mix can be seen in Figure 7.

FIGURE 7: OFFSHORE WIND COMPARED TO RHODE ISLAND'S UTILITY-SCALE GENERATION CAPACITY AND RENEWABLE CAPACITY

(U.S. Energy Information Administration, 2018)



May 23, 2018 may well prove historic for the American offshore wind industry. But, refocusing upon Massachusetts, one fact is particularly intriguing: as Cape Wind languished in Nantucket Sound, the Commonwealth simultaneously set itself on the path leading to the momentous May 2018 selection of the Vineyard Wind project.

In 2016, Massachusetts Governor Charlie Baker (R) signed Massachusetts Bill H.4568, “An Act to Promote Energy Diversity,” into law (190th General Court of the Commonwealth of Massachusetts, 2016). Section 83C outlines Massachusetts’ framework for offshore wind procurement, regulation, and policy. The Commonwealth intends to enter into long-term contracts for 1,600 megawatts of aggregate offshore wind nameplate capacity by 2027. The legislation prohibits deployment of offshore wind turbines within 10 miles of any “inhabited area,” and encourages the pairing of offshore wind with energy storage technology (Dempsey, Downing, Golden, Jones, & Tarr, 2016). This 10-mile buffer zone requirement excluded Cape Wind from consideration for procurement under this legislation (Seelye, 2017).

Thereafter, on June 29, 2017, in coordination with the Massachusetts Department of Energy Resources, Massachusetts utilities⁵¹ issued a request for proposals for long-term power purchase agreements with offshore wind energy projects. This RFP sought to procure a minimum of 400 megawatts of offshore wind capacity (Massachusetts Clean Energy, 2018c). 400-megawatt individual proposals⁵² were required, but supplemental proposals, between 200 and 800 megawatts, were considered. Bids were required to include proposals for integrated storage (to address the intermittency of offshore wind generation), and for build-out of transmission infrastructure.⁵³ To achieve 1,600 megawatts of offshore wind capacity by 2027, subsequent solicitations will be issued every 24 months (Massachusetts Clean Energy, 2018c).

Vineyard Wind⁵⁴ made two proposals, scaled at 400 megawatts and 800 megawatts, with an expandable offshore transmission facility that could potentially transmit a total of 1,600 megawatts (Massachusetts Clean Energy, 2018a). Vineyard Wind’s proposal promises a \$1 million annual investment for 15 years into distributed battery energy storage systems in local Cape Cod and Island—Martha’s Vineyard and Nantucket—

communities (Vineyard Wind, 2018). Vineyard Wind intends to base its construction activities at the New Bedford Marine Commerce Terminal; it projects the creation of approximately 3,600 jobs during the construction phase, and 2,000 jobs over the 25-year operational life of the project (Massachusetts Clean Energy, 2018a). On July 31, 2018, Vineyard Wind and Massachusetts utilities filed power purchase agreements with the Massachusetts Department of Public Utilities stating the 20-year average cost of electricity from the Vineyard Wind project is \$84.23 per megawatt-hour (in levelized nominal dollar terms). This translates to a levelized net present value price (in 2017 dollars) of \$64.97 per megawatt-hour. The Department of Public Utilities must now review and approve these contracts.

New Bedford, Massachusetts is a quintessential New England fishing community and formerly one of the most important whaling ports in the world—the opening of Herman Melville’s *Moby-Dick* is set in New Bedford. The city, owing to the collapse of whale and cod populations, has a history of economic adversity; this was exacerbated by the 2008 economic recession (Revitalization News, 2017). As a result, New Bedford now eyes offshore wind as one facet of its diversified revitalization strategy. The New Bedford Marine Commerce Terminal, the construction of which is being overseen by the Massachusetts Clean Energy Center, has been advertised as the “first [port] facility in the nation designed to support the construction, assembly, and deployment of offshore wind projects” (New Bedford Harbor Development Commission, 2017). The city of New Bedford has already invested approximately \$113 million into the facility (Storow, 2017).

Finally, as noted previously, in April 2018, the Trump Administration proposed the sale of two additional lease areas in the Massachusetts Wind Energy Area, totaling 390,000 acres, for offshore wind development (U.S. Department of the Interior, 2018).

51 In Massachusetts, electricity distribution companies are defined as entities “engaging in the distribution of electricity or owning, operating or controlling distribution facility; provided, however, that a distribution company shall not include any entity which owns or operates plant or equipment used to produce electricity.” (Massachusetts General Laws, chapter 164). Copies of the bidding documents can be viewed at MAcleanenergy.com.

52 Copies of the bidding documents can be viewed at MAcleanenergy.com.

53 Proposals were required to address the construction of (1) a generator lead line intended to deliver power generated by a single offshore wind installation (sometimes called “direct radial”), and, alternatively, (2) an expandable offshore transmission network providing nondiscriminatory access for multiple future offshore wind facilities.

54 This project is a joint venture of Copenhagen Infrastructure Partners and Avangrid.

NEW YORK

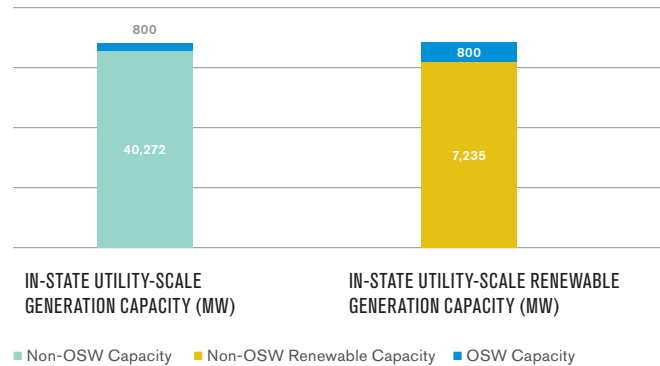
In 2015, New York State released its Clean Energy Plan, which, among other things, inaugurated a state-level goal to procure 50% of New York’s electricity from renewable sources by 2030 (the “50 by 30 mandate”) (NYSERDA, 2015). By Order dated August 1, 2016, the New York Public Service Commission, in adopting the terms of the Clean Energy Plan, created the Clean Energy Standard (State of New York Public Service Commission, 2016). The Clean Energy Standard obligates in-state load serving entities to comply with the 50 by 30 mandate. New York State Governor Andrew Cuomo (D) has promoted the Clean Energy Standard as a provident means of transitioning New York State to cleaner energy sources.

Governor Cuomo’s 2017 State of the State Address announced a then nation-leading pledge to develop 2,400 megawatts of offshore wind power capacity by 2030—enough to supply the electricity needs of 1.2 million New York homes (Governor Andrew M. Cuomo, 2017a; Governor Andrew M. Cuomo, 2017b).⁵⁵ One year later, during the 2018 State of the State Address, Governor Cuomo strengthened this commitment. He called for two solicitations, aimed at procuring (in the aggregate) not less than 800 megawatts of offshore wind capacity; these solicitations will take place during 2018 and 2019 (Governor Andrew M. Cuomo, 2018). Cuomo also directed the New York State Energy Research and Development Authority to invest \$15 million in offshore wind-related workforce and infrastructure development.

Using March 2018 data, this 800-megawatt initial offshore wind procurement would represent about 2% of New York State’s overall utility-scale generation capacity (40,272 megawatts), but nearly 10% of the state’s total utility-scale renewables capacity (7,235 megawatts) (U.S. Energy Information Administration, 2018). Figure 8 illustrates this capacity addition.

FIGURE 8: OFFSHORE WIND COMPARED TO NEW YORK’S UTILITY-SCALE GENERATION CAPACITY AND RENEWABLE CAPACITY

(U.S. Energy Information Administration, 2018)



In January 2018, the New York State Energy Research and Development Authority (“NYSERDA”) released the New York State Offshore Wind Master Plan, which integrates more than two years of research, including 20 supporting studies drawn from wide-ranging disciplines.⁵⁶ According to NYSEDA, New York’s Master Plan is “the most comprehensive offshore wind planning process to be undertaken by any state” (NYSERDA, 2018b).

The Master Plan cites two primary advantages to New York offshore wind development. First, offshore wind can potentially supply “abundant clean energy where New York’s energy system is most strained—New York City and Long Island” (NYSERDA, 2018b). Second, New York expects that offshore wind will boost the state’s economy (to the tune of \$6 billion of in-state expenditures). This projection is based upon the potential of offshore wind to: revitalize maritime communities,⁵⁷ trigger infrastructure investments, and create approximately 5,000 jobs in New York State. Other benefits identified in the Master Plan include reduction of greenhouse gas emissions, and improvements to local air quality in highly populated areas (like New York City).

As a result of the fieldwork, analysis, and stakeholder outreach conducted in support of the Master Plan, in

⁵⁵ By some estimates, New York State possesses approximately 39,000 megawatts of accessible offshore wind energy, which could power up to 15 million homes (NYSERDA, 2018a).

⁵⁶ These reports address “a wide range of topics related to siting, regulatory, wildlife, commercial, economic, and other important considerations” (NYSERDA, 2018b).

⁵⁷ New York Harbor, the Hudson River, and Long Island make up New York’s three distinct coastal geographies.

October 2017, New York State requested that BOEM identify an Area for Consideration⁵⁸ for potential offshore wind development in the New York Bight, a shallow area of the Atlantic Ocean between Long Island (to the north and east) and New Jersey (to the south and west) (NYSERDA, 2017). New York State further requested that BOEM delineate, within the Area for Consideration, at least four new Wind Energy Areas, each capable of supporting at least 800 megawatts of offshore wind. Thereafter, on April 11, 2018, BOEM published a Call for Information and Nominations seeking developer interest in commercial offshore wind energy leases within four proposed areas in the New York Bight. These areas are entitled Fairways North, Fairways South, Hudson North, and Hudson South (the “Call Areas”) (BOEM, 2018i). These call areas together comprise more than 1.7 million acres.

In January 2018, contemporaneously with the release of the Master Plan, NYSERDA filed an Offshore Wind Policy Options Paper with the New York Public Service Commission. Intended to serve as a companion document to the Master Plan, the Policy Options Paper considers the advantages and disadvantages of the different procurement and offtake contracting mechanisms that could be used to achieve New York State’s goal of 2,400 megawatts of offshore wind capacity by 2030. The stated purpose of the Policy Options Paper is to develop an approach that balances “the scale, pace and design of procurements needed to rapidly drive down offshore wind cost in the long run, while seeking to minimize the cost to ratepayers of achieving these objectives” (NYSERDA, 2018c).

The Policy Options Paper opines that the greenhouse gas reduction benefits of New York offshore wind deployment—with an estimated net present value of \$1.9 billion —“could justify the costs of the State’s commitment to [2,400 megawatts] of offshore wind, even before accounting for other anticipated benefits” (NYSERDA, 2018c). It also predicts that, by 2030, New

York’s 2,400-megawatt goal, combined with similar-scale commitments to offshore wind by neighboring states, will result in economies of scale. NYSERDA expects this outcome to drive offshore wind procurement costs lower than the cost of renewable energy credits (“RECs”)⁵⁹ associated with other large-scale renewable technologies in New York State.

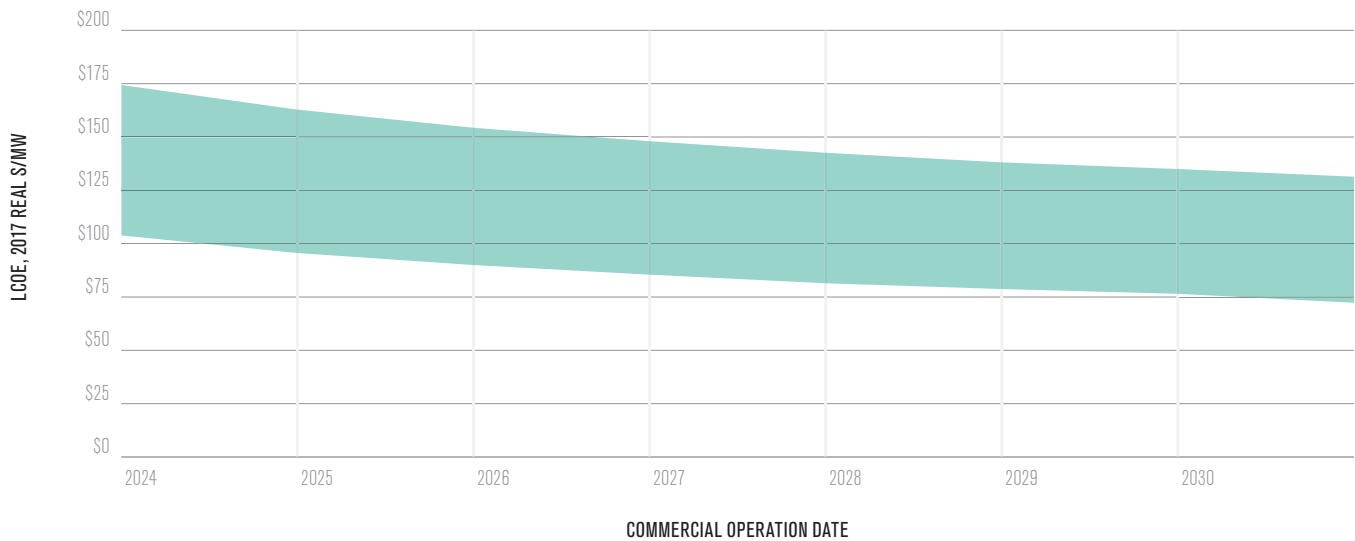
The Policy Options Paper identifies seven different offshore wind subsidy schemes or procurement mechanisms. These schemes vary considerably, both in terms of the level of involvement required by utilities and NYSERDA, and their respective hedging benefits (or lack thereof) against uncertain future commodity prices. Appendix 3 provides a helpful framework for conceptualizing the relative advantages and disadvantages of each procurement option that New York is presently considering.

In addressing procurement, ownership, and operation of the transmission/interconnection assets needed for offshore wind projects, the Policy Options Paper outlines three discrete models—developer ownership, independent ownership, and a regulated asset structure (NYSERDA, 2018c). In the developer ownership model, offshore wind generation and transmission/interconnection assets are bid and procured in a single solicitation; the winning bidder would own and operate all assets. In an independent ownership scheme, separate procurements are conducted for generation assets and for transmission/interconnection assets; it is possible that one entity could win both procurements, and could own and operate all assets. Finally, under a regulated asset structure, the transmission/interconnection assets would be utility-owned and rate-based (NYSERDA, 2018c).

Another consideration involves deciding whether to build the offshore transmission/interconnection assets in “direct radial” configuration, or as a “backbone” network. The former is a transmission line that connects one offshore wind facility to the grid. The latter is “either expandable or sized to accommodate both initial and subsequently built” offshore wind facilities (NYSERDA, 2018c). While

⁵⁸ See footnote 12.

⁵⁹ Renewable energy credits—also called renewable energy certificates, green certificates, green tags, or tradable renewable certificates—often referred to as “RECs,” are one type of state-level subsidy to renewable energy generation projects. A REC “is a market-based instrument that represents the property rights to the environmental, social and other non-power attributes of renewable electricity generation. RECs are issued when one megawatt-hour of electricity is generated and delivered to the electricity grid from a renewable energy source” (U.S. Environmental Protection Agency, 2018). RECs are sold separately from the commodity electricity that is generated by a renewable energy asset. New Jersey and Maryland have offshore renewable energy credits/certificates, or “ORECs,” for offshore wind projects, and ORECs are one option being considered by New York.



(NYSERDA, 2018c)

FIGURE 9: ANTICIPATED COST TRAJECTORY FOR NEW YORK STATE OFFSHORE WIND

recognizing that New York's Phase 1 offshore wind projects⁶⁰ will likely be served by direct radial transmission lines, NYSERDA specifically encourages development of an offshore transmission backbone network (NYSERDA, 2018c).

The Policy Options Paper also forecasts offshore wind farm cost trajectories. New York State envisages that "activities to drive market scale, market visibility, scale economies, construction, operating and financing experience, development of local supply chains, and competition" will precipitate cost declines for future offshore wind projects (NYSERDA, 2018c). Assuming these circumstances transpire as predicted, the levelized cost of electricity for New York State offshore wind projects is expected to trend downwards through 2030, as illustrated in Figure 9.

New York State is already seeing some propitious developments in its offshore wind space. The Long Island Power Authority approved a power purchase agreement for the entire output of the 90-megawatt South Fork Wind Farm⁶¹ (NYSERDA, 2017). In October 2017, BOEM approved the Site Assessment Plan for the lease parcel on which South Fork will be situated, meaning that this project is currently in phase three of the federal Outer Continental Shelf renewable energy development process (see Figures 1, 4; see also Appendix 2). Additionally, in April 2017, Norwegian state energy firm, Equinor (formerly Statoil),⁶² executed an Outer Continental Shelf lease with BOEM (NYSERDA, 2018b).

⁶⁰ Phase 1 projects are those arising out of the 2018 and 2019 offshore wind solicitations called for in Governor Cuomo's 2018 State of the State Address.

⁶¹ The South Fork Wind Farm is being developed by Deepwater Wind.

⁶² During the summer of 2017, Statoil deployed the world's first full-scale floating wind turbine array, Hywind, in Scotland (4C Offshore, 2017).

NEW JERSEY

New Jersey has high population density, above-average electricity prices, and ample shallow water immediately offshore (U.S. Energy Information Administration, 2017; Rahim, 2017). In 2010, then-Governor Chris Christie (R) signed the Offshore Wind Economic Development Act, intended to develop 1,100 megawatts of offshore wind projects to serve New Jersey's electricity needs.

A 2016 Fairleigh Dickinson poll found that, whether Democrat (96%), Republican (83%), or independent (82%), the majority of New Jersey residents support clean energy (Wright, 2016). Additionally, the pilot-scale Fishermen's Atlantic City Wind Farm, a demonstration project proposed for New Jersey state waters near Atlantic City, has secured all necessary permits (Maykuth, 2018). Nonetheless, offshore wind electricity generation in New Jersey has, thus far, not materialized.

In addition to the 1,100-megawatt target, the 2010 Offshore Wind Economic Development Act⁶³ directed the New Jersey Board of Public Utilities to develop a regulatory framework specific to offshore wind, which would include Offshore Renewable Energy Certificates ("ORECs"). But an integrated state-level regulatory framework for New Jersey offshore wind projects never materialized.

The current lack of a state-level regulatory framework has thus far stifled the Fishermen's Atlantic City Wind Farm, a 24-megawatt, six-turbine pilot project planned just three miles offshore Atlantic City. Because the project did not secure a power purchase agreement by December 31, 2016, it lost DOE funding worth \$47 million (Weston & Davidson, 2017). Nevertheless, it appears that there is still hope for Fishermen's. In April 2018, in direct response to state-level political developments in New Jersey (discussed below), EDF Renewable Energy entered into a preliminary agreement to acquire the Fishermen's Atlantic City Wind Farm (EDF Renewable Energy, 2018).

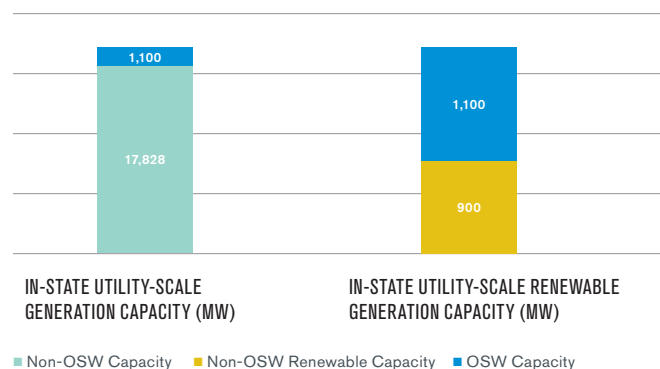
BOEM has executed two leases for offshore wind development in federal waters off New Jersey (BOEM, 2017a). Moreover, it appears that the 2017 election of Governor Phil Murphy (D) will be the catalyst that

finally triggers expansion of New Jersey's offshore wind industry. On January 31, 2018, Governor Murphy issued Executive Order No. 8. This Order directs the New Jersey Board of Public Utilities (and other state agencies) to "take all necessary actions" to implement the 2010 Offshore Wind Economic Development Act. This includes developing an Offshore Wind Strategic Plan, and implementing an OREC program, with the goal of realizing 3,500 megawatts of offshore wind energy generation capacity by 2030 (Governor Philip D. Murphy, 2018). The order also instructs the Board of Public Utilities to "initiate discussions with sister states in the Northeast and Mid-Atlantic region to explore the potential benefits of a regional collaboration on offshore wind and other opportunities to combat climate change."

Thereafter, on February 28, 2018, the Board of Public Utilities approved Executive Order No. 8, directing staff to prepare for New Jersey's first round of applications from offshore wind projects for eligibility to receive ORECs for 1,100 megawatts of capacity (New Jersey Board of Public Utilities, 2018). Based on March 2018 data, this 1,100-megawatt initial procurement would represent about 6% of New Jersey's overall utility-scale generation capacity (17,828 megawatts), but would more than double New Jersey's total utility-scale renewables capacity (900 megawatts) (U.S. Energy Information Administration, 2018). This is illustrated in Figure 10.

FIGURE 10: OFFSHORE WIND COMPARED TO NEW JERSEY'S UTILITY-SCALE GENERATION CAPACITY AND RENEWABLE CAPACITY

(U.S. Energy Information Administration, 2018)



63 N.J.S.A. 48:3-49, et seq.

In May 2018, Governor Murphy signed legislation codifying New Jersey's renewed commitment to offshore wind. Assembly Bill 3723/Senate Bill 2314, among other things, mandates 3,500 megawatts of offshore wind generation capacity by 2030. It also modifies New Jersey's renewable portfolio standard, requiring 35% of New Jersey's electricity to be derived from renewable sources by 2025, which increases to 50% by 2030 (McKeon et al., 2018; Corasaniti & Plumer, 2018). Another bill (Senate Bill 1217) directs the Board of Public Utilities to approve an offshore wind project "located in territorial waters offshore of a municipality in which casino gaming is authorized" (undoubtedly describing the Fishermen's Atlantic City Wind Farm) (Sweeney & Smith, 2018). The third bill (Senate Bill 2313), by way of a zero-emission credit scheme, provides a \$300 million subsidy to the state's nuclear generation fleet (Sweeney et al., 2018).

It is safe to say that Governor Murphy's election has been a boon for New Jersey's offshore wind endeavors.

MARYLAND

Signed into law by Governor Martin O'Malley (D), the Maryland Offshore Wind Energy Act of 2013 specifies that a portion of the electricity sold within Maryland shall be generated by offshore wind. The precise amount shall be determined annually by the Maryland Public Service Commission, but may not exceed 2.5% of the state's total retail electricity sales (Maryland Offshore Wind Energy Act of 2013). The Maryland Public Service Commission is additionally responsible for administering the application and review process for the state's offshore wind projects. The Maryland Offshore Wind Energy Act also limits consumer rate increases associated with offshore wind projects to \$1.50 (in 2012 dollars) per monthly utility bill⁶⁴ (Maryland Offshore Wind Energy Act of 2013; Public Service Commission of Maryland, 2017; Kurtz, 2017). This cap on rate

increases limits the value of Maryland OREC subsidies to \$190 per megawatt-hour (2012\$) (Public Service Commission of Maryland, 2017).

Although New Jersey's 2010 Offshore Wind Economic Development Act first introduced the OREC subsidy model, the Maryland Offshore Wind Energy Act of 2013 followed a similar approach. Maryland ORECs must be awarded by the Maryland Public Service Commission to "Qualified Offshore Wind Projects"⁶⁵ (Maryland Offshore Wind Energy Act of 2013). Maryland utilities are required to purchase the ORECs through a special purpose account established and administered by the Maryland Public Service Commission.⁶⁶ The account is specifically designed to track OREC payments and revenues.

In 2014, after a competitive auction process, BOEM awarded federal leasing rights for two Outer Continental Shelf parcels off the Maryland coast. U.S. Wind, with a total bid of nearly \$9 million, acquired both leases (BOEM, 2018h). U.S. Wind plans to develop a portion of the leased area. Another project, called Skipjack Wind Farm,⁶⁷ is considered to be a Maryland project, although its lease is a part of the Delaware Wind Energy Area. The two projects will have an aggregate installed capacity of 368 megawatts (Public Service Commission of Maryland, 2017). Based on March 2018 data, this 368-megawatt initial offshore wind procurement is almost 3% of Maryland's overall utility-scale generation capacity (13,146 megawatts), and nearly 25% of Maryland's total utility-scale renewables capacity (1,147 megawatts). This can be seen in Figure 11.

On May 11, 2017, the Maryland Public Service Commission issued Order No. 88192, stating that "the State is positioned to become a national leader in the burgeoning offshore wind industry" (Public Service Commission of Maryland, 2017). Order 88192 delineates the net economic impact of the two projects, noting that U.S. Wind and Skipjack, collectively, plan in-state expenditures of approximately \$957 million

⁶⁴ Public Service Commission Order 88192 states "collectively, the net ratepayer impact associated with our approval is projected to be less than \$1.40 per month for residential customers, with an approximate 1.40% impact on the annual bills of nonresidential [i.e. commercial and industrial] customers—both less than the ratepayer impacts authorized by the legislation."

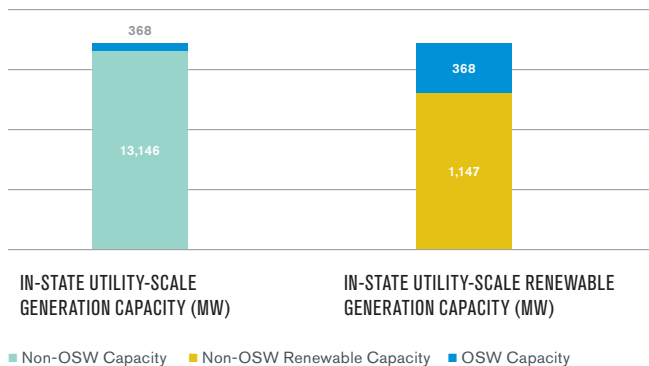
⁶⁵ The Act defines a "qualified offshore wind project" as a wind turbine electricity generation facility that: (1) is located on an Outer Continental Shelf parcel leased from the United States Department of the Interior; (2) is between 10 and 30 miles off the Maryland coast; (3) interconnects to PJM at a point located on the Delmarva Peninsula; and (4) has been approved by the Maryland Public Service Commission. Transmission-related interconnection facilities are also considered part of the "qualified offshore wind project."

⁶⁶ See, Md. Code Ann., Pub. Util. § 7-704.2(c).

⁶⁷ Skipjack is a subsidiary of Deepwater Wind.

FIGURE 11: OFFSHORE WIND COMPARED TO MARYLAND'S UTILITY-SCALE GENERATION CAPACITY AND RENEWABLE CAPACITY

(U.S. Energy Information Administration, 2018)



during the development and construction phases, with an additional \$878 million spent in Maryland during the operations phase (Public Service Commission of Maryland, 2017). The Public Service Commission ultimately fixed the price of each offshore renewable energy credit at \$131.93 per megawatt-hour.

To qualify for the ORECs, the Maryland projects must comply with, among other things, the following conditions: (1) the developers must submit their federal Site Assessment Plan and Construction and Operations Plan to the Maryland Public Service Commission; (2) best commercially-reasonable efforts must be undertaken to minimize (daytime and nighttime) on-shore visibility impacts imposed by the projects; and (3) best commercially-reasonable efforts must be made to mitigate noise pollution during the projects' construction and operation phases (Public Service Commission of Maryland, 2017). Both developers have agreed to utilize the Tradepoint Atlantic port facilities,⁶⁸ located in Baltimore. U.S. Wind pledged \$26.4 million to upgrade Tradepoint Atlantic, while Skipjack will invest \$13.2 million into the facility. Finally, the two developers have together agreed to invest \$76 million in the establishment of a new steel fabrication facility at Tradepoint Atlantic (Public Service Commission of Maryland, 2017).

The Public Service Commission of Maryland predicts a positive net economic benefit to Maryland as a result of the projects, through increased state tax revenues (approximately \$74 million aggregate between the two projects) and 9,700 expected in-state jobs (Public Service Commission of Maryland, 2017). On March 22, 2018, BOEM approved U.S. Wind's Site Assessment Plan, placing this project in phase three of the federal offshore wind development process.

However, offshore wind is not uniformly supported by Marylanders. Officials from Ocean City, Maryland object to the projects—particularly the U.S. Wind facility—on the basis that “the sight of windmills on the horizon could dampen tourism spending and send visitors to the Jersey Shore or Virginia Beach” (Dance, 2018). In March 2018, a Maryland state legislative committee rejected an Ocean City challenge to the projects, but Maryland's offshore wind efforts have also been opposed on Capitol Hill. During the summer of 2017, U.S. Congressman Andy Harris (R-Maryland) introduced an amendment to the Interior Appropriations bill for fiscal year 2018 specifically prohibiting federal funding for BOEM review⁶⁹ of offshore wind projects sited less than 24 nautical miles from the Maryland coast (Sweeney, 2017).

Harris' amendment was ultimately excluded from the federal spending bill signed by President Trump in March 2018, but resistance⁷⁰ to offshore wind continues to smolder in Ocean City (Hallissey, 2018). Moreover, in June 2018, Representative Harris renewed his challenge to the Maryland offshore wind projects. He introduced an amendment to the 2019 Interior and Environment Appropriations bill, which was passed by the House Committee on Appropriations, that “urges BOEM to work with other federal agencies, the State of Maryland, and the people of Ocean City to come to a consensus on the wind turbines' height and distance from shore prior to their approval of any construction and operations plan” (Harris, 2018).

It is premature to render a definitive conclusion as to whether these objections will ultimately halt all offshore wind development in Maryland.

⁶⁸ Tradepoint Atlantic is a port redevelopment project located at the site of the former Sparrows Point steel mill in Baltimore, Maryland.

⁶⁹ BOEM requires this funding to review Site Assessment Plans and Construction and Operation Plans (see Figures 1 and 4).

⁷⁰ One municipal official, characterizing the offshore wind projects as “possibly the biggest threat” to Ocean City, pithily expressed the gravity of aesthetic and visibility concerns: “[i]magine working 20 to 30 years to buy a piece of heaven in Ocean City and they put turbines up and block that view” (Hallissey, 2018).

OFFSHORE WIND DEVELOPMENTS IN OTHER STATES

American interest in offshore wind is not limited to Massachusetts, Rhode Island, New York, New Jersey, and Maryland. Connecticut, Delaware, Virginia, North Carolina, California, and Hawaii are all in different stages of developing their own offshore wind projects.

Connecticut Public Act 17-144 limits offshore wind to 3% of Connecticut's in-state electricity load. On January 31, 2018, Connecticut issued a request for proposals for offshore wind projects capable of delivering 825,000 megawatt-hours on an annual basis (Connecticut Department of Energy & Environmental Protection, 2018b). Connecticut's solicitation was unique among American offshore wind procurements, because it specified an annual energy output requirement (in megawatt-hours), rather than a minimum and/or maximum nameplate capacity (in megawatts). This is because Connecticut's offshore wind legislation, by linking offshore wind penetration to in-state electricity load, diverges from the capacity block-oriented offshore wind procurement frameworks seen in other states.

As noted in the above section discussing phase one of the federal offshore wind development process, on June 13, 2018, Connecticut selected 200 megawatts (824,830 megawatt-hours annually) from Deepwater Wind's Revolution Wind project (Connecticut Department of Energy & Environmental Protection, 2018a). Revolution Wind will also deliver electricity to Rhode Island. This means that lease OCS-A 0486 now has offshore wind projects under development to serve New York (South Fork, 90 megawatts); Rhode Island (Revolution Wind, 400 megawatts); and Connecticut (Revolution Wind, 200 megawatts). Connecticut has also announced a \$15 million investment into port facilities at New London (Delony, 2018).

The First State, Delaware, presents an interesting case. True to its nickname, the first leased parcel (not counting Cape Wind, which was planned for Nantucket Sound)

of the Outer Continental Shelf is located offshore of Delaware. Yet, as noted previously, Maryland's Skipjack Wind Farm—awarded OREC subsidies in May 2017 by the Public Service Commission of Maryland—is planned for an Outer Continental Shelf lease block within the Delaware Wind Energy Area. To add even more confusion, an entity called “Garden State Offshore Energy”⁷¹ shares Skipjack's lease area off of Delaware (BOEM, 2018d). On August 28, 2017, Governor John Carney (D) signed Executive Order 13, which established the Offshore Wind Power Working Group; the Working Group's initial report is still pending (Governor John C. Carney, 2017).

Off of Virginia, Dominion Virginia Power holds a commercial Outer Continental Shelf lease. Ørsted has been contracted to install two 6-megawatt turbines for a pilot project entitled “Coastal Virginia Offshore Wind,” which Dominion describes as “the first phase of a plan that could bring more than 2,000 megawatts of [offshore] wind generated electricity” to Virginia and North Carolina (Dominion Energy, 2018). In October 2017, BOEM approved Dominion's Site Assessment Plan (BOEM, 2018b). Adjacent to Dominion's commercial lease is a research lease held by the Virginia Division of Mines, Minerals, and Energy, which is called the “Virginia Offshore Wind Technology Advancement Project” (BOEM, 2018m).

There is currently one renewable energy project under development offshore North Carolina. Entitled the “Kitty Hawk Wind Energy Area,” this was BOEM's most recent competitive lease sale. Avangrid Renewables, LLC, partial stakeholder in Massachusetts' Vineyard Wind project, was the auction winner (BOEM, 2018c).

Efforts are now underway to bring utility-scale floating offshore wind to California. On June 11, 2018, EnBW North America⁷² announced a partnership with Seattle-based Trident Winds, Inc. to develop a floating offshore

⁷¹ Abbreviated “GSOE.” This is another subsidiary of Deepwater Wind.

⁷² A newly established regional subsidiary of EnBW Energie Baden-Württemberg AG (“EnBW”), a German utility company and offshore wind developer. EnBW and Ørsted are both also investing in offshore wind projects in Taiwan.

wind project off the Central California coast (EnBW, 2018). EnBW believes floating offshore wind systems are representative of the future of the industry, and sees California as an ideal market, with “a strong economy, continuously growing energy demand[,] and ambitious renewable energy and climate goals” (EnBW, 2018). The proposed 650–1,000 megawatt installation could be the first floating offshore wind farm in American waters.

BOEM has received three unsolicited requests for offshore wind energy leases in the waters surrounding Hawaii. Based on this interest, in 2016, BOEM issued a Call for Information and Nominations (BOEM 2018g). BOEM is still in the process of identifying an Area of Consideration. However, because of the significant water depths around Hawaii, any offshore wind projects would require floating turbine technology (Jiminez, Keyser, & Tegen, 2016).

There are also some offshore wind research activities transpiring in Maine (VolturnUS, a 1:8 scale floating turbine), and an ice-resistant turbine for the Great Lakes, appropriately named “Icebreaker Wind” (University of Maine, 2018; Lake Erie Energy Development Corporation, 2018).

EnBW believes floating offshore wind systems are representative of the future of the industry, and sees California as an ideal market, with “a strong economy, continuously growing energy demand, and ambitious renewable energy and climate goals.”

CONCLUSION

Explanations for the solidifying confidence in American offshore wind vary, but, as might be expected, project cost can be determinative. For that reason, some market observers have opined that the combination of improved turbine technology (growth in size, efficiency, and individual capacity), intensifying competition, and lower financing costs drove dramatic declines in European offshore wind project costs in recent years. This, in turn, triggered the invigoration of the American offshore wind market (Beeler, 2018). Improved European offshore wind supply chains, and larger cumulative project capacities (due, in part, to increasing capacities of individual turbines) may have also contributed to these cost declines.

Turbine size is important for several reasons. First, a wind turbine's power output (the power converted from the wind into rotational energy) is directly related to the area swept by the turbine blades. However, to accommodate larger blades, the turbine's rotor must be fixed at a greater height above the sea surface. This elevated stature ensures that the longer blades—even after accounting for wave action—do not strike the water below. It also permits the turbine to access winds at higher altitudes, which tend to be even stronger and more consistent than breezes at lower altitudes. This can manifest itself in greater capacity factors,⁷³ the second advantage of expanded turbine dimensions (U.S. Department of Energy & U.S. Department of the Interior, 2016).

For example, consider an 800-megawatt offshore wind array. With turbines rated at 5 megawatts, 160 individual machines would have to be installed to attain this overall

capacity. That means 160 foundations, 160 towers, 160 nacelles, 480 individual blades, etc. By contrast, if turbines with a nameplate capacity of 8 megawatts are employed, only 100 turbines need be deployed to attain the same cumulative array capacity. Because an offshore wind farm does not require lifetime fuel inputs, the majority of a project's overall cost is in the initial investment expenditure. Thus, by lowering material, manufacturing, and installation costs, a project's overall cost can be decreased.

Others say that interest in American offshore wind has been buoyed by recent closures of nuclear and coal-fired power plants (Lackner & Baker, 2018). Still others argue that progress has been driven by states keen to capitalize upon the 600,000 on- and offshore wind jobs that the U.S. Department of Energy, in a 2015 report, predicted will materialize across the United States by 2050 (U.S. Department of Energy, 2015). More recently, in February 2018, the American Wind Energy Association noted that American offshore wind could “create 40,000 jobs within a decade, revitalize ocean ports, and power millions of homes with clean energy” (American Wind Energy Association, 2018).

Independent of these varied justifications for the domestic industry's ongoing escalation, a few crucial facts should be kept in mind when evaluating the role that offshore wind could play in aiding America's transition to a clean(er) energy future. First, offshore winds blow harder and more consistently than onshore winds (BOEM, 2018j; U.S. Department of Energy,

⁷³ Capacity factor is defined as the ratio of the system's predicted electrical output in the first year of operation to the nameplate output.



2018a). This assertion is supported by data recently gathered from European offshore wind installations, which have seen capacity factors ranging from 29% to 48%, with higher factors attained during windier winter months (WindEurope, 2018). During February 2017, a German offshore wind installation achieved a capacity factor of 67.9%. By comparison, capacity factors for U.S. onshore wind installations in 2017 ranged from 22.3% (August) to 44.9% (April) (U.S. Energy Information Administration, 2018).

Offshore wind resources are also located proximal to locations where the United States requires electricity. The 28 coastal states constitute almost 80% of the nation's electricity demand (U.S. Department of Energy & U.S. Department of the Interior, 2016). This is because America's population is heavily concentrated in coastal areas. The National Oceanic and Atmospheric Administration estimated that, in 2010, approximately four out of every ten Americans (or 123.3 million people) lived in counties lying directly on coastal shorelines (National Oceanic and Atmospheric Administration, 2017). These areas are six times more densely populated than the rest of the country, which can contribute to land usage and transmission constraints.

Moreover, the population of these counties is projected to increase by 10 million people by 2020, meaning that, in less than two years, nearly half (~47%) of all Americans will live in coastal counties, or in counties that drain to coastal watersheds (Bureau of Ocean Energy Management, 2018j). This anticipated upsurge in America's coastal population coincides with the forecasts of offshore wind industry insiders, who predict "steel in the water" (offshore wind construction activities) commencing in the early 2020s (Kelly-Detwiler, 2018).

The same implications hold true for the U.S. Northeast region, where utility-scale American offshore wind is closest to becoming a reality. Although it represents less than 2% of the nation's land area, as of the 2010 Census, 17% of the U.S. population (more than 50 million people) lived in the Boston to Washington, D.C. corridor (America2050, 2016). The region also accounts for 20% of U.S. gross domestic product, and is home to major American cities (Boston, New York City,

Philadelphia, Baltimore, and Washington, D.C.). These demographic and available market factors, combined with the Atlantic Ocean's shallow waters (less than 60 meters deep) and favorable offshore wind resources, may help explain why the American offshore wind industry will see its first utility-scale projects built off the U.S. Northeast. In the span of three weeks (May 23 to June 13, 2018), an historic 1,400-megawatt commitment to American offshore wind was made by Massachusetts (800 megawatts); Rhode Island (400 megawatts); and Connecticut (200 megawatts). It appears that utility-scale offshore wind installations may soon be found in American waters.

An April 2018 analysis by the Lawrence Berkeley National Laboratory concluded that the market value (considering energy and capacity) of offshore wind exceeds "land-based wind, due to offshore wind sites being located closer to major population centers and also having a time-varying profile of electricity production that is more-correlated with that of electricity demand" (Mills, 2018). The report also noted that, owing to higher average electricity prices in ISO-NE and NYISO, the total market value of offshore wind is higher for sites off of New York, Connecticut, Rhode Island, and Massachusetts (Mills et al., 2018). Another recent report, entitled "Wind Power to Spare: The Enormous Energy Potential of Atlantic Offshore Wind," asserts that offshore wind generation can help offset future demand imposed by growing electrification of transportation and heating (Weissman, Cross, & Sargent, 2018).

There is an aphorism about revolutions: "there are decades where nothing happens; and there are weeks where decades happen." With 1,400 megawatts of offshore wind capacity commitments secured in just a few weeks during 2018, this turn of phrase perfectly illustrates the trajectory of this emerging domestic renewable energy industry. After years of setbacks, 2018 has thus far proven historic for American offshore wind power, and the industry is now finally in motion.

APPENDIX 1

AREAS FOR POTENTIAL OFFSHORE WIND DEPLOYMENT

When diving into the mechanics of the American offshore wind development process, a geographic frame of reference is beneficial. Figure 12, below, depicts general regions of the Outer Continental Shelf that might see offshore wind development.

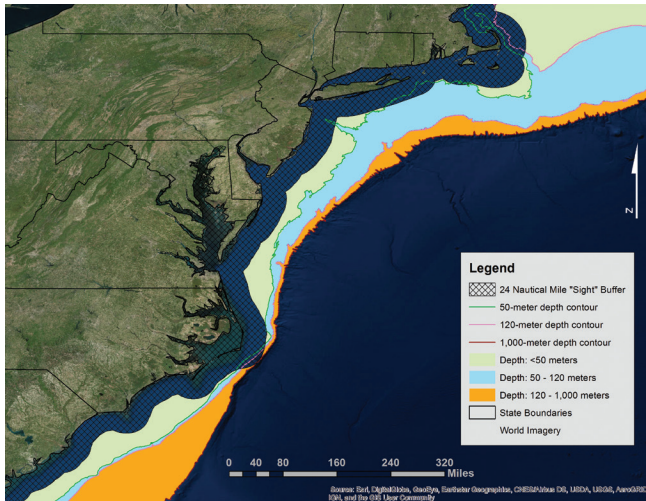


FIGURE 12: OFFSHORE AREAS BOTH: (1) MORE THAN 24 NAUTICAL MILES FROM SHORE, AND (2) LESS THAN 1,000 METERS DEEP

(Joseph S. Torg, 2018)

Figure 12 should not be construed as a comprehensive depiction of all conceivable offshore wind array siting constraints.⁷⁴ Rather, it is intended to broadly convey the magnitude of the offshore areas along the U.S. East Coast that, based solely upon two parameters (proximity to shore⁷⁵ and water depth⁷⁶), would generally qualify for offshore wind development. This exemplification is necessary because view-shed impacts (the visibility of offshore wind turbines to viewers on the shoreline) have generated staunch opposition to offshore wind projects

in both the United States (Cape Wind) and Europe. Figure 12 helps to visually quantify the truly vast portions of the Outer Continental Shelf upon which offshore wind turbines could be installed, but would nonetheless remain essentially invisible to all but the most purposeful onshore viewers.

Four individually delineated areas are observed in Figure 12. The black-lined area of ocean closest to shore is the 24 nautical mile (~27.6 mile) “sight” buffer. This distance was selected based upon a view-shed impact study conducted by the Argonne National Laboratory. The study concluded that offshore wind facilities “were judged to be a major focus of visual attention at distances up to 10 miles (16 km); were noticeable to casual observers at distances of almost 18 miles (29 km); and were visible with extended or concentrated viewing at distances beyond 25 miles (40 km)” (Argonne National Laboratory, 2017). Thus, any turbine sited beyond 27 miles offshore is virtually—if not completely—invisible to a casual land-based observer. Of course, as offshore wind turbines continue to grow in size, their relative visual impacts will increase.

The blue-green shaded sector immediately adjacent to the “sight” buffer zone is the area of the Outer Continental Shelf that: (a) is more than 24 nautical miles from the nearest point of land, and (b) has water less than 50 meters deep. The green line demarcating the seaward edge of this region represents the 50 meter depth contour. 50 meters was selected because nearly all of the world’s currently installed offshore wind capacity is located in waters shallower than that depth, making it representative of the current state of fixed-bottom offshore wind turbine technology (Oh, Nam, Ryu, Kim, & Epureanu, 2018). This expanse, nearly 27,000 square miles, is slightly larger than the land area of West Virginia.

⁷⁴ Offshore wind turbines cannot be sited in particular areas due to shipping lanes, fishing grounds, cable crossings, Department of Defense exclusionary zones, unexploded and discarded ordinance, shipwrecks, ecologically/archaeologically sensitive areas, and other limitations.

⁷⁵ Measured in nautical miles. 1 nautical mile, historically defined as one minute of latitude (or one sixtieth of a degree of latitude), is equal to approximately 1.15 miles.

⁷⁶ Measured in meters.

Moving seaward, the blue shaded region (bounded by the green and pink depth contours) outlines the offshore area with water between 50 and 120 meters deep. 120 meters is the maximum depth associated with Hywind Scotland—the world’s first full-scale⁷⁷ floating offshore wind array—and will thus be used as a proxy for contemporary floating turbine technology (4C Offshore, 2017). This segment totals approximately 28,700 square miles, equivalent to the combined land area of Maryland, Massachusetts, and Connecticut.

Finally, the orange-shaded region, farthest to seaward, shows the offshore area with water depths between 120 and 1,000 meters. 1,000 meters was chosen as the analog for future floating offshore wind turbine technology. This is because the Hywind floating turbines are said to be deployable at depths approaching 900 meters, while risk management firm, DNV GL, projects that future floating turbine technology could be found in waters over 1,000 meters deep (DNV GL, 2017; Gibbens, 2017). This sector is approximately 30,000 square miles in size, slightly smaller than the land area of South Carolina. Importantly, the considerable increase in operable depth afforded by

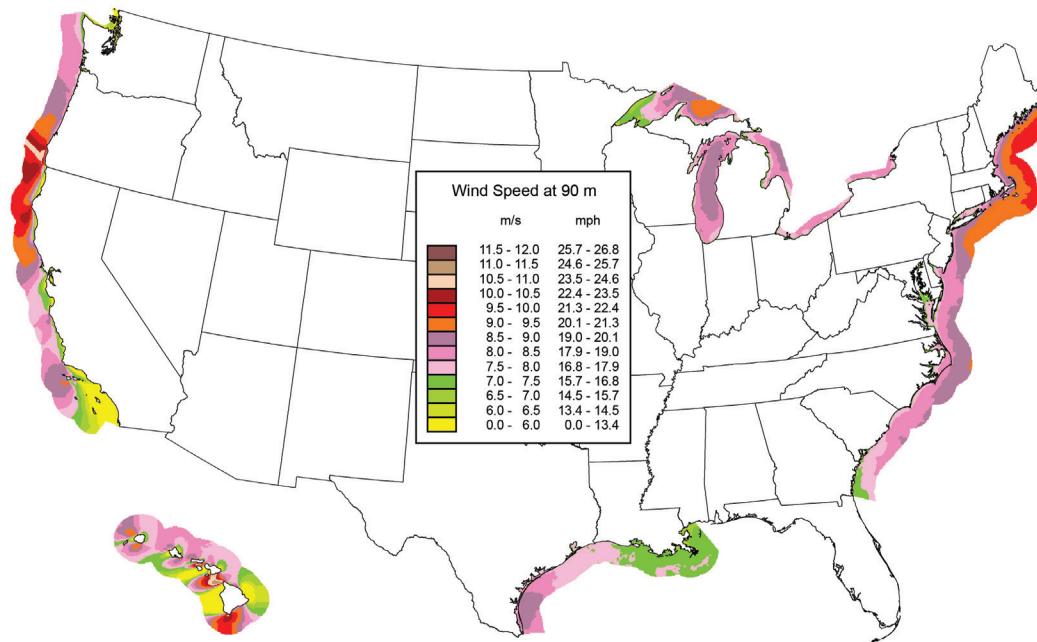
anticipated future floating turbine technology could allow offshore wind to expand to nearshore areas with deep water and strong winds—found off of Japan and the American Pacific Coast, for example—and to regions further offshore, which tend to have even stronger winds (Beiter, Musial, Kilcher, Maness, & Smith, 2017).

Taken together, the above-mentioned three shaded areas of Figure 12 total more than 85,000 square miles, larger than the state of Utah. It must be acknowledged that offshore wind turbines are not sited based solely upon distance from shore and water depth, as a myriad of other elements (see footnote 74) influence the decision. At the same time, the vastness of this area of the Outer Continental Shelf must be recognized. Siting offshore wind turbines so they are invisible from shorelines enables developers to, with relative⁷⁸ ease, avoid a persistent—and, in the case of Cape Wind, ultimately fatal—barrier.

Compare the foregoing with Figure 13, below, from the National Renewable Energy Laboratory, illustrating average U.S. offshore wind speeds at 90 meters above sea level.

FIGURE 13: ANNUAL AVERAGE OFFSHORE WIND SPEED AT 90 METERS

(National Renewable Energy Laboratory, 2018)



77 Full-scale in terms of the size of the offshore wind farm’s individual floating turbines. The Hywind project has an aggregate capacity of 30 megawatts (Statoil, 2017). Hywind achieved a remarkable capacity factor of 65% between November 2017 and January 2018 (Klippenstein, 2018).

78 Relative because siting wind arrays farther offshore requires longer subsea transmission cables, the installation of which can be cost-prohibitive.

APPENDIX 2

U.S. OFFSHORE WIND LEASES: NANTUCKET SOUND

(AS OF AUGUST 2018)

Wind Energy Area	Nantucket Sound	
Project Name	Cape Wind	
Nameplate Capacity (Megawatts)	468	
Project Offtake Status	This OCS lease is currently suspended.	
OCS Lease Number	OCS-A 0478	
Acreage	29,425	
Acquisition Fee	\$0	
Original Lessee	Cape Wind Associates, LLC	
Current Lessee	Cape Wind Associates, LLC	
Lease Effective Date	November 1, 2010	
Site Assessment Plan Status	On July 24, 2015, BOEM approved a request made by Cape Wind Associates, LLC to suspend lease OCS-A 0478 for two years. In June 2017, Cape Wind Associates, LLC requested an additional two-year suspension. BOEM's decision on second suspension request is still pending.	
Construction And Operations Plan Status	On July 24, 2015, BOEM approved a request made by Cape Wind Associates, LLC to suspend lease OCS-A 0478 for two years. In June 2017, Cape Wind Associates, LLC requested an additional two-year suspension. BOEM's decision on second suspension request is still pending.	
Wind Energy Area	Delaware	
Project Name	Skipjack Wind Farm	Garden State Offshore Energy
Nameplate Capacity (Megawatts)	120	Unknown
Project Offtake Status	Awarded ORECs by Maryland Public Service Commission Order No. 88192 on May 11, 2017	To be determined. Initial project owner, NRG, canceled power purchase agreement with Delmarva Power in December 2011.
OCS Lease Number	OCS-A 0482	
Acreage	96,430	
Acquisition Fee	\$24,107	
Original Lessee	Bluewater Wind Delaware, LLC (subsidiary of NRG Energy, Inc.)	
Current Lessee	GSOE I, LLC (subsidiary of Deepwater Wind). Skipjack Offshore Wind, LLC will develop part of this lease.	
Lease Effective Date	December 1, 2012	
Site Assessment Plan Status	According to Skipjack, SAP will be submitted to BOEM no later than the fourth quarter of 2018.	Unknown
Construction And Operations Plan Status	According to Skipjack, COP will be submitted to BOEM no later than the fourth quarter of 2018.	Unknown



U.S. OFFSHORE WIND LEASES: RHODE ISLAND/MASSACHUSETTS

(AS OF AUGUST 2018)

Wind Energy Area	Rhode Island/Massachusetts			
Project Name	South Fork Wind Farm	Revolution Wind (Rhode Island)	Revolution Wind (Connecticut)	N/A
Nameplate Capacity (Megawatts)	90	400	200	
Project Offtake Status	In January 2017, Long Island Power Authority unanimously approved offtake of South Fork Wind Farm's entire output.	On May 23, 2018, Rhode Island selected 400 MW from Revolution Wind project; negotiations with National Grid pending.	On June 13, 2018, Connecticut selected 200 MW from Revolution Wind project; negotiations pending.	
OCS Lease Number	OCS-A 0486		OCS-A 0487	
Acreage	97,498		67,252	
Acquisition Fee	\$3,089,461			
Original Lessee	Deepwater Wind New England, LLC (subsidiary of Deepwater Wind)			
Current Lessee				
Lease Effective Date	October 1, 2013		October 1, 2013	
Site Assessment Plan Status	SAP approved by BOEM on October 17, 2017.		In April 2014, Deepwater Wind advised BOEM that they do not intend to conduct SAP activities for lease OCS-A 0487.	
Construction and Operations Plan Status	Anticipated by end of 2018. April 2022 is current deadline to submit COP to BOEM.		January 2019 is current deadline to submit COP to BOEM.	

U.S. OFFSHORE WIND LEASES: VIRGINIA

(AS OF AUGUST 2018)

Wind Energy Area	Virginia	
Project Name	Coastal Virginia Offshore Wind	Virginia Offshore Wind Technology Advancement Program
Nameplate Capacity (Megawatts)	2,000+ (estimated)	12
Project Offtake Status	To be determined.	This is a non-commercial wind energy research lease. Dominion has contracted Ørsted to install pilot project (two 6 MW turbines).
OCS Lease Number	OCS-A 0483	OCS-A 0497
Acreage	112,799	2,135
Acquisition Fee	\$1,600,000	N/A
Original Lessee	Virginia Electric and Power Company	Commonwealth of Virginia, Department of Mines, Minerals, and Energy (array will be operated by Dominion)
Current Lessee	(d/b/a Dominion Virginia Power)	
Lease Effective Date	November 1, 2013	April 1, 2015
Site Assessment Plan Status	SAP approved by BOEM on October 12, 2017.	On March 24, 2016, BOEM approved Dominion's Research Activities Plan. Because this wind energy research lease is intended for non-commercial purposes, BOEM does not require SAP or COP. Pending final engineering review, approval of the Research Activities Plan granted an easement to shore for the array's transmission cable, and permits installation and operation of two 6 MW turbines.
Construction and Operations Plan Status	April 2022 is current deadline to submit COP to BOEM.	

U.S. OFFSHORE WIND LEASES: MARYLAND

(AS OF AUGUST 2018)

Wind Energy Area	Maryland	
Project Name	U.S. Wind	
Nameplate Capacity (Megawatts)	248	
Project Offtake Status	Awarded ORECs by Maryland Public Service Commission Order No. 88192 on May 11, 2017	
OCS Lease Number	OCS-A 0490	
Acreage	79,707	
Acquisition Fee	\$8,701,098	
Original Lessee	U.S. Wind, Inc.	
Current Lessee		
Lease Effective Date	December 1, 2014	
Site Assessment Plan Status	SAP approved by BOEM on March 22, 2018.	
Construction and Operations Plan Status	March 2023 is current deadline to submit COP to BOEM.	



U.S. OFFSHORE WIND LEASES: MASSACHUSETTS

(AS OF AUGUST 2018)

Wind Energy Area	Massachusetts				
Project Name	Bay State Wind	Constitution Wind	Vineyard Wind		
Nameplate Capacity (Megawatts)	800	200	800		
Project Offtake Status	Pending future OSW solicitations.	Pending future OSW solicitations.	On May 23, 2018, in its first utility-scale offshore wind solicitation, Massachusetts selected Vineyard Wind's 800-megawatt bid. Vineyard Wind's proposed power purchase agreement with Massachusetts utilities must now be approved by the Massachusetts Department of Public Utilities.	To be determined.	
OCS Lease Number	OCS-A 0500		OCS-A 0501	OCS-A 0502	OCS-A 0503
Acreage	187,523		166,886	248,015	140,554
Acquisition Fee	\$281,285		\$150,197	\$496,030 (Minimum bid for auction round 1)	\$281,108 (Minimum bid for auction round 1)
Original Lessee	RES America Developments, Inc.		Vineyard Wind, LLC (formerly OffshoreMW, LLC). Vineyard Wind is owned 50% by Avangrid Renewables (subsidiary of Iberdrola) and 50% by Copenhagen Infrastructure Partners.	This is one of the new lease areas announced April 6, 2018 by U.S. Department of the Interior. Prior to this announcement, two offshore wind developers (PNE Wind USA, Inc. and Statoil Wind US, LLC) submitted unsolicited requests to lease this parcel (OCS-A 0502). Based upon these two submissions, BOEM has determined that competitive interest exists with respect to this parcel. BOEM will therefore proceed with the competitive OCS leasing process, which is conducted via auction.	This is one of the new lease areas announced April 6, 2018 by U.S. Department of the Interior. Prior to this announcement, two offshore wind developers (PNE Wind USA, Inc. and Statoil Wind US, LLC) submitted unsolicited requests to lease this parcel (OCS-A 503). Based upon these two submissions, BOEM has determined that competitive interest exists with respect to this parcel. BOEM will therefore proceed with the competitive OCS leasing process, which is conducted via auction.
Current Lessee	Bay State Wind, LLC (partnership of Ørsted and Eversource)				
Lease Effective Date	April 1, 2015		April 1, 2015		
Site Assessment Plan Status	SAP approved by BOEM on June 29, 2017.		SAP approved by BOEM on May 10, 2018.		
Construction and Operations Plan Status	June 2022 is current deadline to submit COP to BOEM.		Draft COP submitted to BOEM in December 2017. On March 30, 2018, BOEM announced its intent to prepare an Environmental Impact Statement concerning this COP.		

U.S. OFFSHORE WIND LEASES: NEW JERSEY

(AS OF AUGUST 2018)

Wind Energy Area	New Jersey	
Project Name	Ocean Wind	U.S. Wind
Nameplate Capacity (Megawatts)	1,000+ (estimated)	1,500 (estimated)
Project Offtake Status	Pending implementation of New Jersey's OREC scheme and subsequent OSW solicitation	Pending implementation of New Jersey's OREC scheme and subsequent OSW solicitation
OCS Lease Number	OCS-A 0498	OCS-A 0499
Acreage	160,480	183,353
Acquisition Fee	\$880,715	\$1,006,240
Original Lessee	RES America Developments, Inc.	U.S. Wind, Inc.
Current Lessee	Ocean Wind, LLC (subsidiary of Ørsted)	
Lease Effective Date	March 1, 2016	March 1, 2016
Site Assessment Plan Status	SAP approved by BOEM on May 16, 2018.	March 2019 is current deadline to submit SAP to BOEM.
Construction and Operations Plan Status	Anticipated by end of 2020. May 2023 is current deadline to submit COP to BOEM.	Per applicable regulations, COP must be submitted to BOEM within five years of SAP approval.

U.S. OFFSHORE WIND LEASES: NEW YORK

(AS OF AUGUST 2018)

Wind Energy Area	New York	
Project Name	Empire Wind	
Nameplate Capacity (Megawatts)	1,000–1,500 (estimated)	
Project Offtake Status	Pending implementation of New York's subsidy scheme and subsequent OSW solicitation	
OCS Lease Number	OCS-A 0512	
Acreage	79,350	
Acquisition Fee	\$42,469,725	
Original Lessee	Statoil Wind US, LLC (subsidiary of Equinor f/k/a Statoil)	
Current Lessee		
Lease Effective Date	April 1, 2017	
Site Assessment Plan Status	SAP expected mid 2018.	
Construction and Operations Plan Status	Per applicable regulations, COP must be submitted to BOEM within five years of SAP approval.	



U.S. OFFSHORE WIND LEASES: NORTH CAROLINA

(AS OF AUGUST 2018)

Wind Energy Area	North Carolina
Project Name	Kitty Hawk
Nameplate Capacity (Megawatts)	To be determined.
Project Offtake Status	To be determined.
OCS Lease Number	OCS-A 0508
Acreage	122,405
Acquisition Fee	\$9,066,650
Original Lessee	Avangrid Renewables, LLC
Current Lessee	
Lease Effective Date	November 1, 2017
Site Assessment Plan Status	To be determined.
Construction and Operations Plan Status	To be determined.

APPENDIX 3

NEW YORK STATE OFFSHORE WIND PROCUREMENT OPTIONS

■ Optimal ■ Acceptable ■ Suboptimal ■ Lacking

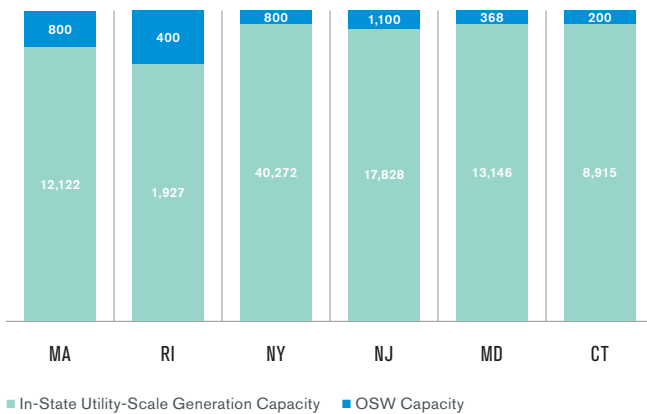
Procurement Options	Brief Description	Feasibility	Scale of Application	Cost Effectiveness	Compatibility & Acceptability
Fixed Renewable Energy Credit (“REC”)	Similar to New York’s previous Large Scale Renewables procurements. NYSERDA pays OSW project a fixed, as-bid REC price throughout contract lifetime.	OPTIMAL Familiar structure, few implementation issues	SUBOPTIMAL Less attractive to developers than hedged options available in other states	LACKING No hedge against fluctuations in energy and capacity markets can elevate risk to developer. Increased cost of capital can translate to higher project costs.	ACCEPTABLE Few concerns, but ratepayers would not benefit from lower program cost if commodity prices rise
Bundled PPA	One or more utilities competitively procure OSW projects and sign agreement (i.e. “PPA”) to purchase both commodity electricity and any RECs. Developer retains ownership of OSW assets. Massachusetts employs a long-term bundled PPA approach for OSW procurement.	SUBOPTIMAL Dependent on utility interest; various IOU implementation and administration issues would take time to resolve	OPTIMAL Strong hedging benefit with creditworthy counterparty	OPTIMAL Low cost of finance due to perfect hedge	SUBOPTIMAL Reduced incentive to maximize locational value due to perfect hedge
Utility-Owned Generation	One or more utilities competitively procure OSW projects, with utilities ultimately retaining ownership of OSW assets.	SUBOPTIMAL Would require a change to New York Public Service Commission policy; various implementation issues would take time to resolve	SUBOPTIMAL Development without ownership may be less attractive to offshore wind developers	OPTIMAL Low cost of finance as rate-based asset	SUBOPTIMAL Reduced beneficial effects of market forces and competition
Split PPA	NYSERDA pays to OSW project a fixed-price REC payment, and OSW project also enters into separate PPA with utility for commodity electricity and capacity.	SUBOPTIMAL Dependent on utility interest and other implementation issues	ACCEPTABLE Strong hedging benefit but contractual complexities due to split in counterparties	SUBOPTIMAL High uncertainty on effective cost to ratepayers until commodity price is agreed upon by utility	SUBOPTIMAL Reduced incentive to maximize locational value due to perfect hedge
Market Offshore Renewable Energy Credit (“OREC”)	OSW project sells energy and capacity as it sees fit (either into NYISO wholesale markets, or via long-term contract). NYSERDA also competitively procures an agreed-upon percentage of an OSW project’s ORECs. The market OREC is a premium that NYSERDA pays to the OSW project; it is calculated by subtracting the OSW project’s actual energy and capacity revenues from the OSW project’s winning bid price (i.e. the OSW project’s all-in revenue amount per megawatt-hour, a/k/a the “strike price”). This procurement scheme builds upon Maryland’s OREC policy structure.	SUBOPTIMAL Directly linking an OSW project’s actual energy and capacity sales to the premium paid per OREC by NYSERDA could create jurisdictional questions under the Federal Power Act, increasing legal risk	OPTIMAL Strong hedging benefit with creditworthy counterparty	OPTIMAL Low cost of finance due to perfect hedge	SUBOPTIMAL Reduced incentive to maximize locational value due to link with actual commodity sales
Index OREC	OSW project sells energy and capacity as it sees fit (either into NYISO wholesale markets, or via long-term contract). NYSERDA also competitively procures an agreed-upon percentage of an OSW project’s ORECs. The index OREC is a premium that NYSERDA pays to the OSW project; it is based on the net difference between an OSW project’s strike price, and the average commodity market price (which is derived from an index or composite of indices, a/k/a the “reference price”), even if OSW project does not sell into regulated wholesale markets. This scheme is based upon the OSW procurement mechanism used in the United Kingdom.	ACCEPTABLE Limited implementation challenges	ACCEPTABLE Significant hedging benefit with creditworthy counterparty	ACCEPTABLE Fairly low cost of finance due to near-perfect hedge	OPTIMAL Maintains locational value incentive; increases in commodity prices would reduce ratepayer cost
Forward OREC	OSW project sells energy and capacity as it sees fit (either into NYISO wholesale markets, or via long-term contract). NYSERDA also competitively procures an agreed-upon percentage of an OSW project’s ORECs. The forward OREC is a premium that NYSERDA pays to the OSW project; it is based on the net difference between an OSW project’s strike price, and the reference price set at the beginning of a two-year period (a “tranche”). This scheme is similar to NY’s Zero-Emission Credits (“ZEC”), and the payment adjusts (upward or downward) at the beginning of each two-year tranche.	ACCEPTABLE Limited implementation challenges	SUBOPTIMAL Funders may not be confident in ongoing availability of two-year commodity hedge products	SUBOPTIMAL Few cost benefits unless funders assume continued availability of two-year hedging products in the market	ACCEPTABLE Maintains locational value incentive, but large volume of offshore wind generation may distort the market for hedging products

APPENDIX 4

This appendix aggregates, into two figures, the data shown in Figures 6, 7, 8, 10, and 11. Figure 14 illustrates the penetration achieved by offshore wind in each state's overall utility-scale generation capacity, while Figure 15 shows offshore wind compared to each state's utility-scale renewable generation capacity.

FIGURE 14: OFFSHORE WIND COMPARED TO IN-STATE GENERATION CAPACITY

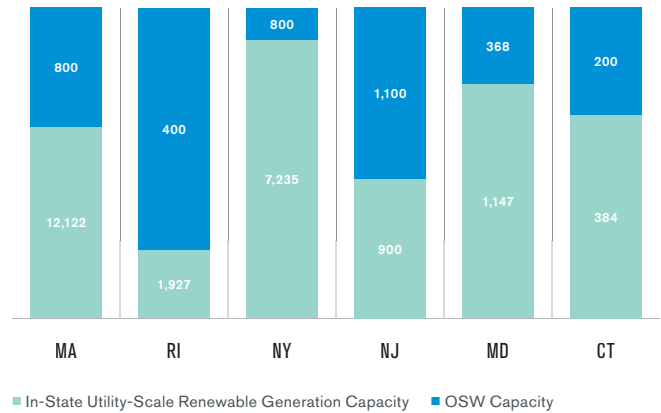
(U.S. Energy Information Administration, 2018)



For Massachusetts (Vineyard Wind), Rhode Island (Revolution Wind), Connecticut (Revolution Wind), and Maryland (Skipjack and U.S. Wind), the offshore wind capacity noted in Figures 6, 7, 11, 14, and 15 is the amount selected for long-term power purchase agreement negotiation (MA, RI, CT), or awarded ORECs (MD). For New York and New Jersey, the offshore wind capacity noted in Figures 8, 10, 14, and 15 is the magnitude of the forthcoming 2018 offshore wind procurements in those states.

FIGURE 15: OFFSHORE WIND COMPARED TO IN-STATE RENEWABLE GENERATION CAPACITY

(U.S. Energy Information Administration, 2018)



These figures are intended to aid in visually comparing only the initial utility-scale offshore wind capacity additions of the respective states. The pre-existing, 30-megawatt (pilot-scale) Block Island Wind Farm is not part of Rhode Island's utility-scale capacity addition. For that reason, although Block Island is an offshore wind installation, it was counted as part of Rhode Island's already-operational overall generation capacity (1,927 megawatts) and renewable generation capacity (113 megawatts), using March 2018 data from the U.S. Energy Information Administration, in Figures 7, 14, and 15.

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