Offshore Wind Market and Economic Analysis

2014 Annual Market Assessment

Prepared for:
U.S. Department of Energy

Client Contact	**Michael Hahn, Patrick Gilman**
Award Number	**DE-EE0005360**

Navigant Consulting, Inc.
77 Bedford Street
Suite 400
Burlington, MA 01803-5154

781.270.8314
www.navigant.com

August 27, 2014

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Prepared for:
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Michael Hahn
Patrick Gilman

Prepared by:
Navigant Consulting, Inc.

Bruce Hamilton, Principal Investigator
Mark Bielecki
Charlie Bloch
Terese Decker
Lisa Frantzis
Kirsten Midura
Jay Paidipati
Feng Zhao

Navigant Consortium Member Organizations	*Key Contributors*
American Wind Energy Association	Chris Long
Great Lakes Wind Collaborative	Becky Pearson and Victoria Pebbles
Green Giraffe Energy Bankers	Marie de Graaf, Jérôme Guillet, and Niels Jongste
National Renewable Energy Laboratory	Eric Lantz and Aaron Smith
Ocean & Coastal Consultants (a COWI company)	Brent D. Cooper, P.E., and Joe Marrone, P.E.
Tetra Tech EC, Inc.	Michael D. Ernst, Esq.

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Acknowledgments

For their support of this report, the authors thank the entire U.S. Department of Energy (DOE) Wind & Water Power Technologies Office, particularly Patrick Gilman and Michael Hahn.

Navigant would also like to thank the following for their contributions to this report:

Stacy Ambrozia	Deepwater Wind
Bruce Bailey	AWS Truepower
Kevin Banister	Principle Power, Inc.
Eric Boessneck	Santee Cooper
Doug Copeland	EDF RE
Fara Courtney	US Offshore Wind Collaborative
John Dalton	Power Advisory LLC
Steve Dever	Lake Erie Energy Development Company
Tim Downey	Saint Lawrence Seaway Development Corporation
Jeremy Firestone	Blue Hen Wind
William Follett	SgurrEnergy Inc.
Richard Frost	Maritime Applied Physics Corporation
Sunny Gupta	AREVA
Robert Hare	Dominion Resources
Jim Lanard	Offshore Wind Development Consortium
Walter Musial	National Renewable Energy Laboratory
Matt Overeem	The WindWay
Steven Pietryk	Dominion Resources
Jacques Roeth	NYSERDA
Michael Shook	AeroHydro, Inc.
Tyler Stehly	National Renewable Energy Laboratory
Katarina Svabcikova	Siemens
Larry Viterna	Nautica Windpower
Gail Walder	Environmental Planning
Bill White	Massachusetts CEC
Paul Williamson	Maine Ocean & Wind Industry Initiative
Andy Zalay	Ewindfarm inc

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Abbreviations

AC	alternating current
ATD	Advanced Technology Demonstration
AWC	Atlantic Wind Connection
AWEA	American Wind Energy Association
BOEM	Bureau of Ocean Energy Management
BPU	Board of Public Utilities
BTMU	Bank of Tokyo-Mitsubishi UFJ (Japan)
CAISO	California Independent System Operator
CBM	condition-based maintenance
CEQ	Council on Environmental Quality
CfD	Contracts for Difference
COP	Construction and Operations Plan
CREZ	competitive renewable energy zone
CZMA	Coastal Zone Management Act
DC	direct current
DD	Direct Drive
DEA	Danish Energy Agency
DECC	Department of Energy and Climate Change (U.K.)
DNR	Department of Natural Resources
DOE	Department of Energy
EA	environmental assessment
EERE	Energy Efficiency & Renewable Energy
EEZ	Exclusive Economic Zone (DK)
EIS	environmental impact statement
EnWG	New German Energy Act
EPA	Environmental Protection Agency
EPAct	Energy Policy Act of 2005 (U.S.)
ETI	Energy Technologies Institute
EU	European Union
EWEA	European Wind Energy Association
FEPA	Food and Environment Protection Act 1985 (U.K.)
FERC	Federal Energy Regulatory Commission
FiT	Feed-in Tariff
FONSI	Finding of No Significant Impacts
FTE	full-time equivalent
GBS	gravity-based structure
GC	green certificate
GDP	gross domestic product
GE	General Electric
GIB	Green Investment Bank (U.K.)
GLOW	Great Lakes Wind
GLWC	Great Lakes Wind Collaborative
GW	gigawatt
GWEC	Global Wind Energy Council
HVAC	high-voltage alternating current
HVDC	high-voltage direct current
IAPEME	International Advisory Panel of Experts on Marine Ecology
IOU	investor-owned utility
IPP	independent power producer
IRR	internal rate of return
ISO	independent system operator
ITC	investment tax credit
JEDI	Jobs & Economic Development Impact
kcmil	thousand circular mils
kV	kilovolt
kW	kilowatt
LCOE	levelized cost of energy
LEEDCo	Lake Erie Energy Development Corporation
LIPA	Long Island Power Authority
LNG	liquefied natural gas
METI	Ministry of Economy, Trade and Industry (Japan)
MISO	Midcontinent Independent System Operator
mmBTU	million British thermal units
MMS	Minerals Management Service
MOU	Memorandum of Understanding
MW	megawatt
MWh	megawatt-hours
NEPA	National Environmental Policy Act
NIP	National Infrastructure Plan
NOAA	National Oceanic and Atmospheric Administration
NPS	National Policy Statement (U.K.)
NREL	National Renewable Energy Laboratory
NYPA	New York Power Authority
O&M	operations and maintenance
OCS	Outer Continental Shelf
OEM	original equipment manufacturer
Ofgem	Office of the Gas and Electricity Markets (U.K.)
OFTO	offshore transmission owner
OREC	offshore wind renewable energy credit
OTB	Offshore Terminal Bremerhaven
OWEDA	Offshore Wind Economic Development Act
PEA	programmatic EA

PEIS	programmatic EIS
PMDD	permanent magnetic direct drive
PMG	permanent magnetic generator
POU	publicly owned utility
PPA	power purchase agreement
PSC	Public Service Commission
PTC	production tax credit
PUC	Public Utilities Commission
R&D	research and development
REC	Renewable Energy Credit
RFP	request for proposal
RO	Renewable Obligation
ROC	Renewable Obligation Certificate
RPS	renewable portfolio standard
RTO	regional transmission organization
SAP	site assessment plan
SCADA	supervisory control and data acquisition
SEA	Strategic Environmental Assessment (U.K.)
TCE	The Crown Estate
TSO	transmission system operator
UMaine	University of Maine
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WAB	Wind Agency Bremerhaven
WEA	Wind Energy Area
WRA	wind resource area

Introduction

This report was produced on behalf of the Wind and Water Power Technologies Office within the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE) as an award resulting from Funding Opportunity Announcement DE-FOA-0000414, entitled *U.S. Offshore Wind: Removing Market Barriers; Topic Area 1: Offshore Wind Market and Economic Analysis*.

The objective of this report is to provide a comprehensive annual assessment of the U.S. offshore wind market. The report has been updated and published annually for a three-year period. The report was first published in early 2013 covering research performed in 2012. The 2nd annual report was published in October 2013 and focused on developments that occurred in 2013. This 3rd annual report focuses on new developments that have occurred in 2014. The report will provide stakeholders with a reliable and consistent data source addressing entry barriers and U.S. competitiveness in the offshore wind market.

The report was produced by the Navigant Consortium, led by Navigant Consulting, Inc. ("Navigant"). Additional members of the Navigant Consortium include the American Wind Energy Association (AWEA), the Great Lakes Wind Collaborative (GLWC), Green Giraffe Energy Bankers, National Renewable Energy Laboratory (NREL), Ocean & Coastal Consultants (a COWI company), and Tetra Tech EC, Inc.

Executive Summary

The U.S. offshore wind industry is transitioning from early development to demonstration of commercial viability. While there are no commercial-scale projects in operation, there are 14 U.S. projects in advanced development, defined as having either been awarded a lease, conducted baseline or geophysical studies, or obtained a power purchase agreement (PPA). There are panels or task forces in place in at least 14 states to engage stakeholders to identify constraints and sites for offshore wind. U.S. policymakers are beginning to follow the examples in Europe that have proven successful in stimulating offshore wind technological advancement, project deployment, and job creation.

This report is the third annual assessment of the U.S. offshore wind market. It includes the following major sections:

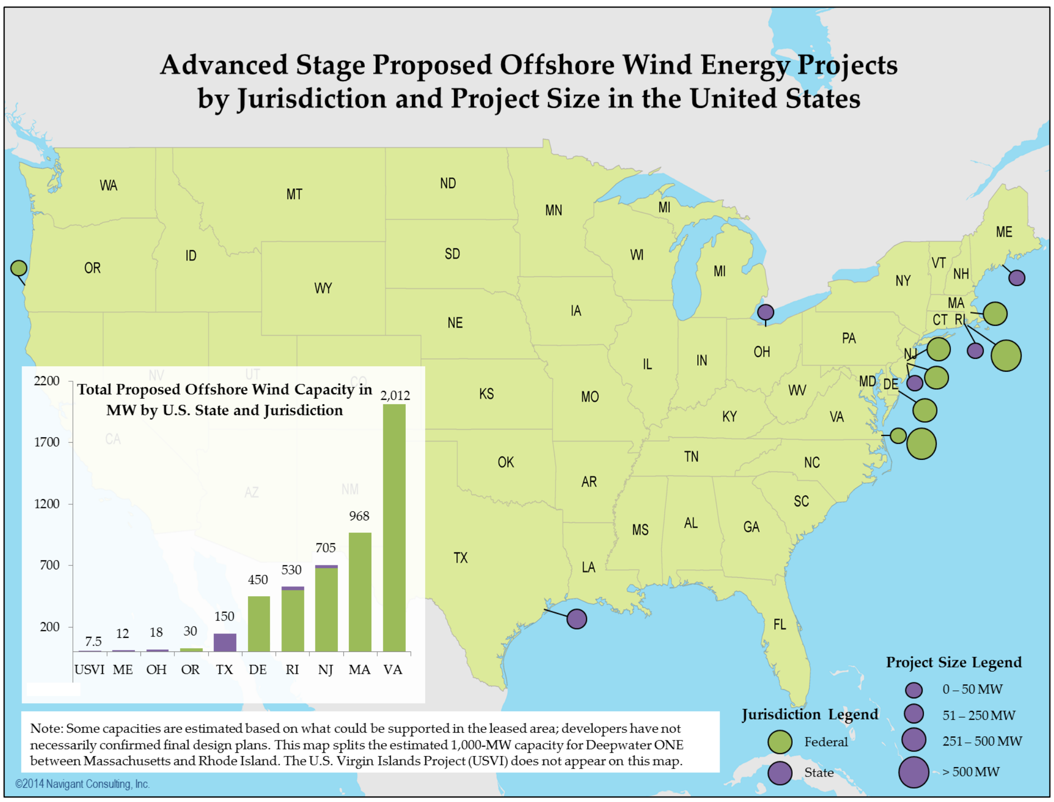
- *Section 1*: key data on developments in the offshore wind technology sector and the global development of offshore wind projects, with a particular focus on progress in the United States
- *Section 2*: analysis of policy developments at the federal and state levels that have been effective in advancing offshore wind deployment in the United States
- *Section 3*: analysis of actual and projected economic impact, including regional development and job creation
- *Section 4*: analysis of developments in relevant sectors of the economy with the potential to affect offshore wind deployment in the United States

Section 1. Global Offshore Wind Development Trends

There are approximately 7 gigawatts (GW) of offshore wind installed worldwide. The majority of this activity continues to center on northwestern Europe, but development in China is progressing as well. In 2013, more than 1,700 megawatts (MW) of wind power capacity was added globally, with the United Kingdom alone accounting for 812 MW (47%) of new capacity. In total, capacity additions in 2013 showed a roughly 50 percent increase over 2012, finally surpassing the pace of installations achieved in 2010. It appears that near-term growth will continue, with more than 6,600 MW of offshore wind under construction in 29 projects globally, including 1,000 MW in China. While this upward trend is encouraging, uncertain political support for offshore wind in European nations and the challenges of bringing down costs means that the pace of capacity growth may level off in the next two years.

Since the last edition of this report, the U.S. offshore wind market has made incremental but notable progress toward the completion of its first commercial-scale projects. Two of the United States' most advanced projects – Cape Wind and Deepwater's Block Island project – have moved into their initial stages of construction. In addition, continued progress with the Bureau of Ocean Energy Management (BOEM) commercial lease auctions for federal Wind Energy Areas (WEAs) has contributed to more projects moving into advanced stages of development. In total, 14 U.S. projects, representing approximately 4.9 GW of potential capacity, can now be considered in advanced stages.[1] A map showing the announced locations and capacities of these advanced-stage projects appears in Figure ES-1.

Figure ES-1. Proposed U.S. Offshore Wind Energy Projects in Advanced Development Stages by Jurisdiction and Project Size



[1] In this report, "advanced stage" includes projects that have accomplished at least one of the following three milestones: received approval for an interim limited lease or a commercial lease in state or federal waters; conducted baseline or geophysical studies at the proposed site with a meteorological tower erected and collecting data, boreholes drilled, or geological and geophysical data acquisition system in use; or signed a power purchase agreement (PPA) with a power off-taker. Note that each of these criteria represents a requisite step that a project will take before it gains final approvals and reaches the construction phase. Simply having achieved one of these milestones, however, does not guarantee that a project will ultimately move forward, and any two projects qualifying as "advanced" may have made different levels of progress relative to one another.

Source: Navigant analysis

On the demonstration project front, the DOE announced continued funding for Offshore Wind Advanced Technology Demonstration (ATD) to three projects in May 2014. Fishermen's Energy, Dominion, and Principle Power were each selected for up to $46.7 million in federal funds for final design and construction of pilot projects off New Jersey, Virginia and Oregon, respectively, from an original group of seven projects that were selected in 2012. Two of the other original seven, the University of Maine and the Lake Erie Economic Development Company of Ohio, will receive a few million each, under separate awards, to continue the engineering designs of their proposed pilot projects.

Overall, offshore wind power project costs may be stabilizing somewhat compared to their recent upward trend. Notably, for those projects installed in 2013 for which data were available, the average reported capital cost was $5,187/kW, compared to $5,385/kW for projects completed in 2012. While it appears that the stabilizing trend may continue for projects completed in 2014, a lack of data for projects anticipated to reach completion in 2015 and 2016 makes it difficult to assess whether the trend will continue. Note that all such capital cost data are self-reported by project developers and are not available for all projects globally; therefore, it may not be fully representative of market trends.

Globally, offshore wind projects continue to trend farther from shore into increasingly deeper waters; parallel increases in turbine sizes and hub heights are contributing to higher reported capacity factors. While the trend toward greater distances helps reduce visual impacts and public opposition to offshore wind, it also requires advancements in foundation technologies and affects the logistics and costs of installation and maintenance. On the positive side, the trend toward higher-capacity machines combines with increasing hub heights and rotor diameters to allow projects to improve energy capture by taking better advantage of higher wind speeds.

The average nameplate capacity of offshore wind turbines jumped substantially from 2010 to 2011 as projects increasingly deployed 3.6 MW and 5 MW turbines. Since then, however, average turbine size has plateaued around 4 MW. This leveling off of average turbine size will likely continue over the next two years as previously ordered 3.6 MW machines are deployed and Asian manufacturers work to catch up with their European counterparts. The upward trend in average turbine sizes will likely resume toward 2018 as developers begin deploying more 5.0 MW and larger turbines. The average turbine size for advanced-stage projects in the United States is expected to range between 5.0 and 5.3 MW, indicating that U.S. projects will likely utilize larger offshore turbines rather than smaller turbines that have previously been installed in European waters.

The shift to more distant locations and larger capacity turbines, along with a desire to minimize tower top mass, has driven continued innovation in drivetrain configurations; however, the majority of installed turbines continue to use conventional drivetrain designs. Other configurations, such as direct-drive and medium-speed drivetrains, have been limited to a combined 3 percent market share of cumulative installed capacity. Deployment of turbines with alternative drivetrain configurations will likely increase significantly over the next several years, as the new 5 to 8 MW class turbine models from Siemens, Vestas, Areva, Alstom, and Mitsubishi are installed at commercial projects.

The past year has seen a continued trend for substructure design innovations, as the challenges of installing larger turbines, siting projects in deeper waters, and the need to reduce installed costs persist. While much of the focus in recent years has been on alternatives to the conventional monopile approach (due to various limitations), the advent of the extra-large (XL) monopile (suitable to a 45 m water depth) may have somewhat lessened the impetus for significant change. Regardless, the optimal type of substructure (and the potential for innovation) is largely driven by site-specific factors, and plenty of opportunity remains for new designs that can address developers' unique combinations of needs. In the near-term, monopiles will continue to comprise the majority of new installations, with multi-pile (jacket and tripod) designs showing notable increases. In addition, the industry continues to explore the potential for floating foundations, with several demonstration-scale projects currently operating and additional installations planned.

Section 2. Analysis of Policy Developments

U.S. offshore wind development faces significant challenges: (1) the cost competitiveness of offshore wind energy;[2] (2) a lack of infrastructure such as offshore transmission and purpose-built ports and vessels; and (3) uncertain and lengthy regulatory processes. Various U.S. states, the U.S. federal government, and European countries have used a variety of policies to address each of these barriers with varying success.

For the U.S. to maximize offshore wind development, the most critical need continues to be stimulation of demand through addressing cost competitiveness and providing policy certainty. Key federal policies expired for projects that did not start construction by year-end 2013: the Renewable Electricity Production Tax Credit (PTC), the Business Energy Investment Tax Credit (ITC), and the 50 percent first-year bonus depreciation allowance. However, the Senate Finance Committee recently passed an extension of both of the PTC and ITC through 2015, maintaining the same new definition of commencing construction, as part of a comprehensive tax extenders bill covering 51 other industries and there is some chance that the full Senate and House will adopt this before the end of 2014.

Furthermore, the DOE announced three projects that will each receive up to $47 million to complete engineering and construction as the second phase of the Offshore Wind Advanced Technology Demonstration Program. On the state level, Maryland began promulgating rules for Offshore Renewable Energy Credits (ORECs) for up to 200 MW, and the Maine Public Utility Commission approved a term sheet with a team led by the University of Maine for a pilot floating wind turbine project.

Increased infrastructure is necessary to allow demand to be filled. Examples of transmission policies that can be implemented in the short term with relatively little effort are to designate offshore wind energy resources zones for targeted offshore grid investments, establish cost allocation and recovery mechanisms for transmission interconnections, and promote utilization of existing transmission capacity reservations to integrate offshore wind. In 2014, there were few tangible milestones in this area,

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[2] The first two contracts for U.S. offshore wind reflect the higher costs by being priced at $187/MWh plus 3.5% annual escalation for Cape Wind and $244/MWh plus 3.5% annual escalation for the Deepwater Wind Block Island Wind Farm.

although long-term plans for offshore transmission projects such as the Atlantic Wind Connection and the New Jersey Energy Link progressed steadily in their development efforts.

Regulatory policies cover three general categories: (a) policies that define the process of obtaining site leases; (b) policies that define the environmental, permitting processes; and (c) policies that regulate environmental and safety compliance of plants in operation. In 2014, the U.S. Bureau of Ocean Energy Management (BOEM) announced additional competitive lease sales for renewable energy off Massachusetts, Maryland and New Jersey.

Section 3. Economic Impacts

Our estimated installed costs have dropped 6% since our 2011 work. This is driven by: new data from European projects, revised design assumptions and more refined estimates from U.S. projects in planning stages. Expected installed costs for a 500 MW farm are $2.86 Billion or $5,700/kW.

Current U.S. employment levels could be between 550 and 4,600 full-time equivalents (FTEs), and current investment could be between $146 million and $1.1 billion. The ranges are driven by Navigant's uncertainty about from where advanced-stage projects are sourcing components. As the advanced-stage projects start construction, employment levels will likely double or triple to support equipment transport and installation.

Section 4. Developments in Relevant Sectors of the Economy

The development of an offshore wind industry in the U.S. will depend on the evolution of other sectors in the economy. Factors within the power sector, such as the capacity or price of competing power generation technologies, will affect the demand for offshore wind. Factors within industries that compete with offshore wind for resources (e.g., oil and gas, construction, and manufacturing) will affect the price of offshore wind power.

Factors in the power sector that will have the largest impact include natural gas prices and the change in coal-based generation capacity. As electricity prices have historically been linked to natural gas prices, a decrease in prices of the latter can lead to a decrease in the price of the former. Natural gas prices declined from above $4 per million British thermal units (MMbtu) in August 2011 to below $2/MMbtu in April 2012, largely due to the supply of low-cost gas from the Marcellus Shale. Lower resulting electricity prices can make investment in other power generation sources such as offshore wind less economically attractive. However, natural gas prices have been rising steadily since then and have remained above $4/MMbtu since late 2013 with periods exceeding $6/MMbtu[3] and may continue to rise with three new liquefied natural gas export terminals recently approved.

In terms of coal, Navigant analysis reveals executed and planned coal plant retirements through 2020 of nearly 40 GW. As this capacity is removed from the U.S. electric generation base, it will need to be replaced by other power generation resources, including but not limited to natural gas and offshore

[3] U.S. Energy Information Administration Daily Energy Prices, June 12, 2014 (http://www.eia.gov/todayinenergy/prices.cfm).

wind. As such, continued coal plant retirements could increase the demand for offshore wind plants in the United States.

1. Global Offshore Wind Development Trends

Since 2013, additional progress has been made to develop commercial and demonstration-scale projects in U.S. waters. Two commercial-scale projects, Deepwater's 30 MW Block Island project and Cape Wind's 468 MW project, have begun initial construction activities and expect to reach completion in 2016. In addition, the Bureau of Ocean Energy Management (BOEM) has continued to make steady progress on its *Smart from the Start* initiative to facilitate siting, leasing and construction of offshore wind energy projects on the Atlantic Outer Continental Shelf. At the demonstration level, the U.S. Department of Energy (DOE) completed the down-selection process for its Advanced Technology Demonstration awards program in May 2014, selecting three projects (from an original pool of seven) for up to $47 million each in funding to help complete engineering and design and reach full deployment by 2017.

As the U.S. market moves forward, it will continue to respond to and reflect the general trends occurring in the global offshore wind market. Through 2014, offshore wind technology has generally continued along historical trends. Turbine sizes and plant capacities have continued to grow, and water depth and distances to shore have increased. As projects move further from shore, taller and larger turbines may allow developers to take advantage of better and more sustained wind resources, thereby increasing capacity factors. On the other hand, these deeper waters and longer distances present new challenges and opportunities for foundations, drivetrains, installation logistics, and operations and maintenance (O&M). Time will tell how well initial U.S. projects align with those global trends in light of region-specific wind resource and seabed conditions.

This section presents an overview of the global offshore wind market and illustrates several of these trends in more detail. This analysis draws upon an offshore wind project database compiled from existing project databases and an ongoing review of developer announcements and industry news coverage.[4] Note that, for planned projects, these data rely primarily on developer projections and news reports and that the status and details of projects under development are subject to change.

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[4]The authors would like to acknowledge Navigant Research (formerly BTM Consult [BTM]), Green Giraffe Energy Bankers, and the National Renewable Energy Laboratory (NREL) for their contributions of project information they had previously collected. In addition, the team relied on publicly available information from the 4C Offshore Wind Farm Database (4C Offshore 2014) and the Global Wind Energy Council (GWEC 2014).

Summary of Key Findings – Chapter 1

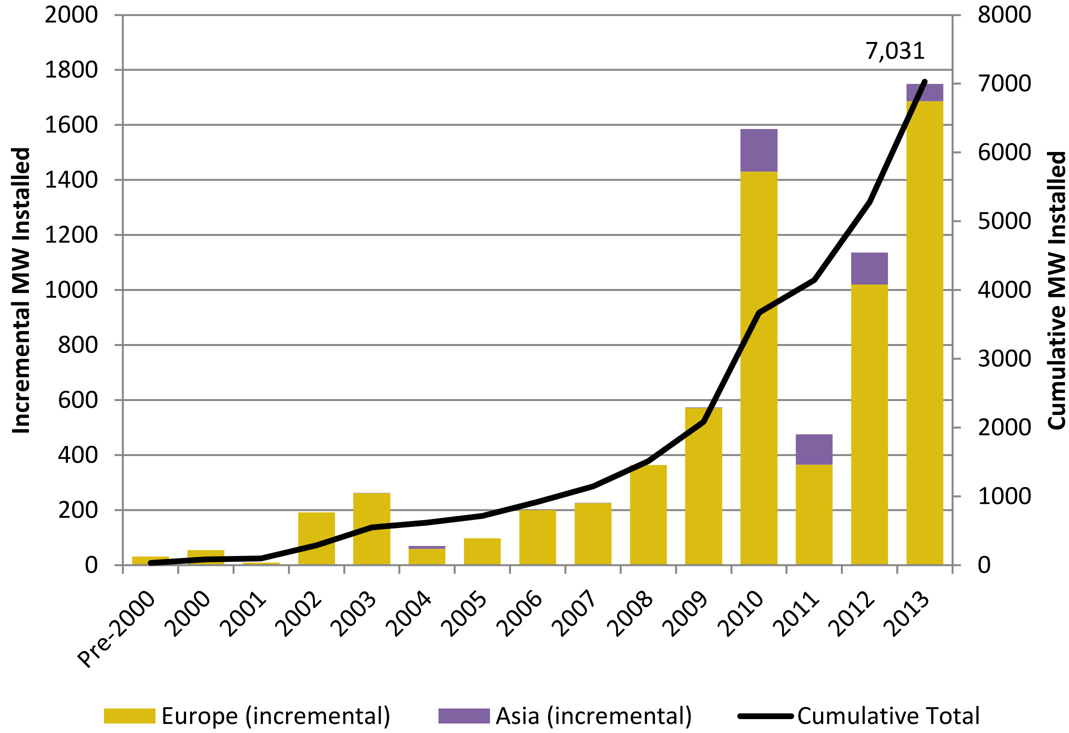
- There are approximately 7 gigawatts (GW) of offshore wind installations worldwide.
- Several potential U.S. projects have achieved notable progress in the past year, with 14 projects now in advanced stages of development. Two projects (Deepwater's 30 MW Block Island project and Cape Wind's 468 MW project) have begun initial construction activities and expect to reach completion in 2016, while a newly announced 7.5 MW, near-shore project in the U.S. Virgin Islands is also aiming for near-term completion.
- Offshore wind power project capital costs may be stabilizing somewhat compared to a previous long-term upward trend.
- The average nameplate capacity of offshore wind turbines installed globally each year has plateaued around 4 megawatts (MW); however, an upward trend will likely resume toward 2018 as developers begin deploying more 5.0 MW and larger turbines.
- Globally, offshore wind projects continue to trend further from shore into increasingly deeper waters. The greater wind energy resources at these locations, combined with larger turbine capacities, are contributing to higher reported capacity factors.

1.1 Global Offshore Wind Development

The majority of new offshore wind installations continue to occur in northwest Europe, and the Asian markets continue to show tentative growth. In 2013, more than 1,700 MW of offshore wind power capacity was added globally, bringing the cumulative global total to 7,031 MW. Of that new capacity installed in 2013, most is attributable to four countries – Belgium (192 MW of new capacity), Denmark (400 MW), Germany (230 MW) and the United Kingdom (812 MW) – with the U.K. comprising 47 percent of 2013 additions globally.[5] Figure 1-1 summarizes the historical growth of the global offshore wind market.

[5] Various sources use different approaches for reporting annual capacity estimates. Navigant's approach has historically reported MW capacity installed in a particular year, regardless of whether it has been connected to the grid. Other sources (e.g., the European Wind Energy Association [EWEA]) report MW capacity based on the year in which it is connected to the grid. As a result, estimates of annual capacity additions may vary. For example, EWEA's estimate for 2011 European capacity additions shows 866 MW (EWEA 2012a), while Navigant Research's shows only 366 MW. This is likely a result of 500 MW installed in 2010 not being connected to the grid until 2011.

Figure 1-1. Historical Growth of the Global Offshore Wind Market



Note: Shows capacity in the year it was installed but not necessarily grid-connected. Includes commercial, test, and intertidal projects.

Source: Navigant analysis of data provided by NREL and Navigant Research (formerly BTM Consult)[6]

[6] BTM Consult, an international wind market research consultancy based in Denmark, was acquired by Navigant in 2010 and is now known as Navigant Research.

In total, capacity additions in 2013 showed a roughly 50 percent increase over 2012, finally surpassing the pace of installations achieved in 2010. While this upward trend is encouraging, uncertain political support for offshore wind in European nations and the challenges of bringing down costs mean that the pace of capacity growth may level off in the next two years (Global Wind Energy Council [GWEC] 2014). In the Asian market, China's progress toward a robust offshore wind power market has been slower than planned; however, approximately 1,000 MW are currently under construction. Table 1-1 provides a summary of the current global offshore market in number of projects, cumulative capacity, and number of turbines by country.

Table 1-1. Summary of Cumulative Installed Global Offshore Capacity through 2013

Region	Country	Number of Operational Projects	Total Capacity (MW)	Total Number of Turbines Installed
Asia	China	15	404	158
	Japan	9	50	27
	South Korea	2	5	2
Europe	Belgium	6	571	135
	Denmark	17	1,274	517
	Finland	3	32	11
	Germany	8	516	115
	Ireland	1	25	7
	Netherlands	4	247	128
	Norway	1	2	1
	Portugal	1	2	1
	Spain	1	5	1
	Sweden	6	212	91
	United Kingdom	30	3,686	1,083
	Total	**104**	**7,031**	**2,277**

Note: Includes commercial and test projects. Individual phases of projects at a single site may be counted as separate projects.

Source: Navigant analysis of data provided by NREL and Navigant Research

As shown in Table 1-1, the United Kingdom continues to lead the market, with 3,686 MW, more than half of global installed capacity. The European market will continue to grow rapidly over the next two years, with projects under construction in 2014 in Belgium, Germany, the Netherlands, and the United Kingdom. As noted above, however, the longer-term outlook is less certain. In the Asia region, Japan, South Korea, and Taiwan continue to work toward their respective goals for offshore wind before the close of the decade; however, like China, initial progress has been slow.

Global capacity additions in 2013 showed a roughly 50 percent increase over 2012, finally surpassing the pace of installations achieved in 2010.

In total, it appears that near-term growth will continue, with more than 6,600 MW of offshore wind under construction in 29 projects globally (Navigant Research 2014). However, forecasts and predictions for the global market in the long-term reflect the inherent uncertainty surrounding the offshore market. Published forecasts for cumulative global offshore wind capacity range from approximately 40 GW to more than 75 GW by 2022 (IHS Emerging Energy Research 2012; Navigant Research 2012; Douglas-Westwood 2013).

1.2 U.S. Project Development Overview

Since the last edition of this report (published October 2013), the U.S. offshore wind market has made incremental but notable progress toward the completion of its first commercial-scale projects. Two of the more advanced projects – Cape Wind and Deepwater's Block Island project – have moved into their initial stages of construction, while Ocean Offshore Energy has quietly advanced efforts to install a smaller (7.5 MW) near-shore project in the U.S. Virgin Islands. Other large-scale projects, however, continue to show limited advancement.

On the demonstration project front, the DOE completed the down-selection process for its Advanced Technology Demonstration (ATD) awards program, choosing three of the original seven ATD projects to receive up to $47 million each in federal funding to reach full deployment. This section provides an overview of these and other updates to U.S. offshore wind project developments.

Most of the progress over the past year has involved advancements in previously announced projects, with a few additions of new advanced-stage projects related to smaller-scale or demonstration efforts. This report defines "advanced-stage" projects as those that have accomplished at least one of the following three milestones:

- Received approval for an interim limited lease or a commercial lease in state or federal waters
- Conducted baseline or geophysical studies at the proposed site with a meteorological tower erected and collecting data, boreholes drilled, or geological and geophysical data acquisition system in use
- Signed a power purchase agreement (PPA) with a power off-taker

Note that each of these criteria represents a requisite step that a project will take before it gains final approvals and reaches the construction phase. Simply having achieved one of these milestones, however, does not guarantee that a project will ultimately move forward, and any two projects qualifying as "advanced" may have made different levels of progress relative to one another.

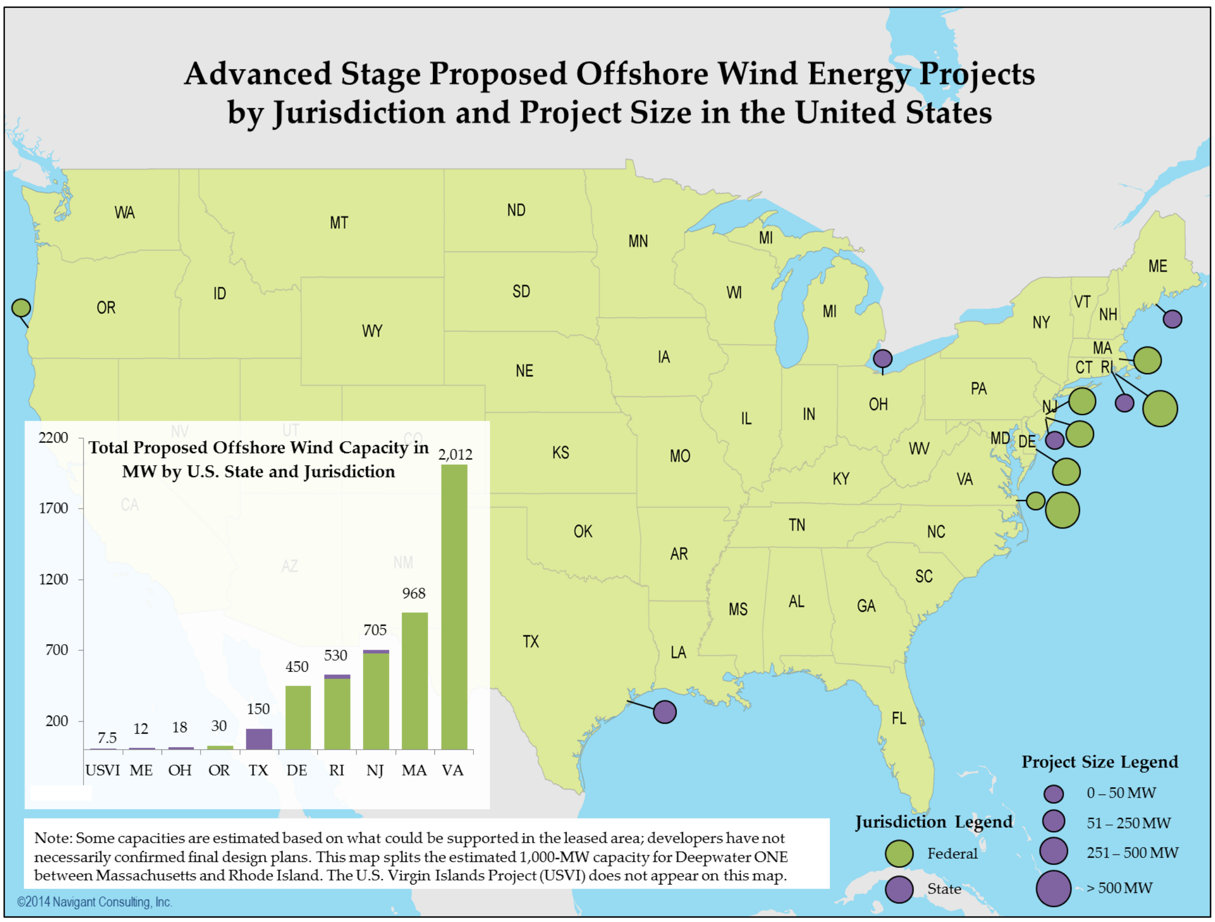
The U.S. offshore wind market has made incremental but notable progress toward the completion of its first commercial-scale project.

In addition, recent and upcoming BOEM WEA leasing activities suggest that additional project announcements are likely to occur in the near future. For example, in late 2013, Dominion Virginia Power signed a lease for the Virginia WEA, which is estimated to hold potential for up to 2,000 MW of offshore wind; however, as of this report's writing, the developer had not announced any detailed project plans, as they are still working through the process of site assessment and analysis. However, the site is adjacent to a DOE funded demonstration project and should be able to leverage lessons learned and technical results from the demonstration project.

Finally, some projects that have reached an advances stage in previous years may be relatively inactive presently, with little evidence (or at least public announcements) that they are continuing to progress their development plans. Conversely, some projects that are making visible progress have yet to achieve any of the milestones that would categorize them as advanced stage.

A map showing the announced locations and capacities for each of 14 advanced-stage projects appears in Figure 1-2**Error! Reference source not found.**.

Figure 1-2. Proposed U.S. Offshore Wind Energy Projects in Advanced Development Stages by Jurisdiction and Project Size



Source: Navigant analysis

These 14 projects represent approximately 4.9 GW of potential capacity. As shown in the figure, 95 percent of this capacity would lie in federal waters (i.e., typically outside a three-nautical-mile state boundary). Notably, this report reveals a significant decrease in advanced-stage project capacity in state waters since 2013; after failing to win an additional DOE ATD award, Baryonyx Corporation canceled U.S. Army Corps of Engineers (USACE) permits for both its demonstration- and commercial-scale projects off the coast of Texas (*ReNews* 2014). According to USACE staff, the developer plans to re-submit a permit for a scaled-down project in 2015; however, the Texas General Land Office announced in late July 2014 that the developer appeared to be letting its leases for the proposed project site expire. These changes continued to shift the balance of U.S. advanced-stage projects almost entirely into federal waters. Table 1-2 provides additional details about each of the 14 advanced-stage projects, including nameplate capacity, number of turbines, turbine make and model, turbine capacity, water depth and distance to shore, status notes, and an estimated completion date. As noted above, some of the advanced-stage projects have been relatively inactive in the past 12 months, while some of the planned demonstration-scale projects failed to gain anticipated federal funding. As a result, the estimated completion dates for several projects (or whether they will be completed at all) should be considered as uncertain.

Table 1-2. Summary of Advanced-Stage U.S. Offshore Wind Projects

Project Name (State)	Proposed Capacity (MW)	Turbines (#)	Distance to Shore (Miles)	Average Water Depth (m)	Projected Turbine Model	Status Notes	Target Complete Date[b]
Block Island Offshore Wind Farm (Deepwater) (RI)	30	5	3	22	Alstom Haliade 6 MW [a]	National Grid has agreed to a 20-year PPA. Signed installation contract with ship-owner Bold Tern in February 2014 for construction in Q3 of 2016. The developer is working to finalize environmental permitting approvals so that it can move beyond the initial stages of construction. The team represents that it has complied with IRS guidance to be eligible to receive the Investment Tax Credit (ITC).	2016
Cape Wind Offshore (MA)	468	130	8	10	Siemens SWT 3.6-107 (3.6 MW)[a]	PPA in place for 77.5% of project's power through National Grid and NStar. Received $600M loan financing commitment in February 2014, bringing estimated total of confirmed funds to at least $1B out of an estimated final cost of $2.6B. In July 2014, the project received a conditional $150M loan guarantee from the DOE. The developer also represents that it has complied with IRS guidance to be eligible to receive the ITC.	2016
Ocean Offshore Energy: Saint Thomas	7.5	3	< 1	22	Mingyang 2.5 MW SCD	Ocean Offshore Energy has proposed a small commercial project off the coast of Saint Thomas in the U.S. Virgin Islands. The developer has completed underwater surveys and as of this report's writing was awaiting approval of its USACE permit.	2016
Fishermen's Energy: Phase I (Atlantic City Wind Farm)(NJ)	25	5	3	11.5	XEMC-Darwind XD115 (5 MW)	Project is fully permitted; however, in April 2014 the New Jersey Board of Public Utilities (BPU) denied allowing the project to use New Jersey's offshore renewable energy certificates (ORECs), citing high (and uncertain) costs for ratepayers. The developer disagrees with the BPU's calculations and assumptions and in May 2014, was one of three ATD projects selected by the DOE for up to $47M in additional federal funding. In August 2014, the Superior Court of New Jersey ruled that the BPU had to reconsider Fishermen's application in the next 120 days.	2016

Project Name (State)	Proposed Capacity (MW)	Turbines (#)	Distance to Shore (Miles)	Average Water Depth (m)	Projected Turbine Model	Status Notes	Target Complete Date[b]
Virginia Offshore Wind Technology Advancement Project (VA)	12	2	27	26	Alstom Haliade 6 MW	Second of three ATD projects the DOE selected for deployment funding. This project will serve as a pilot facility adjacent to the larger commercial lease area for which the group was the winning bidder in September 2013. The team is currently conducting environmental studies and permitting efforts.	2017
Principle Power - WindFloat Pacific (OR)	30	6	15	365	Siemens SWT 6.0-154 (6 MW)	Third of three ATD projects selected by the DOE for up to $47M in federal funding. The BOEM previously had received an unsolicited lease request from Principle Power, and subsequently found no competitive interest in the area. Beginning in late May 2014, BOEM began accepting public comment for a forthcoming Environmental Assessment of the lease area. Principle Power has previously completed a geophysical survey of the lease request area and cable route.	2017
Fishermen's Energy: Phase II (NJ)	330	66	7	17.5	XEMC-Darwind XD115 (5 MW)	Received a met tower rebate from the state and began baseline surveys in August 2009. Has interim limited lease for initial assessment of wind farm feasibility; however, that lease is set to expire in November 2014.	2019
Galveston Offshore Wind (Coastal Point Energy) (TX)[c]	150	55-75	7	14.5	XEMC-Z72-2000 (2-2.75 MW)	Has lease from Texas General Land Office and is collecting wind resources data via a met tower. The team plans to install a non-grid connected, 200-kW test turbine on the met tower foundation sometime in 2014.	2019
Lake Erie Offshore Wind Project (Great Lakes) (OH)	27	9	7	18	Siemens SWT-3.0-101 (3 MW)	Lease signed with State of Ohio and geotechnical surveys completed. Shortly after filing initial permits, the project failed to make the DOE's list of ATD projects to receive full deployment funding. However, DOE announced it would provide the recipient a few million dollars under a separate award to work with the team to advance the project to "deployment readiness."	2019

Project Name (State)	Proposed Capacity (MW)	Turbines (#)	Distance to Shore (Miles)	Average Water Depth (m)	Projected Turbine Model	Status Notes	Target Complete Date[b]
University of Maine (ME)	12	2	13	95	6 MW	The University has a 20-kW, non-grid-connected test turbine installed and generating power closer to shore. The team received an initial DOE ATD award to pursue two more 6-MW turbines, and in January 2014 received Maine PUC approval for a PPA with Central Maine Power. In May 2014, the project failed to make the list of final ATD projects; however, DOE announced it would provide the recipient a few million dollars under a separate award to help complete the design.	2019
Garden State Offshore Energy Wind Farm (NJ)	350	58-70	20	27	(5 or 6 MW)	Awarded an interim limited lease and began conducting baseline surveys in 2009. Launched weather buoy in late 2012. In January 2014, Deepwater and other developers encouraged the BOEM to delay planned lease sales for New Jersey until after the state BPU clarifies which developers can use ORECs to help finance offshore wind projects. The projects' interim lease will expire in 2014.	2019
Deepwater ONE	1,000	167-200	20	40	(5 or 6 MW)	In August 2013, Deepwater was the winning bidder in the first competitive lease sale for a U.S. offshore wind area. They are marketing power to off-takers along the central Atlantic coast in the 13 to 14 cents/kWh range.	2020
Dominion Virginia Power - Virginia WEA Lease Project (VA)	2,000	~333	27	25	(6 MW or larger)	Dominion has a commercial lease for the Virginia WEA, but has not yet released many details about its plans. The developer has only stated that it intends a phased development of up to 2,000 MW.	2022-2024

Project Name (State)	Proposed Capacity (MW)	Turbines (#)	Distance to Shore (Miles)	Average Water Depth (m)	Projected Turbine Model	Status Notes	Target Complete Date[b]
NRG Bluewater's Mid-Atlantic Wind Park (DE)	450	150	12.7	20	3 MW	Received one of the first U.S. offshore leases from BOEM in October 2012 as part of "Smart from the Start" program. However, Delmarva has since canceled a PPA for 200 MW of the power. NRG filed its Site Assessment Plan in 2014, but the project website states that the project is officially on hold. NRG retains its development rights; however, it is unclear whether the project will be developed by NRG or sold.	2021

a) These projects have committed to a specific turbine with a turbine supply agreement in place. All other stated turbines are based on developer statements and may change.
b) Dates shown in this table are based on developer statements and Navigant analysis; they may change based on permitting, leasing, surveying, and other activities.
c) Leasing and permitting requirements for projects in Texas state waters do not involve the Federal Energy Regulatory Commission (FERC) or BOEM and may move more quickly than projects in federal waters.

Source: Navigant analysis based on published project information, developer statements and media coverage

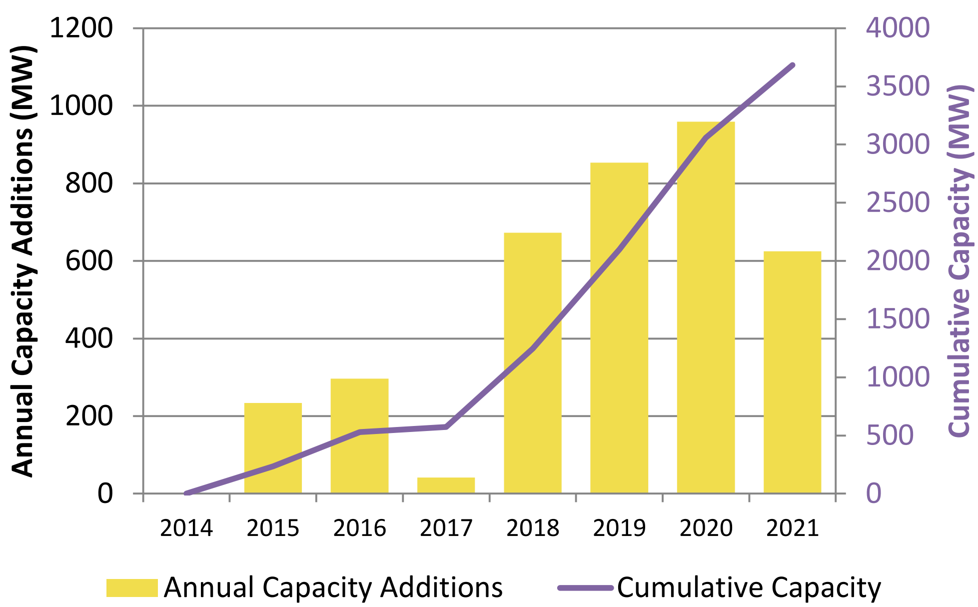
1.2.1 Forecast Capacity and Completion Dates

Developers for three projects – Block Island, Cape Wind, and Fishermen's Energy I – continue to compete to be the first commercial-scale offshore wind farm online in U.S. waters, with all three aiming for full commercial operation by 2016. The certainty and anticipated completion dates for the other commercial-scale advanced projects is less clear. In particular, the viability of the Fishermen's Phase II and Garden State Offshore Energy projects may depend partly on New Jersey BPU decisions regarding eligibility for the state's Offshore Renewable Energy Certificate (ORECs), as well as the results of the BOEM's anticipated competitive lease of the New Jersey Wind Energy Area. Based on this uncertainty, the Navigant team anticipates that these larger New Jersey projects might not reach completion until 2019 or later.

Developers for three projects – Block Island, Cape Wind, and Fishermen's Energy I – continue to compete to be the first commercial-scale offshore wind farm online in U.S. waters.

In general, global historical trends suggest that it is unlikely that all 14 of the advanced-stage projects will achieve these projected completion dates, due to delays, cancelations, or other regulatory or market issues. Viewing these projects in the context of these global trends and assumptions about their rates of completion, Navigant expects that the initial growth of the U.S. offshore market would follow a trajectory like that shown in Figure 1-3, assuming all 14 of these projects ultimately move forward.

Figure 1-3. Growth Trajectory for U.S. Offshore Wind Based on Forecast Construction Dates of Current Advanced-Stage Projects



Note: Based on developer statements, Navigant made a simplifying assumption that Dominion would deploy roughly 400 MW per year beginning in 2020, with a target of full deployment of its stated 2,000 MW potential goal by the end of 2024.

Source: Navigant analysis of collected project data

The three DOE-supported ATD projects are expected to achieve deployment by the end of 2017, shown as the 2017 installations in Figure 1-3. Their smaller scale, receipt of targeted federal support, and state support may facilitate their installation and make them among the first projects in U.S. waters. Section 1.2.3 describes these projects in more detail.

1.2.2 Notable Developments in Advanced-Stage Projects

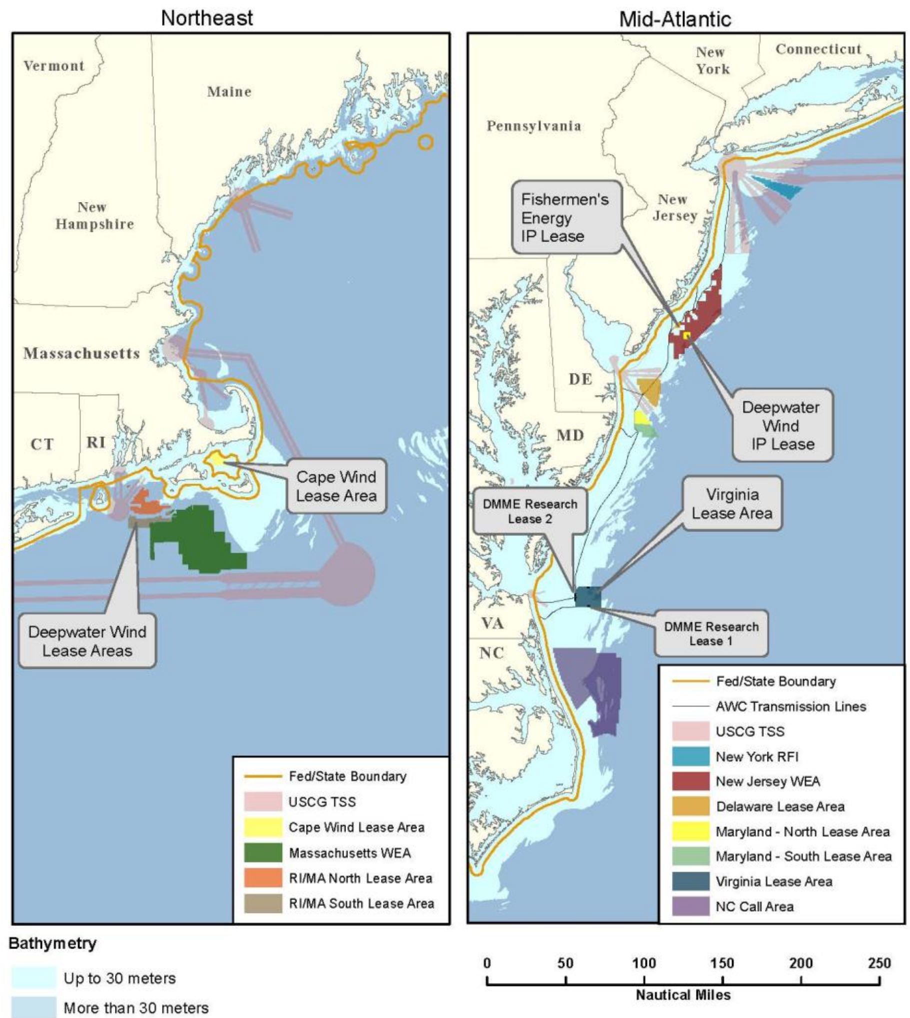
This section briefly highlights some of the key developments and advancements that have occurred in U.S. offshore wind projects since the last edition of this report, which was released in October 2013.

1.2.2.1 BOEM Advancements and Leasing Activities

BOEM continued to make steady progress on its Smart from the Start initiative to facilitate siting, leasing, and construction of offshore wind energy projects on the Atlantic Outer Continental Shelf.[7] As of this report's writing, BOEM was assessing the suitability of and commercial interest in each of seven WEAs, as well as several unsolicited lease requests. Under the initiative, BOEM selected these areas for expedited assessments and planning to help facilitate development of projects along the Atlantic Coast. Figure 1-4 shows the location of each of the seven WEAs.

[7] See http://www.boem.gov/Renewable-Energy-Program/Smart-from-the-Start/Index.aspx

Figure 1-4. Map of BOEM Atlantic Wind Energy Areas



Source: BOEM 2014

BOEM has made initial progress in each of these areas by engaging local stakeholders and government agencies, issuing requests for interest and calls for information for commercial developers and initiating environmental studies. In 2013, it held its first two competitive auctions and awarded leases for the Rhode Island/Massachusetts WEA (awarded to Deepwater Wind) and Virginia WEA (awarded to Virginia Dominion Power). Award of these leases enables the lessee to move forward with site assessment plans and subsequent construction and operations plans. In August 2014, BOEM held an auction for the Maryland WEA and was preparing to hold auctions for the Massachusetts WEA and the New Jersey WEA. Table 1-3 summarizes the BOEM WEAs, including status, area, and estimated gross offshore wind potential.

Table 1-3. Overview of BOEM Wind Energy Areas as of August 2014

WEA	Status	Area (acres)	Area (sq. km)	Estimated OSW potential (GW)*[8]
MA	Announced	742,974	3,007	9.0
RI-MA	Awarded	164,750	667	2.0
NY	Scoping	81,280	329	1.1
NJ	Announced	354,275	1,434	4.3
DE	Scoping	103,323	418	1.3
MD	Awarded	79,706	323	1.0
VA	Awarded	112,799	457	1.4
Total (GW)				**20**

Source: NREL analysis (Musial et al. 2013a; Musial et al. 2013b) and National Wildlife Foundation analysis

As shown in Table 1-3, the commercial lease areas defined by BOEM have the potential to support approximately 20 GW of installed offshore wind capacity off of the Atlantic coast.[2] This estimate conservatively assumes that not all of the gross potential capacity within a given WEA will be developed due to technical challenges (e.g., depth or geotechnical characteristics) as well as to provide adequate spacing between turbines (to minimize wake effects and address other siting constraints).

Since the Fall of 2013, BOEM has also received and responded to several unsolicited lease requests for project sites related to two of the DOE ATD projects. Key activities include the following:

- In December 2013, the BOEM determined that there was no competitive interest associated with a research lease request submitted by the Commonwealth of Virginia Department of Mines, Minerals and Energy (DMME), for an area related to the Dominion ATD project.
- In April 2014, BOEM determined that there was no competitive interest associated with Principle Power's unsolicited lease application for its WindFloat Pacific Pilot Project

See Section 1.2.3 for additional information on each of these ATD projects.

1.2.2.2 *Block Island – Initial Construction Underway*

Deepwater's 30-MW Block Island Offshore Wind Farm has begun early-stage construction activities. The developer shifted plans for the proposed site where its export cable would come to shore to state-owned Scarborough State Beach after failing to gain approval for the original site from the Town of Narragansett (Kuffner 2013). Based on its early-stage construction and supply commitments, the Deepwater team represents that it has complied with IRS guidance to be eligible to receive the federal Investment Tax Credit (ITC), which expired at the end of 2013. In February 2014, Deepwater signed an installation contract with ship-owner Bold Tern, indicating that it would begin turbine installation in the

[8] Assumes an average capacity density of 3 MW per square kilometer based on standard spacing metrics developed in Musial et al. 2013a and Musial et al. 2013b

third quarter of 2016 (Energy Business Review 2014). In addition, Alstom announced in March 2014 that it has agreed to supply the project with five of its 6 MW Haliade direct-drive turbines, including 15 years of operations and maintenance support (Alstom 2014). As of this report's writing, the developer was working to finalize environmental permitting approvals so that it can move beyond initial construction stages.

1.2.2.3 Cape Wind – Continued Focus on Financing and Supply Agreements

Since this report's last update, the 468 MW Cape Wind Offshore wind project team has also made steady progress, both in its effort to complete the project's financing and by overcoming additional legal challenges. The project had previously received approvals for PPAs representing 77.5 percent of the project's power offtake, combining agreements with NSTAR (27.5 percent) and National Grid (50 percent). In February 2014, the developer announced a $600 million loan commitment from Danish export credit agency EKF and, in March 2014, announced that Natixis and Rabobank have signed on as lead arrangers for the project's remaining financing. Combined with previous announcements, these developments brought the project's total of confirmed funding to at least $1 billion of the estimated $2.6 billion final cost. In July 2014, the DOE announced a conditional $150-million loan guarantee for the project, contingent on its securing the balance of its project financing. Like Block Island, the developer represents that its initial construction activities and supply commitments make the project eligible to take advantage of the federal Investment Tax Credit, which expired at the end of 2013 (Engblom 2014). In late 2013, Cape Wind Associates and Siemens signed a supply agreement for Siemens 3.6 MW turbines, an offshore electric service platform, and a 15-year service agreement (North American Windpower 2013). In early 2014, the developer also announced supply agreements with German company EEW Special Pipe Constructions GmbH for monopile foundations and Danish company Bladt Industries A/S for transition pieces (OffshoreWind.biz 2014a).

1.2.3 DOE Advanced Technology Demonstration Projects

This section provides a brief overview on each of the three projects that the DOE has selected for continued funding under its Advanced Technology Development (ATD) program. As mentioned at the beginning of Section 1.2, these three projects were selected from an original field of seven to receive up to $46.7 million each to reach full deployment by the end of 2017. In addition, the University of Maine and the Lake Erie Economic Development Co. received DOE commitments valued at a few million dollars each to continue the engineering design of their pilot projects off the Maine and Ohio shores. Note that all five of these projects meet Navigant's advanced-stage project criteria and appear in Table 1-2.[9]

1.2.3.1 Fishermen's Energy I (Atlantic City Wind Farm)

Fishermen's Energy proposes to install five 5 MW, direct-drive turbines in state waters 2.8 miles off the coast of Atlantic City, New Jersey. The project will result in an advanced, bottom-mounted foundation design and innovative installation procedures that aim to mitigate potential environmental impacts. Innovations or "U.S. firsts" associated with the project include the following:

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[9] For more on each of the ATD projects, see the DOE's Offshore Wind Advanced Technology Demonstration Projects website at: http://energy.gov/eere/wind/offshore-wind-advanced-technology-demonstration-projects.

- First commercial use of Lockheed Martin Wind Tracer
- First commercial use of AXYS Floating Light Detection and Ranging (LiDAR) System
- 5 MW, direct-drive turbines installed in an offshore environment
- Innovative foundation design (i.e., "Inward Battered Guide Structure" or "twisted jacket") and installation techniques (allowing reduced dependence on heavy-lift vessels)
- New technology, post-construction, intensive avian impact studies

Among the more advanced U.S. offshore wind projects, the Atlantic City Wind Farm has had a year of mixed successes and setbacks. As last reported in late 2013, the proposed 25 MW project had completed its permitting process only to be refused approval for state ratepayer-funded subsidies by the New Jersey Board of Public Utilities (BPU) based on concerns about potentially high costs to ratepayers (Johnson 2013, Milford 2013). The BPU gave the developers an opportunity to respond to its objections; however, in March 2014, the Board again ruled against the project based on its analysis of the potential costs and benefits, as well as the project's apparent dependence on uncertain federal funding, including a potential DOE ATD project award (Campbell 2014). After asking the BPU to again reconsider its decision in light of what it claims were mistaken figures and assumptions, the developers received notification that the DOE had in fact selected the project for one of the three ATD awards valued at up to $47 million (North American Windpower 2014, Copley 2014). In August, 2014, the Superior Court of New Jersey ordered the BPU to reconsider its decision, taking into consideration Fishermen's lower estimate of $199 per megawatt hour.

1.2.3.2 Virginia Offshore Wind Technology Advancement Project (VOWTAP)

A team led by Dominion Virginia Power of Richmond has proposed to design, develop, and install two 6 MW direct-drive turbines approximately 27 miles (or 23 nautical miles) off the coast of Virginia Beach. The project will utilize an innovative foundation that offers the strength of traditional jacket or space-frame structures, but use substantially less steel. Innovations associated with the VOWTAP that are being developed include the following:

- Alstom HALIADE 150-meter, 6-MW rotor
- Permanent Magnet Direct Drive (PMDD) generator
- Innovative foundation design (i.e., "Inward Battered Guide Structure" or "twisted jacket") and installation techniques (allowing reduced dependence on heavy-lift vessels)
- Wake effects and wind farm controls
- Supervisory control and data acquisition (SCADA) and condition-based maintenance (CBM) systems

In February 2013, DMME submitted an unsolicited request to BOEM for a research lease in federal waters off the coast of Virginia, and in December 2013, BOEM issued a Determination of No Competitive Interest for the requested area. The research lease area is immediately adjacent to the western border of the Virginia WEA, for which Dominion won and signed a competitive lease in late 2013 (see Figure 1-4).

1.2.3.3 *WindFloat Pacific (WFP)*

Seattle, Washington-based Principle Power has proposed to install five semi-submersible, floating foundations outfitted with Siemens 6 MW, direct-drive offshore wind turbines. The project will be sited 15 miles from Coos Bay, Oregon in approximately 350 meters of water.

Principle Power maintains that the WindFloat design will be more cost-effective than traditional offshore wind foundations because the entire turbine and floating foundation will be built on shore and installed with conventional tug vessels. The innovations associated with the WindFloat design include the following:

- Static and dynamic stability provide pitch performance low enough to use conventional (i.e., fixed-foundation), commercial offshore turbines
- The design and size allow for onshore assembly and commissioning
- The shallow draft of the semi-submersible foundation allows the assemblies to be sited, transported (via wet tow), and deployed in a wide range of water depths

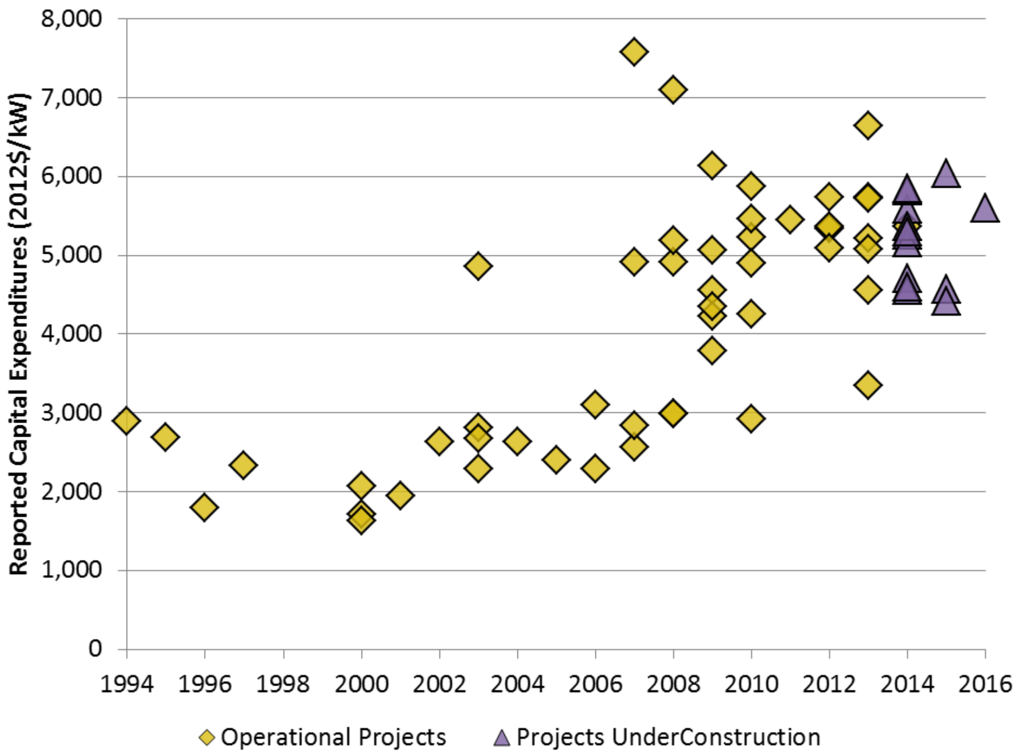
WindFloat's semi-submersible foundation includes patented water entrapment (heave) plates at the base of each of three vertical columns. A closed-loop, active water ballast system moves water between the columns in the semi-submersible foundation in response to changes in wind force and direction. This allows the mast to remain vertical, thereby optimizing electricity production.

On May 14, 2013, Principle Power submitted an unsolicited commercial lease request to BOEM for the demonstration project. In April 2014, BOEM issued a Determination of No Competitive Interest for the area.

1.3 *Capital Cost Trends*

Overall, offshore wind power project costs may be stabilizing somewhat compared to their recent long-term upward trend; however, data for projects anticipated to reach completion in 2015 and 2016 are somewhat limited. Figure 1-5 shows the reported capital costs over time for both operational projects and those under construction. Note that all such capital cost data are self-reported by project developers and is not available for all projects globally; therefore, they may not be fully representative of market trends.

Figure 1-5. Reported Capital Cost Trends for Global Offshore Wind Projects over Time



Note: Data were not available for all projects. Capital costs were inflated to 2012 currency in original currency and converted to U.S. dollars using 2012 average exchange rates. BARD Offshore I was excluded due to a cost overrun of more than 1 billion Euros.

Source: NREL analysis[10]

Offshore wind power project costs may be stabilizing somewhat compared to their recent long-term upward trend.

As noted in past editions of this report, the long-term capital cost increase has been a function of several trends: a movement toward deeper-water sites located farther offshore; increased siting complexity; and higher contingency reserves that result from more limited operational reserves and greater uncertainty when working in the offshore environment (Chapman et al. 2012). As will be discussed in Section 1.4, the industry has continued its efforts – via advancements in technology, installation approaches, and project capacity factors – to try to address this cost issue. As noted above, available capital cost estimates indicate that this upward trend may in fact be slowing. For those projects installed in 2013 for which data were available, the average reported capital cost was $5,187/kW, compared to $5,385/kW for projects completed in 2012.

[10] Analysis was based on peer-reviewed literature, industry white papers, press releases, developer and contractor press releases, and industry databases. Most cost estimates are self-reported figures from project developers and could not be independently verified.

Notably, these capital cost estimates from global projects may not capture all of the costs for which a project in the United States might be responsible. However, until such data become available for advanced-stage offshore wind projects in the U.S., capital cost projections will have to rely on models and assumptions that seek to address those differences. The most recent projection of capital costs by category (e.g., turbine, foundation, installation, etc.) for a theoretical 500 MW project in the U.S. appears in Section 3.3.

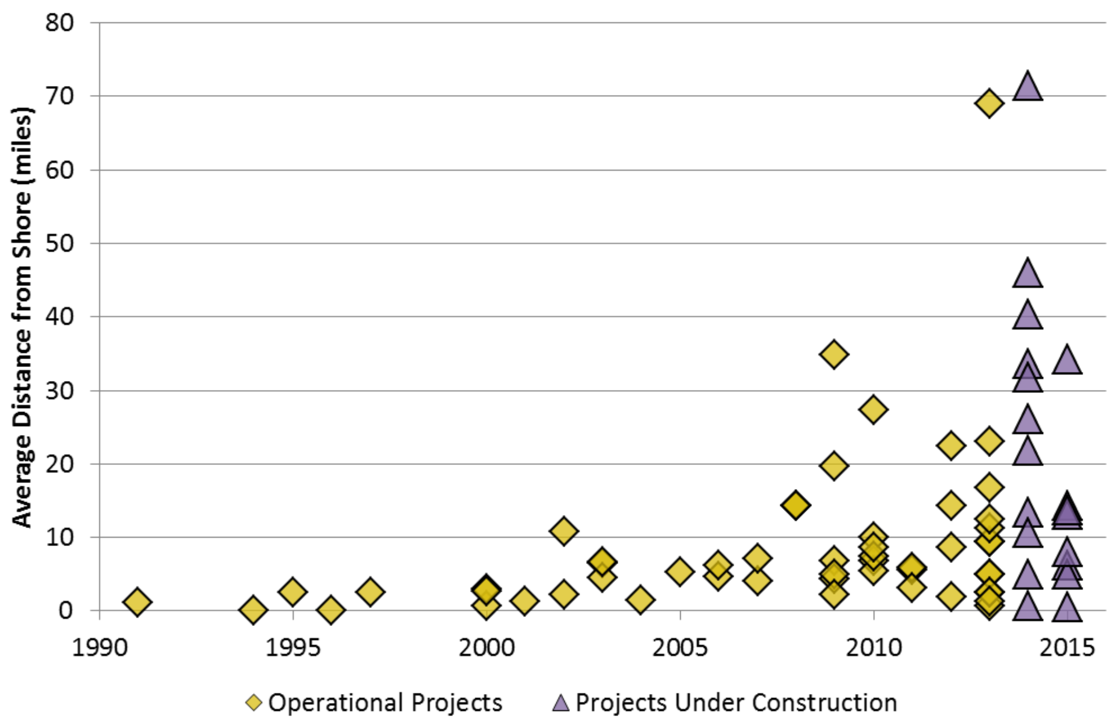
1.4 Market Segmentation and Technology Trends

As noted in the October 2013 edition of this report, global offshore wind projects have followed several general trends over time that will influence the developing U.S. market. In particular, wind farm sites continue to move farther offshore into deeper waters, where more energetic wind resources and increased annual energy production can contribute to increased project revenues. While this trend helps reduce visual impacts and public opposition to offshore wind, it also requires advancements in foundation technologies and affects the logistics and costs of installation and maintenance. Related trends in turbine design continue to shift toward higher capacity machines, which combine with increasing hub heights and rotor diameters to allow projects to take better advantage of higher wind speeds. Similarly, prototype machines are testing alternative drivetrain configurations that aim to increase efficiencies, lower turbine weights, and decrease the frequency of costly trips to service and maintain each turbine. The following sections discuss each of these trends in more detail.

1.4.1 Depth and Distance from Shore

The global trend toward deeper water sites and greater distances from shore continued in 2013, both for completed projects and those newly under construction. With this trend comes increased costs tied to more complex installation in deeper waters, longer export cables (and subsequent line losses), and greater distances for installation and ongoing O&M vessels to travel. Figure 1-6 illustrates the average distance from shore for each global offshore wind project based on the year in which it was installed.

Figure 1-6. Average Distance from Shore for Global Offshore Wind Projects over Time



Note: Multi-phase projects were combined and are reported at the latest year when turbines were added at the project site. Expansions or phases of existing projects sites currently under construction were omitted to avoid skewing the data. Figure includes commercial-scale projects; test and demonstration-scale projects are excluded.

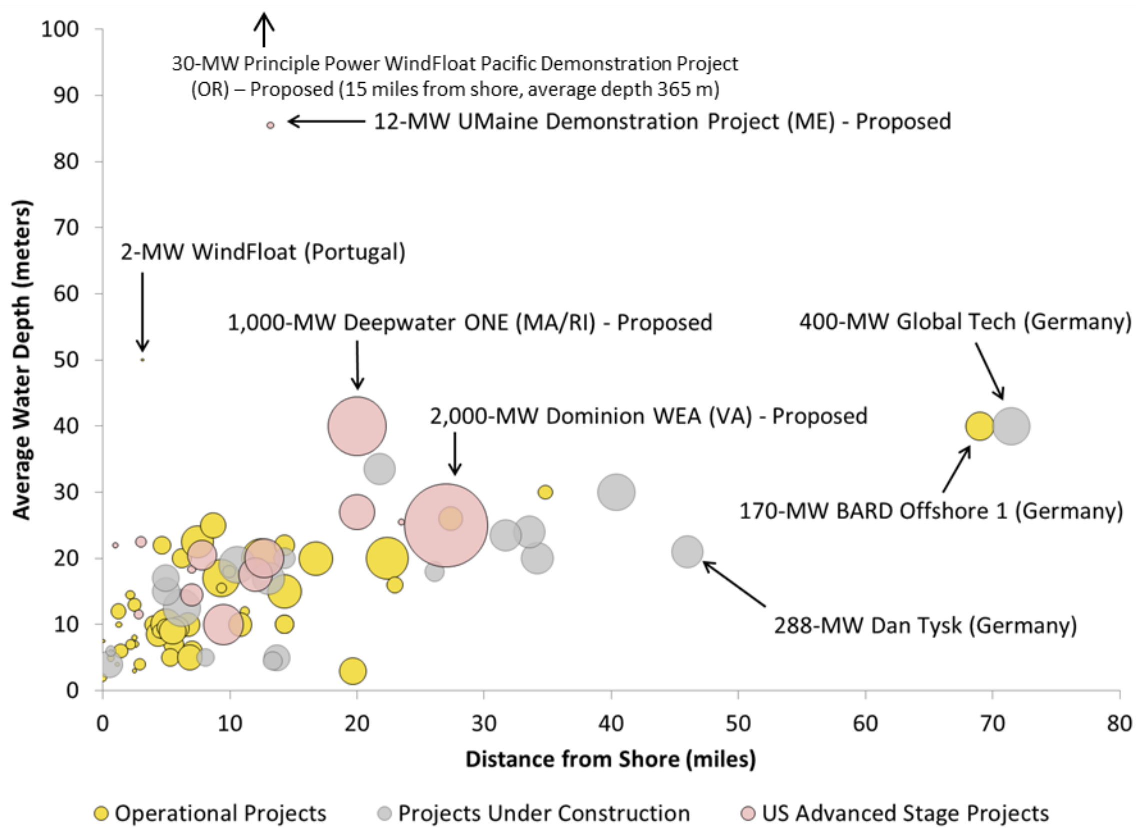
Source: Navigant analysis of data provided by NREL and Navigant Research

As shown above, more projects under construction in 2014 will be installed in waters greater than 20 miles from shore than in any previous year. Of those projects under construction in waters less than 10 miles from shore, all but two are located in the nascent Asian markets of China and South Korea. For commercial-scale projects with capacity additions in 2013, the average water depth was about 15 meters, and the average distance from shore was 13 miles. Figure 1-7 shows the relationship between average distance from shore and average water depth for global offshore wind projects (both operational and under

More projects under construction in 2014 will be installed in waters greater than 20 miles from shore than in any previous year.

construction), as well as planned U.S. projects in advanced stages of development.

Figure 1-7. Depth and Distance from Shore for Global Offshore Wind Farms



Note: Bubble size indicates projects' relative capacities; several projects are labeled for scale. Multi-phase projects were combined to show cumulative project capacity.

Source: Navigant analysis of data provided by NREL and Navigant Research

As shown in Figure 1-6 and Figure 1-7, several projects currently under construction (particularly in Germany) are pushing the current limits of water depth and distance to shore. While advanced-stage U.S. projects are generally planned for closer to shore than these newer European projects, some are planned in BOEM WEAs with relatively deeper waters (e.g., Deepwater ONE). Notably, some of the WEAs have average depths that exceed those of any currently operating commercial projects. The Massachusetts WEA, for example, has an average depth of 50 meters and a maximum depth of 64 meters.

Also of note are several full-scale floating foundation demonstration projects operating in (or planned for) waters at depths of more than 50 meters. Details of operating and planned full-scale floating offshore turbine projects appear in Table 1-4.

Table 1-4. Operating and Planned Global Projects with Floating Foundations

Project	Year Installed	Location	Turbine Capacity	Water Depth (m)	Foundation Type
Statoil Hywind 1	2010	Norway	2.3 MW	220	Floating Spar
Principle Power WindFloat	2011	Portugal	2 MW	50	Semi-submersible Platform
Kabashima/Goto	2013	Japan	2 MW	91	Floating Spar
Fukushima Phase 1	2013	Japan	2 MW	120	Semi-submersible Platform
Fukushima Phase 2 (Planned)	U/C	Japan	2 x 7 MW	120	One Semi-submersible Platform; One Floating Spar
Statoil Hywind 2 (Planned)	Targeted for 2016	Scotland	5 x 6 MW	100	Floating Spar
Principle Power WindFloat Pacific	Targeted for 2017	U.S (Oregon)	6 x 5 MW	365	Semi-submersible Platform

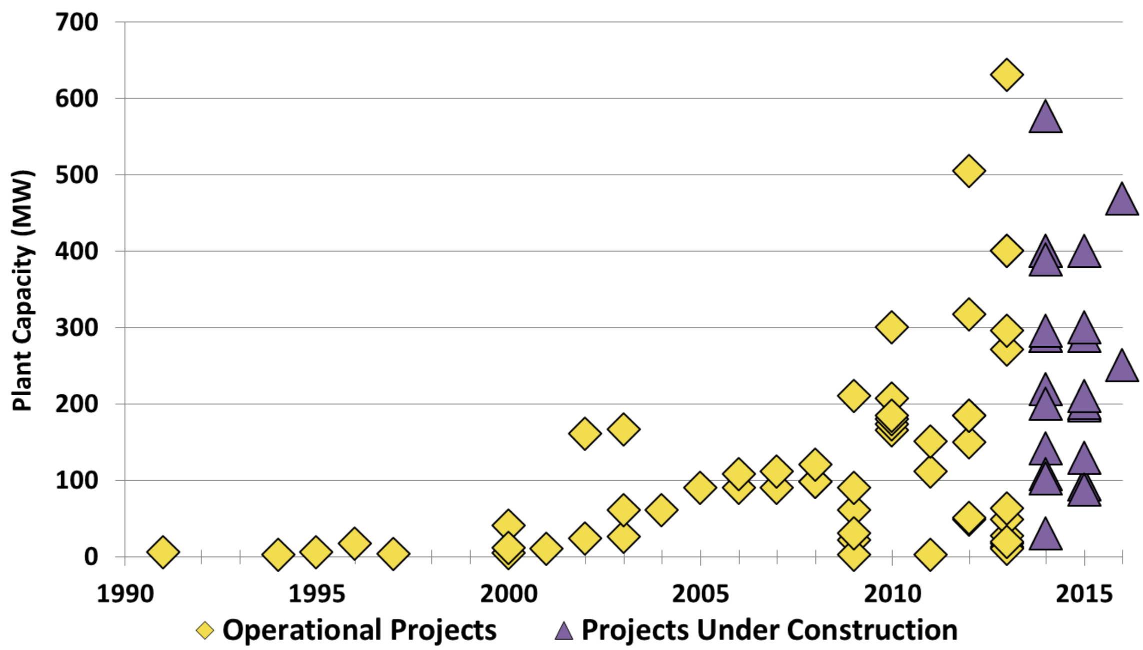
Source: Navigant analysis of data provided by NREL and Navigant Research

In the U.S., the University of Maine has previously proposed two floating, 6 MW demonstration turbines at an approximate depth of 86 meters, as shown in Figure 1-7, while Principle Power has proposed a 30 MW WindFloat Pacific project 15 miles off the Oregon coast in water estimated at 365 meters deep.

1.4.2 Plant Characteristics

The trend of more distant and deeper plant sites has coincided with a continued shift toward larger and higher-capacity projects. Figure 1-8 illustrates the increasing trend in plant sizes over time for both operational projects and those under construction.

Figure 1-8. Global Offshore Wind Plant Capacities over Time



Note: Plant capacities are shown for the year each project reached completion. Multi-phase projects were combined to show cumulative project capacity and are reported at the latest year when turbines were added at the project site. Figure includes commercial-scale projects; test and demonstration-scale projects are excluded.

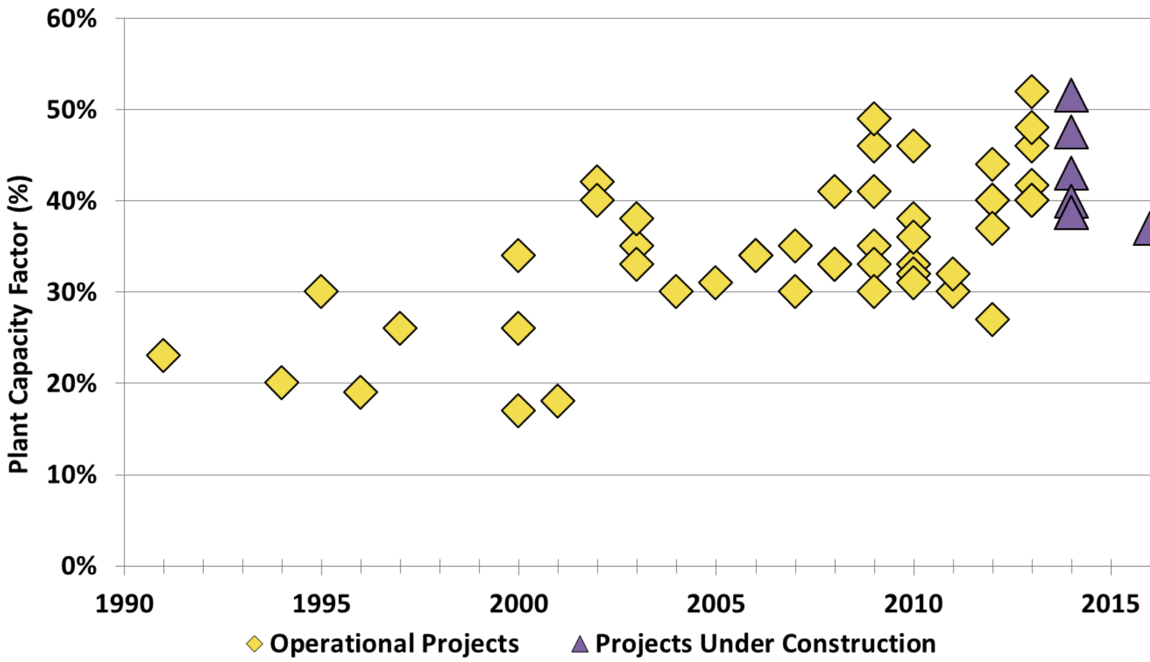
Source: Navigant analysis of data provided by NREL and Navigant Research

As shown in Figure 1-8, the cumulative average capacity for projects completed from 2010 through the end of 2013 is approximately 177 MW.[11] By comparison, the average per-project capacity for installations currently expected to reach completion in 2014 or 2015 is 237 MW, suggesting that the average developed area for these projects is also increasing.

[11] This includes the total capacity for multi-phase projects that added turbines at an existing site over the course of more than one year (e.g., Germany's BARD Offshore and the United Kingdom's Greater Gabbard site)

As developers move further from shore, they also gain access to generally stronger and more consistent wind resources, particularly at higher hub heights. As a result, new plants have continued to show a slow but steady increase in reported capacity factors over time, as illustrated in Figure 1-9.

Figure 1-9. Reported Capacity Factors for Global Offshore Wind Plants over Time



Note: Plant capacity factors are shown for the year each project reached completion. Multi-phase projects were combined to show a single capacity factor and are reported at the latest year when turbines were added at the project site. Figure includes commercial-scale projects; test and demonstration-scale projects are excluded.

Source: Navigant analysis of data provided by NREL and Navigant Research

1.4.3 Turbine Trends

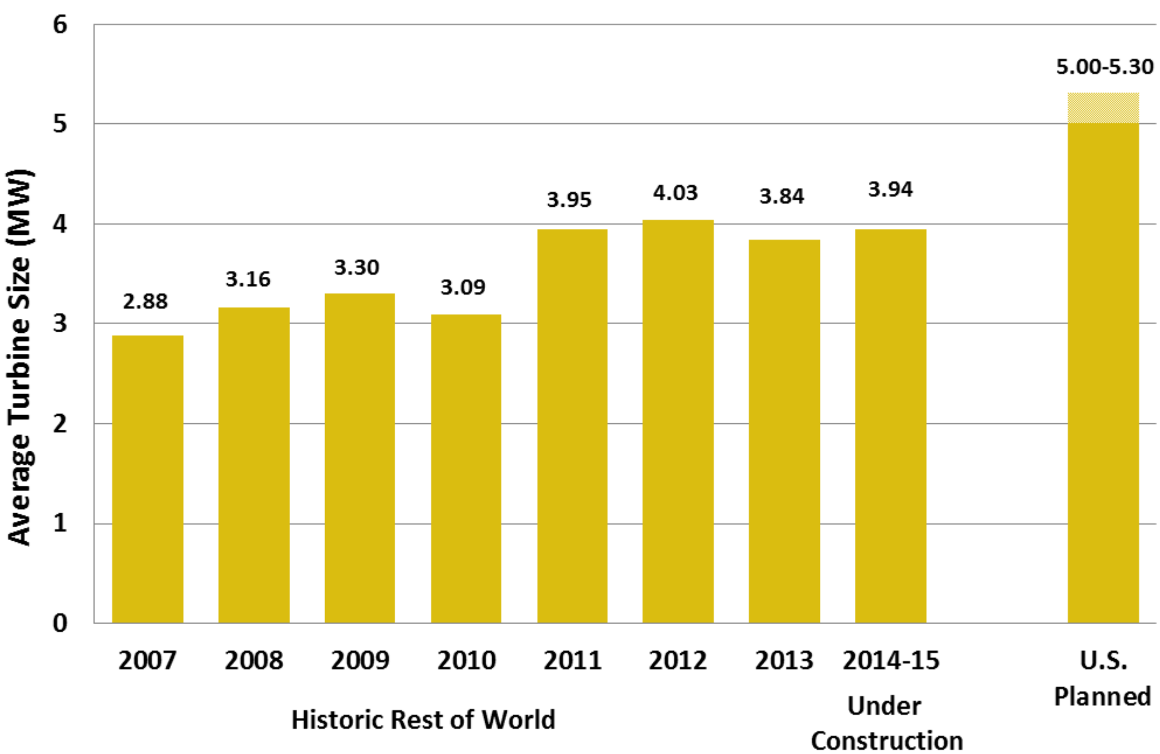
As the offshore wind power market has continued to grow, manufacturers have continued to design larger and more innovative turbine models to address the specific challenges and design conditions of the offshore environment. While fewer logistical constraints (relative to onshore projects) have allowed for larger turbine and blade designs, manufacturers have sought to simultaneously control or reduce overall project costs through increased reliability and tower top (nacelle plus blades) mass reductions, in part through alternative drivetrain configurations. While the growth in average nameplate capacity of installed turbines (as well as blade length and turbine height) has slowed in the past two years, continued announcements of larger turbine and blade designs suggest that the upward trend will continue in the near future. The most recent generation of offshore turbine technology comprises multi-megawatt machines with several different drivetrain configurations specifically designed for offshore use.

1.4.3.1 *Turbine Capacity*

The average nameplate capacity of offshore wind turbines jumped substantially from 2010 to 2011 as projects increasingly deployed 3.6 MW and 5 MW turbines.[12] Since then, however, average turbine size has plateaued around 4 MW. In 2013, 66 units of 5 MW or larger turbines were deployed, including 18 of Senvion's 6.15 MW turbine at Belgium's Thornton Bank Phase II project site. Figure 1-10 shows the annual average turbine size, weighted by each project's share of annual capacity additions, for all global projects and planned U.S. projects.

The upward trend in average turbine sizes will likely resume toward 2018 as developers begin deploying more 5.0 MW and larger turbines.

Figure 1-10. Average Turbine Size for Historic Global and Planned U.S. Offshore Wind Farms



Note: Average turbine size is based on an annual capacity-weighted figure – each individual turbine installed is factored into the annual average. For U.S. Planned projects, the range provided reflects that some developers have not settled on what size turbines they will use. Rest-of-world figures include commercial-scale projects only; test and demonstration-scale projects are excluded.

Source: Navigant analysis of data provided by NREL and Navigant Research

[12] This "capacity-weighted" average accounts for each individual turbine installed at projects globally each year.

Figure 1-10 suggests that this leveling off of average turbine size will likely continue over the next two years, with the average turbine size for known projects under construction totaling 3.94 MW. For those projects currently under construction, 45 percent of the installed turbines are expected to be 3.6 MW machines, while an additional 29 percent will be in the 2.5 to 3.0 MW range. Notably, a majority (about 64 percent) of the smaller (<3.6 MW) turbines currently planned for installation are from Asian manufacturers for projects in China and South Korea. The 3.6 MW turbines mostly comprise Siemens machines for which supply agreements were likely signed before the newer 6 MW turbine became commercially available. This backlog of orders will likely carry through 2015, when Siemens will begin to ramp-up delivery of its 4.0 and 6.0 MW turbines. In general, the upward trend in average turbine sizes will likely resume toward 2018 as developers begin deploying more 5.0 MW and larger turbines. As illustrated in Figure 1-10, this will likely include several U.S. advanced-stage projects, which are expected to have an average capacity of around 5 MW.

As noted in previous editions of this report, there are several compelling drivers for this scaling of offshore wind turbines, including the following:

- Economies of scale may arise from components that do not vary in cost in direct proportion to turbine size (e.g., controls) (EWEA 2009a).
- Advancements in materials, design, processes, and logistics have also allowed manufacturers to build larger components while lowering system costs (EWEA 2009a).
- Higher hub heights and larger rotors enable significant energy capture improvements (Lantz, Wiser, and Hand 2012).
- Offshore wind turbines avoid many of the size constraints of land-based turbines, due to the potential for portside manufacturing and marine transport.
- Greater turbine size enables fewer units to achieve the same installed capacity, helping to reduce total installation, balance of plant, and expected O&M costs on a $/kW or $/kWh basis (van Bussel and Bierbooms 2003).

Given these drivers, turbine scaling is expected to play an important role in offshore wind technology, and turbine manufactures are actively developing new, larger models in a bid to capture a greater share of the growing market. As of 2013, seven companies had commercially available offshore turbines in the 5.0 to 6.15 MW range, including Alstom, Areva, Bard, XEMC Darwind, Senvion, Siemens, and Sinovel. While manufacturers are expected to introduce additional turbines in this range, some are looking to push the range even higher in the next two years, including Mingyang (6.5 MW), Mitsubishi (7 MW), Samsung (7 MW), and Vestas (8 MW) (Navigant Research 2014). The largest of these turbines, the Vestas V164, had a prototype installed in January 2014 and received its first commercial order in February, with DONG Energy selecting the turbine for its extension of the Burbo Bank project in the U.K. (Smith 2014). In late 2013, Areva also announced that it is working on an 8 MW offshore turbine model, while others report that they are pursuing designs in the 10 to 15 MW range (Navigant Research 2014).

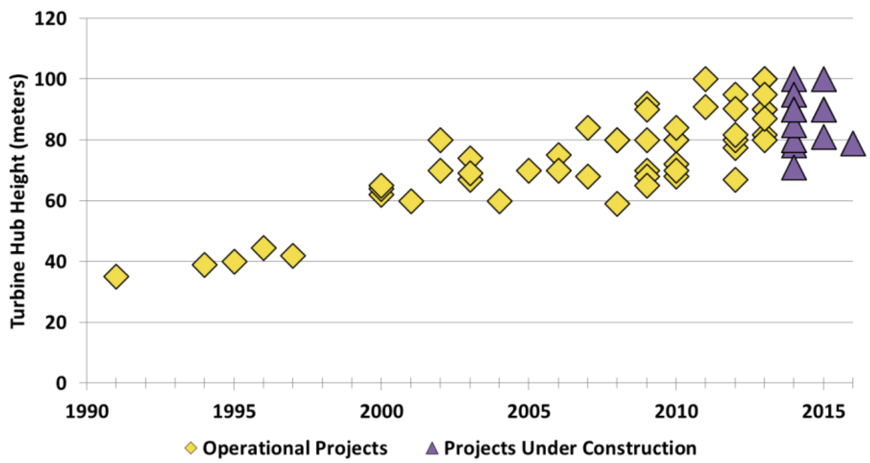
While these announcements suggest some continuous improvement and achievement in turbine design, the development of these larger machines requires a vast array of technical innovations throughout the turbine as well as in foundations, installation strategies, balance of plant equipment, and O&M practices.

To some degree, limitations in these other areas may serve to block, or at least slow, the growth in turbine capacities. For example, advancements in manufacturing will be needed as the castings and bearings for such large turbines push the limits of existing foundries and other players in the wind supply chain. New foundation designs, vessel capabilities, and innovative staging and assembly strategies will likely be as important as the development of future generations of wind turbines.

1.4.3.2 Hub Height and Rotor Diameter

As with average turbine size, the trends toward increasing hub heights and large blade designs appear to be slowing, though likely only temporarily. Figure 1-11 and Figure 1-12 show the hub height and rotor diameters, respectively, of global offshore wind projects over time.

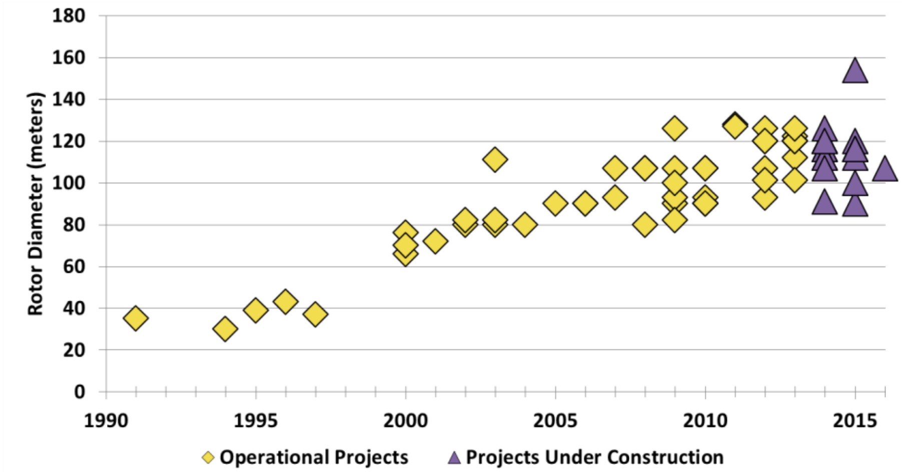
Figure 1-11. Global Offshore Wind Plant Hub Heights over Time



Note: Plant hub heights are shown for the year each project reached completion. Multi-phase projects were combined to show a single hub height and are reported for the latest year turbines were added. Figure includes commercial-scale projects; test and demonstration-scale projects are excluded.

Source: Navigant analysis of data provided by NREL and Navigant Research

Figure 1-12. Global Offshore Wind Plant Rotor Diameter over Time



Note: Rotor diameters are shown for the year each project reached completion. Multi-phase projects were combined to show a single rotor diameter and are reported for the latest year when turbines were added. Figure includes commercial-scale projects; test and demonstration-scale projects are excluded.

Source: Navigant analysis of data provided by NREL and Navigant Research

In general, increasing hub heights and larger blade designs accompany the trend toward larger turbine sizes to provide for increased energy capture per turbine. While larger blades increase each turbine's swept area, the towers on which those turbines are installed must also grow in order to accommodate the required blade-tip clearance between the turbine and the sea surface. As the newly announced 7 MW, 8 MW and larger machines reach commercial deployment in the next few years, the trend toward taller towers and larger blades is likely to resume as well. This includes the following three turbine and blade designs currently being prototyped:

- The Vestas V164 8 MW prototype turbine installed in early 2014 has a rotor diameter of 164 meters, greater than any other turbine currently slated for construction through 2015. Its 80 meter blades use a design that abandons the company's conventional central spar approach (wherein a central "backbone" runs the length of the blade and absorbs most of the structural loads). Instead, the blades incorporate a "structural spar" design that uses three integrated layers of carbon-reinforcement, called shear webs. The main share of structural loads are absorbed by this enhanced blade shell. According to Vestas, this design enables the manufacture of a larger blade while mitigating cost increases, particularly from increased carbon use (de Vries 2013b). DONG announced the first commercial order for the V164 in February 2014 (Smith 2014).
- Mitsubishi completed testing of the 82 meter blade (167-meter rotor diameter) for its SeaAngel 7-MW turbine in May 2014, and expects to complete the development of a full-scale prototype turbine in summer 2014 (Snieckus 2013a; SSE 2014); however, this represents a year-long delay from its original plans. Mitsubishi also plans to deploy the SeaAngel on a floating, semi-submersible platform at the Fukushima Demonstration project in Japan at the end of 2014 (Foster 2014). Earlier in 2013, the company had announced a preliminary agreement to supply 700 units of the 7-MW turbine to projects in the United Kingdom (Backwell 2013). It is unclear,

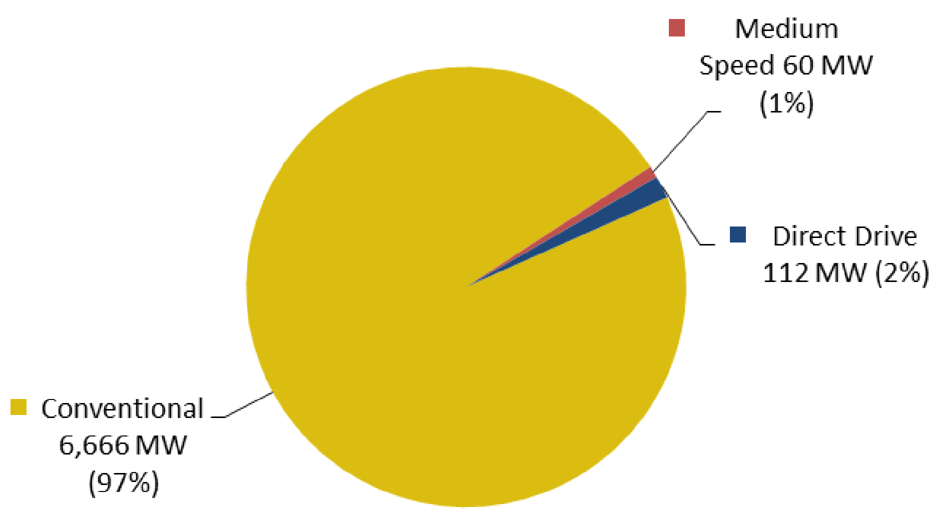
however, whether that agreement will change due to the delays in deployment and testing of the prototype or Mitsubishi's subsequent joint venture with Vestas (which the companies announced in September 2013). Like the Vestas blade, the Mitsubishi blade incorporates carbon-reinforced epoxy resin into its design to reduce weight (de Vries 2013b).

- The Samsung S7.0-171 prototype turbine was commissioned in June 2014 at the Fife Energy Park in Scotland (PE 2013). The blade, developed by SSP Technology, also uses carbon and holds the current record for the longest blade ever produced at 83.5 meters (171-meter rotor diameter). The blade is part of Samsung's 7-MW turbine, which is expected to be deployed in 2015 in South Korea's first offshore wind plant (CompositeWorld 2013).

1.4.3.3 Drivetrain Characteristics

The shift to more distant locations and larger capacity turbines, along with a desire to minimize tower top mass, has driven continued innovation in drivetrain configurations. As shown in Figure 1-13, offshore wind turbines have historically used a conventional drivetrain design, incorporating a high-speed, asynchronous generator (i.e., an induction generator) and a three-stage gearbox.

Figure 1-13. Share of Cumulative Installed Offshore Wind Capacity by Drivetrain Configuration (through 2013)



Note: Figure only includes commercial-scale offshore wind projects. It does not include pilot or prototype projects.

Source: Navigant analysis of data provided by NREL and Navigant Research

Figure 1-13 shows that 97 percent of offshore wind turbines installed in commercial-scale projects have conventional high-speed drivetrain architectures. Other configurations, such as direct-drive and medium-speed drivetrains, have been limited to a combined 3 percent market share of cumulative installed capacity. Deployment of turbines with alternative drivetrain configurations will likely increase significantly over the next several years, as the new 5 to 8 MW class turbine models from Siemens, Vestas, Areva, Alstom, and Mitsubishi are installed at commercial projects (Miller 2014).

As described more fully in previous versions of this report, turbine OEMs are pursuing several alternative drivetrain configurations in an effort to address the cost-of-energy drivers discussed in Section 2.3. These considerations have driven manufacturers (including those who have historically relied on high-speed architectures) to adopt such alternates as the basis for designing next-generation turbine platforms. Table 1-5 summarizes the five main categories of drive systems currently under development.[13]

Deployment of turbines with alternative drivetrain configurations will likely increase significantly over the next several years, as the new 5 to 8 MW class turbine models from are installed at commercial projects.

Table 1-5. Segmentation of Wind Turbine Drivetrain Architectures

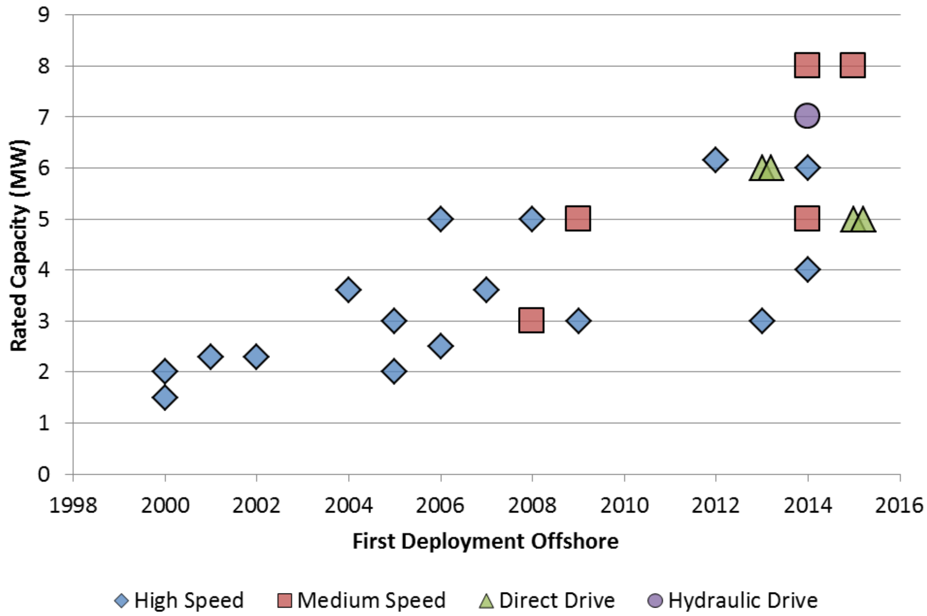
Category	Description
High Speed	Drivetrain design incorporates a 3-stage mechanical gearbox; speed increase ratio generally greater than 60:1; designs typically coupled with asynchronous induction or doubly fed induction generators
Medium Speed	Drivetrain design incorporates a 2-stage mechanical gearbox; speed increase ratio generally between 2:1 and 59:1; designs typically use permanent magnet generators
Direct Drive	Drivetrain design does not incorporate a gearbox; designs typically use permanent magnet generators
Hydraulic Drive	Drivetrain design incorporates a hydraulic gearbox; designs typically use synchronous generators
Distributed or Hybrid Drive	Drivetrain design incorporates a mechanical or hydraulic/mechanical gearbox, with multiple output shafts connected to an equal number of generators (i.e., Clipper Liberty 2.5 MW)

Source: Navigant analysis, Navigant Research 2012

[13] For a detailed technical discussion of these potential drive train configurations, see BTM Consult 2012.

Figure 1-14 illustrates the evolution of drivetrain systems for offshore wind turbines, highlighting the parallel trends in increasing turbine capacity and changing drivetrain configurations since 2000.

Figure 1-14. Offshore Wind Turbine Prototypes by Drivetrain Configuration and Year of First Offshore Deployment



Note: Deployments after 2013 based upon wind turbine manufacturers' announced schedules.

Source: NREL data

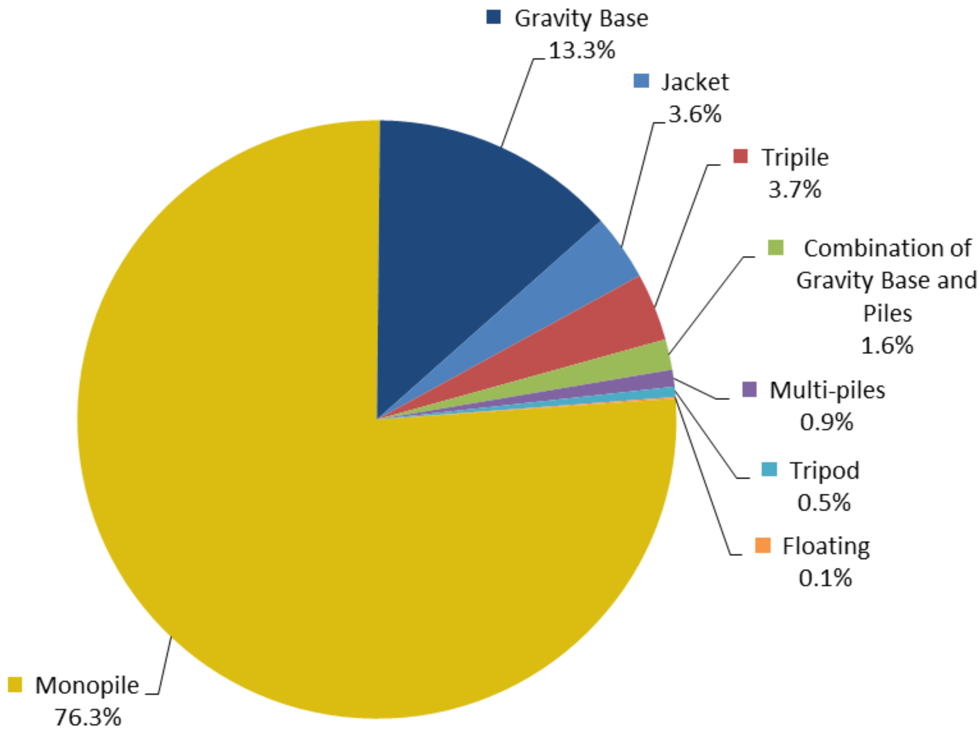
As shown, the average size of next-generation machines aligns with the continuing trend toward larger turbines. The wide spread of rated capacity (between 3 MW and 8 MW) for turbines currently under development reflects manufacturers' divergent design approaches and internal philosophies for how best to meet customer demands while minimizing manufacturing costs. Each architecture offers its own set of advantages, and the diversity of proposed solutions suggests that an optimal approach for offshore machines has yet to be established.

1.4.4 Support Structure Trends

The past year has seen a continued trend for substructure design innovations, as the challenges of installing larger turbines, siting projects in deeper waters, and the need to reduce installed costs persist. While much of the focus in recent years has been on alternatives to the conventional monopile approach (due to various limitations), the advent of the extra-large (XL) monopile (suitable of 45 m water depth) may have somewhat lessened the impetus for significant change. Regardless, the optimal type of substructure (and the potential for innovation) is largely driven by site-specific factors, and plenty of opportunity remains for new designs that can address developers' unique combinations of needs.

Figure 1-15 summarizes the relative market share of each substructure type (based on number installed) for offshore wind projects installed through the end of 2013. As shown, monopile foundations continue to comprise the majority of installed units.

Figure 1-15. Substructure Types for Completed Offshore Wind Projects (Units through 2013)

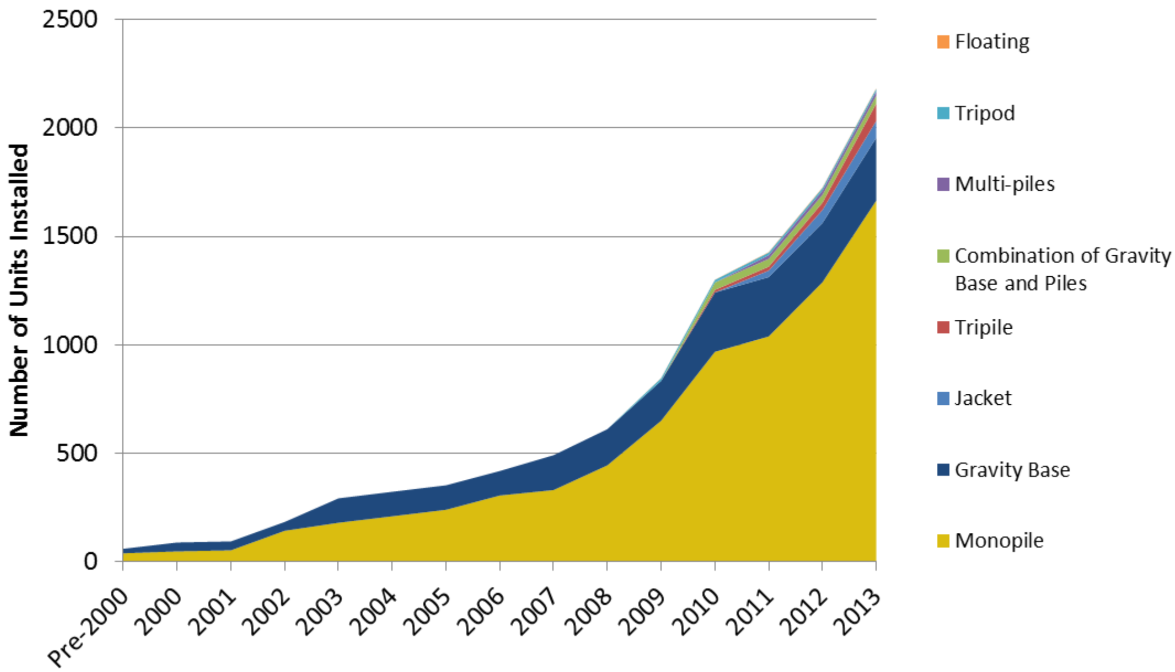


Note: Percentages are based on the number of turbines using each substructure technology. Figure includes commercial-scale projects; test and demonstration-scale projects are excluded.

Source: Navigant analysis of data provided by NREL and Navigant Research

Figure 1-16 illustrates the same metric (i.e., cumulative units installed) over time for completed offshore wind projects. As shown, the general trend toward diversification of substructure types continued modestly in 2013, with 82 percent (377 turbines) of installed units continuing to rely on the monopile approach. The remainder of units installed in 2013 comprised tri-pile (46 units, 10%), jacket (18 units, 4%), and gravity-based (16 units, 3%) foundations.

Figure 1-16. Substructure Types for Completed Offshore Wind Projects by Year Installed



Note: Based on the number of turbines using each substructure technology. Figure includes commercial-scale projects; test and demonstration-scale projects are excluded.

Source: Navigant analysis of data provided by NREL and Navigant Research

These trends appear set to continue for projects currently under construction and expected to reach completion by the end of 2014. Based on NREL and Navigant data, monopiles are expected to comprise approximately 71 percent of units installed in 2014, while multi-member/multi-pile designs (jackets and tripods) will have an increasing share of planned installations (estimated at 11 percent and 18 percent, respectively). Notably, the recent slow-down in deployment of gravity-based foundations appears to also be continuing, with no known installations expected for 2014.

1.4.4.1 Monopiles Continue to Dominate (and Scale)

As noted, monopiles have historically dominated the offshore wind market. In the U.S., the Cape Wind project has committed to using monopiles to support its 3.6 MW turbines. Despite their popularity and familiarity, these large steel pipes (with diameters between 3 and 7 meters) have recently been challenged as increasing water depths and larger turbines sizes pose challenges related to installation logistics, turbine design, and material costs. In 2013, however, it appears that these issues may have been at least partially addressed by the introduction of the XL monopile.

In July 2013, EEW Special Pipe Construction, a major monopile supplier, purchased and demonstrated new fabrication equipment capable of rolling 10-meter diameter piles (Snieckus 2013b). In October 2013, the company shipped its first batch of 39 XL monopiles (albeit of a lesser, 6.5-meter diameter) for EnBW's Baltic 2 wind farm, where they will be installed in depths up to 35 meters and support Siemens 3.6 MW turbines (Snieckus 2013c). In early 2014, the firm also announced supply agreements to supply DONG Energy's Gode 1 and 2 offshore wind farms, which will use Siemens 6.0 MW turbines located in water depths of 25 to 35 meters (OffshoreWind.biz 2014b). Some industry experts postulate that XL monopiles could even be used in water depths up to 60 meters (Daubney 2013).

Despite the potential benefits of these XL monopiles, there may still be challenges to overcome. For example, as they continue to increase in size, these larger foundations may encounter limitations in the vessels that can handle their greater size, weight and diameter, which exceed the capabilities of available piling hammers (IHC Merwede 2012, A2SEA 2014). In addition, some projects have encountered limitations (some imposed, others voluntarily agreed to) related to monopile installation, including on what times of day or parts of the year they can drive piles based on concerns about the noise and vibrations' effects on both the public and marine life (Kuffner 2014).

1.4.4.2 Multi-piles Lead to Broader Diversity in Design Approaches

For sites in deeper water (from 25 to 60 meters), or with 5 MW and larger turbines, developers have historically shown a preference for multi-pile designs (e.g., jackets and tripods). Jacket structures derive from the common fixed-bottom offshore oilrig design, relying on a three- or four-sided lattice-framed structure that is "pinned" to the seabed using four smaller pilings, with one in each corner of the structure (EWEA 2011; Chapman et al. 2012). The tripod structure utilizes a three-legged structure assembled from steel tubing with a central shaft that consists of the transition piece and the turbine tower (EWEA 2011). Like jackets, the tripod is also pinned to the seabed with smaller pilings. The tri-pile, a related foundation type, uses three pilings tied together by a central transition piece above the surface of the water (EWEA 2011).

Of these three multi-pile designs, jackets entail significantly more fabrication and assembly due to a large number of required welds, but are less material intensive than either tripod or tri-pile designs (EWEA 2011). Experience gained through deployment has shown that pre-piled jackets have been much less costly to deploy than either tripods or tri-piles. Thus far, low annual production volumes for multi-pile substructures (less than 100 jackets have been installed, compared to more than 1,000 monopiles), has prevented the optimization of fabrication yards. As a result, each foundation requires a relatively high amount of manual labor to fabricate, which has a large impact on delivered cost.

While the advent of the XL monopile may be offsetting a shift toward multi-pile designs to some degree, it is likely that multi-pile substructures will continue to gain market acceptance.

While the advent of the XL monopile may be offsetting a shift toward multi-pile designs to some degree, it is likely that multi-pile substructures will continue to gain market acceptance, especially in water depths greater than 30 meters and at sites with challenging subsea soil conditions. In addition, several companies are developing new designs to address some of the disadvantages associated with more conventional multi-pile designs. Keystone Engineering, for example, is developing an Inward Battered Guide Structure (IBGS), or "twisted jacket," which it claims offers a 20-percent weight reduction relative to a standard four-leg jacket and has fewer welds to improve manufacturability. This twisted jacket was used to support a met tower at the Hornsea development zone in the U.K. and has been selected as the preferred design for the 12-MW Dominion and the 25-MW Fishermen's demonstration projects in the United States (Keystone 2014; DOE 2014). DONG Energy and SPT Offshore, supported by the U.K.'s Carbon Trust, will deploy an innovative three-legged jacket in 2014 at its Borkum Riffgrund 1 project in Germany (Carbon Trust 2014). This foundation differs substantially from conventional designs in that it is anchored to the seafloor using suction bucket technology instead of driven piles. This design helps to reduce installation costs while eliminating the environmental impacts associated with noise emissions from pilling. Siemens has also filed patents for a jacket design that would replace welded node connections with bolted connections to reduce labor requirements in manufacturing.

While promising, many of these new jacket concepts are still in the demonstration phase, and the designs have yet to be verified. Such verification will be an essential step before the foundations can be adopted for commercial offshore wind and will help to validate the claimed cost reduction potential. There is also a potential near-term risk that the diversity of multi-pile designs that the industry is considering will pose challenges for industrialized fabrication facilities seeking to efficiently manufacture large numbers of foundations. Fragmentation of component designs reduces the predictability of demand and could prevent the industry from achieving sufficient annual volumes required for fabricators to recover investments.

1.4.4.3 Gravity-Based Designs Encountering Challenges

Gravity-base substructures represent the second most prevalent type of substructure, with a market share of approximately 15 percent; however, the popularity of gravity bases has recently declined. The 48-MW Kårehamn offshore wind project was completed with gravity-based foundations in 2013, but no additional projects are currently under construction. Recent experience suggests that conventional gravity-base designs may encounter difficulties in water depths greater than 15 meters due to several key challenges:

- long fabrication durations to allow for curing of concrete;
- high dredging requirements to achieve precise seabed preparation;
- reliance on expensive heavy-lift vessels; and
- the installation schedules' high sensitivity to weather conditions.

Despite these challenges, gravity-base technology got a recent boost when EDF Energies Nouvelles, DONG Energy and Wpd Offshore announced that they would deploy the Seatower Cranefree Gravity® foundation at the Fécamp offshore wind farm located off the coast of France (Merecicky 2014). The Seatower foundation is a self-installing foundation that addresses many of the challenges mentioned above. First, the foundation is designed to be towed to the project site by a spread of three conventional tugs and lowered to the sea floor by flooding the base, thus reducing dependencies on heavy-lift vessels and minimizing sensitivity to weather conditions. Second, the foundation's base is outfitted with a steel skirt that penetrates the seabed during installation and can be filled with concrete. This strategy aims to minimize the amount of seabed preparation required for each foundation site.

If the Fécamp demonstration is successful and adequately addresses the historical issues with gravity foundations, it is likely that the technology will see some resurgence in interest. Iberdrola recently announced that it was considering gravity-based foundations for its 500 MW St-Brieuc project in France due to geotechnical conditions that would pose challenges for jacket technology (Dodd 2014).

1.4.4.4 Floating Foundations Seek to Expand the Market's Reach

Interest in floating offshore foundations continues to grow as the industry seeks to mitigate the material requirements and complex and variable installation requirements of deeper-water project sites. In addition, despite the prevalence of undeveloped project sites appropriate for current approaches, governments and developers are also looking toward the vast wind resources available in sites with deeper waters (those exceeding 60 meters). If successful, floating offshore foundations offer the potential to open up vast new regions to offshore wind development, while reducing foundation material relative to deep-water, fixed-bottom foundations; simplifying installation and decommissioning costs. Each of these attributes has the potential to reduce costs moving forward.

Unfortunately, it will likely take several more years of design, development and testing of potential floating turbine platforms for the industry to adequately assess the long-term cost implications of moving to the technology. Notably, several demonstration-scale floating foundation projects are currently operating, with additional installations planned (see Table 1-4 for a summary of operating and near-term planned demonstrations). Existing demonstration projects include Statoil's Hywind 1 (installed in Norway in 2010), Principle Power's original WindFloat pilot (installed in Portugal in 2011), and the Kabashima project (installed in Japan in 2013).

The most recent floating demonstration project is the Fukushima Floating Offshore Wind Farm Demonstration Project, which is sponsored by the Japanese Ministry of Economy, Trade and Industry (METI). The first phase of this project was completed at the end of 2013 and includes deployment of a 2 MW Hitachi wind turbine on a floating, semi-submersible foundation designed by Mitsui, as well as the world's first floating substation, which will transform power to 66 kV for export. The second phase of the project is scheduled for 2014 and 2015, with plans to deploy two 7MW Mitsubishi SeaAngel turbines on floating platforms (Bossler 2013). Fabrication of the first semi-submersible platform was completed by the Mitsubishi Nagasaki Shipyard in June 2014, and deployment of the turbine is scheduled to occur by the end of 2014.

If successful, floating offshore foundations offer the potential to open up vast new regions to offshore wind development foundations; simplifying installation and decommissioning costs.

A second notable demonstration project is the Wave Hub demonstrator, which is funded by the Energy Technologies Institute (ETI) in the United Kingdom. It includes an initial $6 million engineering study of a 6 MW, direct-drive Alstom turbine, coupled with the Pelastar Tension Leg Platform designed by Glosten Associates. Based on the initial study, ETI is prepared to commit up to $33 million to fund the construction and deployment of the integrated system off the U.K.'s southern coast as early as 2015, likely making it the first global deployment of a tension leg platform (Glosten Associates 2013). A third notable demonstration project is the Hywind II demonstration project off the Scottish cost, where Statoil plans to deploy five 6 MW turbines on an optimized spar foundation, which should greatly reduce costs relative to the Hywind I spar by minimizing the specific mass of the hull. The U.K.'s Crown Estate granted Statoil a commercial lease for the site in November 2013, and the project is scheduled for commissioning in 2017, which could make it one of the first floating offshore wind arrays (Crown Estate 2013; Statoil 2014). Finally, one of the DOE ATD projects described in Section 1.2.3, Principle Power's WindFloat Pacific, also seeks to deploy floating foundations off the coast of Oregon by year-end 2017.

1.4.5 Electrical Infrastructure Trends

In the past year, little has changed with regard to challenges and trends in electrical infrastructure for offshore wind farms. In general, the electrical infrastructure has historically consisted of combinations of medium-voltage (nominally 34 kVA) "array" cables that collect power from the wind turbines and higher-voltage export cables to move the power to shore. A voltage step-up transformer substation connects the two.

Two key trends that continued in 2013 have relevance to the nascent U.S. market. First is European countries' reliance on newly formed, dedicated transmission operation entities responsible for overseeing the transmission networks that serve multiple projects. This approach may provide some lessons for the geographically compact distribution of potential wind energy areas of the northeast coast of the U.S. Second is the continued (but somewhat slowed) shift from high-voltage alternating current (HVAC) to high-voltage direct current (HVDC) export lines. As developers continue to explore sites further from shore, and as companies move up the learning curve in installing these more efficient HVDC lines, the long-term per-unit cost decreases will help improve the overall economics for future U.S. projects. Each of these two trends is described in more detail in the following subsections.

1.4.5.1 Dedicated Transmission Operators

As the European offshore wind power industry has matured, the density of projects and their associated transmission networks has also increased. In response, industry and government stakeholders have taken steps to improve overall costs and efficiencies by taking a more integrated approach to shared transmission planning and operations. In 2009, the U.K. established a licensed regulatory regime for offshore transmission, similar to the onshore grid, that provides for competitively selected Offshore Transmission Owner (OFTO) firms to help develop and offshore transmission infrastructure (DECC 2010). Similarly, Germany requires Transmission System Operators (TSOs) to build out the offshore transmission systems to connect projects to the land-based grid. In December 2009, nine nations bordering the North Sea signed the declaration for the North Seas Countries' Offshore Grid Initiative, which aimed to coordinate the technical, market, political, and regulatory components of the region's offshore electricity infrastructure development.

In the United States, several companies have made efforts to proactively address potential transmission capacity constraints to facilitate future development and interconnection of offshore wind projects. In October 2010, Good Energies, Google, and Marubeni announced investment in a $5-billion, 250-mile offshore transmission backbone along the Atlantic coast of the United States (Malone 2010). The Atlantic

Wind Connection consortium received initial FERC approval for the project to receive a return on equity of 12.59 percent, conditional on it being included in PJM's regional transmission expansion plan (FERC 2011). In early 2013, the consortium announced that it was moving forward with development of the project's first phase along the New Jersey coast. In addition to providing transmission to future offshore wind energy projects, this $1.8-billion New Jersey Energy Link transmission line will initially help to address existing transmission constraints in the state's land-based grid (LaMonica 2013). Notably, this proposed approach could lessen the project's overall financial reliance on serving U.S. offshore projects, many of which continue to face delays and political uncertainty (Goossens 2013). However, as of this report's writing, the proposed project was still being evaluated by New Jersey regulators and grid operator PJM Interconnection.

1.4.5.2 Shift to HVDC Transmission Lines

As projects have moved further from shore, industry interest in HVDC export cables has increased, as they create lower line losses than conventional HVAC lines. Various complications, however, have slowed the anticipated shift to HVDC over the past few years. For example, Siemens has suffered from significant write-offs (totaling €1.1 billion since 2011) for over-budget transmission HVDC projects intended to link offshore wind farms in the North Sea to the land-based grid (Webb 2014).

Notably, the AC-to-DC converter stations for these projects are enormous, expensive, and present some new logistical challenges for their construction installation. In June 2014, for example, Drydock World announced the completion of the DolWin beta HVDC converter platform, one of two major components for TenneT's 900-MW DC offshore grid connection in the North Sea. The structure, an adaptation of semi-submersible offshore oil and gas rigs, weighs approximately 23,000 metric tonnes. The top-side equipment alone weighed 10,000 tonnes, and its installation onto the substructure established a new record for heavy lifts. From its construction port in Dubai, the converter station will be loaded onto a heavy lift vessel for transportation to its commission port in Norway, after which it will be towed to the project site. (Marine Log 2014).

In response to these recent cost overruns and logistical challenges presented by conversion to HVDC, some developers are opting to reduce risk by instead running increasingly longer distances with AC export cables (Simon 2014). In the U.S., the two most advanced U.S. projects, which are relatively near shore compared to the larger European projects, will rely on conventional AC transmission. Deepwater's Block Island project will use a 34.5-kV AC export cable, while Cape Wind, plans to use a 115-kV AC export cable (Tetra Tech 2012; DOE 2012a).

1.4.6 Logistical and Vessel Trends

While little has changed in installation and vessel trends since the last edition of this report, such issues will play a key role in the developing U.S. offshore wind market. This section focuses in particular on recent developments in vessels and logistics strategies in North America, as well as those from overseas that are expected to affect the U.S. market. In particular, developers and contractors have been working to create solutions to the limited availability of vessels, which could represent a potentially limiting factor for the growth rate of the U.S. offshore wind market.

The offshore wind project life cycle includes four general phases: pre-construction, construction, project O&M, and decommissioning. Each of these phases comprises various types of services, each typically requiring one or more unique types of vessel.[14] Recent developments in North America have focused primarily on vessels used during construction and O&M.

As global demand for vessels to serve the offshore wind market has increased, vessel suppliers and construction teams have sought to reduce the time required for installation and for transferring foundations, towers, turbines, and blades to sites farther from shore. In particular, newer jack-up vessels are demonstrating several key trends, including the following:

- Increasing deck space to facilitate storage of more and larger turbine components per trip
- Greater crane capacities (i.e., lifting capacity typically greater than 1,000 metric tonnes and hook heights in excess of 105 meters) to lift increasingly large turbine and substructure components
- Increasingly advanced dynamic positioning (DP2 and DP3) systems to increase operational efficiency and safety
- Longer jack-up legs to enable lifting operations in deeper waters
- Greater ability to continue operations in increasingly severe sea states (i.e., wave height limit of at least two meters) to minimize construction downtime

While crane lifting capacity continues to increase, the maximum lifting height appears to be a new key limitation in selecting the construction vessel, as the trend toward larger rotors and taller towers also continues (Hashem 2014). In addition, the impact of moving to XL monopiles is not yet fully understood by the vessel industry; however, there are a few existing vessels capable of lifting these extra-large monopiles' extreme weights.

As indicated in this report's previous editions, U.S. projects and developers face an additional key consideration in their need to comply with the Jones Act (also known as the *Merchant Marine Act of 1920*).[15] The Jones Act prohibits transfer of merchandise between "points in the U.S." unless the owner and crew of the vessel are American as certified by the Secretary of Transportation. However, the Secretary may approve the use of non-certified vessels upon a finding that no U.S. vessel is suitable and reasonably available for transportation of a "platform jacket" for an offshore wind farm.[16] Currently, existing specialist vessels capable of offshore foundation and turbine installation are mostly European-owned and are in high demand for European projects.

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[14] The full spectrum of vessels that may be needed at various points in the offshore wind life cycle is discussed in the previous iteration of this annual market assessment, published in October 2013.

[15] Section 27 of the *Merchant Marine Act of 1920*, as amended (46 App. U.S.C. 883).

[16] "Platform jacket" is defined as "a single physical component and includes any type of offshore exploration, development, or production structure or component thereof, including platform jackets, tension leg or SPAR platform superstructures (including the deck, drilling rig and support utilities, and supporting structure), hull (including vertical legs and connecting pontoons or vertical cylinder), tower and base sections of a platform jacket, jacket structures, and deck modules (known as "topsides"). 46 App. U.S.C. 883.

Some U.S.-based vessel owners and operators have begun efforts to position themselves to serve the U.S. offshore wind power market. Cranford, NJ-based Weeks Marine, for example, has launched the hull and is currently outfitting the R.D. MacDonald, a jack-up barge intended for U.S. projects (OffshoreWind.biz 2012). In addition, vessels initially used in other industries, like Titan Salvage's lift boats Karlissa and Montco Offshore's Lift Boat Robert, have been identified as capable of installing turbines (Montco 2014). While these vessels may not be as optimized and self-sufficient as the turbine installation vessels in Europe, they have the potential to install initial projects proposed in US waters.

Some U.S.-based vessel owners and operators have begun efforts to position themselves to serve the U.S. offshore wind power market.

In addition to traditional bottom-fixed installations, developers are also investigating ways to reduce dependence on installation vessels. The University of Maine deployed the first (pilot-scale) floating wind turbine in U.S. waters in May 2013; this turbine was fully fabricated on shore and towed to the installation site. The DOE has also supported to varying degrees a number of floating demonstration projects, including UMaine's VolturnUS, Statoil's Hywind, Principle Power's WindFloat Pacific and Technology Development projects by Alstom, Clear Path Energy, Nautica, Pelastar and Texas A&M (DOE 2012b). As discussed in Section 1.2.3, Principle Power was awarded continued funding from DOE for its WindFloat Pacific demonstration project in May 2014. The WindFloat foundation and turbine will be fully outfitted quayside at the installation port and towed into place.

Other strategies being pursued include bottom-fixed foundations that are floating or semi-floating during transit to the installation site. For example, Freshwater Wind's Shallow Water Wind Optimization for the proposed Great Lakes project relies on semi-floating, gravity-based foundation technology to eliminate the need for installation vessels during foundation installation. Note, however, that these projects would still require "traditional" jack up vessels to install the turbines.

Despite these developments and innovative near-term strategies, a thriving U.S. offshore wind market will likely require the development of a more robust domestic fleet.

1.4.7 Operations and Maintenance (O&M) Trends

As highlighted in previous sections, the focus on increased reliability, larger turbines, and increased capacity factors should all contribute to relative reductions in O&M requirements. In particular, larger capacity turbines should lead to a lower maintenance cost per MWh generated. However, a general lack of O&M data for the still relatively young offshore wind industry (most turbines are still under warranty) make it difficult to draw any broad conclusions about the expected long-term costs and trends of O&M offshore wind farms.

Some manufacturers have entered into long-term servicing contracts with project owners, signaling an increased willingness to share in the operational risks of the project.

Apart from turbine design considerations, a few key trends have emerged over the past few years that bear mention. In particular, some manufacturers have entered into long-term servicing contracts with project owners (in addition to standard equipment warranty coverage), signaling an increased willingness to share in the operational risks of the project. In May 2014, for example, Siemens agreed to its biggest ever service contract as part of a $2.1-billion contract to supply turbines to the 600 MW Gemini project in the Netherlands. The agreement will last 15 years and includes a dedicated ship and helicopter (Webb 2014). Notably, Siemens has a 20 percent equity stake in the project. Siemens signed a similar service agreement with the Cape Wind project as part of that turbine supply contract (Business Wire 2013).

Another recent development was the announcement by Offshore Wind Solutions GmbH (OWS) in early 2014 to assume responsibility for the operation and servicing of the BARD Offshore 1 Wind Farm. The project's developer, Bard Group, had announced its plan to cease operations in mid-2014 due to a lack of new offshore wind contracts. In turn, OWS stepped in to take over the operations and service aspects of the project, for which it will hire on many of Bard's current employees (OffshoreWind.biz 2013a). The move may signal the development of additional third-party firms that are dedicated specifically to turbine O&M.

In a final note specific to the U.S. market, there is evidence that some agencies have started looking to identify suitable O&M ports on the Atlantic Coast, building on previous DOE efforts to develop a framework for port assessment (Elkinton et al. 2013). In April 2014, for example, the Maryland Energy Administration issued a request for proposals for a state-specific port infrastructure assessment to identify potential O&M ports to serve future projects to be developed in the Maryland WEA (MEA 2014).

1.5 *Financing Trends*

The wind power market, including land-based wind, has historically faced financing challenges. For the U.S. market in particular, the federal tax credit-based incentive mechanism has typically required the support of tax equity investors. In addition, the offshore wind industry entails additional risks relative to land-based wind that make securing financing more challenging. For example, additional technology risk arises from the newer multi-megawatt turbines, given their relatively short operating history, as well as from new foundation types and HVDC transmission lines. Weather and supply chain constraints may also add additional construction and operating risk. Furthermore, regulatory risk will exist in some jurisdictions until clearly defined regimes for permitting and transmission development are established. As a result, lenders charge risk premiums over the market interest rates for land-based projects to compensate for the project risk they bear.

In the U.S., the Cape Wind project has made notable progress since late 2013, having secured at least $1 billion of its estimated $2.6 billion financing needs and secured a conditional $150-million DOE loan guarantee. Globally, 2013 was a transition year for financing, as regulatory instability in both the UK and Germany led to fewer projects being launched. However, transactions related to operating assets were numerous, reflecting the continued increase in installed capacity, and overall financing volume was stable compared to previous years. Altogether, non-recourse debt finance for offshore wind reached €2.13 billion in 2013, an increase compared to 2012, during which non-

Globally, 2013 was a transition year for financing, as regulatory instability in both the UK and Germany led to fewer projects being launched.

recourse debt financing totaled €1.93 billion. The total amount in 2011 of €2.33 billion was slightly higher than 2013. Over the past three years, project finance funding has represented around 40 percent of the net amount invested in offshore wind for the construction of new wind farms.

1.5.1 Rising Capital Requirements

With projects increasing in size, and despite slight reduction in construction cost per MW, the funding need for offshore wind projects has continued to increase. The increasing size of offshore wind projects also puts pressure on contractors' balance sheets, particularly when a project is large compared to a contractor's size. This increased funding need results in the market looking for alternative means of financing or developing new solutions (see Section 1.5.7).

1.5.2 Utility On-balance Sheet Financing

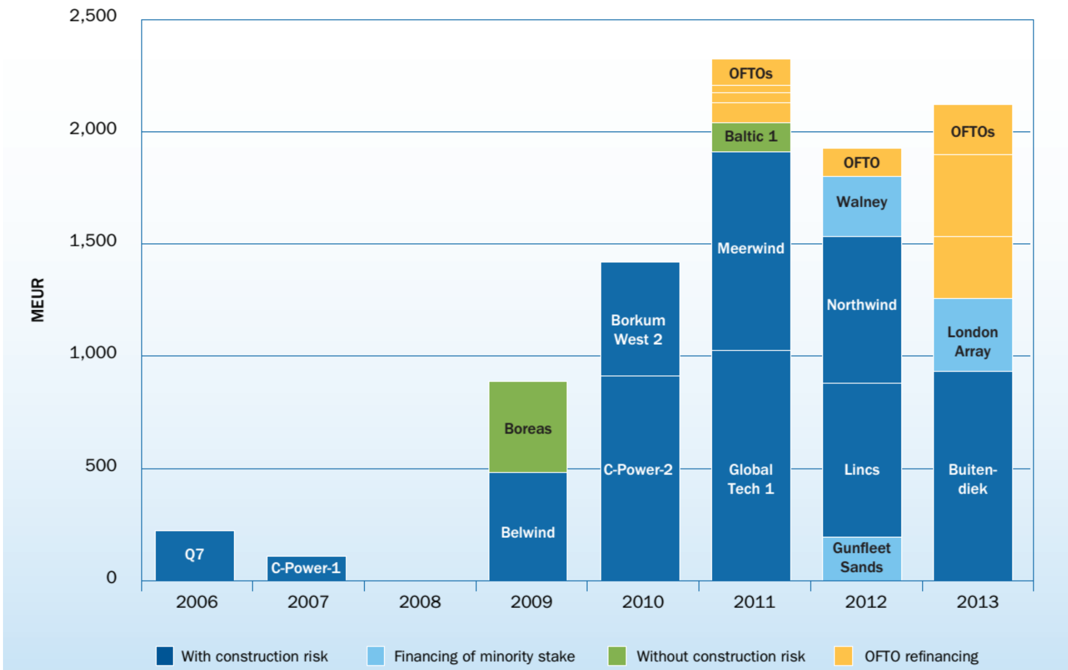
Until 2012, most offshore wind projects were financed on the balance sheets of their developers, generally utilities. Through October 2012, 85 percent of cumulative installed offshore wind capacity was operated by utilities such as DONG Energy, Vattenfall, RWE, and E.ON (Navigant Research 2012). To date, utilities have financed €12.3 billion of the €16 billion spent to build about 5 GW of operating capacity for which detailed financing data are available. However, even though balance-sheet financing costs less than project financing—and is less time-consuming due to a lighter due diligence process—the capital requirements for ever-larger projects like those in U.K. Round 3 have begun to strain the on-balance sheet financing capacity of these utilities. As a result, utilities are investigating alternative financing options.

1.5.3 Project Finance

Despite investors' increased risk aversion during and following the 2008 financial crisis (from which countries are now slowly recovering), the offshore wind industry suffered less than some other markets. Sufficient funding for well-structured projects remained available, in part from the support of multilaterals and export credit agencies. Today, most banks continue to focus on Western European countries, which benefit from current projects' longer operating history and relatively strong government support (e.g., Germany, Belgium and the United Kingdom).

Projects that have secured non-recourse financing appeared insensitive to the effect of the financial crisis. The first offshore wind farm financed with non-recourse debt was the Princess Amalia Wind Farm (formerly Q7) in the Netherlands in 2006. It was followed by the C-Power phase 1 project in Belgium in 2007, which showed that larger turbines (the REpower 5M) were also bankable. In the midst of the financial crisis in 2009, Belgium's Belwind wind farm demonstrated that larger projects (in this case, 165 MW) were bankable and that they could be supported through multilateral involvement (e.g., European Investment Bank [EIB] or Eksport Kredit Fonden [EKF]). Also in 2009, the UK saw its first project-financed deal with the refinancing of Centrica's Boreas project, which involved the participation of 14 banks. Figure 1-17 summarizes these and other key financings for offshore wind projects since 2006.

Figure 1-17. Financing of Offshore Wind Farms: 2006 to 2013 (MEUR)



Source: Green Giraffe Energy Bankers, Int.

As the global market weathered the recession, project financing deals continued to expand and achieve notable milestones. In 2010, for example, C-Power phase 2 and 3 was the first project to receive over €1 billion in financing. This two-year period also saw the project financing of a number of German offshore wind farms. The 200-MW Borkum West 2 project saw the first financing of Areva's 5-MW turbines, while the 288-MW Meerwind project was the first to include construction risk for Siemens turbines, the first to include a private-equity investor (Blackstone), and the first under the German Development Bank's (KfW) offshore wind program. In 2011, the Global Tech I wind farm became the first to achieve the 400-MW mark.

In 2012, key developments focused on the U.K. market, with more than 530 MW of projects (Lincs, 270 MW; Gunfleet Sands, 172 MW; and Walney, 92 MW) financed on a non-recourse basis. Notably, the

Walney project was the first non-recourse refinancing of a minority share on the basis of commercial project financing terms. This structure is unique in the sense that the project financing is not at the project level (where the producing assets are), but rather one step above at the shareholder level. The purpose of this structure was to broaden the universe of potential buyers of minority shares in operational wind farms to include players who need the debt financing to reduce the size of their equity commitment and/or increase their equity returns. Such structures could be replicated on future transactions. In 2013, the refinancing of Masdar's stake in the London Array project in the UK, the largest offshore project in the world, confirmed the development of a secondary market in operating offshore wind farms assets.

Also in 2013, the financing of the Butendiek project, one of Germany's earliest offshore wind projects to be developed, involved EIB, EKF and KfW (under its offshore wind programme) as well as nine commercial banks. This arrangement followed the conventional pattern of mixing public and private funding under a market-tested structure and a simultaneous equity transaction. Notably, this was the first project where pension funds and infrastructure funds took full construction risk for an offshore wind project, a welcome development for an industry that is looking to attract additional investment sources. This development also reveals the financial markets' improved understanding of the risks associated with construction at sea. Previously, German offshore wind project development had slowed due to regulatory uncertainties linked to grid connection availability for future wind farms. Reaching financial close for the Butendiek project came as a positive signal for offshore wind in general, as it signaled that good projects can overcome these kinds of issues and eventually complete the financing process.

In another positive sign, in June 2014, Green Giraffe Energy Bankers announced the finance closing of the 600 MW Gemini offshore wind project in the Netherlands. The €3 billion transaction included a non-recourse debt financing of €2.1 million from a group of 16 international and public banks and the associated equity commitments from a sponsor group comprising Northland Power (60 percent), Siemens (20 percent) Van Oord (10 percent) and HVC (10 percent). The financing was the largest ever for an offshore wind farm and was arranged in record time – after the equity group committed in August 2013 and the banking market was approached in November 2013, the project reached financial close in less than seven months.

The 2014 financing for the 600 MW Gemini project was the largest ever for an offshore wind farm and was arranged in record time.

1.5.4 Multiparty Financing

While a single entity finances most land-based wind farms, the multibillion-dollar offshore projects generally involve co-investment by consortia for risk-sharing and pooling of resources and expertise. For example, seven of the nine Round 3 development zones in the United Kingdom were awarded to consortia, and the 9 GW Dogger Bank Zone was awarded to a consortium of four large utilities. Similarly, projects that have secured project financing (rather than balance sheet financing) have also generally done so through consortia of many banks and other institutions (see the Gemini description in Section 1.5.3). Most of the projects closed over the last few years have typically gathered between five and ten commercial banks, as well as export credit agencies and multilaterals.

1.5.5 Importance of Government Financial Institutions

For larger projects, the support of government or quasi-government agencies has long been critical. Most offshore projects that have been project financed in Europe have received support from some combination of the EIB; the Danish export credit agency, EKF; the German export credit agency, Euler Hermes (EH); and, most recently, the Green Investment Bank (GIB) in the United Kingdom. Notably, EKF is also supporting the Cape Wind project in the U.S. through a $600-million loan; the project has also received U.S. government support via a $150-million loan guarantee from the DOE. The European export credit agencies could potentially facilitate the financing of U.S.-based projects by supporting turbine manufacturers, such as Vestas, Siemens, and REpower.

In addition, the availability of €5 billion from the KfW (the Germany development bank) has facilitated financing for offshore wind projects in Germany. This financing complements other sources, such as the EIB, other export credit agencies, and commercial banks. The proposed Meerwind wind farm, mentioned above, is the first offshore project to have reached financial closing under the KfW's program. The project is also unique in that it did not include EIB funding. In 2012, the 367-MW Walney project in the United Kingdom became the first project to receive funding from the United Kingdom's Green Investment Bank (GIB). The bank contributed approximately one-fifth of the amount needed for the refinancing of the project.

In 2013, the public financing institutions mentioned above (EIB, GIB, EKF and KfW) remained active. In addition to non-recourse debt, EIB also provided corporate financings (such as the €500-million financing to EnBW for the Baltic 2 project and the €500-million funding to Tennet to build offshore grid connections three large projects in Germany) and structured support to transactions such as the credit enhancement bond for the Greater Gabbard OFTO. In the UK, GIB closed its second non-recourse financing with London Array. While this help from public financial institutions has been crucial in the past few years, it is likely to be less so as the offshore wind market matures. In 2012, for instance, the 270-MW Lincs project in the United Kingdom received financing from a group of 10 commercial banks without leveraging any public finance institution funds.

1.5.6 Support from the Supply Chain

Contractors recognize that providing vendor-financing solutions can provide a competitive advantage and shows their commitment to the project through shared financial risk. Such vendor financing solutions include providing senior/mezzanine debt, equity investments, subordination of operational costs, transferring capital expenditures to operational expenses (and vice versa), and guaranteeing pre-completion revenues. The latter three of these are meant to optimize the senior debt amount. These solutions have already been applied to various offshore wind financing structures. For example, Siemens bank was part of the senior debt consortium that project financed the minority stake of the Dutch investors PGGM and Ampere in 2012. Siemens has also directly invested in projects Gwynt y Mor in 2010 (a 10-percent stake) and, as discussed in Section 1.5.3, invested in the Gemini project (a 20-percent stake) in 2014. Also, Van Oord provided subordinated debt for the financing of the construction of Belwind in 2009, as well as a direct investment (10-percent stake) in the Gemini project in 2014.

1.5.7 New Financing Sources

As the offshore wind sector matures, new investors, such as infrastructure and pension funds, private equity groups, and other strategically minded corporations, are also demonstrating interest. These investors have typically purchased minority stakes in operating projects in order to avoid construction risk. DONG Energy has been the primary "seller" of these minority stakes.

As the offshore wind sector matures, new investors, such as infrastructure and pension funds, private equity groups, and other strategically minded corporations, are also demonstrating interest.

In 2009, EIG Global Energy Partners (formerly TCW Energy), an infrastructure fund, purchased a 50-percent stake in a subsidiary of Centrica, which owned the Lynn (97 MW) and Inner Dowsing (97 MW) projects in the United Kingdom. In 2010, Dutch pension fund PGGM joined Ampere Equity Fund to purchase a 24.8-percent stake in the UK's Walney project. DONG again sold off a minority stake of a project in 2011, when it sold 50 percent of the Anholt project to two Danish pension funds, PensionDanmark (30 percent) and Pensionskassernes Administration (PKA, 20 percent).

Other examples of non-traditional offshore wind investors that have entered the market include:

- The previously mentioned Meerwind project in Germany included financing from Blackstone, a U.S.-based private equity firm and the first such firm to participate in an offshore wind project.
- In November 2011, the Japanese trading company Marubeni acquired 49.9 percent of the UK's Gunfleet Sands project from DONG Energy. This deal marked the first to-date financing of a majority stake. Marubeni showed a subsequent increase in its offshore wind activity with the acquisition of Seajacks, a vessel operator, in March 2012, and a 25-percent stake in Mainstream Renewable Power, an Irish project developer, in August 2012.
- In February 2012, DONG Energy sold a 50-percent stake in the 277-MW Borkum Riffgrund I project in Germany to the parent company of LEGO, a Danish toy company. The company cited ambitious environmental goals and long-term financial returns as rationale for the investment.
- In the summer of 2013, another Japanese conglomerate, Sumitomo, acquired minority stakes in a Belgian portfolio of two offshore wind farms (totaling 381 MW) from Parkwind for €100 million. The seller is a holding company jointly owned by an investment company of the Colruyt family and a Flemish investment firm. Notably, one of the other bidders was IKEA, the Swedish furniture company who seems to be following the path previously opened by LEGO.
- In August of 2013, Northland Power Inc., a leading Canadian producer of sustainable energy, agreed to be an equity sponsor of the 600-MW Dutch Gemini project.
- The Green Energy Transmission consortium's December 2013 acquisition of the Greater Gabbard transmission assets was financed through the issue of senior secured project bonds (in an amount of £305 million), including credit enhancement support provided by the EIB (under a European Union-supported project to support infrastructure investment). This move set a precedent for future capital market transactions in the sector and created an additional source of financing for offshore wind assets.

1.5.8 Likely Financing Trends for Offshore Wind in the United States

The independent power producers (IPPs) who are predominantly driving the development of U.S. offshore wind projects are unlikely to self-finance projects through balance sheet financing and will therefore need access to project financing. The banks likely to participate in these U.S. offshore projects will initially be the European banks that have past offshore project financing experience, and they will likely assess U.S. projects in the same way that they assess European projects. However, pricing and other market conditions may be subject to the terms of the U.S. wind project finance market, which at times has deviated from those that are typical in Europe. Given the size of proposed offshore wind projects in the U.S., the support of government agencies (via loans or loan guarantees) could be critical.

As discussed in Chapter 2, offshore wind investors and lenders in Europe rely on support schemes that provide long-term revenue stream stability, either directly through feed-in tariffs (FiTs) or public payments, such as green certificates, or indirectly through long-term PPAs made possible by the underlying regime. Projects in the U.S. to date, such as those in Massachusetts and Rhode Island, rely upon income received from regulated PPAs that provide a fixed price per MWh produced that is well above the wholesale price of power. In addition, each of these U.S. projects expects to qualify for the federal Investment Tax Credit (ITC), an incentive that usually requires the involvement of tax equity investors with sufficient tax liability to leverage the non-refundable credit.[17]

Another support regime that has been proposed in New Jersey is the Offshore Wind Renewable Energy Certificate (OREC) system, which, as a "contract for differences," is not that different from a FiT. However, as discussed in Section 1.2.2, it remains to be seen how the state's Board of Public Utilities will develop guidelines for applying the OREC system.

Both the PPA and OREC systems are expected to be bankable, as they provide sufficient price support to make projects economically viable. The European experience shows that many different regulatory regimes can be successful, as long as the overall price level is compatible with the current installation costs of offshore wind and there is sufficient regulatory stability to cover the relatively long development and construction process.

The DOE's Advanced Technology Demonstration (ATD) project award program has provided additional useful support to demonstration-scale projects (some with ties to planned commercial-scale projects). The application process also provided an opportunity to sound the banking market and gauge banks appetite for offshore wind in the U.S. Based on these "in-principle" responses, there seems to be a market for offshore wind projects that are able to present secured revenues and a sound cost structure.

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[17] At the time of this report's writing, the PTC and ITC had expired at the end of 2013 and had not been renewed. Only Cape Wind and Deepwater's Block Island projects represent that they will qualify to apply the credit based on progress through year-end 2013.

1.5.9 Cape Wind Financing

Since the last version of this report, Cape Wind has made inroads in securing an estimated $1 billion in financing for what analysts expect to amount to a total requirement of $2.6 billion (see Section 1.2.2.3 for a detailed update). Key developments include the following:

- The developer represents that its initial construction activities and supply commitments make the project eligible to take advantage of the federal Investment Tax Credit, which expired at the end of 2013.
- In February 2014, the developer announced a $600 million loan commitment from Danish export credit agency EKF.
- In March 2014, the developer also announced that Natixis and Rabobank had signed on as lead arrangers for the project's remaining financing and that the Bank of Tokyo-Mitsubishi UFJ (BTMU) would be the coordinating lead arranger of the debt portion of financing, corresponding to commercial banks.
- In July 2014, the DOE announced a conditional $150-million loan guarantee for the project, contingent on its securing the balance of its project financing. (Englom 2014).

2. Analysis of Policy Developments

This section provides an analysis of state and federal policy developments with the potential to affect U.S. offshore wind deployment. It includes a description of policies for promoting offshore wind and an evaluation of policy examples to close any competitive gaps. The evaluation systematically defines the offshore program objectives (Section 2.1), identifies barriers to meeting the objectives (Section 2.2), and evaluates examples of policies to address the barriers (Sections 2.3 through 2.6). This section addresses barriers and policies relating to:

- Cost competitiveness of offshore wind energy (Section 2.3)
- Infrastructure challenges (Section 2.4)
- Regulatory challenges, including leasing, permitting, and operations (Section 2.5)
- Summary of representative policies (Section 2.6)

The following table summarizes major policy activities that have occurred in 2014 that affect offshore wind development in various jurisdictions, each of which is discussed in Chapter 2 or in the appendices.

Summary of Key Findings – Chapter 2

- Policies that address cost-competitiveness
  - The U.S. PTC and ITC expired for projects that did not begin construction by year-end 2013. The 50% first-year bonus depreciation allowance also expired at the end of 2013.
  - The DOE announced three projects that will receive up to $47 million each to complete engineering and planning, fabrication and construction as the second phase of the Offshore Wind Advanced Technology Demonstration Program, and two projects that will receive $3 million to continue engineering and design.
  - Maryland began promulgating rules for Offshore Wind Renewable Energy Credits (ORECs) for up to 200 MW and plans to issue a final rule by July 1, 2014.
  - The New Jersey Board of Public Utilities rejected a proposal for ORECs by Fishermen's Energy for a five-turbine project off Atlantic City, NJ.
  - The Maine Public Utility Commission approved a term sheet with a team led by the University of Maine for a pilot floating wind turbine project.
  - The United Kingdom announced the strike prices for land-based and offshore wind generation through 2019, which should expedite the development of Round 3 projects.
  - Spain has made various reductions to its FiT with, in some cases, retroactive effects on existing projects.
- Policies that address infrastructure challenges
  - The New German Energy Act clarifies the compensation that projects impacted by grid delays are entitled to; that law is expected to resolve the grid construction delays.
- Policies that address regulatory challenges
  - BOEM held competitive lease sales for renewable energy off Maryland and announced additional competitive lease sales off Massachusetts and New Jersey in 2014 .
  - China and Japan announced offshore wind target goals.

2.1 *Offshore Wind Program Objectives*

The goals of the U.S. offshore wind program include promoting the development and deployment of offshore wind energy systems at competitive prices. The aim of this program is to maximize the MW capacity of manufacturing production in the United States and increase the development of factories and jobs. Competitive prices achieve a levelized cost of energy (LCOE) at which offshore wind can compete with other regional generation sources without subsidies.

The DOE's 2008 report, *20% Wind Energy by 2030*, determined that it is feasible for wind power to meet 20 percent of U.S. electricity demand by 2030, which would require wind power capacity to increase to over 300 GW (DOE 2008). The report projects that the U.S. could install 54 GW of offshore wind by 2030, with an average levelized cost of energy (LCOE) of 7¢/kWh. While the U.S. may not achieve this level, and while the DOE is updating its projections in a new report to be issued in 2014[18], the DOE's offshore program aims to address barriers and minimize the LCOE of offshore wind.

In 2010, the DOE instituted the Offshore Wind Innovation and Demonstration Initiative (OSWInD) to accelerate the development of commercial offshore wind. The OSWInD Initiative focuses on reducing the cost of offshore wind energy and decreasing the deployment timeline uncertainty. The DOE sees offshore wind as a method of reducing the nation's greenhouse gas emissions, diversifying energy supply, delivering cost-competitive electricity to coastal regions, and stimulating the economy.

The OSWInD initiative will address these objectives through a suite of three focus areas – Technology Development, Market Barrier Removal, and Advanced Technology Demonstration. The following section discusses market barriers that affect U.S. offshore wind development, and the policies that various jurisdictions have considered to address those barriers.

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[18] DOE has announced that its new Wind Vision Initiative includes three major elements:

- A description of the status of wind technology and the wind business, including the state of wind power today, what has changed since the 2008 wind vision report was published, and an updated credible national vision for wind power going forward
- A comprehensive assessment of the national and regional impacts (i.e., benefits and costs) of this wind vision, based on the best available science and other relevant information
- A roadmap describing what needs to be done in order to achieve the vision, including which sectors must conduct needed activities, by when and in what sequence, and estimates of resources required

2.2 Potential Barriers to Meeting the Objectives

There are three high-level barriers that could impact the achievement of the United States' offshore wind objectives. These are cost competitiveness, a lack of infrastructure, and uncertain regulatory processes and timeline. A summary of these is included in Table 2-1 below. Further detail is provided in Appendix A.

Table 2-1. Key Offshore Wind Barriers

Cost Competitiveness	• High Capital Cost • High Cost of Energy Produced by Offshore Wind • High Financing Costs Due to Regulatory Uncertainty and Instability
Technical and Infrastructure	• Lack of Purpose-Built Ports and Vessels • Lack of Domestic Manufacturing • Inexperienced Labor • Insufficient Offshore Transmission Infrastructure • Insufficient Domestic O&M Capabilities
Regulatory	• Uncertain Site Selection Process and Timeline • Fragmented Permitting Process • Environmental and Public Resistance • Uncertain Environmental Impacts

Source: Navigant

2.3 Examples of Policies for Addressing the Cost Competitiveness of Offshore Wind Energy

2.3.1 General Discussion of Policy Examples

As mentioned in Section 2.2 and further described in 5.Appendix A, the high cost of energy produced by offshore wind is the major contributing factor to the lack of cost competitiveness of the U.S. offshore wind industry.[19] The main driver of cost for offshore wind, a technology where most of the spending is upfront, is the cost of capital to spread that upfront cost over many years. That cost of capital depends on several things: the required internal rate of return (IRR) of equity investors and their time horizon; the ability of the project to tap (cheaper) non-recourse debt; and in such cases, the leverage that can be reached, and the maturity of such debt. The average cost of capital is a weighted average of the cost of

[19] One factor that is helping to improve the cost competitiveness of offshore wind energy is the increasing awareness that certain market structures recognize the economic value of peak-coincident generation with no fuel costs, such as offshore wind, which results in substantial savings to most electric ratepayers.

equity (IRR) and cost of debt (overall interest rate). IRR can vary quite a lot, from 8%/year for operating assets to 15+%/year for pre-construction assets, while the cost of debt is typically in the 5-6%/year range.

Lowering the cost of offshore wind means implementing policies that: 1) maximize debt leverage (and, ideally, for the longest possible tenure), and 2) attract capital with lower IRR requirements. What is required is a simple and stable regulatory framework:

- Lenders are willing to take offshore wind risk, including construction risk, and provide medium to long term funding, but this requires a regulatory regime that (i) provides sufficient economics for the project, and (ii) is not subject to later changes in policy. They can typically provide longer (and cheaper) debt when there is limited price risk (i.e. fixed price PPAs, or FiTs, rather than pure market mechanisms, and guaranteed access to the grid). That needs to be in place at the moment of closing.
- Investors need to also consider the permitting and development phase in their thinking; they won't invest development equity (in the tens of millions of dollars for offshore wind) if they have no idea of what the regulatory framework will be when the investment decision needs to be made, and if they have no idea of how long it will take them to get there (i.e. obtain all permits and approvals). The more uncertainty, the higher their IRR requirement.

Investors won't invest development equity if they have no idea of what the regulatory framework will be when the investment decision needs to be made.

Some of these issues (permitting notably) can depend on multiple regulators but all of them can be acted upon. Doing so is vital to reducing LCOE as the difference between a favorable regulatory framework (Germany) and a less favorable one (the UK's ROCs), can be worth more than $20/MWh, or close to 20% of the overall cost, just from the difference in financing terms, for technically identical projects.

Support schemes that address cost competitiveness fall under "investment support schemes" (MW-focused) and "operating support schemes" (MWh-focused). Examples of investment and operating support schemes are listed below, all of which have been used in European countries that are active in offshore wind.

2.3.1.1 Investment Support Schemes

Renewable energy is a capital-intensive industrial sector. Investment support schemes have helped reduce financial burdens for project developers and/or manufacturers via direct or indirect investment subsidies at the time of construction. These subsidies take the form of the following:

- Cash grants, in which part of the investment is paid through public subsidies. This is the simplest and most direct mechanism.
- Loans, which are guaranteed by federal or state governments.
- Accelerated depreciation of assets, which leads to higher taxable losses in early years. Investors with corresponding taxable profits can reduce their tax bills in such years, leading to higher profitability (linked to the tax rate applicable to such underlying taxable profits). Structures are

put in place whereby tax investors (with taxable profits) notionally own the project at the time of investment and share the tax gains from accelerated depreciation with the project's real investors in the form of "tax equity" (i.e., the volume of tax depreciation, multiplied by the tax rate, minus a profit to the remunerator for the use of taxable income).

- Tax breaks, low-interest loans, credits, or deductions, all of which are various direct or indirect structures through the tax code amounting to some combination of the above two mechanisms. In addition, low-interest loans or other incentive mechanisms are provided for manufacturing to help reduce hardware costs.

The use of each of these mechanisms in Europe is summarized in Section 2.3.3.1.

2.3.1.2 Operating Support Schemes

Operating support schemes are linked to the actual energy production from renewable energy sources. There are two main philosophies: one whereby the regulator offers a fixed price to renewable energy producers (volume is therefore uncertain), and one whereby the regulator sets a target volume for renewable energy production (in which case the value of the support will vary). The latter category is typically considered to be more market-oriented.

The following mechanisms are the primary operating support schemes currently in use to support offshore wind:

- Price-driven mechanisms
- FiTs
- Feed-in premiums
- Quantity-based mechanisms
- Green certificates
- Tendering

The use of each of these mechanisms in Europe is summarized in Section 2.3.3.2.

2.3.2 Current U.S. and State Policies

2.3.2.1 U.S. Policies

The primary vehicles for addressing the cost competitiveness of offshore wind energy at the federal level are the Renewable Electricity Production Tax Credit (PTC) and the Business Energy Investment Tax Credit (ITC). Investors in wind projects could choose between these two incentives if they began construction or made non-refundable investments of 5% of total project costs by year-end 2013. Most offshore wind project investors claimed that they would choose the ITC (30 percent of initial capital cost) over the PTC (approximately $23/MWh for the first 10 years of operation), because it offers a larger level of support for offshore wind systems. In 2012 and 2013, the U.S.

Most offshore wind project investors would choose the ITC over the PTC.

Senate Finance Committee considered the option of offering an ITC for offshore wind that does not expire until 3,000 MW are claimed. This option would take the place of approving short-term extensions of the ITC, which would not support the multi-year development process of offshore wind. Although the Finance Committee is still advocating this proposal as of 2014, no further action has been taken on it. Another bill approved by the Senate Finance Committee would extend the PTC and ITC retroactively through 2015, maintaining the same new definition of commencing construction, as part of a comprehensive tax extenders bill covering 51 other industries. To date, the full Senate has not voted on this proposal.

Other federal investment support schemes currently in effect include the DOE Loan Guarantee Program and the Modified Accelerated Cost-Recovery System (MACRS) + Bonus Depreciation. Although the DOE still has authority to issue loan guarantees under Section 1703 of Title XVII of the *Energy Policy Act (EPAct) of 2005*, it has not solicited for new Loan Guarantee applications in several years. Rather, it is only adjudicating applications that are already pending. The MACRS establishes five years as the time over which certain renewable energy properties, including wind power, may be depreciated.

2.3.2.2 *State Policies*

Figure 2-1 and Table 2-2 provide a summary of Renewable Portfolio Standards (RPS), policies, requests for proposal (RFPs), and related activities to address the cost competitiveness of offshore wind energy in selected U.S. states. Appendix B provides additional details of these activities.

Figure 2-1. Summary of Policies to Address Cost Competitiveness in Selected U.S. States

Policy Options ***Barrier: High Cost***	**Jurisdictions where Used**						
	Delaware	**Maine**	**Maryland**	**Massachusetts**	**New Jersey**	**New York**	**Rhode Island**
Renewable Portfolio Standard (RPS)	✓	✓	✓	✓	✓	✓	✓
Incorporate PPAs into competitive situations	✓ 1	✓ 3		✓ 5		✓ 7	✓ 8
RPS with offshore carve out			✓ 4		✓ 6		
Green certificates with premium prices for offshore installations	✓ 2						

(1) Delaware statute directed all-resource competitive bid & Delmarva to negotiate a PPA with Bluewater Wind approved by four Delaware state agencies in 2009 (~$14/MWh).
(2) DE offshore wind RECs count 3.5 times in meeting Delmarva's renewable energy purchase requirements.
(3) Maine legislation authorized bidding process for pilot offshore projects and PPAs; U.Maine team signed term sheet with PUC.
(4) The Maryland Offshore Wind Energy Act of 2013 established Offshore Wind Renewable Energy Credits (ORECs) for up to 200 MW and requires consideration of broad range of economic and ratepayer benefits.
(5) Massachusetts statute requires PPAs for 7% of load and approved Cape Wind PPA for $18.70/MWh with a 3.5%/year escalator
(6) NJ statute requires 1100 MW Ocean RECs at a cost-effective rate based on a comprehensive net benefits analysis.
(7) LIPA conducted competitive bid in 2005 and ended in 2008 due to high prices. NYPA conducted competitive bid in Great Lakes in 2009 and ended in 2011 due to high prices. NYPA, LIPA & Con Edison submitted application for BOEM lease for a 350 -700 MW offshore wind project to meet NY's 700 MW offshore wind target.
(8) Rhode Island issued an RFP for an offshore wind project to produce 15% of the state's electricity demand and subsequently signed a Joint Development Agreement with Deepwater Wind. Approved initial 30MW Pilot PPA for $24.40/MWh.

Source: Navigant analysis

Table 2-2. Policies to Address Cost Competitiveness of Offshore Wind in Selected U.S. States

State	RPS	Offshore Wind RPS	Mandatory PPAs	RFPs and Other Activity
Delaware	25% by 2025-2026	350% multiplier for the Renewable Energy Certificate (REC) value of offshore wind facilities sited on or before May 31, 2017.	Delmarva Power was directed to negotiate a long-term PPA with Bluewater Wind as winner of an all-resources RFP. However, NRG-Bluewater Wind failed to make a substantial deposit to maintain the PPA.	Projects receive a subsidy from the grid operator for construction of the export cable.
Maine	40% by 2017	300 MW offshore wind by 2020; 5000 MW by 2030	Maine Wind Energy Act directed PUC to hold competitive process to award 20-year PPAs to offshore pilot projects	Legislation passed in June 2013 re-opened the bidding process for PPA for ratepayer subsidies of offshore wind pilot projects. U.Maine bid against the Statoil Hywind Maine floating wind farm which had signed a term sheet for 27 cents/kWh for 12 MW, but Statoil withdrew its application in October 2013
Maryland	20% by 2022	The Maryland Offshore Wind Energy Act of 2013 established ORECs for up to 200 MW, limiting ratepayer impacts while broadening the cost-benefit analysis, including consideration of peak coincident price suppression.		Maryland issued an RFP to conduct initial marine surveys of the offshore WEA that BOEM identified. Maryland plans to fund additional surveys with state funds to encourage development of the WEA by private developers after the BOEM competitive auction process. Maryland is promulgating rules by July 1, 2014 to implement the OREC program.

State	RPS	Offshore Wind RPS	Mandatory PPAs	RFPs and Other Activity
Massachusetts	15% by 2020, increasing by 1% each year thereafter with no stated expiration date.	There is no carve-out or REC multiplier for offshore wind.[20] The governor has set a goal of developing 2,000 MW of offshore wind energy to help achieve the RPS requirements.	The Green Communities Act requires each electric distribution company to sign PPAs for 7% of its load with renewable energy generators. The Department of Public Utilities (DPU) has approved contracts with National Grid and NSTAR utilities for 363 MW or 77.5% of the full potential output of the Cape Wind project.	
New Jersey	20.38% Class I and Class II renewables by 2020-2021	The NJ RPS contains a carve-out for offshore wind. The state's Board of Public Utilities will define a percentage-based target of 1,100 MW of OSW.		
New York	29% by 2015	There is no carve-out or REC multiplier for offshore wind.		NYPA, LIPA, and Consolidated Edison have filed an unsolicited request for a lease in federal waters off Long Island, but two expressions of competitive interest by Fishermen's Energy and EMI have been filed, and BOEM will launch competitive auction process after finalizing the lease area borders. BOEM will also issue a Call for Information and Nominations for other lease areas off NY.

[20] DOE 2013b

State	RPS	Offshore Wind RPS	Mandatory PPAs	RFPs and Other Activity
Rhode Island	16% by 2019	There is no carve-out or REC multiplier for offshore wind.		In 2008, Rhode Island issued an RFP for an offshore wind project to produce 15% of the state's electricity demand and subsequently signed a Joint Development Agreement with Deepwater Wind. The Rhode Island Public Utility Commission approved an initial 30 MW Pilot PPA for 24.4 cents/kWh (OffshoreWind.net 2010).
Virginia				Virginia is having the local transmission system owner conduct interconnection studies exploring a high-voltage submarine cable that could interconnect to OSW farms (Power Systems Consulting 2012). The VA State Corporation Commission could extend its current general policy to allow "construction work in progress" costs of offshore wind development to be collected from ratepayers prior to completion of an offshore wind farm.

Source: Navigant analysis

2.3.2.3 Public Utility Commission Approval of Power Purchase Agreements

Ultimately, the state public utility commission (PUC) must approve all PPAs[21] before the costs can be passed through to ratepayers. Most states have legislation requiring the PUC to conduct some form of cost-benefit analysis and determine that the PPA provides "least cost" energy to warrant ratepayer funding. Lawmakers seeking to address the health and environmental costs of certain generation fuels have broadened the cost-benefit analysis. This is because pollution costs are not internalized into the price of the energy produced.

2.3.2.4 Maine

In 2009, the Maine legislature amended the Maine Wind Energy Act to set goals of installing 300 MW of offshore wind by 2020 and 5,000 MW by 2030.[22] The legislature also directed the PUC to hold a competitive bid and approve PPAs for offshore renewable energy pilot projects that met certain conditions.[23] Statoil was determined the winner of the auction process and the PUC approved a term sheet for 12 MW in 2012 at 27 cents/kWh. In July 2013, the Maine legislature revised the statute to authorize additional bidding and the University of Maine submitted a competing bid in September 2013. PUC signed term sheet with U. Maine and is now negotiating a PPA.

2.3.2.5 Maryland

The Maryland Offshore Wind Energy Act of 2013 established ORECs and substantially broadened the cost-benefit analysis for OREC eligibility. The applicant must submit a cost-benefit analysis addressing employment, taxes, health and environmental benefits, supply chain opportunities, ratepayer impacts and the long-term effect on the energy and capacity markets. The act requires the PUC to consider the ratepayer impacts, potential reductions in transmission congestion costs, potential reductions in capacity prices and locational marginal prices, potential long-term changes in capacity prices, and the extent to which the cost-benefit analyses demonstrates positive net economic, environmental, and health benefits when reviewing OREC applications. Therefore, the Maryland act specifically requires a price suppression analysis for peak coincident wind farm generation and evaluation of other electricity market and ratepayer benefits. It is thus the most comprehensive state legislation requiring consideration of all significant economic benefits of a proposed wind farm. Some of these real economic benefits will accrue directly to ratepayers to offset a portion of the rate impacts based only on the higher current capital costs of offshore wind in the United States.

The Maryland act is the most comprehensive state legislation requiring consideration of all significant economic benefits of a proposed wind farm.

[21] With the exception of federal procurements of PPAs.

[22] Maine Revised Statutes Title 35-A §3404.

[23] Maine Revised Statutes Title 35-A §3210-C.

2.3.2.6 *Massachusetts*

To promote renewable energy, the Commonwealth of Massachusetts enacted legislation authorizing the state PUC to approve a renewable PPA if the PPA would achieve the following:

- Provide enhanced electricity reliability within the Commonwealth
- Contribute to moderating system peak load requirements
- Be cost-effective to Massachusetts electric ratepayers over the term of the contract
- Create additional employment in the Commonwealth, where feasible[24]

The PUC was directed to "take into consideration both the potential costs and benefits of such contracts, and [to] approve a contract only upon a finding that it is a cost effective mechanism for procuring renewable energy on a long-term basis." After reviewing substantial written and oral testimony, the PUC concluded the Cape Wind project offers unique benefits relative to other available, renewable resources:

> "In particular, the project's combination of size, location, capacity factor, advanced stage of permitting, and advanced stage of development is unmatched by any other renewable resource in the region for the foreseeable future. This combination of benefits will significantly enhance the ability of [the utility] to achieve renewables [RPS] and greenhouse gas emissions reduction requirements."

On appeal, the Massachusetts Supreme Judicial Court upheld the PUC, concluding, "In sum, our review of the record indicates that there was clearly sufficient evidence of which the department could base its conclusion that the special benefits of PPA-1 exceeded those of other renewable energy resources, and we uphold the department's conclusion that approval of the contract was in the public interest." The Court noted the project location near an area that uses high levels of electricity that would not require long, new, onshore transmission to other generators and the greater capacity factor than generators run on other types of renewable resources.[25]

Cape Wind could lower regional energy costs through price suppression by $7 billion over 25 years.

The Court also noted the PUC's finding that Cape Wind would lower regional energy costs through "price suppression," described as "the reduction of wholesale energy market clearing prices that results from the addition of low-cost generation resources."[26] Cape Wind presented testimony based on an independent economic analysis by Charles River Associates (CRA) that, with zero fuel cost, Cape Wind energy would be dispatched by the regional transmission operator during peak periods displacing fossil fuel generators that are more expensive to operate after constructed. CRA concluded that the total savings

[24] Green Communities Act, Section 83, Chapter 169 of the Acts of 2008.

[25] Alliance to Protect Nantucket Sound, Inc. & others v Department of Public Utilities, 461 Mass. 166, December 28, 2011.

[26] 461 Mass. at 176-177.

that would be spread among all New England ratepayers over the 25-year lifespan of the project could exceed $7 billion.[27] The PUC only recognized 50 percent of this benefit because the utility purchased 50 percent of the capacity. However, the benefit to the contracting utility customers was still significant and the remaining benefit accrued to all other ratepayers in New England.[28]

2.3.2.7 New York

To help meet RPS goals, the New York Power Authority, Long Island Power Authority and Consolidated Edison have teamed to develop an offshore wind farm south of Long Island. The utilities have agreed to lease a site from BOEM and then hold a competitive bid to determine who will develop the wind farm and sell the power to the utilities. The utilities also have agreed to own and develop the transmission interconnection to Long Island.

2.3.2.8 Rhode Island

Rhode Island enacted legislation to promote long term contracts for renewable energy resources including offshore wind.[29] The law requires utilities to hold annual auctions to meet their RPS targets and may sign 20-year contracts that are "commercially reasonable." National Grid held an auction and negotiated a 20-year contract with Deepwater Wind for the Block Island Wind Farm and interconnection cable for 24.4 cents/kWh plus 3.5% annual escalation. The Rhode Island Public Utility Commission reviewed the PPA and determined it was not "commercially reasonable" because it was substantially higher priced than incumbent energy resources. The Rhode Island Legislature then passed another bill to amend the statute to redefine "commercially reasonable" to mean terms and pricing that are reasonably consistent with a project "of a similar size, technology and location" and likely to provide economic and environmental benefits.[30] The PUC then approved the same PPA and it was upheld by the Rhode Island Supreme Court.[31]

2.3.2.9 Virginia

Dominion Virginia Power (Dominion) has decided to explore generation of OSW within its own generation portfolio. Dominion has received $47 million from DOE to develop two 6 MW turbines at the western edge of the VA WEA (Virginia Offshore Wind Technology Assessment Project – VOWTAP). Dominion also won the BOEM competitive auction for the VA WEA and signed a lease in October 2013 to develop up to 2,000 MW of OSW. Dominion will observe the performance of the VOWTAP turbines and foundations before final engineering and applications to develop the commercial wind farm in phases.

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[27] "Update to the Analysis of the Impact of Cape Wind on Lowering New England Energy Prices," CRA Project No. D17583-00, Charles River Associates, March 29, 2012

[28] 461 Mass. at 176-177.

[29] Public Law 2009, Chapter 53.

[30] Public Law 2010, Chapter 32, amending Title 39 Section 26.1.

[31] In re Review of Proposed Town of New Shoreham Project, Case No. 2010-273-M.P., July 1, 2011.

Summary of State Policies that Promote Cost-Competitiveness of Offshore Wind

Renewable Portfolio Standards

- ME, MA, RI, CT, NY, NJ, PA, DE, MD, NC, MI, WI, IL, IN, OH, CA, OR, WA
- Set minimum acquisition requirements for all renewables despite current costs
- Carve-outs such as ORECs required for OSW development if no long term PPA (NJ, MD)

Long Term Power Contracts (ME, MA, RI, DE)

- Accommodate up-front capital costs of renewables and likely increase of fossil fuel prices
- Provide revenue stream to enable financing of billion dollar offshore wind farms
- Utility-Sponsored OSW Generation (VA, NY)
- Utility decides to develop OSW generation within its own generation portfolio with fixed long term costs.
- Construction Work in Progress rate surcharges phase in costs to ratepayers during construction and spreads total cost over greater period of time for reduced impact

Broad Definition of Benefits for Rate Recovery (ME, MA, RI, NJ, MD)

- Incorporation of new jobs, economic and environmental benefits into cost benefit analysis
- Inclusion of peak demand coincident wind energy price suppression into cost benefit analysis recognizes simultaneous real savings to ratepayers from OSW ($7 billion price suppression in New England for Cape Wind's capital cost of ~$3 billion) (MA, MD)

Limits on monthly ratepayer impacts from OSW PPAs prevent excessive, currently over-market prices being passed onto ratepayers and maintain balance with promoting clean new technologies with economic development potential (ME, NJ, MD).

2.3.3 Current Policies in Europe

This section provides an overview of European support schemes for renewable energy and offshore wind. The European Union (EU) has set the following targets for 2020:

- Reduce greenhouse gas emissions by 20 percent
- Reduce primary energy use by 20 percent
- Generate 20 percent of the electricity with renewable sources

All of the EU member states have committed themselves to these targets and have different support schemes in place to achieve these ends.

2.3.3.1 *Investment Support Schemes*

Table 2-3 lists investment support schemes in various EU countries.

Table 2-3. Renewable Energy Investment Support Schemes in Europe

Country	Investment Support Schemes	Comments
Belgium	Grid subsidy	Projects with a capacity of 216 MW or more receive a support from the grid operator (€25 million) for construction of the export cable. (Smaller projects received a prorated amount).)
Denmark	Tax break	
Finland	Cash grant	Up to 40% of investment budget
France	• Accelerated depreciation • Research tax credit	
Ireland	• Accelerated depreciation • Research tax credit	
Italy	Cash grant	Up to 30% of investment budget
Netherlands	Tax break	Will not apply for SDE+
Sweden	Accelerated depreciation	
U.K.	• Tax break • Cash grant	

Source: European Renewable Energy Council, 2009 and Taxes and Incentives for Renewable Energy, 2011 (KPMNG 2011)

2.3.3.2 *Operating Support Schemes*

Feed-in Tariffs

FiTs, which feature a guaranteed price per kWh, are the most frequently used support schemes for renewable energy in Europe. In most countries, the FiT scheme has evolved into an "advanced tariff scheme," whereby the number of years when the FiT applies is limited, ensuring a natural phasing out of the support scheme. In order to provide security for the investors, the support scheme normally has a lifespan of between 10 and 15 years. In addition, in some countries the FiT is also limited to a number of full load hours. Price differentiation between the multiple renewable energy sources takes place in most countries.

Feed-in Premiums

Few European countries use feed-in premiums, which are guaranteed premiums per kWh, incremental to the electricity market price. Belgium is probably the best example of feed-in premium use, although it is technically a green certificate scheme with a floor price. A common criticism of the feed-in premium is that the feed-in premium regime is susceptible to lobbying, as large industrial power consumers will lobby more aggressively against such a regime that imposes a surcharge on the price of electricity, which is largely independent of the price of power.

Green Certificates

Green certificate (GC) regimes (where qualifying producers generate tradable certificates, which others must purchase) have generally been seen as less stable, more complex, and less favorable to investment. Countries with such regimes have seen investment lag behind countries with FiTs. The main difference in impact between FiTs and green certificates is that FiTs provide price certainty (i.e., fixed $/kWh to the wind generator), while green certificates provide volume certainty (i.e., a fixed amount of wind kWh will be generated). Furthermore, while green certificate regimes can work for mature technologies like land-based wind, they do not really promote diversification of renewable energy sources without extensive tinkering, which increases complexity and instability.

Green certificates do not really promote diversification of renewable energy sources without extensive tinkering.

The risk profile for green certificates is steeper than for FiTs, due to twin price risk (in both electricity markets and the green certificates market). For this reason, Belgium has set a minimum price for the green certificates, creating a de facto feed-in premium. Similarly, Poland imposes the average market price of the previous year, and Romania set a floor and cap price. Lithuania has committed to use green certificates beyond 2020.

Tendering

With a tendering regime, regulators set volumes of renewable energy production and provide a specific support regime for that volume over an agreed-upon period, typically via a fixed price or contracts for differences (CfD) mechanism. Such volumes are offered to investors in a competitive process. Renewable energy tenders have a bad track record in various European countries due to the insufficiency of non-compliance penalties, the lack of competition in the bidding process, long project lead times, and complex permitting procedures, which tend to be separate from the tender process.

2.3.3.3 Summary of Support Mechanisms Used in Europe

Table 2-4 shows offshore wind capacity that has been installed under various support schemes currently in use across Europe. Note that a variety of operational schemes have resulted in significant MW installations.

Table 2-4. Offshore Wind Capacity Installed Under Support Schemes Used in Europe

Country	Operational Schemes	Operational Scheme Notes	Installed MW thru 2013	Consented MW thru 2013
Belgium	Green certificates with a floor (de facto Feed-in premium)	OSW: the TSO has an obligation to buy at 107 €/MWh for the first 216 MW, then at 90 €/MWh (incremental to market prices)	571	660
Denmark	FiT by tender	OSW: Tender, fixed price for 50,000 full load hours, then market price	1,270	0
Finland	FiT	12-year FiT set at 84 €/MWh. Until end-2015, "early bird" FiT set at 105 €/MWh	26	660
France	Tender	OSW: 1.9 GW allocated in tenders in 2012 with 170-200 €/MWh tariffs. Applications for the second round of tenders submitted in late 2013 for one more GW	0	1,928[32]
Germany	FiT	OSW: 150 €/MWh for 12+ years or 190 €/MWh for up to 8 years, then 35 €/MWh. 7%/yr digression starting '18	520	6,600
Ireland	FiT	OSW: 140 €/MWh (15 years) capped at 1.5 GW. Offshore wind was not part of the technologies eligible to the FiT scheme	25	2,200
Italy	Tender & floor price	OSW floor price 165 €/MWh for 25 years for project >5 MW	0	30
Netherlands	CfD, tender	OSW: CfD allocated trough 6 rounds per year. Different strike prices, depending on each round (from 88 €/MWh to 188 €/MWh); duration 15 years	247	2,860
Sweden	Green certificates	Market based GC, through a common GC system between Norway and Sweden	212	880
U.K. (current scheme)	Green certificates	2 ROCs/MWh for OSW through 2015, then 1.9 ROCs through 2016, then 1.8	3,681	4,840
U.K. (next scheme)	CfD	Strike prices from 190 €/MWh in 2016, to 170 €/MWh[33] in 2019		

Source: GGEB

[32] An additional volume of 1,022 MW has been allocated under the tender in April 2014.

[33] Converted to Euros for comparison purposes. The actual strike prices are 155 £/MWh and 140 £/MWh.

The remainder of this section describes recent changes in operating support schemes for offshore wind in key countries in Europe.

Belgium

Belgium has allocated zones for seven offshore wind parks, representing around 2.2 GW. Two of them are already operational (C-Power and Belwind), one project is currently under construction (Northwind) and the other projects are under development. In December 2013, Belgium approved the reform of an offshore wind support mechanism moving from a GC system with a premium to a CfD system. The reform aims to minimize costs to consumers while guaranteeing a decent return to investors. It will not apply to parks that are already under construction or in operation. Each project will receive a total fixed price of €138/MWh and will be reassessed on a project by project basis every three years and will be subject to changes in the level of the contracted maintenance costs and the correction factor in the PPA.

Germany

Germany's main issues in 2013 related to worries about the potential expiration of the compressed FiT and grid connection agreements. Offshore wind developers can choose between the standard tariff of €150/MWh for 12 years and the compressed tariff of €190/MWh for 8 years. The compressed model can be very attractive for investors as it helps meet high upfront investment costs. However, it was set to expire at the end of 2017. In late 2013, Germany's coalition government proposed extending the compressed FiT support scheme by 2 years. The most recent proposals (still to be formally approved) would see a tariff of €185/MWh for projects commissioned in 2018 and €180/MWh in 2019. Regardless of which mechanism developers choose (compressed or not), they are entitled to a further FiT of €150/MWh, for a number of additional months determined from the project's water depth and distance to shore[34].

Germany's main issues in 2013 related to worries about the potential expiration of the compressed FiT and grid connection agreements.

In Germany, the grid operator (TenneT for the North Sea, 50Hertz for the Baltic Sea) is responsible for connecting the projects to the onshore grid. As a result of substantial delays (more than a year) that affected projects already in construction in 2011-2013 and some projects for which FID was supposed to be taken in that period, the legislator has adopted a detailed liability regime which includes an obligation for the TSOs to publish a grid plan each year.[35] These plans must detail the completion date, location and size of future grid connections, which will be subject to the review and approval of the German federal energy regulator Bundesnetzagentur. Once the envisaged completion date for the grid connection has been published, a realization plan will need to be agreed upon between the TSO and the developer. Thirty months before the anticipated completion, the announced date of completion becomes binding for both the grid operator and the developer. The wind farm operator is entitled to damages if

[34] The period in which the increased initial remuneration is extended by 0.5 months for every full nautical mile of distance between the system and the coast over twelve nautical miles and by 1.7 months for each full meter of water depth exceeding a depth of 20 meters.

[35] Section 17b of EnWG, the German Energy Act

completion of the grid connection is delayed by more than 11 days. The grid operator is also liable for interruption (if above 18 days per calendar year during construction and above 10 days during the operational phase). Damages claims amount to 90% (100% in case of wilful misconduct) of the feed-in tariff must be paid by the grid operator. It is calculated daily, based on the average production of a comparable wind turbine (Wind Power Monthly 2013).

France

No offshore wind farm exists in France to date. However, the French government has begun to support the development of offshore wind projects by organizing two rounds of tenders for a total capacity of 3 GW. The government has identified six areas for development, in which they have awarded 4 projects (close to 2 GW) as part of the first tender, for which construction is expected to start in 2017-2019. They have also awarded projects in two further areas in April 2014, for an additional 1 GW, for which construction is expected to start in the 2020-2021 period.

The French government has organized two rounds of tenders for a total capacity of 3 GW.

The government has allocated a tariff for 20 years to the tender winners, including a specific component for the grid connection. RTE, the French TSO, builds and owns the grid connection assets, yet the associated construction costs are borne by the project developer. The developer is compensated for this investment through a specific component of the tariff, normatively sized on an expected return for such investment of 7.25% before taxes. After being awarded, each project must negotiate the conditions of the grid connection in a transmission agreement. In case of delays caused by RTE, the 20-year duration of the tariff shall not be affected. In case of low availability of the offshore wind project (below 50%), the grid component of the tariff is reduced.

Ireland

Ireland has one of the best wind regimes in Europe, but offshore wind has not benefited from the same level of support as onshore wind. The government previously said that offshore wind support was too expensive to consider. However, in February 2014 they finally decided to launch a dedicated plan for the sustainable development of offshore renewable energy. This plan is due to be reviewed before end 2017. Projects may also be built for exporting electricity to the U.K., without any cost for Irish consumers. As a result, generators will hereby benefit from the U.K. support system. An inter-governmental agreement is still being negotiated.

Italy

A decree dated July 6, 2012, introduced a competitive bidding mechanism for offshore wind in Italy until 2015, managed by Gestore dei Servizi Energetici (GSE), the state energy agency. Offshore wind projects that have a license will win 25-year energy purchase contracts if they can offer the lowest FiT. The first auction was open in late 2012 but did not lead to any conclusive results (only one bid for 30 MW was higher than the floor price of € 165/MWh, far short of the 650 MW quota eligible for the FiT). During the second auction, there were no bidders at all for offshore wind projects. With zero capacity currently installed and no big projects in the pipeline, Italy is even looking to shift some of the allocated support from offshore to onshore wind.

The Netherlands

The national agreement published in September 2013 sets up a target of 4.5 GW of offshore wind capacity installed by 2023. Among other things, it plans to establish a proper legal framework for offshore wind by 2015, facilitate grid connection and extend the Subsidie Duurzame Energy scheme (SDE renamed SDE+). Under the SDE/SDE+, producers of renewable energy sell all generated electricity to the grid at market prices. On top of these prices, they receive a premium payment, up to a maximum predetermined strike price per kWh. This CfD support guarantees the generators of a relatively fixed income per kWh. The fact that the SDE+ scheme has an annual budget ceiling is expected to encourage competition, as all technologies have to compete against each other. The SDE+ is opened in phases (six in 2013). Table 11 below shows the maximum strike price per phase:

Table 2-5: SDE+ Phases for Offshore Wind in 2013

Phase	Timing for Application	Strike price
Phase 1	April 4 – May 13	€ 87.5 /kWh
Phase 2	May 13 – June 17	€ 100 /kWh
Phase 3	June 17 – Sept 2	€ 112.5 /kWh
Phase 4	Sept 2 – Sept 30	€ 137.5 /kWh
Phase 5	Sept 30 – Nov 4	€ 162.5 /kWh
Phase 6	Nov 4 – Dec 19	€ 187.5 /kWh

Source: GGEB analysis

Developers need to time their application for the SDE+ carefully: phase 1 applications may benefit from lower support levels but the risk of the SDE+ pool of incentives being exhausted is also reduced. Those developers who delay until phase 6 could benefit from a higher support level, but they will also have to run the risk that the SDE+ scheme will have to close early if the pool of funding available for that year has already been allocated (Norton Rose Fulbright 2013). For 2013, €3 billion has been made available under the SDE incentive program, which is a major increase from the €1.7 billion that was available the previous year. The government is also committed to dedicating €3.5 billion to the SDE+ 2014 budget.

Romania

Romania uses tradable green certificates with a floor price and ceiling price. In January, Romania cut its support scheme for new wind, solar and hydro plants. Under the new scheme, wind energy producers get 1.5 GC/MWh until 2017 and 0.75 afterwards, from a previous 2 and 1 respectively.

Spain

Spain has no offshore wind development to date, apart from a 5 MW demonstration turbine installed in 2013 in the archipelago of the Canary Islands. Even though Spain has 5,000 miles of coastline, offshore wind resources are not easily accessible because of deep-water surrounding seas. Development of offshore wind has been further hampered by the ongoing pullback on support for renewable energies. There have been several retroactive changes with the aim to bring down costs. For example, the government abolished the right for developers to choose between a FiT and a premium paid on top of the sale price (e.g. for offshore wind this premium amounted to €84 /MWh in 2007 as per Royal Decree). This measure was expected to save an aggregate amount of €220-500 million per year but has almost killed off new developments in the wind industry in the country.

In July 2013, the Spanish government replaced all renewable energy FiTs with a new scheme under which it guarantees investors "reasonable profitability" of 7.5% over the lifetime of a project. The government will determine the associated support on the basis of this level of return, assuming standard construction costs and operational costs, regardless of the actual costs incurred by the developers. Any renewable energy project that has already achieved this level of return through the previous applicable FiT scheme will not be eligible for any additional support through the new scheme.

United Kingdom

The United Kingdom's Energy Bill, published in December 2012, included a number of measures necessary to reform the U.K. electricity market. These measures aim to guarantee the security of supply and to ensure that carbon targets are met. The bill contains a plan to change the support scheme in 2017, replacing the Renewable Obligation (RO) with a CfD. CfD is a type of FIT where generators will sell their electricity on the market and receive a top-up payment from the government for the difference between the strike price, which is set by the government, and that market price. When the market price increases above the strike price, the difference must be paid to the government. The government will establish a new entity, which will pay the eligible generators and will also have the power to raise levies from suppliers. From 2015 to 2017, the Renewable Obligation Certificates (ROCs) allocated per project will decrease from 2.0 ROC/MWh to 1.8 ROC/MWh. From mid-2014 to March 2017, generators can choose between the ROC and CfD system. From April 2017 onwards, the only system will be the CfD.

From mid-2014 to March 2017, generators can choose between the ROC and CfD system.

Offshore wind CfD strike prices were announced in late 2013: £155/MWh through 2016, £150/MWh in 2016-17 and £140/MWh though 2019. After this announcement, some players (e.g. utilities) decided to exit the industry due to low expected returns. The overall industry feedback suggests that by removing market risk, the move from ROCs to CfD is positive. In the short-term, however, investors will likely ask the first projects using CfDs for a premium to cover the risks linked to any change in support policy.

2.4 *Examples of Policies for Addressing Infrastructure Challenges*

2.4.1 General Discussion of Policy Examples

As mentioned in Section 2.2 and further described in Appendix A, the primary infrastructure challenges faced by the U.S. offshore wind industry include a lack of purpose-built ports and vessels, a lack of domestic manufacturing and experienced labor, and insufficient offshore transmission. Therefore, the primary offshore wind infrastructure policies are related to transmission and port upgrades and providing incentives for local manufacturing.

2.4.1.1 Transmission

Current transmission-related policies for offshore wind focus on the following:

- Direct-connect design (land-based or offshore collector/converter) and system upgrades
- Responsible parties who will plan, build, operate, and maintain the offshore transmission system
- Cost allocation and cost recovery for offshore transmission investments
- Siting/permitting of transmission

Ratepayers eventually pay for all transmission and generation costs, whether their electric bills are bundled or each cost is itemized and added to the local distribution cost. Under the current policy in some parts of the U.S., including the Atlantic coast, any new generator must pay for the cost of the new interconnection to the grid and any transmission system upgrades required to accommodate the new generation reliably. These costs must then be incorporated into the cost of the energy produced by that generator, thereby becoming part of the wholesale cost that is ultimately passed through to the ratepayers. However, offshore wind transmission is prohibitively expensive for single projects to bear. Significant interconnection and grid upgrade costs deter construction of new offshore wind generation because developers must have an assurance of cost recovery in order to obtain financing to build new transmission lines. This creates a "chicken and egg" dilemma for the offshore wind industry. The policies described in this section have been used or considered by various jurisdictions to help address this dilemma.

Offshore wind transmission is prohibitively expensive for single projects to bear.

A substantial onshore wind resource exists in West Texas and the Panhandle, which are hundreds of miles from the major demand centers in Central and Eastern Texas. Wind developers could not afford the cost of single interconnection lines to Central Texas and thus did not pursue development in West Texas. In response, the Texas legislature established Competitive Renewable Energy Zones in West Texas and the Panhandle and decided that the cost of constructing multiple transmission lines from West Texas to Central Texas would be shared by all Texas ratepayers (CREZ 2013). In 2008, in response to legislative action, the Texas Public Utilities Commission established five CREZ lines to be connected to load centers. Each of the five CREZ lines is to be funded by all Texas ratepayers. The PUC called for $4.93 billion of CREZ transmission projects to be constructed by seven transmission and distribution utilities and independent transmission development companies. Transmission lines to each of the five

CREZ areas, totaling 3,600 miles, are now projected to cost $6.8 billion. The initiative will eventually facilitate the transmission of more than 18 GW of wind power from west Texas and the Panhandle to the state's highly populated areas (PUCT 2010).

Atlantic Wind Connection (AWC) recognized that the cost of interconnecting multiple offshore wind farms to onshore substations could be reduced by constructing a major trunk cable offshore. Such a cable could interconnect offshore wind farms with fewer onshore interconnections. AWC has been seeking approval of the regional transmission operator, PJM, to pass the costs of this cable to all the PJM ratepayers who will benefit from the wind power and associated peak-demand price suppression. PJM has determined that AWC could be funded by NJ ratepayers if New Jersey agrees. Therefore, AWC has recently phased its project and, with the New Jersey Board of Public Utilities, is exploring passing the costs of the New Jersey Energy Link portion of the AWC cable onto New Jersey ratepayers. An initial third party analysis of the wholesale generation prices in south and north New Jersey indicates that the New Jersey Energy Link could save NJ ratepayers about $450 million per year just by connecting the grid in southern and northern NJ even before interconnecting offshore wind farms would produce further savings.

The New Jersey Energy Link could save NJ ratepayers $450 million per year just by connecting the grid in southern and northern NJ.

Three New York utilities have teamed to proposed development of an offshore wind farm south of Long Island. The New York Power Authority (NYPA), Long Island Power Authority (LIPA), and Consolidated Edison (NYPA Collaborative) filed an unsolicited request for a lease in federal waters off Long Island for a 350 MW offshore wind project, possibly expandable to 700 MW. The NYPA Collaborative proposes to fund interconnections to the wind farm from both Long Island and New York City instead of require developers to include the cost of the interconnections with the cost of the wind energy.

Massachusetts is funding an offshore wind transmission study to identify optimal interconnections to the Massachusetts Wind Energy Area to be auctioned later in 2014. The Draft Final Report recommends multiple HVDC cables of 1,000 to 3,000 MW capacity to interconnect to the 345 kV grid (ESS Group 2014).

In order to address the issue of planning transmission for offshore wind projects on a piecemeal basis, federal and regional regulators have used comprehensive transmission system planning to optimize grid investments necessary to interconnect offshore wind farms.

- Policy description
    - Transmission system planners identify offshore transmission upgrades or new transmission required to develop an offshore wind project area (i.e., conceptual transmission expansion plans).
    - Developers and transmission system planners evaluate direct single interconnections to each wind farm or joint interconnections to multiple wind farms (such as the proposed AWC submarine cable off the mid-Atlantic coast).
- Policy rationale

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- Optimizing the transmission infrastructure for consolidated wind farms reduces costs to the customer and environmental impacts.
- FERC Order 1000[36] directs regional transmission organizations (RTOs) and independent system operators (ISOs) to consider state and federal energy policies, which include RPSs, when planning expansion of their respective transmission systems. More specifically, Order 1000 requires that each public utility transmission provider must participate in a regional transmission planning process that satisfies the transmission planning principles of Order No. 890 and produces a regional transmission plan.
- A single environmental review and permitting process can be conducted, which reduces costs and timelines.

FERC Order 1000 encourages RTOs and ISOs to allocate costs of offshore grid upgrades to all ratepayers.

In order to address the issue of prohibitively high transmission costs for a single project, jurisdictions have chosen to allocate the costs of offshore transmission system upgrades to all regional transmission system customers. RTOs or ISOs have implemented this recommendation by planning and allocating costs to ratepayers for grid upgrades to accept wind power from offshore projects (as encouraged by FERC Order 1000). AWC has asked PJM Interconnections to spread the cost of the New Jersey Energy Link among all the PJM ratepayers who will benefit from its operation. Texas provides a state model with its legislation to spread the costs of such new grid upgrades to all ratepayers for access to wind energy. 2,600 miles of transmission have been constructed to date out of a total of 3,600 miles, at a projected total cost of $6.8 billion (CREZ 2013).

To address both of the issues mentioned above, states and provinces in the Great Lakes area are planning to establish a basis for inter-RTO and international cost allocation and transmission siting and planning.

- This strategy has enabled developers to send power to multiple load centers, thereby improving project economics, enabling larger offshore wind farms, and minimizing the transmission footprint per MW ratio.
- Participating in the development of DOE's congestion study and National Interest Electric Transmission Corridor report encourages the designation of regions that are attractive for offshore development as National Interest Electric Transmission Corridors. This provides federal assistance for interstate siting that augments transmission planners working through existing institutions like RTOs. However, it does not override state siting authorities that deny construction authority.

To address the issue of a disjointed and unclear permitting process, many jurisdictions are planning to establish clear permitting criteria/guidelines for transmission project siting and installation. Regional

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[36] See FERC website for summary and further information: http://www.ferc.gov/industries/electric/indus-act/trans-plan.asp

organizations are developing model guidelines for individual states to consider. Such regional organizations include RTO Stakeholder Committees and the New England Conference of Public Utility Commissioners.

To address the transmission cost issue, some coastal states are planning to promote utilization of existing transmission capacity reservations to integrate offshore wind. Some conventional generation facilities that are aging and often operate consistently below full capacity may utilize less than their full transmission capacity reservations. Many of these facilities are located in close proximity to the shoreline and could serve as injection points for new offshore wind facilities, so long as a substantial portion of corresponding transmission is not being used. Utilization of consistently unused transmission capacity by new offshore wind facilities may preclude the need for substantial onshore transmission upgrades.[37] Ultimately, this pattern of development could allow offshore wind to be scaled up to utilize the full transmission capacity for conventional generating units, replacing those units as they are run at lower capacities and ultimately retired.

To address the issue of a piecemeal transmission planning process, some states have proposed establishing policies that support the development and implementation of Integrated Resource Planning. State public utility commissions have engaged interested parties in identifying additional transmission resources needed to meet state renewable energy obligations. Utilities could be required to objectively analyze the potential of all available resources. The Eastern Interconnection States' Planning Council has the potential to be a forum for state discussions on this topic.

2.4.1.2 Ports

Maritime ports were not originally designed with the offshore wind sector in mind. In many cases, quaysides, laydown areas, and clearances must be upgraded to accommodate ever-larger turbines and foundations, as well as an increasing volume of offshore projects. Large ports in Europe are undergoing major upgrades to support the development of offshore wind. Massachusetts announced investment of $100 million to upgrade the New Bedford Port for construction of the Cape Wind Farm.

Ports must be upgraded to accommodate ever-larger turbines and foundations.

The primary offshore wind policies related to port infrastructure focus on the following:

- Overall port strategy and planning at the country level
- Upgrades to ports (when ports are held by the state)
- Incentives encouraging port upgrades (when ports are privately held)

[37] This unused transmission capacity would remain "tagged" to the conventional generation unit for purposes of most transmission capacity markets, but would still be available most of the time for energy transmission from wind generation, including during most peak demand periods when the wind energy would be dispatched before these more costly peaking generation units.

The Navigant Consortium identified two policy examples, used in countries such as Germany, the United Kingdom, and Denmark and discussed in detail in Appendix C, related to improving the port infrastructure to better accommodate offshore wind:

Ports Policy Example 1: In order to address the challenge of funding upgrades to ports to accommodate offshore wind, several European countries have chosen to upgrade state-held ports or provide incentives for private port upgrades.

- If a country's ports are held by the state, the national government identifies and performs upgrades needed by strategically positioned ports.
- If a country's ports are held by the private sector, the government provides incentives to encourage the port upgrades. The government may have a vested interest in supporting the private sector (e.g., meeting national renewable energy targets).

Ports Policy Example 2: In order to address the issue of a disjointed ports planning process, European countries often develop a country-wide strategy focusing on a select number of locations spread around the coast. A government agency commissions a study to assess the following:

- Specific requirements of the offshore wind industry for ports
- Current capabilities of the country's ports
- Potential port expansion or development to meet the needs of the offshore wind sector

Based on the study's findings, the government agency develops a policy for long-term port development.

2.4.1.3 *Manufacturing*

Manufacturing-related policies for offshore wind include the following categories:

- Government support for offshore wind manufacturing at port sites
- Favorable customs duties, export credit assistance, or quality certification

Manufacturing Policy Example 1: To address the challenge of promoting a domestic supply chain, countries such as Germany have provided government support for offshore wind manufacturing at port sites, including the following policy mechanisms:

- Expedited permitting for prototype turbines (e.g., Bremerhaven – Multibrid)
- Creation of wind-related training/degree programs at local universities
- Tax credits
- Loans

Manufacturing Policy Example 2: To further address the supply chain issue, European countries have provided favorable customs duties, export credit assistance, and quality certification. A country's export credit agency provides loans or loan guarantees for the sale of domestically manufactured turbine or turbine components to customers in other countries. By assuming part of the risk, the export credit agency increases the likelihood that companies obtain financing from private banks and investors. Frequently, obtaining financing for a project is key to winning orders.

Obtaining financing for a project is key to winning orders.

2.4.2 Current U.S. and State Policies

In the United States, offshore wind energy resource zones for targeted grid investments have not been specified, although such zones have been specified for the land-based wind market. California, Michigan, and Texas have designated specific areas for land-based wind development. The idea is to provide a level of certainty for transmission development to avoid an "if we build it, they will come" situation. Table 2-6 presents an overview of these transmission policies, while Appendix B provides further detail.

Table 2-6. State-based Wind-focused Transmission Policies

State	Land-based Transmission Policy	Economics
California	• Renewable Energy Transmission Initiative (RETI) • Started in 2007 • Identifies and ranks resource zones and develops conceptual transmission plans for highest ranked zones	Developers pay an initial deposit for ratepayer-subsidized transmission development and then later pay the balance of the total transmission interconnection cost through long-term operating revenues.
Michigan	• State legislation in 2008 required the Public Service Commission (PSC) to identify wind energy resource zones • In 2010, the PSC identified two zones • Zones are intended to expedite development of transmission	Affected parties within the zones are given 21 days to reach agreement on a voluntary cost allocation methodology for the transmission upgrade projects.
Texas	• State legislation in 2005 instructed the Texas Public Utilities Commission (PUC) to establish competitive renewable energy zones (CREZ) • In 2008, the PUC designated five CREZs • The initiative aims to facilitate the transmission of more than 18 GW of wind power from west Texas and the Panhandle to the state's highly populated areas	Transmission lines to each of the five sites, totaling 3,600 miles, is to be funded by all ratepayers at a projected cost of $6.8 billion (CREZ 2013).

Source: Navigant analysis

2.4.3 Current Policies in Europe

Table 2-7 is a summary of infrastructure policies currently in place in selected countries in Europe. Detailed descriptions of these policies are provided in Appendix C.

Table 2-7. Policies for Addressing Infrastructure Challenges in Europe

Country	Transmission Policy	Ports Policy
Belgium	• Current framework: TSO is responsible for connecting wind farms to the grid. TSO pays up to €25 million of the connection costs, the rest being covered by the project developer • Future framework: TSO will build and operate transmission assets.	The offshore wind terminal of the Port of Oostende has been financed by both public and private bodies
Denmark	• TSO is responsible for funding and connecting wind farms to the grid • Costs recovered from all customers • No plans for inter-project transmission	Ports funded by municipalities. Investment of $186 million through 2019 in the Port of Esberg
France	TSO builds and owns the transmission assets, but associated construction costs are borne by the project developer. The latter is compensated for this investment through a specific component of the FiT and recovered from all ratepayers	Ports to be developed by developers (members of the consortium)
Germany	• TSOs are responsible for building and operating OSW transmission connections • Costs recovered from all customers • New German Energy Act clarifies liability for construction delays	• State of Bremen supports Bremerhaven with R&D and investment support schemes • New Bremerhaven terminal will be funded through a concession contract expected to be awarded by spring 2014 • Lower Saxony government is directly investing in three North Sea ports

Country	Transmission Policy	Ports Policy
Netherlands	• TSO is responsible for construction and management of the grid • Offshore developers are responsible for project-specific transmission system costs • Developing HVDC interconnection with Denmark. FID expected in 2016	Ports are all independent companies and do not receive any funding or direct support from the government
United Kingdom	• Projects cannot own their transmission systems anymore once built. Thus competitive tenders are organized to become an OFTO and collect 20 years of payments • Project developers can choose to construct their own transmission assets (which they will then need to sell to an OFTO after completion) or opt for an independent OFTO to do it directly. In case of construction delays by the OFTO, the latter is liable to pay LDs to NGET, the UK TSO, and thus is not directly liable toward the project developer, which is a major risk issue for developers and suggests this "OFTO-built" regime will not be used.	• The Crowne Estate is soliciting applications from manufacturers and ports • £60 million is available between 2011 and 2015

Source: Navigant analysis

2.5 *Examples of Policies That Address Regulatory Challenges*

2.5.1 General Discussion of Policy Examples

As mentioned in Section 2.2 and further described in Appendix A, the primary regulatory challenges that the U.S. offshore wind industry faces include uncertain site selection and leasing processes, fragmented permitting processes, and public resistance due to uncertain environmental impacts. The following sections include policy examples regarding leasing, permitting, or operations of offshore wind projects that have been implemented or proposed:

2.5.1.1 General

The following policies have been used to address the issue of a disjointed planning process:

- *Global planning approach that includes offshore*. In 2010, the U.S. Department of the Interior (DOI) established its "*Smart from the Start*" Initiative for Atlantic Ocean wind. This initiative identifies priority WEAs for potential development; improves BOEM coordination with local, state, and federal partners; and accelerates the leasing process. BOEM has established task forces with at least 13 states to engage intergovernmental partners and help inform BOEM's planning and leasing processes.
- *Federal/state policy coordination*. In June 2010, the DOI and a number of states created the Atlantic Offshore Wind Energy Consortium and signed a memorandum of understanding (MOU) to facilitate federal/state offshore wind development coordination. These states included Maine, New Hampshire, Massachusetts, Rhode Island, New York, New Jersey, Delaware, Maryland, Virginia, and North Carolina. In February 2012, five Great Lakes states and ten federal agencies signed an MOU to establish a more coordinated approach to ensure efficient, expeditious, orderly, and responsible evaluation of offshore wind power projects in the Great Lakes.

2.5.1.2 Leasing

The following policies have been used to address the issue of uncertain site selection and leasing processes:

- *Regulatory framework for marine spatial planning*. Marine spatial planning could promote national objectives such as enhanced national energy security and trade, and provide specific economic incentives (e.g., cost savings and more predictable and faster project implementation) for commercial users.
- *Dedicated offshore wind areas*. State regulators who identify environmental constraints and engage in discussions with stakeholders with competing offshore uses lead the identification of WEAs. This policy is the first phase of BOEM's Smart from the Start initiative.
- *Phased access*. Developers have a short-term right to evaluate a wind resource with a longer-term right to develop. (i.e., the limited lease or site assessment terms under BOEM regulations)
- *Regulator selection of sites, followed by developer competitive bidding*. This process is used in Texas, New York, and Denmark.

- *BOEM call for lease nominations*. BOEM held its first two competitive lease sales for offshore wind in Rhode Island and Virginia in 2013 and announced competitive auctions in Maryland, Massachusetts and New Jersey for 2014.

BOEM has announced competitive auctions in MD, MA, and NJ in 2014.

2.5.1.3 Permitting

The initial challenge for offshore wind development was a lack of a specified leasing process. Cape Wind filed its initial permit application with the U.S. Army Corps for its wind farm and transmission interconnection in 2000. The Energy Policy Act of 2005 transferred jurisdiction and lead NEPA federal agency status to the U.S. Minerals and Management Service, now the Bureau of Ocean Energy Management. When BOEM issued its initial proposed draft leasing regulations, the process included three Environmental Impact Statements, which could have taken up to 5 to 7 years to attain.

The main policy examples to address these permitting challenges differ primarily in the level of centralization in producing Environmental Impact Statements (EISs). The following policies have been used to address the issue of fragmented or unclear permitting processes:

- *Require site-specific EISs for every offshore wind project*: Under this policy, developers produce individual EISs for each wind farm, regardless of whether adjacent projects have addressed similar issues.
- *Conduct a programmatic EIS (PEIS) over broad geographic areas to determine categorical exclusions, followed by less-detailed environmental assessments for individual projects*: The objective of this policy is to gain economies of scale and scope in conducting EISs, addressing common issues across multiple projects in a common area and saving time and expense. Issues that are unique to a certain project are addressed in a less detailed, site-specific EIS.

A programmatic EIS addresses common issues across multiple projects.

- *Develop a PEIS for a broad geographic area followed by detailed EISs for selected individual projects*: This example is similar to the previous example, with the exception that the project-specific EISs are more detailed. A PEIS evaluates the impacts and identifies appropriate mitigation for a range of standard technologies to be installed in a relatively uniform environment. The completed PEIS provides guidance to developers and regulators for subsequent specific development proposals. In the United States, if the same technologies are proposed with the mitigation recommended by the PEIS, the subsequent National Environmental Policy Act (NEPA) review can focus only on unique aspects of the specific technologies or environment at the proposed wind farm site and cable route. This can significantly reduce the NEPA review period. A PEIS will generally take a couple of years to complete, but if initiated early - for example, during the initial WEA identification and competitive auction processes - it can significantly expedite final review of the winning leaseholder's project. This is especially true if programmatic EISs or Environmental Assessments (EAs) are conducted for WEAs simultaneously with the lengthy process to determine the winning bidders in areas where competitive interest exists.

2.5.1.4 Operations

There are multiple examples for the environmental and safety compliance monitoring of offshore wind plants, which address the issues of public resistance and uncertain environmental impacts. These examples differ primarily in the party responsible for conducting monitoring activities.

- *Environmental and safety compliance monitoring by the government*: A government agency is responsible for conducting monitoring activities prior to, during, and after construction of an offshore wind farm to assess a baseline characterization of the local environment and any subsequent changes.
- *Self-monitoring by developers or operators*: The developer or operator of a wind farm monitors the impact of its offshore wind farm on the environment and submits the monitoring data to a government agency for verification.
- *Monitoring by third parties*: A certified, independent third party monitors the impact of an offshore wind farm on the environment and submits the monitoring data to a government agency for verification.

In May 2014, the BSEE issued an RFP to conduct a study of OSW inspection procedures and recommend a general approach and standards for OSW inspections. After review of the study, BSEE will propose regulations.

2.5.2 Current U.S. and State Policies

2.5.2.1 Leasing

BOEM has taken an active role in conducting auctions for leases in federal waters.

BOEM held the first two competitive lease sales for renewable energy in federal waters offshore Rhode Island and Virginia in 2013.

On July 31, 2013, BOEM held the first-ever competitive lease sale for renewable energy in federal waters south of Rhode Island and Massachusetts. BOEM auctioned the area as two leases: the 97,500-acre North Lease and the 67,250-acre South Lease, located about 9.2 nautical miles south of Rhode Island. According to a recent NREL report, the North Lease has the potential for installed capacity of 1,955 MW and the South Lease for 1,440 MW. Rhode Island-based Deepwater Wind was the winning bidder, with a bid of $3.8 million for the two sites. Deepwater Wind plans to construct five 6-MW turbines within 3 miles of Block Island, Rhode Island, in 2014 and monitor their performance while seeking offtake agreements for the larger wind farm, including into New York.

On September 4, 2013, BOEM held the second competitive lease sale for a commercial lease area offshore Virginia. Dominion Virginia Power was the winning bidder, with a winning bid of $1.6 million for the single 112,800-acre site. The acreage is located 23.5 nautical miles from Virginia Beach, with a potential for over 2,000 MW. Dominion first plans to construct two 6-MW Alstom turbines on the edge of the WEA and monitor their performance before constructing the large wind farm in subsequent phases.

BOEM held a competitive lease sale for Maryland's Wind Energy Area on August 19th, 2014. Sixteen companies were determined to be legally, technically and financially qualified to participate in the auction. BOEM auctioned the area as two leases; the North Lease Area includes 32,737 acres and the South Lease Area includes 46,970 acres. US Wind Inc. submitted the provisionally winning bid for both lease areas, for a total bid of $8,701,098.[38]

In July 2014, BOEM announced a Proposed Sale Notice for the New Jersey Wind Energy Area. BOEM proposes to auction the area as two leases: the South Lease Area (160,480 acres) and the North Lease Area (183,353 acres), for a total of 344,000 acres.

In addition, BOEM has announced plans for a competitive auction in Massachusetts in 2014 and issued a Call for Information after determining there is competitive interest for the NYPA lease area off New York.[39] The winning bidder must submit a site assessment and a construction and operations plan by 2014, complete surveys within three years after that, and then submit the work for federal review, which could take another three years.

On Aug. 11, 2014, BOEM announced that it has identified three Wind Energy Areas (WEAs) offshore North Carolina:

- The Kitty Hawk WEA begins about 24 nautical miles (nm) from shore and extends approximately 25.7 nm in a general southeast direction. Its seaward extent ranges from 13.5 nm in the north to .6 nm in the south. It contains approximately 21.5 Outer Continental Shelf (OCS) blocks (122,405 acres).
- The Wilmington West WEA begins about 10 nm from shore and extends approximately 12.3 nm in an east-west direction at its widest point. It contains just over 9 OCS blocks (approximately 51,595 acres).
- The Wilmington East WEA begins about 15 nm from Bald Head Island at its closest point and extends approximately 18 nm in the southeast direction at its widest point. It contains approximately 25 OCS blocks (133,590 acres).[40]

[38] BOEM (2013d)

[39] 79 Federal Register at p. 30649, May 28, 2014.

[40] BOEM (2013i)

U.S. states are taking a variety of approaches to offshore wind site selection and leasing. Common themes include forming panels or task forces to engage local stakeholders and to coordinate state efforts with BOEM and various regional consortia. Figure 2-2 provides a high-level summary of state-level policies that are being employed, and further details are provided in Appendix B.

Figure 2-2. Site Selection and Leasing Policies in U.S. States

Policy Options ***Barrier: Regulatory***	**Jurisdictions where Used**													
	Delaware	**Illinois**	**Maine**	**Maryland**	**Massachusetts**	**Michigan**	**Ohio**	**New Jersey**	**New York**	**North Carolina**	**Rhode Island**	**South Carolina**	**Texas**	**Virginia**
General: Panels or task forces in place to engage local stakeholders to identify constraints & sites for offshore wind	✓	✓	✓	✓	✓	✓[1]	✓[2]	✓	✓	✓	✓	✓	✓	✓
Federal/state policy coordination (3)(4)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
Leasing: Regulatory framework for marine spatial planning		✓	✓		✓	✓		✓			✓		✓[5]	
State selects sites & conducts competition													✓[5]	
BOEM lease nominations/applications	✓			✓	✓			✓	✓		✓			✓

(1) Report of the Michigan Great Lakes Wind Council, October 2010, identifies 13,339 square miles which are considered to be most favorable to the sustainable development of offshore wind energy. Five priority areas were identified, known as wind resource areas (WRAs). GLOW Council expired under new Governor who is re-evaluating offshore wind development - similar to Ohio & Wisconsin.
(2) Ohio's Offshore Wind Turbine Placement Favorability Interactive Map Viewer tool can be used to evaluate sites.
(3) In June 2010, the Atlantic Offshore Wind Energy Consortium was created to facilitate Federal-state offshore wind development coordination by an MOU signed by the U.S. Department of the Interior and the states of ME, NH, MA, RI, NY, NJ, DE, MD, VA, and NC.
(4) In February 2012, an MOU was signed among 5 Great Lakes states and 10 federal agencies that creates an Offshore Wind Energy Consortium to promote the efficient, expeditious orderly and responsible evaluation of offshore wind power projects in the Great Lakes.
(5) The TX General Land Office stipulates which areas are available for lease, the minimum MW size, and the minimum royalty rates. Winning bidders are granted phased access, first given research rights and then construction and operation rights.

Source: Navigant analysis

2.5.2.2 *Permitting*

On February 3, 2012, BOEM issued a Notice of Availability for the final EA, and a Finding of No Significant Impact (FONSI) for commercial wind lease issuance and site assessment activities on the Atlantic OCS offshore New Jersey, Delaware, Maryland, and Virginia (BOEM 2013g). Instead of waiting for the site assessment plan (SAP) to be filed to trigger the SAP NEPA review, BOEM initiated a programmatic environmental assessment (PEA) for these four states simultaneously. By covering all major site assessment and characterization technologies and their impacts, this PEA is expected to enable more expeditious review of developers' site assessment proposals in these four states. The PEA was conducted during the nomination of lease sites in Maryland and Virginia and did not delay those calls for information and leases. Winning bidders in Maryland and Virginia may seek expedited EAs and departures from certain SAP requirements. To do so, they must use one of the standard wind measurement technologies that the PEA has already determined do not to cause significant impacts with appropriate mitigation. Even if one or two issues must be addressed that were not covered in the PEA, then only those issues need be addressed, and the EA can be reviewed and issued more promptly than an EA covering all the site assessment issues.

Similarly, BOEM could eventually determine routine measurement activities as "categorical excluded," meaning they do not individually or cumulatively have a significant effect on the human environment and would require no EA or EIS. The Council of Environmental Quality (CEQ) issued new guidance in 2011 on establishing and maintaining categorical exclusions for routine activities. Many oil and gas exploration activities have been granted categorical exclusions. Over time, BOEM has acknowledged that turbine construction may warrant an EA and that site assessment activities, such as installing a meteorological tower, could become routine and may warrant categorical exclusions instead of EAs.[41] As BOEM and other federal agencies review more measurement technologies, they will be able to issue their NEPA reviews more expeditiously and accelerate the permitting process.

States have a regulatory role when a wind energy project is proposed for construction in federal or state waters. Under the Submerged Lands Act, states have authority generally over the first three nautical miles of a state's coastal submerged lands, and states have passed coastal management laws and developed permitting and leasing programs for activities in state submerged lands. Offshore wind energy projects proposed in state waters could be subject to a comprehensive regulation that is managed by a single state agency or to permitting authorities managed by multiple state and local agencies. For example, Massachusetts, Rhode Island, Ohio, and New York have state siting boards that coordinate other state agencies and provide one-stop permitting for in-state generation as well as the interconnection cables offshore and onshore.

States have authority generally over the first three nautical miles.

States will have a regulatory role for projects in federal waters if a portion of the federal project (e.g., a cable) is constructed in state submerged lands. Furthermore, the Coastal Zone Management Act (CZMA) gives states the authority to require that projects in federal waters are consistent with that state's coastal zone policies and the federally-approved coastal zone management program. This state review process is frequently referred to as a CZMA "consistency review."

2.5.2.3 Operations

Federal and state authorities with jurisdiction currently approve energy facilities subject to conditions on construction and operation, which protect the public and environment from new facilities. For offshore wind farms, such conditions may include the following:

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[41] BOEM stated when issuing its Final Rule on offshore leasing: "After the impacts and related mitigation of renewable energy activities on the OCS are better understood, it is possible that projects may require an EA. As the program matures, MMS will review the impacts from the program and make a determination whether we can recommend categorical exclusions for certain activities to the Council on Environmental Quality." 74 Federal Register 19,689.

- Restrictions on public access to the facility for public safety
- Restrictions on operation during extremely high winds that could cause catastrophic failure and loss of the blades
- Post-construction environmental monitoring surveys of birds, bats, and marine mammals
- Seabed inspection of potential s scouring around the foundations to ensure ongoing protection of the environment and mitigation of any significant effects that may arise

The U.S. Fish and Wildlife Service (USFWS) negotiates the survey protocols for avian and bat studies, which include post-construction monitoring through their jurisdiction under the Endangered Species Act and the Migratory Bird Treaty Act. BOEM has issued new guidelines for avian and bat surveys and coordinates the review of such surveys in its role as Lead Federal Agency under NEPA. The USFWS has issued new guidelines for avian and bat surveys for terrestrial wind farms and is beginning to consider guidelines for surveys for offshore wind farms. Earlier studies identified flashing red lights as providing a deterrent effect, unlike flashing white lights, which attract some species. Government-sponsored studies may help identify additional technologies that may deter birds from flying through offshore wind farms.

BOEM also has issued new guidelines for marine mammals and sea turtles and coordinates the review of such surveys in its role as Lead Federal Agency under NEPA. [42]

Cape Wind has agreed to conduct three years of post-construction avian and bat aerial and boat-based surveys as a condition of their BOEM lease. The cost of these post-construction surveys will exceed $1 million per year.

The cost of Cape Wind's avian and bat surveys will exceed $3 million.

While more limited post-construction monitoring of mammals is also required for the Cape Wind project, the biggest concern about marine mammals is contact, or "allision," with vessels. The construction period requires the use of many large vessels and therefore requires mitigation measures to protect endangered or threatened marine mammals, such as the following:

- Reduced vessel operating speeds
- Trained, independent protected species observers
- Hydro-acoustic monitoring
- Construction delays and shutdowns when certain mammals are within exclusion zones

In a first of its kind collaboration, a coalition of leading environmental organizations and offshore wind developers has agreed to a series of voluntary measures that will protect critically endangered North Atlantic right whales, while helping to expedite responsible offshore wind development, in the Mid-Atlantic. Building upon proposed federally mandated protections, the Conservation Law Foundation

[42] Guidelines for Providing Information on Marine Mammals and Sea Turtles for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585 Subpart F

(CLF), the National Wildlife Federation (NWF) and the Natural Resources Defense Council (NRDC), working together with Deepwater Wind, Energy Management, Inc. (owner of Cape Wind in Massachusetts) and NRG Bluewater Wind, drafted a set of protective measures that these developers will voluntarily implement over the next four years in areas designated by the administration as Mid-Atlantic Wind Energy Areas, which stretch from New Jersey to Virginia (map available at http://on.doi.gov/UWoNPF).[43]

Small vessels make O&M visits to offshore turbines, but these visits occur only a couple of times per year and are thus much less threatening to marine mammals.

Further government studies of the mating and calving grounds and migratory routes of endangered whales may help to site wind farms safe distances from the whales and provide more protection during construction and operation of wind farms (BOEM 2014).

[43] The agreement reduces the threat to right whales by limiting meteorological tower construction and certain other activities during the peak migration season, when whales travel through the mid-Atlantic region between southern calving and northern feeding grounds. During other times of the year, when the whales frequent the area less, the activities may take place with additional protective measures. These additional protective measures include enhanced real-time human monitoring for whale activity in the site area and restriction of activities to daylight hours when whales can be spotted, the use of noise-reducing tools and technologies, and a lower speed limit for vessels in the area during migration times to avoid ship strikes. The full details of the agreement can be found at http://docs.nrdc.org/oceans/files/oce_12121101a.pdf.

Great Lakes States and Offshore Wind: Riding the Waves of State Leadership

The excellent to superb wind resources over the Great Lakes offer potential to generate over 700 GW of wind energy. This represents about one-fifth of the total offshore wind potential in the U.S. Despite the great wind resource and the potential to power urban centers such as Milwaukee, Chicago, Cleveland, Erie, or Buffalo, not one offshore wind project is under construction or operating in the Great Lakes.

The reasons offshore wind has not yet become a reality lie partly in the ebb and flow of state policy leadership for renewable energy generally and offshore wind in particular. This story played out in slightly different ways across the region over the past half-decade. Following the U.S. financial crisis of 2007 that triggered a recession leaving millions without jobs, U.S. state and federal policy leaders looked toward the renewable energy industry to create green jobs and lead their states into economic recovery. Starting in 2008, four Great Lakes states (WI, MI, OH and NY) – began to investigate the feasibility and opportunities to develop offshore wind. Guided by state leadership both in the executive and legislative branches, the prospects of offshore wind development in the Great Lakes were explored through multi-stakeholder committees or task forces and agency-led initiatives.

Under the Doyle administration, the Public Service Commission of Wisconsin (PSC) opened a docket (5-EI-144) to explore offshore wind in 2008, which produced a report known as Wind on the Waters (WOW). That report examined the feasibility of developing offshore wind in lakes Michigan and Superior from technical, economic, environmental and legal standpoints. The WOW report was released in 2009, but opposition in the state legislature prevented follow-up action. This same opposition halted the expansion of the state's Renewable Portfolio Standard (RPS) to 25 percent by 2025 which was a high priority for former Governor Doyle.

During the same time period, former Michigan Governor Jennifer Granholm made green job creation a focus to her second term (2007-2011). Passage of a state RPS was part of a strategy to promote renewable energy that included offshore wind. In 2009, Granholm issued an Executive Order establishing the Great Lakes Offshore Wind Council (GLOW Council) to map the most and least favorable areas for offshore wind in Michigan's Great Lakes waters. The final GLOW Council report identified five "most favorable" Wind Resource Areas that are: 45 meters or less in depth, at least six miles offshore, and at least 20 contiguous square miles. The GLOW Council report also proposed a state legislative framework that included permitting guidelines, leasing methods, payment structures, and a public input process. Legislation was introduced into the Michigan House of Representatives in 2010 (House Bill 6564) based on the GLOW Council recommendations, but that legislation never received serious consideration by the legislature. Subsequent changes in state leadership and changes in electric energy markets significantly slowed interest in moving legislation and the development of an offshore wind regulatory framework in Michigan.

Great Lakes States and Offshore Wind: Riding the Waves of State Leadership (cont.)

Similar attempts to make offshore wind a reality were made by Ohio state leadership. Around the same time in 2008, former Ohio Governor Ted Strickland (2007 -2011) signed the state's RPS, calling for 25 percent of the state's energy to be produced by renewable by 2025 and supported other efforts to transform Ohio into a hub for the renewable energy industry. Riding on this wave of state support, a local group in the Cleveland metropolitan area sought to be the first to develop an offshore wind project in Lake Erie. See Section 1.2.3.5 for a description of the LEEDCo project. Since 2011, state leadership on renewables and wind energy has seen a noticeable decline. Ohio Governor John Kasich (2011 to present) supports the 2014 Ohio Senate Bill 38 that would suspend the state RPS for two years. Additionally, a GIS-based offshore wind favorability analysis mapping tool that was released in 2009, was removed from the state's web site in 2012.

New York has experienced similar moves away from interest in Great Lakes offshore wind. In December 2009, New York Power Authority (NYPA) issued a Request for Proposals for offshore wind projects in New York State waters of Lake Erie and/or Lake Ontario and proposals were received in 2010. However, after reviewing the proposals, NYPA announced in 2011 that it was not economically feasible to move forward with the offshore wind on New York's portion of the Great Lakes. Meanwhile, New York has continued and augmented its interest in offshore wind on the state's Atlantic coast.

Responding to earlier wave of interest in offshore wind coupled with regulatory uncertainty, five Great Lakes Governors (IL, MI, MN, NY, and PA) and 10 federal agencies signed a bipartisan federal-state Memorandum of Understanding (MOU) in March 2012 to support the efficient, expeditious, orderly and responsible review of proposed offshore wind energy projects in the Great Lakes. It was envisioned that this effort would produce a regulatory roadmap documenting existing regulatory and review requirements for offshore wind at the federal and state levels. Mirroring trends in individual states, however, interest in implementing the MOU has since waned considerably.

In contrast to the other Great Lakes states, Illinois has continued to demonstrate serious interest in offshore wind. The Illinois Department of Natural Resources (IDNR)-led Lake Michigan Offshore Wind Energy Advisory Committee produced a report to the Governor and General Assembly in June, 2012 which ultimately resulted in enactment of the Lake Michigan Wind Energy Act in August, 2013. The law requires the IDNR to develop an offshore wind "siting matrix" to identify preferred or prohibited development areas in the lake which would inform regulatory decisions regarding leases or permits for offshore wind projects.

Presently, none of the Great Lakes states has a policy (e.g., laws or regulations) or permitting program designed to address the permitting issues specific to offshore wind. Despite current weak state leadership and related interest in offshore wind, institutional mechanisms (e.g., laws and policies) to properly evaluate offshore wind such proposals—and a formal structure to engage the public offshore wind decision-making—will equip state regulators and the public to make informed decisions about the merits and disadvantages of a proposed project when project proposals do arise.

2.5.3 Current Policies in Europe

Table 2-8 summarizes the regulatory policies currently in place in selected countries in Europe. The first row of Table 2-8 describes the challenges in each policy area that exist in the U.S. Detailed descriptions of these policies are provided in Appendix C.

Table 2-8. Policies that Address Regulatory Challenges in Europe

Country	Planning and Concessions	Permitting	Operations
Challenge for the U.S.	Uncertain site selection process and timeline	Fragmented permitting process	Environmental and public resistance
Belgium	• Seven areas identified and reserved for offshore wind development, totaling 2.2 GW • All areas have been conceded, two are in operation, one is under construction	A public body, MUMM, is responsible for carrying out the EIA in collaboration with the project developer	Developers must deploy environmental monitoring programs
Denmark	• Centralized spatial planning procedure • Developers can either respond to tenders from the DEA or apply to develop a site • Six offshore wind areas have been identified. Tenders will be organized this year for 1.5 GW of projects: two offshore and a combination of near-shore projects	• The Danish Energy Agency (DEA) is a one stop shop • The DEA is responsible for providing an EIA	Developers must have comprehensive environmental monitoring programs

Country	Planning and Concessions	Permitting	Operations
France	Six areas identified for offshore wind development, totaling 3 GW and awarded through two rounds of tenders in 2012 and 2013	• A concession from the state on the maritime domain will be required but has not been granted to any project yet. The terms of this concession remain to be fully negotiated, as there are no relevant precedents • Projects must still obtain separate construction permits and there is uncertainty as to what kind of legal recourses may apply to both the concession and these permits	Tender document include the fact that each tenderer has to design, build, operate and dismantle the assets with a view to minimize the impact on the environments in terms of species, landscape and surrounding marine environment
Germany	Five priority areas for offshore wind identified in the German North and Baltic Seas	Central position of BSH, the sole licensing authority. First come first served principle.	Developers are responsible for baseline assessment and annual monitoring
Netherlands	• OSW zones have been identified • Plan to speed up offshore wind deployment published in 2013 (SDE scheme extended, grid connection facilitated)	MTPW is a one stop shop with an integrated assessment framework	Developers must monitor the project's impact on the environment
United Kingdom	• Extensive marine spatial planning • Nine zones identified for Round 3 • 80-year leases for Round 3	• One stop shop approach • New Infrastructure Planning process for OSW permitting	Developers are responsible for monitoring environmental impacts

Source: Navigant analysis

2.6 *Summary*

Table 2-9 is a summary of policy examples that have been used or proposed to address the various barriers to the U.S. offshore wind industry. The left column of the table lists the policies in each area that have been successfully used by European or U.S. federal or state jurisdictions as described in Sections 2.3 to 2.5. The right column of the table provides a summary of U.S. and state offshore wind policy developments in 2014.

Table 2-9. Offshore Wind Policy Examples and Developments

Barrier	Policy Examples	2014 U.S. Developments
Cost Competitiveness	• Long-term contracts for power • ORECs • ITC for developers • PTC for developers • Low-interest loans and guarantees • Accelerated depreciation • State FiTs	• The U.S. PTC and ITC expired for projects that did not begin construction[44] by year-end 2013. The 50% first-year bonus depreciation allowance also expired in 2013. • The DOE announced three projects that will receive $47 M each to complete engineering and construction as the second phase of the Offshore Wind Advanced Technology Demonstration Program. • Maryland began promulgating rules for ORECs for up to 200 MW. • The New Jersey Board of Public Utilities rejected a proposal for ORECs by Fishermen's Energy for a five-turbine project off Atlantic City, NJ. • The Maine Public Utility Commission approved a term sheet with a team led by the University of Maine for a pilot floating wind turbine project.

[44] More info on the IRS definitions are available at http://www.irs.gov/pub/irs-drop/n-13-29.pdf and http://www.irs.gov/pub/irs-drop/n-13-60.pdf

Barrier		Policy Examples	2014 U.S. Developments
Infrastructure		• Promote utilization of existing transmission capacity reservations to integrate offshore wind • Target BOEM Wind Energy Areas and consider public policy mandates, such as RPS, as required by FERC	
Regulatory	Leasing	Similar to BOEM's "Smart from the Start" model - 4 stage authorization process: (1) planning & analysis; (2) leasing; (3) site characterization & assessment; and (4) commercial development	BOEM announced additional competitive lease sales for renewable energy off Massachusetts, Maryland and New Jersey in 2014.
	Permitting	Expedite lease auction process and set efficient schedule for NEPA review of leasing and permitting process in accordance with CEQ NEPA regulations	BOEM continues to issue leasing guidelines, conduct marine research, lead stakeholder meetings to revise WEAs, and hold educational seminars to facilitate leasing and permitting.
	Operations	Self-monitoring of environmental and safety compliance by developers/ operators	Government and stakeholder working groups are developing standardized equipment certifications and construction and operations safety protocols.

Source: Navigant

A review of European policies that are designed to stimulate demand (i.e., policies that address cost competitiveness) indicates that a variety of approaches have resulted in significant offshore wind development. A portfolio approach that incorporates multiple policy elements has also proven effective, as evidenced by the U.S. land-based wind market, which has been stimulated through a mix of PPAs with PTCs, ITCs, and RPSs.

Infrastructure policies have shown to be effective in reducing costs and ensuring the demand can be filled. These policies help to put critical infrastructure components in place such as transmission and ports. Mid- to long-term policies help to instill confidence in the market. Manufacturers built portside manufacturing capacity in the United Kingdom and Germany after those countries signaled that long-term demand would exist.

Regulatory policies also help to streamline the siting and permitting processes and provide more certainty to investors. Clear and stable processes such as one-stop permitting are in place in most European countries that are active in offshore wind. In the U.S., BOEM and many state governments are developing and implementing similar policies to eliminate uncertainty, reduce the time required for development, and ultimately reduce the cost of offshore wind.

3. Economic Impacts

3.1 Introduction

This section identifies the potential economic impacts of the U.S. offshore wind industry. It also provides an update of the expected installed cost for a 500 MW reference plant in the Mid-Atlantic.

Summary of Key Findings – Chapter 3

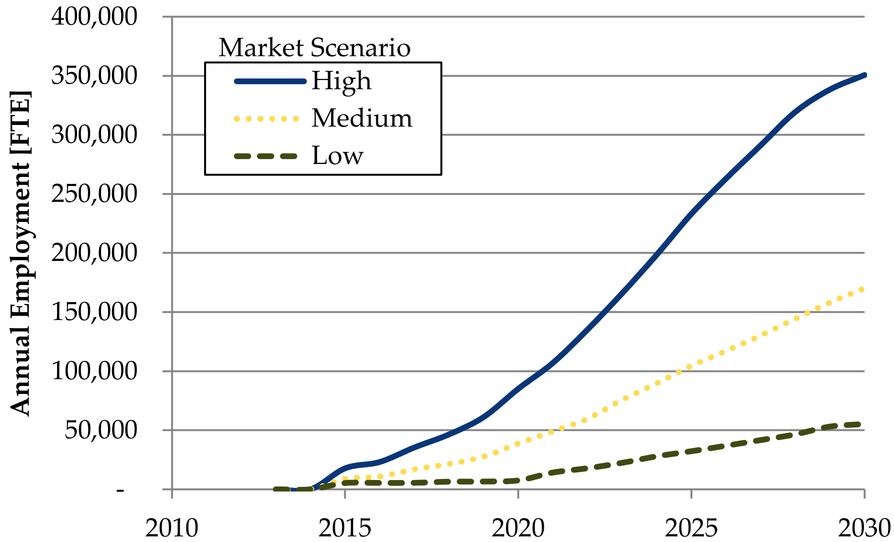
- Expected installed costs are 6% lower than our 2011 report, due to new data from European projects and more refined estimates for U.S. projects.
- Expected installed cost is now $2.86 billion or $5,700/kW for a 500 MW farm using monopiles.
- Current employment could be between 500 and 5,000 FTEs, depending on where equipment is being sourced.

3.2 Scope of Update

The original intent of this annual report on economic impacts of the U.S. offshore wind industry was to benchmark our 2012 projections against actual results in 2013 and 2014. However, as shown in Figure 1-3, our 2012 forecasts did not show installations in 2013 and 2014. Because of this, we did not project any employment or economic impacts in 2013 and 2014, as shown in Figure 3-1 and Figure 3-2, respectively. But we know – through press releases, conference presentations and conversations with industry stakeholders – that people are currently employed in the U.S. offshore wind industry. As a result, we decided to use this year's report to assess current employment and investment to use as a baseline for future studies. We first describe our data collection efforts and then the resulting levels of employment and investment.

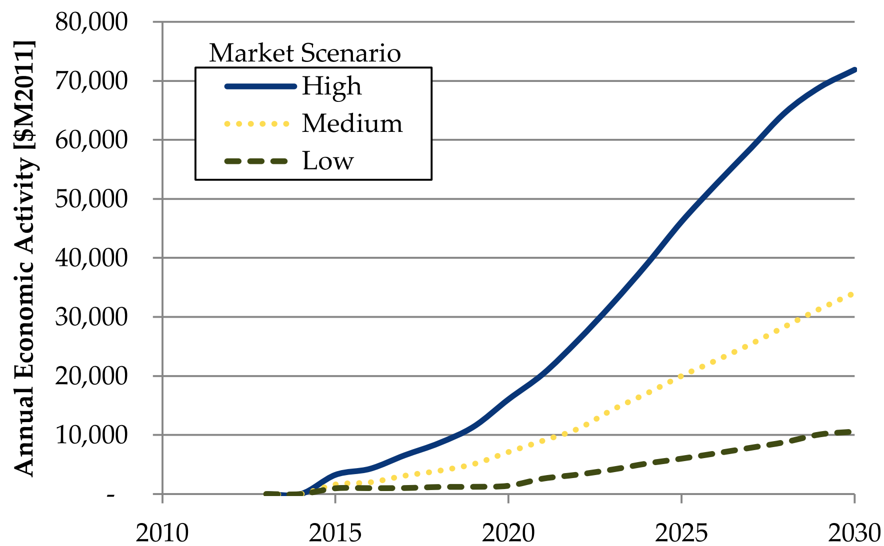
However, we begin the chapter with an update of our installed cost assumptions. We provide an update because of new assumptions about plant design, refined cost data and new information from European projects.

Figure 3-1. Annual U.S. Employment Supported by the U.S. Offshore Wind Industry, 2012 Projection



Source: Navigant analysis

Figure 3-2. Annual U.S. Economic Activity Supported by the U.S. Offshore Wind Industry, 2012 Projection



Source: Navigant analysis

3.3 Installed Cost Update

3.3.1 Overview

Local employment and economic impacts are a function of the amount of spending and labor sourced from the local economy. Before looking at local impacts, the Navigant Consortium collected information on project-level costs at a higher level of detail than is typically reported in literature or project press releases. Thus, the Navigant Consortium's internal knowledge, expert interviews, and vendor quotes were relied upon as sources of cost data. The remainder of Section 3.3 reviews data sources and findings for each cost category.

3.3.2 Typical Project

Many project-specific variables such as water depth, foundation type, distance to shore, and turbine size significantly impact costs for offshore wind farms. Thus, rather than collecting cost information for a generic plant, the Navigant Consortium developed a reference project, summarized in Table 3-1, and then collected cost data for this plant.

Table 3-1. Reference Project

Project Parameter	Value	Rationale	2014 Value	Rationale
Project Location	North Atlantic of the U.S.	This region has many plants proposed and represents a mid-point in labor costs compared to other regions of offshore wind project development	No Change	While projects are moving forward in other areas of the United States, most projects are located in this region and it still believed to be a good baseline.
Year of Construction	2018	Wanted plant costs that were not the first one built (which could be in the middle of this decade), or during a period with a high volume of installations. According to market forecasts, 2018 will likely be such a period. We assume a two year construction period	No Change	N/A
Project Size	500 MW	Common size for plants proposed in the area	No Change	N/A
Turbine Size	3 to 5 MW		No Change	N/A
Water Depth	25m	Common depth for project proposed in the North Atlantic	20m	
Distance to Staging Port	100 miles	Common distance for plants proposed in the North Atlantic relative to suitable ports	No Change	N/A
Distance to Interconnection	50 miles	Common distance for plants proposed in the North Atlantic	No Change	N/A
Distance to Servicing Port	< 30 miles	Assumed that a port closer than the staging port could be used for servicing	No Change	N/A
Foundation Type	Jacket	Most common design for proposed U.S. plants in 20-30 m water depths	Monopile	Will be another common foundation type for early stage U.S. plants.

Source: Navigant analysis

3.3.3 Turbine

Turbine costs and their distribution among the nacelle, blades, and towers were derived from two primary sources. Total turbine costs were sourced from NREL's recent *2011 Cost of Wind Energy Review*

(Tegen et al. 2013), where pricing levels for offshore turbines between 3 MW and 5 MW exhibited a relatively stable trend since 2011. Data reported suggest a representative turbine price of approximately $1,800/kW for a 500 MW project (using 3.6 MW turbines), although the authors note a range between from $1,600/kW and $2,400/kW. Evidence suggests pricing is driven by several factors including the market power of turbine supplier, turbine technology (e.g., turbine rated power, drivetrain type), order size, and contractual terms. Data reported by Tegen et al. (2013) were noted to have been sourced from "recent publications (Douglas-Westwood 2010; BVG 2011; Deloitte 2011) and conversations with offshore wind project developers in the United States."

NREL's *Wind Turbine Cost and Scaling Model* (Fingersh et al. 2006) was utilized to determine the requisite allocation of costs among the three primary turbine components (i.e., the tower, blades, and nacelle) in a land-based plant. This model suggested a general breakdown across an array of turbine sizes, both for machines in production today as well as in prototype testing, of approximately 55% of turbine cost in the nacelle/drivetrain, 25% in the blades, and 20% in the tower. It is recognized that these percentages could vary based on significant differences in tower height, rotor diameter, or drivetrain design; however, in the absence of a large sample of empirical data they were determined to be sufficient.

3.3.4 Foundation and Substructure

In 2011, initial input from a turbine manufacturer yielded jacket foundations as the preferred foundation type for early offshore wind development in the U.S. Therefore, the initial analysis focused primarily on jacket foundations.

For 2014, the Navigant Consortium considered updating the costs to fabricate jacket foundations for U.S. projects. However, due to the hypothetical nature of the project, it was determined that updates to costs were relatively insignificant to the range of cost values obtained by this study. Therefore, rather than updating the jacket costs, the Navigant Consortium evaluated a second foundation and substructure scenario. The 2014 scenario models a monopile foundation installed in 20m of water depth, in lieu of the initial jacket foundation in 25m water depth.

Model and cost inputs assume that the steel required to monopile and transition piece would be sourced within the U.S. Fabrication production rates are consistent with rates observed in the existing Gulf of Mexico oil and gas fabrication industry. These rates are likely consistent with a semi-mature U.S. offshore wind (OSW) fabrication industry as newly developed North Atlantic (the location of our typical project) fabrication yards will have gained some experience from the first OSW projects, but not likely to have invested fully in automated machinery, which will reduce the labor hours required and associated costs. Labor rates were determined using a combination of Davis-Bacon prevailing wage rates and construction labor rates published by the R.S. Means series for the state of Maryland, consistent with the Mid-Atlantic project location. Open-shop (e.g., non-union) fabrication yards will cause a lowering of costs. Therefore, the assumed labor costs are conservative.

Costs input to the JEDI model assume that fabrication and installation are two separate contracts. Though it is possible to issue one RFP for the fabrication and installation of the foundation, the work tasks are fundamentally different and costs are anticipated to be more competitive if bid independently in order to prevent a supply chain bottleneck of qualified companies.

Because jackets are assumed to be fabricated in the North Atlantic, it is reasonable to assume that the fabrication yard will also serve as the foundation installation port; foundation and substructure components will be shipped directly offshore on material barges.

Future projects will consider alternative foundation types, including monopile and gravity base foundations. These two will be selected based on their proven track record in Europe for shallow and transitional water (up to 40m or 130 ft.) depths.

3.3.5 Electrical System

Project Collection System

Our analysis assumes that a representative 3 or 5 MW turbine would be used. We used the 3 MW design for costing - therefore, cost estimates plan for the material and installation of 167 (e.g., a 500 MW array with 3 MW turbines) medium-voltage alternating current (MVAC) inter-array cables. These cables would be laid on the seafloor, pulled into each respective turbine foundation and post-lay buried by a tracked Remotely Operated Vehicle (ROV). Following best practices as recently evidenced in the European market, the model treats inter-array cabling and export cabling as separate contracts. Costs were compiled based on installation rates and costs observed in Europe.

HV Platforms

In 2011, based on industry knowledge available at the time, it appeared most projects built in 2018 would implement high voltage direct current (HVDC) export cable systems. For the 2011 analysis, power was collected at two transformer stations, which stepped up the voltage. From the transformer stations, the power was then moved by HVAC cables to a converter station, which converted the power from HVAC to HVDC for the transit to shore. Upon arriving at the shoreline, another converter station converted the power back to HVAC, which was assumed to tie in at the voltage of the existing network.

However, the offshore wind industry has not launched as rapidly as predicted in 2011. Additionally, technology advances have been made increasing the capability of longer distance HVAC transmission networks. For the 2014 modeling effort, the Navigant consortium elected to use two HVAC transformer stations, similar to the 2011 model. However, for 2014, the power is then exported directly to shore via two HVAC cables, rather than being converted to HVDC. This results in the addition of two HVAC export cables. However; the savings from removing the costly HVDC converter station and HVDC cable results in a net cost reduction for electrical system components.

Technology advances have been made increasing the capability of longer distance HVAC transmission networks.

Export cable

Current cost projections for the 2014 representative project update provide for two HVAC cables to export power from the transformer stations to shore. Unlike the inter-array cables, long-distance export cables will be laid and buried in place simultaneously by a plow towed behind the export cable vessel.

Following best practices, as recently evidenced in the European market, the model treats inter-array cabling and export cabling as separate contracts, though cables may be installed by a single contractor.

Costs were extrapolated from contractors' cost estimates for U.S. projects with similar export cable design parameters. Equipment, cost, and staffing data for the electrical system was collected from interviews with existing cable manufacturers and installation contractors, proposal data from projects in the United States, and from other in-house data. Projected costs were compared to numbers published by reports commissioned by the U.S. Department of the Interior and Bureau of Offshore Energy Management and case studies from European projects.

3.3.6 Development Services

Engineering (project and interconnection facility design)

Engineering costs were compiled based on an average of engineering costs observed for recently completed projects in Europe. We assume the European experience will translate to U.S. projects. Costs were converted to U.S. currency using an approximate exchange rate as observed on July 1, 2011.

Ports and staging

Costs provided for ports and staging were evaluated from publicly reported development costs for ports in Europe and one port in the U.S. that have been specifically developed for the OSW industry. Costs for each port were divided by the number of immediate projects they were anticipated to serve. In practice, a significant amount of the port development costs may be borne by the initial projects. Once ports have been developed, use costs to future projects may be expected to decrease. Investment in ports and waterways is one way that public investment could greatly support offshore wind development, as well as other industries relying on water-based transportation. Therefore, investment in port and navigation projects will have a compounding effect and the cost/benefit ratio will be very favorable.

Investment in ports and waterways is one way that public investment could greatly support offshore wind development.

Air transportation (personnel or materials)

Air transportation for construction was based on 30 months of a quoted rate for a monthly charter of an offshore-certified helicopter, capable of transporting up to six personnel or 1,000 lbs of equipment per transit. The helicopter provider was located in the North Atlantic region and the quoted price is based on establishing a temporary base of operations adjacent to the installation port.

Marine transportation (personnel or materials, including vessel mobilization)

For the 2011 model, jackets were transported by barge to the offshore site and installed by a jack-up barge. For 2014, the monopiles are transported from the staging port to the offshore site by Self-Propelled Installation Vessels (SPIV); that cost is considered in the Erection/Installation line.

For the 2011 model, it was assumed jackets would be fabricated in the Mid-Atlantic and deployed directly from the fabrication facility and therefore did not require transportation to a staging port. For the 2014 monopile scenario, it is assumed the monopiles are fabricated in the U.S. Gulf Coast area. Cost to transport monopiles and transition pieces from the Gulf Coast to the Mid Atlantic is accounted for in this line item. Marine transportation costs were obtained from U.S. offshore contractors as well as reports prepared for BOEM and DOE.

Erection/installation (equipment services only, excludes labor)

For the JEDI model, the turbines will be installed by an independent turbine installation contract. The 2014 model update assumes that monopiles, transition pieces and turbines will all be installed by an SPIV, as opposed to just turbines in the 2011 model. In this case, the U.S. is assumed to benefit from European vessel experience and will have current "next generation" turbine installation vessels available. Primary characteristics of the SPIV selected for this model include:

- Cargo capacity: six complete turbines per trip
- Steaming speed (when not restricted by navigation concerns): 10-14 knots
- Installation rate: 3 days per turbine (inclusive of load, travel times, and weather delay)
- Operating hours: (2) 12 hour shifts per day, work schedule 24/7/365
- Workers are housed on vessel
- Vessel support spread: two crew vessels, full time

Despite the relative complexity of the SPIV type vessels, they are likely to be available in a semi-mature U.S. market due to the turbine OEMs' prohibition of transferring sensitive turbine equipment between floating vessels at sea. Though jack-up barges are another technically viable solution to transport and install turbines, the faster steaming speed of the SPIV vessels relative to the jack-up barges is a strong advantage given the anticipated 100-nautical-mile steaming distance for the representative project.

For both the turbine and foundation installation, the large installation vessels may be chartered with or without installation crew. There has been a trend in Europe for installation vessel charter durations to span multiple seasons and for vessels to work on multiple projects for one developer, reducing mobilization costs to the developer. The long-term contracting arrangements are also preferred by developers and vessel operators because the pipeline of projects allows the vessel standby times (and therefore costs) to be reduced. The JEDI model input considers a vessel mobilization cost for each vessel plus a monthly charter rate over the anticipated installation duration of the project. The smaller support crew vessel day rates typically include the vessel master and crew.

3.3.7 Financing

Financing costs for an offshore wind farm include bank fees, insurance, due diligence costs, interest payments during construction, and several other items. See the 2012 report's appendix for a thorough discussion of these items. The total cost for the typical project comes to $329M.

3.3.8 Summary of Capital Costs

Adding these items together yields installed costs of $2.86B for a 500 MW project or $5,700/kW. This value represents an approximately 6% reduction from the 2011 default value of $6,080/kW.

Near term capital costs for a 500 MW offshore wind farm are estimated at $5,700/kW

The difference between the 2014 and 2011 values is largely driven by the adjustments to site characteristics and technology for the representative project, as described in Table 3-1, as well as improvements in data quality for key items such as rates for U.S. vessels. The major changes are:

- A 21% reduction in electric infrastructure procurement costs due to a decision to use an HVAC export system rather than an HVDC export system.
- A 22% reduction in substructure and foundation procurement costs as a result of switching from Jacket foundations to Monopile foundations, located in a 20% shallower water depth
- An 18% increase in Transportation, Assembly, and Installation costs due to improved data on day rates for the U.S. Vessel fleet. Also, the assumption that monopiles will be fabricated in the Gulf of Mexico, rather than the mid-Atlantic, requires that components be shipped from the fabrication yard to the staging port.

Figure 3-3 shows a comparison between the 2011 and 2014 JEDI defaults for capital expenditures broken down by category and Table 3-2 shows the 2014 data broken down by category.

Figure 3-3. Comparison of 2011 and 2014 Installed Cost Assumptions

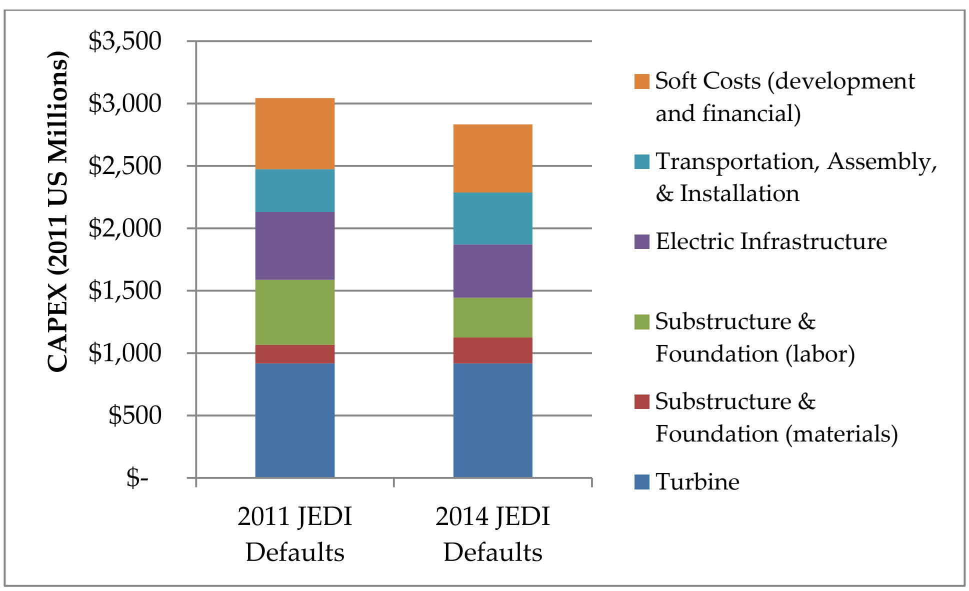


Table 3-2. 2014 Detailed Cost Breakdown

	Cost (2011$)	Cost (2011$ per kW	% of Total Capital Cost
Equipment Costs			
Turbine Costs	$917,500,000	$1,835	32%
Foundation & Substructure	$206,545,000	$413	7%
Collection System	$78,490,000	$157	3%
HV Cable, Converter, & Substations	$349,109,000	$698	12%
Labor Costs[1]			
Foundation & Substructure Installation Labor	$309,828,000	$620	11%
Project Management (Developer/owners management costs)	$8,500,00	$17	0%
Development Costs			
Insurance During Construction	$67,000,000	$134	2%
Development Services (Engineering, Legal, PR, Permitting)	$28,900,000	$58	1%
Ports & Staging	$45,000,000	$90	2%
Erection/Installation (equipment services only)	$301,337,000	$603	11%
Air & Marine Transportation	$79,890,000	$142	2%
Other Costs			
Decommissioning Bonding	$100,000,000	$200	3%
Interest During Construction	$165,843,000	$332	6%
Due diligence, Reserve Accounts, Bank Fees	$163,331,000	$327	6%
Miscellaneous	$17,394,000	$35	1%
Total Construction Cost[2]	**$2,860,701,000**	**$5,721**	

Source: Navigant analysis

3.4 *Baseline Employment Estimate Update*

Our data collection efforts consisted of an online survey sent to offshore wind industry stakeholders. We then followed up via phone calls with key stakeholders (e.g. large developers or construction firms that likely have significant employment in 2013) that did not respond to the online survey.

Finally, as shown in Table 1-2, several projects have reached an advanced stage and components are likely being manufactured for those projects. However, many companies manufacture equipment for both the onshore and offshore markets and do not track employment between the two. Also, we do not have information on what components are being sourced domestically or purchased from countries with lots of offshore wind manufacturing. Given these uncertainties, we looked a range of possibilities on what could be under fabrication now and how much is domestically sourced. We used our JEDI model created in 2012 to assess potential levels of employment.

3.4.1 Online Survey

As discussed above, the Navigant Consortium sent out an online survey to offshore wind industry stakeholders in early 2014. The survey included several questions on employment and investment, as shown below.

- How many full time U.S. employees do you currently have in each of these areas?
  - Component or Subsystem Supplier
  - Wind Turbine OEM
  - Developer
  - OEM
  - EPC
  - O&M
  - Other
- What % of total labor hours in each area are designated exclusively to offshore wind?
- If you have employees dedicated to offshore wind, in what states are they located?
- Has your company made any offshore wind specific investments this year? If so, what was the amount and what category: (a) manufacturing, (b) construction, or (c) other?

107 people viewed the survey, 28 started it and 21 completed it. We received the most information for the Developer and Other categories. To protect the privacy of individual respondents, we will only report on totals, not individual industries or states. The total number of full time equivalents (FTEs) and investment is shown in Table 3-3.

3.4.2 JEDI Estimates

We looked at the projects in [cite advanced stage projects table] and used the offshore wind JEDI model to simulate the manufacturing related employment to support the projects that have 2015 and 2016 install dates. Items that could be in process include blade assemblies, processing of raw materials, forgings and castings, turbine components, electrical sub components and cabling. We then picked a range of possibilities for domestic sourcing and analyzed those using JEDI. The range of results is shown in Table 3-3. The low end assumes no domestic sourcing and the high end assumes 100% domestic sourcing.

3.5 Results

Current employment levels could be between 550 and 5,150 FTE's and investment could be between $146 million and $1.1 billion. The range is driven by our uncertainty about where advanced stage projects are sourcing components from. However, these numbers are several times higher than our 2013 estimates of 150 and 590 FTE's and investment of between $21 and $159 million. Since our 2013 report, more projects are at an advanced stage of development, driving more employment and investment of 2013.

Table 3-3. Estimated Employment in the U.S. Offshore Wind Industry

Data Source	Total FTE's	Total Investment
Online Survey	550	$146M
Modeled Estimates	0 to 4600	0 to $968M
Total	**546 to 5150**	**$146M to $1.1B**

Source: Navigant analysis

4. Developments in Relevant Sectors of the Economy

4.1 Introduction

The development of an offshore wind industry in the United States will depend on the evolution of other sectors in the economy. This section identifies and evaluates the related economic sectors and their potential impact on an offshore wind industry.

Summary of Key Findings – Chapter 4
• The development of an offshore wind industry in the U.S. will depend on the evolution of other sectors in the economy. • Two factors in the power sector will have the largest impact: the change in the price of natural gas and the change in coal-based generation capacity. • Natural gas prices have remained less than $5/MMbtu for most of 2013 and 2014, aside from a period over $6/MMbtu in early 2014. • Navigant analysis reveals actual and announced coal retirements of nearly 40 GW through 2020, not including implications associated with the Clean Air Act Section 111 carbon standards proposed under the Obama Administration's Climate Action Plan. • In 2013, about 50% of U.S. installed electricity generating capacity came from natural gas, and nearly 30% came from solar.

We categorize two types of potential impact: demand for offshore projects and the price of those projects. Table 4-1 summarizes the related economic sectors and their potential impact on offshore wind.

Table 4-1. Factors That Impact Offshore Wind

Economic Sector	Factor	Potential Impact on Offshore Wind		Relative Importance of Factor
		Change in Demand	Change in Price	
Power sector	Change in overall demand for electricity.	X		Low
	Change in the country's nuclear power generation capacity.	X		Medium
	Change in natural gas prices.	X		High
	Change in the country's coal-based generation capacity.	X		High
Oil and gas	Change in level of offshore oil and gas development.		X	Medium
Construction	Change in level of construction activity using similar types of equipment and/or raw materials as offshore wind.		X	Low
Manufacturing	Change in manufacturing of products that utilize similar types of raw materials as offshore wind.		X	Low
Telecommunications	Change in demand for subsea cable-laying vessels.		X	Low
Financial	Change in the cost of capital.		X	Medium

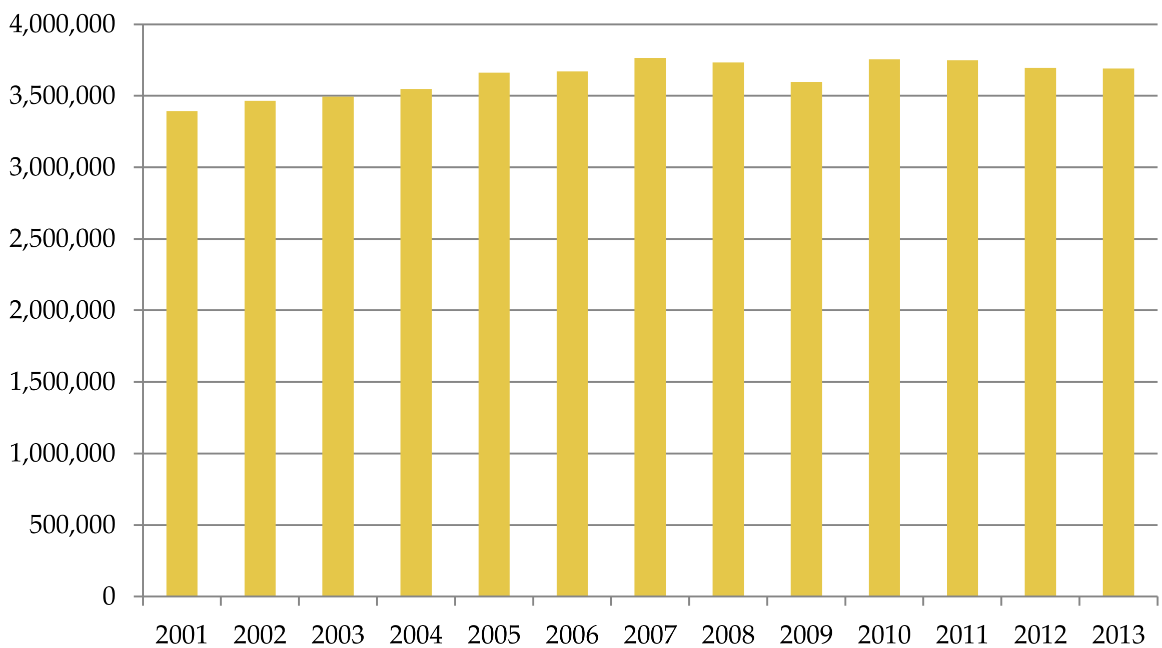
Source: Navigant analysis

4.2 *Power Sector*

4.2.1 Change in Overall Demand for Electricity

Factors such as population growth, changes in the level of economic activity, adoption of energy efficiency and demand response measures, and changes in climate could impact the overall demand for electricity in the United States. This, in turn, could impact the demand for offshore wind projects in the United States. That said, electricity consumption in the United States has increased, on average, less than 1 percent per year over the last decade (see Figure 4-1). Significant increases in electricity consumption are unlikely in the foreseeable future, due to moderate levels of economic growth and population growth, as well as increasing levels of energy efficiency. An early release of the Energy Information Administration's 2014 Annual Energy Outlook report shows a 6 percent decrease in projected 2040 U.S. population when compared to the 2013 report (EIA 2013a). A report by the American Council for an Energy-Efficient Economy released in March of 2014 found that energy efficiency remains the least expensive electric resource (Molina 2014).

Figure 4-1. U.S. Retail Electricity Sales: 2002-2013 (million kWh)



Source: EIA

4.2.2 Change in the Country's Nuclear Power Generation Capacity

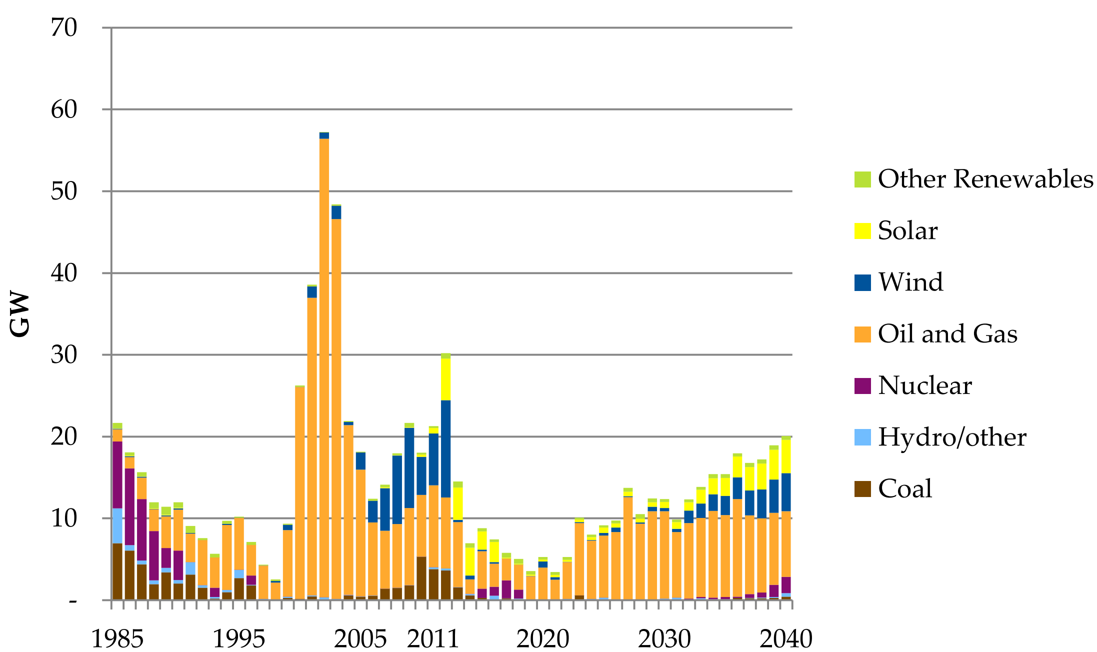
After the Fukushima nuclear accident in Japan in 2011, Germany decided to abandon over 20 GW of nuclear power, closing eight plants immediately, with the remaining nine plants set to close by 2022. Realizing the additional power generation capacity needed to avoid a supply shortfall, the country has developed and begun to execute plans to install a significant number of large offshore wind farms in the North and Baltic Seas. Through 2013, Germany's installed capacity of offshore wind was 520 MW. Navigant expects this to grow to greater than 10 GW by 2020. If another incident like Fukushima were to occur somewhere in the world, it is at least feasible that the United States could contemplate a similar retreat from nuclear power. The subsequent push to make up for the shortfall could increase offshore wind development in the United States.

Similarly, an increased pro-nuclear attitude in the United States, potentially as a way to meet CO_2-reduction targets, could reduce offshore wind activity in the United States if the levelized cost of new nuclear plants were to be more attractive than that of offshore wind. In early 2012, the United States Nuclear Regulatory Commission approved the construction license for four new nuclear reactors, two in South Carolina and two in Georgia. A fifth reactor is under construction in Tennessee. These would be the first nuclear reactors built from scratch in the last 30 years. If these reactors are successfully completed and become operational, their impact on the future of offshore wind in the United States is unclear. There is also uncertainty around the expected LCOE from these new nuclear plants, as the nuclear industry has not had a strong track record of meeting projected costs and schedules.

4.2.3 Change in Natural Gas Prices

Since 2000, most new power generation capacity in the United States has come from natural gas and onshore wind (see Figure 4-2), partly in response to the environmental impacts of coal-fired electricity generation. The early release of the EIA's 2014 Annual Energy Outlook predicts that total electricity generated by natural gas will surpass that of coal in the U.S. by 2035 (EIA 2013a).

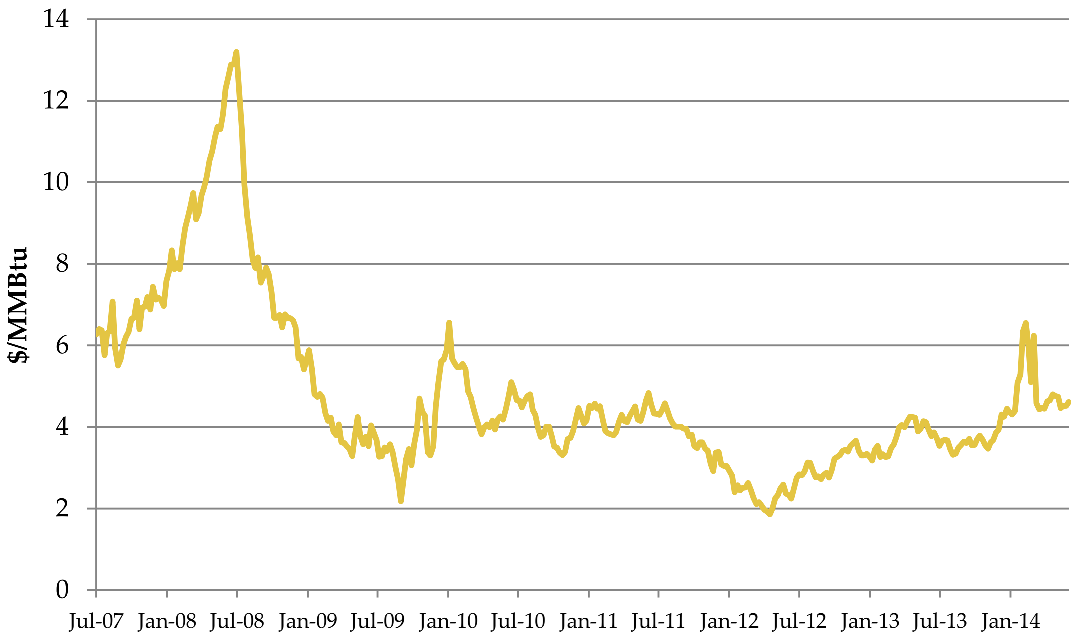
Figure 4-2. U.S. Power Generation Capacity Additions by Fuel Type



Source: EIA

In addition to having a lower carbon intensity than coal, natural gas prices have remained relatively low, in large part to the supply of low-cost gas from the Marcellus Shale. Natural gas prices surpassed $6/MMbtu in January 2010, but since then have largely remained below $5/MMbtu, including a low of less than $2/MMbtu in April 2012 and a brief period above $6/MMbtu in early 2014 (see Figure 4-3).

Figure 4-3. Henry Hub Gulf Coast Natural Gas Spot Price 2007-2014



Source: EIA

This decline has reduced wholesale electricity prices and has made natural gas-fired generation sources even more attractive than wind, in many cases. Continued low natural gas prices could greatly constrain demand for offshore wind farms in the United States. However, if natural gas prices were to rise significantly—for example, due to increased liquefied natural gas (LNG) exports—the attractiveness of offshore wind as an electricity generation source in the U.S. could increase.

4.2.4 Change in the Country's Coal-Based Generation Capacity

In recent years, some electric utilities in the U.S. have announced plans to retire coal-fired power plants or to convert them to natural gas. There are multiple factors involved in these retirement decisions. Many of the U.S.'s coal-fired power plants are over 50 years old and expensive to continue to operate and maintain. Complying with environmental requirements, such as the U.S. Environmental Protection Agency's (EPA's) mercury and air toxics standards can also be costly. Additionally, the rule submitted by the Environmental Protection Agency in June of 2014 to require a 30% reduction in CO_2 emissions from existing power plants from 2005 emission levels by 2030 will likely impact retirement plans for existing coal generators. Navigant analysis reveals actual and announced retirements of nearly 40 GW through 2020. There is significant uncertainty in the projection of planned retirements before 2030 due to Section 111 regulations proposed under the Obama Administration's Climate Action Plan. While the reduction in generation capacity created through coal plant retirements will certainly not be filled entirely by a variable-output resource such as wind, continued coal plant retirements could play a role in increasing the demand for offshore wind plants in the U.S.

4.2.5 Change in the Country's Renewable Generation Capacity

Under the scenarios of existing or future renewable energy policy in the U.S., it follows that the demand for offshore wind could be influenced by market trends from other sources of renewable generation. U.S. solar installations reached record levels in 2013, accounting for nearly 30 percent of all new electricity generating capacity installations (SEIA 2014). U.S. onshore wind installations fell during 2013 due to the uncertainties in federal tax incentives at the end of 2012. However, record levels of onshore wind capacity were under construction in the U.S. at the end of 2013, and Navigant projects the installed capacity to reach nearly 94 GW by the end of 2016.

4.3 Oil and Gas

4.3.1 Change in Level of Offshore Oil and Gas Development

Many of the initial installation vessels used in the offshore wind sector were retrofitted from the offshore oil and gas sector. While certain shipbuilders are designing and building custom vessels for offshore wind development, it can still be economical in some markets to upgrade vessels from the oil and gas sector. An increase in offshore oil and gas activity could limit the availability and/or increase the cost of these vessels for use in wind applications, as they may be returned to service in the oil and gas sector. Indeed, Seajacks, a vessel operator, indicates on its website that its "self-propelled vessels are suitable for installation and maintenance of offshore wind turbines, and are also able to perform maintenance work on offshore oil and gas platforms" (Seajacks 2013). Another potential issue is that the availability of laydown area and cranes at key maritime ports could be constrained by offshore oil and gas activity. This issue, however, is not expected to be as significant in the North and Mid-Atlantic as it is in the North Sea.

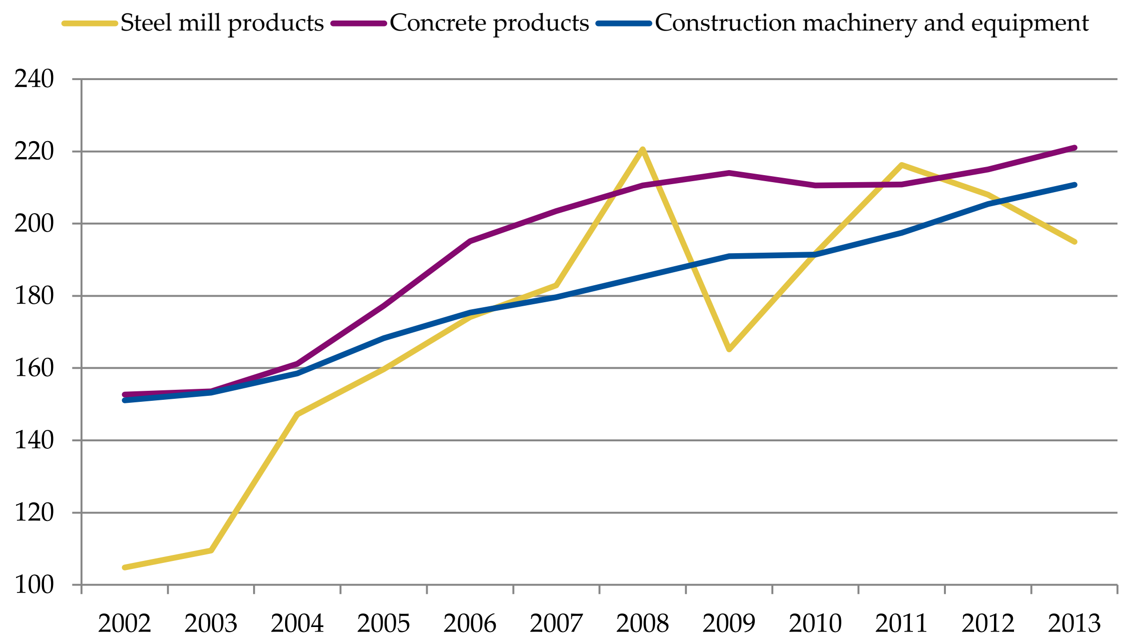
It can still be economical in some markets to upgrade vessels from the oil and gas sector.

4.4 *Construction*

4.4.1 Change in Level of Construction Activity Using Similar Types of Equipment and/or Raw Materials as Offshore Wind

The construction sector and the offshore wind sector use many of the same types of equipment and raw materials. Construction projects such as roads, bridges, buildings, and sports stadiums require equipment such as tall cranes and materials such as concrete and steel. Cranes are needed to lift wind turbine tower segments and foundations and to preassemble rotors onshore. Wind turbine towers require significant quantities of steel, while foundations may require concrete and/or steel. Since towers represent about 7-8 percent of the cost of an offshore wind farm and the foundations and substructures represent about 22-25 percent (Navigant 2012), the level of construction activity in the United States outside of the offshore wind sector could impact the price of offshore wind power. Figure 4-4 shows the evolution of commodity prices since 2002, which is a trend of generally increasing (and volatile in the case of steel) prices.

Figure 4-4. Producer Price Index for Selected Commodities (2003-2013)



Base Year (100) = 1982

Source: United States Department of Labor, Bureau of Labor Statistics

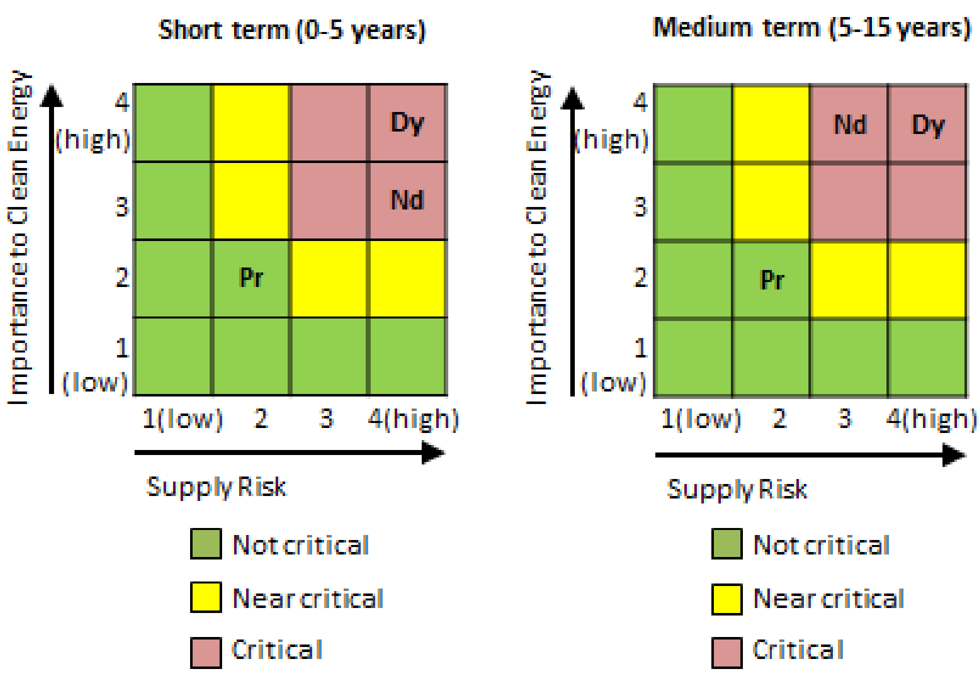
4.5 *Manufacturing*

4.5.1 Change in Manufacturing of Products That Utilize Similar Types of Raw Materials as Offshore Wind

The manufacturing sector similarly uses many of the same raw materials as offshore wind. The manufacture of automobiles, heavy equipment, and appliances, for example, requires significant amounts of steel, a material used in wind turbine towers and offshore foundations. Manufacturing sectors such as aerospace, automotive, and marine vessels use composite materials similar to those used in wind turbine blades. Finally, rare earth materials such as neodymium are used in applications such as the permanent magnets that are used in certain types of electric motors and electrical generators, including those in many direct drive wind turbine generators.

The DOE (DOE 2010) estimates that supply situation for rare earth oxides of neodymium and dysprosium will be "critical" not only over the short term (2010-2015) but also over the medium term (2015-2025). The supply risk for praseodymium was characterized as "not critical". Criticality matrices from this report are shown in Figure 4-5.

Figure 4-5. Rare Earth Criticality Matrices



Sources: U.S. Department of Energy, Navigant

A 2012 report from the Massachusetts Institute of Technology's Materials Systems Laboratory agrees that neodymium and dysprosium will face supply challenges in the coming years (Alonso et al. 2012).

If the supply situation for rare earth metals remains tight and prices rise, so could the cost of offshore wind production.

4.6 *Telecommunications*

4.6.1 Change in Demand for Subsea Cable-Laying Vessels

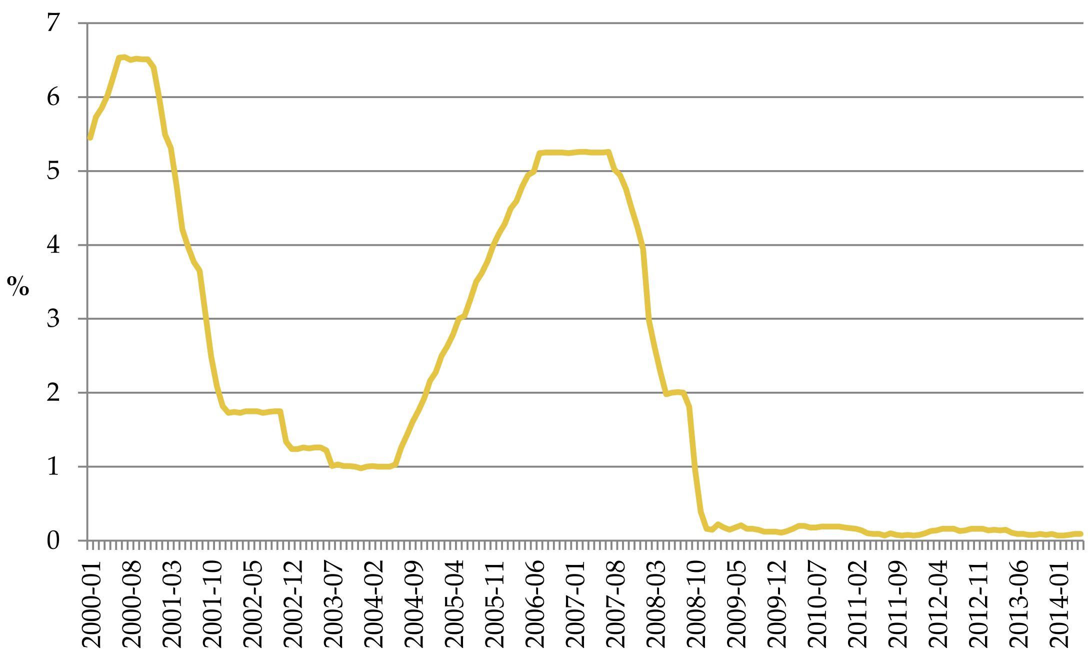
The specialized vessels that are appropriate for subsea cable-laying are relatively few in supply and high in demand (Navigant Research 2012). Not only are these vessels in high demand in Europe for offshore wind projects; many of them are also used to lay subsea cable for the telecommunications industry. An increase in deployment of subsea cables by global telecommunications companies could increase the development costs of offshore wind farms.

4.7 *Financial*

4.7.1 Change in the Cost of Capital

Navigant estimates that construction financing costs could represent up to 12 percent of the total capital costs of a 500-MW offshore wind farm in the United States (Navigant 2012). As a result, changes in the cost of capital can have a significant impact on the cost and price of offshore wind power. An increase in overall economic activity in the country would increase the demand for and therefore the cost of capital. Offshore wind projects would have to compete with other infrastructure projects to secure the capital necessary for development. While interest rates have been very low in recent years, the federal funds rate was above 5 percent as recently as 2007 (see Figure 4-6).

Figure 4-6. Federal Funds Effective Rate (%): January 2000 – May 2014



Source: U.S. Federal Reserve

5. Conclusion

The development of a comprehensive annual market report is an important step for the U.S. offshore wind industry for two reasons. First, market assessments, especially those produced for government agencies, provide stakeholders with a trusted data source. Second, the production of a comprehensive assessment covering technical, regulatory, financial, economic development, and workforce issues will annually inform the creation of policy to remove barriers facing the U.S. offshore wind industry.

This report provides readers with a foundation of information to guide U.S. offshore wind energy development. As discussed in this report, significant technological advances are already unfolding within the offshore wind industry, but more could be accomplished to direct needed improvements to further reduce offshore wind costs and to stimulate needed infrastructure development. Policy examples from Europe have shown that policy designs can stimulate offshore wind markets, but need to be structured correctly to avoid high costs to rate payers. Although current U.S. offshore wind employment levels and investment are modest, employment could be between 550 and 5,150 FTEs, and current investment could be between 146 million and $1.1 billion.

The Navigant Consortium appreciates the important input and cooperation that participants in our offshore wind survey, interviews, and workshops provided. It is hoped that the information provided will prove to be a valuable resource for manufacturers, policymakers, developers, and regulatory agencies to move the market toward a high-growth scenario for the offshore wind industry.

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Appendix A. Potential Barriers to Offshore Wind Development in the U.S.

A.1 Cost-Competitiveness of Offshore Wind Energy

Capital costs for the first generation of U.S. offshore wind projects are expected to be approximately $6,000 per installed kW, compared with approximately $1,940 per installed kW for U.S. land-based wind projects in 2012 (Wiser and Bollinger 2013). Offshore projects have higher capital costs for a number of reasons, including turbine upgrades required for operation at sea, turbine foundations, balance-of-system (BOS) infrastructure, the high cost of building at sea, and O&M warranty risk adjustments. These costs remain high because the offshore wind industry is immature and learning curve effects have not yet been fully realized. There are also a number of one-time costs incurred with the development of an offshore wind project, such as vessels for turbine installation, port and harbor upgrades, manufacturing facilities, and workforce training.

Offshore wind energy also has a higher LCOE than comparable technologies. In addition to higher capital costs, offshore wind has higher O&M costs as a result of its location at sea. Higher permitting, transmission, and grid integration costs contribute to this higher cost of energy, which can be somewhat balanced by an improved wind regime offshore.

Another economic benefit is the wholesale market price suppression of peak-coincident offshore wind energy, especially during the summer. Charles River Associates projects price suppression to be over $7 billion for Cape Wind over 25 years; the Massachusetts public utility commission and Supreme Judicial Court recognized this when approving the Cape Wind PPA.

Offshore wind has higher financing costs, due to the heightened perceived risk**.** Since it is not yet a mature industry, investors still perceive offshore wind as risky, due to regulatory and permitting issues, construction and installation risk, and long-term reliability of energy production. As a result, insurance and warranty premiums remain high. There are also extremely high risks to early-stage capital, given the uncertainty around the price and availability of future off-take agreements for offshore wind.

> The Jones Act
>
> Section 27 of the *Merchant Marine Act of 1920*, better known as the Jones Act, requires that all goods transported by water between U.S. ports be carried in U.S.-flag ships with U.S. crews. Once a wind farm foundation is in place in U.S. federal waters, the structure may be considered a port and thus require servicing by U.S. vessels. Currently, the only existing specialist vessels capable of offshore foundation and turbine installation are mostly European-owned and are in high demand for European projects.

A.2 Infrastructure Challenges

Offshore wind turbines are currently not manufactured in the United States. Domestic manufacturing needs to be in place in the United States in order for the industry to fully develop. The absence of a mature industry results in a lack of experienced labor for manufacturing, construction, and operations. Workforce training must therefore be part of the upfront costs for U.S. projects.

The infrastructure required to install offshore wind farms, such as purpose-built ports and vessels, does not currently exist in the United States. There is also insufficient capability for domestic operation and maintenance. While turbine installation and maintenance vessels exist in other countries, legislation such as the Jones Act may limit the ability of these foreign vessels to operate in U.S. waters. These issues also apply to transmission infrastructure for offshore wind.

The absence of strong demand for offshore wind in the United States makes it difficult to overcome these technical and infrastructure challenges. In order to develop the required infrastructure and technical expertise, there must first be sufficient demand for offshore wind, and that is not expected in the near term due to the high cost of offshore wind and the low cost of competing power generation resources, such as natural gas.

A.3 Regulatory Challenges

A.3.1 Permitting

Offshore wind projects in the United States are facing new permitting processes. After issuing the Final Rule governing offshore wind leasing on the Outer Continental Shelf (OCS) in 2009, the Minerals Management Service (MMS)—now BOEM—staff estimated that the lease process might require three EISs and may extend seven to nine years. Secretary of the Interior Ken Salazar announced his Smart from the Start Program initiative in 2010. One aspect of the initiative was the concept of preparing an EA, which would evaluate the potential environmental impacts of commercial wind lease issuance, associated site characterization surveys, and subsequent site assessment activities (i.e., installation and operation of meteorological towers and buoys) prior to lease issuance, as opposed to preparing an EIS, which likely would be required under NEPA to analyze construction and operation of a wind facility prior to lease issuance. Construction and operations plans proposing the installation of renewable energy generation facilities would be subject to additional project specific environmental reviews. BOEM responded with a regional Mid-Atlantic Environmental Assessment covering typical site assessment activities in New Jersey, Delaware, Maryland, and Virginia, which should expedite review of site assessment plans off those state coasts by eliminating further NEPA review if the same technologies were proposed. This approach seeks to expedite BOEM reviews and establish some certainty for developers and financiers.

A number of state and federal entities have authority over the siting, permitting, and installation of offshore wind facilities. Cognizant federal agencies include BOEM, the U.S. Army Corps of Engineers (USACE), the EPA, the FWS, the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service, and others. BOEM is preparing to sign a MOU with USACE to facilitate coordination of federal approvals of offshore wind facilities and is negotiating MOUs with other federal agencies.

In March 2012, five Great Lakes states (Illinois, Michigan, Minnesota, New York, and Pennsylvania) and ten federal agencies signed a bipartisan federal-state MOU to support efficient, expeditious, orderly, and responsible review of proposed offshore wind energy projects in the Great Lakes. This consortium will help ensure that efforts to meet America's domestic energy demands in an environmentally responsible manner through the use of excellent Great Lakes offshore wind resources occurs in an efficient and effective manner that protects the health and safety of our environment and communities while supporting vital economic growth.

A.3.2 Environmental & Competing Uses

Environmental concerns and public resistance present challenges to the industry. Regulatory agencies must consider a range of environmental concerns related to offshore wind, including bird and bat species, marine mammals, sea turtles, and pelagic and benthic species at risk, as well as potential impacts to water quality. At this point, the environmental impacts of offshore wind in the United States are not well understood. Several environmental organizations worked together with four offshore wind developers to agree on survey vessel protocol to protect endangered whales during site assessment activities.[45] Cultural resources, such as historic preservation sites and tribal resources, must also be considered. In addition, public opposition may arise, especially with offshore wind sites near the shore that could impact viewsheds and environmental resources. In addition, competing human uses such as fishing, shipping and military practice activities must be addressed under BOEM regulations and NEPA.

[45] "Proposed Mitigation Measures to Protect North Atlantic Right Whales from Site Assessment and Characterization Activities of Offshore Wind Energy Development in the Mid-Atlantic Wind Energy Areas," Letter to BOEM, December 12, 2012.

Appendix B. Offshore Wind Policies in Selected U.S. States

This appendix includes details on offshore wind policies and related activities in selected U.S. states. The categories of policies to address cost competitiveness and site selection and leasing are included. A summary of policies that address cost competitiveness is provided in tabular form in Section 2.3.2.

B.1 California

B.1.1 Infrastructure Policies

California has designated specific areas for land-based wind development to provide a level of certainty for transmission development. California started its Renewable Energy Transmission Initiative (RETI) in 2007. The purpose of RETI is to engage the state's renewable energy generation and transmission to participate in a collaborative process to facilitate the designation of transmission corridors and the siting and permitting for renewable energy generation and transmission projects.

The main components of RETI are as follows:

- Identifying CREZ with sufficient energy resource densities to justify building transmission lines to them
- Ranking CREZ on the basis of environmental impacts, the certainty and schedule of project development, and the cost and value to California consumers
- Developing conceptual transmission plans to the highest-ranking CREZ
- Supporting the California Independent System Operator (California ISO), investor-owned utilities (IOUs), and publicly owned utilities (POUs) in developing detailed plans of service for commercially viable transmission projects
- Providing detailed costs and benefit analyses to help establish the basis for regulatory approvals of specific transmission projects[46]

In California, developers pay an initial deposit for ratepayer-subsidized transmission development and then later pay the balance of the total transmission interconnection cost through long-term operating revenues.

[46] CEC 2014

B.2 *Delaware*

B.2.1 Policies to Address Cost Competitiveness

In 2005, Delaware Senate Bill (S.B.) 74 established a RPS of 10 percent by 2019-2020. Two years later, S.B. 19 increased the target to 20 percent. In July 2010, the target was revised again by S.S. 1 for S.B. 119 to 25 percent by 2025-2026.[47]

While Delaware does not have a carve-out for offshore wind, in 2008, S.B. 328 set a 350 percent multiplier for the REC value of offshore wind facilities sited on or before May 31, 2017.[48]

In 2007, an all-resource competitive bidding process was conducted in Delaware. Four state agencies, including the Delaware Public Services Commission, the Office of Management and Budget, the State Controller, and the Department of Natural Resources & Environmental Control, directed Delmarva Power to negotiate a long-term PPA with the company then known as Bluewater Wind. The company, which became a subsidiary of NRG Energy and was later known as NRG-Bluewater Wind, proposed to build a 450 MW offshore wind farm approximately 12 miles from the coast.[49]

In December 2011, NRG-Bluewater Wind failed to make a substantial deposit to maintain the PPA.

B.2.2 Site Selection and Leasing Policies

BOEM issued a Call for Information for Delaware projects and received two lease nominations. BOEM subsequently determined that only one bidder was qualified and thus issued a Determination of No Competitive Interest to NRG-Bluewater Wind on April 12, 2011. NRG Energy negotiated lease terms with BOEM in December 2012. The lease terms provide a schedule requiring NRG to file a SAP and COP within a maximum period of time.[50] NRG filed its Site Assessment Plan in February 2014. NRG is exploring a new development partner or sale of the lease and whoever pursues development of the site will now have to obtain a new PPA. See http://www.nrgenergy.com/nrgbluewaterwind/index.html for more details.

B.3 *Illinois*

B.3.1 Site Selection and Leasing Policies

On August 19, 2013, Illinois governor Pat Quinn signed the Lake Michigan Wind Energy Act, which requires the Illinois Department of Natural Resources (DNR) to develop a detailed offshore wind energy siting matrix for the public trust lands of Lake Michigan. The Act also authorizes the DNR to grant offshore wind energy development site assessment permits and leases and to convert site assessment leases to construction and operation leases and grants other rulemaking powers. Additionally, the Act creates the Offshore Wind Energy Economic Development Policy Task Force, which is charged with

[47] DOE 2013a
[48] DOE 2013a
[49] U.S. Offshore Wind Collaborative (2010)
[50] BOEM 2013c

analyzing and evaluating policy and economic options to facilitate the development of offshore wind energy and proposing an appropriate Illinois mechanism for purchasing and selling power from offshore wind energy projects. This law is an outgrowth of a 2012 Lake Michigan Offshore Wind Energy Advisory Report, which addressed the following issues:

- Appropriate criteria for the DNR to use to review applications for offshore wind development of Lake Michigan lakebed leases
- Criteria for identifying areas that are favorable, acceptable, and unacceptable for offshore wind development
- A recommended process for ensuring public engagement in the DNR's process for leasing Lake Michigan lakebed for offshore wind energy projects
- Options for how Illinois shall be compensated for Lake Michigan lakebed leasing
- A summary of the lessons learned from other domestic and international offshore wind development experiences, including, but not limited to, those related to public policy, regulatory, and siting concerns for offshore wind development
- Identification of local, state, and federal authorities with permitting, siting, or other approval authority for wind power development in Lake Michigan
- Recommendations for needed state legislation and regulations governing offshore wind farm development

Figure B-1. Illinois Offshore Wind Leasing Areas

B.4 *Maine*

B.4.1 Policies to Address Cost Competitiveness

In January 2013, the Maine PUC voted to support the Hywind Maine project's pursuit of a long-term PPA with Central Maine Power Company. However, the project was placed on hold in July 2013 after new legislation created uncertainty regarding the state's prior approval of the project. That approval had included the Maine PUC's agreement for the project to receive ratepayer-funded subsidies after Statoil submitted the only bid in the state's competitive process. In late June, the Maine legislature passed a bill that re-opened the bidding process for the ratepayer subsidies in order to allow the University of Maine to submit a similar proposal for the Aqua Ventus project.

On May 31, 2013, a team led by the University of Maine installed a 65-foot 1/8 scale pilot floating turbine anchored to the bottom of Penobscot Bay, Maine. The VolturnUS is the first grid-connected offshore wind turbine in the U.S. It has survived 7 foot waves and continues to operate successfully as the team designs a 6-MW floating turbine.

Figure B-2. VolturnUS Floating Turbine

Source: University of Maine

B.5 Maryland

B.5.1 Policies to Address Cost Competitiveness

Maryland has an RPS of 20 percent by 2022. The Maryland Offshore Wind Energy Act of 2013 established ORECs for up to 200 MW. The act addresses the cost of offshore wind by broadening the cost-benefit analysis, including consideration of peak coincident price suppression and also capping the impact on ratepayers at $1.50 per month. The Maryland Public Utilities Commission is establishing final OREC regulations by July 1, 2014.

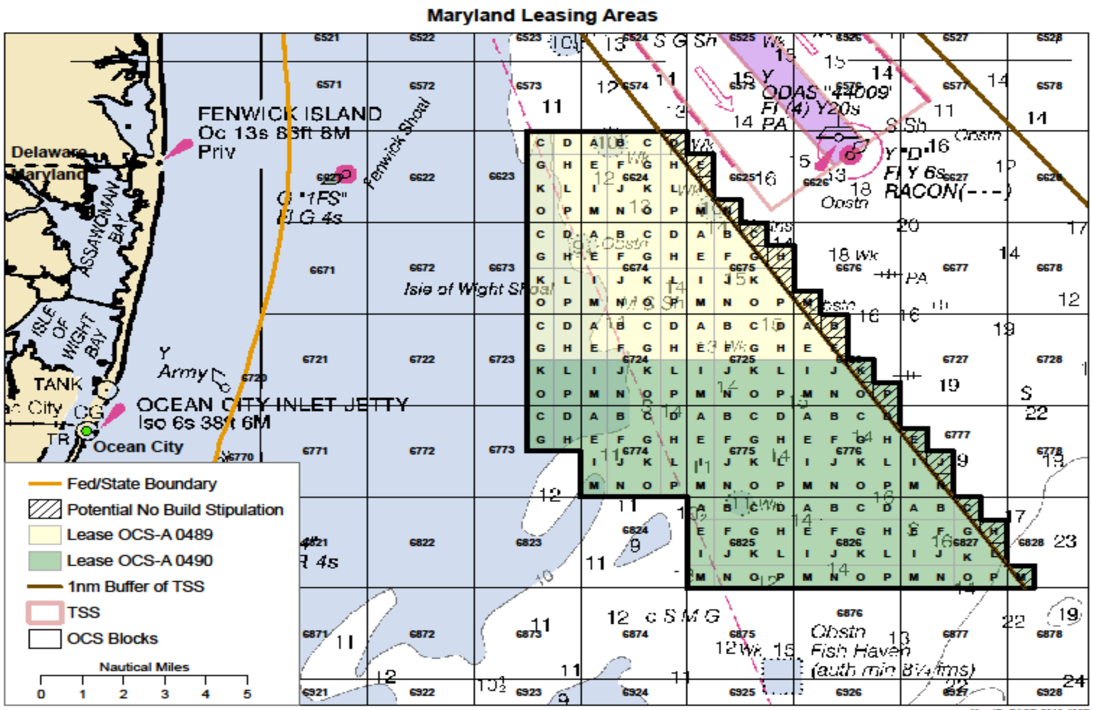
Maryland has completed geophysical, geotechnical and ecological surveys with state funds in the WEA that BOEM identified. Maryland also issued an RFI in April 2014 for information related on the design, manufacture and deployment of an offshore meteorological (MET) tower or buoy(s) to encourage development of the WEA by private developers after the BOEM competitive auction process.

B.5.2 Site Selection and Leasing Policies

BOEM convened a Task Force and, in November 2010, issued a Request for Interest in offshore development off the coast of Maryland. BOEM received several favorable responses and numerous comments on environmental concerns. In February 2012, BOEM issued a Call for Information for a reduced WEA of just a few lease blocks and received ten lease nominations. BOEM has established two WEAs which total about 9 lease blocks to reduce conflicts with shipping and other constraints (see below). BOEM issued a Proposed Sale Notice on December 17, 2013, and completed a competitive lease sale for Maryland's Wind Energy Area on August 19th, 2014. Sixteen companies were determined to be legally, technically and financially qualified to participate in the auction. The WEA covers approximately 80,000 acres and is located about 10 nautical miles off the coast of Ocean City, MD. There is a North Lease Area (32,737 acres) and a South Lease Area(46,970 acres). US Wind Inc. submitted the provisionally winning bid for both lease areas, for a total bid of $8,701,098.[51]

[51] BOEM 2013d

Figure B-3. Maryland Offshore Wind Leasing Areas



B.6 Massachusetts

B.6.1 Policies to Address Cost Competitiveness

The Massachusetts Department of Energy Resources (DOER) has set an RPS for new renewables of 15 percent by 2020. The RPS increases by 1 percent each year thereafter with no stated expiration date. There is no carve-out or REC multiplier for offshore wind.[52] Governor Deval Patrick has set a separate goal of developing 2,000 MW of offshore wind energy to help achieve the RPS requirements.

In 2008, the governor signed the Green Communities Act, which authorized distribution utilities to sign PPAs with renewable energy developers. The Act, as amended, requires each electric distribution company to conduct two solicitations within five years and sign PPAs for 7 percent of its load with renewable energy generators.

The Massachusetts Department of Public Utilities (DPU) has approved a 15-year PPA between the developers of the Cape Wind project and National Grid for half of the project's output. The PPA would start in 2013 (or later, since the project is delayed) at $0.187/kWh, with a 3.5 percent annual increase. The

[52] DOE 2013b

DPU concluded that the contract is cost-effective because its benefits well exceed its costs. It also found that approving the PPA is in the public interest, because no other renewable resource in the region matches Cape Wind in terms of size, proximity to large electricity load, capacity factor, and advanced stage of permitting, and because its bill impacts are in the range of only 1 to 2 percent.

The contract allows for upward and downward price adjustments based on a variety of contingencies. If Cape Wind is unable to tap certain federal subsidies, the price would go up, but under other circumstances the prices could go down, to the benefit of ratepayers. Specifically, should debt financing costs be reduced as a result of a DOE loan guarantee, 75 percent of the savings would be passed along to customers in lower rates. Similarly, if actual project costs, as verified by an independent audit, fall to such an extent that the developer's rate of return on debt and equity exceeds 10.75 percent, the contract price of electricity will be reduced to give ratepayers 60 percent of the benefit of the lower costs; if actual project costs are higher than anticipated and reduce this rate of return, the developer absorbs those losses without impact on rates paid by consumers. This mechanism in the contract assures that the developers of the project will not reap windfall profits.

The order concluded that the contract met the DPU's standard for long-term contracts under Section 83 of the Green Communities Act, as well as the DPU's standard for the public interest. In terms of cost-effectiveness, the DPU concluded that the costs would be outweighed by the benefits provided by the contract, namely assisting National Grid and the Commonwealth to comply with the state's renewable energy and greenhouse gas emissions reduction requirements; providing National Grid the option to extend the contract beyond 15 years at a price that covers the remaining costs of operating the facility plus a reasonable rate of return; enhancing electricity reliability in the state; moderating system peak load; and creating additional employment. The DPU observed that wind data show that Cape Wind's capacity factor would have averaged an impressive 76 percent during the region's top ten historic peak hours. It concluded further that the project will create an average of 162 jobs per year for the 15 years of the contract—but many more than that during the two-plus-year construction period.

In terms of the public interest, the DPU found that the Cape Wind project offers "unique benefits relative to the other renewable resources available." In addition, the DPU found that the contract price was reasonable for offshore wind, which the Department determined to be needed to meet state renewable energy and greenhouse gas requirements. The bill impacts that could occur as a result of the contract "are small relative to the volatility that electric customers regularly experience due to the fluctuations in wholesale electricity prices, and the contract will mitigate that volatility."[53]

The Massachusetts Supreme Judicial Court has upheld this contract on appeal, ruling that the DPU reasonably determined the PPA was cost-effective, based on the administrative record based on non-quantitative benefits of offshore wind moderating peak demand, suppressing wholesale generation prices and the proximity of such large renewable generation to load centers.

[53] The 300-plus-page DPU order is located at http://www.env.state.ma.us/dpu/docs/electric/10-54/112210dpufnord.pdf.

As a condition of approving the merger between Northeast Utilities and NStar, the DPU required the merged entity to purchase 27.5 percent of the output of the Cape Wind project.

After the DPU approved the subsequent contract, opponents challenged the contract under the U.S. Commerce Clause but lost that case in May 2014, the 26th legal victory for Cape Wind. In January, a federal appeals court upheld a finding by the Federal Aviation Administration that the wind farm would pose no significant hazard to nearby aviation. In March, a federal district court ruled in Cape Wind's favor on several environment issues, but did require the National Marine Fisheries Service to issue an incidental take permit regarding potential impacts to Northern Right Whales and the U.S. Fish & Wildlife Service to independently determine certain construction mitigation measures were reasonable and prudent. Cape Wind officials have expressed their confidence in successful resolution of these "compliance measures."[54]

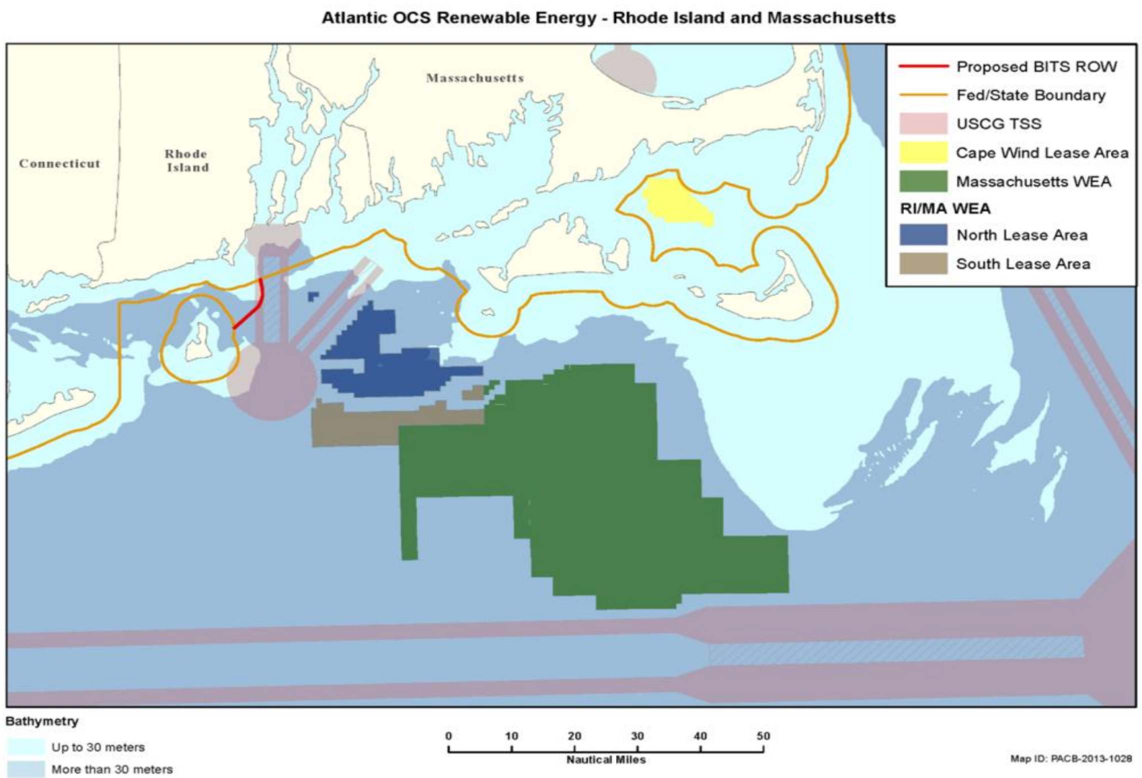
Cape Wind has conducted final geophysical and geotechnical surveys, is negotiating construction contracts, and planning to proceed with construction over the next couple of years. Cape Wind has attracted $1.3 billion of debt financing and continues to seek equity financing for the $2.6 billion project.

[54] Copley 2014

B.6.2 Site Selection and Leasing Policies

BOEM convened a Task Force and in March 2011 issued a Request for Interest in a 2,000 square mile area south of Nantucket and Martha's Vineyard. After extensive negotiations with commercial fishermen, Massachusetts requested, and BOEM agreed, to cut the WEA approximately in half. On February 6, 2012, BOEM issued a Call for Information and received ten lease nominations. On the same date, BOEM issued a Notice of Intent to Prepare an Environmental Assessment with another opportunity for public comment. Because the Massachusetts WEA is so large, BOEM asked NREL to determine how best to divide the WEA into multiple areas for the auction of capacity for approximately 1000 MW each. NREL proposed dividing the WEA into 4 or 5 areas for further comment and evaluation. BOEM held public hearings in June in advance of a Proposed Sale Notice for a lease auction for the Massachusetts WEA later in 2014.[55]

Figure B-4. Rhode Island and Massachusetts Offshore Wind Leasing Areas



55 BOEM 2013h

B.7 Michigan

B.7.1 Site Selection and Leasing Policies

An October 2010 report of the Michigan Great Lakes Wind (GLOW) Council identified 13,339 square miles that are considered most favorable to the sustainable development of offshore wind energy. Five priority areas, known as wind resource areas (WRAs), were identified. The GLOW Council completed its tasks and disbanded in 2010. The current governor is re-evaluating offshore wind development. Similar re-evaluation scenarios are taking place in Ohio and Wisconsin, where political leadership and associated renewable energy policy shifts occurred in 2010.

B.7.2 Infrastructure Policies

Michigan has designated specific areas for land-based wind development to provide a level of certainty for transmission development. State legislation passed in 2008 (PA 295, Part 4) requires the Michigan Public Service Commission to designate a primary wind energy resource zone and provides authority for the designation of additional zones. On January 27, 2010, the Michigan Public Service Commission (MPSC) issued a final order designating two Michigan regions as wind energy resource zones. The primary wind energy resource zone is an area known as "Region 4", which includes parts of Bay, Huron, Saginaw, Sanilac, and Tuscola counties. A second area, known as "Region 1" has been identified by the MPSC as an additional wind energy resource zone. Region 1 includes parts of Allegan County, Michigan.

The MPSC based its decision on the findings of the Wind Energy Resource Zone Board, which submitted its final report in 2009. Wind Energy Resource Zones are intended to expedite siting of the transmission projects needed to move the wind energy onto the electric grid. The designation means that the MPSC will facilitate the planning, siting, and construction of electricity transmission lines in order to facilitate wind energy development in the area. Affected parties within the WREZ are given 21 days to reach agreement on a voluntary cost allocation methodology for the transmission upgrade projects needed to develop wind generation. If an agreement is reached, then the necessary actions will be taken by the parties at the Midcontinent Independent Transmission System Operator, Inc. (MISO). If the parties are unable to reach a cost allocation treatment amongst themselves, the MPSC will pursue another process to resolve the matter.[56]

[56] Michigan LARA 2010

B.8 New Jersey

B.8.1 Policies to Address Cost Competitiveness

New Jersey has an RPS of 20.38 percent Class I and Class II renewables (which include wind) by compliance year 2020-2021. The standard also includes an additional 5,316 GWh of solar-electric energy by compliance year 2025-2026. New Jersey has established a carve-out in its RPS for offshore wind based on offshore wind ORECs. However, a timeline has not been established for the OREC targets. The state's Board of Public Utilities (BPU) must define a percentage-based target to reach 1,100 MW of offshore wind capacity. Projects seeking ORECs must present a price proposal for the credits as well as a comprehensive net benefits analysis. The BPU issued initial rules in 2012 and continues to develop final rules in 2014.

In July 2013, the BPU denied Fishermen's Energy's initial proposed settlement with the New Jersey Division of Rate Counsel (DRC) involving the use of ORECs for its 25 MW project because the project would not result in net economic benefits for the state at $266/MWh. Fishermen's Energy submitted a second proposed settlement to the BPU with a price of $199/MWh contingent on receipt of the second DOE award of $47 million. The BPU rejected the request before DOE selected Fishermen's for the $47 million award. In August, 2014, the Superior Court of New Jersey ordered the BPU to reconsider their decision and to take into account Fishermen's $199/MWh estimate.

Figure B-5. New Jersey Offshore Wind Leasing Areas

B.8.2 Site Selection and Leasing Policies

In July 2014, BOEM announced a Proposed Sale Notice for the New Jersey Wind Energy Area**.** BOEM proposes to auction the area as two leases: the South Lease Area (160,480 acres) and the North Lease Area (183,353 acres), for a total of 344,000 acres.

The announcement also initiated a 60-day public comment period that ends on September 19th. After the public comment period ends, the next step is the issuance of a Final Sale Notice, which will announce the time and date of the lease sale as well as other important details.

B.9 New York

B.9.1 Policies to Address Cost Competitiveness

The New York Public Service Commission (PSC) has adopted an RPS of 29 percent by 2015. New York's RPS does not have a carve-out or a REC multiplier for offshore wind. However, New York will be hard-pressed to generate an additional 3000 MW of renewables to meet their RPS goal without offshore wind.

In 2005, the Long Island Power Authority (LIPA) conducted a competitive bid for offshore wind but cancelled the process in 2008 due to high costs, which were projected to reach 29 cents/kWh.

In 2009, the New York Power Authority (NYPA) conducted a competitive bid for offshore wind in the Great Lakes but ended the process in 2011 due to high costs.

NYPA, LIPA, and Consolidated Edison (NYPA Collaborative) filed an unsolicited request for a lease in federal waters off Long Island for a 350-MW offshore wind project, possibly expandable to 700 MW. If NYPA obtains the lease, then NYPA plans to issue an RFP for private project developers to bid to construct the wind farm. The NYPA Collaborative has conducted the interconnection studies and plans to fund the interconnection and purchase the power from the wind farm, which will provide the basis for the project financing.

The New York State Energy Research and Development Authority (NYSERDA) is planning to issue a report on addressing the cost of offshore wind and has also commissioned an offshore wind policy study.

B.9.2 Site Selection and Leasing Policies

In 2010, New York requested that BOEM establish a task force to facilitate intergovernmental communications regarding OCS renewable energy activities and development. This task force is planning to identify a WEA for lease by private developers in addition to the site that the NYPA Collaborative identified.

BOEM issued a Request for Competitive Interest inviting other developers for the NYPA site to indicate their interest and inviting public comments on environmental concerns. Fishermen's Energy and EMI (Cape Wind developer) expressed interest in developing the same site. Therefore, BOEM determined that competitive interest exists and issued a Call for Information and Nominations for the site on May 28, 2014. After determining the final WEA boundaries, BOEM will initiate a competitive auction process for this site.

Figure B-6. New York Offshore Wind Leasing Areas

B.10 North Carolina

B.10.1 Site Selection and Leasing Policies

On Aug. 11, 2014, BOEM announced that it has identified three Wind Energy Areas (WEAs) offshore North Carolina:

- The Kitty Hawk WEA begins about 24 nautical miles (nm) from shore and extends approximately 25.7 nm in a general southeast direction. Its seaward extent ranges from 13.5 nm in the north to .6 nm in the south. It contains approximately 21.5 Outer Continental Shelf (OCS) blocks (122,405 acres).

- The Wilmington West WEA begins about 10 nm from shore and extends approximately 12.3 nm in an east-west direction at its widest point. It contains just over 9 OCS blocks (approximately 51,595 acres).

The Wilmington East WEA begins about 15 nm from Bald Head Island at its closest point and extends approximately 18 nm in the southeast direction at its widest point. It contains approximately 25 OCS blocks (133,590 acreas).[57]

B.11 Ohio

B.11.1 Site Selection and Leasing Policies

Ohio developed an Offshore Wind Turbine Placement Favorability Interactive Map Viewer to evaluate sites. This tool is no longer publicly available, although some individual maps are available online. Although Ohio does not have specific offshore wind siting rules, the existing Public Utilities Commission certification process and coastal management and submerged lands leasing policies and rules are being used to perform a regulatory review of the offshore wind demonstration project in Lake Erie.

B.12 Rhode Island

B.12.1 Policies to Address Cost Competitiveness

In 2004, Rhode Island established an RPS of 16 percent by 2019. There is no carve-out or REC multiplier for offshore wind.

In 2008, Rhode Island issued an RFP for an offshore wind project to produce 15 percent of the state's electricity demand and subsequently signed a Joint Development Agreement with Deepwater Wind. The Rhode Island Public Utility Commission approved an initial 30-MW Pilot PPA for 24.4 cents/kWh, which was eventually upheld by the Rhode Island Supreme Court. Rhode Island legislative advocates hope that lessons learned from construction and operation of the pilot project will help reduce the cost of constructing and operating a much larger wind farm of 500 to 1,000 MW with the same 6-MW wind turbines.[58]

B.12.2 Site Selection and Leasing Policies

Rhode Island held a competitive bid process in 2008 to select a preferred developer for an offshore wind farm off the coast of Rhode Island. Deepwater Wind LLC was selected as the winner and first negotiated the contract to sell 30 MW of wind energy from a pilot wind farm in state waters off Block Island, Rhode Island. BOEM issued a Request for Competitive Interest for the transmission route through 6 miles of federal waters and then issued a Determination of No Competitive Interest. Deepwater Wind conducted marine surveys, bird and bat surveys, and filed a General Actwith project permitting taking place in 2012 and construction projected for 2015.

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57 BOEM (2013i)

58 OffshoreWind.net 2010

On August 18, 2011, BOEM issued a Call for Information and received nine lease nominations for a larger offshore wind farm or farms on the OCS. On July 2, BOEM issued a Notice of Availability of a draft EA for the WEA off Rhode Island and Massachusetts and scheduled two public hearings during the public comment period.

In 2012, BOEM issued a Pre-Sale Notice of Lease Sale and a Final Notice of Lease Sale scheduling the auction for July 31, 2013. Six developers qualified to bid in the auction. Deepwater Wind has been designated the preliminary winner of both leases for the auction.[59]

B.13 Texas

B.13.1 Site Selection and Leasing Policies

The Texas General Land Office stipulates which areas are available for lease, the minimum MW size, and the minimum royalty rates. Winning bidders are granted phased access, first given research rights, and then construction and operation rights.

B.13.2 Infrastructure Policies

Texas has designated specific areas for land-based wind development to provide a level of certainty for transmission development. In 2008, in response to legislative action, the Texas Public Utilities Commission established five CREZ lines to be connected to load centers. Each of the five CREZ lines is to be funded by all Texas ratepayers. The PUC called for $4.93 billion of CREZ transmission projects to be constructed by seven transmission and distribution utilities and independent transmission development companies. Transmission lines to each of the five CREZ areas, totaling 3,600 miles, are now projected to cost $6.8 billion. The initiative will eventually facilitate the transmission of more than 18 GW of wind power from west Texas and the Panhandle to the state's highly populated areas.[60]

B.14 Virginia

B.14.1 Policies to Address Cost Competitiveness

Virginia is seeking to reduce the cost of offshore wind by developing a pilot offshore wind farm and having the local transmission system owner, Dominion Virginia Power, conduct interconnection studies exploring a high-voltage offshore submarine cable that could interconnect to a few wind farms.[61] The Virginia Department of Mines Minerals and Energy submitted an unsolicited request for a research lease for two 6-MW turbines on a twisted lattice foundation at the western edge of the Virginia WEA known as the Virginia Offshore Wind Technology Assessment Project. BOEM determined no competitive interest after an opportunity for comment and the VOWTAP team submitted a Research Activities Plan to BOEM in February 2014.

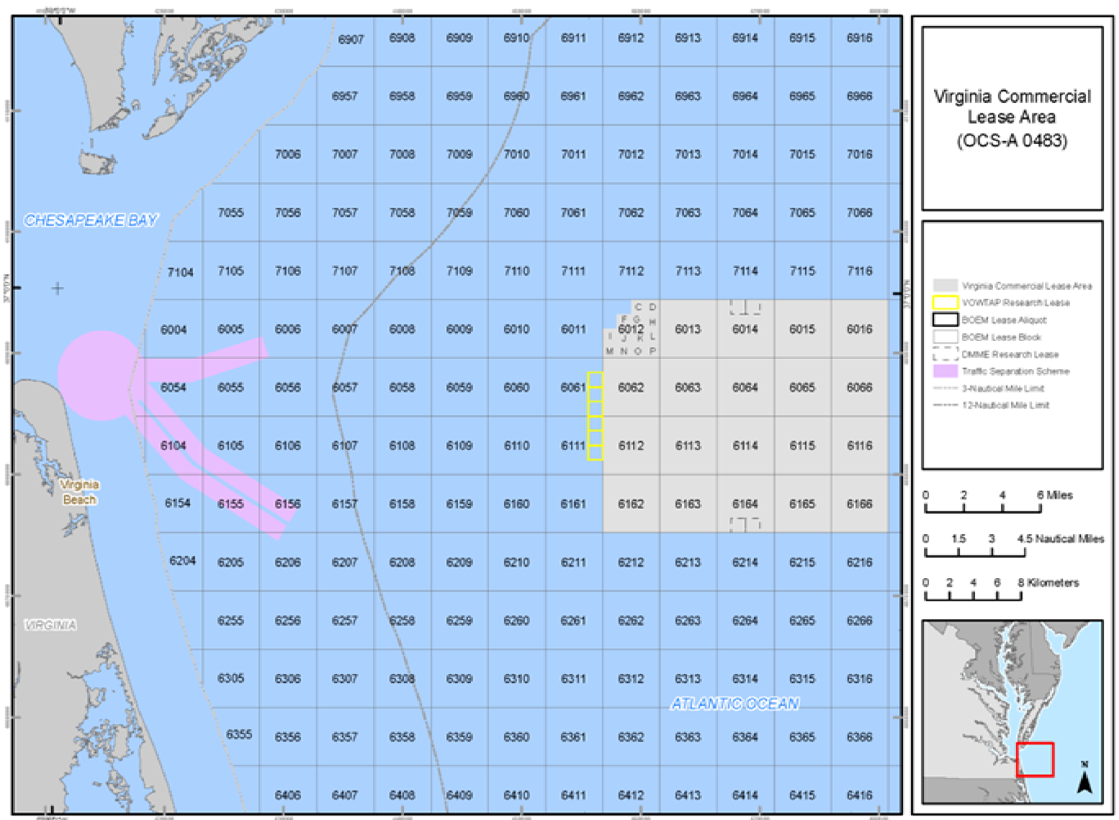
[59] BOEM 2013f
[60] CREZ 2013
[61] ABB Power Systems 2012

NAVIGANT

B.13.2 Site Selection and Leasing Policies

In February 2012, BOEM convened a Renewable Energy Task Force and issued a Call for Information and Nominations, and received several nominations and comments. BOEM issued a Pre-Sale Notice and Final Notice of Lease Sale, conducted an auction on September 4, 2013, and determined that Dominion won the bidding for the entire WEA.[62]

Figure B-7. Virginia Offshore Wind Leasing Areas



62 BOEM 2013g

Appendix C. Offshore Wind Policies in Selected European Countries

This appendix includes details on offshore wind policies and related activities in selected European countries. The categories of policies to address cost competitiveness and site selection and leasing are included. A summary of policies that address cost competitiveness is provided in tabular form in Section 2.3.3.

C.1 Belgium

C.1.1 Transmission

In Belgium, offshore wind projects are responsible for building the electricity generating asset offshore, converting it to high voltage as the case may be and transporting it to the connection point agreed with Elia, the Belgian transmission system operator. Elia is responsible for connecting the wind farms and ensuring that there is sufficient grid capacity. For the existing wind farms, the connection point was onshore and Elia has participated up to € 25 million of the electrical export costs for projects of 216 MW or greater. In 2013, financial close for 1.5 GW of projects has been delayed due to pending approval of network expansion. Grid capacity was insufficient to host any of the upcoming four projects: Norther (350-450 MW), Rentel (288 MW), Seastar (246 MW) and Mermaid (449-490 MW). Elia has therefore developed the Stevin project which consists in expanding the actual network from Zeebrugge to Zomergem and constructing a new high voltage substation in Zeebrugge. Another high voltage substation will be built near Zomergen connecting the northern interconnection between France, Belgium and the Netherlands with the Coastal region. Financial close for any of these four projects cannot be reached until (i) all permits for the Stevin project are secured and free of legal challenges and (ii) there is visibility on a credible timing on completion of the works, which is not expected to occur before mid-2014.[63]

For the upcoming wind farms, there are plans by Elia to build an offshore grid "hub", allowing mutualising the grid connection effort between projects and reducing the overall cost of connection for these projects. This Belgian Offshore Grid (BOG) project will consist of two high voltage stations, "Alpha" and "Beta", a submarine interconnection cable and four submarine cables to the onshore grid connection point in the Steven Location. The transmission assets will be built and operated by Elia resulting in: (i) a lower total investment budget for the project developer given that the grid connection would then be offshore, closer to the generating assets of the project, (ii) new operational expenses for the project in the form of a grid fee to be paid to Elia and (iii) the disappearance of the € 25 million subsidy from Elia. From a risk perspective, this is a major change as the project developer will no longer control the construction timing of the transmission assets. It could lead to situations similar to those observed in Germany where delays in construction of transmission assets by the TSOs occurred on a large scale and affected the expansion of the sector.

[63] Dodd 2013

C.1.2 Ports

Port of Oostende is the major port for offshore wind in Belgium. Since 2010, a project called "Renewable Energy Base Oostende" (REBO) has been developed to make the existing port infrastructure usable for offshore wind activity.[64] It is funded by both public and private partners. Main players in offshore wind are present there. For example, in late 2013, the Alstom 6 MW Haliade turbine, the largest turbine currently on the market, was loaded on the installation vessel at Oostende.[65]

C.1.3 Planning

With the Royal Decree of 17 May 2004, Belgium reserved a zone in the Belgian part of the North Sea for the production of electricity. Between 2004 and 2012, this area has been divided and conceded to seven offshore wind parks, for around 2.2 GW. Two of them are already operational: Belwind (165 MW operational of the total capacity of 330 MW) and C-Power (325 MW). One project is currently under construction (Northwind) which should become operational in the next few months, and the other projects are under development.

C.1.4 Permitting

Each project developer must obtain a domain concession and an environmental permit. The environmental permitting process includes a public hearing during which the public can express any objections. The Management Unit of the North Sea Mathematical Models (MUMM) of the Royal Belgian Institute of Natural Sciences renders advice on the possible environmental impact of the future project to the Minister responsible for the marine environment. MUMM's advice includes an environmental impact assessment, based on an environmental impact study that is set up by the project developer. The Minister then grants or denies the environmental permit.[66]

The permits include a decommissioning obligation including specific amounts to be provisioned to perform the decommissioning.

C.1.5 Operations

As part of the environmental permit obligations, a monitoring program has to be implemented in order to assess the effects of the project on the marine environment. The environmental monitoring is a legal obligation and is a competency of the federal government. The monitoring has two goals: (i) to enable the authorities to mitigate or even halt the activities in case of extreme damage to the marine ecosystem, and (ii) to understand and evaluate the impact of offshore wind farms on the different aspects of the marine environment and consequently support the future policy regarding offshore wind farms.

The monitoring is led by MUMM, but MUMM collaborates with several other institutes that each has a specific expertise of the marine environment. The costs of the monitoring program are paid by the permit holders.[67]

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[64] Port of Oostende 2013

[65] http://www.alstom.com/press-centre/2013/9/alstoms-6mw-haliade-offshore-wind-turbine-loaded-at-ostend/

[66] Degraer 2012

[67] Degraer 2012

C.2 Denmark

C.2.1 Transmission

Offshore wind sites in Denmark are granted through the Danish Energy Agency's (DEA's) competitive tender process. The Danish TSO,), Energinet.dk, is responsible for funding and connecting the wind farms to the onshore grid. The TSO recovers the costs through the transmission tariff collected from all electricity customers. The offshore wind farm and the offshore transmission system development timelines set out in a call for tender are very challenging. However, project termination or delays after tender award are subject to substantial penalties. This is one of the reasons for there being only one bidder during the tendering process of the Anholt wind farm organized in 2009. Due to the design of the tendering process, all projects are connected individually (i.e., point-to-point connections), and there are no plans for inter-project transmission.

C.2.2 Ports

Ports in Denmark are owned by their respective municipalities. Any upgrades made to them are approved by the municipality.

Denmark's primary offshore wind port is the Port of Esbjerg. The port was once one of Denmark's largest fishing ports but had faced a decline in recent decades. It was largely revitalized with the installation of the Horns Rev 2 offshore wind project. Now, 65 percent of wind turbine exports pass through the port.[68] The Port has also been used to ship components to several offshore wind farms outside Denmark including the UK's Lincs, Gunfleet Sands and London Array. [69] The Port of Esbjerg's board of directors has developed a strategic plan through 2019 that includes DKK 1 billion ($ 186 million) of investment.[70] In June last year, the Port of Esbjerg inaugurated the new East Harbour, a 650,000 square meter expansion of the harbour, which represented an investment of more than DKK 500 million. The new section is big enough for hosting the largest existing wind turbines.[71]

C.2.3 Planning

In 1997, the Danish government published Denmark's Action Plan for Offshore Wind. This plan recognized the difficulty in finding sufficient suitable land-based sites for wind power to reach the government's long-term wind targets. The action plan identified five potential large-scale offshore demonstration projects to be funded by a Public Service Obligation and built by public utilities. Subsequently, the government opted to use a tender process for the development of two projects over 160 MW each. The wind farms Horns Rev and Nysted were eventually constructed, the former in 2002 and the latter in 2003. In the 1997 Action Plan, the government also outlined a centralized spatial planning procedure for offshore wind in Denmark, identifying appropriate sites for development while taking into account the potential environmental impacts.

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[68] Esbjerg Kommune
[69] Aagaard 2012
[70] Ministry of Foreign Affairs of Denmark 2009
[71] World Maritime News 2013

In 2004, the DEA called for tenders for two 200-MW offshore wind farms, one at Horns Rev II and one at Rødsand. The former was completed in 2009, while the latter was completed in 2010. In 2007, the Action Plan was updated to reassess selected sites for offshore wind development. The updated plan identified areas with favorable wind resources totaling 4,600 MW of potential capacity, corresponding to 50 percent of Danish electricity consumption.[72]

C.2.4 Concessions

The Danish government controls economic activity within territorial waters, the Contiguous Zone, and the Exclusive Economic Zone (EEZ). It can award offshore wind farm concessions based on the Electricity Supply Act.

The Danish government has a centralized offshore wind spatial planning procedure and awards all offshore wind concessions.

Developers can apply for an offshore license in two ways:

1. Based on the Danish government's action plan for offshore wind development, the DEA invites developers to bid on tenders for pre-specified sites.
2. Through the "open-door principle," developers, at any time, can apply to develop a site. The DEA assesses the site and, if it approves the project, grants development rights on a "first come, first served" basis.[73]

Under the first procedure, the TSO performs and funds the transmission connection to shore. In the second procedure, the developer must perform the grid connection. Cost recovery in this case is based on the onshore rules. Projects following the "open-door principle" must also offer 20 percent ownership to the local population, as is the case with land-based wind. Due to the lack of financial incentives, no major commercial offshore project has been developed through the open-door route.

Six areas in Denmark have been identified for the offshore wind turbines at: Bornholm, Smålandsfarvandet, Sejero Bay, Sæby, and the southern and northern areas of the Danish North Sea. Tenders will be organized this year for the following projects: (i) the 400 MW Horns Rev 3 wind farm, (ii) the 600 MW Krieger's Falk wind farm and (iii) a combination of near-shore wind farms totaling 450 MW. Finally, demonstration projects with a capacity of 50 MW will also be deployed by 2020. Prequalification and final outcomes of the tenders are respectively expected for Q4 2014 and Q3 2015.[74]

C.2.5 Permitting

In Denmark, Chapter 3 of the Promotion of Renewable Energy Act indicates that the right to exploit energy from water and wind within the territorial waters and the EEZ (up to 200 nautical miles) around Denmark belongs to the Danish State. To establish an offshore wind project in Denmark, a developer must obtain three licenses from the DEA. In terms of permitting, this agency serves as a "one-stop shop."

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[72] The Committee for Future Offshore Wind Power Sites 2007
[73] Energi Styrelsen 2013
[74] Danish Energy Agency 2013

It streamlines the project developer's relationship with all of the offshore wind power stakeholders. The Promotion of Renewable Energy Act mentions three licenses:

- License to carry out preliminary investigations
- License to establish the offshore wind turbines (only given if preliminary investigations show that the project is compatible with the relevant interests at sea)
- License to exploit wind power for a given number of years and—in the case of wind farms of more than 25 MW—an approval for electricity production (given if conditions in license to establish project are kept)

The Danish Energy Agency serves as a "one-stop shop" for permitting.

The DEA grants the three licenses for a specific project. If a given project can be expected to have an environmental impact, the developer must perform an EIA. The specific regulations regarding EIAs for offshore wind farms are described in Executive Order no. 815 of August 28, 2000.

C.2.6 Operations

In granting the building permits for Horns Rev and Nysted, Denmark's first two large-scale (i.e., over 100 MW) wind farms, the DEA included an obligation for the project developers to carry out comprehensive environmental monitoring programs. The DEA specified that these programs should include detailed measurements of the environmental conditions before, during, and after construction. Between 2001 and 2006, the program had a budget of DKK 84 million (approximately €11 million). The program was financed as a public service obligation by electricity consumers. The monitoring work has been coordinated by a group consisting of the Danish Forest and Nature Agency, the DEA, and the projects' developers, Vattenfall and DONG Energy. The results of the monitoring programs have been evaluated by the International Advisory Panel of Experts on Marine Ecology (IAPEME).[75]

As part of the preparation of the offshore wind tenders, the DEA is now responsible for preparing site investigations and the EIA –if the project is likely to have an environmental impact, which has been the case for all the existing offshore wind farms– and provide them to the parties considering bidding.[76]

C.3 France

Despite the existence of a feed-in tariff for offshore wind energy in France, no offshore wind farm has been built to date, due to the low level of this existing support scheme. In addition to the existing unsuccessful support scheme, 4 offshore wind sites in France have been granted through competitive tender processes, and two further sites are to be granted in the coming months.

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[75]http://193.88.185.141/Graphics/Publikationer/Havvindmoeller/Offshore_wind_farms_nov06/pdf/havvindm_korr_16nov_UK.pdf

[76] Danish Energy Agency 2014

Candidates have been tendered on the basis of:

(i) the level of the feed-in tariff that they will receive during the first 20 years of operation of the projects,

(ii) the quality of their industrial project, including supply chain aspects, and

(iii) compliance with the environment.

C.3.1 Transmission

The French TSO, Réseau de transport d'électricité (RTE), an independent subsidiary of EDF is the owner of the transmission assets and is responsible for the permitting and the construction and the operation and maintenance of the grid connection assets (high voltage export cables and onshore substation). The offshore wind projects are responsible for the building of the offshore substation; the grid connection point is immediately after the substation.

The construction costs of the grid connection assets owned by RTE are to be borne by the developer. The developer is compensated for this investment through a specific component of the tariff, normatively sized on an expected return for such investment of 7.25% before taxes. The level of the grid component is not part of the tender criteria. The grid component of the tariff shall be adapted if construction costs evolve compared to the estimate, according after signing to a pre-agreed formula included in the tender. After being awarded, each project shall negotiate the conditions of the grid connection in a transmission agreement. In case of delays caused by RTE, the 20-year duration of the tariff shall not be affected. In case of low availability of the offshore wind project (below 50%), the grid component of the tariff is reduced.

C.3.2 Ports

As mentioned in preamble of this paragraph C3, under the tendering process, each candidate is to describe its industrial project. The supply chain, in this case the ports used and the factories to be built are an integral part of the candidate selection.

So far the winning consortia and candidates have announced that they would develop a number of ports that are either close to the offshore sites contemplated or are otherwise located in a place where there is an existing infrastructure for the members of the consortium.

Announcements have been made for facilities to be built in Saint-Nazaire (Alstom), Cherbourg (Alstom), Le Havre (Areva), and Dieppe (Areva).

C.3.3 Planning

No offshore wind farm has been built to date in France. However, the French Government has begun to support the development of offshore wind projects by organizing two rounds of tenders for a cumulated capacity of 3 GW. Six areas had thus been identified of which 4 have been awarded as part of the first tender and two further areas are to be awarded in the coming months, and construction is expected to start in the 2016-2018 period.

The tenders include a deadline for completion of the offshore wind projects set:

- in 2020 for the tender 1 projects, and
- in 2023 for the tender 2 project.

These deadlines may be extended under certain circumstances, but will otherwise lead to a reduction in the duration of the feed-in tariff.

C.3.4 Permitting

The offshore wind projects tendering process does not require any conditions on advancement of permitting. The offshore wind project should benefit from an accelerated permitting procedures once awarded, supported by the *prefecture*.
There is legal uncertainty on the legal framework for offshore wind in France. Offshore wind projects will require a concession from the state on the maritime domain which has never been done so far. The terms of this concession remain to be fully negotiated, as there are no relevant precedents in this respect in France.

C.3.5 Operations

There are currently no operational offshore wind farms in France.

C.4 Germany

C.4.1 Transmission

Two of the four German TSOs, TenneT and 50Hertz, are legally responsible, in their respective areas, for planning, consenting, designing, building, and operating offshore transmission connections for all offshore wind projects whose construction has begun prior to 2015. The TSOs incur investments in offshore transmission assets and recover costs through transmission tariffs from the customers of all four German TSOs.

The main challenge for offshore wind in 2012 was related to the grid, as TenneT, the TSO of the North Sea area, has delayed construction of some of the export cables. The New German Energy Act (EnWG), enacted on January 1, 2013, clarifies the compensation to which projects impacted by such delays are entitled and how the funds can be raised for such purpose. This law is expected to unlock the situation with TenneT. One direct result of the EnWG is a partnership between Mitsubishi and TenneT to invest in four high-voltage cable projects, enabling connection to shore for an estimated 2.8 GW of offshore wind farms. In December 2013, the European Invesment Bank provided a € 500 million corporate loan to TenneT to help finance three high-voltage cable projects (HelWin1, SylWin1 and DolWin1). A total of 6.2 GW connection capacity has been installed by TenneT or is currently under construction. [77]

[77] OffshoreWind.biz 2013

C.4.2 Ports

C.4.2.1 Bremerhaven

The Federal State of Bremen has stated a goal of making Bremerhaven and Bremen into the leading competence center and production area for offshore wind energy in northwest Germany.[78] In 2002, having recognized the emerging potential of offshore wind, the state government of Bremen decided to invest €20 million on infrastructure upgrades and other incentives to help the port of Bremerhaven benefit from the significant wind development already approved for in the German North Sea.[79] The state of Bremen was the first in northern Germany to implement such a policy for offshore wind.[80] Policy actions have included R&D and investment support schemes, as well as support for networks and offshore-oriented infrastructure. The state's policy reserved certain areas for offshore activities and invested in port upgrades to accommodate these activities. Regional policymakers in Bremen strongly recruited companies to relocate or set up their offshore activities in the state. In subsequent years, AREVA (Multibrid), Repower, Powerblade, and Weser Wind established manufacturing facilities at the port of Bremerhaven.

In January 2010, the Bremen Senate decided to commission a new heavy load, assembly, and transshipment facility for the offshore industry at Bremerhaven beginning in 2014. The €180 million facility will be called Offshore Terminal Bremerhaven (OTB). Government officials in Bremen have stated the goal of developing Bremerhaven into the European center for offshore wind energy. The construction, financing, and operation of the OTB will be conducted through a concession model. The state government has selected Bremenports, which has managed the port infrastructure in Bremen and Bremerhaven since 2002, to conduct a European-wide public tender for the project. The operating contractor is expected to be awarded by spring 2014. [81] The Bremen government will grant the concession to the private investor who will recover its costs through user fees. The investor will receive no government startup financing.[82]

C.4.2.2 Cuxhaven

The government of Lower Saxony, having identified the port and logistics needs of the offshore wind energy in the region, is investing to upgrade the North Sea ports of Cuxhaven, Emden, and Brake.[83] This is in contrast to Bremen's concession model that provides no public funds. To shift its focus to offshore wind power, the port of Cuxhaven is investing €450 million to construct two new offshore terminals.[84] This is in addition to storage and laydown areas already completed. Cuxport, the port operator in Cuxhaven, has designed a heavy load berth to accommodate the extreme stresses from foundation sections and generators. In addition, it is planning a new berth for ships of up to 290 meters in length.[85]

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[78] Power Cluster 2008
[79] Aubrey 2009
[80] Fornahl 2011
[81] Bremenports
[82] Bremenports 2011
[83] PES
[84] SeeNews Renewables 2011
[85] http://www.cuxport.de/en/rhenus-cuxport/services/offshorebase-cuxhaven/

C.4.3 Planning

Given the lack of a standardized permitting process, the first few proposed offshore wind farms in Germany had to define their own site investigations plan. More recently, however, the German government has sought to develop a more government-led spatial planning system and regulatory process for offshore wind. Still, the government has not yet implemented a centralized tender or bidding process like those used in the United Kingdom and Denmark.[86] In 2004, Germany's Federal Spatial Planning Act was expanded to the EEZ, which extends 200 nautical miles from the German shore.[87] This enabled the development of a spatial plan for offshore wind led by the permitting agency, the Federal Maritime and Hydrographic Authority (BSH). The first draft of this spatial plan, released in 2008, identified five priority areas (1,100 square kilometers) for offshore wind energy, meaning that wind energy in these zones takes priority over other regional activities. They are located in the North Sea (North of Borkum, East of Austerngrund and South of Amrumbank) and in the Baltic Sea (Kriegers Flak, West of Adlergrund).[88] The draft plan was subsequently revised multiple times based on industry feedback. Offshore wind farm development outside the priority areas is allowed, but it is subject to the results of comprehensive environmental impact assessments.

C.4.4 Permitting

As mentioned in Section 2.5.3, in 2004, Germany's Federal Spatial Planning Act was expanded to the EEZ.[89] This enabled the development of a spatial plan for offshore wind led by the permitting agency, the BSH. The first draft of this spatial plan, released in 2008, identified five priority areas (1,100 square kilometers) for offshore wind energy in the German North and Baltic Seas. The draft plan was subsequently revised multiple times based on industry feedback. Offshore wind farm development outside the priority areas is allowed but is subject to the results of comprehensive EIAs.

In Germany, permits for offshore wind farms are allocated through an open-door procedure. The first candidate to submit a proposal for a project that meets all of the BSH's stated criteria is given priority to develop the site. The principal component of the German regulatory procedure for offshore wind is obtaining the permit from the BSH. The permit provides a developer with exclusive rights to a site. Once the project is fully consented, the developer can submit an application for grid connection. Under German law, an offer for grid connection and the purchase of the electricity generated from the wind farm are mandatory. This last step has been the source of many delays; financial responsibility for these delays has finally been clarified as a result of the EnWG legislation in January 2013.

C.4.5 Operations

In February 2007, the BSH published the third edition of the "Standard for Investigation of the Impacts of Offshore Wind Turbines on the Marine Environment (StUK3)."[90]

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[86] Wiersma 2011
[87] OceanWind 2010
[88] Offshore-WindEnergieNet
[89] OceanWind 2010
[90] Federal Maritime and Hydrographic Agency 2013

In Germany, the approval holder for an offshore wind farm is responsible for conducting the baseline assessment, as well as assessments during the construction and operational phase. Monitoring data must be submitted annually to the approval authority. The monitoring data must include the status prior to construction, as well as any change during and subsequent to construction.

As part of Alpha Ventus (RAVE), Germany's first offshore wind farm, the Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU) initiated and financed the research at RAVE project. The BMU has allocated €50 million for the initiative. The initiative encompasses approximately 25 research projects, some of which are focused on the interdependency of environmental and technological impacts of offshore wind energy generation. Fraunhofer IWES coordinates the initiative.[91]

C.5 The Netherlands

C.5.1 Transmission

In 2010, the Dutch government approved a proposal to make TenneT, the Dutch TSO, responsible for the construction and management of the country's offshore transmission grid.[92]

Currently, offshore wind developers in the Netherlands are responsible for incurring offshore transmission system costs. The TSO bears the costs for reinforcements to the onshore transmission system and recovers them through transmission tariffs collected from all electricity customers. However, due to growth in the Dutch offshore market, there are calls to change this in the near future.

In early 2011, the EIB announced that it would provide €450 million in loans to TenneT to complete the 380kV Randstad transmission ring between The Hague and Rotterdam.[93] The transmission cable would enable the connection of offshore wind farms. The transmission ring is expected to be completed in 2018. TenneT's investments in the Dutch transmission network during the next ten years will account for € 5 billion.[94]

TenneT and the Danish TSO, Energinet.dk, are developing an undersea HVDC interconnector between the two countries' electricity grids. The project is called the COBRAcable. The proposed connection would have a capacity of approximately 700 MW and would be around 275 kilometers in length. The project incorporates the possibility of interconnecting offshore wind farms.[95] Total project cost amount to € 449 million. Final investment decision is expected in 2016 once planning consents and approvals are obtained from the Danish, Dutch and German authorities.[96]

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[91] Fraunhofer Institute 2012]
[92] http://www.tennet.org/english/images/100552%20TEN%20Offshorebroch%20%20EN_tcm43-19468.pdf
[93] EIB 2011
[94] OffshoreWindBiz 2013
[95] http://www.tennet.org/english/projects/Internationaalenoffshore/index.aspx
[96] EC 2013

C.5.2 Planning

The Dutch Ministry of Transport, Public Works and Water Management (MTPW) is the agency authorized to issue the final site approval and permits for offshore wind projects off the Dutch coast. The MTPW is now part of the Ministry of Infrastructure and Environment. The clear responsibilities and procedures administered by this single agency will help to increase developments, as they reduce the developer's risks at an early stage in the project.

An Integrated Management Plan for the Netherlands Economic Zone in the North Sea in 2015 introduces an integrated assessment framework for all activities requiring a permit. One of the key motivators for this plan is the need to plan for offshore wind energy. Specific zones have been identified where future offshore wind development should be concentrated. Specific site locations and delivery schedules are determined by developers in their consent applications.

Dutch Round 2 consisted of 12 projects developed by six consortia who were awarded the right to tender for 950 MW of subsidies. Only three out of these 12 projects succeeded in granting the subsidy scheme, called the Stimulation of Sustainable Energy Production *"Stimulering Duurzame Energie"* (SDE). Neither government nor industry was satisfied with the planning and organization of the Dutch Round 2. As a result, no offshore wind farm has been completed in the Netherlands in the last five years, the only two operational parks being Egmond aan Zee (108 MW, 2006) and Princess Amalia (120 MW, 2008).[97] In February 2014, the Dutch government proposed two new offshore development zones: Hollandse Kust (maximum capacity of 7.3 GW) and the Noorden van de Waddeneilanden block (maximum capacity of 1.2 GW). A public consultation started in January this year. The draft bill has been approved by the council of ministers and will go through the parliament in mid-2014.[98]

C.5.3 Concessions

The rights for development are granted through a competitive tendering process. To take part in this tendering process, the developer has to obtain a planning consent for the site. The winning bidders receive the SDE tariff. To date, two tendering rounds have been held. The third and most significant round was planned, but it did not commence due to political uncertainty and changes recently introduced to the FiT structure. Developers would have looked to obtain consent in anticipation of the third tendering round, thus accounting for the number of projects in the "approved" stage in the Netherlands.

In July 2011, the FiT system was changed, and the first call to tender was launched for renewable energy generation under this new tariff SDE+. The SDE+ scheme is expected to be consumed by other renewable technologies. This is because the tariff is not deemed to provide sufficient returns compared to the high capital costs of offshore wind power. The economic crisis and the unsatisfactory tender results for the previous OWF tender rounds, including several objections and procedures in court, have reduced interest in offshore wind development. But in September 2013, the Dutch government published a plan to speed offshore wind deployment. The national agreement sets a target of 4.5 GW offshore wind

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[97] Wind Power Offshore 2013
[98] Wind Power Offshore 2014

capacity installed by 2023. Among other things, it plans to establish a proper legal framework for offshore wind by 2015, facilitate grid connection and extend the SDE scheme. For 2013, € 3 billion have been made available under the SDE, which is a major increase from the € 1.7 billion that was available the previous year. The government is also committed to dedicating € 3.5 billion to the SDE 2014 budget.

C.5.4 Permitting

As mentioned in Section 2.5.3, the OWEZ project in the Netherlands required consents from numerous authorities, but the process is now managed by a single ministry. A clear procedure is critical to increase developments, as it reduces the developer's risks at an early stage in the project.

An Integrated Management Plan for the Netherlands Economic Zone in the North Sea in 2015 introduces an integrated assessment framework for all activities requiring a permit. One of the key motivators for this plan is the need to plan for offshore wind energy. Specific zones have been identified where future offshore wind development should be concentrated.

C.5.5 Operations

In 2001, the Dutch government decided to support the OWEZ offshore wind energy farm demonstration project. Prior to the project's construction, the Dutch government called for baseline studies on ecology and environmental factors. From 2002-2004, several consultancies conducted the baseline studies. After the wind farm began operation in late 2006, the project developer, NoordzeeWind, continued to monitor the project's impact on the environment, as required in the tender agreement. NoordzeeWind conducted this NSW-MEP Monitoring and Evaluation Programme in cooperation with leading research institutes. The research program began in 2006 and continued until 2012.[99] The Dutch government designated NL Agency, Energy and Climate Change as the responsible party for overseeing the monitoring program on behalf of the Dutch Ministry of Economic Affairs. NL Agency received the data and verified the consistency, integrity, validity, and plausibility of the data. Moreover, NL Agency was instructed to store and distribute the data to third parties.[100]

C.6 United Kingdom

C.6.1 Transmission

The OFTO regime was introduced by Ofgem in response to the 'third energy package' implemented by The European Union in June 2009 to promote competition. Generators of offshore electricity projects were previously responsible for consenting, licensing, constructing and maintaining all of the grid connection assets. This system was however considered to be incapable of delivering cost-effective connections. Therefore, as of 2009, generators of offshore electricity have not been allowed to own the offshore transmission infrastructure (consisting out of the offshore substation and high voltage transmission cable (the so called 'export cable')). Qualifying companies now bid through a competitive tender process to become an OFTO. The OFTOs will receive, via the TSO, National Grid, a 20-year stream of revenue payments. These payments are determined according to the OFTO's bid during the

[99] http://www.agentschapnl.nl/programmas-regelingen/ecology-and-environment
[100] http://www.agentschapnl.nl/programmas-regelingen/monitoring-and-evaluation-windpark-egmond-aan-zee

tender process. Under this regime, offshore wind farm operators can choose to construct their own transmission connections or opt for the OFTO to do so. This approach is unique, as most other European countries have directly tasked their TSOs with construction and maintenance of offshore wind grid connections. To be sure that the OFTO will be able to transmit power produced by the generator, the OFTO is subject to a system of incentives which rewards or penalises it depending on its availability performance against the annual target set at 98%. It can result in penalties of up to 50% of its annual revenue, and conversely, it can reward the OFTO by up to 5% of its annual revenue.

C.6.2 Ports

In 2007, the U.K. government conducted a review of national port policy. The government recommended that the country's major ports, most of which are privately owned and operated, produce master plans.

The Planning Act 2008 was enacted to speed up the approval process for new nationally significant infrastructure projects (NSIPs) in various economic sectors. National Policy Statements (NPSs) were developed for 12 infrastructure sectors, one of which was ports.

In 2008, the DECC commissioned an independent study by BVG Associates entitled *U.K. Ports for the Offshore Wind Industry: Time to Act*.[101] The findings of the report contributed to the Department for Transport's NPS for ports. The NPS on ports was published in October 2011 and presents the government's conclusions regarding the need for new port infrastructure.[102] The statement considers the current role of ports in the country's economy, the ports' forecasted future demand, and the options for meeting future needs. The NPS provides decision-makers with the approach they should use to evaluate port development proposals.

In October 2010, the United Kingdom launched its first National Infrastructure Plan (NIP).[103] Whereas the NPS focus more on infrastructure planning, the NIP focuses on investment in infrastructure. The scope of the sectors covered in the NIP is also greater than that of the NPSs.

In October 2010, to support the achievement of its renewable energy targets for 2020, the United Kingdom's DECC and The Crown Estate (TCE) announced a £60 million investment to establish world-class offshore wind manufacturing at port sites.[104] On publication of its country's first NIP, Prime Minister David Cameron said, "We need thousands of offshore turbines in the next decade and beyond yet neither the factories nor these large port sites currently exist. And that, understandably, is putting off private investors. So we're stepping in." [105]

The government has stated that it will accept applications from manufacturers or joint applications from manufacturers and ports. However, the funding is not available for port-only applications. Applicants

[101] BVG 2009
[102] U.K. Department for Transport 2011
[103] http://www.hm-treasury.gov.uk/d/nationalinfrastructureplan251010.pdf
[104] UK DECC 2010
[105] UK DECC 2010

apply for support under the Grants for Business Investment scheme, the United Kingdom's national business support scheme that supports sustainable investment and job creation in the Assisted Areas of England. Assisted Areas are locations where regional economic development aid may be granted under EU legislation. Funding commenced in April 2011 and is available through March 2015.

Shortly upon the announcement of this funding, turbine manufacturers Siemens, Gamesa, and Vestas committed building portside manufacturing facilities in the United Kingdom. Siemens has committed to produce its 6-MW offshore turbines at the Port of Hull in East Yorkshire,[106] and Gamesa has chosen to manufacture offshore turbines at the Port of Leith near Edinburgh.[107] Gamesa will invest up to € 150 million in this new hub.[108] Vestas eventually abandoned its project to build its V164-7.0 MW turbines at the Port of Sheerness in Kent due to lack of orders.[109]

The United Kingdom has had three rounds of offshore wind concessions, which are discussed in the following three sections.

C.6.3 Round 1

In 2001, developers seeking sites for offshore wind projects initiated Round 1. The relatively quick consenting process for some of the projects in this round, such as North Hoyle and Scroby Sands, reflects the well-established consenting regime for electricity projects in place at the time. This demonstrated the value and importance of a strong permitting framework for offshore wind. The incremental approach used in Round 1—namely, smaller projects that were relatively close to shore, delivered viable projects while also providing significant experience and lessons learned for all stakeholders (i.e., developers, contractors, and government).

The U.K. government recognized the need to streamline the consenting process and created a "one-stop shop" approach for permitting.

C.6.4 Round 2

Whereas Round 1 was developer-led, Round 2, launched in 2003, was government-led. The U.K. government recognized the importance of spatial planning and the need to streamline the consenting process. A "one-stop shop" approach was created for permitting. For Round 2, the government commissioned Strategic Environmental Assessments (SEAs) for three regions deemed attractive for offshore wind development, the Thames Estuary, the Greater Wash, and the North West. In July 2003, TCE issued a formal Invitation to Tender. Round 2 was designed to be significantly more ambitious than Round 1. No limit was placed on size and no restriction to territorial waters was made. Fifteen of the 70 proposed projects were granted leases.

[106] BBC 2012b
[107] The Guardian 2012
[108] Shankleman 2012
[109] BBC 2012a

In Round 2, TCE charged successful applicants a one-time fee based on the spatial area of their respective sites. This ranged from £25,000 to £0.5M. Once operational, owners of Round 2 projects will be required to make lease payments on the order of £0.88/MWh (indexed to inflation). The lease payments are projected to be approximately 1 percent of gross power sales, including incentives. In July 2009, TCE announced an offer to operators of Round 1 and Round 2 wind farms to extend their site leases to 50 years, affording developers greater certainty when considering life-extension and re-powering of their projects. This move was also designed to instill greater confidence in the supply chain, addressing a perceived gap in the project pipeline between Rounds 2 and 3.

C.6.5 Round 3

For Round 3, initiated in 2008, TCE, the seabed owner and manager, established a strategic spatial planning process and identified nine Round 3 Zones in U.K. waters prior to running an extensive tender process to identify credibility and financial robustness. Additionally, the U.K. government has implemented a new Infrastructure Planning process for the permitting of offshore projects, providing an improved, more efficient, and timelier consenting regime.

U.K. Round 3 exemplifies the importance and benefits of "zonation," SEAs, and proactive spatial planning. This framework approach, commencing in 2007 with a national Strategic Environmental Assessment, concluded with an extensive marine spatial planning constraint mapping process undertaken by TCE, with extensive consultation with stakeholders.

In U.K. Round 3, the advantages of zonation have been further extended by providing a collaborative framework with TCE to develop the zones to maximize capacities. The principle of proactive spatial planning has been taken a stage further in Round 3 through the ongoing technical and environmental zone appraisal within the zone by the developer and TCE to utilize regional environmental assessment tools to best locate projects according to environmental and permitting constraints. For Round 3, TCE has granted exclusive development rights for nine zones. New Infrastructure Planning Commission will be a one-stop permitting shop. Permits from local authorities will still have to be obtained.

In December 2007, the Department for Business, Enterprise and Regulatory Reform (BERR) announced the commencement of an SEA, aimed at facilitating significant further expansion for offshore wind. A target of 25 GW of additional capacity by 2020 was also announced. In January 2009, the U.K. Offshore Energy SEA Environmental Report was issued for public consultation. The SEA indicates that the preferred approach of DECC is to apply spatial and operational limitations to offshore wind development zones, where required, to mitigate unacceptable environmental impacts, while supporting the overall use of the U.K. marine environment for achievement of the U.K. government's energy policy objectives.

TCE has published a generic version of a Round 3 pro forma leasing agreement; however, the specifics of individual agreements are negotiated on a project-by-project basis. The pro forma states that leases are offered on an 80-year basis (as opposed to 50-year leases for Round One and Round Two projects). Once awarded a site, developers pay a non-refundable Lease Premium of an amount agreed upon with TCE. Rent from date of lease agreement to commissioning is a notional £500 per annum per leasing agreement. Following wind farm commissioning, the rent payable is a factor of generated electricity.

The 2009 Marine and Coastal Access Act, together with the 2010 Marine (Scotland) Act and upcoming Northern Ireland Marine Bill, have set up a maritime planning system for all U.K. waters. Suitable areas for offshore wind development have been identified through SEAs.

C.6.6 Permitting

Whereas the U.K.'s Round 1 was developer-led, Round 2, launched in 2003, was government-led. The U.K. government recognized the importance of spatial planning and the need to streamline the consenting process. A "one-stop shop" approach was created for permitting. For Round 2, the government commissioned SEAs for three regions deemed attractive for offshore wind development: the Thames Estuary; the Greater Wash; and the North West.

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C.6.7 Operations

In the U.K., offshore wind farm license holders are responsible for monitoring the environmental impacts of their facilities. Licenses under the Food and Environment Protection Act 1985 (FEPA) are required for any construction activity within the marine environment. The FEPA licensing process includes a thorough assessment of the likely impacts of the offshore wind farm on the marine environment and the need for measures to mitigate impacts and/or plans for marine environmental monitoring.

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In 2010, the Centre for Environment, Fisheries & Aquaculture Science (Cefas), with support from FEPA and the Sea Mammal Research Unit (SMRU), conducted a study entitled "Strategic Review of Offshore Wind Farm Monitoring Data Associated with FEPA Licence Conditions."[110] The report concluded the following:

- It is vital to have clearer objectives within license conditions to ensure the developer knows why and what monitoring is required
- It is important to incorporate datasets from national or even international monitoring programs to utilize all available data
- There is a need to develop novel techniques to assess the issues identified in the Environmental Statements

[110] Walker 2010

- Few conditions can be removed from licenses
- License conditions need to better reflect current scientific understanding and need to be more explicit in their wording to aid enforcement
- More work is required within monitoring reports to assess interactions between different receptors
- All topic areas stressed the need to have a standardization of survey and analytical methodologies wherever possible to aid in future comparison and assessment