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Offshore Wind Market and Economic Analysis

Annual Market Assessment

Prepared for:
U.S. Department of Energy

Client Contact Michael Hahn, Patrick Gilman
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Navigant Consulting, Inc.
77 Bedford Street
Suite 400
Burlington, MA 01803-5154

781.270.8314
www.navigant.com

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Prepared for:
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Michael Hahn
Patrick Gilman

Prepared by:
Navigant Consulting, Inc.

Bruce Hamilton, Principal Investigator
Lindsay Battenberg
Mark Bielecki
Charlie Bloch
Terese Decker
Lisa Frantzis
Jay Paidipati
Andy Wickless
Feng Zhao

Navigant Consortium Member Organizations	*Key Contributors*
American Wind Energy Association	Jeff Anthony and Chris Long
Great Lakes Wind Collaborative	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., Joe Marrone, P.E., and Stanley M. White, P.E., D.PE, D.CE
Tetra Tech EC, Inc.	Michael D. Ernst, Esq.

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Fara Courtney	U.S. Offshore Wind Collaborative
Steve Dever	LEEDCo
Tim Downey	Saint Lawrence Seaway Development Corporation (US DOT)
Patrick Fullenkamp	Global Wind Network
Tom Graf	Michigan DEQ
Lynn Gresock	ARCADIS
Jeffrey Grybowski	Deepwater Wind
Jeff Hammond	Ecology and Environment, Inc.
John Hingtgen	California Energy Commission
William Hurley	The Glosten Associates, Inc.
Willett Kempton	University of Delaware
Ben Maples	NREL
Dennis Nielson	DOSECC Exploration Services
Brian O'Hara	Southeastern Coastal Wind Coalition
Doug Pfeister	Offshore Wind Development Coalition
Eric Ritter	LEEDCo
Jacques Roeth	NYSERDA
Bob Schubert	Siemens Energy Inc
Peter D. Stoklossa	ThyssenKrupp Rothe Erde GmbH
Katarina Svabcikova	Siemens Energy
Larry Viterna	Nautica Windpower LLC
Carl Wegener	Signal International, Inc.
Cliff Williams	Orisol Energy
Greg Williams	Bracewell & Guiliani, LLP
Paul Williamson	Maine Wind Industry Initiative
Andy Zalay	windfarm inc

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Table of Contents

List of Figures

List of Tables

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
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
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 will be updated and published annually for a three-year period. The report was first published in early 2013 covering research performed in 2012. This 2nd annual report focuses on new developments that have occurred in 2013. 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 or in the construction phase, there are eleven 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 13 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 second annual assessment of the U.S. offshore wind market. It includes the following major sections:

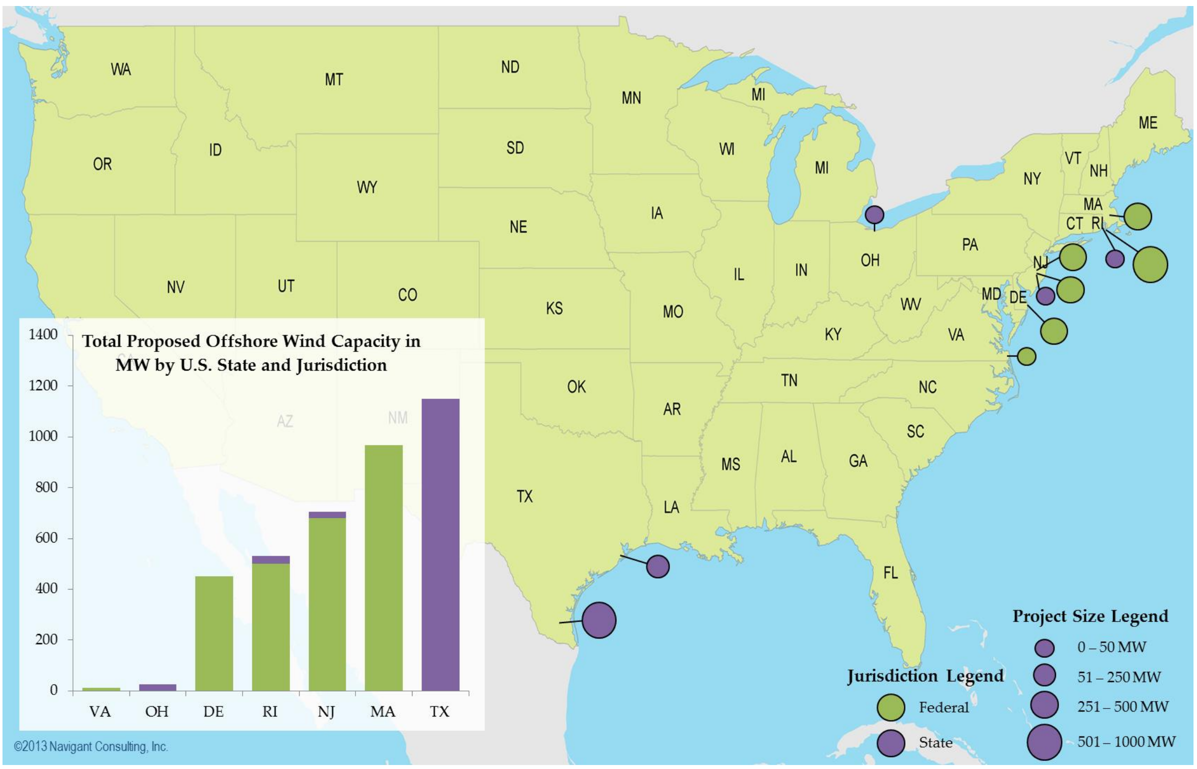
- *Section 1*: key data on developments in the offshore wind technology sector and the global development of offshore wind projects, with a particular focus on progress in the United States
- *Section 2*: analysis of policy developments at the federal and state levels that have been effective in advancing 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 5.3 gigawatts (GW) of offshore wind installations worldwide. The majority of this activity continues to center on northwestern Europe, but development in China continues to progress. In 2012, more than 1,100 megawatts (MW) of wind power capacity was added globally, with the United Kingdom alone accounting for 756 MW of new capacity. The European market will continue to grow rapidly over the next two years, with new and expanding projects likely to contribute a record-setting 2,900 MW in 2013 alone (mostly in Germany and the United Kingdom).

Since the last edition of this report, several potential U.S. offshore wind projects have achieved notable advancements in their development processes. In addition to two Bureau of Ocean Energy Management (BOEM) commercial lease auctions for federal Wind Energy Areas (WEAs), other later-stage commercial-scale projects have made incremental progress toward starting construction. Eleven U.S. projects, representing 3,824 MW, now lie in advanced stages of development.[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



Note: One potential project (the Deepwater Wind Energy Center) spans federal waters off the coasts of Massachusetts and Rhode Island; this map splits its estimated 1,000-MW capacity between the two states.
Source: Navigant analysis

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[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.

On the demonstration-project front, the University of Maine, in partnership with the U.S. Department of Energy (DOE), installed the United States' first offshore wind turbine: a 1/8-scale pilot turbine on a floating foundation. In addition, DOE awarded Advanced Technology Demonstration (ATD) project grants in December 2012. The grants are intended to help address ongoing challenges and cost barriers to offshore wind energy. The DOE will select up to three of these projects to receive additional funding to help carry the projects through final design, fabrication, and installation.

Offshore wind power prices have generally increased over time. For projects installed in 2012 (for which data was available), the average reported capital cost was $5,384/kW. These cost increases are a function of several factors (e.g., a movement toward deeper-water sites and increased siting complexity); however, potential technological advancements aim to help slow and eventually reverse the trend. In addition to advancements in equipment and installation approaches, improved capacity factors may help further mitigate increased capital costs through better energy capture and conversion.

The average nameplate capacity of offshore wind turbines installed globally each year has grown from 2.9 MW in 2007 to 4.1 MW in 2012. This trend toward larger turbines will likely continue, driven by advancements in materials, design, processes, and logistics, which allow larger components to be built with lower system costs. The average turbine size for advanced-stage, planned projects in the United States, however, is expected to range between 4 and 5 MW, indicating that the United States is largely planning to utilize larger offshore turbines rather than smaller turbines that have previously been installed in European waters.

Globally, offshore wind projects continue to trend further 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.

Approaches to drivetrain configurations continue to diversify in an effort to improve reliability and reduce exposure to volatile supplies of the rare earth metals required for direct drive generators. The high costs of addressing past turbine equipment failures in an offshore setting have encouraged manufacturers and developers to continue seeking more robust drivetrain configurations. However, recent interest in direct-drive turbines has been somewhat tempered by limited supply and price volatility for several rare earth metals. As a result, several prototypes of machines employing alternate drivetrain designs are expected to be tested in the next two to three years.

The general trend toward diversification of substructure types also continued in 2012 and 2013, as the industry seeks to address deeper waters, varying seabed conditions, increasing turbines sizes, and the increased severity of wind and wave loading at offshore wind projects. However, alternatives to the monopile and gravity-based approaches have only seen limited deployment since 2009, with a total of 350 units installed through the end of 2012 (out of an overall 1,725 units globally). To date, only two full-scale prototype floating foundations have been installed globally.

Few new developments have occurred with regard to vessels, logistics, and the operations and maintenance (O&M) of offshore wind farms since the previous edition of this report. In general, increased turbine size, plant size, and distance from shore all have direct consequences on vessel requirements and availability, as well as on O&M practices. These trends will add to the logistical difficulties of maintaining offshore turbines, particularly as longer distances from shore increase the challenges in accessing turbines due to weather conditions. The relatively slow ramp-up of the U.S. market will likely provide developers ample opportunity to respond to shifting vessel and O&M needs.

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. In 2013, this critical need was partially addressed through an extension of the U.S. Renewable Electricity Production Tax Credit (PTC), the Business Energy Investment Tax Credit (ITC), and the 50 percent first-year bonus depreciation allowance. In addition, the U.S. DOE announced seven projects that will receive up to $4 million each to complete engineering and planning as the first phase of the Offshore Wind Advanced Technology Demonstration Program. On the state level, the Maryland Offshore Wind Energy Act of 2013 established Offshore Wind Renewable Energy Credits for up to 200 MW, requiring consideration of peak load price suppression and limiting rate impacts.

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 2013, there were few tangible milestones in this area, 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 2013, BOEM held the first two competitive lease sales for renewable energy in U.S. federal waters off the shores of Rhode Island and

[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.

Virginia. On the state level, Illinois passed the Lake Michigan Wind Energy Act, which requires the Illinois DNR to develop a detailed offshore wind energy siting matrix for Lake Michigan.

Section 3. Economic Impacts

Current employment levels could be between 150 and 590 full-time equivalents (FTEs), and current investment could be between $21 million and $159 million. 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 to $3.72/MMbtu in October 2013[3] and may continue to rise with three new liquefied natural gas plants recently approved.

In terms of coal, Navigant analysis reveals executed and planned coal plant retirements through 2017 that exceed 37 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 wind. As such, continued coal plant retirements could increase the demand for offshore wind plants in the United States.

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[3] U.S. Energy Information Administration Daily Energy Prices, October 16, 2013 (http://www.eia.gov/todayinenergy/prices.cfm).

1. Global Offshore Wind Development Trends

Since last year's report, additional progress has been made to develop commercial and demonstration-scale projects in U.S. waters, including the installation of the nation's first pilot-scale, offshore wind turbine. The University of Maine's 20-kilowatt (kW) turbine, resting atop a prototype floating substructure, began generating power in early June 2013. At the commercial scale, some projects that were in early planning stages last year have progressed to a more advanced stage, while other advanced-stage projects have been placed on hold or abandoned altogether. These changes reflect the continuing technology, market, and policy uncertainty surrounding offshore wind power development in the United States. To help address the particular technical challenges of developing projects in the United States, the U.S. Department of Energy (DOE) announced seven Advanced Technology Demonstration grants in December 2012, three of which will be selected for additional funding following their initial feasibility assessments.

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 2012 and into 2013, offshore wind technology has 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, this data relies primarily on developer projections and news reports and that the status and details of projects under development are subject to change.

[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 2013) and the Global Wind Energy Council (GWEC 2013).

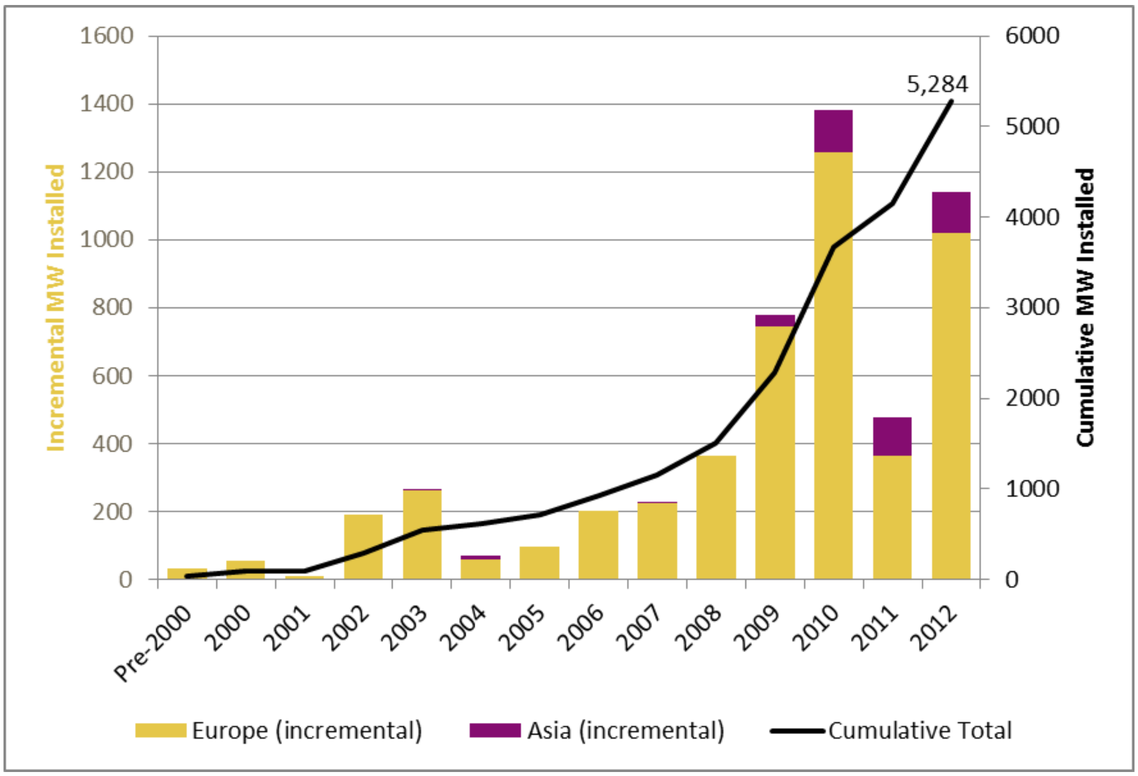
Summary of Key Findings – Chapter 1

- There are approximately 5.3 gigawatts (GW) of offshore wind installations worldwide.
- Several potential U.S. projects have achieved notable progress in the past year, with eleven projects now in advanced stages of development.
- The average nameplate capacity of offshore wind turbines installed globally each year has grown from 2.88 megawatts (MW) in 2007 to 4.03 MW in 2012.
- Globally, offshore wind projects continue to trend further from shore into increasingly deeper waters, resulting in correspondingly higher capital costs. In parallel, however, larger turbine sizes and hub heights are contributing to higher reported capacity factors.
- Approaches to drivetrain configurations continue to diversify in an effort to improve reliability and reduce exposure to volatile supplies of the rare earth metals required for direct drive generators.
- Global trends suggest that U.S. projects are likely to continue facing difficulties in securing financing.

1.1 *Global Offshore Wind Development*

Historically, the offshore wind market has primarily focused on northwest Europe; however, the Asian market has shown signs of increasing activity over the past three years. In 2012, more than 1,100 MW of wind power capacity was added globally, bringing the cumulative global total to 5,284 MW. The majority of capacity additions occurred in European countries, with the United Kingdom alone accounting for 756 MW of new capacity.[5] Figure 1-1 summarizes the historical growth of the global offshore wind market.

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 BTM

[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 BTM's shows only 366 MW. This is likely a result of 500 MW installed in 2010 not being connected to the grid until 2011.

While capacity additions in 2012 represented a large increase over 2011, it failed to surpass the pace of capacity additions in 2010. Much of the downturn from 2010 to 2011 can be attributed to the effects of the global financial crisis, and while the upward trend has resumed annual additions continue to fall behind prior expectations. In Asia, China continues to lead in terms of capacity, with 113 MW added in 2012 and 365 MW of cumulative capacity.[6] While China previously announced plans to install 5 GW of offshore wind by 2015 (Global Wind Energy Council [GWEC] 2013), it appears decreasingly likely that the goal will be achieved, with only 222 MW of new capacity expected for 2013.[7] 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 Installed Global Offshore Capacity through 2012

Region	Country	Number of Operational Projects	Total Capacity (MW)	Total Number of Turbines Installed
Asia	China	13	365	138
	Japan	5	28	16
	South Korea	2	5	2
Europe	Belgium	3	380	91
	Denmark	16	875	406
	Finland	3	32	11
	Germany	7	286	69
	Ireland	1	25	7
	Netherlands	4	247	128
	Norway	1	2	1
	Portugal	1	2	1
	Sweden	5	164	75
	United Kingdom	24	2,874	850
	Total	**85**	**5,284**	**1,795**

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 BTM

As shown in Table 1-1, the United Kingdom continues to lead the market, with 2,874 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 2013 in Belgium, Denmark, Germany, Sweden, and the United Kingdom. In fact, these new and expanding projects will likely contribute to a record-setting year, with up to 2,900 MW expected to be installed before the end of 2013 (mostly in Germany and the United Kingdom).

[6] Notably, 251 MW of that capacity comprises inter-tidal projects, some of which were installed using methods more similar to land-based wind farms.

[7] As of September 2013.

Apart from China's 365 MW in the Asia region, Japan and South Korea have installed a combined 33 MW of demonstration-scale projects, with more under construction or planned. Like China, other Asian countries have announced ambitious plans for growing their offshore wind markets. Taiwan has set a target of 600 MW by 2020 and 3 GW by 2030, while the South Korean government set a target of 1.5 GW by 2019, with an eventual goal of 2.5 GW (GWEC 2013).

Despite announced goals and targets, uncertainty around the political, economic, and supply-chain factors influencing the global offshore wind market causes various forecasts and predictions for future activity to range widely. 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; BTM 2012; Douglas-Westwood 2013).

1.2 U.S. Project Development Overview

Since the last edition of this report, several potential U.S. offshore wind projects have achieved notable advancements in their development processes. In addition to two BOEM commercial lease auctions for federal Wind Energy Areas (WEAs), other, later-stage, commercial-scale projects have made incremental progress toward starting construction. On the demonstration project front, the DOE awarded seven Advanced Technology Demonstration (ATD) project grants in December 2012 that will help address ongoing challenges and cost barriers to offshore wind energy. In addition, in June 2013, the University of Maine (in partnership with the DOE) installed the United States' first offshore wind turbine, a 1/8-scale pilot turbine on a floating foundation. This section provides an overview of these and other updates to U.S. offshore wind project developments.

The United States is still awaiting the installation of its first commercial-scale offshore wind project; however, several developers continue to push forward on previously announced project plans. While several dozen potential projects have been announced over the past five years, this report focuses on those that have reached what Navigant considers to be an advanced stage of development. This "advanced stage" includes projects that have accomplished at least one of the following three milestones:

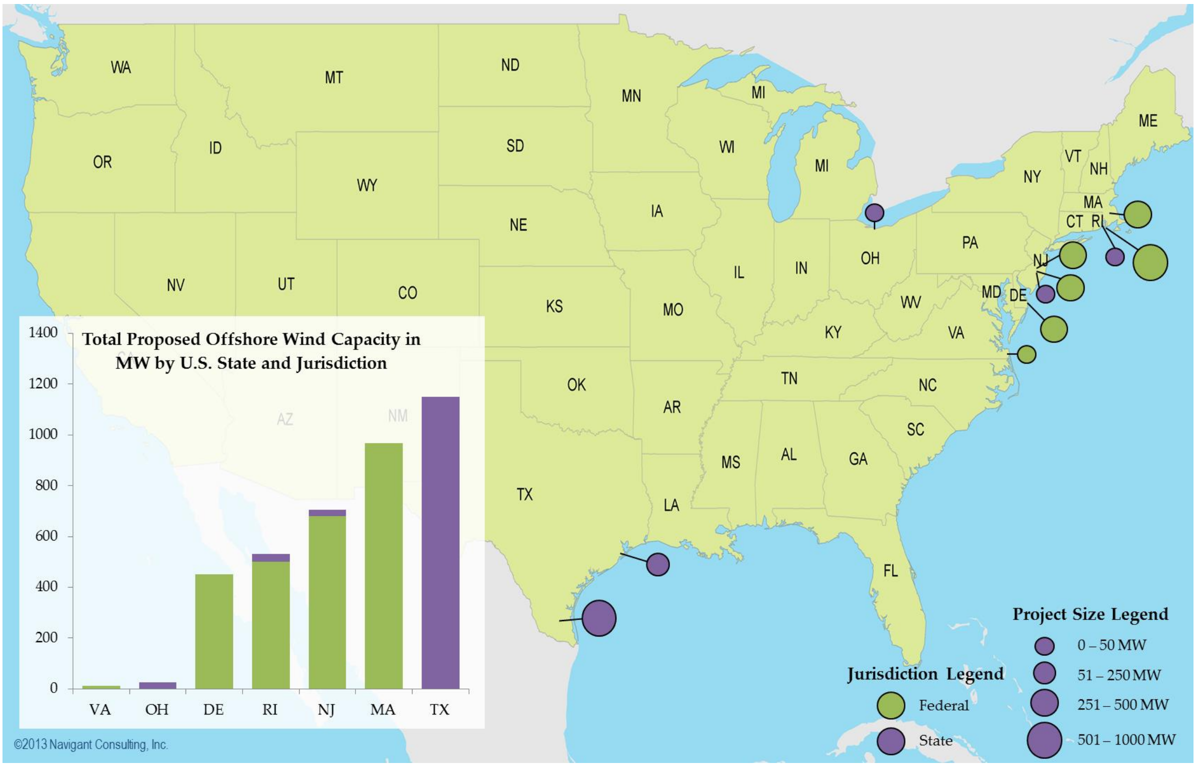
- Received approval for an interim limited lease or a commercial lease in state or federal waters
- Conducted baseline or geophysical studies at the proposed site with a meteorological tower erected and collecting data, boreholes drilled, or geological and geophysical data acquisition system in use
- 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.

In addition, some advanced-stage projects may be relatively inactive, 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, capacities, and recent activities for each of eleven advanced-stage projects appears in Figure 1-2.

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



Note: One potential project (the Deepwater Wind Energy Center) spans federal waters off the coasts of Massachusetts and Rhode Island; this map splits its estimated 1,000-MW capacity between the two states.
Source: Navigant analysis

These eleven projects represent 3,842 MW of planned capacity. As shown in the figure, roughly two-thirds of this potential capacity lies in federal waters (i.e., typically outside a three-nautical-mile state boundary). Notably, this represents a reversed trend from two years ago, when a greater share of advanced-stage planned capacity lied within state waters. This shift arose in part from developments in federal leasing activities, as well as a refocusing of development efforts in Texas state waters (the federal water boundary in Texas lies further out at nine nautical miles). Table 1-2 provides additional details about each of the eleven 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.

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

Project Name (State)	Proposed Capacity (MW)	Turbines (#)	Distance to Shore (Miles)	Average Water Depth (m)	Projected Turbine Model	Status Notes	Target Completion Date[b]
Block Island Offshore Wind Farm (Deepwater) (RI)	30	5	3	22	Siemens SWT 6.0-120 (6 MW)[a]	National Grid has agreed to a 20-year PPA. U.S. Army Corps of Engineers environmental studies completed. Submitted final state and federal permit applications in October 2012. Developers recently proposed an alternate location for the project's export cable at Scarborough State Beach after a proposed landing was rejected by the Town of Narragansett.	2015
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. Invited to negotiate contract with DOE for an initial award under the Wind and Water Power Program in 2012. Geotechnical surveys completed. DOE ATD grant recipient.	2015
Fisherman's Energy: Phase I (Atlantic City Wind Farm)(NJ)	25	5	3	11.5	XEMC-Darwind XD115 (5 MW)	Fully permitted. Completion date unclear after the New Jersey Board of Public Utilities denied a settlement agreement between Fisherman's and the NJ Division of Rate Counsel over concerns about the project's potential ratepayer impacts (July 2013). DOE ATD grant recipient.	2015
Cape Wind Offshore (MA)	468	130	10	10	Siemens SWT 3.6-107 (3.6 MW)[a]	Approved for federal waters; commercial lease offered in April 2010. Commenced geotechnical and geophysical survey operations in July 2012. PPA in place for 77.5% of project's power through National Grid and NStar (with contingency that construction begins by end of 2015).	2016
Dominion Virginia Power - Virginia Offshore Wind Technology Advancement Project (VA)	12	2	23.5	26	Alstom Haliade 6 MW	In February 2013, Dominion submitted an unsolicited research lease application for an area off the coast of Virginia. In September 2013, the group was the winning bidder in the second competitive lease sale for an adjacent U.S. offshore wind area. DOE ATD grant recipient.	2017
Fisherman's Energy: Phase II (NJ)	330	66	7	17.5	XEMC-Darwind XD115 (5 MW)	Received a meteorological tower rebate from the state and began baseline surveys in August 2009. Has interim lease for initial assessment of wind farm feasibility.	2018

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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. Announced intention to install a 750-kW test turbine.	2018
Baryonyx Rio Grande Wind Farms (North and South) (TX)[c]	1000	100-200	7.8	20.5	Siemens SWT 6.0-120 (6 MW)[a]	Received lease from Texas General Land Office in 2009. Army Corps of Engineers environmental studies underway. DOE ATD grant recipient.	2019
Garden State Offshore Energy Wind Farm (NJ)	350	58-70	20	27	(5 or 6 MW)	Awarded interim limited lease; began baseline surveys in 2009. State funding pulled in October 2012 because of inaction. Launched state-of-the-art buoy to study offshore weather conditions in November 2012.	2019
Deepwater Offshore Wind Energy Center	1000	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.	2019
NRG Bluewater's Mid-Atlantic Wind Park (DE)	450	150	12.7	20	3 MW	Received one of the first U.S. offshore leases (non-competitive) from BOEM in October 2012 as part of "Smart from the Start" program; however, Delmarva had canceled a PPA for 200 MW of the power. The project website states that the project is officially on hold, and it is unclear whether Bluewater will develop or sell the project.	2020

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.

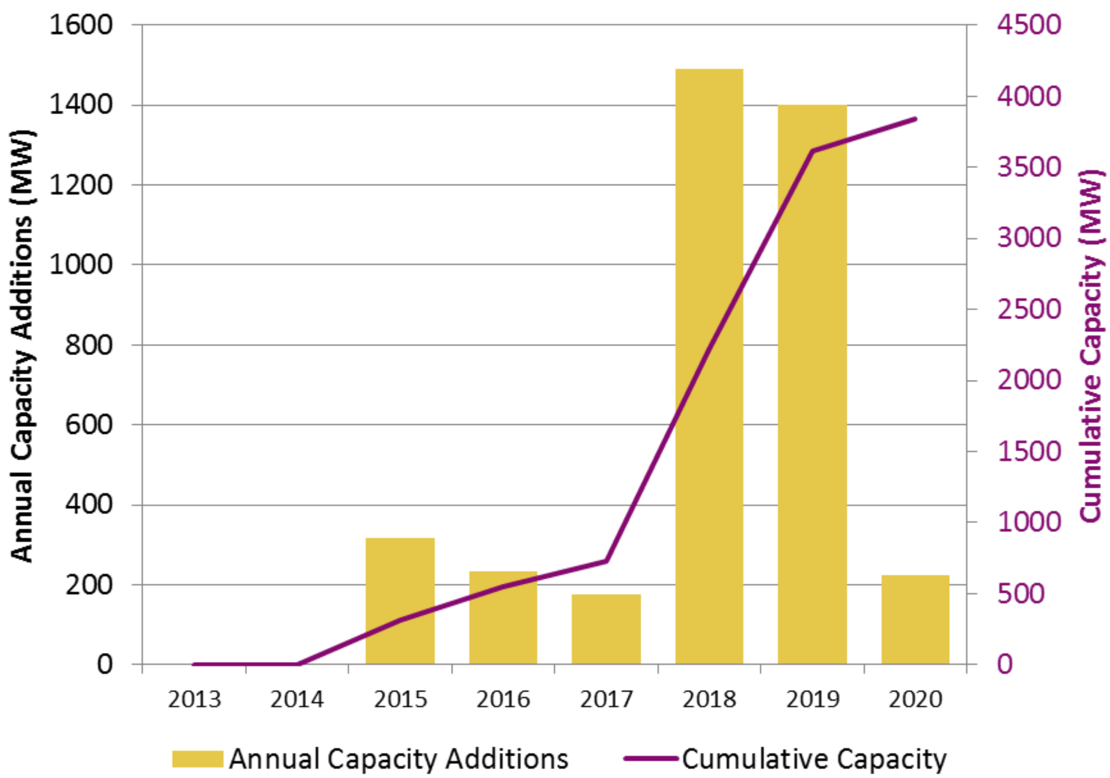
c) Leasing and permitting requirements for projects in Texas state waters do not involve the Federal Energy Regulatory Commission (FERC) or the BOEM Minerals Management Service and may move more quickly than projects in federal waters.

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

1.2.1 Forecast Capacity and Completion Dates

According to developer statements, seven of the eleven projects have target completion dates before the end of 2018, and developers for three of the projects——Block Island, Cape Wind, and Fisherman's Energy I—continue to compete to be the first commercial-scale offshore wind farm online in U.S. waters. Given global historical trends, however, it is unlikely that all eleven of these projects will achieve these targets, 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 eleven of these projects ultimately move forward.

Figure 1-3. Growth Trajectory for U.S. Offshore Wind Based on Forecast Construction Dates



Source: Navigant analysis of collected project data

In addition to these advanced-stage projects, the DOE-supported ATD projects will continue to make progress over the next few years. 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 the development of U.S. offshore wind projects since the last edition of this report.

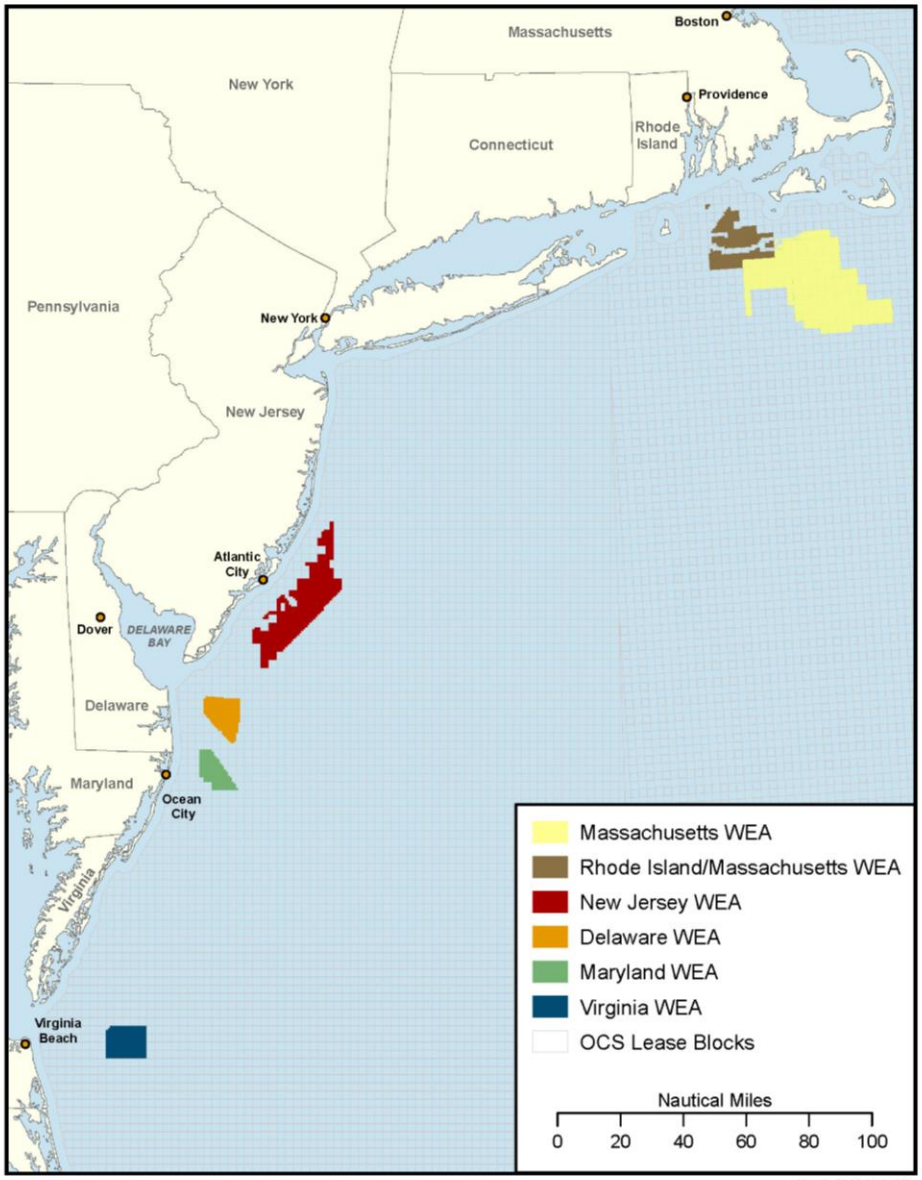
1.2.2.1 BOEM Advancements and Leasing Activities

The 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.[8] Notably, in October 2012, it issued its first non-competitive commercial lease to NRG Bluewater Delaware for the intended site of its 450-MW Mid-Atlantic Wind Park. However, as noted in Table 1-2, NRG's anticipated initial off-taker, Delmarva Power, had previously cancelled its PPA for the project. It is yet unclear what steps, if any, NRG will take to move the project forward.

In 2013, BOEM also made significant progress in assessing the suitability of and interest in each of six WEAs. 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 these six areas.

[8] 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 2012

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 mid-2013, it held its first two competitive auctions and awarded leases for two of these WEAs. On July 31, 2013, Deepwater Wind New England LLC submitted the winning bid for two leases within the Rhode Island/Massachusetts WEA, and it subsequently signed the lease on September 20. On September 4, 2013, Virginia Electric and Power Company (doing business as Dominion Virginia Power) won the second BOEM competitive lease for the Virginia WEA. Award of each lease enables the lessee to move forward with its site assessment plans and subsequent construction and operations plans.

Since the fall of 2012, BOEM has also received and responded to several unsolicited lease requests for project sites related to three of the DOE ATD projects. Key activities include the following:

» In December 2012, BOEM issued a notice of no competitive interest for a previously submitted (October 2011), unsolicited commercial lease submitted by Statoil for a site in Maine related to its Hywind demonstration project.
» In February 2013, the Commonwealth of Virginia Department of Mines, Minerals and Energy (DMME), in partnership with Dominion Virginia Power, submitted its second unsolicited research lease request for an area related to the Dominion ATD project.
» In May 2013, Principal Power submitted an unsolicited application for a site in Oregon for its WindFloat Pacific Pilot Project

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

1.2.2.2 Cape Wind – Focus on Financing and Year-End Construction Start

The 468-MW Cape Wind Offshore wind project has continued to press forward despite its long history of public comment, technical reviews, and legal challenges. A significant milestone for the project was the Massachusetts Department of Public Utilities' approval of Cape Wind's PPA with NSTAR in November 2012. The NSTAR PPA is for 27.5 percent of Cape Wind's power that, when combined with National Grid's PPA for 50 percent, represents the majority of the project's output. Subsequent attention turned to solidifying financing for the project, and developers confirmed a $200 million investment from PensionDanmark, a Danish pension fund, in July 2013. The project has also indicated tentative commitments from the Bank of Tokyo-Mitsubishi UFJ (which is coordinating the project's financing) and Siemens (the projects' turbine supplier), but specific dollar amounts are not confirmed. Notably, the PensionDanmark investment is conditioned on Cape Wind securing the remainder of its $2.6 billion financing and beginning construction by the end of 2013, which is the deadline for the project to take advantage of the federal Investment Tax Credit (Lindsay 2013, McKenna 2013).

1.2.2.3 Fishermen's Energy I (Atlantic City Wind Farm) – Subsidies, Costs and Rate Impacts

As one of the other more advanced offshore projects, Fishermen's Energy Atlantic City Windfarm was making encouraging progress before encountering a series of decisions in 2013 that have further delayed the proposed 25-MW pilot project. As the project sought to qualify for New Jersey ratepayer-funded subsidies, the New Jersey Division of Rate Counsel has opposed the project, citing concerns about the potentially high costs to ratepayers (Johnson 2013). In an attempt to reach a settlement on the issue, the developers submitted a filing to the Division in March 2013, which the Division subsequently accepted and endorsed to the New Jersey Board of Public Utilities (BPU). In mid-July, however, the BPU rejected the settlement, citing several specific objections related to potential ratepayer impacts and benefits (Milford 2013). The BPU gave the developers an opportunity to respond to the objections, but at the time this report was published, no further agreements had been announced. Later that month, the Division of Rate Counsel filed a reply brief to the BPU's position, affirming that the project meets the "net benefits" test required by the Offshore Wind Economic Development Act (OWEDA) and urging the BPU to move ahead with the project. This issue remained unresolved as of this report's publication.

Notably, Fisherman's Energy I is also one of the DOE's ATD project grant recipients; details of the technological innovations it hopes to demonstrate appear in Section 1.2.2.3.

1.2.2.4 Block Island – Navigating Public Opposition

The third later-stage, advanced U.S. project, Deepwater's 30-MW Block Island Offshore Wind Farm, faced increasing public scrutiny and opposition in 2013. The project has completed its U.S. Army Corps of Engineers environmental studies, submitted its requisite permits, and secured a 20-year PPA from National Grid. In August 2013, the developers adjusted their plans after failing to gain approval from the Town of Narragansett for the sale of easements for the originally planned location of the project's transmission line. (Campbell 2013). As of this report's publication, Deepwater had announced a proposed alternate site for the cable to come ashore at Scarborough State Beach and was awaiting approval from the State Properties Committee (Kuffner 2013).

1.2.3 U.S. DOE Advanced Technology Demonstration Projects

This section provides a brief overview of each of the seven projects that have received DOE ATD grants. As previously stated, the DOE will provide up to $4 million to each project to complete initial engineering, planning, and feasibility assessments. The DOE will then select up to three of the projects to receive additional funding to help carry the projects through final design, fabrication, and installation. Note that some of these projects meet Navigant's advanced-stage project criteria and appear in Table 1-2.

1.2.3.1 New England Aqua Ventus I

The DeepCwind Consortium, a team led by the University of Maine (UMaine), has proposed a pilot floating offshore wind farm of two 6-MW, direct-drive turbines on concrete, semi-submersible foundations near Monhegan Island, Maine. As mentioned previously, the UMaine separately partnered with the DOE to install and connect a 1/8-scale prototype floating turbine to the grid on June 13, 2013. The 65-foot-tall prototype was designed and fabricated at UMaine; assembled at Cianbro's facility in Brewer, Maine; and towed nearly 30 miles from Brewer to Castine, Maine, by the Maine Maritime Academy. The prototype is anchored off the coast of Castine in approximately 24 meters of water and is the first grid-connected offshore wind platform in the Americas.

The Consortium will use the data acquired during the deployment of the prototype to optimize the design of UMaine's VolTurnUS floating turbines (patent pending). The VolTurnUS turbines utilize floating concrete foundations that the Consortium anticipates will result in improvements to commercial-scale production and provide offshore wind projects with a cost-effective alternative to traditional fixed steel foundations. Once scaled to full size and incorporating economies of scale (based on the number of turbines), the team hopes to reduce the cost of offshore wind to a point that it can compete (without subsidies) with other forms of electricity generation.

On August 30, 2013, UMaine filed a bid with the Maine Public Utilities Commission (PUC) to provide long-term power to the grid. As of this report's writing, anticipated next steps were for the PUC staff to review the proposal and request supplemental information prior to asking UMaine to develop a term sheet or contract. The PUC plans to decide whether to award UMaine a long-term contract before December 31, 2013.

1.2.3.2 Hywind Maine

Statoil North America of Stamford, Connecticut, planned to deploy four 3-MW wind turbines on floating spar buoy structures approximately 19 miles offshore in the Gulf of Maine in approximately 140 meters of water. These spar buoys will be assembled portside (to help reduce installation costs versus constructing offshore) in Boothbay Harbor, Maine, and then towed to the installation site to access the Gulf of Maine's extensive deep water offshore wind resources. The Hywind Project follows Statoil's first Hywind demonstration project off the coast of Norway; in 2009, Statoil installed a single 2.3 MW turbine (with an 82-meter rotor diameter) on a spar buoy with 100-meter draft to test the effects of wind and waves on a floating turbine. The project has produced 15 megawatt-hours (MWh) since startup in 2010.

In January 2013, the Maine PUC voted to support a term sheet for a 20-year 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 and UMaine submitted a similar proposal for the Aqua Ventus project. On October 15, 2013, citing increased uncertainty created by the change in legislation, as well as more general schedule challenges, Statoil announced its intent to abandon the Hywind Maine project and focus its floating offshore wind efforts on a proposed demonstration in Scotland.

1.2.3.3 Fisherman's Energy I (Atlantic City Wind Farm)

As described in Section 1.2.2.3, 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:

» First commercial use of Lockheed Martin Wind Tracer
» First commercial use of AXYS Floating Light Detection and Ranging (LiDAR) System
» 5-MW, direct drive turbine installed in an offshore environment
» New technology, post-construction, intensive avian impact studies

All necessary federal and state approvals have been issued for the proposed project, and Fishermen's Energy anticipates the project to achieve commercial operation by the fall of 2015. An update on the status of the project appears in Section 1.2.2.3.

1.2.3.4 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 off the coast of Virginia Beach. The project will utilize innovative foundations that offer the strength of traditional jacket or space-frame structures but use substantially less steel.

Several organizations are collaborating with Dominion on the project: Alstom, a wind turbine manufacturer; the Commonwealth of Virginia DMME; the National Renewable Energy Laboratory (NREL); Virginia Tech, representing the Virginia Coastal Energy Research Consortium; KBR, a global engineering and construction services firm with experience in offshore wind; Newport News Shipbuilding, a division of Huntington Ingalls Industries; and Tetra Tech, an environmental consulting firm.

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., "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. BOEM issued a Request for Competitive Interest for the research lease site in August; however, as of this report's writing, BOEM had not yet issued a Determination of No Competitive Interest. The research lease area is immediately adjacent to the western border of the Virginia WEA, shown in Figure 1-4.

1.2.3.5 Project Icebreaker

Lake Erie Energy Development Corporation (LEEDCo), a regional public-private partnership based in Cleveland, Ohio, plans to install six 3-MW, direct-drive wind turbines on "ice breaker" monopile foundations that are designed to reduce ice loading. The project will be installed on Lake Erie, approximately seven miles off the coast of Cleveland. The Ohio Department of Natural Resources (ODNR) has identified the proposed site as "favorable," and LEEDCo and ODNR have signed a land lease option for the site. LEEDCo has been collecting wind measurements at the Cleveland water intake crib, three miles offshore, since 2005. An extensive feasibility study was published in 2009, which confirmed the environmental and technical viability of offshore wind energy in Lake Erie. In 2013, the project team completed the first phase of a site-specific subsurface investigation program.

1.2.3.6 Gulf Offshore Wind (GOWind)

Baryonyx Corporation, which is based in Austin, Texas, proposed to install three Siemens 6-MW, direct-drive wind turbines in state waters near Port Isabel, Texas. The project will demonstrate an advanced jacket foundation design and integrate lessons learned from the oil and gas sector on hurricane-resistant facility design, installation procedures, and personnel safety. According to Baryonyx's CEO, a key project objective includes demonstrating how the cost of energy from offshore wind can be driven down by combining an excellent wind source and efficient large capacity turbines with the design, fabrication, and installation experience that already exists in the Gulf of Mexico.

Baryonyx has negotiated a lease with the Texas General Land Office for more than 67,000 acres of submerged state lands for three offshore wind farm sites between Corpus Christi and Brownsville. The GOWind project occupies a small portion of the 41,455-acre Rio Grande Lease Area off South Padre Island. In August 2013, Baryonyx submitted an application to the U.S. Army Corps of Engineers, Galveston District, for the construction of the three-turbine demonstration project. As of this report's writing, the application had been placed on public notice until October 18, after which time it will undergo the standard review process.

The founders of Baryonyx successfully developed the 150-MW Ormonde offshore project off the west coast of the United Kingdom using 5-MW turbines on jacket foundations.

1.2.3.7 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. Subsea cabling will export power to the planned South Dunes Power Plant, which is a combined-cycle natural gas power plant associated with the Jordan Cove Energy Project, a $7.5-billion liquid natural gas export facility currently under development at the Port of Coos Bay.

Principle Power maintains that the WindFloat design is 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

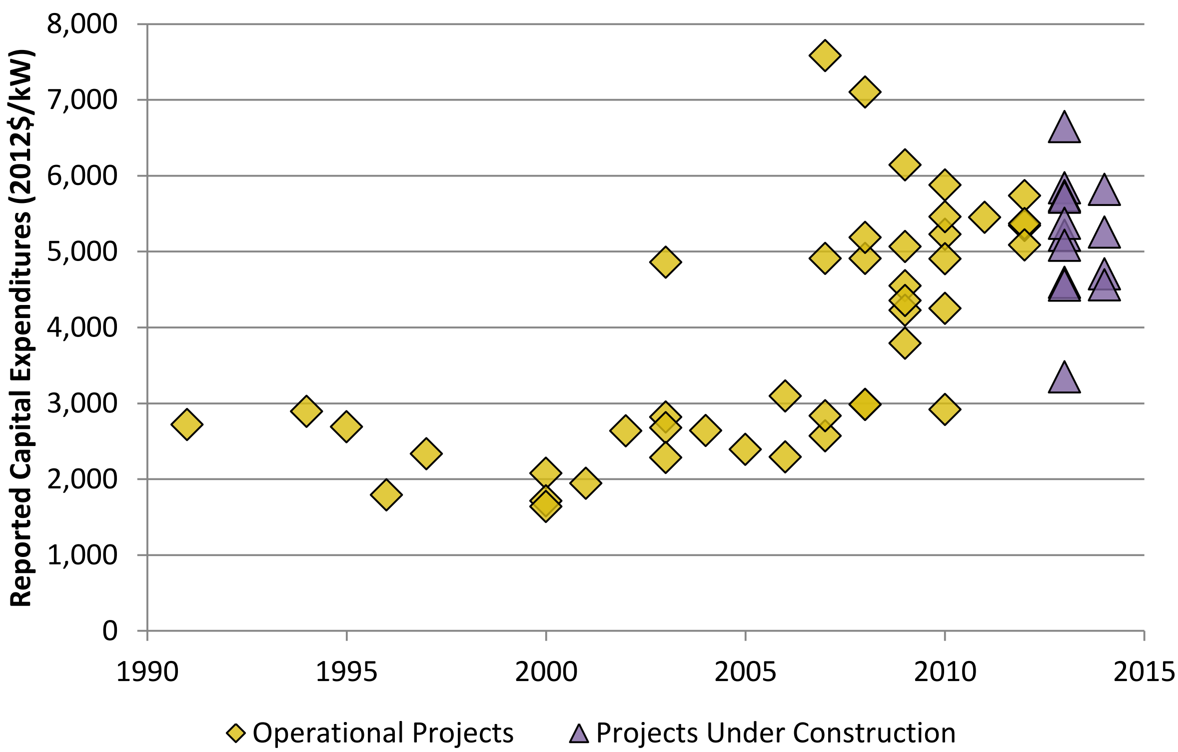
WindFloat's semi-submersible foundation includes patented water entrapment (heave) plates at the base of each of three vertical columns. A closed-loop, active water ballast system moves water between the columns in the semi-submersible foundation in response to changes in wind force and direction. This 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. The application indicated that Principle Power and Jordan Cove Energy are negotiating a PPA with a term and price sufficient to meet the economic needs of the WFP Project. As of October 2013, BOEM had determined the lease request to be complete and issued a Request for Competitive Interest to determine competitive interest in and understand what stakeholders would be affected by development of the proposed site.

1.3 *Capital Cost Trends*

Offshore wind power prices (both historical and announced costs for proposed projects) have been following a generally increasing trend (Musial and Ram 2010; UKERC 2010; Wiser et al. 2011, Navigant 2013). These cost increases are 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). Figure 1-5 shows the reported capital costs over time for both operational projects and those under construction.

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



Note: Data was 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[9]

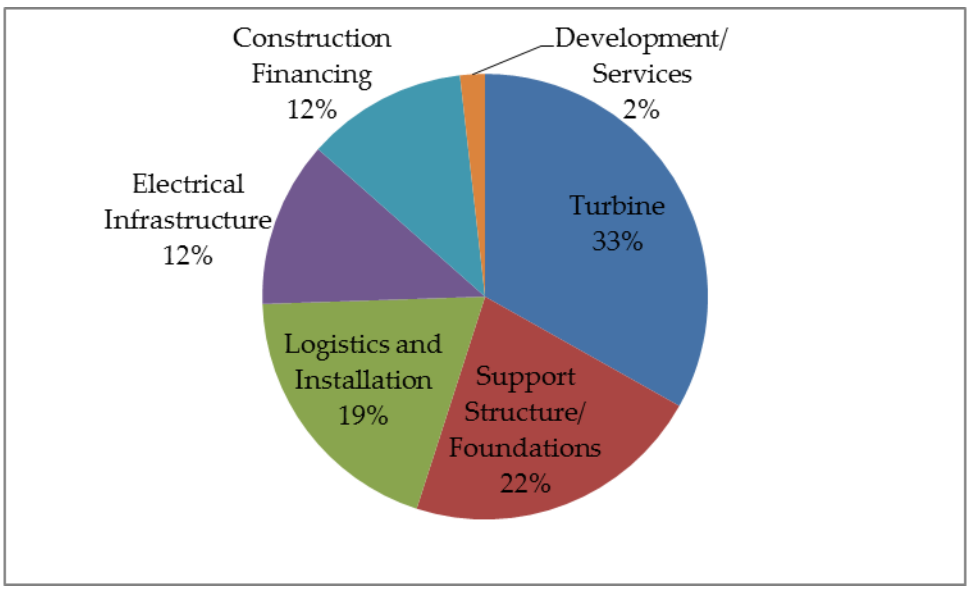
For those projects installed in 2012 for which data was available, the average reported capital cost was $5,384/kW. As will be discussed in Section 1.4, some of the key technology trends in the offshore wind

[9] 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.

market aim to help slow and eventually reverse the increasing cost trend, even as projects face greater challenges. In addition to potential advancements in equipment and installation approaches, improved capacity factors may help further mitigate increased capital costs through better energy capture and conversion.

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. For example, in Germany the costs of grid connection are borne by the transmission system operator and not by the project owner. Nonetheless, recent estimates of the capital cost for offshore wind power in the United States are on the order of $5,000/kW to $6,000/kW (Tegen et al. 2012). These capital costs are well distributed across each aspect of the project's development and construction, suggesting that improvements in each area could contribute to future cost reductions. Figure 1-6 shows the estimated all-in capital cost breakdown for a hypothetical 500-MW offshore wind farm in U.S. waters developed as part of a supply chain study Navigant published in early 2013 (Navigant 2013).

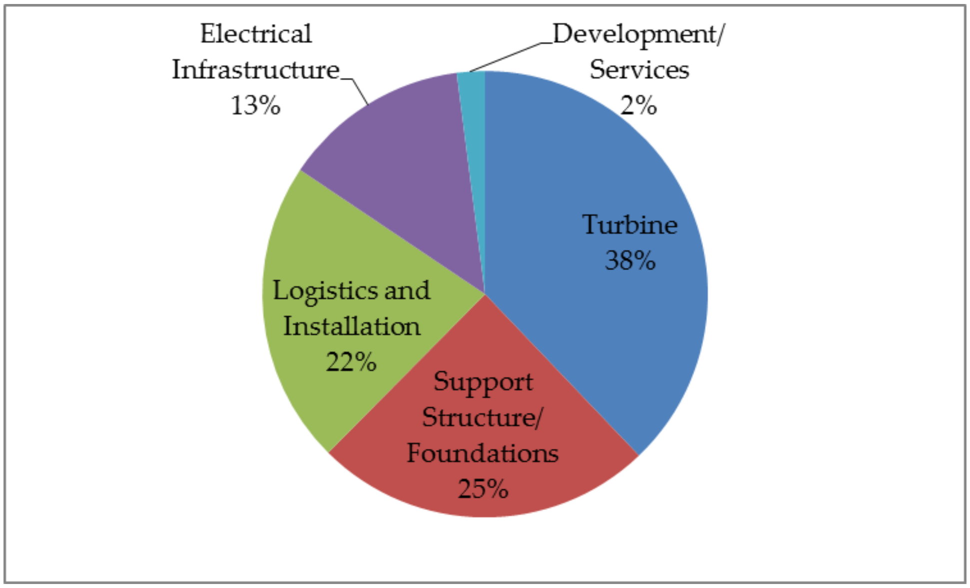
Figure 1-6. Offshore Wind Plant Capital Cost Breakdown



Source: Navigant 2013

As shown, the turbine equipment costs (including the nacelle, tower and blades) comprise the largest share (33 percent) of the capital cost, with the foundation and substructure representing an additional 22 percent. Notably, the bottom-up estimates conducted for this study resulted in construction finance-related costs that comprise 12 percent of the overall plant capital cost (see Navigant 2013 for a detailed list of these estimated costs). Some offshore wind studies, however, exclude construction financing costs from their capital cost analyses. Figure 1-7 presents a similar breakdown of overnight capital costs (which exclude construction financing).

Figure 1-7. Offshore Wind Plant Capital Cost Breakdown (without Construction Financing)



Source: Navigant 2013

As shown, under this assumption, the turbine's share of the overall capital cost (before installation) jumps to 38 percent, while the foundation and substructure increases to 25 percent.

1.4 *Market Segmentation and Technology Trends*

As noted in the previous 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 further offshore into deeper waters. 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

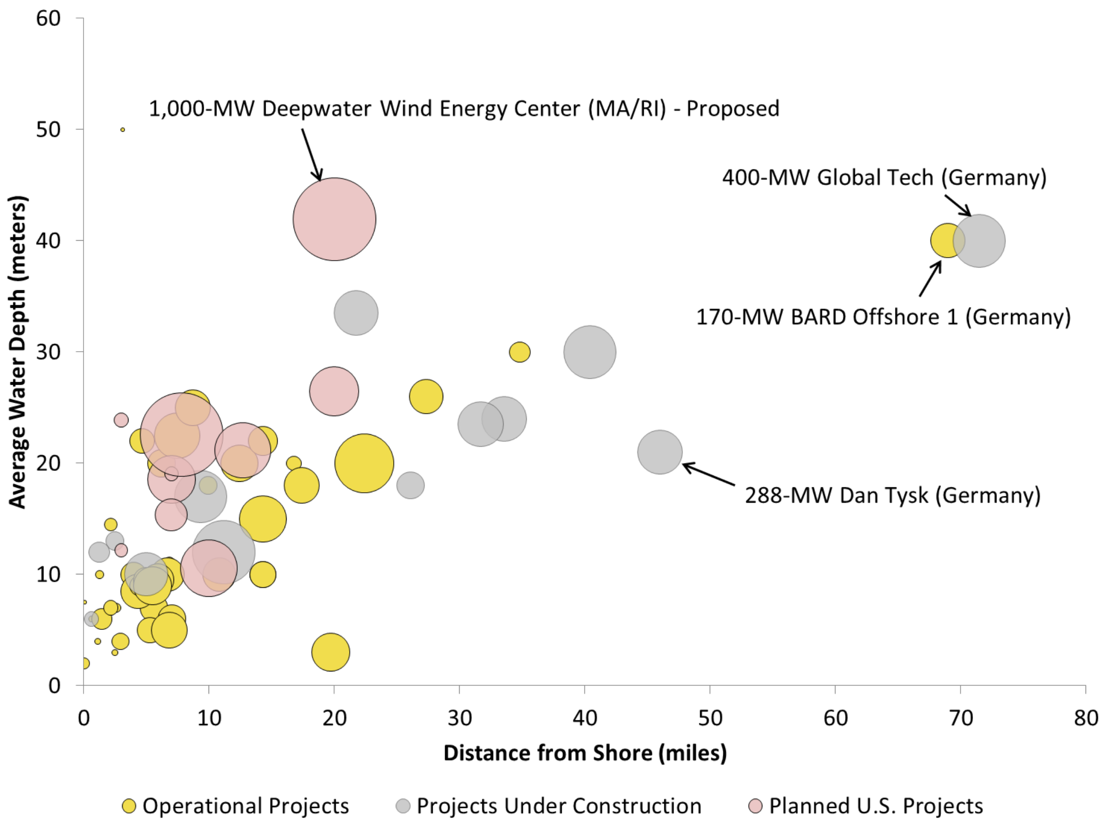
As noted above, developers are increasingly building offshore wind plants further from the coast and in deeper waters. A project's distance is commonly measured from the approximate center point of the developed area to the nearest point of land. While this metric approximates the relative likelihood that a project is visible from land, other measured distances have a greater influence on a project's cost and operation. The distance to the point of interconnection, for example, directly impacts the material and construction cost of the project's export cable and factors into line-loss calculations for the exported energy. Similarly, distances to the nearest construction and service ports impact, respectively, costs of installation and ongoing O&M costs. For simplicity, this report focuses on the average distance from shore metric, which generally reflects the trends of all three distances. Figure 1-8 illustrates the average distance from shore for each global offshore wind project based on the year in which it was installed.

Figure 1-8. Average Distance from Shore for 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.
Source: Navigant analysis of data provided by NREL and BTM

As shown above, an increasing number of projects have been installed in waters greater than 10 and even 20 miles from shore since 2009, with many more currently under construction. For commercial-scale projects with capacity additions in 2012, the average water depth was about 23 meters, and the average distance from shore was 24 miles. Logically, these greater-distance project sites generally entail increasing water depths, adding to the challenges faced in a project's design and construction. Figure 1-9 shows the relationship between average distance from shore and average water depth for global offshore wind projects (both operational and under construction), as well as planned U.S. projects in advanced stages of development.

Figure 1-9. 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.

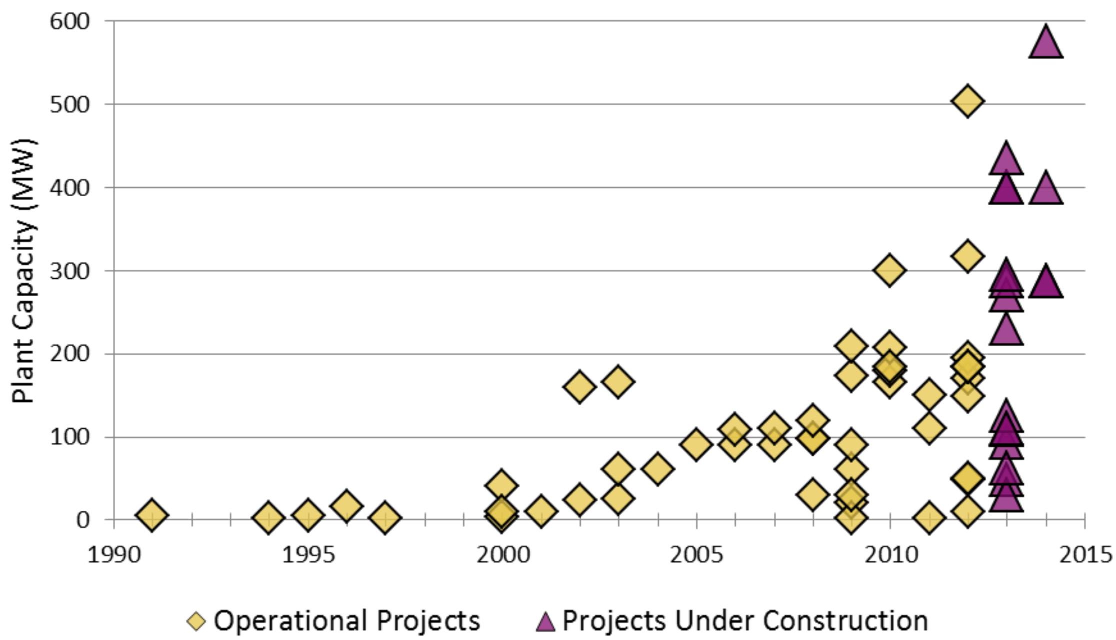
Source: Navigant analysis of data provided by NREL and BTM

As shown in Figure 1-9, several projects currently under construction (particularly in Germany) are continuing to push into more distant and deeper waters. Advanced-staged projects in the United States are generally planned for closer to shore than more recent European projects; however, some are sited in relatively deeper waters. Notably, some of the BOEM 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.

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 1-10 illustrates the increasing trend in plant sizes over time for both operational projects and those under construction.

Figure 1-10. 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.
Source: Navigant analysis of data provided by NREL and BTM

As shown in Figure 1-10, the cumulative average capacity for projects completed from 2010 through the end of 2012 is approximately 173 MW.[10] By comparison, the average per-project capacity for installations currently expected to reach completion in 2013 or 2014 is 247 MW, suggesting that the average developed area for these projects is also increasing. 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 shown a slow but steady increase in reported capacity factors over time, as illustrated in Figure 1-11.

[10] 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)

Figure 1-11. 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.
Source: Navigant analysis of data provided by NREL and BTM

1.4.3 Turbine Trends

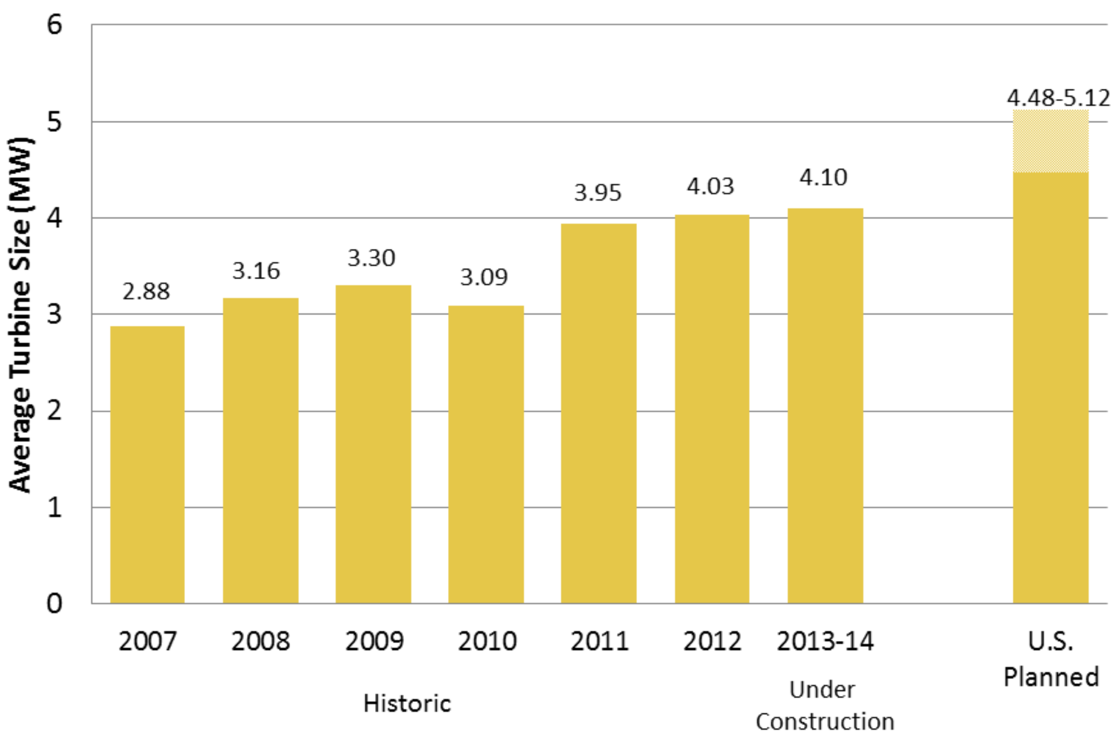
The first generation of commercial wind turbines installed offshore were essentially marinized versions of land-based machines. As turbine manufacturers gained experience, and as the size of the market for offshore wind turbines expanded, they began to introduce new turbine models designed specifically to address offshore design conditions and requirements. Offshore wind turbine models are now diverging from their land-based counterparts, due to differing system value drivers (e.g., balance of station costs represent 70 percent of offshore wind energy capital costs versus 30 percent for land-based) and fewer logistical constraints for offshore wind turbines (e.g., scaling of land-based machines is often limited by transportation considerations).

Offshore specific designs have also shown an accelerated scaling trend compared to land-based machines. Modern land-based machines range from roughly 1.5 MW to 3.0 MW, employ rotors ranging from 70 to 120 meters, and stand on towers that are typically 80 meters or higher (Wiser and Bolinger 2013). Compared to an average 2-MW capacity in 2000, today's offshore machines have grown to sizes ranging from 3 MW to 6 MW, employ rotors in excess of 120 meters in diameter, and stand with hub heights of between 70 and 100 meters. Machines in the prototype or advanced design phase imply that the trend will continue, with capacities of between 4 MW and 8 MW. These machines, which are expected to become commercially available in the 2014 to 2016 timeframe, also explore a variety of innovative drivetrain and generator configurations that aim to increase capacity and reliability while minimizing tower top mass (i.e., rotor plus nacelle).

1.4.3.1 Turbine Capacity

The average nameplate capacity of offshore wind turbines installed between 2007 and 2012 ranged from 2.88 MW to 3.30 MW.[11] Since then, the average size of newly installed turbines has steadily increased to 4.03 MW as projects have increasingly deployed 3.6 MW and 5 MW turbines (210 and 18 units, respectively, in 2012). 2012 also saw the first installation of REpower's 6.15-MW turbine at Belgium's Thornton Bank Phase II project site. Figure 1-12 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.

Figure 1-12. 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.
Source: Navigant analysis of data provided by NREL and BTM

As shown in Figure 1-12, this trend toward larger turbines will likely slow over the next two years, with the average turbine size for known projects under construction totaling 4.10 MW. However, the upward trend will likely resume toward 2018 as developers begin deploying more 5-MW or 6-MW turbines. As

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

illustrated in Figure 1-12, this will likely include several U.S. advanced-stage projects, which are expected to have an average capacity of 4 to 5 MW.

The drivers for this offshore wind turbine scaling are compelling, with potential for significant economic efficiencies for both the turbine and the plant as a whole. For example, turbine economies of scale may arise from components that do not vary in cost in direct proportion to turbine size, such as controls and foundations (EWEA 2009a). Advancements in materials, design, processes, and logistics have also allowed manufacturers to build larger components while lowering system costs (EWEA 2009a). For components like blades and towers, the costs of which would theoretically increase in proportion to turbine size, such innovations have mitigated the otherwise expected cost increases. This allows turbines to achieve significant energy capture improvements via higher hub heights and larger rotors (Lantz, Wiser, and Hand 2012). Offshore wind turbines also avoid many of the size constraints of land-based turbines, due to the potential for portside manufacturing and marine transport. The trend toward siting projects further from population centers also reduces concerns that can constrain the design of land-based machines, including shadow flicker, noise emissions, and visibility impacts.

Notably, the cost drivers for offshore wind plants are weighted significantly more toward balance of plant procurement and installation relative to the land-based wind cost drivers. Such balance of plant costs represents approximately 70 percent of capital expenditures for offshore wind plants, compared to only 30 percent for land-based projects (Tegen et al. 2012). Greater turbine size also enables fewer units to achieve the same installed capacity, helping to reduce total installation and balance of plant costs on a $/kW basis. Increasing the size of individual generating units can also lead to fewer site visits for preventative and corrective maintenance activities, representing a significant advantage given the difficulties of accessing turbine in harsh open-ocean conditions (van Bussel and Bierbooms 2003).

Given these drivers, turbine scaling will continue to play an important role in offshore wind technology. A number of wind turbine manufacturers, industry consortia, and academic research groups continue to explore the technical and economic feasibility of very large turbine designs, with rated capacities above 8 MW (BVG Associates 2012). Several of these entities have announced conceptual designs for large machines, including, among others, American Super Conductor (10 MW), Azimut Consortium (15 MW),[12] GE (15 MW), Goldwind (10 MW), Guodian United Power (12 MW), Mecal (12 MW), Sinovel (10 MW), and Sway (10 MW). Furthermore, the Upwind project explored the technical feasibility of a 20-MW wind turbine concept and found no significant problems, provided that key technologies can be developed and integrated into the system to offset or mitigate the mass increases that would be assumed from classical scaling theory (EWEA 2011).

The turbine concepts in the development pipeline today (and those machines envisioned for future development) will require a vast array of technical innovations throughout the turbine as well as in foundations, installation strategies, balance of plant equipment, and O&M practices. Advancements in manufacturing will be needed as the castings and bearings for such large turbines push the limits of

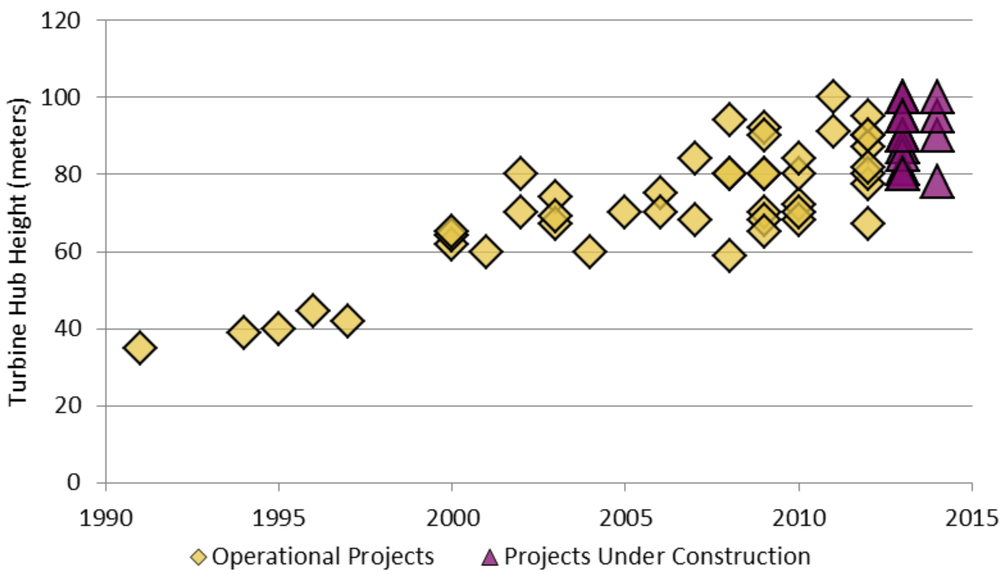
[12] The Azimut Project is a Spanish research consortium composed of major industrial companies (including Gamesa, Acciona, Alstom, Iberdrola Renovables, as well as 22 research organizations) that aims to develop a 15-MW wind turbine for the 2020 timeframe (Gamesa 2010).

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. Possible changes in design architecture and an ability to withstand a wider array of design considerations, including hurricanes, surface icing, and rolling and pitching moments associated with deployment on floating platforms, will also likely be needed.

1.4.3.2 Hub Height and Rotor Diameter

Increasing hub heights and larger blade designs have accompanied the continuing trend toward larger turbine sizes. Taller towers allow developers to access the increased wind speeds that occur at higher elevations, while larger blades increase each turbine's swept area. In combination, these factors can capture more energy at a particular turbine location. Figure 1-13 and Figure 1-14 show the hub height and rotor diameters, respectively, of global offshore wind projects over time.

Figure 1-13. 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.
Source: Navigant analysis of data provided by NREL and BTM

Figure 1-14. 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.
Source: Navigant analysis of data provided by NREL and BTM

Various improvements to blade technologies, including manufacturing processes, design configurations, and use of innovative materials, have enabled the increase in rotor diameter over time that is shown in Figure 1-14. These longer blades have played a key role in enabling manufacturers to build larger machines (see Figure 1-12) and have contributed to the higher capacity factors observed for offshore wind projects (see Figure 1-11).

As with turbines, Navigant expects average rotor diameters to continue to scale upward; in 2012 and 2013, a number of wind turbine manufacturers announced the fabrication and testing of blade prototypes that exceed the previous record of 61.5 meters. In 2012, Siemens and Alstom began testing blades for their 6-MW machines on test turbines at land-based sites. These blades reach approximately 75 meters in length and correspond to rotor diameters exceeding 150 meters. The Siemens blade uses a glass-reinforced epoxy resin with an innovative, one-piece manufacturing process. The blade designed by LM Windpower, the Alstom machine's supplier, employs glass-reinforced polyester resin, which the manufacturer suggests offers improved infusion and curing characteristics relative to epoxy resin (Siemens 2012; de Vries 2011). Interestingly, neither of these record-breaking blades incorporates carbon fiber into its design.

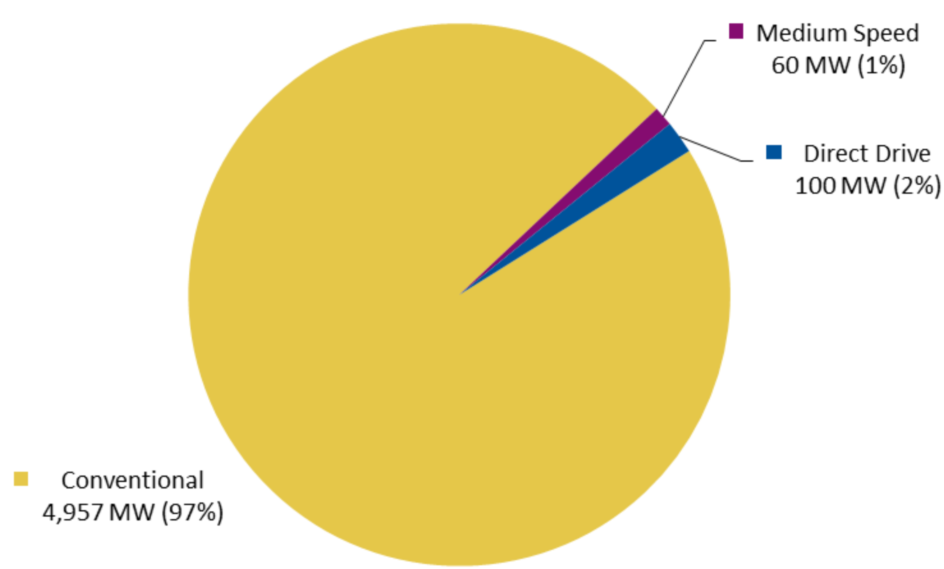
In 2013, Mitsubishi, Vestas, and Samsung began testing blades that exceed 80 meters for their next generation of 7-MW and 8-MW machines. The Mitsubishi blade, developed by Euros, incorporates carbon-reinforced epoxy resin into its design (to reduce weight) and innovative core materials gleaned from the aerospace industry (de Vries 2013a). Vestas has also chosen to use carbon in its blade design, having switched to an innovative structural shell design philosophy (rather than the conventional internal spar structure) wherein the blade shell absorbs structural loads (de Vries 2013b). The Samsung blade, developed by SSP Technology, also uses carbon and holds the current record for the longest blade ever produced at 83.5 meters, corresponding to a 171.2 meter rotor diameter (SSP Technology 2013).

Blade Dynamics, based in the Isle of Wight, is pushing even further with a conceptual 100-meter blade design. This design will employ carbon fiber and will use a structural shell. Blade Dynamics claims that these features will reduce weight by 40 percent relative to a conventional glass fiber blade. The company has also developed an innovative manufacturing process wherein blades are constructed in small modules rather than in single lengths, a process it claims will reduce costs and increase quality. Blade Dynamics recently won a £15.5-million investment from the Energy Technologies Institute in the United Kingdom to mature the technology and plans to develop a prototype by year-end 2014 (Blade Dynamics 2013).

1.4.3.3 Drive Train Characteristics

The shift to more distant locations and larger capacity turbines, along with a desire to minimize tower top mass, has contributed to innovations in drive train configurations. As shown in Figure 1-15, offshore wind turbines have historically used a conventional drive train design, incorporating a fast-speed, asynchronous generator (i.e., an induction generator) and a three-stage gearbox.

Figure 1-15. Share of Cumulative Installed Offshore Wind Capacity by Drive Train Configuration (through 2012)



Source: Navigant analysis of data provided by NREL and BTM

These machines, however, have experienced a number of failures linked to their gearboxes. The costs of addressing these faults and breakdowns are exacerbated by the difficulties of accessing open-ocean sites, the costs of vessels required to perform replacements, and the revenues lost to turbine downtime. As a result, manufacturers and developers are seeking more robust drive train configurations. In the past few years, increasing interest in direct-drive turbines, which eliminate the gearbox altogether, has been somewhat tempered by limited supply and price volatility for several rare earth metals that are key components of the large permanent magnet generators (PMGs) most often used in such configurations. By the end of 2012, only 100 MW of direct-drive generators had been installed offshore, at China's Rudong Inter-tidal Project (40 Goldwind 2.5-MW turbines).

A second potential solution to the drive train reliability issue lies in a medium-speed generator-gearbox configuration, which uses fewer gearbox stages than a conventional, fast-speed generator and fewer PMGs than a direct-drive configuration. These medium-speed generator configurations result in a lower number of rotations, thereby reducing the relative wear on the drive train and turbine. By year-end 2012, only 60 MW of cumulative medium-speed generator capacity had been installed at offshore wind sites, including six of AREVA's M5000-116 (5-MW) turbines at Denmark's Alpha Ventus site and ten of WinWind's WWD-3 (3-MW) turbines at Sweden's Vänern Gässlingegrund site (all installed in 2009).

Developers' desire to reduce overall cost of energy through turbine design and selection comprises three key drivers:

- Higher-rated capacity to increase energy capture and reduced balance of plant costs
- Higher reliability to minimize the need for corrective maintenance and increase turbine availability
- Lighter weight to reduce the cost of the support structure and lower lifting requirements during installation

Turbine manufactures have responded by developing new offshore wind turbine models in a bid to capture a greater share of the growing market. A key challenge emerges when attempting to scale conventional high-speed machines to the envisioned capacities without significantly increasing top-head mass. This factor in particular has driven manufacturers (including those who have historically relied on high-speed architectures) to adopt alternative drive systems as the basis for designing next-generation turbine platforms. Table 1-3 summarizes the five main categories of drive systems currently under development.[13]

Table 1-3. Segmentation of Wind Turbine Drivetrain Architectures

Category	Description
High Speed	Drivetrain design incorporates a 3-stage mechanical gearbox; 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; ratio generally between 2:1 and 59:1; designs typically use permanent magnet generators
Direct Drive	Drivetrain design does not incorporate a gearbox (ratio of 1:1); 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)

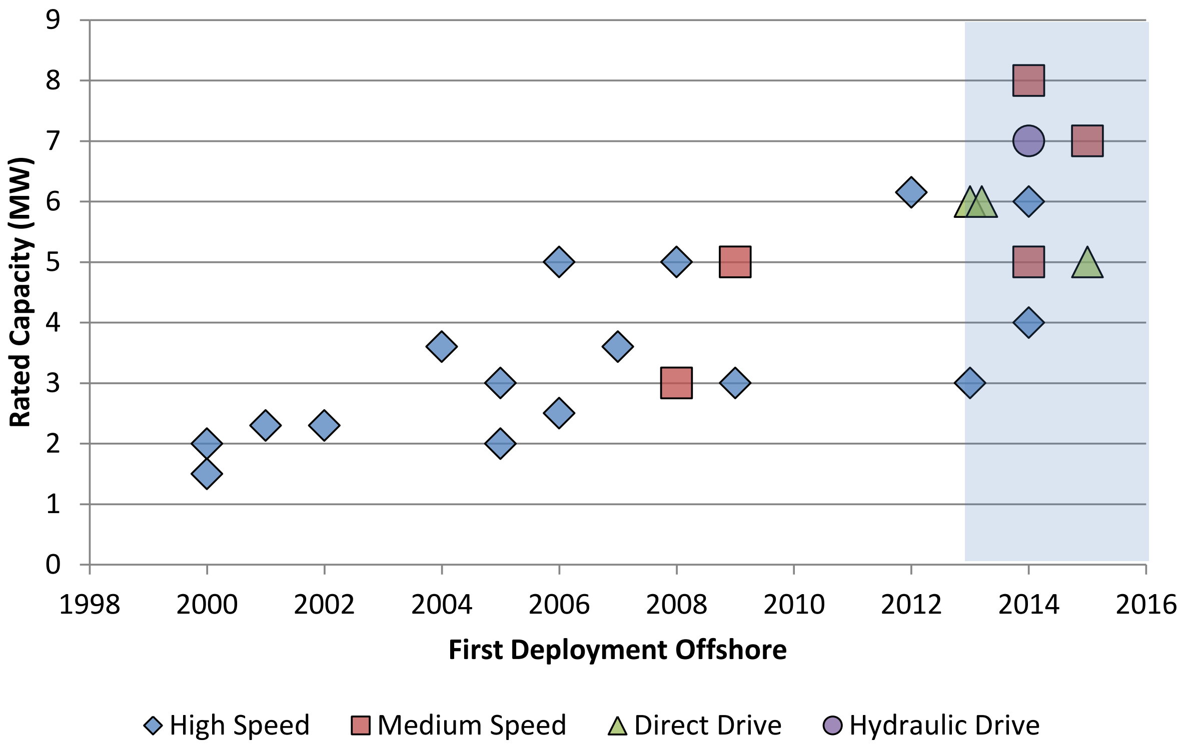
Source: Navigant analysis

Among these configurations, hydraulic drives represent the newest (and least-tested) innovation and seek to address the challenges of increasing turbine size in a different way. In essence, the objective of the hydraulic drive design is to separate the rotational speed of the rotor from that of the generator, subsequently enabling the use of standard synchronous generators without the need for a frequency converter. If the design uses a high-voltage generator, the need for a transformer is also negated. This configuration potentially allows for the elimination of components most susceptible to failure while reducing the turbine top mass (BTM Consult 2012).

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

Hydraulic drives have yet to reach commercialization either in land-based or offshore turbines; however, Mitsubishi began testing its Digital Displacement Transmission hydraulic drivetrain in a modified 2.4-MW MWT100 machine in January 2013 (Mitsubishi 2013). Figure 1-16 illustrates the evolution of drive train systems for offshore wind turbines, highlighting the parallel trends in increasing turbine capacity and changing drivetrain configurations since 2000.

Figure 1-16. Offshore Wind Turbine Prototypes by Drivetrain Configuration and Year of First Offshore Deployment



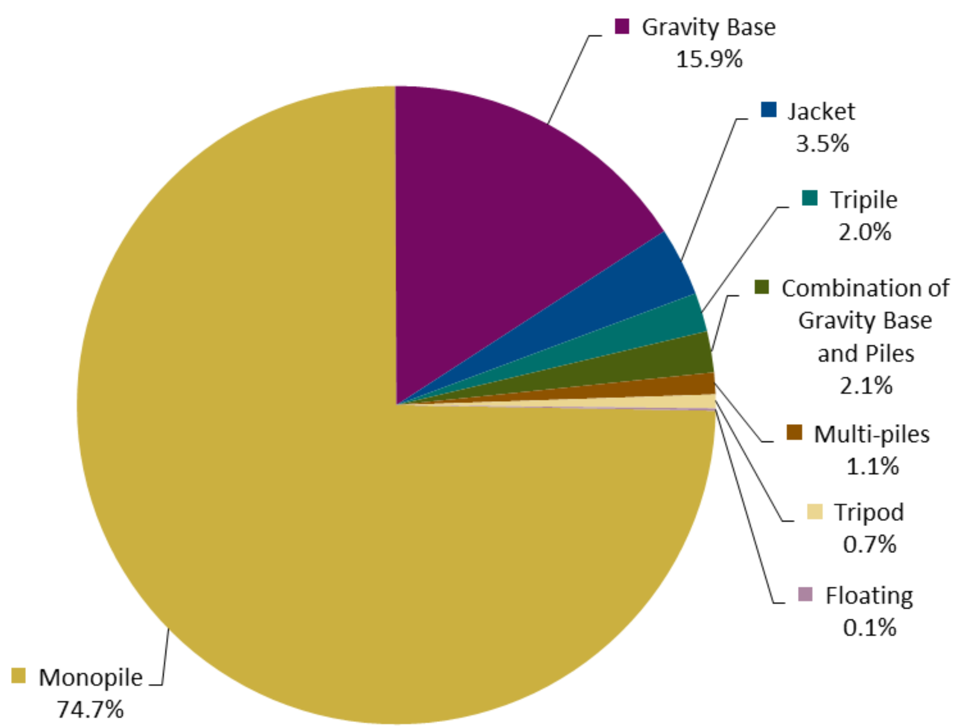
Note: Deployments after 2012 based upon wind turbine manufacturers' announced schedules.
Source: NREL data

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. With each architecture offering its own set of advantages, the diversity of proposed solutions suggests that an optimal approach for offshore machines has yet to be established.

1.4.4 Support Structure Trends

Site-specific factors driving the selection of a substructure design for offshore wind projects include the predominant water depth, the static and dynamic loads that the turbine generates, metocean conditions (especially extreme events), and sea bed conditions. The move to deeper water, the increasing size of turbines, and the increased severity of wind and wave loading at offshore wind projects all pose increasing technical challenges for developers. These challenges, along with the persistent pressure to reduce cost of energy, are driving innovations in substructure designs, including several alternatives to the conventional monopile approach. Figure 1-17 summarizes the relative market share of each substructure type (based on number installed) for offshore wind projects installed through the end of 2012.

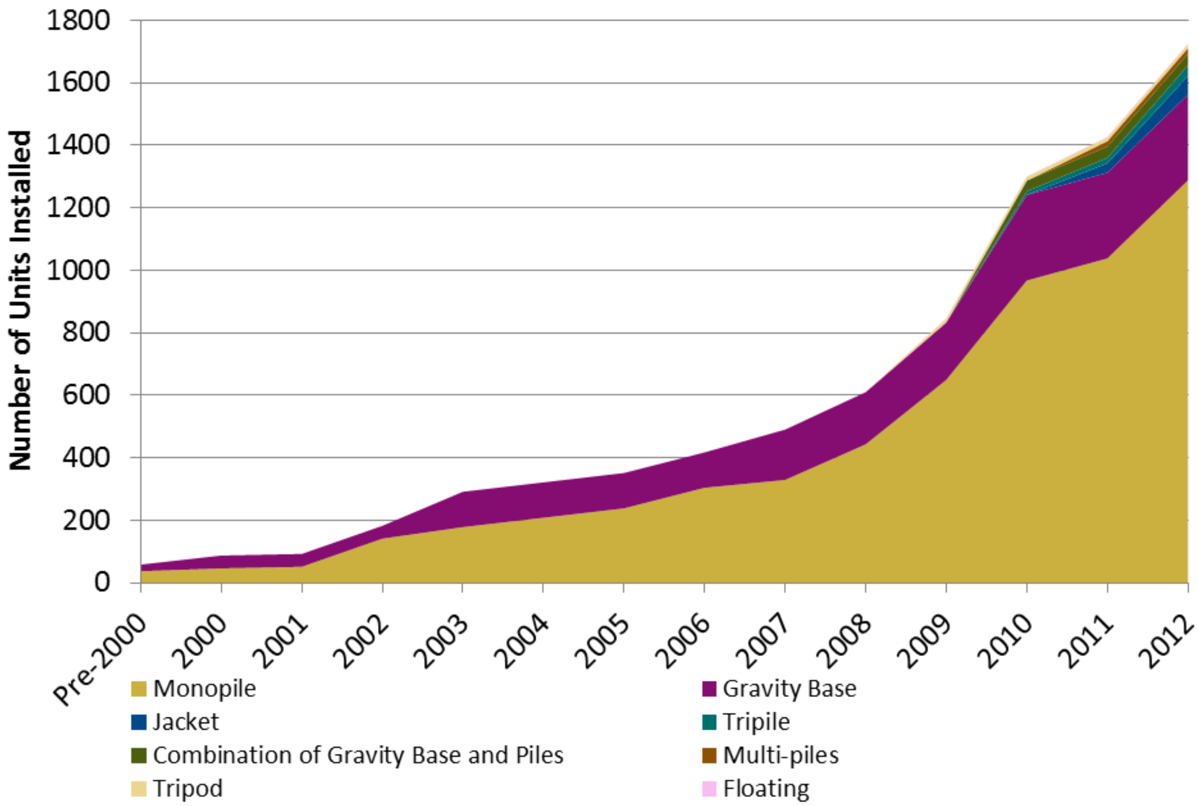
Figure 1-17. Substructure Types for Completed Offshore Wind Projects (through 2012)



Note: Percentages are based on the number of turbines using each substructure technology.
Source: Navigant analysis of data provided by NREL and BTM

Figure 1-18 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 in 2012 and 2013. Alternatives to the monopile and gravity-based approaches, however, have only seen limited deployment since 2009, with a total of 350 units installed through the end of 2012 (out of an overall 1,725 units globally). This includes two full-scale prototype floating foundations, one at Norway's Hywind site (a 2.3-MW turbine located 7.5 miles from shore in over 200 meters of water) and another at Portugal's Windfloat site (a 2-MW turbine located three miles from shore in 48 meters of water). Given the diversity of possible design conditions, it is unlikely that a single optimal substructure solution will arise.

Figure 1-18. Substructure Types for Completed Offshore Wind Projects by Year Installed



Note: Based on the number of turbines using each substructure technology.

Source: Navigant analysis of data provided by NREL and BTM

As noted above, monopiles (which are typically large steel pipes with diameters between 3 and 7 meters) have historically dominated the offshore wind market, accounting for approximately 75 percent of installed capacity. While monopiles will likely retain a leading market share over the next five years, the increasing complexity of offshore wind project locations and the increasing size of turbines suggest that alternative substructure configurations will become an increasingly attractive option. Some suppliers have suggested that "super-size" or "XL" monopiles, with diameters of 10 meters or more, might allow monopiles to serve as an economic solution for projects in deeper waters and/or with larger turbines. In

2013, EEW Special Pipe Construction, a major monopile supplier, purchased and demonstrated new fabrication equipment capable of rolling 10-meter diameter piles (Snieckus 2013). However, these larger monopiles have not yet been tested, and the economics remain uncertain. Such large piles will likely pose new challenges for installation, given their size, weight, and diameter, which exceed the capabilities of available piling hammers (IHC Merwede 2012).

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 is the only project currently under construction that will deploy gravity-base foundations. Recent experience suggests that conventional gravity-base designs may encounter difficulties in water depths greater than 15 meters, due to several key challenges. These challenges include long fabrication durations to allow curing of concrete, high dredging requirements to achieve precise seabed preparation, reliance on expensive heavy-lift vessels, and the high sensitivity of installation schedule to weather conditions. For example, the C-Power consortium selected gravity-base foundations for the 30-MW pilot phase of the Thorton Bank project, which is located in 27-meter-deep water and features 5-MW turbines. After experiencing initial challenges with these gravity-base substructures, C-Power opted instead for jacket foundations for the remaining 295 MW (Peire et al 2009). That said, several companies continue to work on promising new concepts to address these fabrication and installation challenges, including both self-floating designs and specialized vessel concepts (LORC 2011).

For sites in deeper water (from 30 m to 60 m), developers have typically shown a preference for space-frame designs (e.g., jackets and tripods). Jacket structures derive from the common fixed-bottom offshore oil rig design, relying on a three- or four-sided 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 tripile, a related foundation type, uses three pilings tied together by a central transition piece above the surface of the water (EWEA 2011). Of the three, jackets entail significantly more fabrication and assembly, but are less material intensive than either tripod or tripile designs (EWEA 2011). Experience gained through deployment has shown pre-piled jackets have been much less costly to deploy than either tripods or tripiles.

Several innovative support structure designs under development aim to provide cost-effective solutions to the increasingly demanding site conditions that are associated with new offshore wind project developments. A selection of such designs is summarized in Table 1-4.

Table 1-4. Selected Offshore Wind Foundation Designs under Development

Concept	Designer	Design Depth	Key Advantages	Status
Twisted Jacket	Keystone Engineering (USA)	30 to 60 m.	Simpler fabrication; less steel than regular jacket; reduced transport and installation requirements	Demonstration – Hornsea Met Mast
Suction Bucket Monopile	Universal Foundation (DK)	30 to 60 m.	Simple fabrication; less steel than regular monopile; no piling	Demonstration – Dogger Bank Met Mast
Tri-bucket	SPT Offshore and Wood Group (DK)	30 to 60 m.	No piling; new installation concept; quayside integration of turbine	Demonstration – Hong Kong Met Mast
GBF Gravity Structure	Gifford/ BMT/ Freyssinet (U.K.)	30 to 45 m.	Concrete structure; new installation vessel; quayside integration of turbine	Concept
Hexabase	Thyssen Krupp (DK)	30 to 60 m.	Less steel than regular jacket; standard pipe dimensions; automated fabrication; small piles simplify installation	Concept (DNV approved)

Note: Design depth refers to the range of water depths for which the foundation design is intended.
Source: Carbon Trust 2012, Wind-Kraft Journal 2012

While a great deal of offshore wind resource remains to be developed at depths amenable to fixed-bottom foundations, interest in floating offshore foundations continues to grow. In addition to the material requirements and complex and variable installation requirements of fixed-bottom foundations, even greater wind resources exist at water depths exceeding 50 to 60 meters. Unfortunately, the offshore wind industry knows relatively little about the long-term cost implications of moving to floating offshore platforms. The technology, which is still in its infancy, will likely require several more years of design and testing before it reaches commercial viability and large-scale deployment. These demonstration-scale projects include several of the DOE ATD projects described in Section 1.2.3. Two other notable projects are described below.

The most near-term 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 is scheduled to be completed by the end of 2013. It will encompass the 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 7-MW Mitsubishi turbines on floating platforms (Bossler 2013).

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 southern coast of the United Kingdom as early as 2015, likely making it the first global deployment of a tension leg platform (Glosten Associates 2013).

If successful, floating offshore foundations offer the potential for less foundation material relative to deep-water, fixed-bottom foundations, as well as greatly simplified installation and decommissioning. Each of these attributes could support lower costs moving forward. Reductions in material also help to incrementally decrease the impact of variable commodity prices, while smaller anchors and reduced seafloor disruption could lessen potential environmental impacts.

In the United States, most projects have yet to commit firmly to a specific substructure type. As in other global regions, water depth and seabed soil conditions will play a key role in determining the optimal design for each project. While the Cape Wind project has reiterated its plan to use monopiles, it has not yet committed to a supplier. Deepwater intends to use a jacket design for its five-unit Block Island Offshore Wind project, as does Fishermen's Energy for the six-unit, first phase of its New Jersey project development. As noted in Section 1.2, the University of Maine (in partnership with the DOE) installed a 1/8-scale pilot floating turbine on a concrete, semi-submersible hull in June 2013.

1.4.5 Electrical Infrastructure Trends

The offshore wind industry faces a number of regulatory transmission planning issues in order to deliver power to load centers. The ambitious offshore wind development plans for many countries will necessitate the construction of significant offshore transmission infrastructure as well as onshore network upgrades, as some interconnection points may be a significant distance inland. As a result, several current initiatives, both industry- and government-driven, aim to create shared offshore transmission infrastructure. These initiatives include the following:

» In 2009, the United Kingdom's Department of Energy and Climate Change (DECC) and Office of the Gas and Electricity Markets (Ofgem) established a licensed regulatory regime for offshore transmission similar to the onshore grid. The regime established Offshore Transmission Owners (OFTOs), who will be selected through a competitive tendering process and will receive a steady income stream for a period of 20 years. The regime is expected to generate £15-20 billion in investment in offshore transmission infrastructure between 2010 and 2020 (DECC 2010).

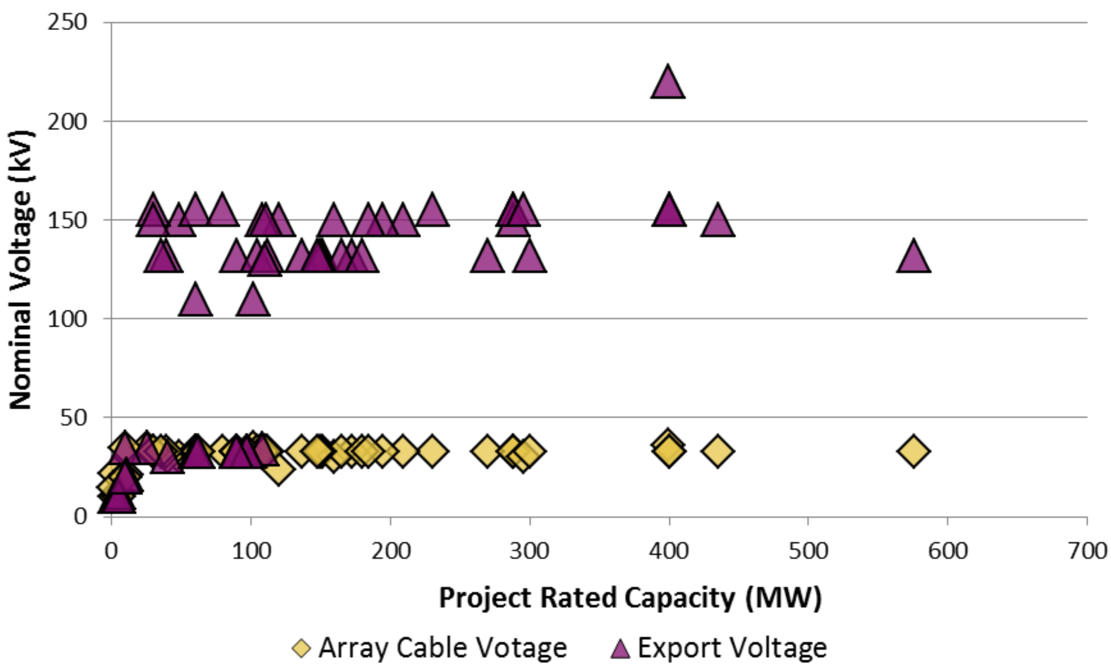
» In Germany, Transmission System Operators (TSO) are required to build out offshore transmission systems to connect projects to the land-based grid. In many cases, due to decisions to site offshore wind projects up to 50 miles from shore, the TSOs are selecting configurations that use high-voltage direct current (HVDC) technology to connect clusters of projects to the grid. Several of these projects have been delayed, due to technical complexity and supply chain issues, which has subsequently led a number of developers to freeze investment in the market (Andresen and Nicola 2012).

» In December 2009, nine nations bordering the North Sea signed the declaration for the North Seas Countries' Offshore Grid Initiative. The declaration set the objective of coordinating the technical, market, political, and regulatory components of offshore electricity infrastructure development in the North Sea region.

» In the United States, several companies are trying to proactively address transmission limitations to avoid additional slowdowns for the undeveloped U.S. offshore market. 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). FERC awarded the project a return on equity of 12.59 percent, conditional on the project being included in PJM's regional transmission expansion plan (RTEP) (FERC 2011).

The electric infrastructure for offshore wind projects has historically consisted of a medium-voltage array cable system to collect power from the turbines, an offshore substation to increase power from medium to high voltage, an export cable system to deliver power to shore, and onshore electric infrastructure to connect with the electric power grid. Small projects and projects located close to shore sometimes avoid offshore substations by exporting power at the array voltage. Trends in electrical infrastructure layout and configuration have remained relatively constant thus far. Figure 1-19 shows array cable and export cable system voltages plotted against the rated capacity of each operating global offshore wind project.

Figure 1-19. Array and Export Voltages for Offshore Wind Projects



Source: NREL data

Figure 1-19 reveals that the majority of offshore wind projects have selected 33-kV array cable systems to collect power from substations. Historically, these arrays have been composed of radial strings connected in series to the substation. However, this layout means that if a fault occurs in the cable, all cables behind the fault are unable to export power to the grid, which can result in significant lost revenues. Many industry watchers have suggested that alternative, redundant designs, such as ring configurations, could deliver improved reliability and increased revenue. The ring array concept is being demonstrated for the first time at the Riffgat offshore wind project in Germany (Riffgat Offshore Windpark 2013).

The number of turbines that can be included on each array cable string is predominately driven by turbine capacity. For example, while approximately eleven 3.6-MW turbines could be connected on a typical 33-kV cable, this cable could only accommodate seven 6-MW machines.[14] As turbine capacities increase and array cable configurations evolve to incorporate greater redundancy, developers will likely shift to higher voltage array cables rated at approximately 66 kV.

High-voltage export cables have been used for the majority of offshore wind projects that exceed 100-MW rated capacity. By accommodating more power per cable, high-voltage cables reduce the overall number of cables required for a project. High-voltage systems also provide for lower electrical losses, which can result in increased revenue. The benefits of higher voltage generally become more pronounced as distance to the point of interconnection increases. As shown in Figure 1-18, no clear trend exists to suggest that export cable voltages are increasing with larger project capacities. Rather, it seems that country-specific conventions have been the major driver of export voltage; data suggests that projects in the United Kingdom generally use 132-kV, high-voltage alternating current (HVAC) export cables, while projects in Germany, Belgium, Denmark and the Netherlands prefer 150-kV HVAC cables. The 400-MW Anholt project in Denmark is using 230-kV export cables, which are the highest-voltage AC cables currently planned for an offshore wind project.

Despite the higher initial costs discussed in Section 1.3, distant offshore projects (located more than 50 miles offshore) have increasingly shown a preference for high-voltage direct current (HVDC) lines, which offer even lower transmission line losses. Such line loss reductions are particularly valuable for larger, high-production facilities. Continued evolution of HVDC conversion technology and development of the high-voltage cable supply chain are expected to push HVDC costs lower in the future. Improvements in cable-laying vessels, including replaceable cable reels, increased marine cable-laying capacity, and innovative trenching equipment, might also offer electrical infrastructure cost reductions.

Innovations in offshore substations and converter stations continue to move slowly. Notably, some designers have opted for self-floating, self-installing platforms that they can tow to the project site and install without the use of a heavy floating crane vessel. While such designs generally have a much higher steel weight and fabrication cost than conventional substations, avoiding the high mobilization costs and day rates associated with large floating crane vessels may make them less costly in the end.

1.4.6 Logistical and Vessel Trends

While little has changed in installation and vessels 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 the availability of the vessels required to develop and construct offshore wind farms, 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 a unique type of vessel. Table 1-5 highlights the more than 17 different types of vessels that may be needed at various points in the offshore wind life cycle.

[14] Assumes a cable cross-section of 1,000 thousand circular mils (kcmil), or 500 mm^2.

Table 1-5. Vessel Types Required for Each Offshore Wind Project Phase

Vessel Type	Pre-construction (Phase 1)				Construction (Phase 2)				O&M (Phase 3)	Decommissioning (Phase 4)		
	Environmental Survey	Geotechnical Survey	Geophysical Survey	Installation of Met Mast	Turbine Foundation Installation	Turbine Installation	Converter Station Installation	Cable Installation	O&M Routine and Overhaul	Turbine Decommission	Substation Decommission	Met Mast Decommission
ROV Support Vessel	•											
Geotechnical Survey Vessel		•										
Geophysical Survey Vessel			•									
Multi-purpose Survey Vessel	•	•	•									
Jack-up Barge or Vessel				•	•	•			•	•		•
Heavy Lift Vessel				•	•	•	•			•	•	•
Construction Support Vessel				•	•	•	•			•	•	•
Inter-array Cable Installation Vessel								•				
Export Cable Installation Vessel								•				
Tugboat				•	•	•	•	•		•	•	•
Service Crew Vessel/Boat					•	•	•	•	•			
Diving Support Vessel					•	•	•	•				
Safety Vessel/Standby ERRV					•	•	•	•				
Multi-purpose Project Vessels (MPPV)	•				•	•	•	•	•			
Tailor-made O&M Vessel									•			
Accommodation Vessel					•	•		•				
Multi-purpose Cargo Vessel (MPV)	Primarily provide the inbound services for wind turbine and BOP related tasks											

Source: BTM Consult - A part of Navigant – August 2013

Table 1-6 shows the global distribution of different service vessel types currently in operation with a track record of serving offshore wind projects. The numbers are based on the region associated with each vessel's flag. Notably, Europe plays a leading role in each vessel category, while other regions show potential deficits in current vessel availability. Despite the identification of some vessels in both Asia Pacific and North America, their primary use is for project construction. At present, no project crew transfer boat or vessel has been recorded in regions outside of Europe.

Table 1-6. Availability of Different Vessel Types with Track Record of Serving the Offshore Wind Industry by Region (Based on Vessel Flag) as of 2013 (In-operation only)

Vessel Type/ Region	Total World	Europe	Asia Pacific	North America	Rest of world
Accommodation Vessel	8	5	1	2	0
Cable Laying Vessel	66	53	7	5	1
Construction Support	25	17	3	4	0
Diving Support Vessel	4	1	0	2	1
Heavy Lift Vessel	29	14	11	4	0
Jack-up Barge or Vessel	48	28	6	12	0
MPPV	63	52	2	8	1
MPV	14	7	0	6	1
Service Crew Boat/Vessel	83	82	0	0	0
Safety/Standby EERV	11	10	0	1	0
Survey Vessel	15	11	1	3	0
Tugboat	32	28	2	1	0

Note: Only includes vessels with a track record of serving the offshore wind industry (i.e., that can be linked to a specific project) and those presently in operation. Not all North American region boats are U.S.-flagged.
Source: BTM Consult - A part of Navigant - September 2013

While noteworthy, this potential vessel supply situation will likely ease over time, as the long lead times and relatively slow ramp-up of the U.S. market will provide vessel owners and manufacturers the opportunity to respond to shifting market needs by repurposing existing vessels or constructing new ones.

As global demand for vessels to serve the offshore wind market has increased, vessel suppliers and construction teams have sought to address the desire to reduce the time required for installation and for transferring foundations, towers, turbines, and blades to sites farther from shore. These advancements have been aided by the increased use and development of more innovative jack-up vessels. New generation jack-up vessels generally have the following characteristics:

- Increased deck space to facilitate storage of larger numbers of turbine components per trip
- Larger 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
- Advance dynamic positioning (DP2) systems to increase operational efficiency and safety
- Longer jack-up legs to enable lifting operations in deeper waters

- Ability to carry out operations in harsh open-ocean conditions (i.e., wave height limit of at least two meters) to minimize construction downtime

Historically, jack-up vessels have represented the primary means for installing offshore turbines and foundations. As identified in the last edition of this report, some turbine suppliers and project owners are seeking to hedge against the potential future scarcity of such vessels by building their own vessels or entering into strategic relationships to secure access to them. This trend appears to be continuing, as evidenced by the following:

- DONG Energy and Siemens jointly own the offshore vessel operator A2Sea
- RWE has built two jack-up vessels to install its own offshore wind projects
- REpower is currently building two jack-up vessels; the first should be available in 2013 and the second in 2014
- Areva Wind has a long-term charter on the HGO Infrasea Solutions Innovation

This approach allows suppliers and project owners to avoid potential bottlenecks based on jack-up vessel availability. It also provides assurance that they can meet their construction and operation obligations and improves their responsiveness to major O&M activities.

As indicated in this report's previous edition, 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, but there are some plans to construct jack up barges in the U.S. for construction of offshore wind farms.

While developers may develop near-term strategies for complying with this act despite constraints on non-U.S.-flagged installation vessels, a thriving U.S. offshore wind market will likely require the development of a more robust domestic fleet.

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[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.

1.4.7 Operations and Maintenance Trends

Similar to vessels and logistics, few new developments have occurred in the O&M of offshore wind farms since the previous report. In general, increased turbine size, plant size, and distance from shore all have direct consequences on O&M practices, but it is unclear what long-term trends may materialize. These trends will add to the logistical difficulties of maintaining offshore turbines, particularly as longer distances from shore increase the challenges in accessing turbines due to weather conditions. 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.

Apart from these turbine design considerations, several vessel and logistical trends are emerging in response to the requirements of more distant offshore wind farms. They include the following:

» **Dedicated project crew and accommodation vessels:** As wind plant sizes and distances from shore increase, developers may find justification for dedicating service and crew transfer vessels to their larger projects. In this case, additional crew vessels may need to be built to keep up with demand. Plants farther from shore may also require technician crews to reside at accommodation facilities or large crew vessels for one- to two-week periods. Such vessels may serve as a more versatile and mobile alternative to fixed hoteling platforms, which allow technicians to service multiple projects within a general area while reducing transport time and cost.

» **Purpose-built equipment.** Particularly for larger plants, developers will need to consider whether to buy, lease, or share each type of equipment or vessel they will require for long-term O&M. The breakeven point for justifying the purchase of a dedicated, purpose-built lifting vessel is approximately 100 turbines (including the use of the vessel during the construction period). In the future, owners and operators of large wind farms will increasingly demand such purpose-built vessels for O&M, and in some cases tailor made for their own specific climate and location.

» **Proactive maintenance methods.** Within the wind industry in general and offshore wind in particular, there has been movement toward utilizing more proactive maintenance methods (e.g., condition monitoring, predictive maintenance, etc.) in an effort to preserve availability and reduce operating costs. Predictive maintenance activities are only performed when there is an impending need rather than based upon a specified period of time.

» **Multi-contracting of O&M services.** Over the past few years, there has been a clear shift in the O&M offerings that turbine manufacturers provide. Offshore wind O&M is now generally treated in a multi-contract fashion. Turbine suppliers are limiting their risk exposure by focusing solely on operating and maintaining their turbines and are obligating the owner to contract for the other services.

» **Project owners assume access risk.** The inability to access a wind farm due to inclement weather conditions can have a significant impact on plant availability. In recent O&M service agreements, the contractual risk associated with accessing the turbines has been assumed by the owner rather than the turbine manufacturer (who is conducting the O&M). This represents a key shift in scope from earlier turbine O&M service agreements.

1.5 Financing Trends

The wind power market, including land-based wind, has historically faced financing challenges. For the U.S. land-based market in particular, obtaining financing has not been easy. Prior to the Section 1603 Cash Grant program, the federal tax credit-based incentive mechanism in the United States required the support of tax equity investors, as fewer companies had sufficient tax liabilities to capture the tax credits. The relatively small pool of large tax equity investors has grown even smaller since the recent economic crisis, although it is starting to grow again.

However, the offshore wind industry entails additional risks relative to land-based wind that make securing financing more challenging. There is additional technology risk, especially with turbines over 5.0 MW, given their relatively short operating history. As projects move farther offshore, technology risk will also arise from new foundation types and HVDC transmission lines. Weather and supply chain constraints will add additional construction and operating risk until new mitigation mechanisms are developed. 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.

1.5.1 Rising Capital Requirements

The pursuit of economies of scale in offshore wind farms drives up project sizes. Larger project capacity and higher per-MW installation costs compared to land-based wind increase the amount of capital needed. Given the higher per-MW costs of offshore projects, the total cost of offshore wind farms is already surpassing that of even the largest land-based wind farms.

1.5.2 Utility On-balance Sheet Financing

Most offshore wind projects through 2012 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 (BTM 2012). Balance sheet financing costs less than project financing and is less time-consuming, due to the lack of need for banks to conduct due diligence. However, the capital requirements for ever larger projects, such as those in U.K. Round 3, have begun to strain the on-balance sheet financing capacity of these utilities. As a result, utilities have sought out alternative financing mechanisms.

1.5.3 Project Finance

The continuing economic crisis and the relative immaturity of the offshore market made many investors more risk-averse, with many banks reducing their exposure to less-established markets. However, the offshore wind industry appeared to suffer less from the effects of the financial crisis, as sufficient funding capacity remained available (with the support of multilaterals and export credit agencies) for well-structured projects. Most banks continue to focus on Western European countries where a number of offshore wind projects are already successfully operating and where there is relatively strong government support (e.g., Germany, Belgium and the United Kingdom).

A few projects that 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, which began operation in 2008. The C-Power phase 1 project in Belgium in 2007 showed that larger turbines, namely the REpower 5M, were bankable. The Belwind wind farm, also in Belgium, demonstrated that larger projects—in this case, 165 MW—were bankable and could be supported through multilateral involvement (e.g., European Investment Bank [EIB], Eksport Kredit Fonden [EKF], commercial banks, etc.). This project reached financial closing in 2009, in the midst of the financial crisis. The United Kingdom saw its first project financed deal with the refinancing of Centrica's Boreas project. This deal involved the participation of 14 banks. C-Power phase 2 and 3 reached financial closing in 2010 and was the first to receive over €1 billion in financing.

Furthermore, the years 2010 and 2011 saw the project financing of a number of German offshore wind farms. The first deal in Germany was for the 200 MW Borkum West 2 project in 2010. This deal saw the first financing of Areva's 5-MW turbines. In 2011, the 288-MW Meerwind project became the first project to include construction risk for Siemens turbines, the first with a private equity investor, and the first under the German Development Bank's (KfW) offshore wind program. Also in 2011, the Global Tech I wind farm became the first 400-MW project to be financed. More recently, the Butendiek project in Germany reached financial closing at the beginning of 2013. Since 2011, Germany offshore wind project development slowed down due to regulatory uncertainties linked to grid connection availability for future wind farms. This latest transaction came as a positive signal for offshore wind in general, as it signaled that good projects can overcome these kind of issues and eventually complete the financing process.

2012 was a booming year for the U.K. offshore wind market, with more than 530 MW (Lincs, 270 MW; Gunfleet Sands, 172 MW; and Walney, 92 MW) of projects financed on a non-recourse basis. In particular, 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.

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. Seven of the nine Round 3 development zones in the United Kingdom were awarded to consortia. 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. The previously mentioned Meerwind project involved seven commercial banks and a private equity firm, as well as an export agency and a development bank.

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. The export credit agencies could facilitate the financing of U.S.-based projects by supporting turbine manufacturers, such as Vestas, Siemens, and REpower.

The availability of €5 billion from the KfW has facilitated financing for offshore wind projects in Germany. This financing complements other sources, such as the EIB, export credit agencies, and commercial banks. The proposed Meerwind wind farm, mentioned above, is the first offshore project to reach financial closing under the KfW's program. The project is 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 GIB. The bank contributed approximately one-fifth of the amount needed for the refinancing of the project.

As the offshore wind market matures, it will require less help from public finance institutions. In 2012, the 270 MW Lincs project in the United Kingdom received financing from a group of 10 commercial banks but did not leverage a public finance institution.

1.5.6 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 demonstrating interest. These investors have typically purchased minority stakes in operating projects, thus avoiding construction risk. DONG Energy has been the primary "seller" of these minority stakes.

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 United Kingdom'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).

The previously mentioned Meerwind project in Germany included financing from Blackstone, a U.S.-based private equity firm. Previously, no private equity funds had been used in offshore wind projects.

Other non-traditional offshore wind investors have entered the market as well. In November 2011, the Japanese trading company Marubeni acquired 49.9 percent of the United Kingdom's Gunfleet Sands project from DONG Energy. This deal marked the first financing of a majority stake to date. Marubeni has shown an 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.

1.5.7 Likely Financing Trends for Offshore Wind in the United States

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

As discussed in Section 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 United States 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. 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. Both 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.

1.5.8 Cape Wind Financing

Since the last version of this report, Cape Wind has made inroads in securing financing for what analysts expect to amount to $2.6 billion. As mentioned in Section 1.2.2.2, in March 2013, the Bank of Tokyo-Mitsubishi UFJ (BTMU) was engaged as the coordinating lead arranger of the debt portion of financing, corresponding to commercial banks. Additionally, in June 2013, PensionDanmark pledged $200 million, which is contingent upon Cape Wind securing its remaining financing needs and beginning construction by the end of the year.

2. Analysis of Policy Developments

This section provides an analysis of policy developments at the federal and state levels with the potential to affect offshore wind deployment in the United States. It includes a description of policies for promoting offshore wind and an evaluation of policy examples to close any competitive gaps. The evaluation employs a systematic approach of defining the offshore program objectives (Section 2.1), identifying barriers to meeting the objectives (Section 2.2), and evaluating examples of policies to address the barriers (Sections 2.3 through 2.6). The categories of barriers and policies that are addressed are summarized as follows:

- » 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 2013 that affect offshore wind development in various jurisdictions, each of which is discussed in Section 2 or in the appendices.

Offshore Wind Policy 2013 Highlights
» Policies that address cost-competitiveness o The U.S. PTC and ITC were extended for projects that begin construction by year-end 2013. The 50% first-year bonus depreciation allowance was also extended for one year. o The U.S. DOE announced seven projects that will receive up to $4 million each to complete engineering and planning as the first phase of the Offshore Wind Advanced Technology Demonstration Program. o The Maryland Offshore Wind Energy Act of 2013 established Offshore Wind Renewable Energy Credits (ORECs) for up to 200 MW. o The Maine legislature passed a bill that re-opened the bidding process for ratepayer subsidies to offshore wind projects. o 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. o Spain has made various reductions to its FiT with, in some cases, retroactive effects on existing projects. » Policies that address infrastructure challenges o 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 o BOEM held the first two competitive lease sales for renewable energy in U.S. federal waters off the coasts of Rhode Island and Virginia. o Illinois passed the Lake Michigan Wind Energy Act, which requires the Illinois DNR to develop a detailed offshore wind energy siting matrix for Lake Michigan. o Denmark initiated feasibility studies for six areas that have been identified for offshore

2.1 *Offshore Wind Program Objectives*

The goals of the U.S. offshore wind program can be broadly defined as promoting the development and deployment of offshore wind energy systems at competitive prices while aiming to maximize the MW capacity of manufacturing production in the United States, resulting in more factories and jobs. Competitive prices are defined by achieving 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 (U.S. DOE 2008). The report projects that 54 GW of offshore wind could be installed by 2030, with an average levelized cost of energy (LCOE) of 7¢/kWh. While this level may not be achieved and the DOE is updating its projections in a new report to be issued in 2014[17], 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 is focused on reducing the cost of offshore wind energy and decreasing the deployment timeline uncertainty. The DOE sees offshore wind as a method to reduce the nation's greenhouse gas emissions, diversify energy supply, deliver cost-competitive electricity to coastal regions, and stimulate 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. This section discusses market barriers that affect U.S. offshore wind development and the policies that have been used or considered by various jurisdictions to address those barriers.

[17] 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 Risks
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 analysis

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 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. Support schemes that address cost competitiveness can be divided into "investment support schemes" (MW-focused) and "operating support schemes" (MWh-focused). Examples of investment and operating support schemes are listed below. All of these examples 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 the burden 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 can choose between these two incentives as they apply to projects that begin construction by year-end 2013. Most offshore wind project investors will 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 relatively larger level of support for offshore wind systems. In 2012, the U.S. Senate Finance Committee considered an ITC for offshore wind that does not expire until 3,000 MW are claimed, rather than approving short-term extensions of the ITC, which would not support the multiyear development process of offshore wind. Although this proposal is still advocated in 2013, no further action has been taken on it.

Other investment support schemes currently in effect at the federal level 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 hasn't solicited for new Loan Guarantee applications in several years and 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. In January 2013, the *American Taxpayer Relief Act of 2012* (H.R. 8, Sec. 331) further extended the 50 percent first-year bonus depreciation allowance for property placed in service during 2013.[18]

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.

[18] http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US06F&re=1&ee=1

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

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

(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) Massachusetts statute requires PPAs for 3% of load and approved Cape Wind PPA for $18.70/MWh.
(3) Long Island Power Authority conducted competitive bid in 2005 & ended in 2008 for high prices. New York Power Authority conducted competitive bid in Great Lakes in 2009 and ended in 2011 for high prices. NYPA, LIPA, Consolidated Edison, and others issued an RFI for a 350 MW offshore wind project, possibly expandable to fill NY's 700 MW offshore wind target.
(4) 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.
(5) 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.
(6) Statute requires 1100 MW Ocean RECs at a cost-effective rate based on a comprehensive net benefits analysis.
(7) Offshore wind RECs count 3.5 times in meeting Delmarva's renewable energy purchase requirements.
(8) Maine legislation authorized bidding process for pilot offshore projects and PPAs, which is currently ongoing.

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.

State	RPS	Offshore Wind RPS	Mandatory PPAs	RFPs and Other Activity
Massachu-setts	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.[19] 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.

[19] http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=MA05R&re=1&ee=1

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.[20]
Virginia				Virginia is having the local transmission system owner conduct interconnection studies exploring a high-voltage submarine cable that could interconnect to OSW farms.[21] 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.

[20] See http://offshorewind.net/OffshoreProjects/Rhode_Island.html

[21] See https://www.dom.com/news/2012/pdf/dominion_offshore_public_report_3-13-2012.pdf

Public Utility Commission Approval of Power Purchase Agreements

Ultimately, the state public utility commission (PUC) must approve all PPAs[22] before the costs can be passed through to ratepayers. Most states have legislation providing guidance for such approvals that typically requires 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 because pollution costs are not internalized into the price of the energy produced.

Massachusetts

The Commonwealth of Massachusetts enacted legislation to promote renewable energy by 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[23]

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 the other renewable resources available:

> "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

[22] With the exception of federal procurements of PPAs.
[23] Green Communities Act, Section 83, Chapter 169 of the Acts of 2008.

long, new, onshore transmission to other generators and the greater capacity factor than generators run on other types of renewable resources.[24]

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."[25] Cape Wind presented testimony based on an independent economic analysis by Charles River Associates (CRA) that 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 which would be spread among all New England ratepayers over the 25 year lifespan of the project could exceed $7 billion.[26] Although the PUC only recognized 50 percent of this benefit because the utility purchased 50 percent of the capacity, the benefit to the contracting utility customers was still significant.[27]

Rhode Island

Rhode Island enacted legislation to promote long term contracts for renewable energy resources including offshore wind.[28] 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 some other renewable resources such as onshore wind. 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.[29] The PUC then approved the same PPA and it was upheld by the Rhode Island Supreme Court.[30]

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 public utility commission to consider the ratepayer impacts, potential reductions in transmission congestion costs,

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

[25] 461 Mass. at 176-177.
[26] "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
[27] 461 Mass. at 176-177.
[28] Public Law 2009, Chapter 53.
[29] Public Law 2010, Chapter 32, amending Title 39 Section 26.1.
[30] In re Review of Proposed Town of New Shoreham Project, Case No. 2010-273-M.P., July 1, 2011.

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, and unlike New Jersey, the Maryland act specifically requires a price suppression analysis for peak coincident wind farm generation and evaluation of other electricity market and ratepayer benefits and 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.

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.[31] The legislature also directed the PUC to hold a competitive bid and approve PPAs for offshore renewable energy pilot projects that met certain conditions.[32] 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 which is currently under review by the PUC. As noted above, in October 2013 Statoil announced its abandonment of its Maine project due to these changes and more general schedule concerns.

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 require OSW acquisition (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
- 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 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)

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

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

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:

1. Reduce greenhouse gas emissions by 20 percent
2. Reduce primary energy use by 20 percent
3. 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 subsidy from the grid operator (€25 million) for construction of the export cable. (Smaller projects received a prorated amount.)
Finland	» Cash grant	Up to 40% of investment budget
France	» Accelerated depreciation » Research tax credit	
Greece	» Tax break » Cash grant » Leasing subsidies	Total investment incentives up to 40% of investment budget
Italy	» Cash grant	Up to 30% of investment budget
Netherlands	» Tax break	
Poland	» Tax break » Cash grant	Renewable energy is exempt from tax. Grant from EU structural funds
Spain	» Accelerated depreciation	Free depreciation of new tangible assets used in economic activity

Source: European Renewable Energy Council, 2009 and Taxes and Incentives for Renewable Energy, 2011[33]

[33] http://www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/Documents/Taxes-Incentives-Renewable-Energy-2011.pdf

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 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). This increased risk was obvious during the banking crisis of 2008, when lending in such countries was reduced much more drastically than in FiT countries.

For this reason, Belgium has set a minimum price for the green certificates, thus 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	Investment Schemes	Operational Schemes	Operational Scheme Notes	Installed MW thru 2012	Construction MW 12/31/2012	Permitted MW thru 2012
U.K.	Tax breaks	Green certificates	2 ROCs/MWh for OSW through 2015, then 1.9 ROCs through 2016, then 1.8	2,948	2,359	1,840
Denmark	Tax breaks	FiT by tender	OSW: Tender, fixed price for 50,000 full load hours, then market price	921	400	0
Germany	-	FiT	OSW: 150 €/MWh for 12+ years or 190 €/MWh for up to 8 years, then 35 €/MWh. 7%/yr digression starting '18	280	580	6,992
Belgium	Cash grant	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)	379	296	736
Netherlands	Tax breaks	FiT, tender	OSW: premium capped at 144 €/MWh; duration 15 years	247	0	3,238
Sweden	-	Green certificates	GC + Premium in place until 2030; 28 €/MWh (on top of wholesale electricity price) for 15 years	164	0	920
Finland	-	FiT	12-year tariff with additional tariff for projects built in the first 3 years	26	0	736
Ireland	-	FiT	OSW: 140 €/MWh (15 years) capped at 1.5 GW	25	0	1,656

Italy	Cash grant	Tender & floor price	OSW floor price 176 €/MWh for 25 years	0	0	736
France	Accelerated depreciation	Tender	OSW: 1.9 GW allocated in tenders in 2012 with 170-200 €/MWh tariffs	0	0	184[34]

Source: Navigant analysis

[34] A volume of 2,448 MW has been allocated under the tender in April 2012.

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

Belgium

Belgium will need to decide on the next zones to reach its target in 2020, after having allocated the 7 zones initially designated for offshore developments. Three of these zones are operational or under construction; the others will have to wait until additional grid capacity is built onshore. Additionally, discussions about the support scheme for these projects have been taking place to cap the level of support awarded to projects, with no conclusion to date.

Germany

The German FiT payment rate for offshore wind energy has recently become a topic of political discussion, imposing pressure on the offshore wind sector to reduce its costs. Two federal ministers (Peter Altmaier, the Federal Minister for the Environment, and Philipp Rösler, the former Federal Minister of Economics and Technology) conceived a draft law that would reduce the tariff level, including for projects currently under construction, which created industry-wide worries about retroactive decisions and a loss of support for the industry. However, the proposal has no chance of passing (the government not having a majority in the upper house of parliament) and is widely seen as electioneering in the context of parliamentary elections later in 2013. It nevertheless had a chilling effect for the industry.

France

France awarded four projects (close to 2 GW) in April 2012 under a competitive tender. The bidders with the lowest prices won, accounting for industrial experience and local development (and jobs) plans. The winning projects will receive a fixed tariff for 15 years. Another tender for two additional projects has been launched and will be awarded in late 2013. Projects are expected to be built over the next several years, starting in 2017.

Greece

The renewable energy law passed by the Greek parliament in June 2012 resulted in switching from a fixed FiT to an auction mechanism. In that same month, the Greek Regulatory Authority for Energy issued the country's first offshore production license, granted under the former non-competitive tendering rules. In the meantime, Greece implemented a new tax on renewable energy. The levy is 10 percent on the turnover and applies retroactively. Given this change in law and the current Eurozone crisis, no wind development is expected in Greece in the short term.

Ireland

Ireland will not prevent the development of offshore wind farms, but it will not provide a tariff for offshore wind, either (currently, Ireland is entitled to only €68/MWh). Projects may be built for export to the United Kingdom (without any cost for Irish consumers), and a large transmission project between the two countries is currently under development.

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 opened in late 2012 but had no conclusive results.

The Netherlands

All of the *Subsidie Duurzame Energy* (SDE) incentive program subsidies (a form of CfD) have been allocated. It is not clear yet what the next steps will be. The government increased the target from 14.5 percent renewable energy in 2020 to 16 percent in 2020, but it has yet to decide on the policy to realize this new target.

Romania

Romania uses tradable green certificates with a floor price and ceiling price. In order to in order to limit spending on renewable energy, the government has issued an emergency ordinance (retroactively) cutting the ceiling price and subsidies on renewables.

Spain

The Spanish government announced a €1.35-billion cut to renewable subsidies in Spain. Among the many changes, Spain has made various reductions to its FiT, with, in some cases, retroactive effects on existing projects. This has soured investors about the country and has led to a collapse in investment in renewable energy in the country.

United Kingdom

The heart of the U.K.'s Energy Bill is the plan to change the support scheme in 2017 from the Renewable Obligation to a type of FiT known as Contracts for Difference.

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 also ensure that carbon targets are met. The bill contains a plan to change the support scheme in 2017, replacing the Renewable Obligation (RO) with CfD, a type of FiT. From 2015 to 2017, the Renewable Obligation Certificates (ROCs) allocated per project will be decreased from 2.0 ROC/MWh to 1.8 ROC/MWh. 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.

In June 2013, the U.K. DECC announced the strike prices for land-based and offshore wind generation through 2019.[35] The prices are largely in line with the current RO, with land-based wind priced at £100/MWh and offshore wind at £155/MWh (183 €/MWh) through 2016. This announcement should resolve the uncertainty that has been delaying the development of Round 3 projects.

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. The primary infrastructure policies for offshore wind that have been implemented or proposed are therefore 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 interconnection and grid upgrade costs must then be incorporated into the cost of the energy produced by that generator to become part of the wholesale cost of that energy 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 following policies have been used or considered by various jurisdictions to help address this dilemma.

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[35] http://www.argusmedia.com/pages/NewsBody.aspx?id=853372&menu=yes

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.[36] 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.[37] 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.[38]

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 to interconnect with offshore wind farms but have fewer onshore interconnections. AWC has been seeking approval of the regional transmission operator, PJM, to pass the costs of this cable to all the ratepayers in PJM who will benefit from the wind power and associated price suppression during peak demand periods. AWC has recently phased its project and is exploring with the New Jersey Board of Public Utilities passing the costs of the New Jersey Energy Link portion of the AWC cable onto New Jersey ratepayers.

Three New York utilities have teamed to proposed development of an offshore wind farm south of Long Island. 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.

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

- » Policy description
    - o Transmission system planners identify offshore transmission upgrades or new transmission required to develop an offshore wind project area (i.e., conceptual transmission expansion plans).

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[36] CITE

[37] CITE

[38] http://www.texascrezprojects.com/

- o 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
  - o Optimizing the transmission infrastructure for consolidated wind farms reduces costs to the customer and environmental impacts.
  - o FERC Order 1000[39] directs regional transmission organizations (RTOs) and independent system operators (ISOs) to consider state and federal energy policies, which includes 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.
  - o A single environmental review and permitting process can be conducted, which reduces costs and timelines.

In order to address the issue of prohibitively high transmission costs for a single project, jurisdictions have chosen to <u>allocate the costs of offshore transmission system upgrades to all regional transmission system customers</u>. 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.[40]

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

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

- » This strategy has enabled developers to send power to multiple load centers can improve project economics and enable larger offshore wind farms, thereby 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 certain regions attractive for offshore development as National Interest Electric Transmission Corridors. This provides federal assistance for interstate siting that augments transmission planners working through existing

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

[40] CREZ Progress Report No.12, at page 6, July 2013.

institutions like RTOs but does not override state siting authorities that deny construction authority.

In order 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. Model guidelines for consideration by individual states are being developed by regional organizations such as RTO Stakeholder Committees and the New England Conference of Public Utility Commissioners.

In order 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 be utilizing 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 if 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.[41] 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.

In order to address the issue of a piecemeal transmission planning process, some states have proposed to establish policies supporting 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.

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)

[41] 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.

- » Incentives encouraging port upgrades (when ports are privately held)

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 based on our research:

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

Manufacturing Policy Example 1: In order 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: In order 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.

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 to provide a level of certainty for transmission development to avoid an "if we build it, they will come" situation. Table 2-5 presents an overview of these transmission policies, while Appendix B provides further detail.

Table 2-5. 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.[42]

Source: Navigant analysis

[42] CREZ Progress Report No.12, at p. 6, July 2013.

2.4.3 Current Policies in Europe

Table 2-6 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 2-6. Policies for Addressing Infrastructure Challenges in Europe

Country	Transmission Policy	Ports Policy
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
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 model » Lower Saxony government is directly investing in 3 North Sea ports
Netherlands	» TSO is responsible for construction and management of the grid » Offshore developers are responsible for transmission system costs » Developing HVDC interconnection with Denmark	Ports are all independent companies and do not receive any funding or direct support from the government
United Kingdom	» Competitive tender to become an OFTO and collect 20 years of payments » Operators can choose to construct their own transmission connections or opt for the OFTO to do so	» The Crowne Estate is soliciting applications from manufacturers and ports » £60 million is available between 2011 and 2015

Source: Navigant analysis

2.5 *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 faced by the U.S. offshore wind industry include uncertain site selection and leasing processes, fragmented permitting processes, and public resistance due to uncertain environmental impacts. The following policy examples that affect the leasing, permitting, or operations of offshore wind projects 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 to identify priority WEAs for potential development; improve BOEM coordination with local, state, and federal partners; and accelerate 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, a memorandum of understanding (MOU) signed by the DOI and the states of Maine, New Hampshire, Massachusetts, Rhode Island, New York, New Jersey, Delaware, Maryland, Virginia, and North Carolina created the Atlantic Offshore Wind Energy Consortium to facilitate federal/state offshore wind development coordination. 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*, where developers have a short-term right to evaluate a wind resource with a longer-term right to develop.
- *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.

2.5.1.3 Permitting

The initial challenge for offshore wind development was lack of a specified leasing process. Cape Wind filed its initial permit application with the US Army Corps for its wind farm and transmission interconnection in 2000 and then 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.
- *Develop a programmatic EIS (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, which may 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.

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.

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.

U.S. states are taking a variety of approaches to offshore wind site selection and leasing. Common themes are to form 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**	**Texas**	**Virginia**
General: Panels or task forces in place to engage local stakeholders to identify constraints and 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 call for lease nominations				✓	✓			✓			✓		✓

(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 as in 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 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.[43] 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

[43] http://www.boem.gov/Renewable-Energy-Program/State-Activities/VA/Commercial-Lease-for-Wind-Energy-Offshore-Virginia.aspx

of site assessment proposals by developers 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 if they 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.[44] 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 and the interconnection cables offshore and onshore.

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 federally-approved coastal zone management program. This state review process is frequently referred to as a CZMA "consistency review."

[44] 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.

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:

- 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 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. [45]

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.

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

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[45] 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

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.

2.5.3 Current Policies in Europe

Table 2-7 summarizes the regulatory policies currently in place in selected countries in Europe. The first row of Table 2-7 describes the challenges in each policy area that exist in the U.S. Detailed descriptions of these policies are provided in Appendix C.

Table 2-7. 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
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	» DEA is a one stop shop » EIA is required if environmental impact is likely	Developers must have comprehensive environmental monitoring programs
Germany	» Five priority areas for offshore wind identified in the Germany North and Baltic Seas	» Open door procedure for permits	Developers are responsible for baseline assessment and annual monitoring
Netherlands	» OSW zones have been identified » Preparing for Dutch Round 3 » Competitive tendering for development rights	» 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 2-8 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 2013.

Table 2-8. Offshore Wind Policy Examples and Developments

Barrier	Policy Examples	2013 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 were extended for projects that begin construction[46] by year-end 2013 but another short-term extension is unlikely unless part of major tax reform. The 50% first-year bonus depreciation allowance was also extended in 2013. » The U.S. DOE announced seven projects that will receive $4M in funding to complete engineering and planning as the first phase of the Offshore Wind Advanced Technology Demonstration Program. » The Maryland Offshore Wind Energy Act established Offshore Wind Renewable Energy Credits for up to 200 MW, limiting ratepayer impacts while broadening the cost-benefit analysis, including consideration of peak coincident price suppression. » The Maine legislature passed a bill that re-opened the bidding process for ratepayer subsidies to offshore wind projects. » The NJ BPU continues to promulgate rules for 1100 MW of ORECs.
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	» Massachusetts is investing $100M to upgrade the New Bedford Port for construction of the Cape Wind Farm. » Atlantic Wind Connection was split into New Jersey Energy Link as the first phase and continues to ask that all ratepayers share the costs as well as the benefits.

[46] 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

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 held the first two competitive lease sales for renewable energy offshore Rhode Island and Virginia. » Illinois passed the Lake Michigan Wind Energy Act which requires the Illinois DNR to develop a detailed offshore wind energy siting matrix for Lake Michigan.
	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 analysis

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 to be 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

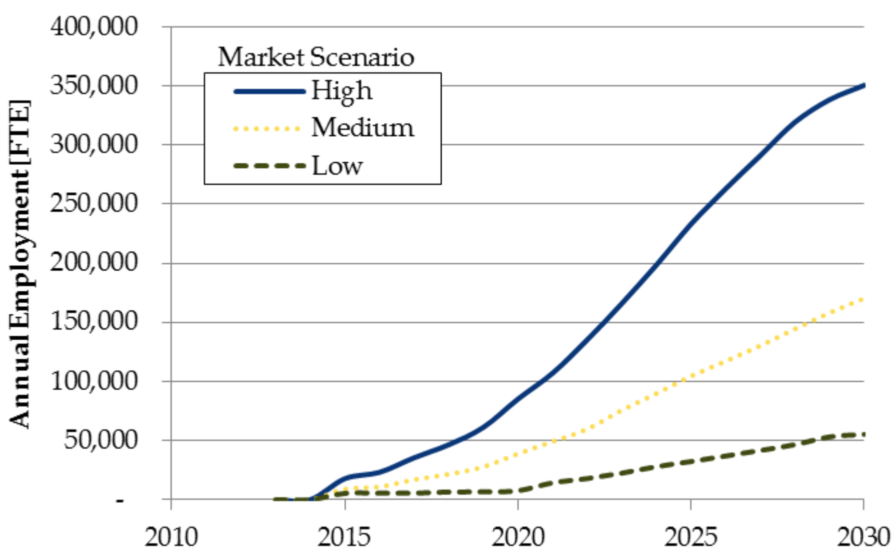
3.1 *Summary*

Summary of Key Findings – Chapter 3
» Construction has not yet started on offshore wind farms, so employment levels are low. » Employment likely ranges from 150 to approximately 600 FTEs, based on a survey of current stakeholders.

3.2 *Scope of Update*

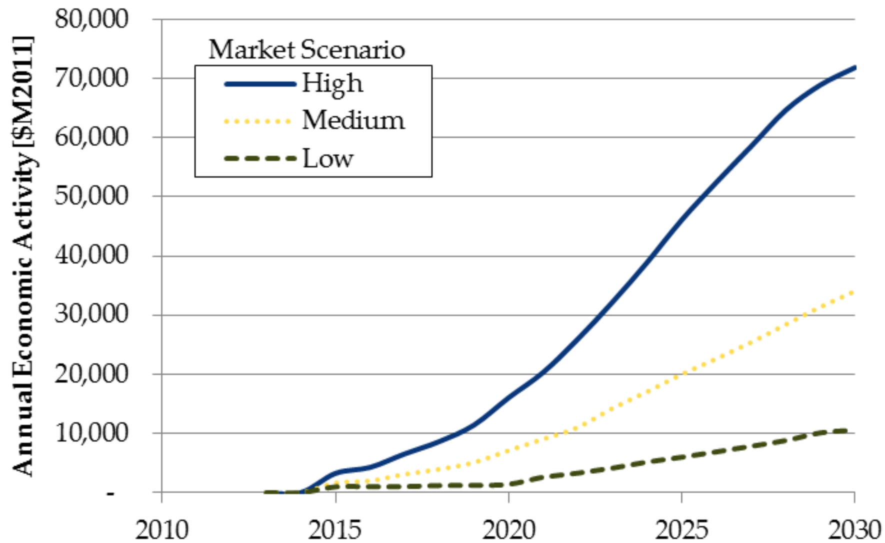
The original intent of this annual report on economic impacts of the U.S. offshore wind industry was to benchmark our 2012 projections against actual results in 2013 and 2014. However, as shown in Figure 1-3, our 2012 forecasts did not show installations in 2013 and 2014. Because of this, we did not project any employment or economic impacts in 2013 and 2014, as shown in Figure 3-1 and Figure 3-2, respectively. However, 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 as a baseline for future studies. We first describe our data collection efforts and then the resulting levels of employment and investment.

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 Baseline Data Collection

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 significant 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[47] model, which was created in 2012, to assess potential levels of employment.

3.3.1 Online Survey

[47] NREL's JEDI models are publicly available spreadsheet tools that apply state-specific IMPLAN year 2010 multipliers. The JEDI analysis tools were developed by NREL in conjunction with MRG & Associates. For more information on the JEDI tools, see http://www.nrel.gov/analysis/jedi/.

As discussed above, the Navigant Consortium sent out an online survey to offshore wind industry stakeholders in early 2013. 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 percent 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 was the category: (a) manufacturing, (b) construction, or (c) other?

122 people viewed the survey, 40 started it, and 30 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 FTEs and investment are shown in Table 3-1.

3.3.2 Phone Survey

As part of the online survey, we collected information on what company each respondent worked for. For companies that likely employed people right now or were making large investments, we reached out to them via phone calls. We were able to collect information from several more companies, and the results are included in Table 3-1.

3.3.3 JEDI Estimates

We examined the projects in Table 1-2 and used the offshore wind JEDI model to simulate the manufacturing related employment to support the projects that have 2015 and 2016 installation 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 selected a range of possibilities for domestic sourcing and analyzed those using JEDI. The range of results is shown in Table 3-1. The low end assumes zero domestic sourcing, and the high end assumes 100 percent domestic sourcing.

3.4 *Results*

Current employment levels could be between 150 and 590 FTEs, and current investment could be between $21 million and $159 million. The ranges are driven by our uncertainty about from where advanced-stage projects are sourcing components. These estimates now provide us a baseline to check employment against for future reports. As the advanced stage projects start construction, employment levels will likely double or triple to support equipment transport and installation. Our 2014 report will focus on trying to capture those impacts.

Table 3-1. Estimated Employment and Investment in the U.S. Offshore Wind Industry

Project Phase	Data Source	Total FTE's	Total Investment
Development	Online and Phone Survey	150	$21M
Manufacturing and Construction	Modeled Estimates	0 to 440	0 to $138M
	Total	150 to 590	$21M to $159M

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.

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

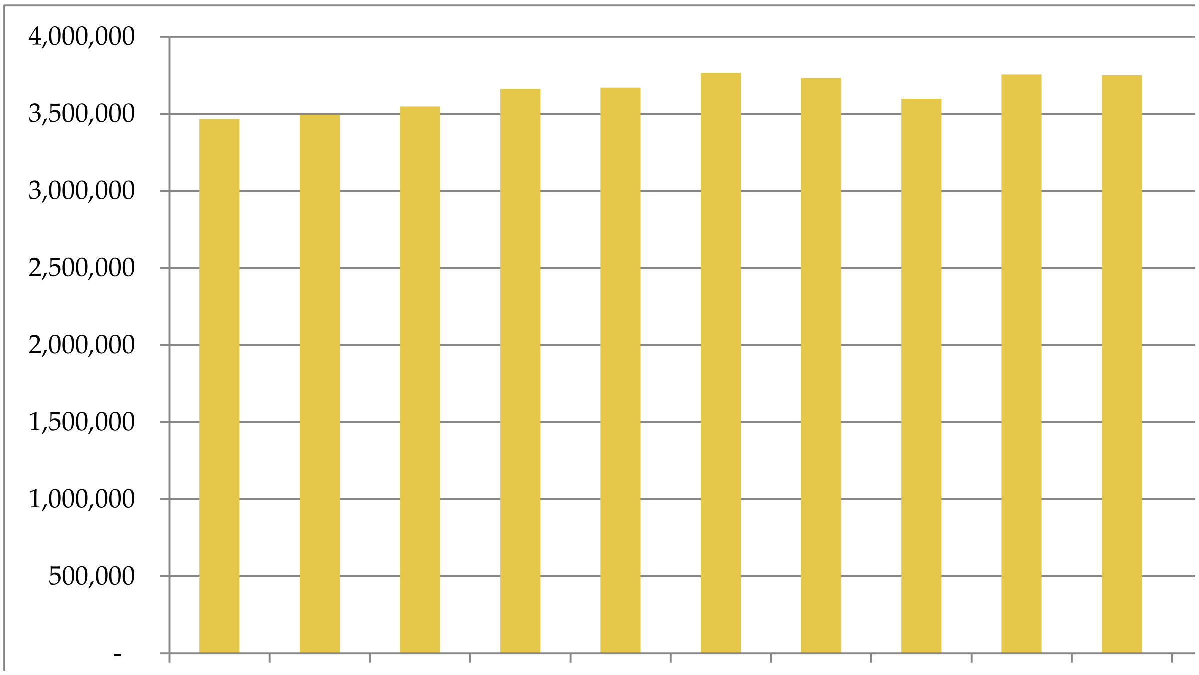
Source: Navigant analysis

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 change 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.

Figure 4-1. U.S. Retail Electricity Sales: 2002-2012 (million kWh)



Source: EIA

4.2.2 Change in the Country's Nuclear Power Generation Capacity

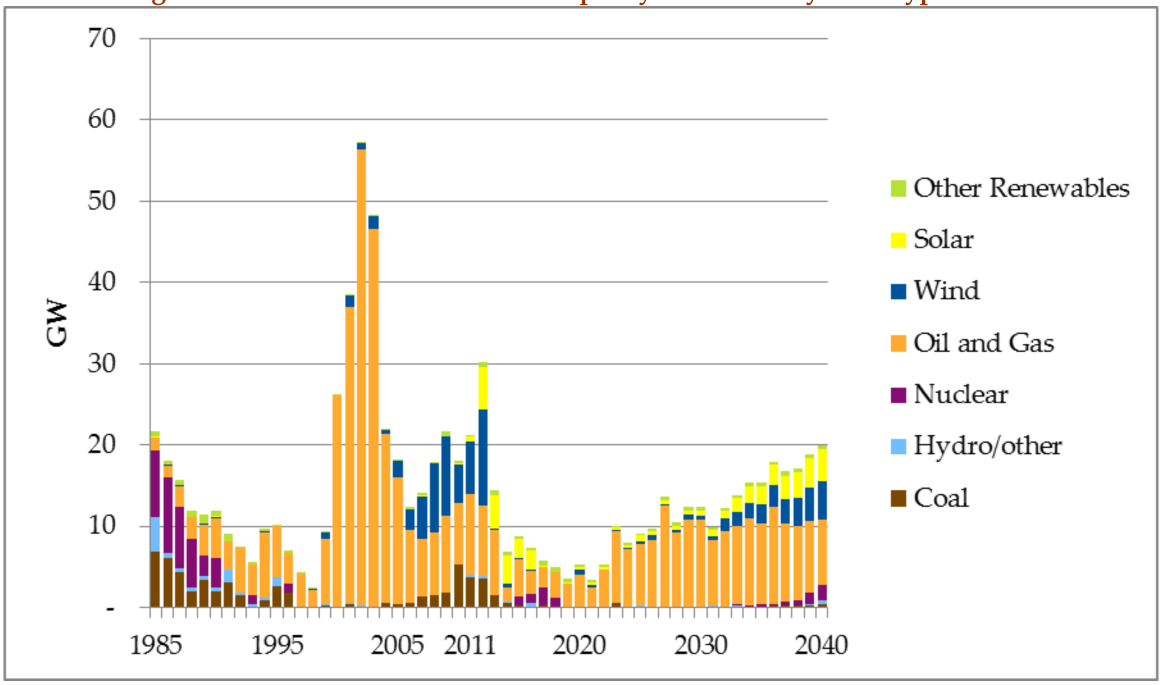
After the Fukushima nuclear accident in Japan in 2011, Germany decided to abandon over 20 GW of nuclear power, closing eight plants immediately, with the remaining nine plants set to close by 2022. Realizing the additional power generation capacity needed to avoid a supply shortfall, the country has developed and begun to execute plans to install a significant number of large offshore wind farms in the North and Baltic Seas. Through 2012, Germany's installed capacity of offshore wind was 278 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. 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 wind (see Figure 4-2), partly in response to the environmental impacts of coal-fired electricity generation.

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 (see Figure 4-3).

Figure 4-3. Henry Hub Gulf Coast Natural Gas Spot Price 2007-2013

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 United States could increase.

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

In recent years, some electric utilities in the United States have announced plans to retire coal-fired power plants or to convert them to natural gas. Navigant analysis reveals executed and planned retirements through 2017 that exceed 37 GW. There are multiple factors involved in these retirement decisions. Many of the United States' 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 and proposed carbon dioxide emissions limits, can also be costly. 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 United States.

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."[48] 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.

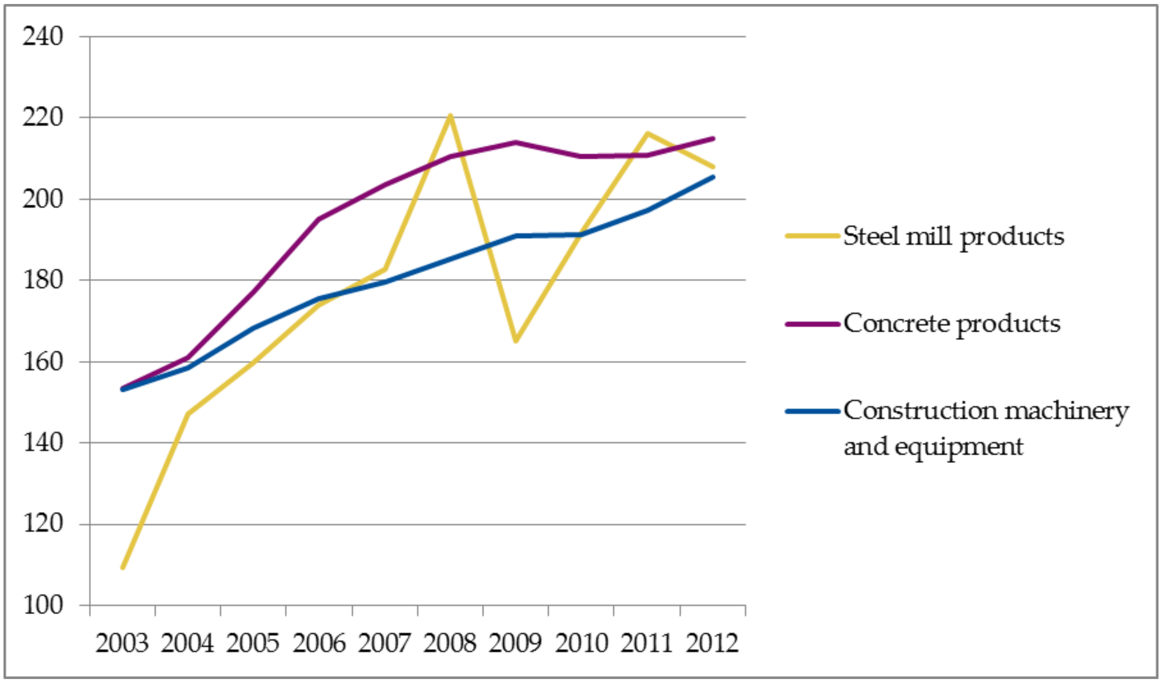
4.4 Construction

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 7-8 percent of the cost of an offshore wind farm and the foundations and substructures represent 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.

[48] http://www.seajacks.com/who_we_are.php

Figure 4-4. Producer Price Index for Selected Commodities (2003-2012)



Base Year (100) = 1982
Source: United States Department of Labor, Bureau of Labor Statistics

4.5 Manufacturing

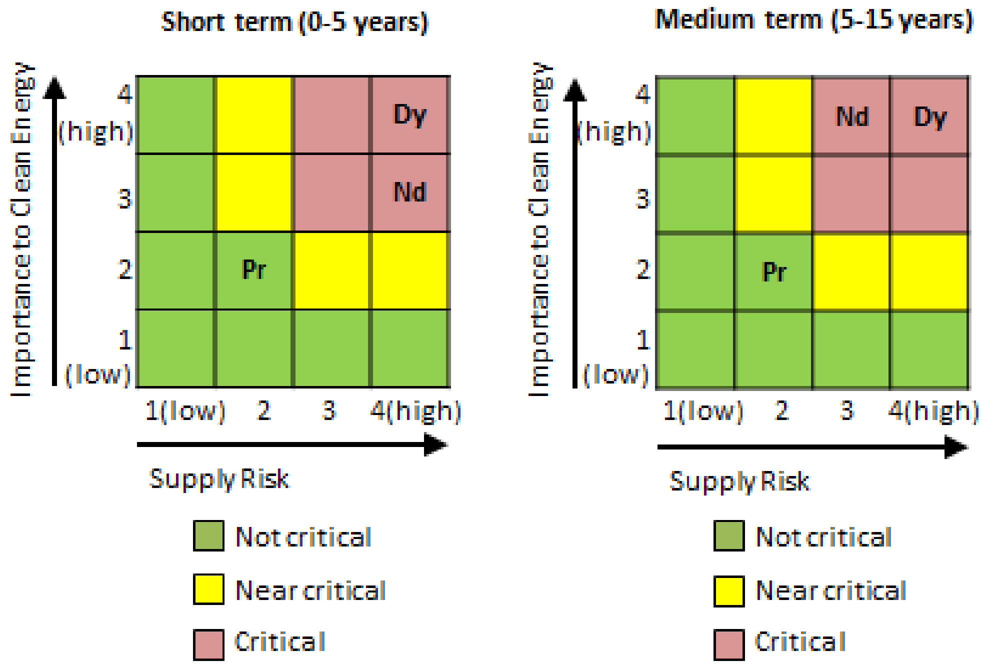
4.5.1 Change in Manufacturing of Products That Utilize Similar Types of Raw Materials as Offshore Wind

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[49] 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.

[49] U.S. Department of Energy. Critical Materials Strategy. December 2010.

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.[50]

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 (BTM 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.

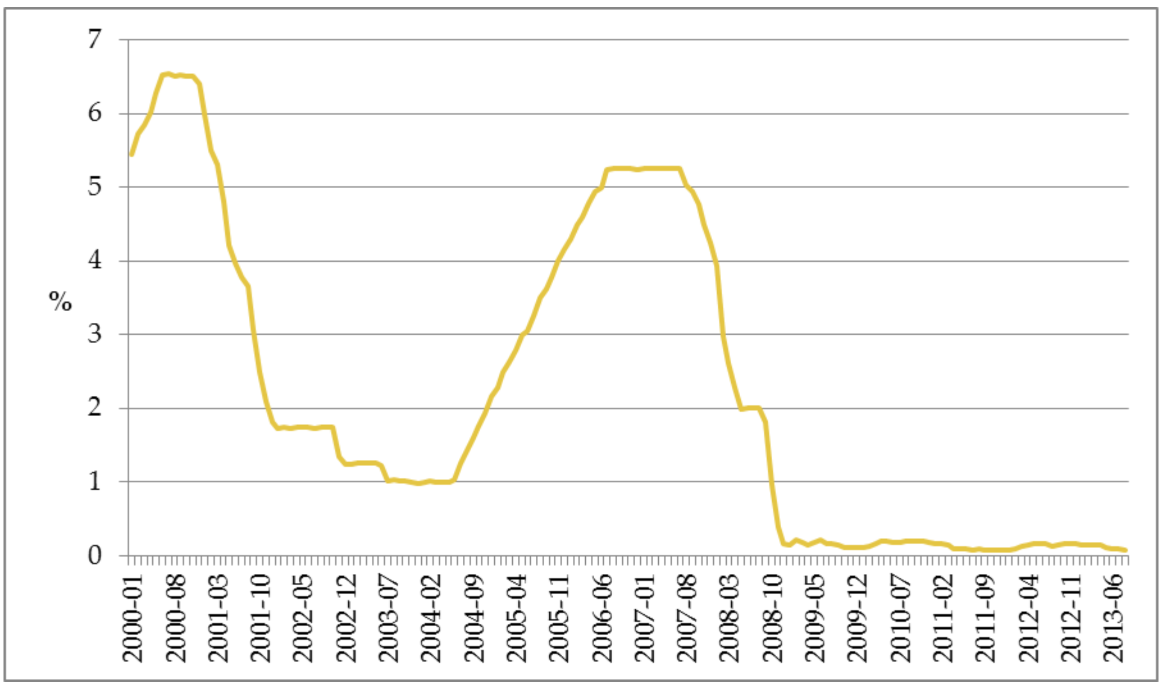
[50] Massachusetts Institute of Technology Materials Systems Laboratory. Evaluating Rare Earth Element Availability: A Case with Revolutionary Demand from Clean Technologies. February 2012.

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 – July 2013



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 proper policy designs can stimulate offshore wind markets. Although current U.S. offshore wind employment levels and investment are modest, employment could be between 150 and 590 FTEs, and current investment could be between $21 million and $159 million. As this report is updated and published annually, the Navigant Consortium hopes 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.

The survey, interviews, and workshops that provided important inputs to this report content will be repeated each year as part of the annual data collection and dissemination process. The Navigant Consortium appreciates the input and cooperation that participants have provided and looks forward to similar involvement in future installments of this report.

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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.

<u>The Jones Act</u>

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. 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, 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 would also 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. This approach seeks to 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), 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

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, 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.[51] 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, environmental resources, and competing human uses such as fishing.

[51] "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[52]

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.

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.[53]

[52] http://www.energy.ca.gov/reti/RETI_FAQ.PDF

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.[54]

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.[55]

In December 2011, NRG-Bluewater Wind failed to make a substantial deposit to maintain the PPA. NRG negotiated a lease for the site from BOEM after BOEM determined that there was no competitive interest in the site. 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.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.[56]

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 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:

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[53] http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=DE06R&re=1&ee=1
[54] http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=DE06R&re=1&ee=1
[55] http://www.usowc.org/states/de.html
[56] See http://boem.gov/Renewable-Energy-Program/State-Activities/Delaware.aspx.

- 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

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.

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.

Maryland issued an RFP in July 2012 to conduct initial marine surveys with state funds 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.

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 reduced the WEA to 9 lease blocks to reduce conflicts with shipping and other constraints.[57]

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.[58] 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 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

[57] See http://boem.gov/Renewable-Energy-Program/State-Activities/Maryland.aspx.

[58] http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=MA05R&re=1&ee=1

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."[59]

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.

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.

Some additional lawsuits challenging environmental approvals of the project have been consolidated and remain outstanding, but Cape Wind has conducted final geophysical and geotechnical surveys, negotiating construction contracts, and planning to proceed with construction over the next couple of years.

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.[60]

B.7 Michigan

B.7.1 Site Selection and Leasing Policies

[59] The 300-plus-page DPU order is located at http://www.env.state.ma.us/dpu/docs/electric/10-54/112210dpufnord.pdf.
[60] See http://boem.gov/Renewable-Energy-Program/State-Activities/Massachusetts.aspx.

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.[61]

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 plans to issue final rules in 2013.

[61] http://www.michigan.gov/mpsc/0,4639,7-159-16400_17280-230708--,00.html)

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. Fishermen's Energy has submitted a second proposed settlement to the BPU for review.

B.8.2 Site Selection and Leasing Policies

BOEM issued a Call for Information for New Jersey projects on April 20, 2011, and received 11 lease nominations and 16 comments on environmental issues and competing uses. NREL is determining how to divide the WEA into 3 to 5 blocks for the lease auction.[62]

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.

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. BOEM issued a Request for Competitive Interest inviting other developers for this 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, which will result in a competitive process for development of this WEA.

NYPA has issued an RFP to hire consultants to prepare a Site Assessment Plan to file after BOEM's Determination of No Competitive Interest. 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.

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[62] See http://boem.gov/Renewable-Energy-Program/State-Activities/New-Jersey.aspx.

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.

B.10 Ohio

B.10.1 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.11 Rhode Island

B.11.1 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.[63]

B.11.2 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 has initiated marine surveys, bird and bat surveys, with project permitting taking place in 2012 and construction projected for 2015.

[63] See http://offshorewind.net/OffshoreProjects/Rhode_Island.html.

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.[64]

B.12 Texas

B.12.1 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.12.2 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.[65]

B.13 Virginia

B.13.1 Policies to Address Cost Competitiveness

Virginia is seeking to reduce the cost of offshore wind by having the local transmission system owner, Dominion Energy (Virginia Power), conduct interconnection studies exploring a high-voltage offshore submarine cable that could interconnect to a few wind farms.[66]

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

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[64] See http://boem.gov/Renewable-Energy-Program/State-Activities/Rhode-Island.aspx.

[65] http://www.texascrezprojects.com/

[66] See https://www.dom.com/news/2012/pdf/dominion_offshore_public_report_3-13-2012.pdf.

Final Notice of Lease Sale, conducted an auction on September 4, 2013, and determined that Dominion won the bidding for the entire WEA, subject to the anti-trust review.[67]

[67] See http://boem.gov/Renewable-Energy-Program/State-Activities/Virginia.aspx

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 Denmark

C.1.1 Transmission

Offshore wind sites in Denmark are granted through the Danish Energy Agency's (DEA's) competitive tender process. The Danish transmission system operator (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 recent tendering process of the Anholt wind farm. 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.1.2 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 of Esbjerg's board of directors has developed a strategic plan through 2019 that includes DKK 1 billion (USD 183 million) of investment for new infrastructure and reconfiguring the port's facilities to create additional space for wind turbines in a new south harbor.[69]

C.1.3 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

[68] http://www.esbjergkommune.dk/Admin/Public/DWSDownload.aspx?File=Files/Filer/Engelsk/New_Energy_Esbjerg.pdf
[69] http://www.investindk.com/News-and-events/News/2009/Offshore-wind-farms-mean-big-business-for-the-Port-of-Esbjerg

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.

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.[70]

C.1.4 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.[71]

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. Feasibility studies for those areas have been initiated in January 2013 and prior notice of availability will be published during 2013. Also in January 2013, the DEA published details of the tender process and the provisional timetable for 1,500 MW of planned offshore wind power to be installed by 2020. The DEA

[70] http://ec.europa.eu/ourcoast/download.cfm?fileID=983
[71] http://www.ens.dk/en-US/supply/Renewable-energy/WindPower/offshore-Wind-Power/Procedures-and-permits-for-offshore-wind-parks/Sider/Forside.aspx

will initiate the tender process for two large offshore wind farms in 2013 (Horns Rev 3 and Krieger's Flat); however, the outcome of these tenders are not expected until 2015.[72]

C.1.5 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." 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.1.6 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).[73]

C.2 Germany

C.2.1 Transmission

[72] http://www.offshorewind.biz/2013/01/31/denmark-to-launch-offshore-wind-tenders-timetable-now-ready/
[73] http://193.88.185.141/Graphics/Publikationer/Havvindmoeller/Offshore_wind_farms_nov06/pdf/havvindm_korr_16nov_UK.pdf

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.

C.2.2 Ports

C.2.2.1 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.[74] 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.[75] The state of Bremen was the first in northern Germany to implement such a policy for offshore wind.[76] 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 €200 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 Bremen

[74] http://www.power-cluster.net/AboutPOWERcluster/ProjectPartners/BremerhavenEconomicDevelopmentCompany/tabid/624/Default.aspx

[75] http://www.ewea.org/fileadmin/ewea_documents/documents/publications/WD/2009_september/Mini_Focus_September_2009.pdf

[76] http://druid8.sit.aau.dk/acc_papers/16vikj17dhdajdhyxsi7vymf446q.pdf

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.[77]

C.2.2.2 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.[78] 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.[79] 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.[80]

C.2.3 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.[81] In 2004, Germany's Federal Spatial Planning Act was expanded to the EEZ, which extends 200 nautical miles from the German shore.[82] 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 in the Germany 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 it is subject to the results of comprehensive environmental impact assessments.

C.2.4 Permitting

As mentioned in Section 2.5.3, in 2004, Germany's Federal Spatial Planning Act was expanded to the EEZ.[83] 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

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[77] http://www.bremenports.de/misc/filePush.php?id=571&name=Offshore_Broschuere_eng.pdf
[78] http://www.pes.eu.com/assets/misc_new/pp52-55seaportspdf-202124705931.pdf
[79] http://renewables.seenews.com/news/germanys-ports-in-cuxhaven-bremerhaven-bet-on-offshore-wind-power-23354
[80] http://www.cuxport.de/en/rhenus-cuxport/services/offshorebase-cuxhaven/
[81] http://www.northsearegion.eu/files/repository/20120320110429_PC-StateoftheOffshoreWindIndustryinNorthernEurope-Lessonslearntinthefirstdecade.pdf
[82] http://www.nve.no/Global/Energi/Havvind/Vedlegg/Offshore%20wind%20experiences%20-%20A%20bottom-up%20review%20of%2016%20projects%20(Ocean%20Wind).pdf
[83] http://www.nve.no/Global/Energi/Havvind/Vedlegg/Offshore%20wind%20experiences%20-%20A%20bottom-up%20review%20of%2016%20projects%20(Ocean%20Wind).pdf

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.2.5 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)."[84]

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.[85]

C.3 The Netherlands

C.3.1 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.[86]

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

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[84] http://www.bsh.de/en/Products/Books/Standard/7003eng.pdf

[85] http://www.iwes.fraunhofer.de/en/press_media/overview/2012/alpha-ventus--research-and-industry-present-common-achievements.html

[86] http://www.tennet.org/english/images/100552%20TEN%20Offshorebroch%20%20EN_tcm43-19468.pdf

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.[87] The transmission cable would enable the connection of offshore wind farms.

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.[88]

C.3.2 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. Neither government nor industry is satisfied with the planning and organization of the Dutch Round 2, and final decisions on how to organize Round 3 have not been made. Current plans are that the Ministry of Transport and Waterworks may reserve four large areas totaling about 1,000 square kilometers for offshore wind. Consortia may then be asked to tender for wind concessions in those areas, together with earmarked financial support. Selection should then be based upon financial strength of the consortia, their plans, and their track record, as in the U.K. system.

C.3.3 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 Stimulation of Sustainable Energy Production (SDE) tariff. To date, two tendering rounds

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[87] http://www.eib.org/projects/press/2011/2011-013-eib-supports-key-dutch-grid-project-to-connect-offshore-wind-farms.htm

[88] http://www.tennet.org/english/projects/Internationaalenoffshore/index.aspx

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 and have resulted in new government strategies to reach the 2020 renewables targets.

In December 2008, the Dutch cabinet announced two locations in the North Sea where future offshore wind farms can be developed, a 344-square-kilometer area located some 35 km off the coast of Walcheren and a 1,170-square-kilometer area approximately 90 km off the coast of the Noord-Holland province. In addition, two search areas were defined, one just off the coast of Noord-Holland and a second area to the north of the Wadden Sea Islands. It is TenneT's responsibility to prepare its transmission grid in due time to accommodate these new offshore wind farms.

C.3.4 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.3.5 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.[89] 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

[89] http://www.agentschapnl.nl/programmas-regelingen/ecology-and-environment

consistency, integrity, validity, and plausibility of the data. Moreover, NL Agency was instructed to store and distribute the data to third parties.[90]

C.4 United Kingdom

C.4.1 Transmission

The U.K. government's offshore electricity transmission regulatory regime separates the generation from the transmission. Ofgem regulates offshore transmission in the United Kingdom. In the country's offshore wind market, qualifying companies 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 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.

C.4.2 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*.[91] 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.[92] 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).[93] 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.

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[90] http://www.agentschapnl.nl/programmas-regelingen/monitoring-and-evaluation-windpark-egmond-aan-zee
[91] www.berr.gov.uk/files/file49871.pdf
[92] http://assets.dft.gov.uk/publications/national-policy-statement-for-ports/111018-ports-nps-for-das.pdf
[93] http://www.hm-treasury.gov.uk/d/nationalinfrastructureplan251010.pdf

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.[94] 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." [95]

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 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,[96] and Gamesa has chosen to manufacture offshore turbines at the Port of Leith near Edinburgh.[97] Assuming that a solid pipeline of projects exists, Vestas will build its V164-7.0 MW turbines at the Port of Sheerness in Kent.[98]

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

C.4.3 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.4.4 Round 2

Whereas Round 1 was developer-led, Round 2, launched in 2003, was government-led. The U.K. government recognized

[94] http://www.decc.gov.uk/en/content/cms/news/pn10_111/pn10_111.aspx
[95] http://www.decc.gov.uk/en/content/cms/news/pn10_111/pn10_111.aspx
[96] http://www.bbc.co.uk/news/uk-england-humber-17993593
[97] http://www.guardian.co.uk/environment/2012/mar/23/gamesa-offshore-windfarm
[98] http://www.vestas.com/en/media/news/news-display.aspx?action=3&NewsID=2662

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.

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.4.5 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.4.6 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.4.7 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.

In the U.K., offshore wind farm license holders are responsible for monitoring the environmental impacts of their facilities.

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."[99] 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
- 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

[99] http://cefas.defra.gov.uk/media/393490/strategic-review-of-offshore-wind-farm-monitoring-version-final-19-august-2010-sir.pdf