

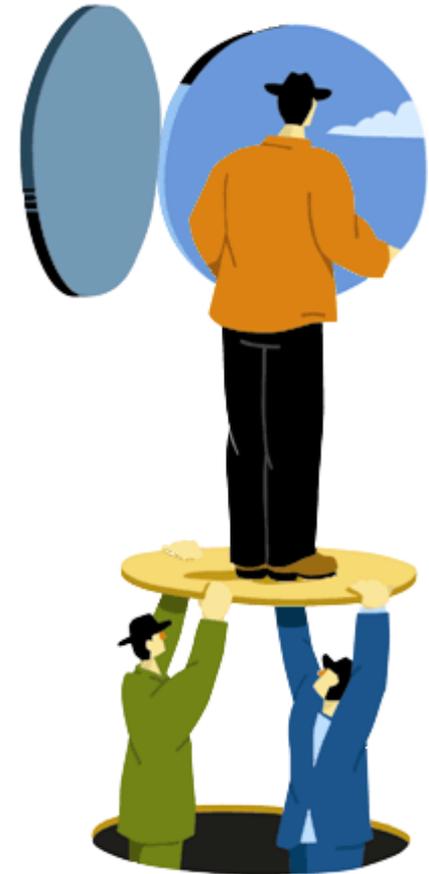
## Offshore Wind Market and Economic Analysis Summary

*U.S. DOE's WINDEXchange webinar on the Economic Impacts of Offshore Wind: Market, Manufacturing, and Jobs*



Presented by **Bruce Hamilton** | Navigant  
November 19, 2014

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## Content of Report

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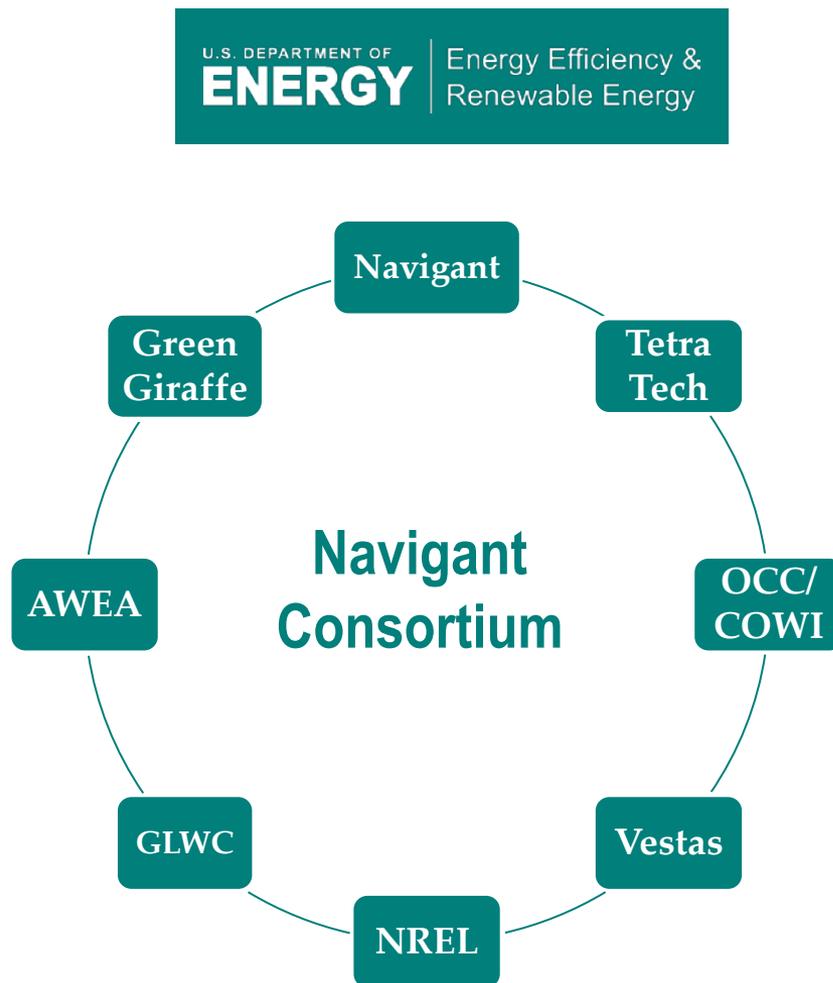
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November 2014

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**This presentation summarizes the 2014 Offshore Wind Market & Economic Analysis report produced by the Navigant Consortium for the U.S. DOE.**



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## **1 » Global Offshore Wind Development and Technical Trends**

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## There are approximately 7 gigawatts (GW) of offshore wind (OSW) installations worldwide.

### Installed Global Offshore Capacity through 2013

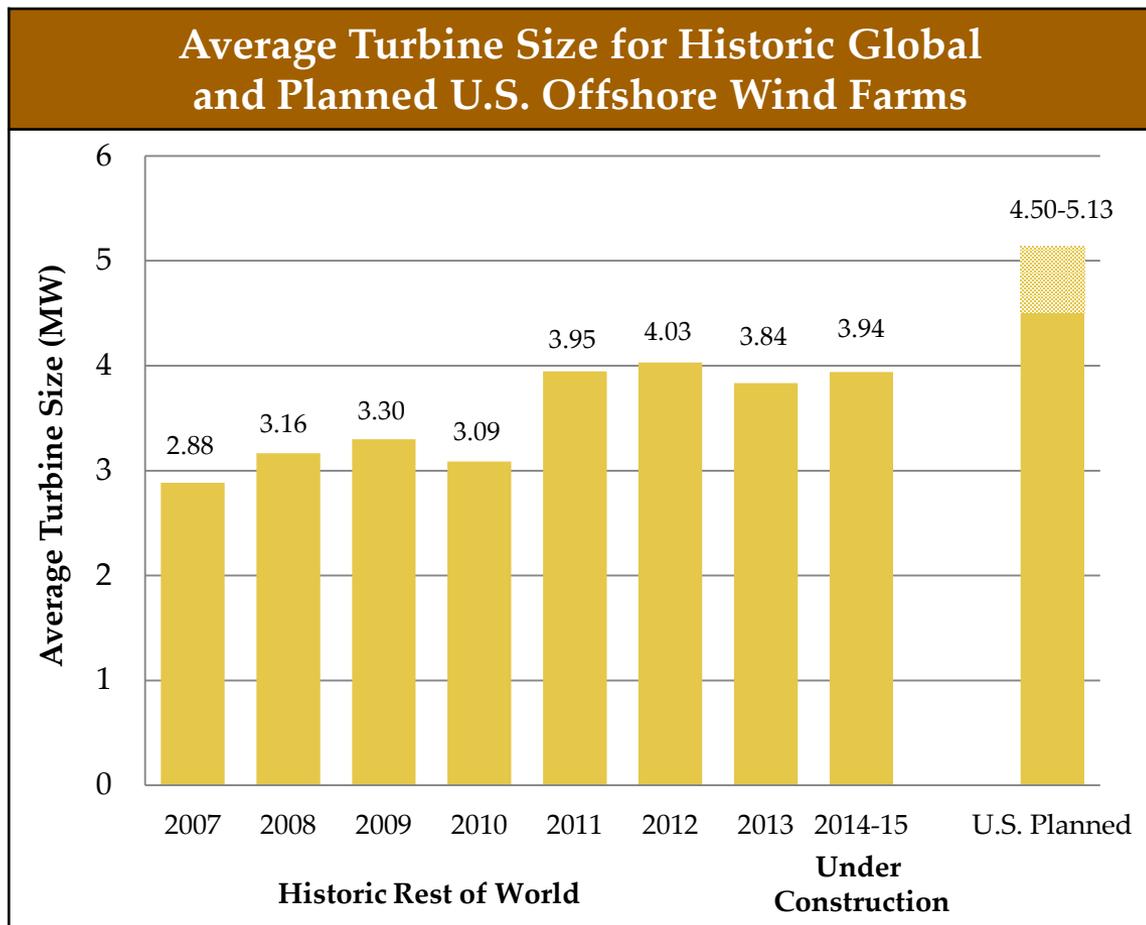
Region	Country	Total Capacity (MW)	Operational Projects	Installed Turbines
Europe	U.K.	3,686	30	1,083
	Denmark	1,274	17	517
	Belgium	571	6	135
	Germany	516	8	115
	Netherlands	247	4	128
	Sweden	212	6	91
	Finland	32	3	11
	Ireland	25	1	7
	Spain	5	1	1
	Norway	2	1	1
	Portugal	2	1	1
Asia	China	404	16	159
	Japan	52	9	28
	South Korea	5	2	2
<b>Total</b>		<b>7,031</b>	<b>104</b>	<b>2,277</b>

- Majority of activity continues to center on northwestern Europe.
- Development in China continues to progress.
- In 2013, 1,720 MW were added globally.
- The European market will continue to grow rapidly over the next two years
- New and expanding projects likely to contribute a record-setting 2,290 MW in 2014 alone (mostly in Germany and U.K.).

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

## The growth in average nameplate capacity of offshore wind turbines installed globally each year tapered off around 4 MW in 2013.

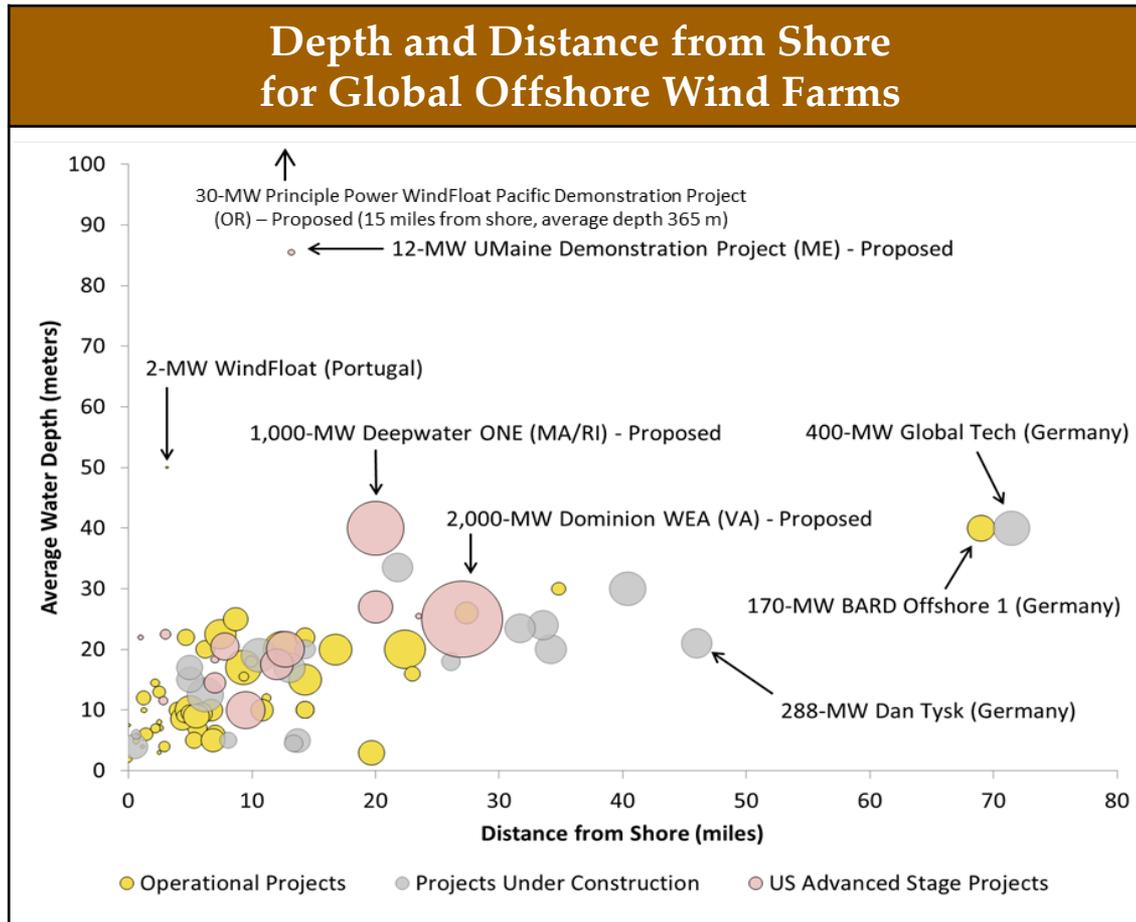


- Smaller turbines in Asian projects are the main reason for the drop in average size.
- Nearly two-thirds (64%) of turbines installed in 2013 were 3.6-MW models.
- 14% of installed turbines were larger (5 to 6.15 MW).
- Long-term trend toward larger turbines is likely to continue.
- Beyond Cape Wind, LEEDCo and Galveston Offshore Wind, most U.S. projects plan to utilize larger ( $\geq 5$ MW) offshore wind turbines.

Note: Average turbine size is based on an annual capacity-weighted figure (each project's turbine size is weighted against its share of annual installed capacity). While it has begun construction activities, Cape Wind (which plans to use 130 3.6-MW turbines) is included in the U.S. Planned category.

Source: Navigant analysis of data provided by NREL and BTM

## Globally, offshore wind projects continue to trend further from shore into increasingly deeper waters.

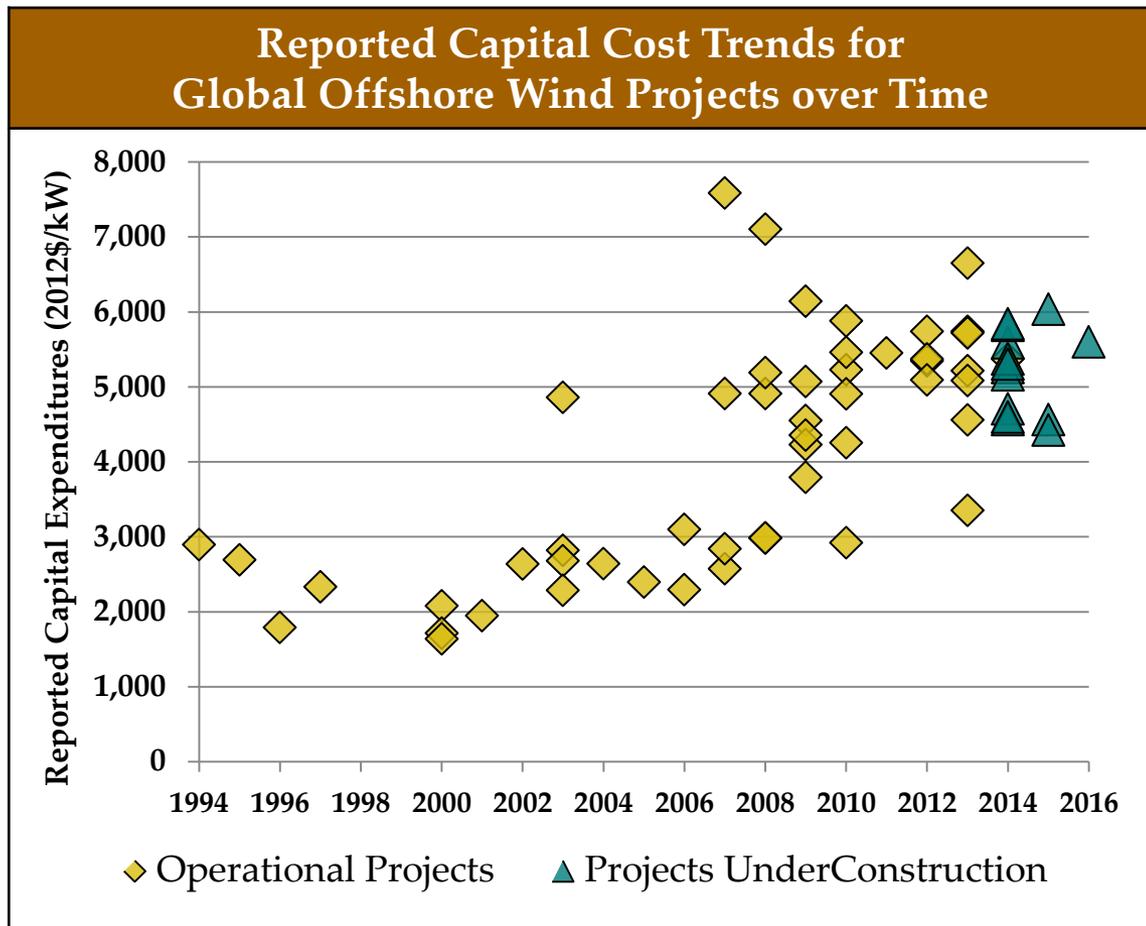


- Several projects currently under construction are continuing to push into more distant and deeper waters.
- Advanced-staged projects in the U.S. are planned for closer to shore than recent European projects.
- Two of the potential DOE advanced demonstration projects (UMaine and Oregon’s WindFloat) have proposed floating turbines at record-setting depths.
- Notably, some of the BOEM WEAs have average depths that exceed those of any currently operating commercial projects.

Note: Bubble size indicates projects’ relative capacities; several projects are labeled for scale. Multi-phase projects were combined to show cumulative project capacity. Chart does not include the proposed Principle Power WindFloat project off the coast of Oregon (365 meter depth, 15 miles from shore)

Source: Navigant analysis of data provided by NREL and BTM

Offshore wind power prices have been following a generally increasing trend, although average costs decreased slightly in 2013.



- Cost increases are a function of several trends:
  - a movement toward deeper-water sites located farther offshore;
  - increased siting complexity; and
  - higher contingency reserves and greater uncertainty when working in the offshore environment.
  
- For projects installed in 2013 for which data was available, average reported capital cost was \$5,186/kW.

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

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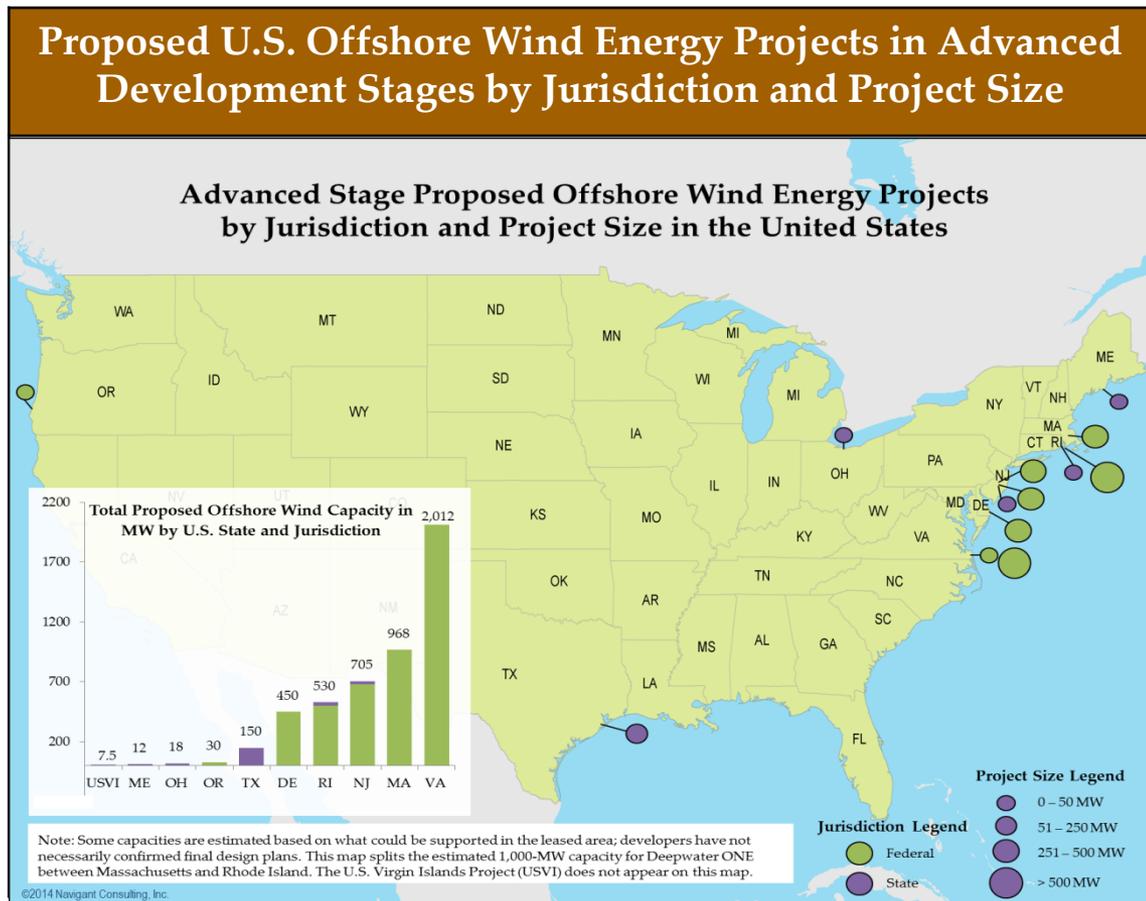


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**In the U.S., according to Navigant’s analysis, 14 offshore wind projects, totaling 3.9 GW, have reached an advanced stage of development.**



- Criteria for “Advanced-Stage” Projects:
  - Received approval for an interim limited lease or a commercial lease in state or federal waters
  - Conducted baseline or geophysical studies with met tower erected and collecting data, boreholes drilled, or geological and geophysical data acquisition system in use
  - Signed power purchase agreement

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

## Since last year's report, some potential U.S. offshore wind projects have achieved notable advancements, while others have emerged.

Project Name (State)	Proposed Cap. (MW)	Status Notes	Target Compl. Date <sup>a</sup>
Block Island Offshore Wind Farm (Deepwater) (RI)	30	National Grid has agreed to a 20-year PPA. Signed installation contract with ship-owner Bold Tern in February 2014 for construction in Q3 of 2016. The developer is working to finalize environmental permitting approvals so that it can move beyond the initial stages of construction. The team represents that it has complied with IRS guidance to be eligible to receive the Investment Tax Credit (ITC).	2016
Cape Wind Offshore (MA)	468	PPA in place for 77.5% of project's power through National Grid and NStar. Received \$600M loan financing commitment in February 2014, bringing estimated total of confirmed funds to at least \$1B out of an estimated final cost of \$2.6B. In July 2014, the project received a conditional \$150M loan guarantee from the DOE. The developer also represents that it has complied with IRS guidance to be eligible to receive the ITC.	2016
Ocean Offshore Energy: Saint Thomas	7.5	Ocean Offshore Energy has proposed a small commercial project off the coast of Saint Thomas in the U.S. Virgin Islands. The developer has completed underwater surveys and as of this report's writing was awaiting approval of its USACE permit.	2016
Fishermen's Energy: Phase I (Atlantic City Wind Farm)(NJ)	25	Project is fully permitted; however, in April 2014 the New Jersey Board of Public Utilities (BPU) denied allowing the project to use New Jersey's offshore renewable energy certificates (ORECs), citing high (and uncertain) costs for ratepayers. The developer disagrees with the BPU's calculations and assumptions and in May 2014, was one of three ATD projects selected by the DOE for up to \$47M in additional federal funding. In August 2014, the Superior Court of New Jersey ruled that the BPU had to reconsider Fishermen's application in the next 120 days.	2016
Virginia Offshore Wind Technology Advancement Project (VA)	12	Second of three ATD projects the DOE selected for deployment funding. This project will serve as a pilot facility adjacent to the larger commercial lease area for which the group was the winning bidder in September 2013. The team is currently conducting environmental studies and permitting efforts.	2017
Principle Power - WindFloat Pacific (OR)	30	Third of three ATD projects selected by the DOE for up to \$47M in federal funding. The BOEM previously had received an unsolicited lease request from Principle Power, and subsequently found no competitive interest in the area. Beginning in late May 2014, BOEM began accepting public comment for a forthcoming Environmental Assessment of the lease area. Principle Power has previously completed a geophysical survey of the lease request area and cable route.	2017

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.

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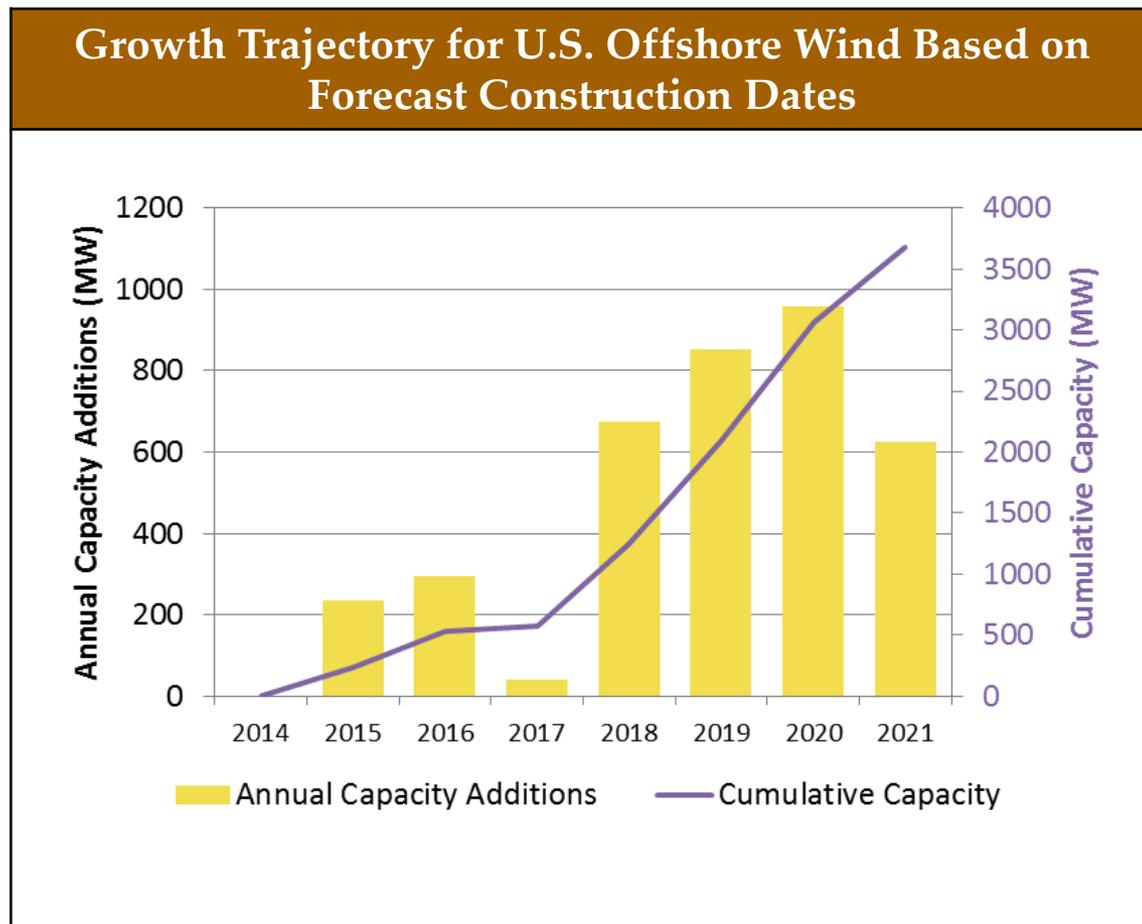
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Source: Navigant analysis based on published project information, developer statements and media coverage

## Since last year's report, some potential U.S. offshore wind projects have achieved notable advancements, while others have emerged.

Project Name (State)	Proposed Cap. (MW)	Status Notes	Target Compl. Date <sup>a</sup>
Fishermen's Energy: Phase II (NJ)	330	Received a met tower rebate from the state and began baseline surveys in August 2009. Has interim limited lease for initial assessment of wind farm feasibility; however, that lease is set to expire in November 2014.	2019
Galveston Offshore Wind (Coastal Point Energy) (TX) <sup>c</sup>	150	Has lease from Texas General Land Office and is collecting wind resources data via a met tower. The team plans to install a non-grid connected, 200-kW test turbine on the met tower foundation sometime in 2014.	2019
Lake Erie Offshore Wind Project (Great Lakes) (OH)	27	Lease signed with State of Ohio and geotechnical surveys completed. Shortly after filing initial permits, the project failed to make the DOE's list of ATD projects to receive full deployment funding. However, DOE announced it would provide the recipient a few million dollars under a separate award to work with the team to advance the project to "deployment readiness."	2019
University of Maine (ME)	12	The University received an initial DOE ATD award to pursue two more 6-MW turbines, and in January 2014 received a term sheet from the Maine PUC for a PPA with Central Maine Power. In May 2014, the project failed to make the list of final ATD projects; however, DOE announced it would provide the recipient \$3 million under a separate award to help complete the design.	2019
Garden State Offshore Energy Wind Farm (NJ)	350	Awarded an interim limited lease and began conducting baseline surveys in 2009. Launched weather buoy in late 2012. In January 2014, Deepwater and other developers encouraged the BOEM to delay planned lease sales for New Jersey until after the state BPU clarifies which developers can use ORECs to help finance offshore wind projects. The projects' interim lease will expire in 2014.	2019
Deepwater ONE	1,000	In August 2013, Deepwater was the winning bidder in the first competitive lease sale for a U.S. offshore wind area. They are marketing power to off-takers along the central Atlantic coast in the 13 to 14 cents/kWh range.	2020
Dominion Virginia Power - Virginia WEA Lease Project (VA)	2,000	Dominion has a commercial lease for the Virginia WEA, but has not yet released many details about its plans. The developer has only stated that it intends a phased development of up to 2,000 MW.	2022-2024
NRG Bluewater's Mid-Atlantic Wind Park (DE)	450	Received one of the first U.S. offshore leases from BOEM in October 2012 as part of "Smart from the Start" program. However, Delmarva has since canceled a PPA for 200 MW of the power. NRG filed its Site Assessment Plan in 2014, but the project website states that the project is officially on hold. NRG retains its development rights; however, it is unclear whether the project will be developed by NRG or sold.	2021

## Navigant has projected expected completion dates for each project based on developer statements and recent activities.



- Developers for three of the projects continue to compete to be the first commercial-scale offshore wind farm online in U.S. waters.
- It is unlikely that all 14 projects will achieve these targets, due to delays, cancellations, or other regulatory or market issues.
- Navigant expects that the initial growth of the U.S. offshore market would follow a trajectory like that shown to the left.

Source: Navigant analysis of collected project data

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## A portfolio approach that incorporates multiple policy elements has proven to be effective in overcoming market development barriers.

### Effective Federal Policies

- Extend Investment Tax Credits: Extended Years or 3000 MW
- Provide Lower Cost Financing
  - Loan Guarantees/Tax Exempt Bonds:
    - Approve Cape Wind, Deepwater Block Island, Fishermen's NJ
  - Master Limited Partnerships extended to Wind Generation
- Streamline Leasing & Permitting
  - Successful Competitive Auctions in RI/MA & VA

### Effective State Policies

- Strengthen Renewable Portfolio Standards -- Offshore Wind Carve Outs
  - Ocean Renewable Energy Credits (NJ, MD – issue regulations & ORECS)
- Long Term Power Purchase Agreements (RFPs in MA, RI, NY)
- Coordinated Competitive Procurement (New England States: RFP in 2014)
- Expand Transmission/Interconnection Incentives
  - Offshore Submarine Backbones (Atlantic Wind Connection to file GAP)
  - Broaden Transmission Cost Allocation (FERC Order 1000)

## 2014 has been an active year in OSW policy development at all levels.

### 2014 Global Developments

- The UK announced the strike prices for land-based and offshore wind generation through 2019, which should expedite Round 3 projects.
- The New German Energy Act clarifies the compensation that projects impacted by grid delays are entitled to, which should resolve grid construction delays
- China and Japan announced offshore wind target goals

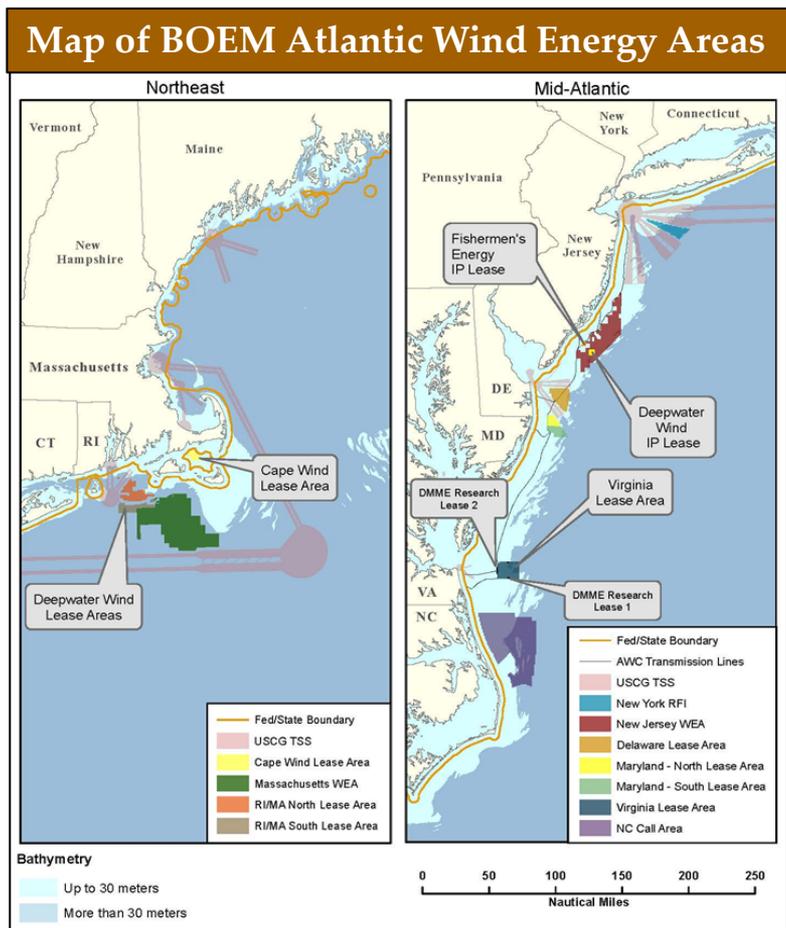
### 2014 Federal Developments

- PTC and ITC expired for projects that did not begin construction by year-end 2013. The 50% first-year bonus depreciation allowance also expired in 2013
- DOE announced three projects that will receive \$47 M each to complete engineering and construction as the second phase of the Offshore Wind Advanced Technology Demonstration Program.
- BOEM announced additional competitive lease sales for renewable energy off MA, MD, and NJ

### 2014 State Developments

- Maryland began promulgating rules for ORECs for up to 200 MW.
- The New Jersey Board of Public Utilities rejected a proposal for ORECs by Fishermen's Energy for a five-turbine project off Atlantic City, NJ
- The Maine Public Utility Commission approved a term sheet with a team led by the University of Maine for a pilot floating wind turbine project.

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



Source: BOEM 2014

Overview of BOEM Wind Energy Areas				
WEA	Status	Area (acres)	Area (sq. km)	Estimated OSW Potential (GW)*
MA	Announced	742,974	3,007	9.0
RI-MA	Awarded	164,750	667	2.0
NY	Scoping	81,280	329	1.1
NJ	Announced	354,275	1,434	4.3
DE	Scoping	103,323	418	1.3
MD	Awarded	79,706	323	1.0
VA	Awarded	112,799	457	1.4
<b>Total</b>		<b>1,639,107</b>	<b>6,635</b>	<b>20</b>

Source: NREL analysis (Musial et al. 2013a; Musial et al. 2013b) and National Wildlife Foundation analysis, August 2014

- July 2013 RI-MA lease awarded to Deepwater Wind
- Sept 2013 VA lease awarded to Dominion
- May 2014 Announcement of plans for an auction in MA and a Call for Information in NY
- July 2014 Announcement of NY Proposed Sale Notice
- Aug 2014 MD lease awarded to US Wind
- Aug 2014 Identification of 3 WEAs in NC

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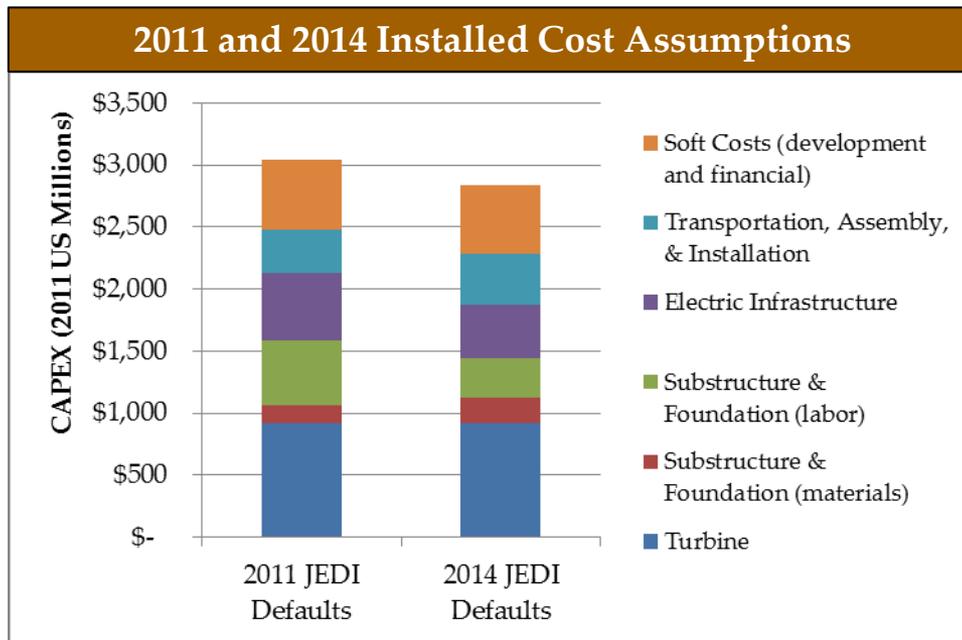
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## Navigant's cost projection for a 500 MW project in the Mid-Atlantic in 2018 is \$2.86 billion or \$5,700/kW, down 11% from our 2011 estimate.



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

## Summary

- **Global Offshore Wind Development and Technical Trends**

- Offshore wind plant size, turbine size, and capacity factors have shown a slow but steady increase over time.
- Globally, offshore wind projects continue to trend further from shore into increasingly deeper waters.
- Offshore wind power prices have been following a generally increasing trend, although average costs decreased slightly in 2013.
- Increasing capital requirements for ever-larger projects are causing utilities to investigate alternative financing options.

- **14 U.S. offshore wind projects, totaling 3.9 GW, have reached an advanced stage of development.**

- **Policy Developments**

- A portfolio approach that incorporates multiple policy elements has proven to be effective in overcoming market development barriers.
- BOEM has taken an increasingly active role in conducting auctions for OSW leases in federal waters.

- **Economic Impacts**

- Navigant's cost projection for a 500 MW project in the Mid-Atlantic in 2018 is \$2.86 billion or \$5,700/kW, down 11% from our 2011 estimate.
- The development of an offshore wind industry in the U.S. will depend on the evolution of other sectors in the economy.

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