U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

WIND AND WATER POWER TECHNOLOGIES OFFICE

U.S. Department of Energy Wind and Water Power Technologies Office Funding in the United States:

OFFSHORE WIND PROJECTS

Fiscal Years 2006 - 2016

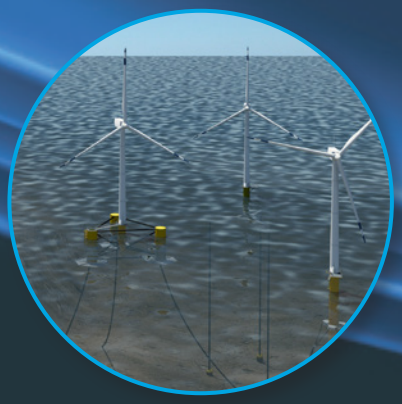

Photo from NREL

Introduction

Wind and Water Power Technologies Office

The Wind and Water Power Technologies Office (WWPTO), within the U.S Department of Energy's (DOE's) Office of Energy Efficiency and Renewable Energy (EERE), supports the development, deployment, and commercialization of wind and water power technologies. WWPTO works with a variety of stakeholders to identify and support research and development (R&D) efforts that improve technology performance, lower costs, and—ultimately—deploy technologies that efficiently capture the abundant wind and water energy resources in the United States. WWPTO is one office that contains two distinct focus areas: wind and water. The Wind Program and the Water Power Program operate as integrated, but separate entities within WWPTO.

The Wind Program provides R&D funding across six broad areas:

1. Offshore Wind Projects
2. Testing, Manufacturing, and Component Development Projects for Utility-Scale and Distributed Wind Energy
3. Wind Integration, Transmission, and Resource Assessment and Characterization Projects
4. Environmental Projects
5. Market Acceptance Projects
6. Workforce Development Projects

The breakdown of WWPTO funding is presented in a series of reports that showcase the projects funded in each of the six abovementioned areas.

Types of Funding Sources

The Wind and Water Power Technologies Office's (WWPTO's) research and development (R&D) projects are financed through two primary sources of funding: Congressional Appropriations and Congressionally Directed Projects (CDPs). Congressional Appropriations determine the operating budgets for each EERE program. WWPTO-funded R&D projects are typically awarded to recipients as cooperative agreements through competitive Funding Opportunity Announcements (FOAs) that are dedicated to specific topic areas. CDPs are also funded by Congress, but are outside of the annual federal budget process. Frequently, there is a cost-share requirement for recipients of both competitive cooperative agreements resulting from FOAs and CDPs.

In addition to these two primary funding sources, the WWPTO may be financed directly through specific legislation passed by Congress. In Fiscal Year (FY) 2009, for example, Congress passed the American Recovery and Reinvestment Act of 2009 (Recovery Act). A portion of Recovery Act funding was dedicated to WWPTO's offshore wind R&D projects.

WWPTO also funds research projects at DOE's national laboratories through the laboratories' annual operating plans. This funding is not detailed in this report. However, a national laboratory may be lead or a partner on a competitively awarded project covered in this report. In these cases, the national laboratory is identified as the lead or partner in the appropriate project descriptions.

The Small Business Innovation Research (SBIR) program in DOE's Office of Science provides competitive awards-based funding for domestic small businesses engaging in R&D of innovative technology. SBIR has funded several projects with relevance to the offshore wind industry; however, these projects are not covered in this report.

Offshore Wind

The strong, consistent, and abundant winds off the United States' lengthy coastlines can be captured to provide a clean, domestic, and renewable source of power for the nation. Although offshore wind is still considered an emerging industry in the United States, it possesses immense potential as a renewable energy resource that can decrease the country's greenhouse gas emissions, diversify its energy supply, generate affordable electricity for homes and businesses with high energy costs, and help revitalize key economic sectors, including manufacturing. DOE estimates that the technical offshore wind resource potential from state and federal waters along the United States and the Great Lakes coasts is more than 4,000 gigawatts (GW).[1] While not all of this potential can be realistically developed due to certain restrictions (e.g., competing uses, environmentally sensitive areas), with 50% of the American population living within 50 miles of the coast, a cost-effective offshore wind industry could still supply the nation with a substantial amount of capacity.

The Wind Program helps industry develop, demonstrate, and deploy offshore wind technologies that can harness this renewable, emissions-free resource to generate environmentally sustainable and cost-effective electricity.

Through support for public, private, and nonprofit efforts, the Wind Program promotes the responsible development of a world-class offshore wind industry in the United States and works to remove the market barriers currently inhibiting its growth. Although the United States has more wind turbine generating capacity installed on land than almost any other country, there are presently no offshore wind turbines installed in U.S. waters. Major barriers include the high costs of offshore wind facilities; technical challenges surrounding installation, operation, maintenance, and grid interconnection; and the long and uncertain permitting processes governing deployment.

In addition, there are specific challenges associated with installing offshore wind farms in deep water off the coast of the United States that will require unique designs and solutions. In 2010, DOE launched the Offshore Wind Innovation and Demonstration Initiative, which developed a National Offshore Wind Strategy that aims to overcome some of these challenges and advance the state of commercial offshore wind development in the United States. The strategy's primary objectives are to reduce the cost of offshore wind energy to ensure cost-competitiveness with other electrical generation sources, and to reduce the timelines and uncertainties associated with U.S. offshore wind project development. These objectives are met by focusing project investments in three key areas: the removal of market barriers to facilitate deployment and reduce technical challenges facing the entire industry; the development of innovative technologies that lower the cost of energy of offshore wind farms; and the demonstration of advanced technologies that verify innovative designs and technology developments and validate full performance and cost under real operating and market conditions.

From 2006 to 2016, DOE's Wind Program announced awards totaling more than $190 million for 73 projects focused on offshore wind. Table 1 provides a brief description of each of these projects. There are two sources of funding for offshore wind projects covered in this report: competitive Funding Opportunity Announcements (funded by Congressional Appropriations) and Congressionally Directed Projects (CDPs). See "Types of Funding Sources" on previous page.

Photo from Principle Power

Table 1: 2006–2016 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
ABB, Inc.	National Offshore Wind Energy Grid Interconnection Study	$900,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	North Carolina
Project Description				
ABB assessed the likely impacts of offshore wind development in the various regions of the United States from the electric utility perspective. This work included developing energy production profiles, performing an initial integration analysis, and evaluating the applicability of traditional integration study methods and potential energy collection and delivery technologies. ABB's final report suggests that the United States has sufficient offshore wind energy resources to enable the installation of at least 54 GW of offshore wind capacity—enough to power nearly 17 million homes—and that the appropriate transmission technologies already exist to connect this offshore wind energy to the grid. The final report and executive summary can be found at http://energy.gov/eere/downloads/national-offshore-wind-energy-grid-interconnection-study-nowegis.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Advanced Magnet Lab, Inc.	Lightweight, Direct Drive, Fully Superconducting Generator for Large Wind Turbines	$1,896,850	FY11 Next Generation Drivetrain FOA	Florida
Project Description				
Advanced Magnet Lab has developed a design for an innovative direct-drive, Fully Superconducting Generator (FSG) for large wind turbines. Key aspects of the FSG have been de-risked through analysis, experimentation and development of new composites and superconductor configurations. The FSG offers potential advantages in cost, weight and efficiency over conventional generator technology for large wind turbines.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Alstom Power, Inc.	Cost of Energy Reduction for Offshore Tension Leg Platform Wind Turbine Systems through Advanced Control Strategies for Energy Yield Improvement, Load Mitigation and Stabilization	$4,130,557	FY11 U.S. Offshore Wind: Technology Development FOA	Virginia
Project Description				
Alstom Power is developing an advanced control system that integrates innovative sensors on a floating wind turbine design. This control system will maximize energy production while providing technology for effective monitoring and adjustment to prevent excessive loads on the turbine that reduce power generation.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
AWS Truepower, LLC	National Offshore Wind Energy Resource and Design Data Campaign	$900,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	New York
Project Description				
AWS Truepower has developed a Web-based, national inventory called Met-Ocean Data Center for Offshore Renewable Energy (USMODCORE). Over the course of the project, AWS Truepower established data needs for wind energy resources and design conditions, identified existing sources of relevant data, and carried out a gaps analysis to establish long-term requirements for new data to be gathered and disseminated through national public-private collaboration initiatives.				

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[a] DOE Funding Amounts identified in this table reflect the total DOE funding planned for award to each project for the total period of project performance that may span multiple years. DOE Funding Amounts shown in this table may be subject to change.

Table 1: 2006–2016 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Baryonyx Corporation	Gulf Offshore Wind (GOWind) Demonstration Project	$3,819,878	FY12 U.S. Offshore Wind: Advanced Technology Demonstration Projects	Texas
Project Description				
Baryonyx completed longitudinal wind resource assessments, conducted avian surveys, and designed an advanced jacket foundation using lessons learned from the oil and gas sector for the company's planned Gulf Offshore Wind Demonstration Project off the coast of Texas.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Biodiversity Research Institute	Modeling Wildlife Densities and Habitat Use Across Temporal and Spatial Scales on the Mid-Atlantic Continental Shelf	$4,500,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	Maine
Project Description				
The Biodiversity Research Institute completed the Mid-Atlantic Baseline Studies Project. This project studied wildlife distributions, densities, and movements on the mid- Atlantic Outer Continental Shelf between 2012 and 2014. Utilizing a combination of boat and high resolution digital video aerial surveys, the Mid-Atlantic Baseline Studies Project was intended to provide regulators, developers, and other stakeholders for offshore wind energy with information that can be used to identify important wildlife areas, data gaps, and approaches for collecting and incorporating natural resource data into decision-making.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Boulder Wind Power (operated by Core Wind Power, Inc.)	Boulder Wind Power Advanced Gearless Drivetrain	$486,000	FY11 Next Generation Drivetrain FOA	Colorado
Project Description				
Boulder Wind Power's advanced gearless drivetrain project developed a design concept for an innovative permanent magnet-based direct-drive generator for improved performance and reliability of a large utility-scale turbine up to 10 megawatts for land-based and offshore applications.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Bowling Green State University	Coastal Wind Ohio	$2,531,900	FY06, FY08, FY09 CDPs	Ohio
Project Description				
Bowling Green State University is conducting research to remove impediments for deployment of wind turbines in Lake Erie. The primary research questions are intended to address the deployment design and environmental issues.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Bowling Green State University	Coastal Ohio Wind Project: Removing Barriers to Great Lakes Offshore Wind Energy Development	$738,359	FY10 CDP	Ohio
Project Description				
Bowling Green State University is conducting the Coastal Ohio Wind Project to address problems that impede deployment of wind turbines in the coastal and offshore regions of Northern Ohio. The University will conduct research to improve monitoring tools used for surveillance; to better understand operational data from wind turbines and issues that relate to ice mitigation; and to understand different economic scenarios that may emerge from deployed offshore wind turbines.				

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Table 1: 2006–2016 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Case Western Reserve University	Great Lakes Offshore Wind: Utility and Regional Integration Study	$540,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	Ohio
Project Description				
Case Western University is evaluating potential impacts of offshore wind on the electric grid in the Great Lakes region and determining requirements for interconnection, control systems, and the application of additional support for different transmission systems. The project is providing regional stakeholders with the knowledge base and capabilities to develop state-of-the-art, long-range strategies for mitigating the impacts of offshore wind interconnection, as well as realizing the economic cost reductions and benefits that can be achieved through implementing these strategies.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Clear Path Energy, LLC	Pivot Offshore Wind Turbine	$500,000	FY11 U.S. Offshore Wind: Technology Development FOA	Delaware
Project Description				
Clear Path Energy created a conceptual design for offshore wind systems that can be deployed in water deeper than 35 meters using innovative foundation technology and installation techniques.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Clemson University	Large Wind Turbine Drivetrain Testing Facility	$44,555,252	FY09 American Recovery and Reinvestment Act	South Carolina
Project Description				
Clemson University constructed a large wind turbine drivetrain test facility. The test facility will enhance the performance, durability, and reliability of both land-based and offshore utility-scale wind turbines by enabling the United States to expand its development and testing of large-scale drivetrain systems in the 5-15 megawatt range.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Clipper Windpower	Novel, Low-Cost, High Reliability Wind Turbine Drivetrain	$468,450	FY11 Next Generation Drivetrain FOA	Iowa
Project Description				
Clipper Windpower developed a megawatt-scale, low-cost drivetrain design based on a chain-drive concept. The project analyzed potential improvements in the areas of cost, serviceability, and compliance to rotor loads.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
DNV Renewables, Inc.	Creation of a Model for Interaction of Bottom-Fixed Wind Turbines with Surface Ice for Use with Common Simulation Codes	$306,192	FY11 U.S. Offshore Wind: Technology Development FOA	Washington
Project Description				
DNV Renewables is creating a computational tool to simulate how an offshore wind turbine platform may be structurally impacted by interactions with ice on the surface of the water in regions such as the sub-Arctic or the Great Lakes. The project will lead to a design code for ice loading on the towers of offshore, bottom-mounted wind turbines that can interface with common simulation codes and is accessible to the public.				

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Table 1: 2006–2016 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Dominion (operated by Virginia Electric and Power Company)	Virginia Offshore Wind Technology Advancement Project: Demonstration of an Innovative Offshore Wind System off the Coast of Virginia	$10,666,667	FY12 U.S. Offshore Wind: Advanced Technology Demonstration Projects	Virginia
Project Description				
Dominion Virginia Power adapated a domestically-produced twisted jacket foundation design for resilience to hurricanes, which will be important to ensure that future U.S. deployments on the Atlantic and Gulf coasts are reliable, safe, and cost-effective. Dominion also secured the nations' first approval of a wind energy research lease in U.S. federal waters from the Bureau of Ocean Energy Management. Dominion's development activities have engaged industry stakeholders, leading to an enhanced understanding of the unique aspects of offshore wind energy and identifying several areas and pathways to future cost reductions.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Dominion (operated by Virginia Electric and Power Company)	Integrated Optimization and Cost of Energy Analysis of an Innovative Offshore Wind Plan for the Virginia Outer Continental Shelf	$350,000	FY11 U.S. Offshore Wind: Technology Development FOA	Virginia
Project Description				
Dominion, an electric and natural gas utility, is analyzing the performance and cost-of-energy estimates of a hypothetical 600 megawatt offshore wind project for a variety of sites on the U.S. Atlantic coastline in water depths up to 60 meters.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Douglas-Westwood, LLC	Optimized Vessel Assessment for Offshore Wind in the United States	$300,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	New York
Project Description				
Douglas-Westwood identified the national vessel requirements under several offshore wind industry growth scenarios. The project collected data on the vessels currently deployed in the international offshore wind industry; assessed necessary trends for future dedicated vessels; and identified resources to implement innovative strategies to support companies seeking to build new vessels and establish related services as the industry grows. The project's final report can be found at http://energy.gov/eere/wind/downloads/assessment-vessel-requirements-us-offshore-wind-sector.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Duke Energy Business Services, LLC	Carolinas Offshore Wind Integration Case Study	$534,910	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	North Carolina
Project Description				
Duke Energy Business Services conducted a study that examined the potential system impacts of offshore wind development on the Duke Energy Carolinas system, determined the costs of upgrading the transmission system to support large-scale offshore projects, and assessed strategies for system integration and management. The first phase of the study found that new high-voltage transmission infrastructure is needed to reliably integrate offshore wind resources. The final report is date marked 06 June, 2013 and can be found at http://nctpc.org/nctpc/document/REF/2013-06-06/COWICS_Phase_1_Final_Report1%5B1%5D.pdf.				

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Table 1: 2006–2016 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Eaton Corporation	Reliable, Lightweight Transmission for Offshore, Utility-Scale Wind Turbines	$533,518	FY11 Next Generation Drivetrain FOA	Michigan
Project Description				
Eaton Corporation conducted research to reduce the technical risk for a hydrostatic drivetrain for high-power, utility-scale wind turbines. Research included detailed design and cost analysis of key components including the pump, shaft connection, and controls.				
Project Recipient	**Project Title**	**DOE Funding Amount**	**Funding Source**	**Project Location**
Fishermen's Atlantic City Windfarm, LLC	Fishermen's Atlantic City Windfarm	$10,666,667	FY12 U.S. Offshore Wind: Advanced Technology Demonstration Projects	New Jersey
Project Description				
Fishermen's Energy of New Jersey will install up to six wind turbines, with a total capacity of at least 20 megawatts, in state waters approximately three miles off the coast of Atlantic City, New Jersey. Fishermen's Energy Atlantic City Windfarm will demonstrate the use of a twisted jacket foundation that is easier to manufacture and install than traditional foundations, helping drive down the cost of energy produced by the offshore wind system. In order to ensure the safety of the workers who will service the offshore turbines, Fishermen's has teamed up with foundation developer Keystone Engineering to demonstrate a new access ladder that is rotated 90 degrees, bringing the maintenance vessel closer to the turbine foundation while allowing the worker to side step onto the ladder. Fishermen's project will act as an at-sea laboratory to further our knowledge about offshore wind, investigate the interactions between turbines, test new control systems, and provide information about potential environmental impacts of offshore wind while reducing the levelized cost of energy from offshore wind.				
Project Recipient	**Project Title**	**DOE Funding Amount**	**Funding Source**	**Project Location**
Freshwater Wind, LLC	Shallow Water Offshore Wind System Optimization for the Great Lakes	$500,000	FY11 U.S. Offshore Wind: Technology Development FOA	Ohio
Project Description				
Freshwater Wind created a computational model to study how existing wind turbine systems could be optimized for shallow water conditions found in the Great Lakes. The project analysis included a detailed study of different foundations and installation concepts for the soil composition and shallow waters, a larger rotor for the low wind speed, an optimized layout leveraging cable costs with Annual Energy Production, and improved operating and maintenance strategies.				
Project Recipient	**Project Title**	**DOE Funding Amount**	**Funding Source**	**Project Location**
Garrad Hassan America, Inc.	User-Friendly Analysis Tool for Optimized Offshore Wind Installation, Operation, and Maintenance Strategies	$199,100	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	California
Project Description				
Garrad Hassan America identified and quantified key areas for offshore wind project installation and operations where advancements in the approach or technology may lower the cost of energy produced by offshore wind plants. The project developed a user-friendly tool that enables project developers, owners, and managers to evaluate and compare how various installation and maintenance strategies and technical approaches impact cost of energy.				

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Table 1: 2006–2016 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Garrad Hassan America, Inc.	User Friendly Analysis Tool for Optimized Offshore Wind Ports Assessment	$497,725	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	California
Project Description				
Garrad Hassan America incorporated lessons learned from Northern European offshore wind projects to identify the port requirements necessary to meet various offshore wind industry growth scenarios in the United States. The project created a publicly available analysis tool to enable decision-makers to perform cost-benefit assessments of potential port infrastructure investments in support of offshore wind development. The project's report can be found at http://energy.gov/eere/wind/downloads/wind-offshore-port-readiness and the analysis tool is available at http://www.offshorewindportreadiness.com/Home.				
Project Recipient	**Project Title**	**DOE Funding Amount**	**Funding Source**	**Project Location**
General Electric (GE) Global Research	Superconductivity for Large-Scale Wind Turbines	$449,183	FY11 Next Generation Drivetrain FOA	New York
Project Description				
GE Global Research adapted low-temperature superconductivity technology to the design of a direct-drive wind turbine generator at the 10 megawatt power level. The design employs a unique stationary superconducting component design that reduces the risk of cryogenic fluid leakage.				
Project Recipient	**Project Title**	**DOE Funding Amount**	**Funding Source**	**Project Location**
The Glosten Associates, Inc.	Innovative Offshore Wind Plant System Design Studies	$401,941	FY11 U.S. Offshore Wind: Technology Development FOA	Washington
Project Description				
Glosten Associates is developing the design of an offshore wind farm in water depths exceeding 60 meters using floating offshore wind tension leg platforms (TLPs). This project will create tools for optimizing floating offshore wind TLPs, perform testing on new anchor tendons, and develop the preliminary design for a TLP installation vessel.				
Project Recipient	**Project Title**	**DOE Funding Amount**	**Funding Source**	**Project Location**
GLWN (Westside Industrial Retention and Expansion Network)	U.S. Wind Energy Manufacturing and Supply Chain: A Competitiveness Analysis	$300,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	Ohio
Project Description				
Building on their existing database of wind energy supplier capabilities, GLWN interviewed major companies involved in the offshore global production of wind energy to identify potential resource requirements and global competitiveness, as well as gaps in the supplier value stream. In addition, they collaborated with established wind industry partners, associates, and National Institutes of Standards and Technology Manufacturing Extension Partnerships in the coastal states. The findings from this study are available at http://energy.gov/eere/downloads/us-wind-energy-manufacturing-supply-chain-competitiveness-analysis, and have been presented at workshops, key wind industry forums, and conferences.				
Project Recipient	**Project Title**	**DOE Funding Amount**	**Funding Source**	**Project Location**
Grand Valley State University	Michigan Alternative and Renewable Energy Center Offshore Wind Demonstration Project	$1,427,250	FY09 CDP	Michigan
Project Description				
To lower critical data collection costs, Grand Valley State University is validating state-of-the-art floating Light Detection and Ranging (LIDAR) instrument measurements with conventional meteorological data. In addition, the University is conducting research on the unique engineering challenges and environmental conditions found in the Great Lakes.				

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Table 1: 2006–2016 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Great Lakes Commission	Great Lakes Wind Collaborative: Best Practices to Accelerate Wind Power in the Great Lakes Region and Beyond	$99,730	FY09 20% Wind by 2030 FOA	Michigan
Project Description				
The Great Lakes Commission, an interstate agency based in Ann Arbor, Michigan, conducted a study in support of states in the Great Lakes region to identify best practices and policies for wind development; build awareness and knowledge among all wind energy stakeholders for best practices and policies; and build capacity among states to create policies based on an assessment of the benefits of wind power projects in the Great Lakes region.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Indiana University Trustees	An Integrated Approach to Offshore Wind Energy Assessment: Great Lakes 3D Wind Experiment	$700,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	Multi-State (Indiana, Ohio)
Project Description				
Indiana University, in partnership with Case Western University, Clarkson University, and Arizona State University, is conducting a project to integrate wind data from remote sensing, aerial and satellite measurements, and meteorological towers in producing a high resolution wind characterization of Lake Erie. The project will also analyze the effectiveness of various measurement instruments and develop best practices for each type.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Lake Erie Energy Development Corporation	Lake Erie Offshore Wind Project Icebreaker™	$3,999,654	FY12 U.S. Offshore Wind: Advanced Technology Demonstration Projects	Ohio
Project Description				
Lake Erie Energy Development Corporation (LEEDCo) plans to install six 3.45-megawatt direct-drive wind turbines on Mono Bucket foundations seven miles off the coast of Cleveland in Lake Erie.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Lake Erie Energy Development Corporation	Icebreaker Foundation Engineering & Assessment	$3,000,000	FY15 Alternate Project Designs for Offshore Wind Power	Ohio
Project Description				
Lake Erie Energy Development Corporation assessed the technical and cost performance of the Icebreaker foundation throughout the East Coast and the Great Lakes as compared to other alternatives. Through significant engineering analysis, LEEDCo decided to use Mono Bucket foundation, which will reduce installation time, costs, and environmental impacts compared to traditional foundations that require pile driving.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Massachusetts Clean Energy Center	Massachusetts Wind Technology Testing Center	$24,752,779	FY09 American Recovery and Reinvestment Act	Massachusetts
Project Description				
The Massachusetts Clean Energy Center used project funding to establish the Wind Technology Testing Center, the nation's first facility capable of testing wind turbine blades 90 meters in length. The Center's testing capabilities will accelerate technical innovation in turbine and blade design and speed up deployment of longer turbine blades, which can produce more energy per turbine and help reduce the overall cost of wind energy.				

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Table 1: 2006–2016 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Michigan State University	Bat and Avian Migration Along the Lake Michigan Coastline: A Pilot Study to Inform Wind Turbine Siting	$99,951	FY09 20% Wind by 2030 FOA	Michigan
Project Description				
Michigan State University studied bird and bat migration routes near the Great Lakes coastline in high-priority wind development areas. The project is providing valuable information to the wind power industry for the siting of both individual turbines and large wind farms.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
National Center for Atmospheric Research	Impacts of Stratification and Non-Equilibrium Winds and Waves on Hub-Height Winds	$702,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	Colorado
Project Description				
The National Center for Atmospheric Research is evaluating surface level to hub-height level wind speed extrapolations and methods in an effort to evaluate and improve the siting and design of turbines, as well as the accuracy of wind energy predictions.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
National Center for Atmospheric Research	Investigating Marine Boundary Layer Parameterizations by Combining Observations with Models via State Estimation	$702,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	Colorado
Project Description				
The National Center for Atmospheric Research is examining the layer of the atmosphere that has direct contact with the ocean to determine how temperature changes in the atmosphere can affect the ocean, and how temperature changes in the ocean can affect atmospheric conditions impacting wind energy production and facility design parameters.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
National Renewable Energy Laboratory (operated by Alliance for Sustainable Energy, LLC)	U.S.-Sourced, Next Generation Drivetrain for Land-Based and Offshore Wind Turbines	$1,804,500	FY11 Next Generation Drivetrain FOA	Colorado
Project Description				
The National Renewable Energy Laboratory next generation drivetrain project is optimizing and testing a hybrid design that combines the advantages of geared and direct-drive concepts through an improved single-stage gearbox and a medium speed permanent magnet generator that reduces the need for rare earth materials. The technology developed will improve drivetrain reliability, increase efficiency, and be scalable to 10 megawatts.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
National Renewable Energy Laboratory (operated by Alliance for Sustainable Energy, LLC)	Floating Platform Dynamics Models	$1,500,000	FY11 U.S. Offshore Wind: Technology Development FOA	Colorado
Project Description				
The National Renewable Energy Laboratory-led team is improving the hydrodynamics modeling capability of FAST, an open-source computer-aided engineering tool. The added features will improve modeling of extreme wave loads and response in severe sea states. Validation will make use of data being collected from international floating wind demonstration projects.				

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Table 1: 2006–2016 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
National Renewable Energy Laboratory (operated by Alliance for Sustainable Energy, LLC)	Coupled Wind/Wave Simulation Models to Characterize Hurricane Load Cases	$400,000	FY11 U.S. Offshore Wind: Technology Development FOA	Colorado
Project Description				
The National Renewable Energy Laboratory (NREL)-led team is developing a Coupled Hydro-Aerodynamic Interface for Storm Environments using the fully coupled atmosphere-wave-ocean forecast model now used for hurricane research and prediction, linked to the NREL-developed FAST wind turbine simulation software. This will facilitate improved systems designs and lowered risk for offshore wind turbine systems located in extreme weather areas.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
National Renewable Energy Laboratory (operated by Alliance for Sustainable Energy, LLC)	Simulator for Offshore Wind Farm Applications (SOWFA)	$1,200,000	FY11 U.S. Offshore Wind: Technology Development FOA	Colorado
Project Description				
The National Renewable Energy Laboratory team is developing and validating the first design tool to fully simulate the entire multi-scale, multi-physics system of offshore wind plants under a single software framework. The Simulator for Offshore Wind Farm Applications will be a freely available, open-source, computer-aided engineering tool.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
National Renewable Energy Laboratory (operated by Alliance for Sustainable Energy, LLC)	Hurricane Resilient Wind Plant Concept Study	$500,000	FY11 U.S. Offshore Wind: Technology Development FOA	Colorado
Project Description				
The National Renewable Energy team is designing and analyzing a 500 megawatt wind plant comprised of 10 megawatt wind turbines, deployed in 25-meter water depths in the western Gulf of Mexico. New technology will be evaluated to overcome the challenges posed by hurricanes while still achieving a low cost of energy.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
National Renewable Energy Laboratory (operated by Alliance for Sustainable Energy, LLC)	Analysis of Installation, Operation, and Maintenance Strategies to Reduce Levelized Cost of Energy	$200,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	Colorado
Project Description				
The National Renewable Energy Laboratory is combining its offshore wind cost modeling capabilities and those of the Energy research Centre of the Netherlands, along with the operating experience of an expert industry panel, to conduct an assessment of optimized installation, operation, and maintenance strategies and technologies to evaluate their relative costs and benefits for offshore wind projects in U.S. waters.				

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Table 1: 2006–2016 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Nautica Windpower, LLC	Advanced Floating Turbine	$500,000	FY11 U.S. Offshore Wind: Technology Development FOA	Ohio
Project Description				
Nautica Windpower is developing a conceptual design for a deep water offshore wind farm using downwind rotors with flexible blades and lightweight floating platforms with improved access for maintenance.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Navigant Consulting, Inc.	U.S. Offshore Wind Market and Economic Analysis, Annual Market Assessment	$600,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	Illinois
Project Description				
The Navigant Consortium authored a series of three Offshore Wind Market and Economic Analyses between 2012 and 2014 to provide stakeholders with a reliable and consistent data source on offshore wind market trends, barriers to entry, and U.S. competitiveness in the offshore wind market. The reports and underlying data are available at http://energy.gov/eere/wind/downloads/offshore-wind-market-and-economic-analysis.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Navigant Consulting, Inc.	U.S. Offshore Wind Manufacturing and Supply Chain Development	$349,998	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	Illinois
Project Description				
Navigant Consulting examined factors and strategies influencing development of a U.S. supply chain for the offshore wind industry. Through industry surveys and stakeholder forums, the project identified potential gaps in the supply chain and opportunities for manufacturers and technical services companies to contribute to the domestic content of offshore project facilities. The project's report can be found at http://energy.gov/eere/wind/downloads/us-offshore-wind-manufacturing-and-supply-chain-development.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Oregon State University	A Synchronized Sensor Array for Remote Monitoring of Avian and Bat Interactions with Offshore Renewable Energy Facilities	$600,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	Oregon
Project Description				
Oregon State University is monitoring avian and bat interactions with offshore wind turbines using a fully integrated sensor array monitoring system with on-board custom designed data post-processing and statistical-based software.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
The Pennsylvania State University	A High-Performance Computing "Cyber Wind Facility" Incorporating Fully Coupled Computational Fluid Dynamics and Computational Structural Dynamics for Turbine-Platform-Wake Interactions with the Atmosphere and Ocean	$1,200,000	FY11 U.S. Offshore Wind: Technology Development FOA	Pennsylvania
Project Description				
The Pennsylvania State University is developing a computer-modeled "Cyber Wind Facility" to simulate large wind energy array performance for both offshore and land-based wind turbines. The Cyber Wind Facility will model the impacts of complex wind and wave dynamics on wind turbine structures and energy performance, enabling developers to make more informed decisions on array and turbine placements.				

continued >

Table 1: 2006–2016 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Principle Power, Inc.	WindFloat Pacific Offshore Wind Demonstration Project	$10,666,667	FY12 U.S. Offshore Wind: Advanced Technology Demonstration Projects	Multi-State (Washington, Oregon)
Project Description				
Principle Power's research and development on their domestically-developed semi-submersible WindFloat system have advanced the state of knowledge regarding floating offshore wind platforms, including decreasing the weight and cost of the platform while increasing the platform turbine capacity to 8 MW to accommodate the next generation of offshore wind turbines. Floating offshore wind systems have the potential to harness the than 60% of U.S. offshore wind resources that are found in deep water. The WindFloat system can be assembled on shore and towed out to sea, mitigating the need for the costly vessels typically used to assemble and install offshore wind systems at sea. Principle Power also worked with the Bureau of Ocean Energy Management (BOEM) to make significant progress under the BOEM permitting process. This process included extensive stakeholder outreach and consultation with local Native Americans, resulting in the enhanced understanding of the unique aspects of floating offshore wind technologies.				
Project Recipient	**Project Title**	**DOE Funding Amount**	**Funding Source**	**Project Location**
Sandia National Laboratories (operated by Lockheed Martin Corporation)	Innovative Offshore Vertical-Axis Wind Turbine Rotors	$4,140,000	FY11 U.S. Offshore Wind: Technology Development FOA	New Mexico
Project Description				
During this five-year project, a collaborative team consisting of members from Sandia National Laboratories, several universities, and a major U.S. wind blade manufacturer are designing, building, and testing advanced vertical-axis wind turbine rotors for deepwater offshore wind energy production on the 10-20 megawatt turbine scale.				
Project Recipient	**Project Title**	**DOE Funding Amount**	**Funding Source**	**Project Location**
Savannah River National Laboratory (operated by Savannah River Nuclear Solutions, LLC)	Advanced Technology for Improving the Design Basis of Offshore Wind Energy Systems	$554,845	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	South Carolina
Project Description				
Savannah River National Laboratory is developing new techniques for characterizing steep and breaking waves and resulting structural loads on monopile foundations.				
Project Recipient	**Project Title**	**DOE Funding Amount**	**Funding Source**	**Project Location**
Siemens Energy, Inc.	Offshore 12-Megawatt Turbine Rotor with Advanced Materials and Passive Design Concepts	$366,500	FY11 U.S. Offshore Wind: Technology Development FOA	Florida
Project Description				
Siemens Energy is investigating the use of various passive aeroelastic and aerodynamic control technologies for their potential to improve the aerodynamic performance of wind turbine blades and decrease the cost of energy.				
Project Recipient	**Project Title**	**DOE Funding Amount**	**Funding Source**	**Project Location**
Stantec Consulting Services, Inc.	Deepwater Offshore Bat and Avian Monitoring Program	$599,501	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	Maine
Project Description				
Stantec Consulting Services has collected critical information on offshore bird and bat activity. The project will result in more advanced equipment and methodologies for remote offshore bird and bat migration data collection and monitoring systems.				

continued >

Table 1: 2006–2016 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
The Research Foundation of the State University of New York (led by Stony Brook University)	Improving Atmospheric Models for Offshore Wind Resource Mapping and Prediction Using LiDAR, Aircraft, and In-Ocean Observations	$675,219	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	New York
Project Description				
The State University of New York is verifying instrumentation and developing an improved understanding of modeling and boundary layer physics through intensive data collection around the Cape Wind site. The improved modeling will be applied to constructing more accurate wind resource maps for the East Coast of the United States.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Statoil Wind U.S., LLC	Hywind Maine Floating Offshore Wind Project	$4,000,000	FY12 U.S. Offshore Wind: Advanced Technology Demonstration Projects	Maine
Project Description				
Statoil North America performed numerous environmental surveys in the Gulf of Maine, as well as design studies, in order to refine its proposed design, advancing the state-of-the-art in specialized floating spar buoy substructures.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Stevens Institute of Technology	Field Evaluation and Validation of Remote Wind Sensing Technologies: Shore-Based and Buoy Mounted LIDAR Systems	$702,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	New Jersey
Project Description				
Stevens Institute of Technology is systematically evaluating the capability of scanning and vertically profiling LIDAR to accurately measure the three-dimensional wind field, in comparison to fixed meteorological towers. The project will also quantify variability in offshore winds off the coast of New Jersey.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Sustainable Energy Advantage, LLC	Mid-Atlantic Wind - Overcoming the Challenges - Defining and Overcoming the Technical, Economic, and Legal Issues	$100,000	FY09 20% Wind by 2030 FOA	Massachusetts
Project Description				
Sustainable Energy Advantage studied and documented the technical, economic, and policy issues that have been impeding the development of wind energy in the Mid-Atlantic region and worked to identify mechanisms for overcoming or mitigating those barriers. The results of the study are documented in the report, Mid-Atlantic Wind - Overcoming the Challenges: http://www4.eere.energy.gov/wind/resource_center/resource/mid-atlantic-wind-overcoming-challenges.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Texas Engineering Experiment Station at Texas A&M	Development of Mooring-Anchor Program for Coupling with FAST (Fatigue, Aerodynamics, Structures, and Turbulence)	$400,000	FY11 U.S. Offshore Wind: Technology Development FOA	Texas
Project Description				
The Texas Engineering Experiment Station at Texas A&M built on existing computer models to simulate mooring dynamics of floating offshore wind turbine structures. The project's model takes into account a variety of interactions between platform anchors and the seabed.				

continued >

Table 1: 2006–2016 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Town of Hull	Hull Municipal Light Plant Offshore Wind Project	$210,298	FY09 CDP	Massachusetts
Project Description				
The Town of Hull on the east coast of Massachusetts conducted a multi-phase offshore wind project that consisted of organizing events and planning for the development of an offshore wind R&D facility. The town conducted a workshop to analyze the concept of designing and constructing an offshore wind testing platform and wind energy generation facility. The project developed a plan for the design, construction, operation, and maintenance of an offshore wind testing platform and offshore wind energy generation facility.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
University of Delaware	Wind Turbine Model and Pilot Project for Alternative Energy	$2,427,250	FY09, FY10 CDPs	Delaware
Project Description				
The University of Delaware initiated a multidisciplinary project that provides research, policy analysis, and greater development capacity and outreach through the use of a shore-side, utility-scale wind turbine that was installed using the project's funds.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
University of Delaware	Advanced Offshore Wind Energy: Atlantic Consortium	$747,540	FY09 Wind University Consortia FOA	Delaware
Project Description				
The University of Delaware is focused on establishing the design requirements for the offshore wind industry in the United States. Research includes: resistance to extreme weather and corrosion; top-to-bottom redesign of offshore turbines to meet unique requirements, including engineering of underwater mounting, gearbox improvement, and corrosion characterization; development of educational programs; and a university program to train design professionals and managers.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
University Of Delaware	Empowering Coastal States and Utilities through Model Offshore Wind Legislation and Outreach	$99,967	FY09 20% Wind by 2030 FOA	Delaware
Project Description				
The University of Delaware has drafted model legislation for offshore wind development and conducted workshops. The project built upon existing research and policy development for offshore wind in order to advance wind energy development to meet human health, energy security, economic development, and climate change goals in an environmentally responsible manner.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
University of Delaware	Mid-Atlantic Offshore Wind Interconnection and Transmission	$540,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	Delaware
Project Description				
The University of Delaware is examining potential effects of wind penetration on the Mid-Atlantic electric grid and facilitating grid operations planning by identifying necessary system upgrades and grid management strategies to ensure reliable and efficient operation of the electric system.				

continued >

Table 1: 2006–2016 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
University of Delaware	System Design Optimized for a Large-Turbine Wind Farm near Wilmington Canyon	$500,000	FY11 U.S. Offshore Wind: Technology Development FOA	Delaware
Project Description				
The University of Delaware is analyzing design trade-offs for offshore wind farms in 20-40 meter water depth for turbine production, deployment, and maintenance. The analysis will determine ways to maximize energy production, improve reliability, reduce and simplify operations at sea, and decrease operating and capital cost.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
University of Maine	DeepCWind - Deepwater Offshore Wind Consortium	$7,080,197	FY09 American Recovery and Reinvestment Act (part of the FY09 Wind University Consortia FOA)	Maine
Project Description				
The University of Maine developed floating offshore wind farm technologies for deep water deployment. The project partially validated computer models for designing and analyzing floating offshore wind turbines and researched integrating more durable, lighter, hybrid composite materials into offshore wind floating platforms and towers. The University of Maine-led consortium includes universities, non-profits, and utilities; firms with expertise in wind project siting and environmental siting; and industry organizations to assist with education and tech transfer activities.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
University of Maine	Offshore Wind Initiative	$5,000,000	FY10 CDP	Maine
Project Description				
The University of Maine's Deepwater Offshore Wind Research Program partially validated numerical models; analyzed how floating platform designs can be optimized by integrating more durable, lighter, alternative materials and composite technology; and fabricated and deployed a 1:8 scaled floating platform at University of Maine's Deepwater Offshore Wind Test. The project constructed and deployed a 20 kilowatt floating wind turbine on a semi-submersible foundation off of Castine, Maine to collect data and support model validation. This project builds on previous funding from DOE and National Science Foundation-Partnerships for Innovation.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
University of Maine	New England Aqua Ventus I	$4,001,000	FY12 U.S. Offshore Wind: Advanced Technology Demonstration Projects	Maine
Project Description				
The University of Maine plans to install a pilot floating offshore wind farm with two 6-megawatt direct-drive turbines on concrete semisubmersible foundations at a test site off Monhegan Island, Maine. The pre-stressed concrete substructures proposed in this project could offer significant cost reduction opportunities over steel if manufactured at a large scale. This project is a stepping stone for a contemplated New England Aqua Ventus II commercial-scale offshore wind farm consisting of 83 6-megawatt VolturnUS floating wind turbines.				

continued >

Table 1: 2006–2016 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
University of Maine	New England Aqua Ventus I- 100% Hull Design	$3,000,000	FY15 Alternate Project Designs for Offshore Wind Power	Maine
Project Description				
The New England Aqua Ventus I project consists of a two-turbine pilot-floating wind farm planned for deployment off the coast of Maine. This project evaluated and completed the engineering design of Aqua Ventus's concrete semisubmersible hull, called VolturnUS, and tower. A focus on commercial-scale manufacturing and reducing costs has led to significant reductions in the internal steel requirements and vastly improved manufacturability of the foundation.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
University of Massachusetts	Offshore Wind Energy Systems Engineering Course Development	$252,687	FY09 20% Wind by 2030 FOA	Massachusetts
Project Description				
The University of Massachusetts developed a formal course entitled "Offshore Wind Energy Systems Engineering" and will disseminate the course content and materials for use across the United States. The University plans to make continued updates to the Web-based course material in the future.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
University of Michigan, Board of Regents	Measurement and Analysis of Extreme Wave and Ice Actions in the Great Lakes for Offshore Wind Platform Design	$692,782	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	Michigan
Project Description				
The University of Michigan is evaluating the conditions and processes for development of freshwater ice in the Great Lakes and its resulting impact on offshore wind energy support structures. The project will evaluate the seasonal and decade-long trends in historical icing data through field measurements and by evaluating extreme loading due to combined wind, wave, and icing effects.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
University of Michigan, Board of Regents	Bottom Fixed Platform Dynamics Models Assessing Surface Ice Interactions for Transitional Depth Structures in the Great Lakes	$399,998	FY11 U.S. Offshore Wind: Technology Development FOA	Michigan
Project Description				
The University of Michigan is developing a modeling tool to simulate surface ice impact on innovative wind turbine substructure designs. The project will lead to the development of an ice-loading design module simulating interaction of freshwater ice features with offshore wind turbine structures in the Great Lakes.				

continued >

Table 1: 2006–2016 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
University of Minnesota, Board of Regents	High-Resolution Computational Algorithms for Simulating Offshore Wind Farms	$1,200,000	FY11 U.S. Offshore Wind: Technology Development FOA	Minnesota
Project Description				
The University of Minnesota is developing computational tools to simulate wave and wind interactions within various floating offshore wind farm configurations. The project is validating computational models using data from laboratory measurements specifically tailored to emulate the key dynamic features of floating wind turbines and farms, as well as field data from a land-based field site. The computational tools will be tailored to take full advantage of high-performance computing and will thus enable industry to design efficient and reliable offshore turbines, and optimize turbine arrays on a site-specific basis.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
University of Rhode Island Coastal Resources Center	Rhode Island Ocean Special Area Management Plan	$666,050	FY09 CDP	Rhode Island
Project Description				
The University of Rhode Island's Coastal Resources Center developed the Ocean Special Area Management Plan for the Rhode Island Coastal Resources Management Council. The plan will assist in the siting of renewable energy in Rhode Island's offshore environment, while serving as a coastal management and regulatory tool to promote a balanced and comprehensive approach to responsibly develop ocean- based resources.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
The University of Texas-Austin	Assessment of Offshore Wind Farm Effects on Sea Surface, Subsurface, and Airborne Electronic Systems	$500,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA	Texas
Project Description				
The University of Texas-Austin assessed the potential of offshore wind farms to cause electromagnetic or acoustic interference of electronic detection, communication, and navigation equipment operating in the marine environment. The project interacted closely with commercial and governmental stakeholders to identify concerns and recommending mitigation methods when required. The project's final report can be found at http://energy.gov/eere/wind/downloads/final-report-de-ee0005380-assessment-offshore-wind-farm-effects-sea-surface.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
University of Toledo	Advanced Offshore Wind Turbine/ Foundation Concept for the Great Lakes	$750,000	FY09 Wind University Consortia FOA	Ohio
Project Description				
The University of Toledo is developing computer modeling for a two-bladed downwind offshore turbine and foundation design. The project is also creating curriculum for offshore wind turbine design at the University of Toledo.				

Project Recipient	Project Title	DOE Funding Amount	Funding Source	Project Location
Zimitar, Inc.	High-Efficiency Structural Flowthrough Rotor with Active Flap Control	$3,998,763	FY11 U.S. Offshore Wind: Technology Development FOA	California
Project Description				
Zimitar is creating a two-bladed wind turbine design that incorporates active aerodynamic controls. This project will result in rotors that are lighter than conventional designs, which will increase energy capture and reduce the cost of energy.				

Offshore Wind Funding Distribution

DOE has funded 73 offshore wind projects through the Wind Program from 2006 to 2016. These projects are categorized in the following sections by activity area, topic area, geographic region and division, state, recipient type, and funding source.

Offshore wind is an emerging renewable energy industry actively working to research, develop, and demonstrate technology. To support the deployment of advanced technology, the Wind Program is investing broadly across a suite of technology and market solutions to address the unique challenges of installing and operating offshore wind systems in U.S. waters.

Funding by Activity Area and Topic Area

The Wind Program's R&D efforts between 2006 and 2016 fall under three activity areas: Technology Development, Market Acceleration and Deployment, and Advanced Technology Demonstration. The Wind Program's Technology Development projects are aimed at reducing the overall cost of offshore wind energy, diminishing the technical barriers to system development, improving system reliability and performance, and enhancing the understanding and evaluation of various systems and components. The Wind Program's offshore Market Acceleration and Deployment projects are aimed at reducing the time and costs associated with siting wind projects; better quantifying the potential magnitude, costs, and benefits of wind power generation; and identifying and addressing other barriers to deployment. Advanced Technology Demonstration projects mitigate risks and facilitate the development of the domestic offshore wind industry by bringing innovations to market and supporting in-water installations. When total DOE funding for offshore wind from 2006 to 2016 is categorized by activity area, Advanced Technology Demonstrations received 54.7% of the funding, while Technology Development activities received 37.8%, and Market Acceleration and Deployment activities received the remaining 7.5%.

Within the Technology Development and Market Acceleration and Deployment activity areas, the Wind Program funds particular topics in priority areas. More than half of the Technology Development funding went to two large wind test facilities for the next generation of land- based and offshore wind turbines. The second half of Technology Development spending is spread fairly evenly across multiple technical areas, with a slight focus on Advanced Turbine Technologies R&D. Under the Market Acceleration and Deployment activity area, Siting – Environmental and Permitting represented the largest funded topic area. Table 2 provides details on the offshore wind funding for each topic area within the Technology Development, Market Acceleration and Deployment, and Advanced Technology Demonstration activity areas.

Table 2: 2006– 2016 Offshore Wind Funding Distribution by Activity Area & Topic Area

Activity Area	Total Funding	Percent of Total
Technology Development Subtotal	**$113,844,570**	**59.8%**
Test Facilities	$69,308,031	36.4%
Advanced Turbine Technologies	$18,274,321	9.6%
Modeling, Simulation, and Design Tools	$23,010,277	12.1%
Optimized Wind Plant Systems	$3,251,941	1.7%
Market Acceleration and Deployment Subtotal	**$22,617,172**	**11.9%**
Siting - Environmental and Permitting	$9,131,111	4.8%
Resource Characterization	$5,628,846	3.0%
Market Acceleration and Barrier Reduction	$5,342,305	2.8%
Grid System Planning and Operations	$2,514,910	1.3%
Advanced Technology Demonstration Subtotal	**$53,820,533**	**28.3%**
Offshore Wind Demonstrations Phase 1	$15,820,532	8.3%
Offshore Wind Demonstrations Phase 2	$32,000,001	16.8%
Determination of Non-competitive Financial Assistance	$6,000,000	3.2%
Total	**$190,282,274**	**100.0%**

Funding by Geographic Region & Division

Offshore wind projects were awarded in each of the nation's four geographic regions, with the South Atlantic and Northeast divisions receiving a large portion due to American Recovery and Reinvestment Act funding for wind turbine testing facilities being constructed in South Carolina and Massachusetts. Table 3 provides details on how the Wind Program's funding was distributed within regions and divisions.

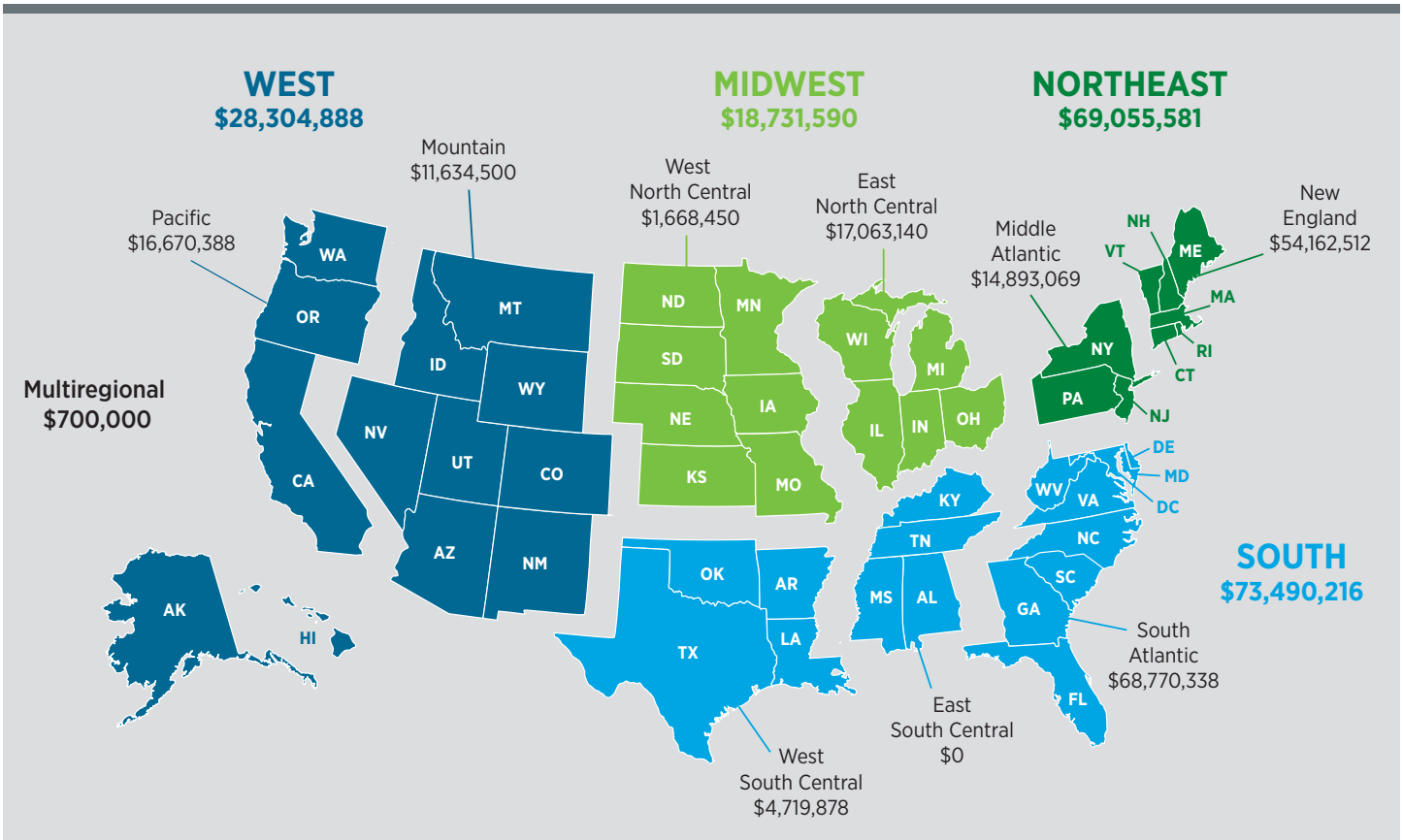
The geographic regions and divisions used to present the distribution of WWPTO's funding are based on the U.S. Census Regions and Divisions.[2]

Exhibit 1 provides a map that shows how the Wind Program's offshore wind funding was distributed throughout the United States.

Table 3: 2006–2016 Offshore Wind Funding by Geographic Region & Division

Region	Region Total Funding	Division	Division Total Funding
West	$28,304,888	Mountain	$11,634,500
		Pacific	$16,670,388
South	$73,490,216	South Atlantic	$68,770,338
		West South Central	$4,719,878
		East South Central	$0
Northeast	$69,055,581	New England	$54,162,512
		Middle Atlantic	$14,893,069
Midwest	$18,731,590	East North Central	$17,063,140
		West North Central	$1,668,450
Multi	$700,000	Multi	$700,000
		Total	**$190,282,274**

Exhibit 1: 2006–2016 Offshore Wind Funding by Geographic Region & Division



Funding by State

Wind Program funding for the 73 offshore wind projects was broadly distributed to organizations in 22 states (see Table 4).

Location of a funded organization is not necessarily an indicator of the technical focus of its work. Each of the U.S. coastal areas where offshore wind may be deployed (Atlantic, Great Lakes, Gulf, Pacific) has both unique characteristics and attributes it shares with other regions or states. Within the group of Wind Program projects, there are efforts addressing the range of design and operations considerations (e.g., hurricanes, icing, and deepwater sites) characterizing all coastal areas.

Table 4: 2006–2016 Offshore Wind Funding Distribution by State

State	Total Funding
California	$4,695,588
Colorado	$7,494,500
Delaware	$4,814,757
Florida	$2,263,350
Illinois	$949,998
Iowa	$468,450
Maine	$28,180,698
Massachusetts	$25,315,764
Michigan	$3,253,229
Minnesota	$1,200,000
New Jersey	$11,368,667
New Mexico	$4,140,000
New York	$2,324,402
North Carolina	$1,434,910
Ohio	$12,859,913
Oregon	$600,000
Pennsylvania	$1,200,00
Rhode Island	$666,050
South Carolina	$45,110,097
Texas	$4,719,878
Virginia	$15,147,224
Washington	$708,133
Multi	$11,366,667
Total	**$190,282,274**

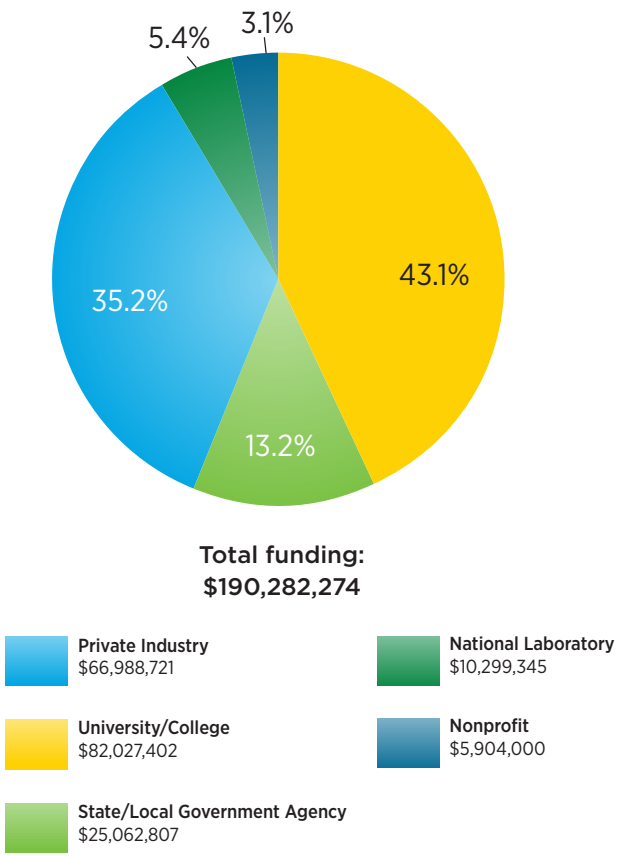
Funding by Recipient Type

DOE funds a variety of recipient types, including private industry, nonprofit organizations, universities and community colleges, investor-owned utilities and public utilities, local and state government agencies, as well as DOE national laboratories, and federal agencies.

More than 60% of the total offshore wind funding from 2006 to 2016 was awarded to 29 private industry firms for such diverse projects as advanced technology demonstrations, grid integration studies, development of new power generation technologies and control strategies, and assessment of floating turbine platforms for deepwater deployment. Nineteen different universities received more than a quarter of the funding, Clemson University being the largest award for developing a large wind turbine drivetrain test facility for the research of technologies applicable to both land-based and offshore wind development. Three state and local government agencies received 8% of funding to construct a wind technology testing center, develop an offshore wind R&D facility, and conduct stakeholder outreach in the Great Lakes region.

The remaining funds were awarded to national laboratories and nonprofit organizations. Exhibit 2 provides these details by recipient type.

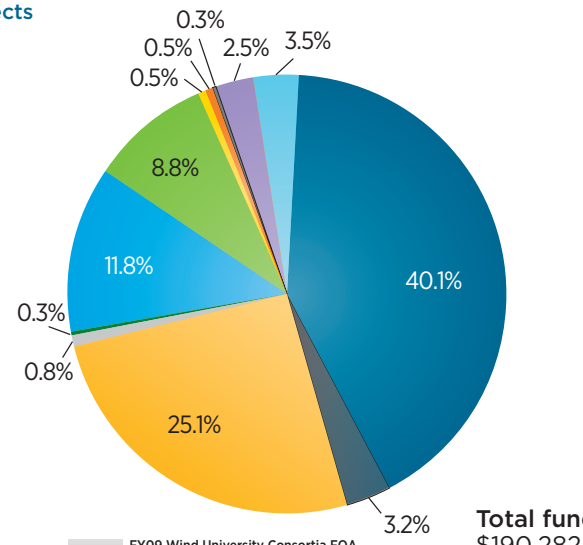
Exhibit 2: 2006–2016 Offshore Wind Funding Distribution by Recipient Type



Funding Sources

In 2009, the American Recovery and Reinvestment Act awarded more than $76 million to three offshore wind projects, one of which was a Wind University Consortia FOA awardee. In addition, from 2009 to 2012, the Wind Program issued six competitive FOAs with offshore wind awards. These FOAs provided more than $200 million in announced awards for 62 offshore wind projects. An additional $14.8 million was awarded to seven offshore wind projects through congressionally directed funds from 2006 to FY 2010. Exhibit 3 provides details on the funding sources for the Wind Program's 73 offshore wind projects.

Exhibit 3: 2006–2016 Funding Sources for Offshore Wind R&D Projects



Total funding: $190,282,274

Total number of projects: 73

FOA 49.9%

- **FY09 Wind University Consortia FOA**
  $1,497,540
  Number of Projects: 2[b]
- **FY09 20% Wind by 2030 FOA**
  $652,335
  Number of Projects: 5
- **FY11 U.S. Offshore Wind: Technology Development FOA**
  $22,493,951
  Number of Projects: 19
- **FY11 U.S. Offshore Wind: Removing Market Barriers FOA**
  $16,790,080
  Number of Projects: 23
- **FY11 Next Generation Drivetrain FOA**
  $5,638,501
  Number of Projects: 6
- **FY12 U.S. Offshore Wind: Advanced Technology Demonstration Projects**
  $47,820,533
  Number of Projects: 4

CDP[c] 6.8%

- **FY06 CDP**
  $990,000
  Number of Projects: 1[c]
- **FY08 CDP**
  $590,400
  Number of Projects: 1[c]
- **FY09 CDP**
  $4,682,348
  Number of Projects: 5[c]
- **FY010 CDP**
  $6,738,359
  Number of Projects: 4[c]

Recovery Act 40.1%

- **FY09 American Recovery and Reinvestment Act**
  $76,388,228
  Number of Projects: 3

Non Competitive 3.2%

- **Alternate Project Designs for Offshore Wind**
  $6,000,000
  Number of Projects: 2

[b]The total number of offshore wind projects awarded under this FOA was three; however, the University of Maine DeepCWind project was funded under the Recovery Act, so that is where its funding is represented in this exhibit.

Accomplishments

The Wind Program has allocated more than $190 million in funding for 73 offshore wind projects since FY 2006, with numerous projects operating over multiple years. The Wind Program has already realized significant return on the federal investment to date and anticipates significant key accomplishments in years to come. A few of the Program's project accomplishments include the following:

- **LiDAR Field Validation in Lake Michigan**: Grand Valley State University conducted a wind resource assessment and LiDAR (Light Detection and Ranging) verification study in the Great Lakes to help answer the question "Are floating, laser-pulse sensors an effective alternative to offshore, tower-mounted anemometers?" An AXYS Technologies WindSentinel buoy system was deployed to a near-shore location near Muskegon Lake in 2011 and to the mid-lake plateau of Lake Michigan in 2012. A comparison of the buoy-mounted LiDAR unit to fixed anemometer and fixed LiDAR units found no significant differences in instrument operation or measured wind speed.
- **Large Blade Testing Facility**: In May 2009, Massachusetts was awarded $25 million in funding to accelerate development of the state's Wind Technology Testing Center (WTTC), also known as the large blade test facility. Constructed with a combination of funding from DOE (through the American Recovery and Reinvestment Act) and the State of Massachusetts, the WTTC is the first test facility in the world with the ability to test blades up to 90 m in length. The facility's high bay features three test stands and 100 tons of overhead bridge crane capacity to provide industry partners with the latest wind turbine blade testing and prototype development methodologies, blade repair, and workforce training. In October 2011, the WTTC, with help from NREL, completed its first commercial static test applied in four directions (max flap, max edge, min flap, and min edge) to a multi-megawatt-size blade manufactured in the United States.
- **Offshore Wind Advanced Technology Demonstration Projects:** Since 2012, the Energy Department has supported a portfolio of advanced wind energy technology demonstration projects that represent some of the nation's most innovative offshore wind projects in state and federal waters. These demonstrations are among the first of their kind making their way through permitting, approval, and grid interconnection processes in the United States. The three projects currently in the demonstration portfolio—Fishermen's Energy's Atlantic City Windfarm, Lake Erie Energy Development Corporation's Icebreaker project, and the University of Maine's New England Aqua Ventus I project—are breaking new ground at virtually every step in the process and providing valuable lessons that will benefit

[c]The number of distinct offshore wind CDP projects is seven; some projects were funded as CDPs in multiple years (see Table 1).

the development of the nation's offshore wind industry for years to come. Each of these projects is eligible to receive up to $40 million in additional funding in future performance periods, after achieving specific milestones.

- **Advanced Wind Turbine Drivetrain Research**: In June 2011, six projects were selected by DOE to receive a total of nearly $6 million over two years to advance next-generation designs for wind turbine drivetrains. These early R&D projects focused on reducing the cost of wind energy by increasing component reliability or redesigning drivetrains to eliminate the need for some components altogether. Each project was selected to receive up to $700,000 to conduct technology cost and readiness assessments during Phase I. Following the six-month Phase I funding period, the work was reviewed and two projects—Advanced Magnet Lab and the National Renewable Energy Laboratory (NREL)—were selected for additional funding for continued development and testing. Advanced Magnet Lab has developed a design for an innovative direct-drive, Fully Superconducting Generator (FSG) for large wind turbines. Key aspects of the FSG have been de-risked through analysis, experimentation and development of new composites and superconductor configurations. The FSG offers potential advantages in cost, weight and efficiency over conventional generator technology for large wind turbines. The National Renewable Energy Laboratory next generation drivetrain project is optimizing and testing a hybrid design that combines the advantages of geared and direct-drive concepts through an improved single-stage gearbox and a medium speed permanent magnet generator that reduces the need for rare earth materials. Dynamometer testing of the drivetrain and testing of the hybrid power converter modules is currently underway. The technology developed will improve drivetrain reliability, increase efficiency, and be scalable to 10 megawatts.
- **Rhode Island Ocean Special Area Management Plan**: The University of Rhode Island carried out research studies aiding in the identification of preferred sites for offshore renewable energy development in Rhode Island waters. The research provided the Rhode Island Coastal Resources Management Council with sound technical information to assist in the responsible siting of wind turbines through establishment of renewable energy zones, protected areas (Areas of Particular Concern, and Areas for Conservation) within state waters, and the Area of Mutual Interest in federal waters. Renewable energy zones are located within state waters in areas where offshore projects would have minimal impact on avian species and other critical habitats, as well as minimal interference on the state's charter fishing industry.
- **Great Lakes Best Practices Report**: The Great Lakes Commission published results of its study to identify best practices and policies for wind development, and to build capacity among state policymakers to create policies based on accurate assessment of the benefits of individual wind power projects across the region. This report is available for download in the form of a user-friendly toolkit at the Great Lakes Commission website: http://www.glc.org/energy/wind/bestpractices.html.
- **Large Turbine Dynamometer**: In November 2009, DOE announced the selection of Clemson University to receive up to $45 million in American Recovery and Reinvestment Act funds for the Clemson Wind Turbine Drivetrain Testing Facility. The facility, which commissioned the 7.5 megawatt test stand in 2013, features dynamometer equipment capable of performing highly accelerated endurance testing of drivetrain systems and power grid simulation for land-based and offshore wind turbines rated up to 15 megawatts.
- **100-meter Blade Project**: In 2012, Sandia National Laboratories (SNL) created a publicly accessible project website and model files for the Sandia 100-meter all-glass baseline blade design along with the associated 13.2 megawatt turbine model. Dozens of wind researchers have requested the model files since their publication, in many cases to support graduate student research. The public models support research addressing the challenges of very large blades including aeroelastic stability (flutter) and high mass and cost. The baseline provides a comparison tool for the industry to evaluate new technologies and their relative impact on potential performance and cost improvements. More information can be found at: http://energy.sandia.gov/?page_id=7334.
- **Empowering Coastal States and Utilities through Model Offshore Wind Legislation and Outreach**: The University of Delaware created two model documents to facilitate offshore wind power development in state waters: A Model Request for Proposals (RFP) and Model Access Legislation, the latter of which built on their previously devised access framework for state waters. The University also examined Feed-in-Tariffs as an alternative to RFPs.
- **Bat Studies in the Offshore Environment**: Stantec Consulting Services collected data from numerous bat echolocation detector systems deployed in 2012 at locations in the Gulf of Maine, Mid-Atlantic coastal areas, and the Great Lakes. This project seeks to help offshore wind developers and regulators understand potential effects of offshore wind farms on bats by assessing how widespread bat occurrence is offshore. By the end of the project, the team aims to obtain regional and multi-year data on seasonal offshore bird and bat activities and to refine equipment, methods, and logistics to aid in the development of a remote offshore bird and bat migration data collection and monitoring system.
- **Mid-Atlantic Wildlife Impact Studies**: From 2012 to 2014, the Biodiversity Research Institute conducted high-definition aerial and boat-based surveys of the Mid-Atlantic. Data from this project will be used to model wildlife densities and movements across temporal and spatial scales on the Mid-Atlantic continental shelf which will inform responsible and expedited siting of offshore wind projects in this region in conjunction with the "Smart from

the Start" Wind Energy Areas designated by the Bureau of Ocean Energy Management.

- **Baseline Infrastructure Studied for Informed Decision Making**: Three DOE awardees on effective development of the infrastructure needed to support offshore wind energy projects—supply chain, ports, and vessels—began coordinated research on baseline studies in 2012. These activities included industry surveys, stakeholder workshops to gauge relevance of preliminary findings and Web-based analysis tools, and development of three possible offshore wind industry growth scenarios to aid decision-makers in assessing needs for and risks of infrastructure investments. The first of these studies, the *U.S. Offshore Wind Manufacturing and Supply Chain Development report* by Navigant Consulting, was released in October 2012. Douglas-Westwood's *Assessment of Vessel Requirements for the U.S. Offshore Wind Sector* report was released in September 2013, and Garrad Hassan's *Assessment of Ports for Offshore Wind Development in the United States* report was released in March 2014. More information is available at energy.gov/eere/offshore-wind-market-acceleration-projects.

- **National Offshore Wind Resource Maps**: In 2012, NREL issued a wind resource map that displays both land-based and offshore wind speeds on the same map. The combined map, posted on the Energy Department's Wind Program website, provides developers and policymakers with a comprehensive picture of the nation's wind resources at 80 meters (m) for all 50 states, as well as offshore resources up to 50 nautical miles from shore at a spatial resolution of 2.5 km and interpolated to a finer scale. The map also substantiates the potential for offshore resources to provide significant portions of the electricity needs of the heavily populated coastal regions in 2014. The resource potential maps show that as wind turbine technology advances and can be installed at higher hub heights, areas with previously limited wind resources—such as the southeastern United States—have the opportunity to add new wind power capacity using taller utility-scale wind energy technologies. More information is available at wind.energy.gov/resource_assessment_characterization.html.

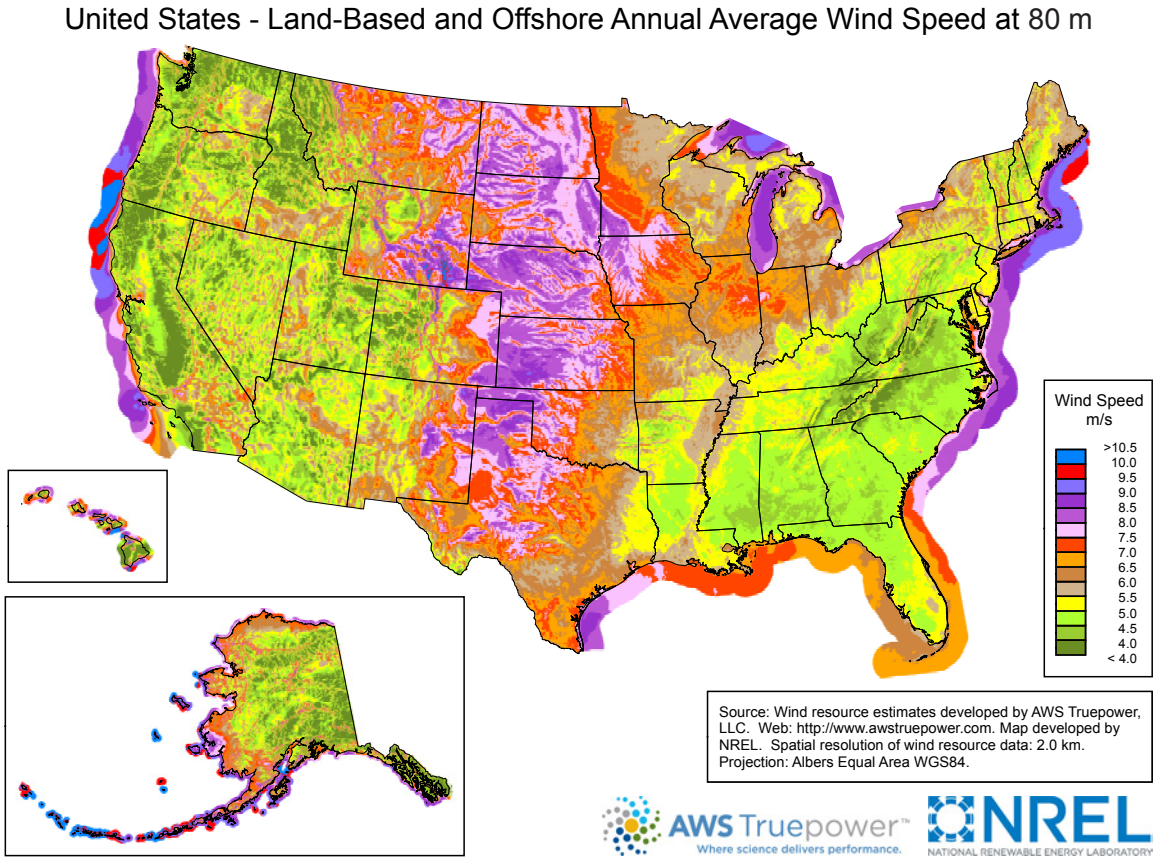


Photo from NREL

For more information, including updates and results from national laboratory research not detailed in this report, see energy.gov/eere/wind/offshore-wind-research-and-development.

End Notes

[1] Musial, W. and Ram, B., 2010, *Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers* (NREL/TP-500-40745), Golden, CO: National Renewable Energy Laboratory. September 27, 2012. http://www.nrel.gov/wind/pdfs/40745.pdf

[2] Energy Information Administration, U.S. Census Regions and Divisions. June 14, 2000. http://www.eia.gov/consumption/residential/maps.cfm

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