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

OFFSHORE WIND PROJECTS

Fiscal Years 2006 - 2012
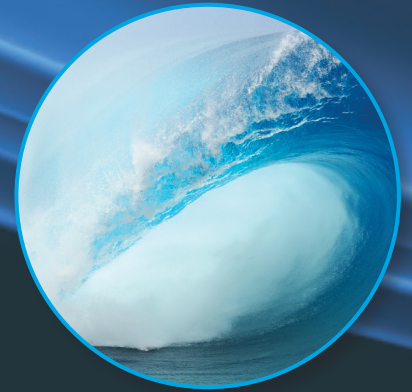
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Photo from NREL

Introduction

Wind and Water Power Program

The Wind and Water Power Program (WWPP), 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. The Program 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.

From Fiscal Year (FY) 2006 to FY 2012, WWPP provided R&D funding across eight broad areas:

1. Conventional Hydropower Projects
2. Marine and Hydrokinetic Projects
3. Offshore Wind Projects
4. Wind Turbine Projects
5. Wind Integration Projects
6. Environmental Impacts of Wind Projects
7. Wind Market Acceptance Projects
8. Wind Workforce Development Projects.

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

Types of Funding Sources

The Wind and Water Power Program's (WWPP'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. WWPP-funded R&D projects are typically awarded to recipients as grants 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 FOA grants and CDPs.

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

WWPP 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 Technology

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 deepwater 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 FY 2006 to FY 2012, DOE's Wind Program announced awards totaling more than $140 million for 64 projects focused on offshore wind. These projects focus largely on removing market barriers to deployment or developing innovative technologies – as outlined in the *National Offshore Wind Strategy* – and will be followed in future years by advanced technology demonstration project awards. Table 1 provides a brief description of each of these 2006-2012 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: FY 2006 – FY 2012 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source
ABB, Inc.	National Offshore Wind Energy Grid Interconnection Study	$900,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA

Project Description

ABB is assessing the likely impact of offshore wind development in the various regions of the U.S. from the electric utility perspective. This work includes 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.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Advanced Magnet Lab, Inc.	Lightweight, Direct Drive, Fully Superconducting Generator for Large Wind Turbines	$1,896,850	FY11 Next Generation Drivetrain FOA

Project Description

Advanced Magnet Lab is developing an innovative superconducting direct-drive generator for large wind turbines. The project will employ a new technology for the drivetrain coil configuration to address technical challenges of large torque electric machines.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Alstom Power, Inc.	Cost of Energy Reduction for Offshore Tension Leg Platform Wind Turbine Systems through Advanced Control Strategies	$3,039,985	FY11 U.S. Offshore Wind: Technology Development FOA

Project Description

Alstom Power is developing an advanced control system that integrates innovative sensors on a floating wind turbine designs in order to maximize energy production while minimizing undesirable structural loads.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
AWS Truepower, LLC	National Offshore Wind Energy Resource and Design Data Campaign – Analysis and Collaboration	$900,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA

Project Description

AWS Truepower is establishing a Web-based national met-ocean wind energy resource and design conditions data inventory. The project will establish data needs, identify existing sources of relevant data, and carry out a gaps analysis to establish long term requirements for new data to be gathered and disseminated through national public-private collaboration initiatives.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
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

Project Description

Biodiversity Research Institute is collecting and analyzing data on bird, sea turtle, and marine mammal abundance and movement in the mid-Atlantic region to determine species risk to offshore wind plant interaction. The project is performing baseline surveys using a variety of technologies to develop predictive and risk assessment frameworks.

[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: FY 2006 – FY 2012 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Boulder Wind Power (operated by Core Wind Power, Inc.)	Boulder Wind Power Advanced Gearless Drivetrain	$486,000	FY11 Next Generation Drivetrain FOA
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
Bowling Green State University	Coastal Wind Ohio	$2,531,900	FY06, FY08, FY09 CDPs
Project Description			
Bowling Green State University conducted research aimed at removing impediments for the deployment of wind turbines in Lake Erie to: 1) determine the feasibility of different wind turbine designs in offshore environment using computational tools and model analysis for reducing constructional and operational costs; 2) determine migratory patterns across the northern shore of Lake Erie using a custom-built monitoring system consisting of marine radar, IR camera, and acoustic recorders; 3) accurately describe the potential impact of wind turbines on breeding and migrating birds to help guide policy on best management practices for offshore bird risk assessments; and 4) establish a geospatial database for supporting robust offshore wind turbine development that meets important environmental and economic criteria. This is one project funded with three separate CDPs.			

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Bowling Green State University	Coastal Ohio Wind Project: Removing Barriers to Great Lakes Offshore Wind Energy Development	$1,000,000	FY10 CDP
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 site assessment; to better understand operating characteristics of wind turbines, particularly issues that relate to ice mitigation; and to understand different economic scenarios related to the deployment of offshore wind turbines.			

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Case Western Reserve University	Great Lakes Offshore Wind: Utility and Regional Integration Study	$540,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA
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.			

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Clear Path Energy, LLC	Buoyancy Stabilized Offshore Wind Turbine	$500,00	FY11 U.S. Offshore Wind: Technology Development FOA
Project Description			
Clear Path Energy is creating a conceptual design for offshore wind turbine farm systems that can be deployed in water deeper than 35 meters using innovative foundation technology.			

Table 1: FY 2006 – FY 2012 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Clemson University	Large Wind Turbine Drivetrain Testing Facility	$44,555,252	FY09 American Recovery and Reinvestment Act
Project Description			
Clemson University is constructing 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
Clipper Windpower	Novel, Low-Cost, High Reliability Wind Turbine Drivetrain	$468,450	FY11 Next Generation Drivetrain FOA
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
DNV	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
Project Description			
DNV 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.			

Project Recipient	Project Title	DOE Funding Amount	Funding Source
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
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
Douglas-Westwood, LLC	An Optimized Vessels Assessment for Offshore Wind in the United States	$300,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA
Project Description			
Douglas-Westwood is identifying national vessel requirements under several offshore wind industry growth scenarios. The project is collecting data on the vessels currently deployed in the international offshore wind industry; assessing trends for future dedicated vessels; and identifying resources to implement innovative strategies to support companies seeking to build new vessels and establish related services as the industry grows.			

Table 1: FY 2006 – FY 2012 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Duke Energy Business Services, LLC	Carolinas Offshore Wind Integration Case Study	$534,910	FY11 U.S. Offshore Wind: Removing Market Barriers FOA

Project Description

Duke Energy Business Services is examining the potential effects of offshore wind development on the Duke Energy Carolinas system by determining costs of upgrading the transmission system to support large-scale offshore projects, and assessing strategies for system integration and management.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Eaton Corporation	Reliable, Lightweight Transmission for Offshore, Utility-Scale Wind Turbines	$533,518	FY11 Next Generation Drivetrain FOA

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
Freshwater Wind, LLC	Shallow Water Offshore Wind System Optimization for the Great Lakes	$394,000	FY11 U.S. Offshore Wind: Technology Development FOA

Project Description

Freshwater Wind is creating a computational model to study how existing wind turbine systems could be optimized for shallow water conditions found in the Great Lakes.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
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

Project Description

Garrad Hassan America is identifying and quantifying key areas of 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 is developing 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.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
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

Project Description

Garrad Hassan America is incorporating lessons learned from Northern European offshore wind projects in identifying port requirements to meet various offshore wind industry growth scenarios in the United States. The project is creating 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.

Table 1: FY 2006 – FY 2012 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source
General Electric (GE) Global Research	Superconductivity for Large-Scale Wind Turbines	$449,183	FY11 Next Generation Drivetrain FOA
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
The Glosten Associates, Inc.	Innovative Offshore Wind Plant System Design Studies	$401,941	FY11 U.S. Offshore Wind: Technology Development FOA
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
Grand Valley State University	Michigan Alternative and Renewable Energy Center Offshore Wind Demonstration Project	$1,427,250	FY09 CDP
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.			

Project Recipient	Project Title	DOE Funding Amount	Funding Source
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
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
Indiana University	An Integrated Approach to Offshore Wind Energy Assessment: Great Lakes 3D Wind Experiment	$700,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA
Project Description			
Indiana 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.			

Table 1: FY 2006 – FY 2012 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Massachusetts Clean Energy Center	Massachusetts Wind Technology Testing Center	$24,752,779	FY09 American Recovery and Reinvestment Act
Project Description			

The Wind Technology Testing Center is the nation's first large wind blade test facility and is capable of testing longer blades than any other facility in the world. The center will help reduce the cost of wind energy, accelerate technical innovation in turbine and blade design, and speed the deployment of the next generation of wind turbine blades for both offshore and land-based wind energy.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
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
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
National Renewable Energy Laboratory (operated by Alliance for Sustainable Energy, LLC)	U.S.-Sourced, Next Generation Drivetrain for Land-Based and Offshore Wind Turbines	$1,998,626	FY11 Next Generation Drivetrain FOA
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 be scalable to 10 megawatts.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
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
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.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
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
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.

Table 1: FY 2006 – FY 2012 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source
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

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
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

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
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

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.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Nautica Windpower, LLC	Advanced Floating Turbine	$500,000	FY11 U.S. Offshore Wind: Technology Development FOA

Project Description

Nautica Windpower is developing a conceptual design for a deepwater offshore wind farm using lightweight floating platforms with improved access for maintenance.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Navigant Consulting, Inc.	U.S. Offshore Wind Market and Economic Analysis, Annual Market Assessment	$514,999	FY11 U.S. Offshore Wind: Removing Market Barriers FOA

Project Description

Navigant Consulting is issuing a comprehensive assessment of the U.S. offshore wind market each year over a three-year period. The project will provide stakeholders with updated information, data analysis, and trends on technical, regulatory, financial, economic, and workforce development drivers influencing industry growth.

Table 1: FY 2006 – FY 2012 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Navigant Consulting, Inc.	U.S. Offshore Wind Manufacturing and Supply Chain Development	$349,998	FY11 U.S. Offshore Wind: Removing Market Barriers FOA

Project Description			
Navigant Consulting is examining factors and strategies influencing development of a U.S. supply chain for the offshore wind industry. Through industry surveys and stakeholder forums, the project is identifying potential gaps in the supply chain and opportunities for manufacturers and technical services companies to contribute to the domestic content of offshore project facilities.			

Project Recipient	Project Title	DOE Funding Amount	Funding Source
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

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
The Pennsylvania State University	A High Performance Computing "Cyber Wind Facility" for Turbine-Platform-Wake Interactions with the Atmosphere and Ocean	$1,200,000	FY11 U.S. Offshore Wind: Technology Development FOA

Project Description			
The Pennsylvania State University is developing a high-fidelity "Cyber Wind Facility" to simulate land-based and offshore wind plants using high-performance computing. The model will simulate the impacts of complex wind and wave dynamics on wind turbine structures and energy performance.			

Project Recipient	Project Title	DOE Funding Amount	Funding Source
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

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
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

Project Description			
Savannah River National Laboratory is developing new techniques of characterizing breaking wave conditions and resulting structural loads. These loading characterizations will inform wind plant design calculations, which will in turn reduce uncertainty and cost in construction of offshore energy systems.			

Table 1: FY 2006 – FY 2012 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Siemens Energy, Inc.	Offshore 12 MW Turbine Rotor with Advanced Materials and Passive Design Concepts	$4,093,185	FY11 U.S. Offshore Wind: Technology Development FOA

Project Description
Siemens Energy is investigating the use of various passive aerodynamic control technologies that are capable of significantly improving the performance of wind turbine blades and decreasing the cost of energy.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Stantec Consulting Services, Inc.	Deepwater Offshore Bat and Avian Monitoring Program	$599,501	FY11 U.S. Offshore Wind: Removing Market Barriers FOA

Project Description
Stantec Consulting Services is collecting 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.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
State University of New York	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

Project Description
The State University of New York is verifying 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 used to construct more accurate wind resource maps for the East Coast of the United States.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
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

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
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

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://www.perihq.com/documents/Mid-AtlanticWind%20Rpt.%2031.5.12_FINAL%20SUBMISSION.pdf.

Table 1: FY 2006 – FY 2012 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Texas Engineering Experiment Station at Texas A&M	Development of Mooring-Anchor Program for Coupling with Floater Program for Floating Offshore Wind Turbine Models	$400,000	FY11 U.S. Offshore Wind: Technology Development FOA

Project Description

The Texas Engineering Experiment Station at Texas A&M is building 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.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Town of Hull	Hull Municipal Light Plant Offshore Wind Project	$1,701,500	FY09, FY10 CDPs

Project Description

The Town of Hull on the east coast of Massachusetts is conducting a multi-phase offshore wind project that consists 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 will ultimately develop a plan for the design, construction, operation, and maintenance of an offshore wind testing platform and offshore wind energy generation facility. This is one project funded with two separate CDPs.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
University Corporation 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

Project Description

The University Corporation 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
University Corporation 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

Project Description

The University Corporation 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
University of Delaware	Wind Turbine Model and Pilot Project for Alternative Energy	$2,427,250	FY09, FY10 CDPs

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. This is one project funded with two separate CDPs.

Table 1: FY 2006 – FY 2012 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source
University of Delaware	Advanced Offshore Wind Energy: Atlantic Consortium	$747,540	FY09 Wind University Consortia FOA

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
University Of Delaware	Empowering Coastal States and Utilities through Model Offshore Wind Legislation and Outreach	$99,967	FY09 20% Wind by 2030 FOA

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
University of Delaware	Mid-Atlantic Offshore Wind Interconnection and Transmission	$540,000	FY11 U.S. Offshore Wind: Removing Market Barriers FOA

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.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
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

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
University of Maine	DeepCWind - Deepwater Offshore Wind Consortium	$7,100,000	FY09 American Recovery and Reinvestment Act (part of the FY09 Wind University Consortia FOA)

Project Description

The University of Maine is developing floating offshore wind farm technologies for deepwater development. The project will partially validate computer models for designing and analyzing floating offshore wind turbines and research integrating more durable, lighter, hybrid composite materials into offshore wind floating platforms and towers.

Table 1: FY 2006 – FY 2012 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source
University of Maine	Offshore Wind Initiative	$5,000,000	FY10 CDP

Project Description
The University of Maine's Deepwater Offshore Wind Research Program is conducting research that will provide partial validation of existing numerical models; analyze how floating platform designs can be optimized by integrating more durable, lighter, alternative materials and composite technology; and result in the fabrication and deployment of a scaled floating platform at University of Maine's Deepwater Offshore Wind Test Site and other sites. The project is constructing a 20 kilowatt floating wind turbine on a semi-submersible foundation that will be deployed off of Castine, Maine, and Monhegan, 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
University of Massachusetts	Offshore Wind Energy Systems Engineering Course Development	$252,687	FY09 20% Wind by 2030 FOA

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
University of Michigan	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

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
University of Michigan	Bottom Fixed Platform Dynamics Models Assessing Surface Ice Interactions for Transitional Depth Structures in the Great Lakes	$229,998	FY11 U.S. Offshore Wind: Technology Development FOA

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.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
University of Minnesota	High-Resolution Computational Algorithms for Simulating Offshore Wind Farms	$1,200,000	FY11 U.S. Offshore Wind: Technology Development FOA

Project Description
The University of Minnesota is developing a multi-scale, multi-resolution computational tool to simulate wave and wind interactions with various floating offshore wind farm configurations.

Table 1: FY 2006 – FY 2012 Offshore Wind Project Descriptions[a]

Project Recipient	Project Title	DOE Funding Amount	Funding Source
University of Rhode Island Coastal Resources Center	Rhode Island Ocean Special Area Management Plan	$666,050	FY09 CDP

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
The University of Texas at 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

Project Description
The University of Texas at Austin is assessing 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 will interact closely with commercial and governmental stakeholders in identifying concerns and recommending mitigation methods if required.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
University of Toledo	Advanced Offshore Wind Turbine/ Foundation Concept for the Great Lakes	$750,000	FY09 Wind University Consortia FOA

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
Zimitar, Inc.	High-Efficiency Structural Flowthrough Rotor With Active Flap Control	$3,998,763	FY11 U.S. Offshore Wind: Technology Development FOA

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, increase energy capture, and reduce the cost of energy.

Photo from NREL

Offshore Wind Funding Distribution

DOE has funded 64 offshore wind projects through the Wind Program from FY 2006 to FY 2012. 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 FY 2006 and FY 2012 fall under two activity areas: Technology Development and Market Acceleration and Deployment. 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. When total DOE funding for offshore wind from FY 2006 to FY 2012 is categorized by activity area, Technology Development activities received 85% of the funding, while Market Acceleration and Deployment activities received the remaining 15%.

Within the Technology Development and Market Acceleration and Deployment activity areas, the Wind Program funds particular topics in priority areas. Nearly 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 and Market Acceleration and Deployment activity areas.

Photo from NREL

Table 2: FY 2006 – FY 2012 Offshore Wind Funding Distribution by Activity Area & Topic Area

Activity Area	Total Funding	Percent of Total
Technology Development Subtotal	**$119,643,294**	**85.2%**
Test Facilities	$69,308,031	49.3%
Advanced Turbine Technologies	$21,854,560	15.6%
Floating Foundation Technologies	$13,501,941	9.6%
Modeling, Simulation, and Design Tools	$10,408,412	7.4%
Optimized Wind Plant Systems	$4,570,350	3.3%
Market Acceleration and Deployment Subtotal	**$20,760,332**	**14.8%**
Siting – Environmental and Permitting	$9,392,752	6.7%
Resource Characterization	$4,936,064	3.5%
Market Acceleration and Barrier Reduction	$3,916,606	2.8%
Grid Systems Planning and Operations	$2,514,910	1.8%
Total	**$140,403,626**	

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 Program's funding was distributed within regions and divisions. The geographic regions and divisions used to present the distribution of WWPP'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: FY 2006 – FY 2012 Offshore Wind Funding by Geographic Region & Division

Region	Region Total Funding	Division	Division Total Funding
West	$17,832,347	Mountain	$11,828,626
		Pacific	$6,003,721
South	$62,504,780	South Atlantic	$60,739,784
		West South Central	$900,000
		East South Central	$864,997
Northeast	$48,898,918	New England	$44,672,517
		Middle Atlantic	$4,226,402
Midwest	$11,167,579	East North Central	$9,499,129
		West North Central	$1,668,450
		Total	**$140,403,626**

Exhibit 1: FY 2006 – FY 2012 Offshore Wind Funding by Geographic Region & Division
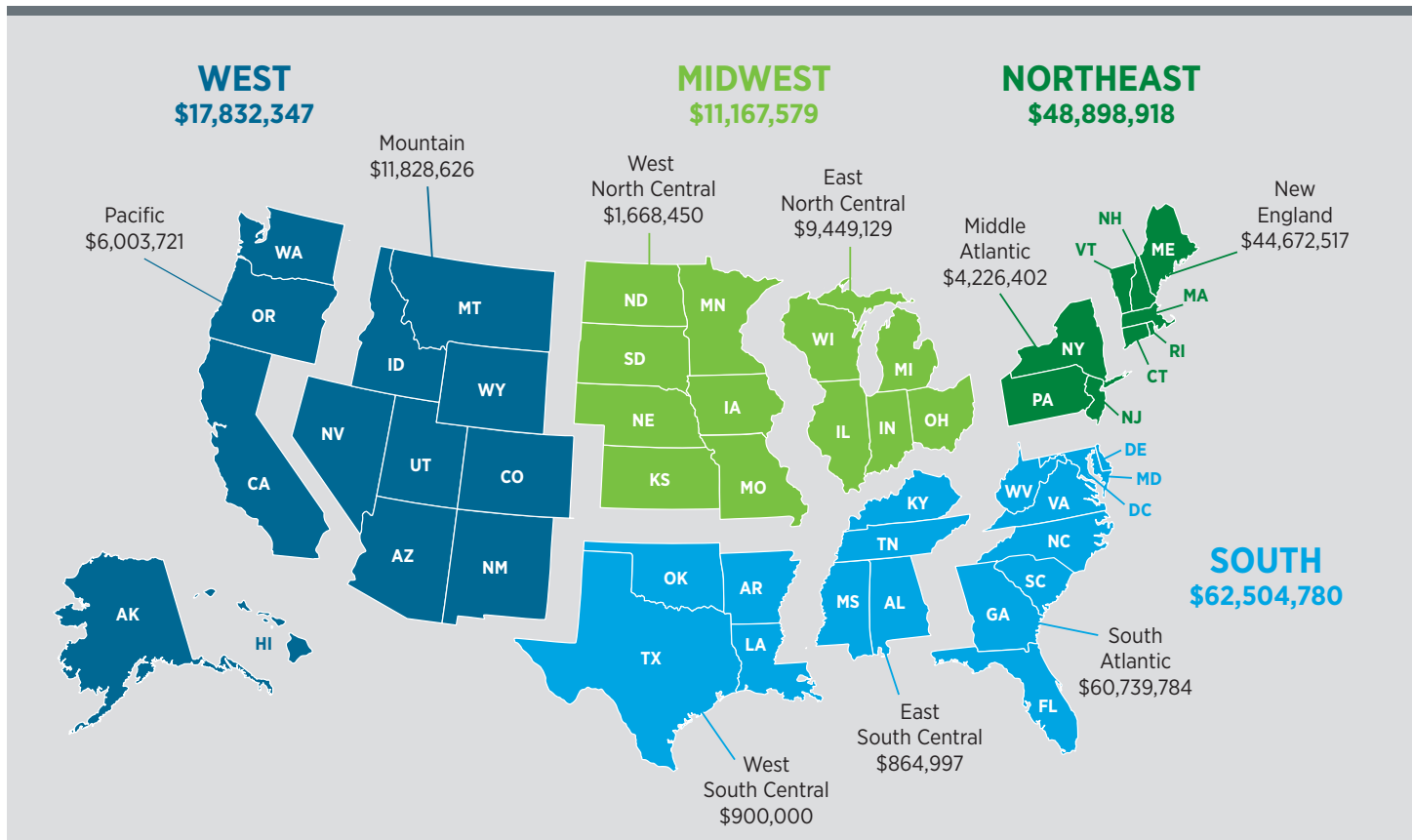
Funding by State

Wind Program funding for the 64 offshore wind projects was broadly distributed to organizations in 23 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: FY 2006 – FY 2012 Offshore Wind Funding Distribution by State

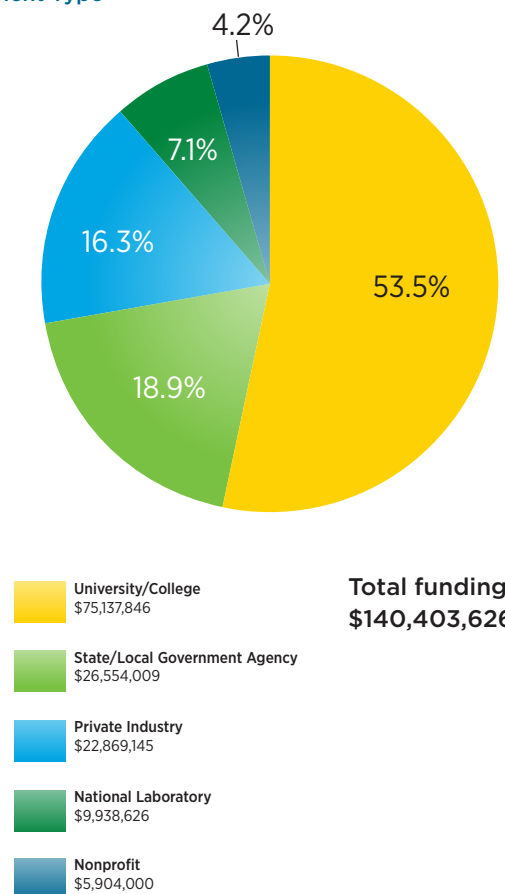| State	Total Funding
California	$4,695,588
Colorado	$7,688,626
Delaware	$4,814,757
Florida	$5,990,035
Illinois	$864,997
Indiana	$700,000
Iowa	$468,450
Maine	$17,199,501
Massachusetts	$26,806,966
Michigan	$3,083,229
Minnesota	$1,200,000
New Jersey	$702,000
New Mexico	$4,140,000
New York	$2,324,402
North Carolina	$1,434,910
Ohio	$5,715,900
Oregon	$600,000
Pennsylvania	$1,200,00
Rhode Island	$666,050
South Carolina	$45,110,097
Texas	$900,000
Virginia	$3,389,985
Washington	$708,133
Total	**$140,403,626**

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 half of the total offshore wind funding from FY 2006 to FY 2012 was awarded to universities. Among universities, Clemson University is developing a large wind turbine drivetrain test facility for the research of technologies applicable to both land-based and offshore wind development. A wide range of private companies received more than 16% of funding for such diverse projects as grid integration studies, development of new power generation technologies and control strategies, and assessment of floating turbine platforms for deepwater deployment. Three state and local government agencies received almost 19% 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.
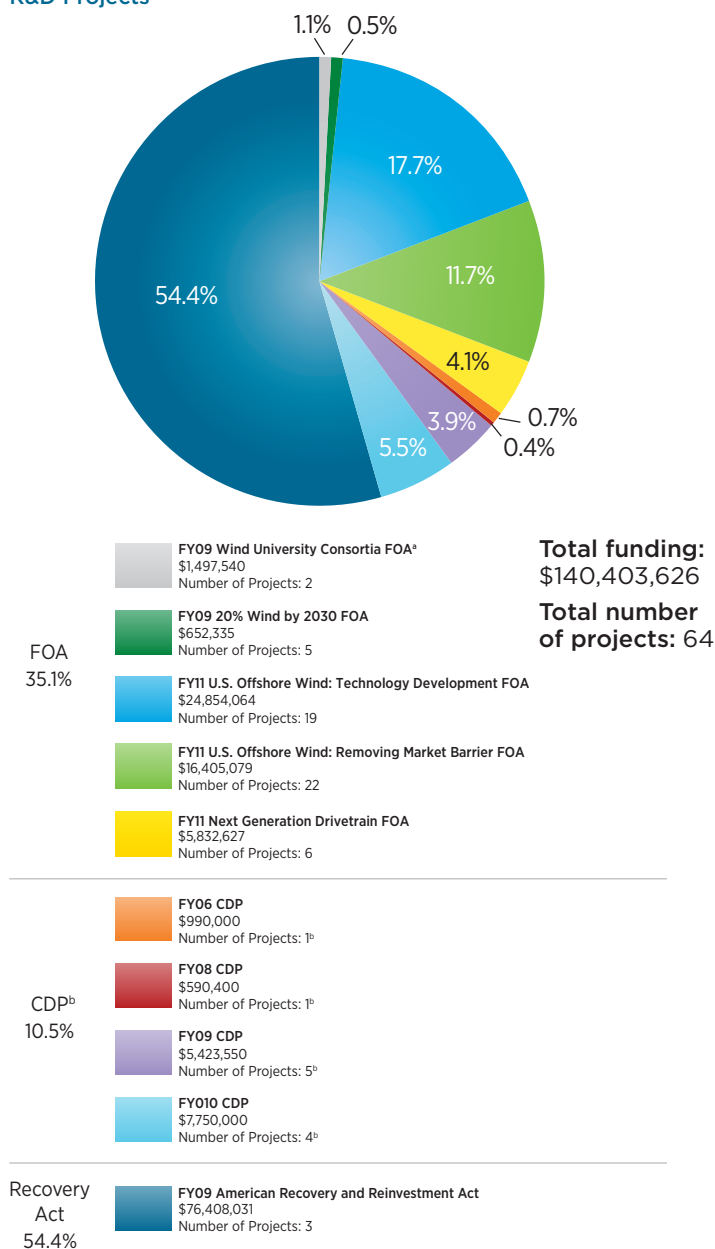
Exhibit 2: FY 2006 – FY 2012 Offshore Wind Funding Distribution by Recipient Type

Total funding: $140,403,626

- University/College $75,137,846 — 53.5%
- State/Local Government Agency $26,554,009 — 18.9%
- Private Industry $22,869,145 — 16.3%
- National Laboratory $9,938,626 — 7.1%
- Nonprofit $5,904,000 — 4.2%

Funding Sources

In FY 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 FY 2009 to FY 2012, the Wind Program issued five competitive FOAs with offshore wind awards. These FOAs provided more than $49 million in announced awards for 54 offshore wind projects. An additional $14.8 million was awarded to six offshore wind projects through congressionally directed funds from FY 2006 to FY 2010. Exhibit 3 provides details on the funding sources for the Wind Program's 64 offshore wind projects.

Exhibit 3: FY 2006 – FY 2012 Funding Sources for Offshore Wind R&D Projects

- 1.1%
- 0.5%
- 17.7%
- 11.7%
- 54.4%
- 4.1%
- 3.9%
- 0.7%
- 0.4%
- 5.5%

Total funding: $140,403,626

Total number of projects: 64

FOA 35.1%

FY09 Wind University Consortia FOA[a]
$1,497,540
Number of Projects: 2

FY09 20% Wind by 2030 FOA
$652,335
Number of Projects: 5

FY11 U.S. Offshore Wind: Technology Development FOA
$24,854,064
Number of Projects: 19

FY11 U.S. Offshore Wind: Removing Market Barrier FOA
$16,405,079
Number of Projects: 22

FY11 Next Generation Drivetrain FOA
$5,832,627
Number of Projects: 6

CDP[b] 10.5%

FY06 CDP
$990,000
Number of Projects: 1[b]

FY08 CDP
$590,400
Number of Projects: 1[b]

FY09 CDP
$5,423,550
Number of Projects: 5[b]

FY010 CDP
$7,750,000
Number of Projects: 4[b]

Recovery Act 54.4%

FY09 American Recovery and Reinvestment Act
$76,408,031
Number of Projects: 3

[a]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.

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

Accomplishments

The Wind Program provided more than $140 million in funding for 64 offshore wind projects from FY 2006 to FY 2012, 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.

- **University of Maine Floating Platform Tank Testing**: In the spring of 2011, the University of Maine-led DeepCwind Consortium tested three different 1:50 scale floating wind turbine concepts at the Maritime Research Institute Netherlands (MARIN). Detailed performance and structural data were collected for a spar buoy, a tension leg platform and a semi-submersible floating turbine model, in response to combined wind and wave loads generated in the testing tank. It was the first time that such extensive scale model tests had been conducted in this field, anywhere in the world. Multiple reports on the testing program have been published and presented at conferences worldwide. The data are being used to validate computer-aided engineering design tools such as the National Renewable Energy Laboratory's FAST tool.

- **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 is developing an innovative superconducting direct-drive generator for large wind turbines, and NREL is developing a hybrid design that combines the advantages of both geared and direct-drive systems through an improved single-stage gearbox and medium speed permanent magnet generator that reduces the need for rare earth magnetic materials.

- **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 recently began pouring the foundations for the 7.5 and 15 megawatt test stands, 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. The facility will be fully commissioned in the first half of 2013.

- **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 is actively collecting 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**: In 2012, the Biodiversity Research Institute conducted the first of three years of 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.

- **Offshore Engineering Curriculum**: The University of Massachusetts developed the course content and teaching materials of a formal academic course entitled "Offshore Wind Energy Systems Engineering" for dissemination to colleges across the United States. The University plans to make continued updates to the Web-based course material in the future. See: http://www.meetingproceedings.com/2012/posters/awea/SplitViewer.asp?PID=NTY1NTA0MDA#.

- **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, will be released in October 2012, with the remaining studies coming by the end of 2012.

- **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 new 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. More information is available at wind.energy.gov/resource_assessment_characterization.html.

United States - Land-Based and Offshore Annual Average Wind Speed at 80 m
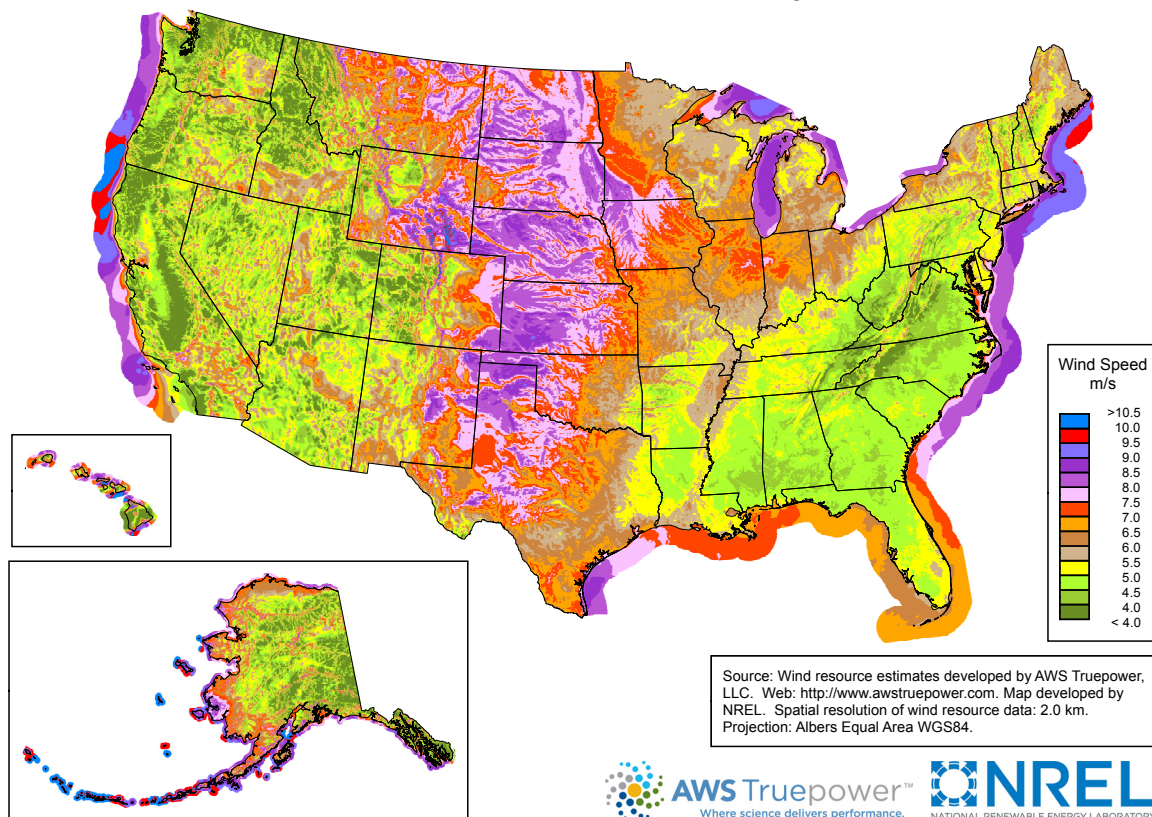
Wind Speed m/s

>10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
< 4.0

Source: Wind resource estimates developed by AWS Truepower, LLC. Web: http://www.awstruepower.com. Map developed by NREL. Spatial resolution of wind resource data: 2.0 km. Projection: Albers Equal Area WGS84.

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Photo from NREL

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.doe.gov/emeu/reps/maps/us_census.html

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Energy Efficiency &
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