

Department of Energy Awards \$43 Million to Spur Offshore Wind Energy

In September, the U.S. Department of Energy announced that it will award \$43 million over the next five years to 41 projects across 20 states to speed technical innovations, lower costs, and shorten the timeline for deploying offshore wind energy systems. The projects will advance wind turbine design tools and hardware, improve information about U.S. offshore wind resources, and accelerate the deployment of offshore wind by reducing market barriers such as supply chain development, transmission and infrastructure.

The projects announced in September focus on approaches to advancing offshore technology and removing market barriers to responsible offshore wind energy deployment. Funding is subject to Congressional appropriations.

Nineteen offshore wind technology development projects will receive \$26.5 million to address technical challenges and provide the foundation for a cost-competitive offshore wind industry in the United States. Awardees, in collaboration with industry, will develop the engineering modeling and analysis tools required to lower overall offshore facility costs and to design the next generation of innovative large-scale turbines optimized for installation and operation in the marine environment. These projects include research and development for innovations in key components such as floating support structures and turbine rotor and control subsystems that may lead to capital cost reductions of up to 50 percent.



3.6-MW GE Wind turbine at Arklow Bank offshore wind facility near Arklow, Ireland. Photo from GE Wind Energy All Rights Reserved
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Twenty-two market barrier removal projects will receive \$16.5 million

to research factors limiting the deployment of offshore wind in the nation's coastal and Great Lakes regions. Topic areas include project design factors such as environmental impact assessment and characterization of the offshore wind resource; subjects related to investment and infrastructure development such as categorization of financial risks and long-term manufacturing needs and port requirements; and technical offshore wind interface topics such as transmission grid integration, and assessment of potential impact on offshore navigation and communication systems.

DOE Releases 2010 Wind Technologies Market Report

The Department of Energy released its 2010 Wind Technologies Market Report produced by Lawrence Berkeley National Laboratory (LBNL) in July.



The report analyzes trends in capacity, manufacturing, performance, and costs. According to the report, wind power capacity grew by a healthy 15% in 2010, representing \$11 billion in new investment despite the economic downturn. Component manufacturing also increased. Nine of the eleven wind turbine manufacturers with the largest share of the U.S. market in 2010 had one or more manufacturing facilities in the United States, and a number of new manufacturing facilities both domestic and foreign opened in 2010. Domestically produced goods used in U.S. wind power projects increased to 68% in 2009-2010, up from 52% in 2005-2006.

Other highlights from the report include:

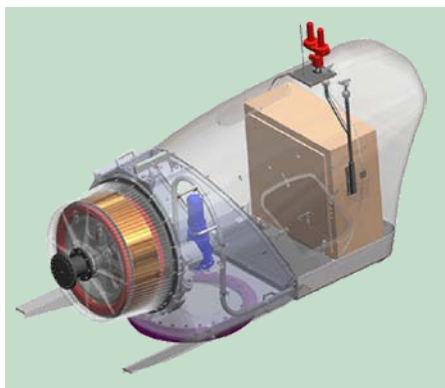
- Nine offshore wind projects totaling 2,322 MW have advanced significantly in the permitting and development process. Three of the nine projects have signed power purchase agreements.
- The environment for wind power project finance improved steadily throughout 2010. By the end of the year, approximately \$4 billion in tax equity was committed to wind power projects—more than twice as much as was invested in 2009.
- The average installed cost of wind power projects held steady in 2010 but is expected to decline in the near term, and wind turbine prices continued to decline from the 2008 peak.
- Transmission development continued to grow with 8,800 circuit miles of new transmission added in 2010, another 3,100 miles under construction, and an additional 39,000 circuit miles projected by 2020.
- Lower wind turbine and wind power pricing and key federal incentives for wind energy will lead to moderately higher wind power capacity additions in 2011 and 2012.

Lawrence Berkeley National Laboratory addresses the world's most urgent scientific challenges by advancing sustainable energy, protecting human health, creating new materials, and revealing the origin and fate of the universe. Founded in 1931, Berkeley Lab's scientific expertise has been recognized with 12 Nobel Prizes. The University of California manages Berkeley Lab for the U.S. Department of Energy's Office of Science.

Department of Energy Funds Six Companies to Develop Advanced Drivetrain Designs

In June, the Department of Energy announced awards totaling nearly \$7.5 million to companies and research institutions working to develop the next generation of advanced wind turbine drivetrain designs. Some of the new designs will focus on reducing the cost of energy by increasing component reliability or by reducing the number of components. For example, direct-drive generators eliminate the need for a gearbox, which reduces weight, eliminates moving parts, and reduces maintenance costs. Other designs focus on increasing the amount of energy drivetrains produce or will minimize the use of rare-earth materials.

The companies selected for awards are Advanced Magnet Lab in Palm Bay, Florida; Boulder Wind Power in Boulder, Colorado; Clipper Windpower in Carpinteria, California; Eaton Corpo-



A direct drive wind turbine nacelle.
Source: Northern Power Systems 100KW

ration in Cleveland, Ohio; GE Global Research in Niskayuna, New York; and the National Renewable Energy Laboratory in Golden, Colorado. Each company will receive up to \$700,000 to conduct technology cost and readiness assessments during the first six-month funding period. Several of the companies will then be selected to receive an additional \$2 million each to conduct follow-on performance tests on their new designs.

Wind Forecasting Improvement Project

In July, the Department of Energy launched a \$6 million project with the National Oceanic and Atmospheric Administration (NOAA) and private partners to improve wind forecasting. Wind power forecasting allows system operators to anticipate the electrical output of wind plants and adjust the electrical output of other generating plants fueled by coal and natural gas accordingly. Industry power forecast providers currently supply wind power forecasts to some grid operators, but the forecasts can have large uncertainties, forcing the operators to keep more reserve genera-

tion than needed. Uncertain forecasts can also have financial consequences for wind power plant operators, as they may be penalized when their plants produce less energy than estimated and may receive no payment for more power than estimated.

To improve wind power forecasts, DOE and NOAA are working with teams led by AWS Truepower LLC in Albany, New York, and WindLogics in Saint Paul, Minnesota, to collect data and assess utility benefits of improved forecasting. During the next 12 months, the teams will use atmospheric instruments that include radar and sodar to measure wind speeds and characteristics in the Upper Midwest and in Texas. NOAA will then incorporate the data into an advanced weather forecasting model to provide more accurate meteorological inputs into wind power forecasts.

DOE's National Renewable Energy Laboratory will analyze the improved wind power forecasts produced by AWS Truepower and WindLogics to determine the economic benefits to grid operators, including cost savings from the reduction in reserve and regulation requirements, more efficient generator scheduling and dispatch, and reduction of imbalance costs and penalties.

New Model Examines Cumulative Impacts of Wind Energy Development on Sensitive Species

DOE's Argonne National Laboratory recently developed the prototype of a spatially explicit individual-based model for examining the cumulative impacts of wind energy development on populations and habitats of the greater sage grouse (*Centrocercus urophasianus*)—an

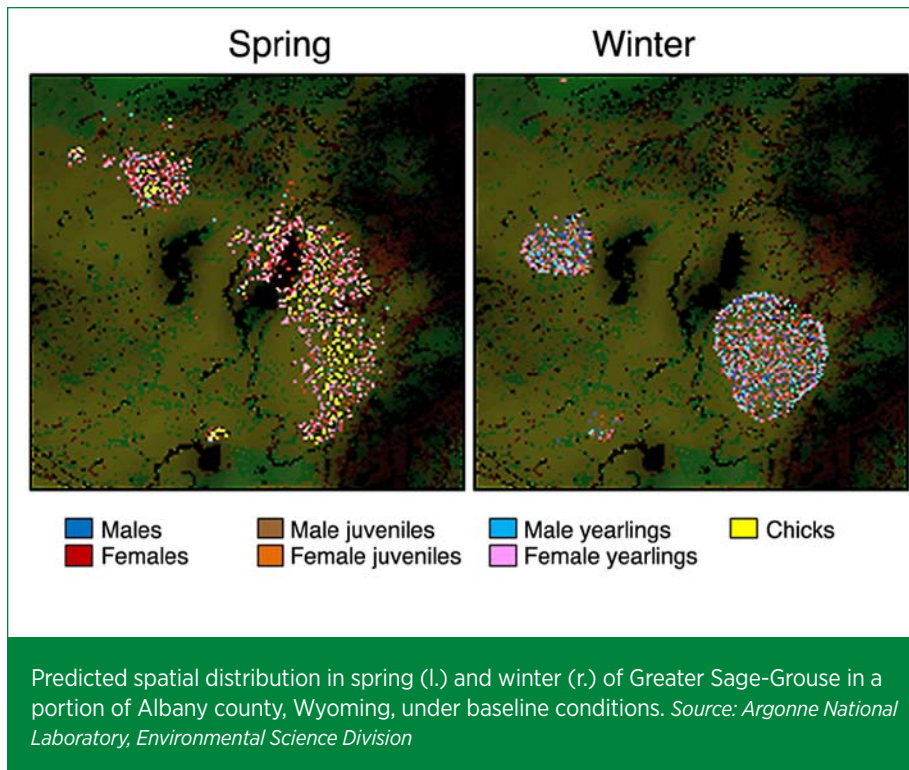
important wildlife species that has been affected by energy development in the western United States. The two-year project, "Wind Energy Development in Critical Wildlife Habitats: Considering Cumulative Impacts and the Maintenance of Sustainable Populations," was initiated with funding from DOE's Wind and Water Power Program.

Increasing concerns over the sustainability of sage-grouse populations in the face of increasing development have led to restrictions on development in sage-grouse core areas, but an incomplete understanding of the bird's response to the development of wind farms and other structures could lead to unnecessary or ineffective restrictions. The model is intended to facilitate smart development that minimizes impact by synthesizing available information into a predictive model.

In July 2011, Argonne completed testing of a prototype model that was based on conditions within Albany County, Wyoming, an area that currently supports important populations of greater sage grouse and has high wind energy development potential. Once fully developed



Sage grouse sitting in grassland.
Photo from LuRay Parker, Wyoming Game and Fish Department, NREL/PIX 17429



beyond the prototype stage, this model will allow stakeholders to assess cumulative impacts of proposed wind and other energy development on the sage-grouse early in the planning and siting process, identify appropriate mitigation strategies if necessary, and avoid or reduce potentially lengthy and costly project delays.

The sage grouse has an unusual, complex life history, including movements between different areas from season to season. The species also uses traditional strutting grounds (called leks) where males perform courtship displays. Disruption of any portion of the annual life cycle could result in long-term impacts in a wider portion of the species range. The Argonne model incorporates the species' requirements and movements to better understand how wind energy projects could affect populations. Five major processes for seven age-sex classes are represented in the model. These pro-

cesses include seasonal movements, habitat selection, condition change, reproduction, and survivorship.

Given a lack of observed data on how wind energy developments affect the sage-grouse, the model uses information regarding the impacts of other infrastructure development (such as oil and gas) as a proxy. DOE is funding other efforts to collect data on sage grouse around wind farms. These data will be used to validate the model, which will then provide valuable information to support siting decisions and minimize ecological impact. With this tool, users will be able to determine the proximate cause of sage grouse population changes (e.g., changes in survivorship, reproduction, and habitat suitability), and this information could be used to help design improved mitigation strategies. The model also provides a framework that can be adapted and applied to other regions with high wind

potential and species that are identified as at-risk from wind development.

Argonne plans to take the model from prototype stage to a fully functioning, user-friendly tool for land management agencies, planners, developers, and other stakeholders to evaluate the effects of wind development on this critically important wildlife species. Future work will focus on incorporating the latest information on habitat suitability, sage-grouse biology, and wind development effects.

Argonne National Laboratory outside Chicago, Illinois, is also working on wind turbine drivetrain reliability issues, advanced superconducting drivetrain concepts, improved methodologies for wind power forecasting, the use of wind power forecasting in power systems operations, and a visual impact risk analysis and mitigation system.

DOE's NREL and LLNL team with NOAA and University of Colorado to Study Wind Inflow Conditions

Invisible to the eye, wind wakes created by multimegawatt wind turbines can nevertheless strongly impact performance of other turbines downstream. That's why understanding atmospheric effects such as wind shifts and wake behavior can be critical to advancing turbine design and improving their siting within wind farms. While wakes have been studied before, as turbines grow in size—approximately doubling in height over the past five years—they present more complex challenges to researchers and operators.

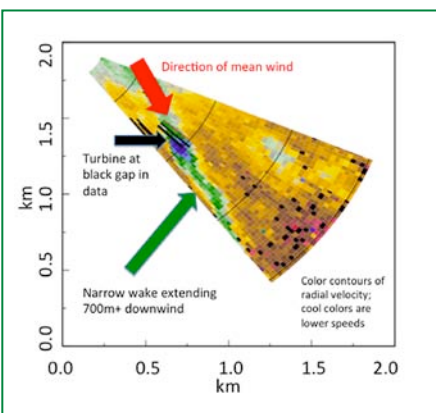
To gain new insights into turbine wind wakes, the U.S. Department of Energy's Wind Program and the Renewable and Sustainable Energy Institute (RASEI)

joined together to fund a high-tech study in April and May of 2011. A multi-organizational team of experts used precise instruments to create a detailed picture of the atmosphere surrounding large turbines. Among these instruments was the high-resolution Doppler LIDAR, developed at the National Oceanic and Atmospheric Administration (NOAA), and used for the first time to produce a three-dimensional portrait of atmospheric activity in the wake of a multimegawatt wind turbine. The LIDAR captures a slice of air up to 3,280 feet from the ground and 4.3 miles long (Figure 3). Researchers focused on a 2.3-megawatt turbine that rises 80 meters (328 feet) from its base to its hub. The turbine is installed at DOE's National Renewable Energy Laboratory's (NREL) National Wind Technology Center near Boulder, Colorado.

The interagency team—from NREL, the University of Colorado at Boulder, NOAA, and DOE's Lawrence Livermore National Laboratory (LLNL)—also deployed other high-resolution atmospheric instrumentation. Researchers gathered wind and turbulence data using commercial platforms, including a specialized laser called a Windcube LIDAR and a sonic detection and ranging (SODAR) system, the SecondWind Triton. These data were supplemented by the high-frequency sonic anemometers installed on two new 135-meter (440 feet) meteorological towers at NREL's National Wind Technology Center. Each of these instruments contributes a unique perspective on the dynamic turbine wake system, and these data will be incorporated into advanced computer models. New questions are being explored, such as how wakes in wind farms lower the

velocities of downwind turbines, and how the lengths of wakes depend on how strong the wind is as it enters the turbine.

“Even fluctuations in air temperature throughout the day can affect wind turbine wakes,” said Julie Lundquist, professor of atmospheric and oceanic sciences at the University of Colorado and joint appointee at NREL. “The resulting changes in wake behavior can impact the productivity of wind farms with their many rows of turbines, so it's important to observe them in detail and understand how to minimize their impacts.”



A typical horizontal slice captured by LIDAR. Color contours show radial wind speed velocity; cool colors are lower speeds. *Graphic courtesy of NOAA/ESRL*

Findings will be reported in upcoming journal publications. Also, data will be shared with the international wake modeling community. NREL researchers are optimistic about the analyses. The knowledge gained from this research could lead to improved turbine design standards, increased productivity in large wind farms, and a lower cost of energy from wind power.

The National Renewable Energy Laboratory (NREL), located in Golden, Colo-

rado, provides industry with the technical support it needs to develop advanced wind energy systems. NREL's research capabilities include design review and analysis; software development, modeling, and analysis; systems and controls analysis; turbine reliability and performance enhancement; certification and standards; utility integration assessment; wind resource assessment and mapping; technology market and economic assessment; workforce development; and outreach and education.

The Lawrence Livermore National Laboratory (LLNL) in Livermore, California, has a robust and growing program in wind power to help address the challenges in developing clean and renewable energy. Currently, a staff of nearly 20 scientists and engineers, drawn from programs in atmospheric science, engineering, and computation, are directly involved in wind power. The laboratory includes a 7,000-acre rural facility in the Altamont foothills that is being used for meteorological data acquisition and wind resource characterization.

Tool Improves Electricity Demand Predictions to Make More Room for Renewables

A new tool is available to help integrate wind and solar power into the electric grid by predicting the ranges in which power demand could increase or decrease in the immediate future.

Developed by the Department of Energy's Pacific Northwest National Laboratory (PNNL), the Online Analysis and Visualization of Operational Impacts of Wind and Solar Generation tool can help grid operators see where their power generation units fall short of covering possible changes in demand. The largest

electric grid balancing authority in the Western U.S., the California Independent System Operator (California ISO), is currently testing the tool.

Renewable energy sources are valued because the electricity they generate is largely free of the carbon emissions and other types of pollution associated with traditional power. As a result, many states have set ambitious renewable energy goals. California, for example, aims to have 33 percent of its energy come from renewables by 2020.

But incorporating wind and solar power into the existing electric grid can be a challenge. It can be difficult to accurately predict when and where wind will blow or the sun will shine. Unexpected gusts or clouds provide electric grid operators little time to adjust their conventional power generation enough to absorb the quick change in power availability.

Today, grid operators prepare for demand changes by using specific estimates for power demand at a given time. Recognizing that accurately pinpointing future power demand is nearly impossible, PNNL developed a new tool that uses a unique algorithm to predict a range of possible power demand scenarios for the immediate future within a desired percent confidence rate.

A recent, momentary peak in California prices provided a test of the tool's abilities. On June 24, California's wholesale power price rose to nearly \$1,000 per megawatt-hour for a five-minute interval. Using the tool, California ISO engineers were able to predict a shortfall in the system's ability to increase power generation to meet expected demand.

California ISO has been testing PNNL's tool for about three months. While look-

ing at their system's historical performance, California ISO engineers report they are encouraged by the tool's ability to predict power generation deficiencies. They're also finding similar results in real-time tests: Engineers are seeing if available generation capacity can adequately adjust to the variability of wind and solar energy production and meet expected demand changes.

Such advanced notice can give operators time to adjust their power generation abilities and prevent large peaks in power prices. Smoothing out the grid's operation makes room for a broader mix of energy sources and can make renewables more cost-competitive with traditional power.

DOE's Wind and Water Power Program funded the tool's initial development. The California Energy Commission also supported developing the tool for California's needs.

In addition to its systems integration work, the Pacific Northwest National Laboratory (PNNL) is working to accelerate the design, installation, and operation of offshore wind facilities by examining the potential impacts of those installations on the marine environment. To achieve this, PNNL is developing an environmental risk evaluation system and data storage capability to determine the priority risks from offshore wind development, and is investigating the use of monitoring technologies for avian and marine animals in offshore areas. PNNL is also conducting a multi-season meteorological field study to develop data products that can evaluate the performance of atmospheric models and quantify farm and turbine inflow conditions in complex terrain.

NREL Publishes Gearbox Reliability Collaborative Findings Report

In June, DOE's National Renewable Energy Laboratory (NREL) published the first formal report on the efforts of the Gearbox Reliability Collaborative (GRC) to address a major challenge for the wind energy industry—gearbox reliability. Gearbox failures require expensive and time-consuming replacement, significantly increasing the cost of wind plant operation while reducing the plant's power output and revenue. In an effort to help industry increase gearbox reliability, DOE and NREL launched the Wind Turbine Gearbox Reliability Collaborative (GRC) in 2006 to validate the typical gearbox design process through a comprehensive dynamometer and field-test program on extensively instrumented gearboxes. The collaborative brought together a team of the world's leading turbine manufacturers, consultants, and experts from more than 30 companies and organizations.

The report published by NREL—GRC Project Report: Findings from Phase 1 and Phase 2 Testing—provides a description of the project's major objectives, the activities that have been conducted to date, and, most significantly, a listing of findings that will help to improve wind turbine gearbox reliability. The report also contains recommendations for future research.

Wind Program Events

www.wind.energy.gov/events.html

- **Wind Powering America Webinar: Offshore Wind Development and Industry Update**, 10/19/2011: This free webinar is part of the U.S. Department of Energy's Wind Powering America 2011 webinar series. Advance registration is not required.
- **Renewable Energy Markets 2011**, 11/15/2011 – 11/18/2011: The Renewable Energy Markets Conference is the nation's premier forum for the energy community to gather, learn from each other, and recognize best practices for promoting renewable energy. It is organized by the Center for Resource Solutions and cosponsored by the Department of Energy and the U.S. Environmental Protection Agency Industry Events
- **AWEA Offshore WINDPOWER Conference**, 10/11/2011 – 10/13/2011: The AWEA OFFSHORE WINDPOWER 2011 Conference and Exhibition brings together exhibitors and attendees from all over the world who are interested in becoming players in this new and highly promising market. The event will be held at the Baltimore Convention Center in Baltimore, Maryland. www.offshorewindexpo.org/
- **UWIG Fall Technical Workshop**, 10/11 – 10/14, 2011: The 2011 UWIG Fall Technical Workshop to be held in Lahaina, Maui, Hawaii, will provide attendees with an expanded perspective on the status of wind and solar generation on utility systems in the United States and other countries.
- **AWEA Wind Energy Fall Symposium**, 11/2/2011 – 11/4/2011: Providing information and tools to help attendees operate in a complex and global marketplace, the 2011 AWEA Wind Energy Fall Symposium's educational program includes sessions that address not only industry trends and innovations but also how to best communicate wind energy's benefits to external audiences.

Recent Publications

www.wind.energy.gov/publications.html

- 2010 Wind Technologies Market Report
- International Energy Agency (IEA) Wind Energy Annual Report
- Gearbox Reliability Collaborative Project Report: Findings from Phase 1 and Phase 2 Testing
- Offshore Resource Assessment and Design Conditions Public Meeting Summary Report
- Renewable Energy Cost Modeling: A Toolkit for Establishing Cost-Based Incentives in the United States
- The Role of Renewable Energy Certificates in Developing New Renewable Energy Projects
- Assessing Atmospheric Stability and its Impacts on Rotor-disk Wind Characteristics at an Onshore Wind Farm – preprint

Financial Opportunities

www.wind.energy.gov/financial_opportunities.html

- DOE's Wind Program Financial Opportunities
- DOE's Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Funding Opportunities. www.science.energy.gov/sbir/funding-opportunities/



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