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

Wind Program Newsletter

June 2012 Edition

wind.energy.gov

Learn About the Energy Department's Latest Wind Energy R&D Efforts, Its Accomplishments, and Funding Opportunities

The Energy Department's Wind Program leads the nation's efforts to improve the performance, lower the costs, and accelerate the deployment of wind technologies. The program works with national laboratories, industry, universities, and other federal agencies to conduct research and development activities through competitively selected, cost-shared projects.

The Energy Department publishes this quarterly newsletter to provide its partners and industry stakeholders with information about the program's land-based and offshore wind R&D projects, its accomplishments, upcoming events, funding opportunities, and recent publications. The newsletter is posted on the Wind Program Website and distributed electronically by email.

To receive this newsletter by email or to sign up for Breaking News on funding opportunities and other topics, go to the Wind Program's Newsletter Website. *wind.energy.gov/newsletter*

IN THIS ISSUE

Energy Department Wind Program Presenters at WINDPOWER 2012

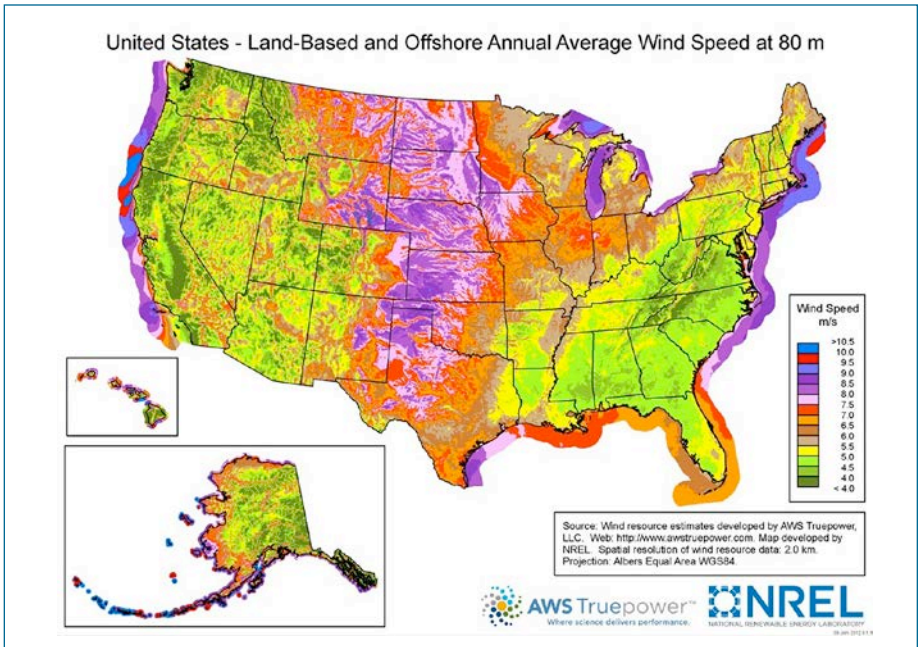
DATE	PRESENTER	PRESENTATION	ROOM	TIME
MONDAY **June 4**	**Mark Higgins** Energy Department, Wind and Water Power Program	**Energy Department Update on Research Efforts both Land-Based and Offshore**	B309	10:30 a.m.–12:00 p.m.
	Mark Bolinger *Staff Scientist* Lawrence Berkeley National Laboratory	**Tracking the U.S. Wind Industry: The Latest Cost, Performance, and Pricing Trends**	B401/402	10:30 a.m.–12:00 p.m.
	Stephanie Savage *Energy Project Analyst* National Renewable Energy Laboratory	**Distributed Wind Energy Policy: What's Working and What's Not?**	B314	1:30–3:00 p.m.
	Suzanne Tegen *Energy Analyst* National Renewable Energy Laboratory	**Local and Economic Impacts of Distributed Wind**	B314	1:30–3:00 p.m.
	Brendan Kirby *Consultant* National Renewable Energy Laboratory	**System Operator Scheduling of Storage to Reduce Wind Integration Costs**	B309	3:30–5:00 p.m.
TUESDAY **June 5**	**Yuki Hamada** *Geospatial Scientist* Argonne National Laboratory	**An Individual-Based Model to Assess the Cumulative Impacts of Wind Energy Development on Greater Sage-Grouse**	B407	10:30 a.m.–12:00 p.m.
	Mark Bolinger *Research Scientist* Lawrence Berkeley National Laboratory	**Revealing the Long-Term Value of Wind through a Review of Forward-Looking Power Purchase Agreement Prices**	B309	1:30–3:00 p.m.
	Allan Wright *Principal Engineer* National Renewable Energy Laboratory	**Advanced Control Strategies for Onshore and Offshore Wind Turbines**	B314	1:30–3:00 p.m.
	Ian Baring-Gould *Technology Deployment Manager* National Renewable Energy Laboratory	**Managing and Evaluating the Market Impacts of the Social Acceptance of Wind Energy**	B407	3:30–5:00 p.m.
WEDNESDAY **June 6**	**Debbie Lew** *Senior Engineer* National Renewable Energy Laboratory	**How Does Wind Impact Conventional Generation?**	B314	10:30 a.m.–12:00 p.m.
	Michael Milligan *Principal Analyst* National Renewable Energy Laboratory	**Integration Costs: Are They Unique to Wind and Solar Energy?**	B314	10:30 a.m.–12:00 p.m.
	D. Todd Griffith *Principal Member of the Technical Staff* Sandia National Laboratories	**Challenges and Opportunities in Large Offshore Rotor Development: Sandia 100-Meter Blade Research**	B309	1:30–3:00 p.m.
	Eduardo Ibanez *Engineer* National Renewable Energy Laboratory	**A Reliability-Based Assessment of Transmission Impacts in Systems with Wind Energy**	B314	1:30–3:00 p.m.
	Pengwei Du *Research Engineer* Pacific Northwest National Laboratory	**Calculating Individual Resource Variability and Uncertainty Factors**	B314	1:30–3:00 p.m.

Energy Department Releases New Land-Based/Offshore Wind Resource Map

The Energy Department recently released a new wind resource map compiled by the National Renewable Energy Laboratory (NREL) and AWS Truepower that combines land-based with offshore resources. The new combined map, posted on the Department's Wind Program website, provides developers and policymakers a comprehensive picture of the nation's wind resources at 80 m for all 50 states as well as offshore resources up to 50 nautical miles from shore. It allows users to easily compare land-based with offshore wind resources. For example, it shows that the offshore wind resource of the Great Lakes is comparable to that found in the windier areas of the western plains states. It also demonstrates the potential for offshore resources to provide for the electricity needs of the heavily populated coastal regions.

The new resource map was developed with the support of the Energy Department through a collaborative effort between NREL and AWS Truepower of Albany, New York. It shows the predicted mean annual wind speeds at 80-m height produced from AWS Truepower's data at a spatial resolution of 2.5 km and interpolated to a finer scale.

To read more about the Wind Program's wind resource assessment efforts, visit wind.energy.gov/resource_assessment_characterization.html. For state-specific maps of offshore wind resources at 90 m and land-based resource maps at a variety of heights (including residential and community applications), visit the Wind Powering America website. www.windpoweringamerica.gov/windmaps/



The new 80-m wind resource map produced by NREL and AWS Truepower shows both land-based and offshore wind resources.

Wind Powering America's Wind for Schools Team Honored with Wirth Chair Award

The University of Colorado at Denver and the Wirth Chair awarded the Energy Department's National Renewable Energy Laboratory (NREL) a Wirth Chair Sustainability Award for its work on the Wind for Schools Project. NREL manages the Wind for Schools project as part of its support to the Department's Wind Powering America initiative. NREL and its project partners, the Colorado governor's energy office and the Colorado State University Wind Application Center, were recognized at an awards luncheon on April 25th.

This year marks the 13th anniversary of the Wirth Chair Awards that celebrate the "Creators of a Sustainable Future." The Wirth Chair in Sustainable Development at the School of Public Affairs at the University of Colorado Denver is named for former U.S. Senator and Under Secretary of State, Timothy E. Wirth. It honors environmental and sustainable development achievements across Colorado.

The Energy Department's Wind Powering America initiative has helped to launch the Wind for Schools project in 11 states, including Colorado. The program provides training in wind design and implementation for engineering students at the universities and gives K-12 students, teachers, and the community a hands-on opportunity to learn about wind as well.

In 2009, the Colorado Wind Application Center at Colorado State University (CSU) in Fort Collins and the Colorado governor's energy office selected six rural Colorado schools to participate in the Wind for Schools project. The

governor's energy office provided a $5,000 grant for each school to help purchase and install a Skystream 3.7 wind turbine. These turbines provide the basis for learning about wind energy in the schools.

NREL manages the program, funds the wind application centers through subcontracts, and trains teachers and community facilitators that work with the K-12 schools to build community support. NREL also worked with CSU to develop its curriculum and with the National Energy Education Development Project to develop a K-12 curriculum.

To learn more about Wind for Schools, visit the Wind Powering America website. www.windpoweringamerica.gov/schools_wfs_project.asp

Energy and Interior Departments Host Offshore Energy Knowledge Exchange Workshop

More than 150 experts on U.S. and European offshore renewable energy and the oil and gas industry met in Washington, D.C., on April 11 and 12 to exchange information and build relationships in support of U.S. offshore renewable energy development. The Offshore Energy Knowledge Exchange workshop was a collaborative effort between the Energy Department's Office of Energy Efficiency and Renewable Energy and the Interior Department's Bureau of Ocean Energy Management, and Bureau of Safety and Environmental Enforcement. The workshop was an outgrowth of a Memorandum of Understanding signed in 2010 by the two Departments to coordinate more closely on responsible development of commercial renewable offshore energy projects on the U.S. outer continental shelf.

During the two-day workshop, the maritime and offshore industries and government agencies exchanged "lessons learned" based on international renewable energy and U.S. traditional energy development. Among the issues discussed were infrastructure and cabling, access to necessary vessels, development of procedures for offshore maintenance, and approaches to safe operations. Potential technical solutions offered by traditional offshore industries that may be applicable to renewable energy development on the outer continental shelf were also identified, including those relating to electrical infrastructure, foundation designs, installation methods, and more efficient operations models. Workshop sessions also discussed the importance of a safety culture for the offshore renewable energy industry and the development and use of effective engineering standards. The workshop attendees represented a broad cross-section of the offshore energy industry.

A summary report about the offshore energy knowledge exchange workshop will be available this summer in the Wind Program's Publication Library. wind.energy.gov/publications.html

Interagency Field Test and Evaluation Evaluates Co-operation of Turbines and Radar

The Department of Energy and federal agency partners recently completed the first in a series of three radar technology field tests and demonstrations. The Interagency Field Test and Evaluation of Wind-Radar Mitigation Technologies is an $8 million demonstration initiative co-funded by the Energy Department, Department of Defense (DOD), Department of Homeland Security (DHS),

Photo courtesy of HC Sorensen, Middelgrunden Wind Turbine Cooperative, NREL/PIX 17856

and Department of Transportation's Federal Aviation Authority (FAA). The demonstration will help industry and government evaluate radar mitigation technologies that are designed to eliminate radar interferences caused by physical and operational effects of wind turbines. Improved radar detection will increase our nation's opportunity to deploy more wind turbines in sites where abundant wind resources interact with air traffic control and other radar systems that are part of the nation's critical radar infrastructure.

Sandia National Laboratories (Sandia) helped organize the field test, which was conducted in Tyler, Minnesota, a location selected for its high concentration of wind turbines and high wind speeds. Sandia worked with local wind farm operators to collect data on specific turbine physical and operational performance. The Massachusetts Institute of Technology's Lincoln Laboratory, a DOD Research and Development Laboratory, developed the performance models and scientific equipment to compare the field test results and validate the performance of the radar technologies.

Multiple agencies rely on radar systems to protect our nation and this interagency field test and demonstration effort is proving vital for the acceptance of new wind turbine radar mitigation technologies. Since 2000, wind generation capacity in the United States has increased from 5 GW to 46 GW and could grow to as much as 20 percent of the nation's electricity by 2030. To accommodate future wind energy growth in the United States, new technologies are needed to mitigate the potential interference impacts from wind turbines on radar systems, which include decreased sensitivity, false targets, and corrupted track quality.

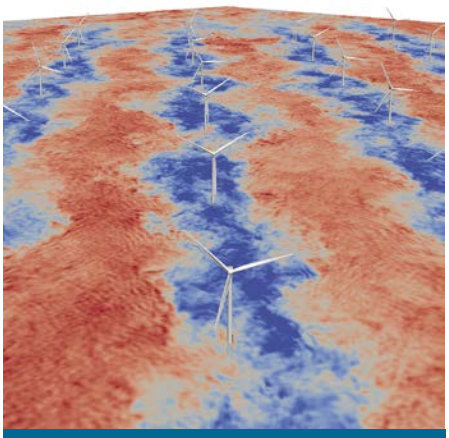
Complex Flow Workshop Assesses Future R&D Needs

The Energy Department's Wind Program occasionally convenes expert workshops to help identify and assess promising new areas of research. One such area is the study of multiscale complex aerodynamics, which spans everything from large-scale national weather patterns all the way down to millimeter-scale wind interactions with individual wind turbine blades. Substantial gains in understanding these truly complex flows represent one of the largest remaining opportunities to reduce the levelized cost of energy for land-based wind power. Researchers have identified the following opportunities for cost reduction:

- *Power losses can be as high as 20%–30% in operating wind farms, due solely to complex wake interactions occurring in wind farm arrays.*
- *Forecasting accuracy improvements of as little as 10%–20% could result in hundreds of millions of dollars (estimated at $140 M–260 M) in annual operating cost savings for the U.S. wind industry.*
- *Drivetrain components such as gearboxes are failing significantly earlier than their 20-year design life. These failures are caused in large part by uncertainty in aerodynamic loading conditions.*

To obtain input on existing gaps and future opportunities for research in complex flow modeling and experimental validation, the Wind Program held a 2-day workshop in January in Boulder, Colorado. The meeting provided participants with an opportunity to share information and facts regarding this topic based on individual experience.

The public meeting consisted of an initial plenary session in which invited speakers surveyed available information and needs for various applications related to complex flow modeling and validation. For the remainder of the meeting, breakout groups provided participants an opportunity to present Energy Department representatives with information on specific areas. Groups were organized around the following topics:



This complex flow simulation shows the contours of velocity in the wakes of a row of 2.3 MW turbines in the Lillgrund wind farm. Blue represents low wind speed and red represents higher wind speed.

- **Mesoscale Modeling and Validation:** Participants examined the meteorological effects at the regional, multi-wind-farm-scale. This exploration of atmospheric science topics included model nesting (examining turbine-scale within wind-farm-scale within regional-scale models), long-term data collection requirements, and downwind effects of wind farms.
- **Wind-Farm-Scale Modeling:** Participants examined complex aerodynamic phenomena in, around, and through wind farms, including turbine-wake interaction, wake-wake interaction, complex terrain, and turbulence effects.
- **Wind-Turbine-Scale Modeling:** Participants examined inflow and outflow characteristics in the vicinity of individual wind turbines, as well as the implications for aerodynamic loading of the rotor and overall structure.
- **Experimental Data and Validation Requirements:** Participants examined the requirements for, as well as the feasibility and efficacy of, existing and future experimental techniques for cost-effective, high-fidelity data collection.

While the detailed findings from each breakout group were distinct in terms of scale and scope, there was considerable

overlap. Participants from multiple groups noted that future complex flow research and development will require substantial improvements to meteorological and engineering models, as well as high-fidelity measurements that cross spatial and temporal scales simultaneously. Phenomena of different spatial and temporal scales need to be predicted and measured using different modeling and observational techniques. This need for various techniques provides a challenge when modeling because the techniques need to be coupled, and this requires that an experimental research program be well planned. For example, national weather forecast models must interface with wind farm models, which in turn must interface with individual wind turbine models. This represents a range of scales from hundreds of kilometers down to millimeters. Further complicating the matter, each model will require validation data to be collected at each of these scales. Once validated, these improved simulations, which may require significant high-performance computing resources, must eventually be reflected in the tools used by industry to plan, manufacture, and operate wind farms.

A report summarizing the workshop will be available at wind.energy.gov/publications.html this summer. For more information about current complex flow research, see *A Large-Eddy Simulation of Wind-Plant Aerodynamics.* www.nrel.gov/docs/fy12osti/53554.pdf

Cooperation Among Balancing Authorities Offers Greater Use of Renewable Energy with Lower Integration Costs

Since February 2010, the Variable Generation Subcommittee at the Western Electricity Coordinating Council (WECC) has been investigating the benefits of cooperation between Balancing Authorities (BAs) in the Western Interconnection. In support of this investigation, the Energy Department funded the Pacific Northwest National Laboratory to lead a team of researchers from the National Renewable Energy Laboratory, WECC, and Energy Exemplar. The team is working to develop a detailed procedure for demonstrating the benefits of BA consolidation, and to determine the savings in production costs from consolidating BAs within a large geographic area and by operating them as a single consolidated BA (CBA).

As part of its detailed procedure, the team proposed and evaluated four key technical metrics—capacity and ramp duration, rate, and energy—to demonstrate the potential gains with respect to reductions in balancing reserve requirements that would be accrued from operating 37 geographically contiguous BAs in the Western Interconnection as a CBA.

The main function of a BA is to maintain the balance between load and generation in an interconnected power system to avoid instability that could lead to large-scale blackouts. This is done by consistently matching loads to resources within the system, maintaining scheduled interchanges with other BAs, maintaining frequency within reasonable limits, and providing sufficient generation capacity to maintain operating reserves.

The nature of wind and solar power, as variable natural resources, makes it more challenging for operators to manage these sources of energy within a given electric power system or BA. As wind and solar penetration increases in each of the 37 BAs in the Western Interconnection, it becomes more challenging and costly for the individual BAs to operate independently from one another. Cooperation among BAs can facilitate a high level of variable-generation penetration without significant increase in integration costs, because the collective impact of variability and uncertainty is accumulated over a large geographic area, across multiple distributed resources, and is combined with all other sources of variability and uncertainty (including system load).

The research team found that effective use of the diversity in load and renewable generation over a wide area can indeed achieve significant savings. The team tested its detailed procedure for computing the savings derived from BA consolidation and its evaluation metrics for demonstrating the benefits of BA consolidation using several study scenarios designed for the set of BAs in the western United States. Study results showed significant reduction in the required capacity and ramp rates of balancing services. The CBA, with a much wider geographical boundary, results in significantly less load following, and regulation reserve requirements compared to the sum carried by the individual BAs. It allows for the sharing of variability between BAs and can provide access to additional existing physical response capability. The savings could be realized immediately by reallocating regulation and load following reserve requirements between the BAs to reduce the operational burden.

For a scenario where wind and solar penetration in the Western Interconnection equals 11% of total expected 2020 demand, the research shows that the yearly production cost savings of thermal units for a consolidated WECC ranges between $400 million (2.4% of total annual production cost) to $600 million (3.2%) without taking into consideration the implementation cost for the CBA. The research also shows that the consolidated WECC will have about a 50% overall reduction in balancing reserves in comparison with total reserve requirements that need to be carried by different BAs if they operate individually. The study is currently investigating the potential benefits as the variable generation penetration level increases to 33%. It is also investigating the potential benefits of another form of BA cooperation through the implementation of 10-minute interchange schedules between BAs rather than traditional 1-hour schedules.

Outcomes reported represent an upper bound of potential benefits of BA cooperation and provide the evidence needed to motivate such cooperation to enable higher levels of renewable penetration without significant integration costs. WECC is performing a complementary study to quantify the cost/benefits of implementing a real-time energy imbalance market in the Western Interconnection, which represents another form of cooperation between BAs.

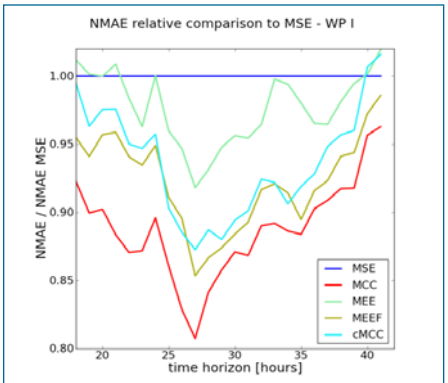
The Pacific Northwest National Laboratory (PNNL) is working to help increase wind and water power production using its expertise in environmental sciences, atmospheric sciences, and electric grid management. This includes developing tools and methodologies that allow more variable generation to flow through our grid system, as well as improving the accuracy of renewable resource predictions through observations and modeling.

ANL Software Improves Wind Power Forecasting

Since 2008, Argonne National Laboratory and INESC TEC (formerly INESC Porto) have conducted a research project to improve wind power forecasting and use of forecasting in electricity markets. One of the main results from the project is ARGUS PRIMA (PRediction Intelligent MAchine), a software platform for testing advanced statistical algorithms for short-term wind power forecasting. The software platform contains a set of novel statistical algorithms, also developed during the project, to generate more accurate wind power point and uncertainty forecasts.

Improved wind power forecasting is key to achieving more efficient operation of power systems with large shares of wind power and other renewable energy resources. The improved statistical algorithms in ARGUS PRIMA can help lower the cost of integrating wind power into the electric power grid.

"We are excited about the results from testing the new algorithms. Our test results show significant improvements in forecast performance compared to more traditional approaches," said Audun Botterud, principal investigator for the project.



Relative comparison of mean absolute error (NMAE) for ITL criteria (i.e., MEE – Minimum Error Entropy, MCC – Maximum Correntropy Criteria, MEEF – Minimum Error Entropy with Fiducial Points, cMCC – Maximum Centered Correntropy Criterion) with MSE (Minimum Square Error) for a wind farm in the Midwestern United States.

For wind power point forecasting, ARGUS PRIMA trains a neural network using data from weather forecasts, observations, and actual wind power generation, to produce the most accurate power prediction. The key novelty is the training criteria used in the neural network, which is based on concepts from information theoretic learning (ITL). Results from tests on real-world data from two large-scale wind farms in the Midwestern United States, using the new ITL training criteria as compared to the traditional minimum square error criterion (see Relative comparison figure), show distinct reductions in forecasting errors.

However, despite reduced forecasting errors, there will always be a degree of uncertainty in wind power forecasts. It is therefore important to estimate the level of uncertainty to better account for it when making operational decisions. ARGUS PRIMA contains two new computational learning methods for estimating the forecast uncertainty.

The new algorithms have been tested on datasets from the Eastern Wind Integration and Transmission Study, as well as on two wind farms located in the Midwestern United States. Testing shows that the new algorithms better match the observed wind power probability distribution than results obtained through more traditional statistical approaches.

ARGUS PRIMA is made available to users under a licensing agreement.

"We are seeing a lot of interest in our research. The licensing arrangement helps to facilitate transfer of the statistical learning algorithms developed in the project to industry use. A leading forecast provider in the United States has just licensed our software," said Botterud.

The research has been sponsored by the U.S. Department of Energy's Wind Program. For more on this project, visit Argonne's Wind Power Forecasting and Electricity Markets Web page. www.dis.anl.gov/projects/windpowerforecasting.html

The Argonne National Laboratory outside Chicago, Illinois, supports the Energy Department's Wind Program by researching improved methodologies for wind power forecasting and analyzing the use of wind power forecasting in power systems operations. The lab also addresses wind turbine drivetrain reliability issues, develops advanced superconducting drivetrain designs, assesses wind energy developments in critical wildlife habitats, and develops a GIS-based visual impact risk analysis and mitigation system.

Flow Distortion Study Completed for the Chesapeake Light Tower

With the completion of a flow distortion study, a first stage-gate has been passed in the Wind Program's evaluation of the Chesapeake Light Tower for possible use as a reference facility for offshore renewable energy. Such a facility does not currently exist in U.S. waters and is needed to validate new technologies for resource assessment and to support research and development to advance offshore wind and marine and hydrokinetic (MHK) energy. The Chesapeake Light Tower stands in open water approximately 13 miles east of Virginia Beach.

The centerpiece of the potential reference facility will be a new meteorological mast that extends to approximately 100 m above the sea surface. This is roughly hub height for wind turbines that are expected to be deployed offshore. The mast will include devices to measure winds and turbulence at multiple heights. It will also include other supplemental meteorological measurements. The plan is to affix the mast to the existing light tower to cost-effectively take advantage of the existing foundation.

With the light tower similar in profile to offshore oil platforms, one concern was whether its bulky cross section would disturb the wind blowing around it so that measurements on the mast would have unacceptable errors. It was not practical to make detailed wind measurements around the tower, therefore the Energy Department's Pacific Northwest National Laboratory (PNNL) managed a computational fluid dynamics modeling study executed by DNV Renewables that used a very high resolution numerical

Photograph of the Chesapeake Light Tower. *Photo courtesy USCG 2005*

technique to examine how much and where the wind is deflected as it blows past the light tower structure. This method used architectural drawings of the tower to construct a numerical solid model of the light tower. This was placed, numerically, within a computational grid made up of closely spaced points in all three dimensions. As the wind blew (in the model) around the tower, its value was calculated at each of the grid points to provide a detailed assessment of the tower's effect.

The study showed, as expected, that for typical meteorological conditions offshore, wind speeds and directions are strongly affected in the immediate vicinity of the structure. Wake effects are pronounced for several hundred meters downwind as well. However, the study also shows that there should be little effect on the existing structure at heights of 50 m and higher above the sea surface. Moreover, disturbance of the wind does not extend far from the light tower in the crosswind directions. This is good news for the proposed use of the tower as a reference facility. It means that new technologies such as floating

lidars could be placed for validation close to a meteorological mast on the tower. It also means that it is feasible to take advantage of an existing structure to greatly reduce the cost of an offshore reference facility.

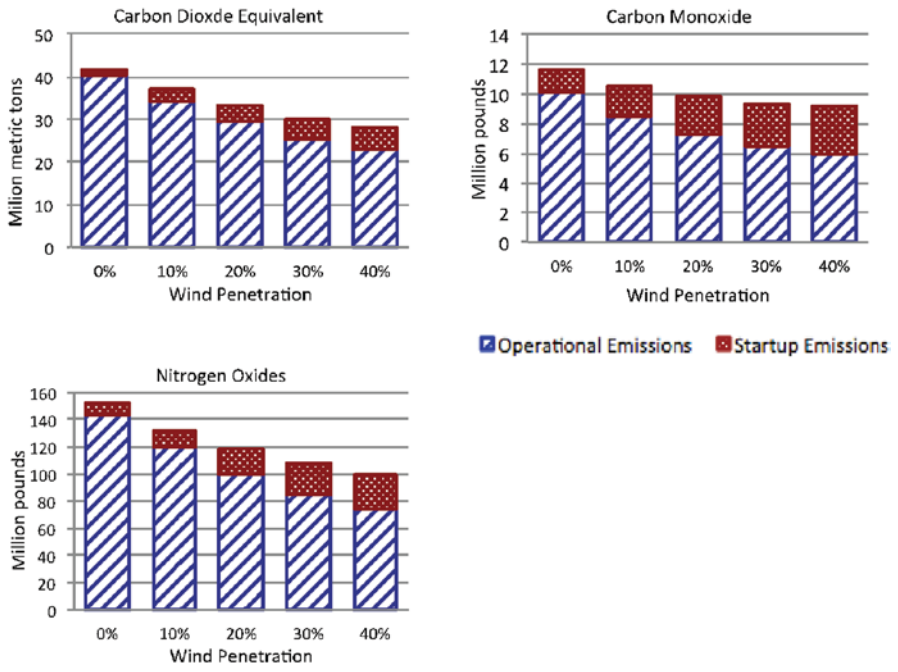
ANL Study Shows Wind Power Decreases Power Sector Emissions

A study recently published by the Energy Department's Argonne National Laboratory (ANL) examined the effects of introducing wind energy into the electric power system. After conducting a detailed emissions analysis based on a comprehensive model of power system operations, ANL researchers found that as wind power penetration increases, pollutant emissions decrease overall due to the replacement of fossil fuels.

"Our study clearly shows that using wind to generate electricity has a discernible impact on pollution," said Audun Botterud, who led the research team.

The study analyzed the effects of start-up and cycling events as a result of increasing wind power use. Wind is variable and uncertain, which can lead fossil-fuel plant operators to adjust their output, start-up, or shut-down to accommodate wind inputs.

In the analysis, the researchers looked at power system operations and resulting emissions during both start-up and operational periods, considering the impacts of emissions control technologies. Using power grid data from 2006 as a starting point, a case study on the Illinois power system was performed to simulate the impact of different wind generation levels for a 4-month period. Total emissions from all power plants in the grid for seven pollutants were determined.



Total emissions results. The blue striped bars represent emissions resulting from normal operational periods, and the red dotted bars represent emissions resulting from start-ups. Carbon dioxide equivalent (CO_{2e}) includes CO_2, CH_4, and N_2O.

"Our analysis shows that total greenhouse gas emissions decrease with increasing wind power use, despite more start-ups and increased cycling of fossil-fuel power plants," said Botterud.

Gearbox Reliability Collaborative Debuts on the Web

Premature gearbox failures have a significant impact on the cost of wind farm operations. In 2007, the Energy Department's National Renewable Energy Laboratory (NREL) initiated the Gearbox Reliability Collaborative (GRC). The project combines analysis, field testing, dynamometer testing, condition monitoring, and the development and population of a gearbox failure database in a multipronged approach to determine why many wind turbine gearboxes do not achieve their expected design life—the time period that manufacturers expect them to last.

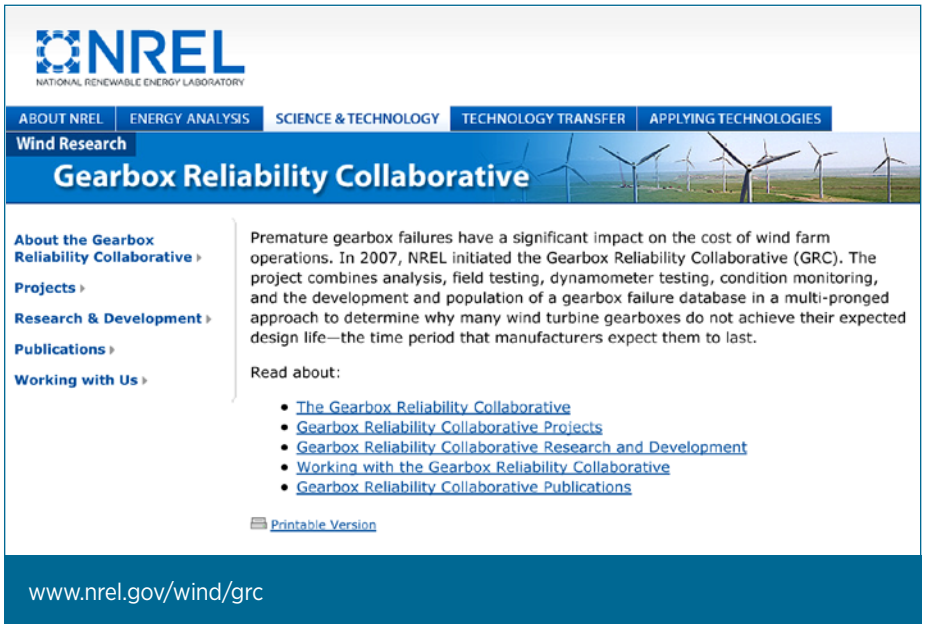
The collaborative of manufacturers, owners, researchers, and consultants focuses on gearbox modeling and testing and the development of a gearbox failure database. Members of the collaborative also investigate gearbox condition-monitoring techniques. Data gained from the GRC will enable designers, developers, and manufacturers to improve gearbox designs and testing standards and create more robust modeling tools. The Gearbox Reliability Collaborative (GRC) website at www.nrel.gov/wind/grc/ offers wind turbine

manufacturers and researchers accessible information on the latest results and reports by the collaborative.

The GRC project instrumented two identical, representative gearboxes. Knowledge gained from the field and dynamometer tests conducted on these gearboxes builds an understanding of how the selected loads and events translate into bearing and gear response. The GRC also investigates condition-monitoring methods to improve turbine availability; evaluates current wind turbine gearbox gear and bearing analytical tools and models; develops new tools and models; and recommends improvements to design and certification standards.

Information gained from the various projects within the GRC led to the development of the GRC Failure Database. This database provides the means for multiple partners to document root cause analyses in a tool that identifies key failure trends. Once identified, the trends allow researchers to focus on the solution to gearbox challenges, and the database provides a method to measure improvements.

NREL and its GRC partners have been able to identify shortcomings in the design, testing, and operation of wind turbines that contribute to reduced gearbox reliability. In contrast to private investigations of these problems, GRC findings are quickly shared among GRC participants, including many wind turbine manufacturers and equipment suppliers. The GRC website makes the findings public for use throughout the wind industry.



In February, the GRC members met at NREL in Golden, Colorado, to discuss the completion of Phase 2 testing, which included hundreds of hours of steady state and dynamic loads testing. Selected data sets have been released to the GRC partners to aid in data validation and modeling assumption convergence. The February meeting included planning of Phase 3 modeling, analysis, and testing activities to be conducted in the remainder of 2012 and in 2013. Condition-monitoring data were collected and disseminated into a recently completed condition-monitoring round-robin analysis by GRC condition-monitoring partners.

Wind Program Events

- **WPA Webinar: Success Stories**
  www.windpoweringamerica.gov/filter_detail.asp?itemid=3532
  Date: 6/20/2012 3:00 p.m. EDT (1:00 p.m. MDT)

  This free webinar is part of the U.S. Department of Energy's Wind Powering America 2012 webinar series. Wind Powering America's National Technical Director Ian Baring-Gould will provide an overview of recent wind energy deployment success stories. The webinar is free; no registration is required.

- **Tribal Webinar: Grid Reliability—Impacts to Tribal Renewable Projects**
  windpoweringamerica.gov/calendar.asp
  (View *Events by Month,* July 2012)
  Date: 7/25/2012 11:00 a.m.–12:30 p.m. MT

  This webinar is part of a series provided by the Energy Department's Office of Indian Energy Policy and Programs, the Department's Tribal Energy Program, the U.S. Environmental Protection Agency's (EPA's) Green Power Partnership Program, and Western Area Power Administration (WAPA). The webinars promote tribal energy sufficiency and foster economic development and employment on tribal lands through the use of renewable energy and energy efficiency technologies.

  Tribes interested in responding to utility-offered renewable RFPs and/or interested in learning more about the competitive power market, utility staff, and other stakeholders should attend.

  There is no charge to participate in the webinar. However, you must register.

  In 2008, NERC reliability standards compliance became mandatory. This has raised the importance of compliance programs throughout the electric industry, as noncompliance can result in monetary sanctions. This webinar will provide an overview of the purpose and organization of a compliance program, what parts of the bulk electric system are in scope, the range of reliability standards affecting power operations and maintenance, responsible registered entities, and how tribal renewable projects can be impacted by reliability requirements.

- **Tribal Webinar: Energy Department's Office of Indian Energy START Program Status Updates**
  windpoweringamerica.gov/calendar.asp
  (View *Events by Month,* September 2012)
  Date: 9/26/2012 11:00 a.m.–12:30 p.m. MT

  This webinar is part of a series provided by the Energy Department's Office of Indian Energy Policy and Programs, the Department's Tribal Energy Program, the U.S. Environmental Protection Agency's (EPA's) Green Power Partnership Program, and Western Area Power Administration (WAPA). The webinars promote tribal energy sufficiency and foster economic development and employment on tribal lands through the use of renewable energy and energy efficiency technologies.

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  This webinar will provide an update on the Office of Indian Energy's Strategic Technical Assistance Response Team (START) Program and the range of projects that were selected in 2012. START and Alaska START aim to advance clean energy generation in Indian Country and provide federally recognized Native American and Alaska Native governments with strategic technical assistance to accelerate clean energy project deployment.

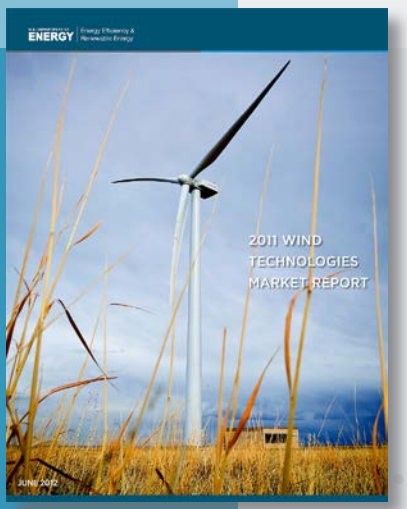
Financial Opportunities

- DOE's Small Business Innovation Research and Small Business Technology Transfer Program is accepting applications for a funding opportunity to support energy technology development in areas including land-based and offshore wind energy.
  www.science.doe.gov/grants/pdf/SC_FOA_0000715.pdf

Recent Publications

- Animated U.S. Installed Wind Capacity Map 1999–2011
  www.windpoweringamerica.gov/wind_installed_capacity.asp
- A Tale of Two Cities: Greensburg Resurrected as a National Model for Green Communities
  www.nrel.gov/docs/ fy12osti/ 53177.pdf
- Data Collection for Current U.S. Wind Energy Projects: Component Costs, Financing, Operations, and Maintenance,
  www.nrel.gov/docs/fy12osti/52707.pdf
- Procurement Options for New Renewable Electricity Supply,
  www.nrel.gov/docs/fy12osti/52983.pdf
- Variance Analysis of Wind and Natural Gas Generation under Different Market Structures: Some Observations
  www.nrel.gov/docs/fy12osti/52790.pdf
- Western Region Renewable Energy Markets: Implications for the Bureau of Land Management
  www.nrel.gov/docs/fy12osti/53540.pdf
- Wind Program Accomplishments, wind.energy.gov/pdfs/wind_accomplishments.pdf

Cover photos, clockwise from top: Patrick Corkery, NREL/PIX 17696; Warren Gretz, NREL/PIX 13214; Joseph B. Verrengia, NREL/PIX 16867; Todd Spink, NREL/PIX 16513; Lee Jay Fingersh, NREL/PIX 16269



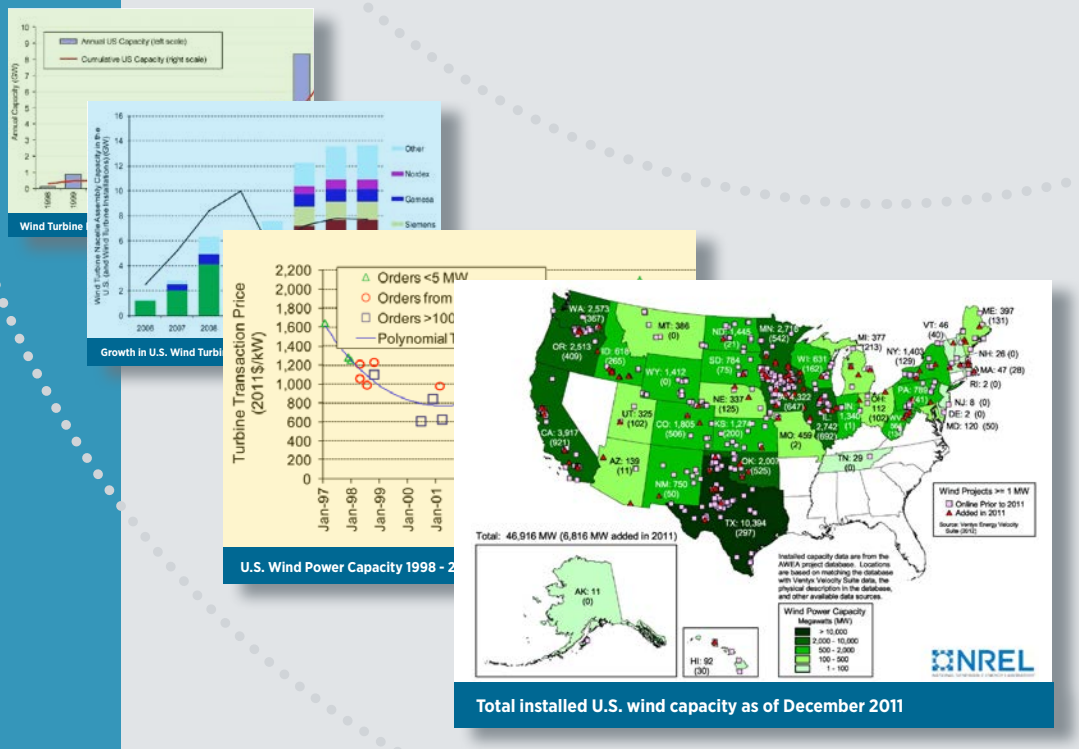
Coming Soon!

2011 Wind Technologies Market Report

This valuable report will be available this summer! Prepared by the Energy Department's Lawrence Berkeley National Laboratory, the report is a must read, providing a comprehensive overview of United States wind industry:

- Installation Trends
- Industry Trends
- Price, Cost, and Performance Trends
- Policy and Market Drivers
- Future Outlook

Download your copy at wind.energy.gov, or sign up for Wind Program Breaking News to receive it by email.



Source: 2011 Wind Technologies Market Report

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