NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Up to Wind Speed

Up to Wind Speed — June Newsletter

Up to Wind Speed is a quarterly newsletter from NREL's National Wind Technology Center (NWTC).

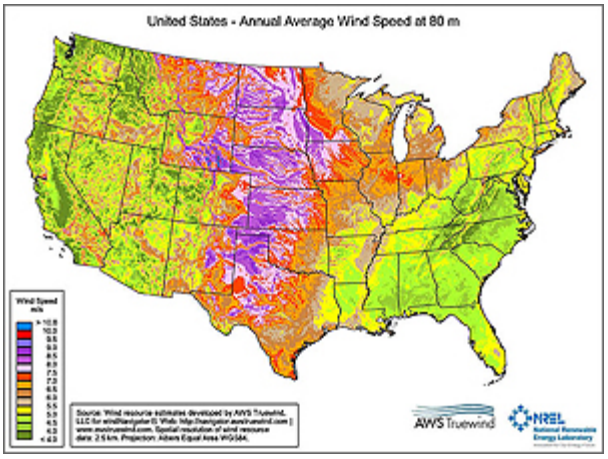
For more than two decades, research conducted by NREL's Wind Program has helped industry advance wind energy technology, increasing reliability and lowering the cost of energy. As we continue our efforts with the wind industry in 2010, we will keep you up to speed on what's happening in wind energy research and development and provide you with links to NWTC's recent publications.

In this issue:

DOE and NREL Release New Estimates of Nation's Wind Energy Potential

The Department of Energy (DOE) and NREL recently released new estimates of the U.S. potential for wind-generated electricity, tripling previous estimates of the size of the nation's wind resources. The new study, conducted by the National Renewable Energy Laboratory (NREL) and AWS TruePower, finds that the contiguous 48 states have the potential to generate up to 37 million gigawatt-hours annually. In comparison, the total U.S. electricity generation from all sources was roughly 4 million gigawatt-hours in 2009.

Along with state-by-state estimates of wind energy potential, NREL and AWS TruePower have developed wind resource maps for the United States and for the contiguous 48 states that show the predicted average wind speeds at an 80-meter height. The wind resource maps and estimates provide local, state, and national policymakers with accurate information about the nature of the wind resource in their areas and across the nation, helping them to make informed decisions about wind energy in their communities.



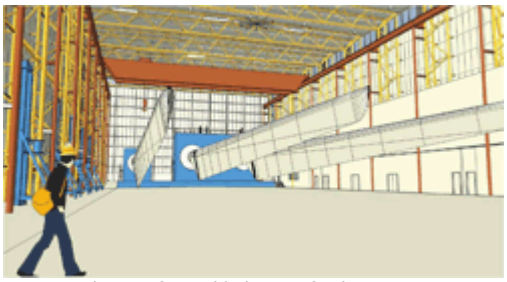
The new estimates reflect substantial advances in wind resource assessment technology that have occurred since DOE's last national wind resource assessment conducted in 1993. For example, previous wind resource maps showed predicted average wind speeds at a height of 50 meters, which was the height of most wind turbine towers at the time. The new maps show predicted average wind speeds at an 80-meter height, the height of today's turbines. Because wind speed generally increases with height, turbines built on taller towers can capture more energy and generate more electricity. For more information about the maps, visit the Wind Resource Assessment Web page.

DOE/NREL/MASSCEC Develop New Blade Test Facility

A cooperative research and development agreement (CRADA) was formed between NREL and the Massachusetts Clean Energy Center (MASSCEC) to produce the nation's largest wind turbine blade testing facility. In addition to financially supporting this CRADA, DOE provided American Recovery and Reinvestment Act funds of $25 million for the creation of the Wind Technology Testing Center (WTTC), which will run tests on wind turbine blades up to 90 meters in length.

The facility will perform a full suite of laboratory blade testing including static tests that apply steady loads and fatigue tests that simulate wear and tear on the blade by applying alternating loads, similar to repeatedly bending a paperclip back and forth.

"NREL functions as an expert partner providing 30 years of blade testing experience and leveraging our knowledge to make the new facility a success," explained NREL's Derek Berry, Engineering Supervisor at the new site. Construction on the facility began in 2009 and it is scheduled to be commissioned in the first quarter of 2011.


Artist rendering of new blade test facility.

Current turbine blades in production have grown to 62 m long. Four times more energy is captured with each doubling of blade length; therefore, the length of turbine blades has grown to capture more energy. The National Wind Technology Center tests blades up to 50 m. When complete, the long industrial type building at WTTC will provide the nation's wind turbine manufacturers with commercial blade certification and reliability testing for blades longer than NWTC's capacity. The facility will be capable of testing several blades simultaneously and WTTC's location at an existing deep water port facilitates blade transport by water. WTTC will provide a critical component in the nation's wind energy program.

For more information, contact Rahul Yarala, Executive Director—Wind Technology Testing Center, Massachusetts Clean Energy Center at 617-315-9307.

The *Whispering* of Wind Energy

For decades, engineers have been researching methods to reduce the sounds emitted by wind turbines. Addressing mechanical sound sources associated with gearboxes, bearings, and other turbine elements has been successful. However, other aeroacoustic emissions are not well understood or controlled.

The NWTC's capability to test for turbine sound sources is unique in the United States wind energy community. NWTC engineers conduct aeroacoustic tests to identify the physical causes of sound to assist in the development of quieter designs that do not sacrifice aerodynamics.

Aeroacoustic emissions are the sounds made by air interacting with the blades. The primary sources of aeroacoustic emissions in wind turbines are thought to be boundary-layer trailing-edge interaction, surface irregularities on the blades, and trailing edge bluntness.

Research at NWTC through the acoustic array project explores the sounds emanating from wind turbines. Turbine sounds recorded through multiple microphones surrounding the turbine are pictorially represented and plotted based on their location. Visual hotspots appear red in the picture.

A radar-like picture of the sounds a wind turbine blade makes with the loudest region at the apex of the blade rotation in a half-moon shape.
Sound source locations in rotor plane of 100kW wind turbine.

Analysis conducted on data from the acoustic array project allows more accurate pinpointing of sound sources and their relative amplitudes. Locating the source of the sound assists researchers in determining the physical cause and therefore, how best to reduce it. This research could lead to the design of quieter wind turbines. Designing for sound reduction requires analyses, wind tunnel tests, and field verification. The acoustic array is the latest tool that can be used in this process.

Modeling Floating Wind Turbines

NWTC researchers have completed a comprehensive dynamic-response analysis of three offshore floating wind turbine concepts. Models were composed of one 5-MW land-based turbine and three 5-MW offshore turbines. Each offshore turbine model incorporated a different floating-system concept: a tension leg platform, a spar buoy, and a barge. A loads and stability analysis adhering to the procedures of international design standards was performed for each model using the fully coupled time-domain aero-hydro-servo-elastic design code FAST with AeroDyn and HydroDyn. The concepts are compared based on the calculated ultimate loads, fatigue loads, and instabilities. The results of this analysis will help resolve the fundamental design trade-offs between the floating-system concepts.

Click on the report title to access the full report, A Quantitative Comparison of the Responses of Three Floating Platforms.

Three illustrations of wind turbines attached to a tension leg platform, a spar buoy, and a moored barge.
Illustrations of the NREL 5-MW wind turbine on (from left to right) the MIT/NREL tension leg platform, OC3-Hywind spar buoy, and ITI Energy barge.

NWTC Participates at AWEA Windpower 2010

Thirty researchers and staff from the NWTC, a leader in wind technology for more than 30 years, attended the WINDPOWER 2010 Conference & Exhibition. The National Wind Technology Center's (NWTC) participation at this year's AWEA Windpower Convention in Dallas, TX, included nine posters, six research papers and seven presentations on topics such as:

- the launch of the scientific track—the research community's perspective
- an overview of the new large turbine blade testing facility in Massachusetts
- the development of an equivalent wind plant power curve
- new wind potential estimates for the United States
- validation of Hawaii's wind integration data set
- scoping and framing social opposition to U.S. wind projects

- a community perspective on the future of wind energy research
- the Gearbox Reliability Collaborative
- ancillary services and wind integration
- the current status of wind manufacturing in the United States
- strategic energy planning of wind as an answer in times of energy and water scarcity.

The American Wind Energy Association's annual event is the largest annual wind conference and exhibition in the world.

Wind Powering America Convenes 9th Annual All-States Summit in Dallas

The Wind Powering America team convened the 9th Annual All-States Summit in Dallas on May 26 and 27, immediately following the annual Windpower Conference and Exhibition. The Summit provided Wind Powering America's network of state wind working groups, state energy officials, DOE and national lab representatives, and its professional and institutional partners an opportunity to review successes, opportunities, and challenges for wind energy at the state level. Participants shared strategies and lessons learned, reviewed priority activities, and celebrated and recognized accomplishments among peers.

State roundtable discussions at the Dallas Convention Center kicked off on the eve of the Summit. An industry-sponsored reception at the Adolphus Hotel was followed by the annual awards ceremony. This year's Wind Powering America award recipients are:

Western Regional Advocate: Amanda Ormond for her effective and committed leadership of the Arizona Wind Working Group and in influencing Arizona renewable energy policy

Midwest Regional Advocate: Michael Vickerman for his vision and creative leadership in RENEW and his leadership of the Wisconsin Wind Working Group

Eastern Regional Advocate: Sue Jones for her commitment to a bold wind energy future for Maine and her leadership in forming the Maine Wind Working Group

Young Advocate: Kevin Schulte for his entrepreneurial spirit and effective leadership in developing community projects in the New England region

Friend of the Program: Peggy Beltrone for her willingness to share her time, wisdom, and experiences with the Wind Powering America project leadership and its network

Outstanding Leadership: Steve Wegman for his creative and engaging leadership in educating South Dakota's next generation of wind practitioners

Outstanding Wind Working Groups: the Indiana Wind Working Group for excellence in wind outreach to a broad stakeholder group in helping to achieve 1,000 megawatts and the Utah Wind Working Group for creative excellence in communicating the wind opportunity to Utah stakeholders.

Outstanding Partners: The National Wind Coordinating Collaborative for its leadership and technical integrity in addressing and communicating wind's greatest challenges and Randy Manion for his tireless commitment to communicating the wind opportunity to public power.

Small Wind Advocate: Robert Preus for his leadership and dedication to championing the U.S. small wind turbine market.

The main event on May 27 included a plenary by Don Furman of Iberdrola, a summary of the annual wind energy market report by Ryan Wiser of Lawrence Berkeley National Laboratory, and a luncheon keynote address by Jeremy Fielding of Lynn, Tillotson, Pinker, & Cox.

Two panel discussions were also featured this year. NREL's Larry Flowers moderated a

public acceptance panel featuring Mark Bastasch (CH2MHill, sound); Willett Kempton (University of Delaware, offshore polling); Ron Lehr (AWEA, deliberative polling); Ned Farquhar (Department of the Interior/Bureau of Land Management, federal lands); and Peggy Beltrone (Montana's Cascade County, transmission). Sue Jones of Community Energy Partners moderated a community wind panel featuring Andy Kruse (Southwest Windpower, wind for schools); Tom Wind (Wind Consulting, rural municipalities); Jeff Nelson (East River Cooperative, rural electric cooperatives); Kevin Schulte (Sustainable Energy Developments, New England projects); and George Baker (Fox Island Cooperative, Maine's Fox Island project).

In the afternoon, attendees participated in regional breakout sessions (East, Midwest, and West) and selected 6 of 16 topical table discussions to attend.

Wind and Wildlife

NREL's Wind-Wildlife Impacts Literature Database (WILD) is a searchable bibliographic database of documents that focuses on the effects of wind energy development on wildlife. The database includes domestic and international documents, journal articles, conference proceedings, government publications, books, and utility company reports. Maintained by the NWTC, the database is continually updated as new publications become available. Link to WILD.

Recent NWTC Publications

- Development of Regional Wind Resource and Wind Plant Output Datasets: Final Subcontract Report, 15 October 2007 – 15 March 2009. SR-550-47676
- Estimation of Seismic Load Demand for a Wind Turbine in the Time Domain: Preprint. CP-500-47536
- FAST Simulation of Seismic Wind Turbine Response. CP-500-46225
- Integrated Risk Framework for Gigawatt-Scale Deployments of Renewable Energy: The U.S. Wind Energy Case. SR-500-47129
- Marine & Hydrokinetic Technologies (Fact Sheet). Wind and Water Power Program (WWPP). (2010). FS-500-47688; DOE/GO-102010-3038.
- Model Development and Loads Analysis of an Offshore Wind Turbine on a Tension Leg Platform with a Comparison to Other Floating Turbine Concepts: April 2009. SR-500-45891
- Nebraska Statewide Wind Integration Study: Executive Summary. SR-550-47285
- Nebraska Statewide Wind Integration Study: April 2008 – January 2010. SR-550-47519
- Quantitative Comparison of the Responses of Three Floating Platforms. CP-500-46726
- Short Circuit Current Contribution for Different Wind Turbine Generator Types: Preprint. CP-550-47193
- Small Wind Electric Systems: A Maryland Consumer's Guide (Revised). BR-500-45911; DOE/GO-102009-2857
- Systems and Controls Analysis and Testing; Harvesting More Wind Energy with Advanced Controls Technology (Fact Sheet). (2010). FS-500-45687.
- Transmission and Grid Integration: Electricity, Resources, & Building Systems Integration (Fact Sheet). National Wind Technology Center (NWTC), National

Renewable Energy Laboratory FS-500-45650.

- Verification of BModes: Rotary Beam and Tower Modal Analysis Code; Preprint. CP-500-47953
- Western Wind and Solar Integration Study: Executive Summary, (WWSIS) May 2010. SR-550-47781.
- Wind Energy Technology Trends: Comparing and Contrasting Recent Cost and Performance Forecasts (Poster). PO-6A20-48007.
- Wind Turbine Micropitting Workshop: A Recap. TP-500-46572.
- Wind Powering America: FY09 Activities Summary (Book). Wind and Hydropower Technologies Program (WHTP). BK-7A2-47185; DOE/GO-102010-2952
- Wind Power Today: Building a New Energy Future, Wind and Hydropower Technologies Program 2009. (2009). BR-500-44889; DOE/GO-102009-2803.
- Wind Turbine Safety and Function Test Report for the ARE 442 Wind Turbine from Abundant Renewable Energy. TP-500-47030

All NREL publications are available at: NREL Publications Database