



## NREL's Wind R&D Success Stories

**N**REL's wind energy research and development efforts at the National Wind Technology Center (NWTC) have contributed to numerous successes for the wind industry. In addition to helping its industry partners develop commercially successful wind turbines, NREL has developed award-winning components and modeling software. The Laboratory also engages in deployment activities that help schools, communities, and utilities understand the benefits of wind energy and how it can be successfully integrated into our nation's electrical system to provide for a cleaner, more secure energy future.

NREL's successes in wind energy research, development, and deployment have:

- Reduced the cost of large and small wind turbine technologies
- Increased wind energy system reliability and operability
- Lowered risk by validating performance and design
- Increased the understanding of the true impacts of wind energy on the U.S. electrical infrastructure
- Expanded wind energy markets.

### Utility-Scale Wind Turbines

**General Electric (GE) Wind Energy**—The design of GE's 1.5-MW wind turbine, which claims the largest percentage of the U.S. large wind turbine market today, was based on work conducted in



GE Wind Energy 1.5-MW wind turbines at a wind plant in Hagerman, Idaho. PIX14336.

partnership with NREL. We were involved in testing components such as blades, generators, and control systems from the first prototype developed more than a decade ago to the turbine's successful commercialization today.

**Clipper Windpower**—NREL helped Clipper produce a prototype of its 2.5-MW Liberty wind turbine after only three years of R&D in a technology development partnership. The Liberty turbine features a new

light-weight, enlarged rotor that increases power production and a revolutionary generator design that improves reliability. Its design sets a new standard for turbine size for future turbines in the United States and Europe.

### Small Wind Turbines

**Southwest Windpower**—NREL worked with Southwest Windpower to develop the Skystream 1.8-kW wind generator, sometimes referred to as the first "plug-and-play" wind turbine. It is easier to install, operate, and maintain and was designed as a renewable energy appliance for the residential market. Southwest received the 2006 "Best of What's New" Award from *Popular Science* for the Skystream and was recognized by *Time Magazine* for "Best Inventions in 2006."



Clipper Windpower 2.5-MW wind turbine installed at a wind plant near Medicine Bow, Wyoming. PIX14645.



A Skystream 3.7 residential wind turbine located in Flagstaff, Arizona. PIX15030

**Windward Engineering**—We worked with Windward Engineering to produce a 4.25-kW machine called "the Endurance," which was commercialized in 2008.

**Northern Power Systems**—Northern Power and NREL received an R&D 100 award in 2000 for the development of the NorthWind 100/20 wind turbine. The NorthWind was originally designed for

operation in remote, cold-climate areas but has since been reconfigured for use in a variety of applications.

## Award-Winning Components

**Advanced Airfoils**—NREL received an R&D 100 award in 1991 from *R&D Magazine* for the development of advanced wind turbine blades. The new blade designs produce up to 30% more electricity than previous designs and have become an industry standard.

**Power Electronics**—In 2006, Northern Power Systems received a Technology Achievement Award from the American Wind Energy Association for a modular, highly efficient power electronics package developed through a partnership with NREL. The package can be scaled for use in a wide range of wind turbines, from small kilowatt to large multimewatt systems. The new converter improves wind turbine reliability, energy capture, and grid performance.

## Software

**JEDI (Job and Economic Development Impact)**—NREL developed this easy-to-use modeling software for wind developers, renewable energy advocates, and decision makers, that can be used to analyze the economic impacts (e.g., number of jobs) and the costs of constructing and operating wind power plants.

**Wind Turbine Design Codes**—In 2005, Germanischer Lloyd (the standards approval authority in Europe) of Hamburg, Germany, accepted two wind turbine design codes, FAST and ADAMS, developed by NREL for calculating land-based wind turbine loads for design and certification. This international approval will help U.S. industry partners accelerate the development and certification of advanced wind turbines in worldwide markets.

## Market Development

**High-Resolution Wind Resource Maps**—NREL develops high-resolution wind resource maps for policy makers and the wind industry. These new maps have a higher resolution than the maps produced during the past two decades. They use Geographic Information Systems software to add overlays of significant features, such as power lines, park boundaries, and roads. By 2009, NREL had produced and validated high-resolution maps for 39 states, Puerto Rico, and the Virgin Islands.

**Wind Powering America**—To boost the deployment of wind energy, NREL's Wind Powering America (WPA) team worked with state and regional representatives to form state wind working groups and provide them with the information they needed to promote wind energy within their states. When the project started in 1999, only four states boasted more than 100 MW of installed wind capacity. By the end of 2008, WPA had formed 33 state wind working groups and 22 of the states had more than 100 MW of wind capacity.

**20% Wind Energy by 2030**—NREL partnered with the U.S. Department of Energy (DOE), the American Wind Energy

Association, and Black & Veatch in 2007 to create a detailed, technical document that describes the impacts, costs, and benefits of producing 20% of the nation's projected electricity demand from wind technology. The collaboration included input from wind industry leaders, utility sector leaders, national laboratories, and nongovernmental organizations. Analytical results support the primary conclusion that producing 20% of the nation's electricity from wind technology is technically feasible and offers many benefits to the nation.

## Grid Integration

**Grid Integration of Wind Technologies**—As more wind was installed across the United States through the early years of this decade, the integration of large amounts of wind into the nation's electric system became a key concern for utility system operators. NREL worked with other national laboratories, university researchers, independent system operators, regional transmission organizations, the Federal Energy Regulatory Commission, and DOE's Office of Electricity Delivery and Energy Reliability on several high-penetration utility wind integration studies that demonstrate that significant wind energy generation can be integrated cost effectively into electric grid systems with minimal operational impact.

**Utility Wind Integration Group**—In 1998, NREL helped DOE form the Utility Wind Integration Group (UWIG), an organization of utilities dedicated to accelerate the development and application of good wind engineering and operational practices. UWIG was a hallmark in changing the understanding of utilities regarding the implementation of wind technologies in the United States.

## Siting and Environment

NREL also works with organizations such as the National Wind Coordinating Collaborative, American Wind Energy Association, U.S. Fish and Wildlife Service, Bats and Wind Energy Cooperative, and Grassland Shrub Steppe Species Collaborative to resolve environmental issues affecting the deployment of wind energy technologies. NREL's efforts supported the formation of the American Wind Wildlife Institute that focuses on the responsible development of wind energy while protecting wildlife and wildlife habitat. The Laboratory has also supported numerous studies on wind wildlife interaction and has contributed to dozens of reports, which led to the creation of the Wind-Wildlife Impacts Literature Database (WILD) at <http://www.nrel.gov/wind/wild.html>. WILD is a searchable bibliographic database that contains more than 1,000 citations of publications from around the world regarding the impacts of wind projects on wildlife.

### National Renewable Energy Laboratory

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NREL is a national laboratory of the U.S. Department of Energy  
Office of Energy Efficiency and Renewable Energy  
Operated by the Alliance for Sustainable Energy, LLC

NREL/FS-500-46635 • January 2010

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 10% post consumer waste.