



U.S. Department of Energy  
**Energy Efficiency  
and Renewable Energy**

Bringing you a prosperous future where energy  
is clean, abundant, reliable, and affordable



**U.S. Department of Energy  
Wind and Hydropower  
Technologies**

**Top 10 Program  
Accomplishments**



# Top 10 Program Accomplishments


Important activities or technologies developed by or with the support of the Wind Energy Program that have led to the vibrant wind energy market of today.

## Advancing Wind Turbines

### Wind Powered Electricity

Although the wind has been harnessed to deliver power for centuries, it was only as recently as the 1970s, through the efforts of the U.S. Department of Energy's (DOE's) new Wind Energy Program, that wind power evolved into a viable source for clean commercial power. During that decade, the Wind Energy Program designed, built, and


tested the 100-kilowatt (kW) "Mod" series (100 kW was the benchmark for large wind at the time) of wind turbines. These early machines proved the feasibility of large turbine technology and paved the way for the multimegawatt wind turbines in use today.




DOE's MOD-5B 3.2-MW wind turbine, Kahuku, Oahu, Hawaiian Islands, 1987.

### The Quintessential American Turbine

Wind Energy Program researchers have worked with GE Energy and its predecessors, Zond and Enron Wind, since the early 1990s to test components such as blades, generators, and control systems on various generations of machines. This work led to the development of GE's 1.5-megawatt (MW) wind turbine. By the end of 2007, more than 6,500 of these turbines, generally considered the quintessential American wind turbine, had been installed worldwide.



GE Energy 1.5-MW wind turbine, Hagerman, Idaho, 2005.



Clipper Windpower 2.5-MW Liberty wind turbine, Medicine Bow, Wyoming, 2006.



## The Liberty Turbine—a New Benchmark

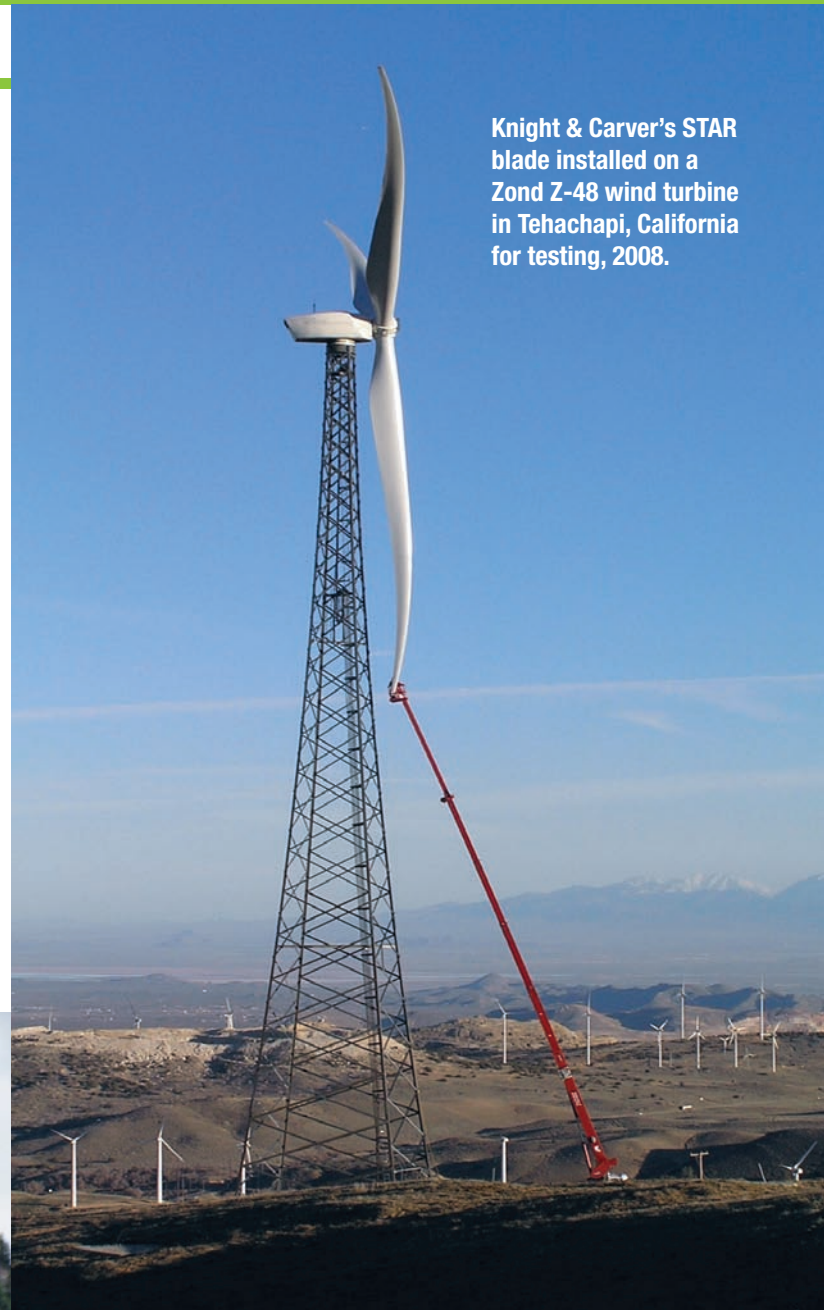
At the start of this decade, the Wind Energy Program launched an effort to develop the next generation of wind turbine technology. Thanks to its support for cutting-edge research and close partnership with industry, the Clipper 2.5-MW Liberty series was introduced in 2006. The Liberty turbine features a new lightweight, enlarged rotor that increases power production and a revolutionary generator design that improves reliability. Its design sets a new standard for turbine size. Researchers expect this advanced design to set the benchmark for future turbines developed in the United States and in Europe.

## First “Plug and Play” Small Wind Turbine

The award-winning Southwest Windpower 1.8-kW Skystream wind turbine represents state-of-the-art technology within the small wind market. From drawing board to market, the Wind Energy Program assisted with the development and certification of this machine. The Skystream represents the first “plug and play” small wind energy system. It’s easier to install, operate, and maintain and was designed as a renewable energy appliance for the residential market.



Southwest Windpower  
1.8-kW Skystream wind  
turbine, National Wind  
Technology Center,  
Boulder, Colorado, 2006.



Knight & Carver’s STAR  
blade installed on a  
Zond Z-48 wind turbine  
in Tehachapi, California  
for testing, 2008.

## STAR—The New Evolution in Blade Design

The blades of a wind turbine are the bridle that harnesses the energy of the wind. In the 1980s, the Wind Energy Program developed advanced wind turbine blade designs that produced up to 30% more electricity than previous designs and became the industry standard for nearly 20 years. Ongoing research on new blade designs will once again revolutionize the wind turbine market, leading to even larger, more efficient blades while reducing their weight and the loads they exert. In 2005, the program partnered with Knight & Carver to develop the first “STAR” (Sweep Twist Adaptive Rotor) blade. This design is distinctive for its gently curved tip that maximizes performance at all wind speeds. The STAR design sets the stage for the next major evolution in wind turbine blade design.



DOE's experimental wind turbine installed in the NASA Ames wind tunnel, 2000.

## Industry Support

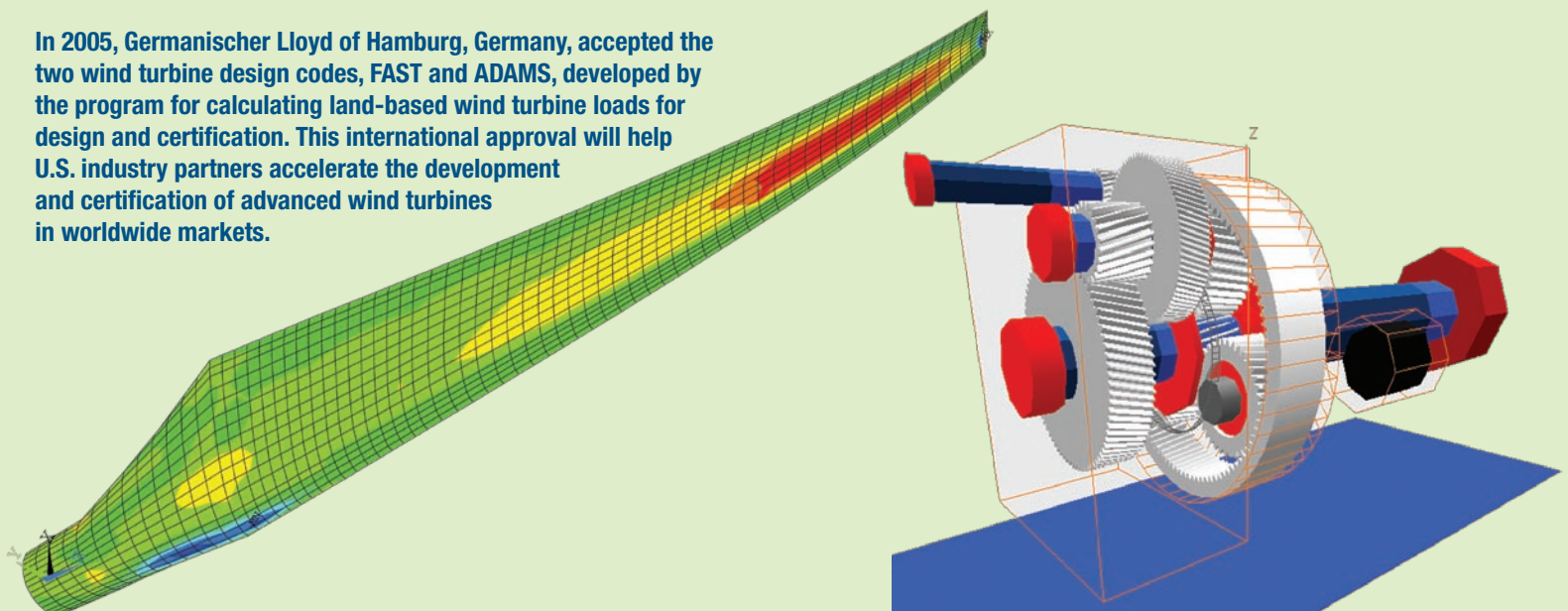
### The Nation's Most Comprehensive Wind Energy NASA Wind Tunnel Testing

In 2000, the Wind Energy Program launched an unprecedented testing effort with the installation and testing of a large-scale wind turbine in the NASA Ames Research Center's 80' x 120' wind tunnel. The results of the testing in these controlled conditions provided a wealth of information that has been used by both U.S. and European manufacturers to validate and improve wind turbine design and aerodynamic software models.

### Computer Codes for Modeling Wind Systems

The Wind Energy Program has developed a series of computer codes that support the design of next-generation turbine blades and other components. These codes are vital to the industry as they provide the means to build virtual models of blades and full systems. They also predict the performance of new designs before prototypes are constructed and tested, thus reducing development costs significantly. These computer codes, such as FAST and AeroDyn, are available to the public and are utilized broadly by universities, government agencies, and the wind energy industry.

In 2005, Germanischer Lloyd of Hamburg, Germany, accepted the two wind turbine design codes, FAST and ADAMS, developed by the program 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.





National Wind Technology Center, Boulder, Colorado.

## 20% Wind Energy by 2030

### Looking Ahead to New Wind Possibilities

In response to the Energy Policy Act of 2005 and the President's Advanced Energy Initiative, the Wind Energy Program engaged with dozens of leading industry partners and stakeholders to create a detailed technical analysis of the impacts, costs, and benefits of producing 20% of the nation's electricity demand using wind technologies by 2030. This multifaceted analysis that involved representatives from the industry and the electric power sector concluded that the goal of producing 20% of the nation's electricity from wind energy by 2030 is technically feasible and offers many benefits to the nation.



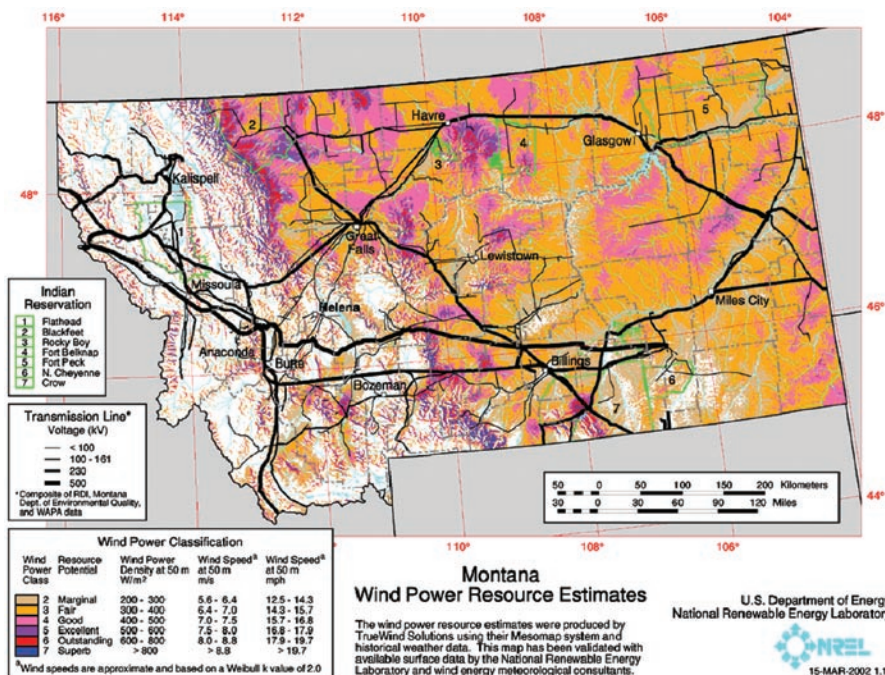
## The Nation's Most Comprehensive Wind Energy Research Facility

The major developments that have occurred in the U.S. wind energy industry can be attributed to the commitment of resources that support the research and development efforts of our leading scientists and engineers. In 1994, DOE dedicated the National Wind Technology Center (NWTC) to support industry efforts to advance wind energy technologies. Located south of Boulder, Colorado, it is one of the leading wind energy research and development facilities in the world and is recognized internationally for its capabilities and successes. The NWTC supports the development and testing of each new generation of wind turbines, the components that support them, and the international manufacturing and testing standards required to ensure the highest level of quality and reliability.

## Deployment Activities

### Widely Used High Definition Wind Maps

Wind Energy Program researchers are developing new high-resolution wind resource maps that are based on advanced meteorological models and are validated with real data. These maps, which can be enhanced with overlays that describe important features such as power lines, park boundaries, and roads, help developers and policy makers determine which areas are best suited for wind energy development. The program has created maps for more than 35 states and territories.



# Advancing Wind Policies

Partnering with National, State,  
 and Local Organizations to  
 Support Policies that Expand  
 Wind Opportunities.



Supporting State  
 Wind Working  
 Groups and . . .



Working with Policy Makers.



NATIONAL  
 WIND  
 COORDINATING  
 COLLABORATIVE

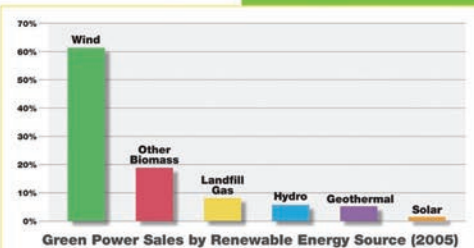


**UWIG**  
 Utility Wind  
 Integration Group



Partnering with  
 Industry Groups and . . .

Assessing Incentives and Standards.



For further information call 1-877-EERE-INF or  
 visit [www.eere.energy.gov](http://www.eere.energy.gov)

## Successful Collaboration and Communication

It is broadly recognized that paradigm shifts, such as new energy sources, require motivation, resources, and effective communications. The Wind Energy Program helped to form, and continues to support, several organizations that play a key role in providing information regarding the appropriate deployment of wind power. The Utility Wind Integration Group (UWIG) works to accelerate the development and application of good engineering and operational practices as wind power is integrated into our national grid. The National Wind Coordinating Collaborative (NWCC) identifies issues that affect the use of wind power and facilitates dialogue among key stakeholders. And the program's Wind Powering America (WPA) effort supports more than 30 state wind working groups. Using the WPA "train the trainers" model, each working group is tasked to provide decision-makers with timely and accurate information on the current state of technology, wind resources, economic and development impacts, and policy options for the use of wind energy. More recently, WPA has initiated the Wind for Schools Program that is intended to engage rural school teachers and students in wind energy education; equip college and university students with the requisite knowledge, skills, and motivation to make an immediate impact upon entering the wind industry; and introduce wind energy on a small scale to rural communities.

## Award Winning Research

Since the inception of the Wind Energy Program in 1972, researchers at the National Renewable Energy Laboratory and Sandia National Laboratories and their program partners have received many awards and recognitions for their research and development work to improve the cost, performance, and reliability of wind energy technologies. These include two prestigious R&D 100 Awards for turbine development and blade design; a 2006 Best of What's New Award from Popular Sciences for the Skystream 3.7 small wind generator; the acceptance of two wind turbine design codes developed by the program for the design and certification of wind turbines to international standards; numerous patents; and many industry accolades. The program and its partners continue to push the technology envelope, working to ensure that wind energy can supply a clean and affordable energy future for our children and future generations.

## A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

### For more information contact:

EERE Information Center — 1-877-EERE-Inf (1-877-337-3463)  
[www.eere.energy.gov](http://www.eere.energy.gov)

Produced for the  
**U.S. Department of Energy**  
**Energy, Efficiency, and Renewable Energy**  
 1000 Independence Avenue, SW, Washington, DC 20585

By the **National Renewable Energy Laboratory**,  
 a DOE National laboratory

DOE/GO-102008-2622  
 May 2008

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