



[www.nrel.gov/wind](http://www.nrel.gov/wind)

Wind energy is one of the fastest growing electricity generation sources in the world. NREL's National Wind Technology Center (NWTC), the nation's premier wind energy technology research facility, fosters innovative wind energy technologies in land-based and offshore wind through its research and testing facilities and extends these capabilities to marine hydrokinetic water power.

Research and testing conducted at the NWTC offers specialized facilities and personnel and provides technical support critical to the development of advanced wind energy systems. From the base of a system's tower to the tips of its blades, NREL researchers work side-by-side with wind industry partners to increase system reliability and reduce wind energy costs. The NWTC's centrally located research and test facilities at the foot of the Colorado Rockies experience diverse and robust wind patterns ideal for testing. The NWTC tests wind turbine components, complete wind energy systems and prototypes from 400 watts to multiple megawatts in power rating.

## NWTC Facilities and Capabilities

For many years, the NWTC has tackled wind industry challenges developing and refining specialized testing to advance wind technology, reducing the cost of wind energy through increased performance and improved reliability. The NWTC provides its industry partners with every aspect of the technical support they need to develop a wind turbine. From the design table to the marketplace, the NWTC research supplements industry knowledge to innovate for the nation's energy future.

## Capabilities

The NWTC conducts research across a complete spectrum of applicable wind energy engineering disciplines, including atmospheric fluid mechanics and aerodynamics; dynamics, structures, and fatigue; power systems and electronics; and wind turbine engineering applications.

The NWTC's specific wind energy research and testing capabilities include:

- Design review and analysis
- Software development, modeling, and analysis
- Advanced controls development and testing
- Certification and design evaluation testing
- Highly Accelerated Life Testing
- Transmission and grid integration
- Wind resource assessment



Wind technicians work on the DOE 1.5 MW turbine at the National Wind Technology Center. Photo by Dennis Schroeder, NREL/PIX 19067

## Facilities

Comprised of field test turbines and sites, test laboratory facilities, industrial high-bay work areas, electronics and instrumentation laboratories, and research office space, the NWTC supports hundreds of test articles and supporting components such as turbines, meteorological towers, custom test apparatus, calibration and measurement instruments, data acquisition systems, load frames, computers, and electronics. In short, the NWTC contains the gamut of necessary infrastructure, along with experienced personnel, to support wind energy system research and testing.

The NWTC test facilities are unique in the nation and include:

- **Dynamometer Testing** – The NWTC provides the nation's wind industry with three dynamometers able to test drive trains from 225 kW to 5 MW. Dynamometers can simulate "wind" input to validate designs and evaluate mechanical and electrical performance.
- **Structural Testing** – Three test laboratories are available for component and full-scale testing of wind turbine blades and structural components. The NWTC is accredited to perform full scale blade testing according to the IEC 61400-23 standard, with capabilities to test blades up to 50-m in length. A comprehensive inventory of specialized hydraulic equipment and an intensive array of data acquisition and instrumentation is available for loading and validating components under extreme and fatigue conditions.



NREL's blade test facility provides industry the means to test longer blades like the 50-m blade shown here. *Photo by Dave Snowberg, NREL/PIX 19513*

- **Controlled Advanced Research Turbines (CARTs)** – Research turbines at the NWTC allow NREL researchers to explore potential control innovations and field test advanced control systems. Ongoing investigations explore potential control innovations and involve field-testing of simulation-tested control systems.
- **Controllable Grid Interface** – The ability to test power controls is critical to design development and the NWTC provides electrical power control hookups for test apparatus power simulations.
- **Field Testing** – Manufacturers test their prototype and commercial machines at the NWTC to International Electrotechnical Commission (IEC) and Measuring Network of Wind Energy Institutes (MEASNET) standards.

Accredited through the American Association of Laboratory Accreditation (A2LA), the NWTC performs tests required by wind turbine certification agencies, financial institutions, and other organizations throughout the world. The NWTC is accredited by the A2LA to perform the following tests in accordance with international standards:

- Acoustic Noise to IEC 61400-11 and MEASNET
- Power Performance to IEC 61400-12-1 and MEASNET
- Mechanical Loads to IEC 61400-13
- Power Quality to IEC 61400-21 and MEASNET
- Duration Testing to IEC 61400-2
- Safety and Function to IEC 61400-2

*Photos front page, top row, left to right: Dennis Schroeder, NREL/PIX 19007; Lee Jay Fingersh, NREL/PIX 15005; Warren Gretz, NREL/PIX 12415; Lee Jay Fingersh, NREL/PIX 14691; Dennis Schroeder, NREL/PIX 18937*

## Water Power

What do wind and water have in common? Marine hydrokinetic (MHK) energy devices are high-force, low-speed machines, similar to wind turbines that convert the kinetic energy of a moving fluid into electrical energy. Development of energy through the Earth's largest, most predictable, and renewable water resources – its oceans and rivers – requires increasingly efficient, high capacity devices designed and deployed to maximize performance and reduce capital costs. The NWTC's expertise to test and validate device performance has been extended to water power devices and critical research efforts are underway to support this burgeoning industry.

For more information, contact Fort Felker, Center Director, at [Fort.Felker@nrel.gov](mailto:Fort.Felker@nrel.gov), 303-384-6905 or Brian Smith, Lab Program Manager, at [Brian.Smith@nrel.gov](mailto:Brian.Smith@nrel.gov), 303-384-6911.

## Helpful Web Sites

National Renewable Energy Laboratory's  
National Wind Technology Center (NWTC)  
[www.nrel.gov/wind](http://www.nrel.gov/wind)

Department of Energy - Energy Efficiency and  
Renewable Energy Wind Program  
[www1.eere.energy.gov/wind/](http://www1.eere.energy.gov/wind/)

Department of Energy – Energy Efficiency and  
Renewable Energy Water Power Program  
[www1.eere.energy.gov/water/](http://www1.eere.energy.gov/water/)



Multimegawatt turbines at the National Wind Technology Center yaw toward the wind flowing off the Rocky Mountains. *Photo by Dennis Schroeder, NREL/PIX 19082*

## National Renewable Energy Laboratory

1617 Cole Boulevard, Golden, Colorado 80401  
303-275-3000 • [www.nrel.gov](http://www.nrel.gov)

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-5000-53405 • December 2011