



NATIONAL WIND  
TECHNOLOGY CENTER

# 35 YEARS OF INNOVATION

Leading the Way to a Clean Energy Future

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.

# Vision

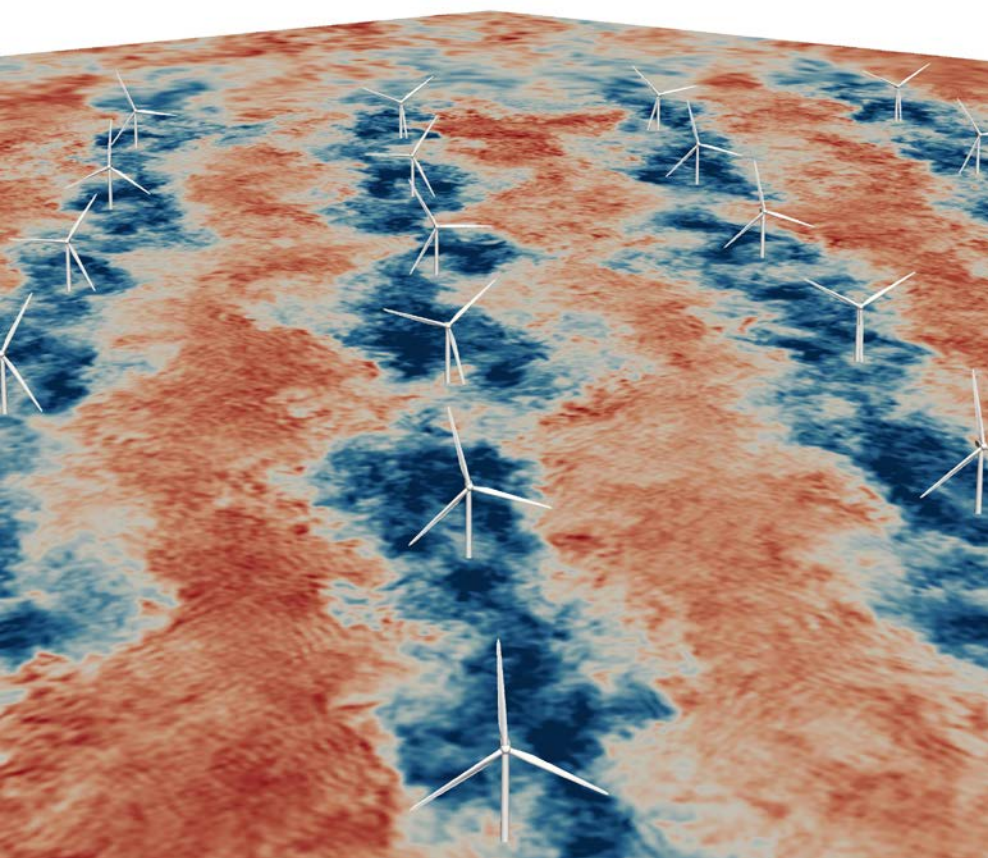


The U.S. Department of Energy (DOE) National Wind Technology Center (NWTC) at the National Renewable Energy Laboratory (NREL) is at the forefront of energy innovation. For more than three decades, our researchers have built unparalleled expertise in renewable energy technologies while supporting the nation's vision that wind and water can provide clean, reliable, and cost-effective electricity. The NWTC strives to be an essential partner to companies, other DOE laboratories, government agencies, and universities around the world seeking to create a better, more sustainable future.

The NWTC goes to great lengths—and heights—to help wind turbine manufacturers develop advanced technologies that improve performance and lower costs. *Photo by Dennis Schroeder, NREL 27195*



NREL has the capabilities to research and test new wind and water power technologies. One such device is Ocean Renewable Power Company's TidGen Power System, shown here. *Photo from Ocean Renewable Power Company*



NREL's dynamic simulation tools help wind and water power technology manufacturers worldwide see how the fluid flows created by wind and water affect a power plant's overall energy production. *Simulation by NREL*

## One Team, Unlimited Possibilities

Just south of Boulder, Colorado, the NWTC is nestled at the base of the Rocky Mountain foothills. The 305-acre site experiences diverse and vigorous wind patterns—more than 100 miles per hour—making it an ideal setting for testing the reliability and performance of wind turbines. The NWTC comprises the necessary infrastructure, highly experienced staff, and state-of-the-art equipment needed to provide its partners and stakeholders with a full spectrum of research and development (R&D) capabilities to develop everything at one location—from small residential wind turbines and components to utility-scale offshore wind and water power technologies.

With the NWTC, partners can:

- Test wind and water power components and systems to improve designs and reduce risk
- Utilize in-depth economic analyses to better understand economic performance and drivers
- Employ high-performance simulation tools to produce realistic models of wind and water power technologies in complex environments
- Analyze turbine connectivity with the utility grid to increase the amount of variable generation
- Collaborate with experts to develop innovative technologies and accelerate time to market.

# Collaboration



GE Power and Water, DOE, and NREL officials join together to celebrate the commissioning of the new 5-megawatt dynamometer test facility at the NWTC. Here, partners can test their wind and water power turbine drivetrains in a controlled environment. *Photo by Dennis Schroeder, NREL 28235*

## One Goal, Many Partners

Developing clean energy requires teamwork. That's why NWTC experts work with industry, research laboratories, and academic institutions to share valuable experience and knowledge; solve technological challenges; and develop best practices. Ultimately, this collaboration, coupled with our unique capabilities, helps speed the widespread deployment of the next generation of wind and water power systems and system components.

There are a number of ways to collaborate with the NWTC. Interested parties can license our technologies, engage in a cooperative research and development agreement, hire NREL to conduct research through work for others or sponsored research, submit a proposal in response to an active solicitation, or participate in research internships and fellowships for undergraduate and graduate students. The center is one of only a few facilities in the United States certified by the American Association of Laboratory Accreditation to test wind turbine prototypes and their components. To learn more about how to partner with us, visit NREL's Technology Transfer Program at [www.nrel.gov/technologytransfer/](http://www.nrel.gov/technologytransfer/). Or visit [www.nrel.gov/wind/working\\_with.html](http://www.nrel.gov/wind/working_with.html) to learn more about specific wind and water power partnership opportunities or call 303-384-6900 to speak to someone directly.

## Breakthrough Ideas, Driving Change

NREL has pioneered many of the components and systems that have taken wind energy technologies to the next level, increasing power production and system reliability while reducing costs. The lab currently holds 20 patents for wind technologies and has received numerous awards recognizing the NWTC's innovative technologies and excellent performance. Through our expertise and one-of-a-kind assets, the NWTC has become a guiding force in helping partners advance their technologies from the initial concept to testing and beyond.

Some of the NWTC's revolutionary technological innovations include:

- FAST. Software that models the physics of wind turbines, including the interaction between wind, waves (for offshore systems), turbine components, and the controller and electrical devices.
- Simulator for On/Offshore Wind Farm Applications (SOWFA). A comprehensive tool that simulates the atmospheric boundary layer and complex flows within a wind plant as well as the impacts of the environment on individual wind turbine components.
- Integrated electrical and structural dynamics testing. The integration of the NWTC's 7-megawatt (MW) controllable grid interface with the 5-MW and 2.5-MW dynamometers, utility-scale field turbines, and multimegawatt energy storage systems provides the powerful simulation, structural dynamics, electrical transients, and ancillary services testing capabilities needed to analyze impacts and interactions between utility-scale renewable energy technologies and the transmission grid.
- A next-generation drivetrain. NWTC researchers and partners are developing an innovative wind turbine drivetrain design that has the potential to increase reliability, decrease mass, improve efficiency, and reduce the cost of wind energy—including the ability to scale up to turbine ratings as high as 10 MW.

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From topography to velocity, the Simulator for Wind Farm Applications simulates all the different variables that affect air flow and performance at wind farms—allowing investors and wind developers to better determine how to maximize energy production across the entire system. *Photo by Dennis Schroeder, NREL 31413*

# Innovation



# Impact

## Today's Technology, Tomorrow's Transformation

The NWTC plays a pivotal role in increasing the reliability and performance of wind technologies, greatly reducing the cost of wind energy and contributing to record-breaking industry growth. The center's impact is industry-wide, ranging from the creation of award-winning components to helping partners develop the nation's most commercially successful renewable energy technologies.

### Improving Wind and Water Power Technologies

The NWTC's R&D and testing efforts have contributed to the development of wind turbines for industry partners such as Gamesa, GE Power and Water, North Wind, Clipper, Siemens, Alstom, Bergey, and Southwest Windpower. The center has also tested new marine and hydrokinetic devices for Northwest Energy Innovations, FloDesign, and Free Flow Power, and assisted with the design and testing of a prototype device for Ocean Renewable Power Corporation and a tidal current blade for Verdant Power.

### Understanding Economic Drivers

NREL analysts work with industry partners, utility and community groups, and other government agencies to collect high-quality project and component-level data that resolve key technical and economic uncertainties, quantify current market trends, and help industry stakeholders explore the cost of energy for renewable generation technologies at specific geographic locations.

### Assessing Wind and Water Resources

With advanced resource characterization and assessment tools and techniques, NWTC researchers are helping develop new methods of ground-based remote sensing devices to measure wind speed and direction from a distance. These devices provide developers with valuable data that aids in the initial siting process as well as quantifies performance once a wind turbine or plant is in place.

To identify the best location for wind energy development, NREL works with a variety of companies to create high-resolution maps at heights of 30 to 100 meters above ground. For water power, NREL worked with the Electric Power Research Institute to map the nation's ocean wave energy resource and study the in-stream energy potential of major rivers in the continental United States and Alaska.

### Accelerating the Deployment of Clean Energy

NREL's market acceleration and deployment team provides accurate information that articulates the potential impacts and benefits of wind and water power technologies to state and local communities. In addition, NREL's WINDEXchange team focuses its outreach efforts on education, rural economic development, public power partnerships, and small wind systems. NREL's deployment activities include:

- Studying the impacts of noise and appearance of wind turbines on property values
- Providing the information needed by developers to engage communities, perform adequate site assessments, and gain acceptance of wind and water power plants
- Assessing the impacts of wind energy on bird and bat populations
- Helping the U.S. Department of the Interior develop the U.S. Fish and Wildlife Service Wind Energy Guidelines
- Conducting regional grid system integration studies to help utilities understand how to integrate larger quantities of variable generation.

NREL is working with partners like Alstom to make offshore wind energy a reality in the United States. *Photo from © Alstom Broadcast Assistance Belgium/Johann Roggeman*

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The NWTC's diverse research staff has the experience and skills to help partners design, fine-tune, and deploy their wind and water power technologies. *Photo by Lee Jay Fingersh*

**LEARN MORE**  
about the NWTC by visiting [www.nrel.gov/nwtc](http://www.nrel.gov/nwtc)





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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/BR-5000-63254 • December 2014

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Front and back cover photo by Dennis Schroeder, NREL 25914