Quick Facts

In the early 1980's, NREL scientists invented specialized airfoils designed to withstand strong winds and maintain maximum efficiency while soiled, leading to three patented airfoil families licensed by turbine manufacturers.

Early dynamometer testing led NREL researchers and General Electric (GE) engineers to develop a Highly Accelerated Life Test that allowed them to rapidly subject wind turbine gearboxes to an equivalent of 20 years of fatigue damage.

NREL researchers partnered with turbine builders to develop variable-speed turbines that operate at lower wind speeds. This innovation was used by GE to improve the performance of its 1.5-MW turbines and build global market share. Since GE entered the wind industry in 2002, it has installed 18,000 wind turbines and expanded from 500 MWs to 28 gigawatts of installed capacity.

A new dynamometer facility has dramatically expanded the capability of NREL and partners to verify the performance of wind turbine drivetrain prototypes and commercial machines. At 5 MW, the facility is large enough to test virtually any land-based turbine for the foreseeable future.

NREL's Controllable Grid Interface (CGI) test system is the first U.S. test facility that has voltage-fault simulation capabilities and allows manufacturers and system operators to conduct the grid code compliance tests required for certification.

NREL Innovations Help Drive Wind Industry Transformation

For nearly 30 years, the National Renewable Energy Laboratory (NREL) has helped the wind turbine industry through design and research innovations. The comprehensive capabilities of the National Wind Technology Center (NWTC), ranging from specialized computer simulation tools to unique test facilities, has been used to design, develop, and deploy several generations of advanced wind energy technology.

In the early 1990s, wind turbines were experiencing expensive gearbox failures even though designs were within specifications. NREL built a unique dynamometer at the NWTC that allowed engineers to conduct lifetime endurance tests, applying 20 years of wear in a matter of months. With this capability, NREL initiated a combined field and dynamometer testing program to discover the root causes of gearbox problems and to enable designers to develop reliable wind turbine drive trains. In recent years, gearbox reliability has been on a steady trend upward.

NREL scientists have worked with industry to produce wind energy resource maps. Sponsored by the Department of Energy's Office Energy Efficiency and Renewable Energy, NREL partnered with industry to provide the first wind resource map that features both land-based and offshore resources. The new wind resource map showed that most states have a viable wind resource with modern wind technology.

NREL is a leader in developing wind turbine simulation tools to predict wind turbine performance and loads. For example, NREL developed and maintains an open-source, modular computer-aided engineering tool—called "FAST" for fatigue, aerodynamics, structures, and turbulence model—that has state-of-the-art capabilities for full dynamic system simulation. NREL makes the tools accessible to industry for design and testing of new wind turbines.

As part of a steady evolution, NREL researchers collaborated with turbine manufacturers to develop variable-speed turbines to take advantage of lower wind conditions. This innovation allowed GE to develop and refine its 1.5-megawatt (MW) turbines and build global market share.

NREL's Controllable Grid Interface (CGI) test system at the NWTC is the only system in the world that is fully integrated with two dynamometers. The CGI can also be used for grid compliance testing of other renewable energy technologies such as inverters and energy storage systems. NREL engineers will continue to provide wind industry manufacturers, developers, and operators with turbine and component testing that ensures performance and reliability.

Aerial view of NREL technicians working on the 1.5-MW GE wind turbine at NREL's National Wind Technology Center.
Photo by Dennis Schroeder, NREL 21865

For more NREL innovations, visit *www.nrel.gov/innovation/*

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