U.S. National Renewable Energy Laboratory (NREL)

Simulating extreme conditions in one of the world's largest grid simulators with a variable speed drive

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A series of tests have to be performed to understand the behavior of wind turbines during grid disturbances. (Aerial view of NREL's National Wind Technology Center (NWTC). Photo by Dennis Schroeder / NREL)

Together with ABB, the NREL has developed a powerful and flexible power grid simulator. A specially configured truck delivers the nacelle to the new 5 MW dynamometer. (Photo by Mark McDade / NREL)

Efficient testing of wind turbine generators

Customer benefits
Reduced time and cost of certification of wind generators
High flexibility to perform a wide range of tests with the same equipment
Easy integration into the customers systems
Customized solution for testing high power electronic equipment

The wind power plant sector is developing dynamically all around the world. The U.S. National Renewable Energy Laboratory (NREL) develops new technologies and tests turnkey solutions in this field. In 2014, the laboratory was supplied with a power grid simulator – one of the largest devices of this type ever built. A team of specialists from ABB Medium Voltage Drives contributed significantly to its construction.

The power of the wind power generators currently installed in offshore wind farms can reach up to 10 megawatts (MW). These gigantic machines have to be thoroughly tested prior to going into production. Such tests include mechanical resistance control and analysis of electrical resistance of the turbine to any potential adverse events occurring in the power grid.

Standardization of simulation tests

The American National Renewable Energy Laboratory in Golden, Colorado, is the largest laboratory in the United States, and one of the largest in the world, specializing in such testing.

Several years ago, the NREL launched a project aimed at developing a power grid simulator that would enable the testing of wind turbine generators in fully controlled and repeatable.

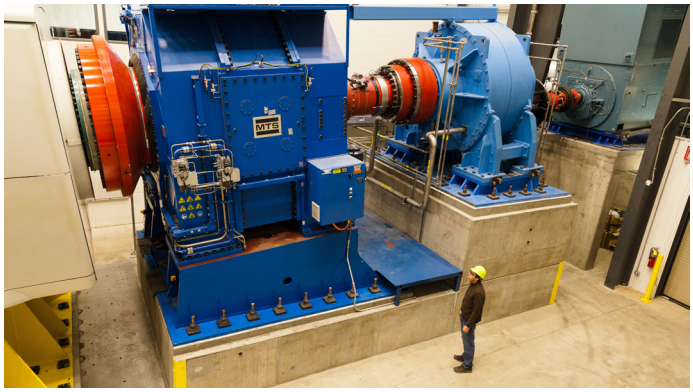
A team of experts from ABB in Switzerland, specializing in medium voltage drives, put forward the idea of grid simulators constructed by ABB based on the ACS6000 converter.

Two opposite functions

The ACS6000 medium voltage alternating current (AC) drive controls the rotational speed and torque of electric motors. It was designed to drive even the most demanding applications, and quickly gained a very good reputation due to its high quality and reliability.

It thus came as no surprise that the project would be based on the ACS6000 converter with a specially developed application controller. The new controller was able to significantly modify the functionality of the drive.

The ABB team designed the simulator according to the specific needs of the NREL, resulting in the development of one of the largest power grid simulators in the world, supporting voltages of 13.2 kV and powers of 7 MW. In the laboratory it serves two functions: on one hand it generates an ideal power supply, while on the other, for testing purposes, it simulates all types of grid disturbances such as overvoltage, sags, and incorrect waveforms. Any problem that has ever been faced in power grids can now be reproduced in tests.



The 5 MW Dynamometer Drive Line at the National Wind Technology Center is one of the largest dynamometers in the world. (Photo by Mark McDade / NREL)

The ACS6000 Controllable Grid Interface (CGI) has considerably reduced the time and cost of certification of wind generators. (Photos of the inside of the CGI. Photo by Dennis Schroeder / NREL)

The first and only testing facility

The grid simulator itself, however, is just one of the elements of the entire testing system. Simultaneous mechanical control plays an equally important part. A turbine shaft is connected to a powerful ABB motor that simulates the operation of a large rotor turned by wind force.

At the same time, servomotors installed on both sides of the nacelle simulate shocks and stresses caused by extremely difficult weather conditions, such as violent offshore gusts of wind. These measures are designed to test the mechanical resistance of a turbine to various types of loads.

The entire system thus makes it possible to simulate extreme operating conditions and to analyze the behavior of a wind turbine during stormy weather and power grid instabilities.

The turbine is subjected to critical conditions during tests to verify whether it complies with the standards which define disturbances and loads that must be supported by a turbine without affecting its operation.

This is the first testing facility in the United States that is able to simulate failures, and currently the only system in the world to be fully integrated with two power stations. This allows researchers to simultaneously carry out mechanical and electrical tests of a device operating in specified conditions.

Excellent simulator performance

After a smooth commissioning by engineers from ABB USA and several months of operation, the management team of the NREL is very satisfied with the simulator's performance. The laboratory has already announced that the simulator will also be used for research work in the fields of solar energy generation and energy storage. The team emphasizes that the Controllable Grid Interface (CGI) has considerably reduced the time and cost of certification of wind generators.

In addition to the grid simulator, the NREL uses an ACS6000 to control a 5 MW dynamometer and an ACS2000 for a 2.5 MW dynamometer with the aim of verifying the performance and reliability of wind turbine drivetrains.

The National Renewable Energy Laboratory (NREL). (Photo by Dennis Schroeder / NREL)

The NREL is headquartered in Golden, Colorado. It is a research agency of the Office of Energy Efficiency and Renewable Energy within the United States Department of Energy, and is supported by the Alliance for Sustainable Energy, LLC.

Its personnel consists of 1,721 permanent employees who focus primarily on technologies related to renewable energy generation and energy efficiency.

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