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NWTC Controllable Grid Interface

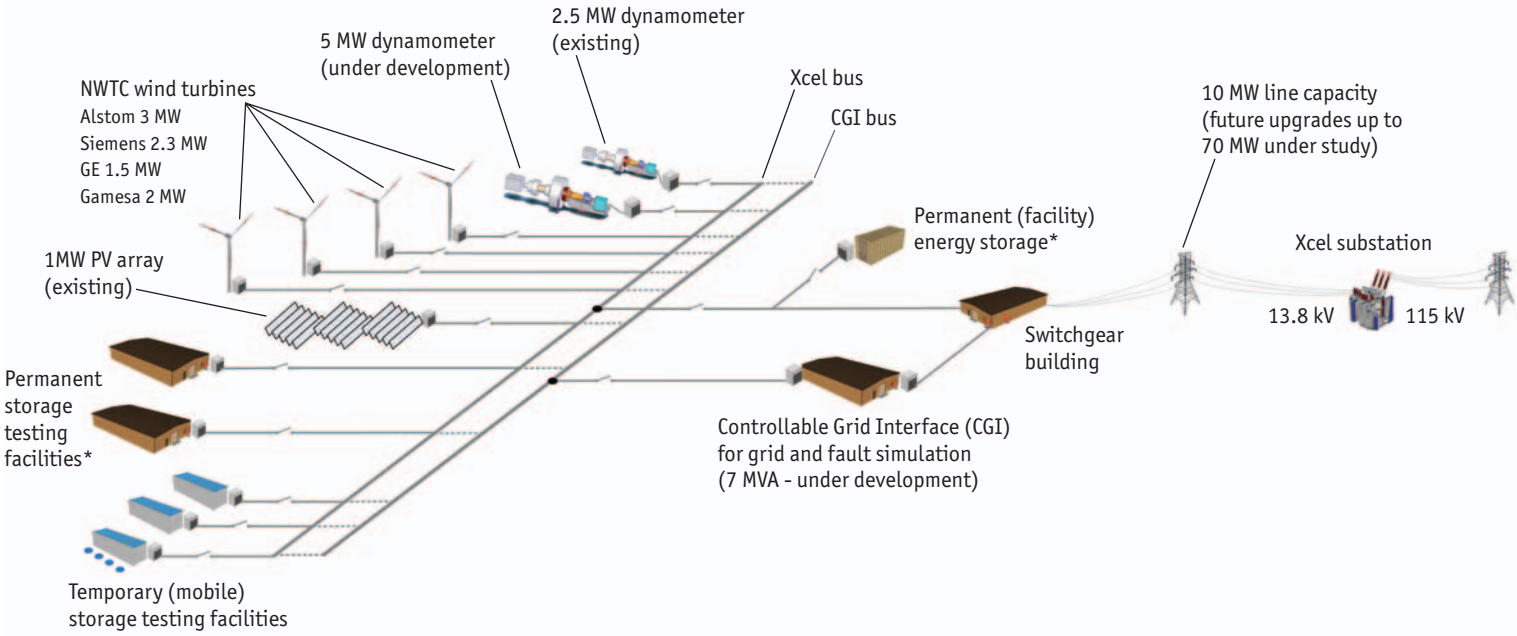
NREL's new controllable grid interface test system can significantly reduce certification testing time and costs while providing system engineers with a better understanding of how wind turbines react to grid disturbances.

To understand the behavior of wind turbines during grid disturbances, manufacturers and utility grid operators need to perform a series of tests and accurate transient simulation studies. The latest edition of the IEC 61400-21 standard describes methods for such tests that include low voltage ride-through (LVRT), active power set-point control, ramp rate limitations, and reactive power capability tests. The IEC methods are being widely adopted on both national and international levels by wind turbine manufacturers, certification authorities, and utilities.

Utility operators also need to estimate how much power wind turbines might be able provide to help regulate grid frequency during situations when they need additional energy quickly, and after design modifications or changes are made to control software, manufacturers may be required to retest their turbines.

But testing wind turbines in the field can be a lengthy and expensive process often requiring manufacturers and utility operators to send equipment and personnel to remote locations for long periods of time.

NREL's National Wind Technology Center (NWTC) has developed a new Controllable Grid Interface (CGI) test system that can significantly reduce the time and cost required to conduct these tests. The CGI is first test facility in the United States that has fault simulation capabilities and allows manufacturers and system operators to conduct the tests required for certification in a controlled laboratory environment. It is the only system in the world that is fully integrated with two dynamometers and has the capacity to extend that integration to turbines in the field and to a matrix of electronic and mechanical storage devices, all of which are located within close proximity on the same site. NREL's 7.5 MVA CGI tests wind turbines off-line from the grid, verifies compliance with standards, and provides grid operators with the performance information they need for a fraction of the time and cost it would take to test the turbine in the field.



*Permanent storage facility concept is under evaluation

The NWTC's CGI allows manufacturers and system operators to test many aspects of grid integration for utility-scale renewable energy generation and storage technologies. *Illustration by Vahan Gevorgian, NREL*

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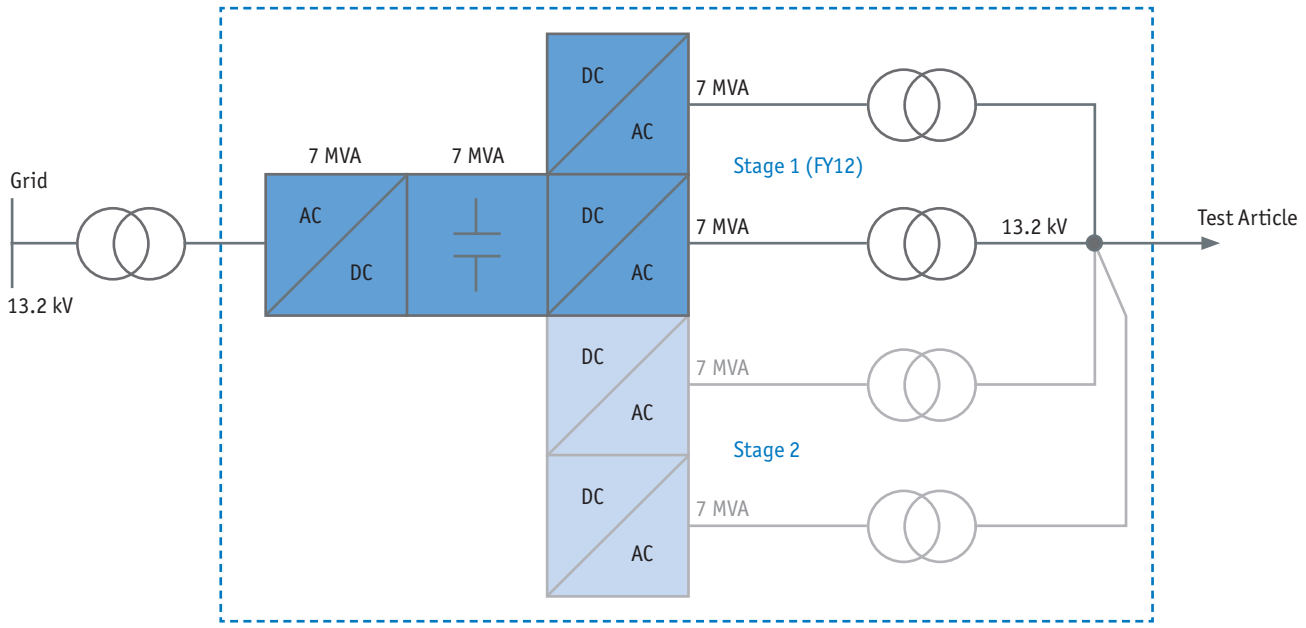

The electrical topology of the 7-MVA CGI consists of multiple voltage source converters. The line side converter is connected to the utility's 13.2 kV line, and two test article side converters are connected in parallel for increased short circuit current capability (14 MVA for stage 1). Up to 28 MVA short circuit current capability is possible with two additional parallel converters that will be added later if necessary. *Illustration by Vahan Gevorgian, NREL*

The system combines hardware and real-time control software and is designed to operate with the NWTC's 2.5-MW dynamometer as well as the center's new 5-MW dynamometer test facilities. It is designed to work with four types of wind turbines, photovoltaic systems, and energy storage inverters. Results from the dynamometer tests can also be used to fine tune and validate the dynamic models used in integration studies and help industry improve turbine performance and develop test standards for renewable technologies and energy storage.

The CGI's capabilities include:

1. Voltage fault ride-through—tests wind turbine responses to various types of grid voltage faults (zero voltage, low voltage, high voltage) for one, two, or three line-to-line or line-to-ground cases
2. Frequency response—tests inertial response, governor droop functionality (or wind turbine participation in primary frequency response)
3. Continuous operation under unbalanced voltage conditions
4. Grid condition simulation (strong and weak)
5. Grid voltage distortions simulation
6. Reactive power, power factor, voltage control testing
7. Protection system testing (over and under voltage and frequency limits)
8. Islanding operation
9. Sub-synchronous resonance conditions
10. 50 Hz tests

Helpful Websites

NREL's National Wind Technology Center
www.nrel.gov/wind

Department of Energy Wind Power Program
www.wind.energy.gov

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

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