In order to understand the behavior of wind turbines experiencing grid disturbances, it is necessary 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. On-site testing of wind turbines might be expensive and time consuming since it requires both test equipment and personnel presence in sometimes remote locations for significant periods of time because such tests need to be conducted at certain wind speed and grid conditions. Changes in turbine control software or grid disturbances can require redoing of all tests. Significant cost and test-time reduction can be achieved if these tests are conducted in controlled laboratory environments that replicate grid disturbances and simulation of wind turbine interactions with power systems. Such testing capability does not exist in the United States today. An initiative by NREL to design and construct a 9-MVA grid simulator to operate with the existing 2.5 MW and new upcoming 5-MW dynamometer facilities will fulfill this role and bring many potential benefits to the U.S. wind industry with the ultimate goal of reducing wind energy integration costs.

**NWTC’s New Test Grid Concept**

The NWTC Grid and Fault Simulator as a New Unique Testing Capability

The proposed grid simulator is a combination of hardware and real-time control software for simulating disturbances on wind turbine terminals and estimating impacts of turbine response on the grid. Also, the performance of wind turbine drivetrain components (both mechanical and electric) can be tested and quantified under such conditions.

**Main Specifications**

**Output loads:**
- Type 1 wind turbines
- Type 2 wind turbines
- Type 3 wind turbines
- Type 4 wind turbines
- PV inverters
- Energy storage inverters

**Power rating:**
- Line side - 9 MVA (with 125% overload capacity)
- Generator side – 27 MVA (with 125% overload capacity)

**Other specifications:**
- Output Frequency: 50/60 Hz (±3 Hz)
- Programmable impedance
- Symmetrical voltage variations (±10%)
- IEC-LVRT tests, NERC-LVRT/HVRT tests
- Voltage magnitude modulations: 0-10 Hz

**References**

2. C. Wessels, T. Wehrend, F.W. Fuchs, “Transformer based voltage sag generator to test renewable energy systems during grid faults in laboratory”.