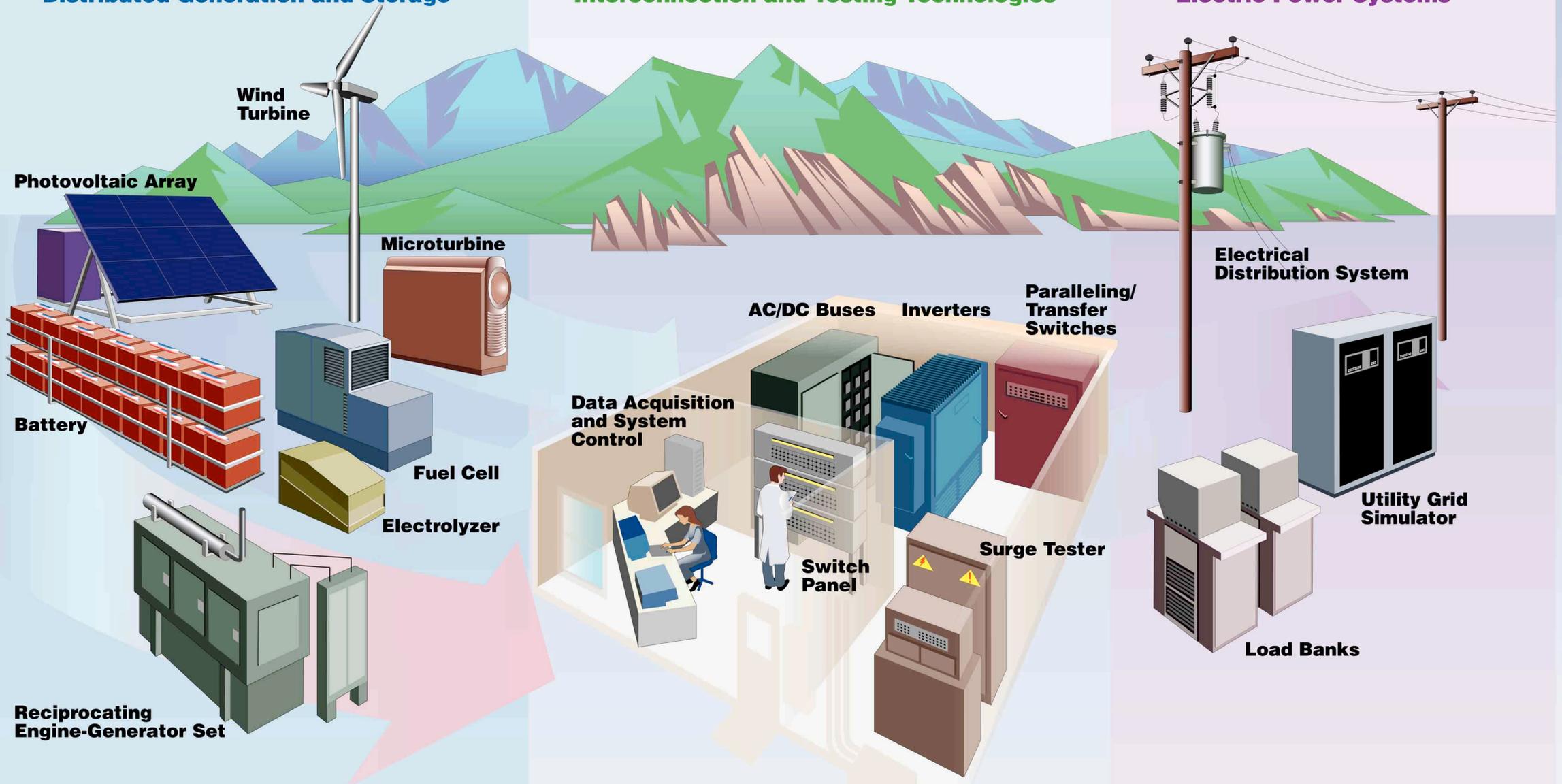


## NREL Test Facility

### Distributed Generation and Storage

### Interconnection and Testing Technologies

### Electric Power Systems



## Testing Activities

- Characterizing, testing, and evaluating the performance of interconnection systems and controls to make sure they operate properly and meet interconnection, communication, and other standards; validating performance from DEER Distribution and Interconnection R&D programmatic contract deliverables
- Developing protocols and procedures for testing and evaluating systems to ensure that they meet performance, safety, and compatibility standards; developing and validating IEEE P1547.1 testing procedures
- Testing advanced designs for grid-connected or stand-alone use, microgrids, and hybrid systems

\*SMARTConnect™- enabling a modernized, reliable, highly automated, and more efficient electric power distribution system through increased use of distributed energy resources

## Interconnection and Testing Equipment

### Data Acquisition and System Control

Because many of the parameters tested involve sub-cycle transient times, a relatively high-speed data acquisition system is used for testing. To accomplish this, a power analyzer capable of sampling rates up to 5 million samples per second is used. Voltage and current measurements are accurate to  $\pm 0.2\%$  of the reading values, with the time scale accurate to  $\pm 0.05\%$ . The data acquisition and system control allows for the monitoring of up to 25 various devices (generation, storage, and loads).

### Switch Panel

The switch panel allows for easy interchangeability of equipment pieces once they are interconnected to the electrical buses. The AC bus can connect up to 15 AC devices (DG, loads, utility, etc.), and the DC bus can connect up to 10 DC devices (batteries, PV, fuel cell, etc.).

### AC/DC Buses

The AC and DC electrical buses are the wire connections that allow the various devices to be interconnected. The current system is capable of handling up to 200 kW of generation.

### Inverters

Inverters convert DC electricity to AC electricity that is compatible with the utility grid. Inverters not only do the power conversion for DC devices but also include protection and synchronization functions.

### Paralleling/Transfer Switches

These switches allow the interconnection of synchronous generators to the utility grid. These switches monitor the DG and utility and provide protective functions and synchronization between the two sources. Paralleling switches allow the DG to remain in parallel with the utility, and transfer switches only operate when the utility goes down.

### Surge Tester

This unit produces various electrical surges that can be used to test the reaction of electrical devices to electrical problems such as lightning strikes. Specific tests can be programmed based on IEEE and IEC standards.

## Electric Power Equipment

### Utility Grid Simulator

The utility grid simulator is a specially designed AC power supply. Four units are paralleled to provide a combined capacity of 250 kVA (200 kW) at 480 V with the use of a transformer. This design allows fully programmable control of individual phase voltage, current, and frequency. Output regulation and total harmonic distortion are less than 1% for normal 60-Hz operations. The grid simulator is capable of fast response times, responding to a 100% step load change in less than 300 ms. The grid simulator can reproduce disturbances such as sags, swells, and harmonic problems with the utility.

### Load Banks

The load banks used at the test facility are customized versions of commercial load banks. The units can provide 165 kW of resistive loads and 404 kVAR of inductive and capacitive loads. Step sizes as small as 125 W and 312.5 VAR can be achieved. A LabView graphical user interface controls the unit through serial ports back to the system control.