

NREL Distributed Energy Resources Test Facility

Advancing Distributed Power Technology



What Are Distributed Energy Resources?

Distributed energy resources (DER) are modular electric generation or storage located near the point of use. Distributed power (DP) systems include biomass-based generators, combustion turbines, concentrating solar power and photovoltaic systems, fuel cells, wind turbines, microturbines, engine/generator sets, and storage and control technologies. DP systems can be grid-connected or operate independently of the grid. Those connected to the grid are typically interfaced at the distribution system. DP systems typically range from less than a kilowatt to tens of megawatts.

When effectively integrated into an electric power system, DP systems can provide high-value energy, capacity, and ancillary services such as voltage regulation, power quality improvement, and emergency power. However, achieving these benefits requires that the systems be carefully integrated with the electric power system. For this to proceed smoothly, the issue of how to integrate the growing number of distributed generators into grid networks must be addressed.

NREL DER Test Facility

The Distributed Energy Resources Test Facility (DERTF) is an integral part of the National Renewable Energy Laboratory's Electric and Hydrogen Technologies and Systems Center and is designed to help the U.S. DP industry develop and test DP systems. Researchers use state-of-the-art laboratories and outdoor test beds to characterize the performance and reliability of DP systems, support standards development, and investigate emerging, complex system integration issues.

Co-located with the Hybrid Power Test Bed at the National Wind Technology Center, the 2,000-ft² test facility works closely with the DP community—

especially those in industry—to study and evaluate advanced or emerging DP technologies.

This work includes:

- Characterizing, testing, and evaluating the performance of interconnection systems and controls to ensure that they operate properly and meet interconnection, communication, and other standards
- Developing protocols and procedures for testing and evaluating systems to ensure that they meet performance, safety, and compatibility standards
- Testing advanced designs for grid-connected or standalone use and use in microgrids and hybrid systems
- Coordinating laboratory and industry testing activities, particularly by defining and providing standard testing and evaluation procedures.

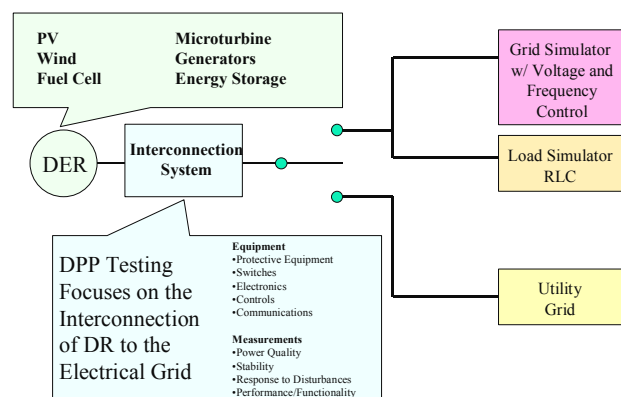


Diagram of distributed power testing

Test Facility Capabilities

Engineers can evaluate the real-time dynamics of DP systems, gather data about long-term performance, or demonstrate new design concepts at the DERTF. High-speed data acquisition systems monitor power quality, harmonic distortion, and electrical transients. The 200-kW grid simulator can emulate a utility, allow for voltage and frequency control, and reproduce disturbances such as sags, swells, and harmonic problems with the utility.



A 200-kW grid simulator

A load simulator with resistive, inductive, and capacitive elements can create power factors up to 0.37, allowing engineers to evaluate system operation under severe conditions that may be encountered in real power systems. With this equipment, researchers can investigate the power system's response to sudden load changes and to conditions of phase imbalance or loss of phase.



A researcher measures inside a 100-kW inverter

Standards and Codes

Researchers work with industry to develop and validate consensus standards and codes for the interconnection of DER with electric power systems. This includes Institute of Electrical and Electronics Engineers, International Electrotechnical Commission, and National Electric Code codes and standards.

Interconnection and Systems Integration

Researchers are working to develop and validate procedures for IEEE 1547 Standard for Distributed Resources Interconnected With Electric Power Systems and IEEE P1547.1 Standard Conformance Test Procedures for Equipment Interconnecting Distributed Resources With Electric Power Systems. All of the tests in the standards—including voltage and frequency disturbances, islanding conditions, surges, harmonics, and flicker—can be carried out at the DERTF. Three power systems and 15 components can be integrated and tested simultaneously. This unique capability enables research on how DP systems interact with one another and the utility.

Publications

Ye, Z.; Finney, D.; Zhou, R.; Dame, M.; Premerlani, B.; Kroposki, B.; Englebretson, S. "Testing of GE Universal Interconnection Device." NREL/TP-560-34676. August 2003.

Kroposki, B.; Englebretson, S.; Pink, C.; Daley, J.; Siciliano, R.; Hinton, D. "Validation of IEEE P1547.1 Interconnection Test Procedures: ASCO 7000 Soft Load Transfer System." NREL/TP-560-34870. September 2003.

Publications are available on the NREL publications database, <http://www.nrel.gov/publications/>.

Contacts

NREL DER Test Facility

Ben Kroposki (303) 275-2979
National Renewable Energy Laboratory
1617 Cole Blvd.
Golden, CO 80401

NREL DEER Technology Manager

Richard DeBlasio (303) 275-4333
National Renewable Energy Laboratory
1617 Cole Blvd.
Golden, CO 80401

DOE Program Manager

Eric Lightner (202) 586-8130
U.S. Department of Energy
EE-2D/Forrestal Building,
1000 Independence Ave., SW
Washington, DC 20585

Additional Distributed Power Information

www.electricity.doe.gov



National Renewable Energy Laboratory

1617 Cole Boulevard
Golden, CO 80401-3393

NREL is a U.S. Department of Energy National Laboratory

Operated by Midwest Research Institute • Battelle • Bechtel

NREL/FS-560-35044 October 2003

Printed on paper containing at least 50% wastepaper, including 20% postconsumer waste.