

Center for Electric & Hydrogen Technologies & Systems—Energy Systems Group Distributed Power Systems Integration Team

Interconnecting Distributed Energy Resources with the Electric Power System

NREL's Distributed Power Systems Integration Team supports the Department of Energy's Distributed Energy Program (within the Office of Energy Efficiency and Renewable Energy) and Electric Distribution Transformation Program (within the Office of Electric Transmission and Distribution) by conducting collaborative research and providing technical support in a range of distributed generation areas. These areas include interconnection engineering and standards, system integration engineering and testing, interconnection interface applications, and policy and regulatory analysis.

Distributed generation is generally defined as smaller power systems (less than 10 MW) located near the customer who uses the electricity produced. Distributed energy resources, or DER, include a variety of distributed energy generation and storage technologies.

DER can provide many benefits to users. For example, DER can provide higher-quality power and more reliability than is generally available from the electric grid. In addition, distributed generation systems are easier to site and, in combined heat and power configurations, can achieve significantly higher efficiencies than traditional central-station power plants.

When effectively integrated into the electric power system, DER can also provide benefits such as high-value energy and capacity as well as ancillary services such as voltage regulation, power quality improvement, and emergency power system-wide. In such a scenario, DER can serve not only to supplement but also to strengthen the entire electric power system.

The Distributed Power Systems Integration Team supports the development of technologies and policies that will enable the interconnection and integration of DER with the electrical distribution system of the future.

Distributed Resources and Interconnection Testing

NREL's Distributed Energy Resources Test Facility is a working laboratory for interconnection and systems integration testing. Co-located with the National Wind Technology Center, this state-of-the-art facility includes generation and storage, interconnection technologies, and electric power system equipment to simulate a real-world electric system.



Researchers at the Distributed Energy Resources Test Facility can vary equipment configurations and simulate disturbances to test DER systems.

Researchers at the facility can vary equipment configurations and introduce common electrical disturbances such as sags, swells, and harmonic issues. These capabilities allow them to evaluate the real-time dynamics of distributed power systems, collect information about the long-term performance of such systems, and test new design concepts.

Data from tests at the facility are used to characterize DER equipment and support the development and validation of interconnection standards and certification tests. These results can lead to better equipment, improvements to help equipment meet interconnection requirements, and a better understanding of the dynamics of equipment interconnected with the power grid. In addition, the facility is increasingly used by industry and academia for cooperative testing and characterization of developmental DER systems.

Distribution System and Interconnection Collaborative Research

Since 1999, NREL has led DOE efforts to engage in collaborative research with industry, academia, and other government laboratories to further the development of distributed power. Today, the Distributed Power Systems Integration Team works with equipment manufacturers, universities, analysts, and energy engineers and power companies to

produce new technologies and approaches for the future of distributed and electric power systems.

This cooperative approach has resulted in the largest body of publicly available project-related DER research. Other key reports include:

- *DG Power Quality, Protection, and Reliability Case Studies Report*
- *Making Connections: Case Studies of Interconnection Barriers and Their Impacts on Distributed Power Project*
- *Distributed Energy Resources Interconnection Systems: Technology Review and Research Needs.*

By identifying the technical framework for further investigations of interconnection and distribution system dynamics as well as potential barriers to interconnection and areas of needed research, such reports are critical to the future development of distributed power systems and interconnection standards.



DER can support and strengthen the nation's electric power system if policy and standards barriers are addressed.

Technical Standards Development and Support

Requirements for interconnecting DER vary widely among states and even neighboring utilities. This lack of uniform installation and interconnection requirements results in technical and economic inefficiencies, interconnection delays, and unnecessary expenses.

Driven by demands from industry and other market stakeholders, the Distributed Power Systems Integration Team provides leadership and resources to the development of standards to support the interconnection of DER. Staff are building on NREL's decades of experience from producing

interconnection standards for photovoltaics to create a framework to guide future DER installations. Current activities include work on standards and codes for the Institute of Electrical and Electronics Engineers, the International Electrotechnical Commission, and the National Electrical Code.

Uniform standards will ensure the safety, performance, and maintenance of interconnected DER equipment while making the interconnection of small DER systems less cumbersome and less expensive.

Mitigation of Regulatory and Institutional Barriers

Today's electric power system — now many decades old — was not designed for the type of two-way power flow needed to support high penetrations of interconnected DER. Complicating matters, the regulations that govern these systems were developed around a central-station generation model in which all such assets were owned by monopoly providers. The market adoption of DER technologies will require regulators to take into account the many significant changes in these assumptions. It therefore poses a challenge to the practices of state utility and environment regulators.

Beginning with the development of *Making Connections: Case Studies of Interconnection Barriers and Their Impacts on Distributed Power Projects*, the Distributed Power Systems Integration Team has been a leader in identifying and addressing barriers to interconnection. Today, the team works closely with state and federal regulators, utilities, and other stakeholders to identify and address potential barriers. Other activities include informing policymakers about the benefits of DER and researching innovative policy options to incorporate DER into the power system.

For More Information

The work of the Distributed Power Systems Integration Team directly supports the goals of the Department of Energy's Distribution and Interconnection R&D activity. To learn more about this work, visit <http://www.eere.energy.gov/distributedpower>.

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