NREL
NATIONAL RENEWABLE ENERGY LABORATORY

ENERGY SYSTEMS INTEGRATION

ESI optimizes the design and performance of electrical, thermal, fuel, and water pathways at all scales.

INTEGRATE: SMARTER GRID SOLUTIONS

Demonstrating Distribution Feeder Voltage Control

Electric utilities have traditionally employed centralized control systems to keep the electric grid operating optimally, focusing mainly on balancing load with generation and, to the extent possible, controlling power flows on the transmission grid. For the most part, distribution feeders have been controlled passively through the use of locally controlled distribution apparatus, such as capacitor banks that help regulate the voltage and supply reactive power, or breakers that would trip the feeder offline in the event of faults.

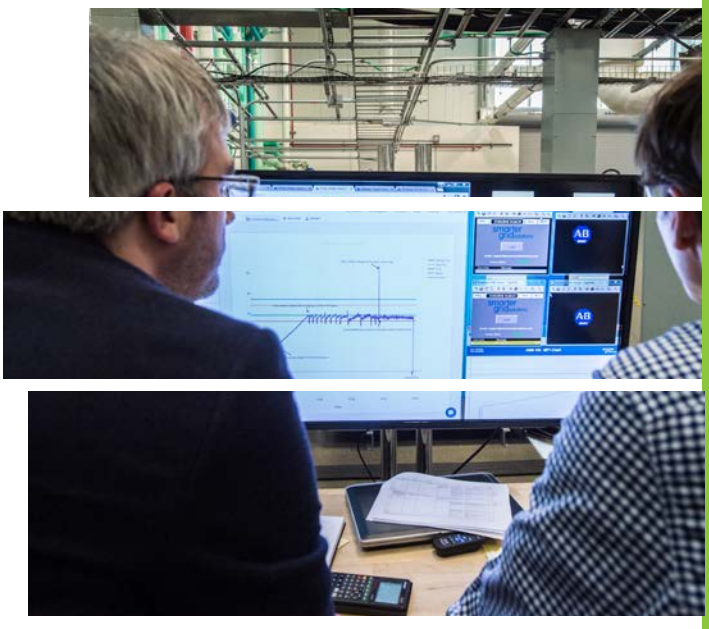
However, as a growing number of distributed energy resources (DER), such as solar photovoltaic (PV) systems, are being interconnected to feeders, utilities are looking to gain greater control of their distribution systems. The reason, in part, is the need for greater voltage control, as excess PV capacity on a feeder can drive up voltages on a sunny day, potentially causing the voltage to exceed statutory limits.

As a result, utilities are looking for a means of "grid-edge" control, that is, actively controlling what is happening on their distribution systems. A system that provides automated or coordinated control of all of a utility's distribution lines could yield significant benefits in terms of allowing greater use of renewable energy, providing demand-side management, and increasing feeder reliability. That's why the National Renewable Energy Laboratory (NREL) worked with New York-based Smarter Grid Solutions (SGS) under the Integrated Network Testbed for Energy Grid Research and Technology Experimentation (INTEGRATE) project.

Active Network Management Enables Greater Renewable Energy Hosting Capacity

SGS has employed its Active Network Management (ANM) system at NREL to manage and maintain a modeled distribution grid within normal operating limits through the autonomous management, coordination, and control of DERs in real time. This integrated, flexible, plug-and-play grid management solution can enhance the grid's capacity to host renewable energy resources. The ANM system demonstrated at the Energy Systems Integration Facility (ESIF) at NREL showed that dynamic grid hosting capacity can enable much higher penetrations of solar and wind energy on the distribution grid, achieving 50% penetration or more.

SGS first demonstrated that its system can monitor a home's smart meter data and control the power flow from the home's photovoltaic system to the home itself, to an electric vehicle (EV), and to and from the home's energy storage system. The company then demonstrated its ability to manage the same level of power flow and voltage control across a campus with a high penetration of solar power by creating a virtual smart campus in the ESIF that was interconnected to a modeled distribution network.



Researchers at the ESIF simulate the Active Network Management system developed by Smarter Grid Solutions, demonstrating the system's ability to provide power flow control and voltage control for a campus with a high penetration of solar power. *NREL 36634*

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

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Check out a video about the Smarter Grid Solutions INTEGRATE project at https://www.youtube.com/watch?v=aNoNNlsDDU8

Partner with us

The ESIF provides a unique, integrated energy systems platform on which our academic, industry, or laboratory partners can work with a team of specialized scientists and engineers to identify and resolve the technical, operational, and financial risks of integrating emerging energy technologies into today's energy environment. Bring us your biggest energy system challenges, and let's solve them together.

Contact the ESIF User Program at 303-275-3027 or **userprogram.esif@nrel.gov** to discuss opportunities.

Learn more about the ESIF and see a list of current partners at **www.nrel.gov/esif/partners.html.**

For complete details on the ESIF's capabilities, tools, research focus areas, and user facility opportunities, please visit **www.nrel.gov/esif.**

The ESIF simulations created a virtual smart campus that was then interconnected to a real-time simulation of a distribution network consisting of:

- A 1-megawatt grid simulator
- 500-kilowatt controllable load banks
- A 500-kilowatt PV inverter
- A 500-kilowatt battery inverter, and
- An EV (with four additional EVs in the simulation).

The simulations proved the ANM system's ability to provide power flow control and voltage control for a campus with a high penetration of solar power. For instance, when the PV system generated too much power for the distribution grid, the ANM system directed some of the power to the battery and the EVs to avoid curtailing the PV power. The project then demonstrated the coordination and real-time management of an entire distribution grid, subsuming the smart home and smart campus scenarios into the larger model.

Guided by an Advisory Board and Funded by the Energy Department

The project is directed by an Industry Project Advisory Board that includes members from Pecan Street Inc., NRG Energy, SolarCity, New York State Smart Grid Consortium, Con Edison, National Grid, Iberdrola USA, the National Rural Electric Cooperative Association, and SIMARD SG.

The project is one of five partnerships NREL is managing under (INTEGRATE) project, which aims to enable the nation's electric grid to handle increasing amounts of renewable energy. INTEGRATE is a $6.5-million, cost-shared project between the U.S. Department of Energy and industry partners that aims to allow renewable energy systems and other clean energy technologies to be connected to a smart power grid in a "plug-and-play" manner, similar to how computers automatically connect to new devices plugged in by the users. INTEGRATE is part of the U.S. Department of Energy's Grid Modernization Initiative.

With renewable energy expanding at all scales, new tools and technologies are needed to enable the grid to handle high penetrations of these renewable energy systems, particularly the smaller systems installed on utility distribution feeders as distributed energy resources. To address this need, NREL is managing five partnerships under the Integrated Network Testbed for Energy Grid Research and Technology Experimentation (INTEGRATE) project. See the NREL news release on INTEGRATE at: http://www.nrel.gov/news/press/2015/18515. *Photo from istock 514327842*

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