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: OMNETRIC GROUP

Demonstrating Distributed Grid-Edge Control Hierarchy

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 protection devices, such as capacitor banks that help the feeder ride through electrical disturbances, or breakers that would trip the feeder offline.

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 power to reverse and flow back toward the substation.

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 the greater use of renewable energy, providing demand-side management, and increasing feeder reliability. That's why the National Renewable Energy Laboratory (NREL) worked with OMNETRIC Group—a joint venture between Siemens and Accenture—under the Integrated Network Testbed for Energy Grid Research and Technology Experimentation (INTEGRATE) project.

Distributed Controls Respond Quickly to Changing Grid Conditions

OMNETRIC Group, in collaboration with Siemens, has developed a distributed control hierarchy—based on an open field message bus (OpenFMB) framework using Siemens' Microgrid Management System—that allows control decisions to be made at the edge of the grid. This in turn enables more timely responses to changing conditions. OMNETRIC Group's open-source-based, interoperable platform allows distributed energy assets to communicate in real time with intelligent grid devices in the field. As part of the INTEGRATE project, OpenFMB was demonstrated to support large-scale complex operations, which allow for the integration and wider penetration of renewable energy resources.

OMNETRIC Group first developed and validated its system in the Energy Systems Integration Facility (ESIF) at NREL with a combination of hardware and software simulations representing real-world utility scale operations. The ESIF validations included testing data exchanges with the representative renewable energy devices available at NREL, while the ESIF grid simulator was used to test balancing renewables with other resources.

Working with project partners Duke Energy, CPS Energy, and the University of Texas San Antonio (UTSA), OMNETRIC Group then demonstrated its system on two in-field functional demonstration microgrids: one owned by Duke Energy and a second at Joint Base San Antonio, a joint Army and Navy post in

After validating its distributed grid-edge control hierarchy at the ESIF, the OMNETRIC Group installed an in-field functional demonstration microgrid at two locations, including the Joint Base San Antonio, a joint Army and Navy post in Texas.
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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.**

Texas. The Duke Energy project demonstrated the ability to forecast power production and loads, provide highly reliable power with the microgrid, and balance renewables with other resources to yield a predictable net energy production.

The Texas system combines a photovoltaic system, battery storage, a low-cost "sky cam" developed by UTSA for weather prediction, and a microgrid management system developed by Siemens. The project demonstrated the integration needed to support both area- and site-specific forecasts of renewable power production. The system functioned well as the microgrid was islanded from the larger grid and then reconnected. Both utilities are using the successful demonstrations to guide their long-term distributed resource and microgrid strategies.

The project is one of five partnerships NREL is managing under the 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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