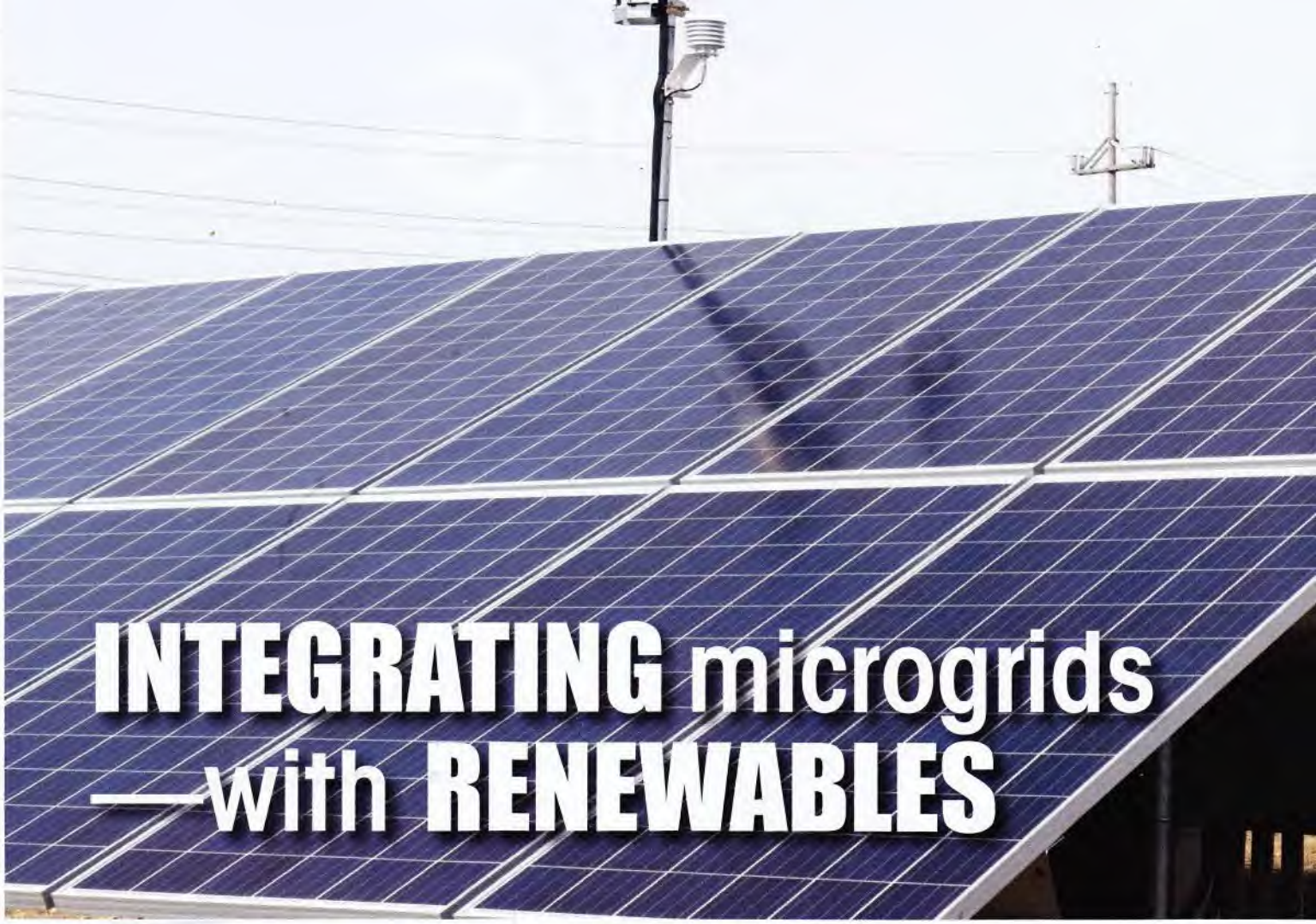

INTEGRATING microgrids —with RENEWABLES

S&C Electric Company has helped power utility Ameren Illinois design, install, and automate an advanced microgrid, with an energy-storage capability that enables the system to operate on 100 percent renewable energy.

By Diane Mettler

In 2016, regulated power utility Ameren Illinois wanted to learn more about the operations, control, and integration of distributed energy resources (DER) on its distribution system. To do that, the company decided to build a microgrid with two nested microgrids at its Technology Applications Center near the University of Illinois campus, which will support the center and a 1-MW residential load.

Ameren's goals were lofty. Build a microgrid to test 16 use cases where it saw a potential to create a return on investment. This return could include improving grid resiliency and reliability; more easily incorporating renewable energy; and enabling the utility to go off-grid to supply power, which would be beneficial if a major storm knocks out the overhead lines that supply electricity from the main source of power generation. One of the most important features was the ability to "black start" the microgrid and be able to return to the grid from island mode without an outage occurring.

Ameren went to Chicago-based S&C Electric Company to help them design and later install and automate the project. The result was not just any microgrid but "the most advanced utility-scale mcrogrid in North America," says S&C's David Chiesa, senior director of Global Business Development. The first challenge for S&C was to design a microgrid that met all of Ameren's needs.

"There were 16 different things that Ameren wanted

to test to see if they would work, which is a lot," Chiesa says. "So we started looking at what's the most efficient way to do this, given the system that they already have there, and how to make it work. It took us about a month, but we actually came up with a very workable—and affordable—design."

The design involved creating a nested 100-kW microgrid within a 1.25-MW microgrid, all interconnected at 12 kV. S&C would oversee the construction of both a 100-kW wind turbine and a 125-kW solar array, and it would provide the utility with two 500-kW natural gas generators as additional alternative energy sources. Most importantly, S&C would provide a 250-kW/500-kWh energy-storage capability that would serve as the backbone of the 100-kW microgrid, enabling it to operate on 100 percent renewable generation.

By the time S&C had gone through the RFP process and was ready to go forward with the project, it was late June 2016, and the clock was ticking. The microgrid had to be completed by December 22. It was then that S&C discovered, based on regulations in Illinois, that Ameren couldn't own a generation facility.

"In deregulated markets, you don't have vertically integrated utilities, you have separate utilities for generation, distribution, and retail power," Chiesa explained. "The way we had it all laid out, Ameren was going to buy all the components directly from S&C."

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Much of the project's success was attributed to its "rock solid suppliers", with experience in the utility industry: Northern Power for the wind turbine; Caterpillar for the natural gas engines; Yingli for the solar panels; ABB for the solar inverters; and S&C for the medium-voltage Vista switch gear and the SMS 250 energy storage management system. Everyone got their equipment to the site on time and made it work.

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The Solution!

The answer was to go out and find a way to lease these assets. The first two approaches did not move forward, but by September, Clean-View Capital stepped forward and worked out a very competitive lease. The real concern was that S&C was now looking at an extremely short construction timeline on a project that included a 125-kilowatt solar field, a wind turbine, a natural gas line extension, two natural gas generators, and an energy storage system.

Chiesa says there was also another interesting element to the project's construction: Ameren wanted a "mobile capable" microgrid.

Chiesa says all of the components were skid-mounted except for the solar panels and wind turbine that had to be permanently installed. "If we needed to, we could take the control house that has the microgrid controller and some of the HMI-type human machine interface devices, which is skid-mounted, and pick up and move it.

"The natural gas generators are also skid-mounted, as well as the

energy storage and the transformer, which are all on one skid. I'm not saying it's an easy thing to pick them up and move them, but the capability does exist that you could put them on a truck and move it if you needed to."

Another project management challenge not only involved installing all these various elements quickly and safely, but Ameren also needed to dig an extension of a natural gas line. "There is a gas distribution station adjacent to us, but you couldn't take it straight off of that line. We had to have a separate line at a specific PSI for the natural gas generators."

In addition, there was the tricky engineering component. Engineering all of these various resources required specific input from each of the suppliers and Ameren. Incorporating all that into the whole, says Chiesa, impacts your overall system and specifically the protection system. "It impacts your ability to protect and balance loads, and more importantly, how they react. You are dealing with a lot of different factors there."

In short, Chiesa says, "There were a lot of moving pieces."

Despite the incredibly short timeline, the project was installed by December 22, 2016.

Chiesa attributes much of the project's success to "having rock solid suppliers", with experience in the utility industry: Northern Power for the wind turbine; Caterpillar for the natural gas engines; Yingli for the solar panels; ABB for the solar inverters; and S&C for the medium-voltage Vista switch gear and the SMS 250 energy storage management system. Everyone got their equipment to the site on time and made it work.

Although the microgrid has been operational since May, one of the biggest tests took place in August when Ameren wanted to prove that they could conduct continuous operations in a microgrid environment for an indefinite period of time without using any fossil fuel generation and no service interruptions to the customer.

> "Ameren Illinois now has one of the few microgrids in the world that operates at utility-scale voltages and can seamlessly transition from grid-connected to island mode and back again."

At 8:00 a.m. on August 3, S&C initiated a 24-hour system test, with the battery's state of charge at 97 percent capacity. Once the battery was depleted to 90 percent capacity, solar and wind generation kicked in, simultaneously carrying the load and charging the battery. This pattern continued throughout the day, never letting the battery fall lower than 88 percent capacity. In short, the microgrid functioned without any human interaction, automatically coordinating renewable resources and ensuring power never faltered.

Even more amazing was that the transition from the grid to island mode, and back again, was seamless. That is an important step forward for microgrids. "We have one of the few microgrids in the world that operates at utility-scale voltages and can seamlessly transition from grid-connected to island mode and back again," said Ron Pate, senior vice president, operations and technical services at Ameren Illinois. "This successful test provided tangible proof that the system can accomplish what it was designed to do. The microgrid isn't theoretical, and our tests don't need to be lab simulations. We were able to prove that this technology works and can provide key benefits to our customers."

Chiesa wasn't surprised at the positive results of the test. "When designing this microgrid, we were confident that the seamless transition and the ability to run solely on renewable generation would be two of the biggest features to this system,"

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This project and the recent test prove that microgrids are becoming more commonplace on the grid.

With sustainable energy resources becoming more utilized, and microgrids able to store and manage the energy distribution from these varied energy technologies, Chiesa believes the long-term future of the energy grid will be a "grid of microgrids."

In a recent article, Building Unintentional Microgrids on Purpose, Chiesa wrote, "We used to have people say, 'I want to put a microgrid here,' as they looked at a wide open field, with endless possibilities. Developers would engineer and develop the project from the ground up, integrate it into the grid, and then study it. In the relatively short history of microgrids, that is how nearly all of the existing deployments came about. And of the existing microgrids, many were designed as pilot or one-off projects that developers, utilities, and policymakers could use to better understand the functionality and impact of microgrids on the grid.

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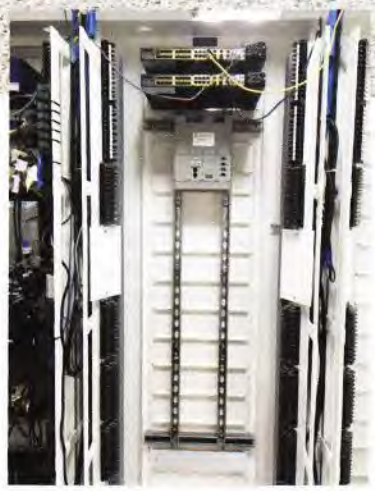

"Now, we are in the middle of a shift in perspective. We are getting more and more customers saying, 'I have some distributed generation (wind, solar, etc.), and it's performing really well. I'll bet we could incorporate a microgrid around this asset to improve our reliability and add additional services.'"

Chiesa says it's only a matter of time before we recognize the most cost-effective way to do that is microgrids. Eventually—maybe not today or tomorrow—it is coming.

"You're going to see them everywhere. It's going to be the predominant tool in the distribution engineer's toolbox. The engineer's going to say, 'Rather than put a feeder tie in here, why don't we just microgrid this area? I see that I've got some segmentation here on my feeder, we could drop in (name the resource). We'll just microgrid them, and they'll be fine.' And it won't be a big deal.

"When these concepts step away from being specialized, unique, and exotic, when they become a standard tool in the toolbox of the utilities—specifically the distribution utility—you're going to see them take off and proliferate," says Chiesa. e