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PennWell

Creating and Maintaining a Microgrid: Tools to Get You from Concept to Reality to O&M

Increased interest in microgrids coupled with better and more robust digital tools to operate and maintain assets is leading to innovation in the microgrid design space.

JENNIFER RUNYON, *Chief Editor*

If the energy industry learned anything in 2017, it was that energy systems are highly vulnerable to damage from hurricanes, wild fires and other natural disasters and work should be done to make the world's electric grids much more resilient.

Enter the microgrid, a concept that has been around for decades but is only now beginning to be recognized for the full benefits that it can offer. Because they are attached to the larger grid, but have the ability to function as a small grid, microgrids can be put in place around critical infrastructure like hospitals, schools, police stations, and shelters in any given village, city or town across the world. This way, if the greater grid experiences an outage, grid operators can first restore power to the microgrid, bringing critical power to people when they need it. Once the microgrid is functional, crews can work to restore power to the greater grid.

In addition to the resiliency aspect of microgrids, they also

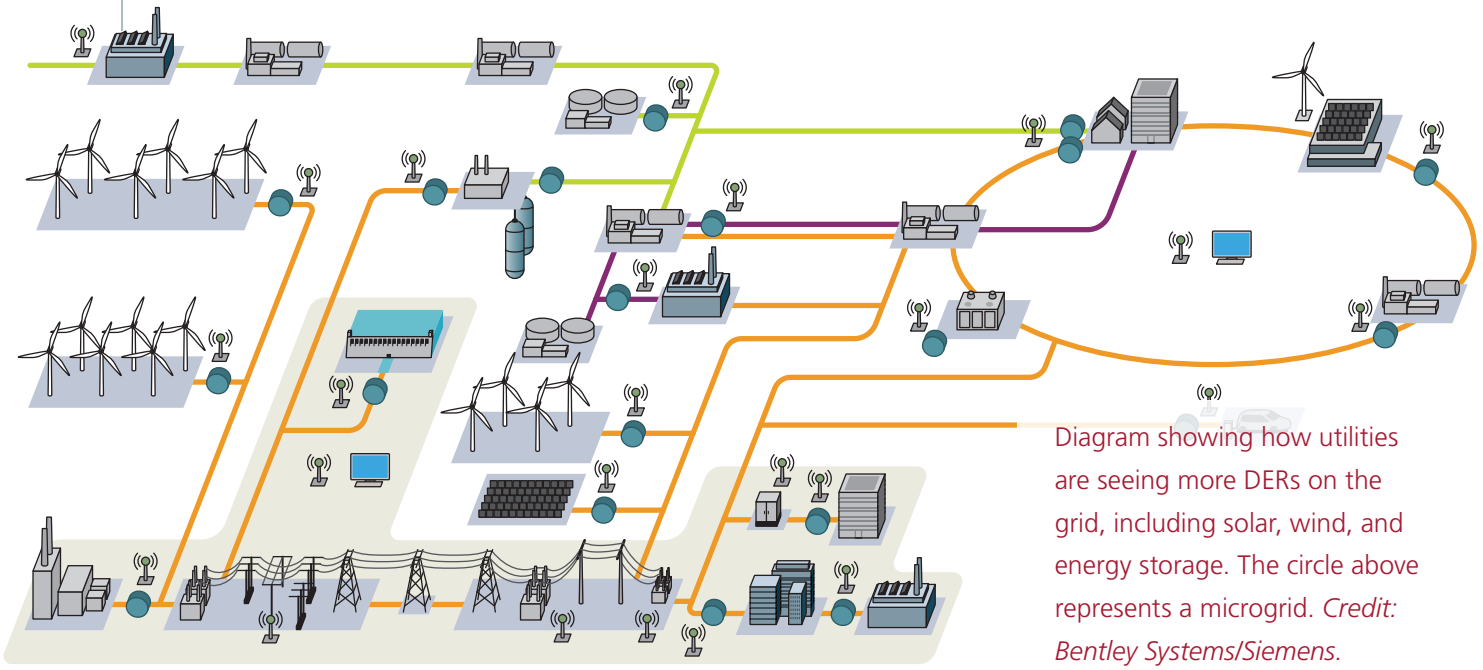


Diagram showing how utilities are seeing more DERs on the grid, including solar, wind, and energy storage. The circle above represents a microgrid. *Credit: Bentley Systems/Siemens.*

carry with them the benefit of allowing for greater integration of renewable energy.

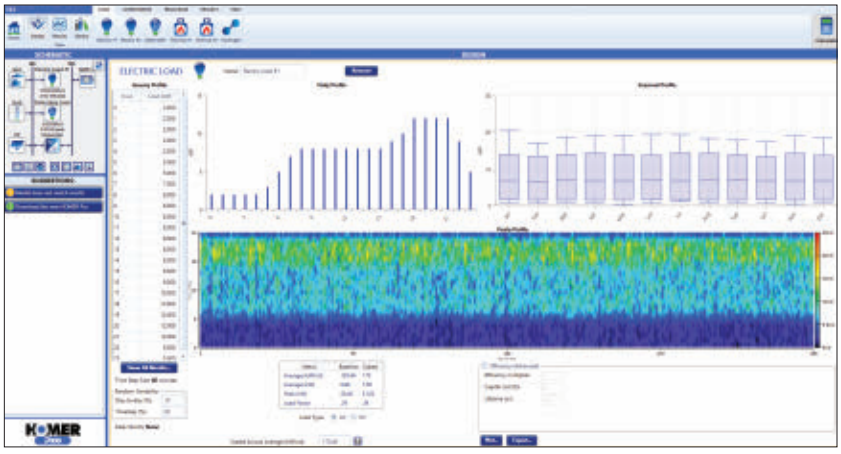
"If you want to have renewables at a high penetration, it's just easier to do that on a microgrid," said Peter Lilienthal, CEO and founder of Boulder, Colorado-based HOMER Energy, maker of microgrid modeling software. Lilienthal added, "big utilities will tell you they are doing great at 20-30 percent [renewable energy integration] but on a microgrid you can do 80 percent easily."

Start from Scratch

Lilienthal describes the microgrid design process as having three phases. The first phase is when all that exists is an idea.

"I think there is real value in playing around with ideas," he said. "What doesn't work well is for someone to have a really concrete idea of what the system should look like early in the development process because they are probably wrong."

HOMER Energy's software has been used by more than 150,000 people in 193 countries in the 25 years it has been in existence. Lilienthal explained that he created the software in 1992 when he worked at the National Renewable Energy Lab



HOMER Pro electric load profile screen. *Credit: HOMER Energy.*

(NREL) and then he privatized it when he founded his company, HOMER Energy, in 2009. Major customers include World Bank, General Electric, Caterpillar, ABB, and Tesla.

"What HOMER Pro is good for is understanding the tradeoffs," explained Lilienthal, adding, "the more renewables or storage you have, the less you need your backup generator…what drives the tradeoffs is the economics." The software combines the technical simulation and optimization with economics so that users can evaluate those tradeoffs.

Once you have figured out your design, you begin selecting components for your microgrid, said Lilienthal, which is another place that the software shines.

"We call that detail design," said Lilienthal. "That's where you narrow it down and you are choosing between specific components," he said.

HOMER Pro is technology and vendor agnostic and Lilienthal estimates that his company works with all of the major distributed energy resource (DER) vendors on the market. The software helps users select components. Vendors are able to pay to get priority placement in the component list, however the software is not biased in favor of certain companies, said Lilienthal.

"What we hear over and over again is the amount of time that [DER] salespeople spend educating prospective customers," he said, adding that many times these customers turn out not to be prospective customers at all because a component they might think they want in a microgrid, won't actually provide the service they are looking for.

"We do them a big favor by educating their prospective customers," he said.

Lilienthal said that at this second stage, users will need to bring in different software companies "to start looking at other things like power flow on the wires, how much wiring do you need, what kind of protection devices do you need, etc." he said.

The third and final stage is the construction stage, when the design is complete, engineering drawings have been developed and a firm has been hired to do the construction. The software is not part of that process.

As far as performing ongoing operations and maintenance (O&M) of the finished microgrid, HOMER Pro is not there yet, although the system does factor upkeep into its calculations.

"O&M is part of our analysis because we are trying to minimize total cost of ownership," he said.

"We can put in a whole maintenance schedule that shows after a certain number of operating hours you need to do a tune-up or an overhaul or a major overhaul. So, it's an important consideration," he said, adding that an integrated design and O&M software is something the company would like to do in the future.

Companies can purchase a monthly or annual license for the software. Lilienthal said they can do a 3-year license and that they have special pricing for academic institutions. Although some utilities use it, like Horizon Power in Australia and Kauai Electric Coop in Hawaii, the software is mostly used by engineering firms, equipment vendors and project developers.

"What we have found is that people that serve the big utilities aren't interested in working with the small utilities," said Lilienthal, adding that island utilities in particular are very neglected, "so we help them."

Serving Bigger Utilities

While HOMER's sweet spot is microgrids between 100 kW and 10 MW, Bentley Systems' OpenUtilities application, which is now integrated with Siemens Power Systems Simulation Suite (PSS), works for any size of network, according to Ton De Vries, Business Development Director for Utilities at Bentley Systems, based in Exton, Pennsylvania.

However, De Vries acknowledges that if the project is a one-off small system, it might be best to outsource.

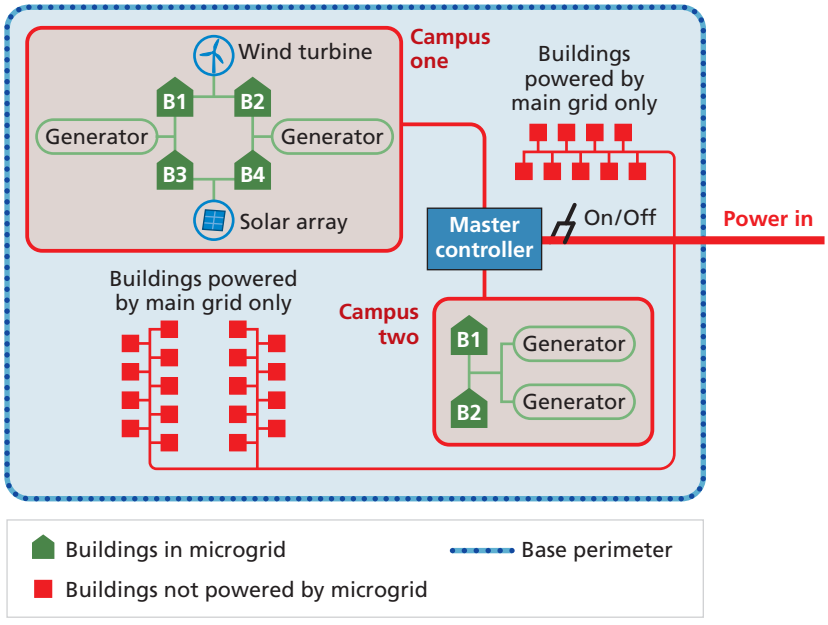
"If it is really small, maybe you are better off outsourcing to an engineering firm but if you do this frequently or have a mixture of microgrids and you want to continue to regularly expand the grid and modify or replace equipment in the grid, the tool is equipped for doing both," he explained.

Utilities use software like Bentley's OpenUtilities, to create a model of their grid infrastructure. The technology can be used to create a microgrid within an existing grid, and offers decision support tools to make the process of adding DERs to an existing grid more efficient. De Vries explains that in general that process can be quite lengthy with traditional methods.

"That process takes time and includes the planning department to do the calculations," he explained. "One of the components we are providing with OpenUtilities is a decision support tool that, on the fly, supports decisions based on your company's parameters."

De Vries explained that users can set the utility's parameters for components on a grid and then when the project is seeking a permit, "by just providing the address of the [proposed] DERs, [the permitter] will get a response back whether the system will stay within those boundaries or will go over," he said.

If a DER, such as a solar array or storage system, will not exceed the utility's pre-determined boundaries, then the project



A basic representation of campus microgrids on an Air Force installation. Each campus has separate energy resources and both campuses are controlled by a master controller to island them from the main grid and direct power within or between them. *Credit: U.S. Air Force illustration by Jeff Pendleton.*

moves forward. But, "if it goes over then it must go to the planning or engineering department to see what kind of modification is needed," said De Vries. This is where Siemens comes into play.

Announced last year at DistribuTECH, the integration of Siemens and Bentley combines Bentley's expertise in infrastructure asset modelling and GIS with Siemens' knowledge and experience in energy system planning and simulation.

"What Siemens brings to the table is the quality of power," explained De Vries. "By including those capabilities in the OpenUtilities application, we are providing designers and engineers with the capability of geographically and — from a cost perspective — optimizing their design as well as from a power quality perspective."

The applications together allow utilities to not only model their entire grid, with all of the DERs included, but also allows them to perform simulations and see how grid-edge power will integrate into the whole network.

"The influence of distributed energy resources on the grid edge requires utility companies to be a little cautious of the components and the power flow at the grid edge," said De Vries.

Finally, as the microgrid moves through the design process and is ultimately built, what results is the physical microgrid, built using OpenUtilities and a digital twin, which engineers can optimize by running simulations to determine, for example, how they could increase the power output of the microgrid, optimize the maintenance schedule, or optimize the performance of the system.

Barriers to Adoption

De Vries acknowledges that while utilities are starting to embrace digital tools, there is still a ways to go. "It's an evolution driven by requirements," he said. Today, utilities have a lot to manage and while some are embracing digital tools, oftentimes the result of those tools is a static model, "so while you are digitizing part of the process, you are not creating a digital representation of the asset you are managing and maintaining," said De Vries.

Bentley is trying to make the process easier.

"We are starting to offer these capabilities fully hosted in the cloud, which means that internal IT work and cost are minimized, giving utilities the option to deploy these systems pretty quickly and also get quick return on investment," he said. ◑