

Microgrid: Ability to Detach from the Grid

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A microgrid is a localized electrical network that allows campuses and other similar-sized districts to generate and store power from various distributed energy resources (DERs). Potential DERs include cogeneration as well as renewables sources such as wind turbines and solar photovoltaics. Balancing captive supply and demand resources—including thermal and electrical load—within its defined boundaries, this type of energy system provides resiliency. A microgrid is capable of “islanding” itself as needed or desired from the larger utility grid, for example during extreme weather events or at times when self-generation is more cost-effective. A smart interface allows power to be supplied to and/or received from the grid. A working microgrid typically includes distributed generation, storage, power electronics and, increasingly, smart buildings.

Distributed generation (DG) allows any combination of local energy sources (e.g., natural gas generators, microturbines, hydrogen fuel cells, solar PV, distributed wind, combined heat and power (CHP) cogeneration systems) to serve the loads of a campus, city, or other defined district. Often “greener” than the power produced by a traditional central power plant, DG is more efficient in transmission to its nearby served loads. Implementation of 15MW onsite CHP to supplement outside electrical utilities is a central component of

strengthening utility systems at the University of Texas Medical Branch Galveston (UTMB) in the aftermath of Hurricane Ike. CHP islanding capability will reduce the threat of hurricane disruption to UTMB operations. Fifty percent more efficient than conventional systems, UTMB’s two new CHP plants will also save approximately \$3 million annually, with a five-year simple payback.

As more and more DG sources connect to the grid and supply power,

ingly enable large numbers of DG sources to link to the grid through highly controllable power processors, allowing efficient and reliable distributed power delivery during regular grid operation, and powering specific “islands” in case of faults and contingencies, such as natural disasters. Power electronics facilitate the efficient and seamless conversion of DC to AC current and vice versa. One example of the scale of such power electronics are the multiple megawatt solar inverters

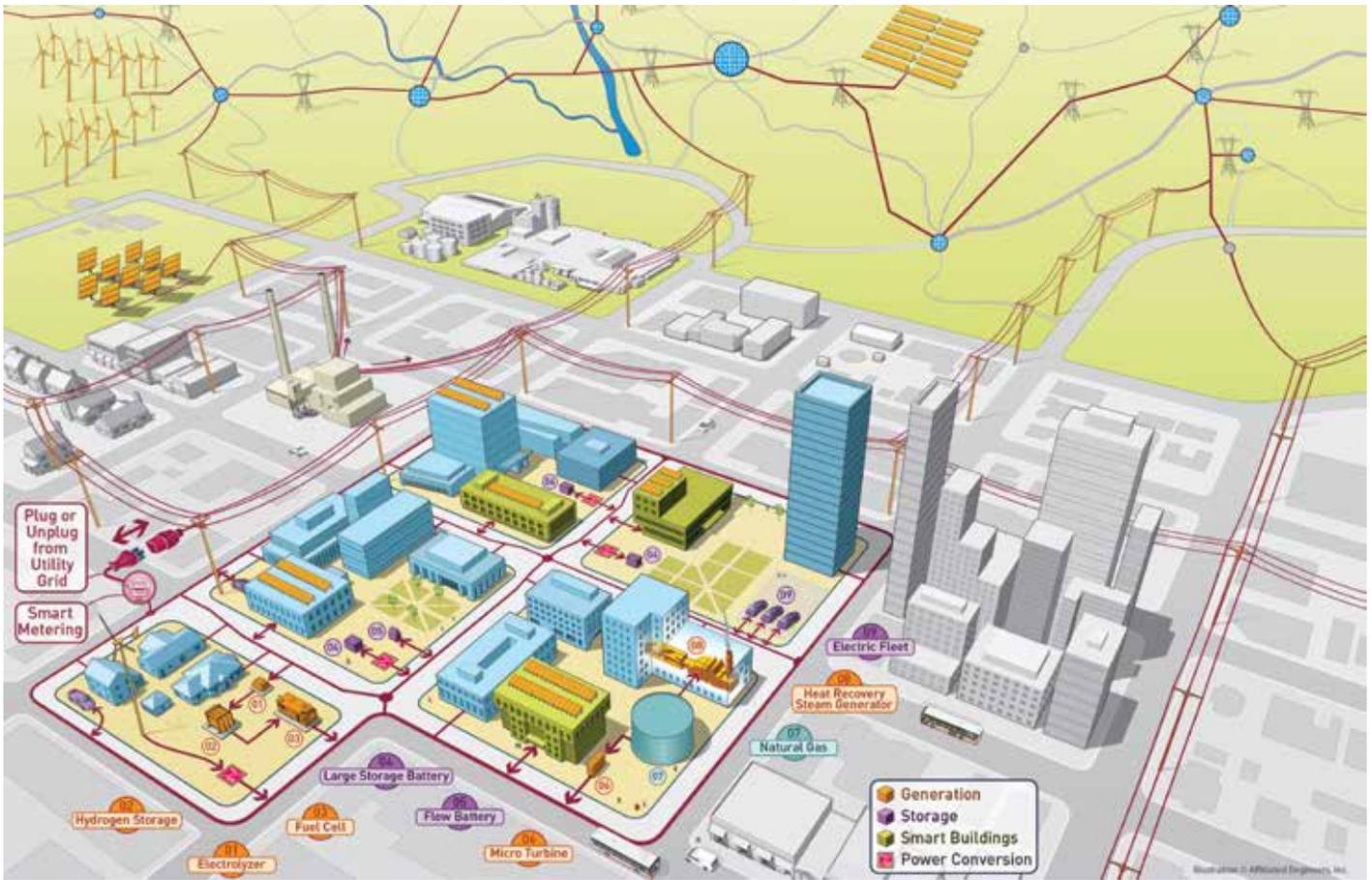
A MICROGRID IS CAPABLE OF “ISLANDING” ITSELF. . . FROM THE LARGER UTILITY GRID, FOR EXAMPLE DURING EXTREME WEATHER EVENTS OR AT TIMES WHEN SELF-GENERATION IS MORE COST-EFFECTIVE.

multiple forms of **storage** are a necessity to harness this power and ensure that loads can be served reliably at any time. Evolving storage options include flow batteries, which offer virtually unlimited longevity by pumping externally stored liquid (electrolytes) to create electrical current, and hydrogen electrolyzers, which convert electricity to hydrogen for storage. In turn, hydrogen can supply fuel cells and offers advantages over batteries that need to be electrically recharged. Smart vehicles and smart buildings that interconnect with the grid may also serve over time to store and supply power.

Advanced **power electronics** and communications technologies increas-

required for utility scale PV power stations installed in areas such as southern California. These inverters have been developed to maximize allowable DC string voltage and tested to meet the requirements of National Electrical Code (NEC) Articles 690.11 and 690.12 for DC arc fault protection and rapid shutdown, as well as IEEE 1547 standards for voltage and frequency response.

Smart buildings can improve the operation of a microgrid by which they are served. As load centers in a given locality, buildings that are technologically enabled to monitor their own energy consumption can be further enabled to reschedule certain power usage to



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An example of a microgrid.

off-peak hours, improving the overall efficiency of a microgrid. These “intelligent” buildings can also monitor and adjust building performance to reduce load and bolster cost savings.

Florida’s Santa Fe College (SFC) had an impressive history of year-to-year reductions in energy use intensity, but as the 24,000-student school reached the end of capital project improvement opportunities, they turned to smart building strategies—specifically, data analytics and visualization techniques—to further reduce consumption. First optimizing existing building automation systems, SFC added instrumentation and metering, established common data historian storage in an open database format, normalized at 15-minute intervals, and developed equipment-specific algorithms, rules, and queries to allow continuous analysis. Use of data visualiza-

tion tools to identify patterns and plot energy use intensity per day revealed imbalances and anomalies, providing a basis for utility optimization strategies. SFC credits data analytics and visualization with the 12 percent energy savings they have experienced over the two years since introducing smart building strategies.

At the forefront of research on microgrid and smart building integration is the U.S. Department of Energy’s Energy Systems Integration Facility (ESIF) at the National Renewable Energy Lab (NREL). The ESIF uses a megawatt scale research electrical distribution bus (REDB) as well as hardware-in-the-loop (HIL) prototyping to validate technologies and techniques advancing interconnection of distributed energy systems and the seamless integration of renewable energy technologies into the grid.

SFC’s consultants planned, designed, and engineered ESIF’s primary research areas and laboratory systems, focusing on the REDB interconnecting “plug and play” testing components, hydrogen research exploring simpler and more scalable energy storage, and fuel cell and cell component development. A safety- and data integrity-driven SCADA system (supervisory control and data acquisition) deploys hardware-independent software to govern the array of function-specific control systems and disseminate real-time data to principal investigators collaborating worldwide. ☞

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