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The Future of Microgrids
Their Promise and Challenges

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For some, microgrids hold the promise of becoming a basic “building block” in the implementation of the next generation smart grid infrastructure. However, as is the case with most new technology, there will be significant implementation challenges to overcome.

In many respects, microgrids are smaller versions of electrical grids. Like electrical grids, they consist of power generation, distribution, and controls such as voltage regulation and switch gears. However, they differ from electrical grids by providing a closer proximity between power generation and power use, resulting in efficiency increases and transmission reductions. Microgrids can also be integrated with renewable energy sources such as solar and wind power. The use of renewable energy introduces the need for energy storage and/or off-peak energy source integration, something modern microgrids are designed to manage. Security and independence from potential grid interruptions such as blackouts and brownouts are also considered microgrid benefits, especially for critical applications running at hospitals and military bases.

This benefit is illustrated by the performance of the Sendai microgrid at Tohoku Fukushi University. While the overall electrical grid was compromised during the devastating 2011 earthquake and tsunami, the microgrid, using distributed generators and batteries, continued to provide power to a variety of facilities.

Microgrids can meet the needs of a wide range of applications in commercial, industrial, and institutional settings. Larger microgrid applications include communities ranging from neighborhoods to small towns to military bases. Another largely untapped application is the “off-grid” area of the world where one billion-plus people live without regular access to electricity. These “off-grid” areas are currently served (if at all) by diesel generators or similar small scale electricity generating equipment.

Overall, the microgrid's structure makes it a viable platform for large entities to reduce energy costs and generate revenue through the sale of energy during periods of peak demand. Additionally, microgrids can efficiently and effectively provide "off-grid" areas with regular access to electricity as well as "keep the lights on" in times of crisis for critical applications like a hospital.

Challenges to Microgrid Adoption

Utilities have been reluctant to endorse microgrids. The valid historical argument has been the safety concern of unintentional “islanding”, that is, a part of the grid that has become separated from the grid but not shut down during a black out. The safety concern is that unintentional islanding can be dangerous to utility workers, who may not be aware that a circuit within the “island” still has power. Secondly, islanding may prevent automatic re-connection of devices into the grid. Existing grid protocols address this concern in that they dictate that all distributed power generation must shut down during power outages. To address these concerns, new inverter technologies are designed to integrate renewable energy sources such as solar and wind while allowing safe operation in island mode.

Another challenge has been the lack of established standards for microgrids. A positive step in addressing this was the 2011 adoption of the Institute of Electrical and Electronics Engineers (IEEE) standard P1547.4, "Guide for Design, Operation, and Integration of Distributed Resource Island Systems with Electric Power Systems". The standard provides best practice guidelines for implementing different ways a microgrid can island and re-connect, all while seamlessly providing power to users of the microgrid. Another step in creating standards is the establishment of the Consortium for Electric Reliability Technology Solutions (CERTS) in 1999. This group consists of national laboratories, industry, and universities that collaborate on research and develop technologies to protect and enhance the reliability of the U.S. electric power system, including furthering the development of microgrid designs.

CERTS is investigating optimal microgrid design and have field tests in operation. For example, CERTS established the Microgrid Test Bed Demonstration with American Electric Power to demonstrate the integration of small energy sources into a microgrid. The project included three advanced techniques, collectively referred to as the CERTS Microgrid concept, which has reduced the need for custom field engineering solutions needed to operate microgrids.

Perhaps the key 'tipping point" for the adoption of microgrids into the overall smart grid architecture is cost. As costs for key microgrid elements such as renewable energy sources (e.g., solar), energy storage (e.g., batteries, supercapacitors), advanced load generation controls, and smart switches continue to decline, the economics for microgrids for specific applications will become cost competitive compared to traditional power sources.

Microgrids – What's Next?

Although the technical immaturity, utility reluctance, and current cost structure of microgrids will limit their application to niche markets in the short term, the future for microgrids is promising. Power equipment companies now investing in pilot microgrid projects and currently available market opportunities will be well positioned for market leadership as the demand for microgrids increases over time. However, perhaps the largest benefactors of microgrids will be foresighted utilities, communities, industrial parks and the like, that will leverage microgrids to optimize their energy costs with the added bonus of generating revenue opportunities by selling energy back to the grid during periods of peak demand.

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