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Distributed Generation: Cleaner, Cheaper, Stronger

Microgrids in the Evolving Power System

Overview

Distributed energy resources allow electricity to be generated closer to where it is used, protecting businesses and institutions from unexpected outages caused by natural disasters and other disruptions. The U.S. national laboratories as well as public-private partnerships provide financial resources and access to research facilities to foster innovations to modernize the power sector from a 100-year-old centralized system to one that incorporates disparate clean technologies such as microgrids, batteries, and energy smart tools. These investments and the resulting new products and capabilities decrease costs, improve grid reliability, reduce emissions, and offer consumers more options.

Microgrids are small groupings of interconnected power generation and control technologies that can operate within or independent of a central grid, mitigating disturbances and increasing system reliability. By enabling the integration of distributed resources such as wind and solar, these systems can be more flexible than traditional grids. This market presents a new and important opportunity for end users, generators, and planners to provide increased efficiency and resiliency in the evolving grid.

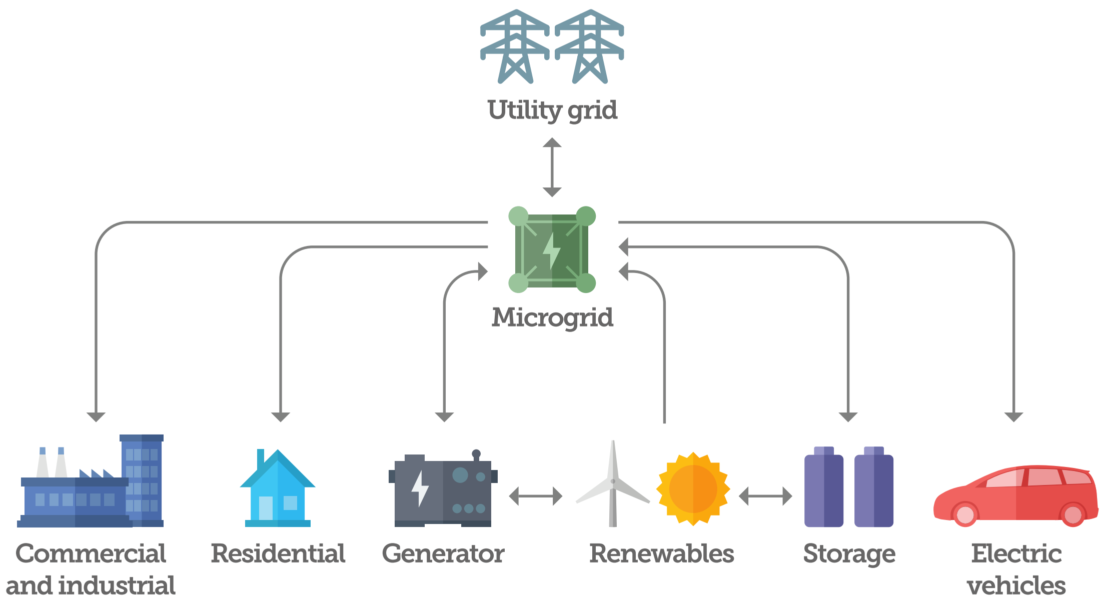
Localized power generation and management

Microgrids are at the forefront of the nation's evolving electric grid because they balance supply and demand to optimize energy distribution and production within a defined geographic area. Many are able to disconnect from the larger grid and operate autonomously, ensuring uninterrupted power. A microgrid can be as simple as a generator that provides power to a building during a blackout or as complex as generation, distribution, and management technologies that control production and consumption to meet the electricity, heating, and cooling needs of a whole neighborhood.[1]

> "What will make this work is understanding that it's a package deal. It's combined heat and power; it's storage; it's demand reduction."
>
> —Daniel C. Esty, *former commissioner, Connecticut Department of Energy and Environmental Protection*

Microgrids Can Incorporate a Range of Technologies to Ensure Power for Critical Facilities

Sample system design and interconnection



Source: LG CNS

Microgrids integrate distributed resources and strengthen the energy system

Microgrids make renewable, storage, and efficiency technologies more attractive by integrating them into a unified energy system. Connecting such a wide variety of resources improves flexibility and efficiency and reduces transmission and distribution losses. Further, increased deployment of clean and efficient power technologies cuts greenhouse gas and other emissions and boosts energy security by enabling the system to mitigate disturbances and, if necessary, operate in isolation from the grid.[2] Microgrids also benefit local utilities by providing on-demand generation and ancillary services (e.g., voltage, frequency, and wave form stability) and by helping to manage the grid load.[3] These attributes offer increased control over fluctuations in demand and can lower costs for all customers by offsetting expensive peak loads with local generation and reducing overall grid congestion by requiring centralized producers to deliver less power.[4]

As of July 2015, 124 microgrids were in operation across the country, with a total capacity of 1,169 megawatts.[5] Industry experts expect that by 2020, nationwide microgrid capacity will exceed 2,850 MW, an increase of almost 145 percent,[6] and estimate that total market value will surpass $3.5 billion, growing nearly 270 percent.[7]

Federal support promotes technology development

The U.S. Department of Energy leads federal research to advance development and deployment of microgrids through partnerships with organizations such as the national laboratories, academic institutions, and the private sector. The DOE's interest lies in using the technology to improve electricity reliability and resiliency, help communities prepare for future grid outages, and encourage growth of clean and efficient energy industries.[8]

The Energy Department's national labs host a variety of projects to advance microgrid capabilities. At the Lawrence Berkeley National Laboratory, the Microgrids Group studies customer adoption of the systems and researches storage and distribution, project design, and installation.[9] Since 2000, this program has been working on an economic and environmental model to broaden development of resilient microgrids.[10] The Sandia National Laboratories are exploring the role of microgrids in providing energy reliability through a computer-based risk assessment approach that identifies critical needs and enables smart grid functionality (i.e., demand response,[11] interconnection and integration of resources, and net metering).[12] In 2014, the DOE allocated more than $8 million through seven equal awards to support microgrid research, development, and design.[13] Recipients included the University of California, Irvine; the Electric Power Research Institute; Commonwealth Edison Co.; and private-sector businesses.[14]

The Advanced Research Projects Agency-Energy (ARPA-E), which helps commercialize cutting-edge energy technologies, has embraced the microgrid concept. As of December 2015, ARPA-E has invested $86.7 million in funding to 31 completed grid and distributed energy technology projects and is supporting 56 other initiatives with $154.4 million in grants. In early 2015, the agency announced that its Network Optimized Distributed Energy Systems program will invest $30 million in projects that use microgrids to integrate clean and efficient generation with the central grid. The program aims to improve overall power efficiency and reliability and increase the deployment of renewables by 50 percent or more.[15] In November 2015, ARPA-E announced that microgrid research led by the University of Tennessee, Knoxville was among 41 projects selected for a grant of $2.4 million to develop an operating system that responds to changes in power availability with a goal of decreasing the costs.[16]

The Department of Defense's adoption of microgrid technology is helping to spur industry growth and demonstrate feasibility for both military and civilian applications through on-base project deployment. The department is implementing advanced microgrids that incorporate sophisticated controls for managing demand, producing and distributing power, and allowing bases to operate independently of the commercial grid. The Installation Energy Test Bed program, established in 2009 to demonstrate new technologies in real-world situations, includes microgrid commercialization as one of its five focus areas.[17] As a result, bases across the country—including Fort Carson in Colorado and Joint Base Pearl Harbor-Hickam and Camp H.M. Smith in Hawaii—are incorporating renewable and storage technologies with advanced data analysis systems to create self-sufficient and resilient power resources that ensure operational readiness.[18]

Policies to advance microgrid technologies

For these benefits to be realized, however, improved federal policies that address the specific components of microgrids are needed. These systems tend to be underutilized and undercompensated for the services and social and economic benefits they provide. The traditional utility business model does not adequately incentivize either customer generation of power or efficiency. In addition, most regulatory policies are not designed for customers who are also generators, a factor that limits deployment.[19] An equitable regulatory environment for energy technologies would encourage greater adoption of microgrids and ensure that all economic, environmental, and security benefits and services of these products are recognized and captured.[20]

Lawmakers can create a supportive marketplace by providing regulatory guidance or best practices related to system development and interconnection. Policies that provide certainty about where and how projects can connect and interact with the commercial grid would increase the deployment of microgrids. Valuing economic, environmental, and security benefits and services would further clarify the role of these technologies and allow investors to monetize their attributes for a quicker return on investment, making the projects more attractive.[21]

Government grants and tax credits can also spur adoption by providing capital to prospective users.[22] Many state governments are exploring "green banks"—which provide low-interest, long-term financing for clean energy development—as well as revolving loans and other financial incentives to help communities pay for pre-development assessments.[23] States could also include microgrids as eligible technologies for clean and renewable incentives or alternative energy portfolios to help drive market growth.[24] Further, programs that require consideration of microgrids as part of planning for future capacity needs can ensure that deployment opportunities are not overlooked.[25]

Federal commitments to clean energy can encourage adoption as well. In part because of early funding and a focus on technology demonstration and commercialization efforts, the military is a leading adopter of these systems. According to a report released in April 2015, more than 40 bases have installed microgrids, have plans to develop them, or have conducted preliminary studies.[26] The DOD is expected to produce more than 54.8 MW of capacity by 2018.[27] The Army, Navy, and Air Force will each generate 1 gigawatt of renewable energy by 2025 as part of a larger goal to produce or procure at least 25 percent of total facility energy needs from renewable sources and incorporate microgrids and storage capabilities.[28] Microgrids are also identified for continued investment and research in the DOD Annual Energy Management Report as a means to help achieve these goals.[29]

In April 2015, the Department of Energy released the Quadrennial Energy Review (QER) examining modernization of the nation's energy infrastructure to promote economic competitiveness, energy security, and environmental responsibility, with a focus on energy transmission, storage, and distribution.[30] The report identifies microgrids as a key component of the evolving energy system, contributing to new approaches for flexible and cost-effective grid management.[31]

Among its recommendations, the QER discusses the importance of industry standards for connection of customer-owned generation to the local distributed system, not only for improving grid safety but also for overall system reliability and incorporation of distributed resources.[32] Most state public utility commissions use the Institute of Electrical and Electronics Engineers' 2003 voluntary standard for interconnection protocols and procedures.[33] This standard is under revision to support continued sector innovation, including development of microgrid technologies. Updated procedures that account for emerging technologies could reduce and streamline interconnection challenges, further promoting market growth and community adoption.

Conclusion

Analysts predict significant growth in the domestic microgrid market in coming years, but that will depend largely on whether federal and state policy values and promotes these technologies. To overcome technical and financial obstacles, federal regulations and guidance must clarify the rules for integrating microgrids. In addition, government support for research and development and public-private partnerships will lead to lower-cost technologies and increased market adoption, resulting in a cleaner, cheaper, and stronger grid. Congressional support and investment in programs that ensure that the technologies of the future are developed and produced domestically are vital to maintaining U.S. leadership in the clean energy arena.

Endnotes

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