White paper

Microgrids: a primer for policymakers

The status quo in the power industry is changing fast, and microgrids are on the cutting edge. Technologies (e.g., solar inverters, control systems, energy storage) are advancing and costs are coming down, strengthening the microgrid business case. Reliability is the main driver, but integration of renewables is becoming more important. Microgrids have a lot to offer for utilities as well as end customers, and could form the basis of the decentralized grid of the future.

However, despite substantial government funding of microgrid projects, the regulatory environment for microgrids remains less than welcoming. Policymakers can play a vital role in accelerating the development and deployment of microgrids by removing obstacles that are often the result of outdated regulatory models. At the federal level in particular, government can leverage its ability to convene the interested parties to craft new regulatory frameworks and model legislation that puts microgrids on an even footing.

Microgrid: an independently operable part of the distribution network, including distributed energy sources, loads and network assets that is controlled within clearly defined geographical boundaries and can operate in grid-connected or islanded mode. (Definition courtesy of GTM Research)

In the beginning there was remote power and cogeneration

For decades microgrids—small self-contained electrical networks—have come in two varieties. The first is perhaps the most recognizable: remote sites where grid service is not an option, such as mines or military outposts. The second type may be grid-connected but still relies primarily on local power generation, often combined heat and power (CHP) systems. These are industrial or institutional sites with an economic need for cogeneration, or a critical load center such as a hospital that cannot afford to rely solely on grid power.

Solar PV array at Fort Hunter Liggett, California. Military installations have made up a large portion of the microgrid market to date.

Most microgrids to date have used diesel or gas-fired generators (usually to provide heat as well as power), but that is changing. Increasingly, microgrids are being installed to enable the use of more renewable energy resources. A renewed focus on reliability in the wake of superstorm Sandy is also driving interest, notably in grid-connected systems.

The outlook for growth in the sector over the near term is dramatic. GTM Research estimates that roughly half of all microgrids operating in the United States today were commissioned within the last three years. By 2020, installed microgrid capacity will more than double from 1.2 GW today to 2.8 GW. The annual market for microgrid systems, equipment and services is similarly projected to grow substantially. GTM Research sees a six-fold rise in the market in just the period from 2014 to 2017.

So, what is driving this rapid pace of development?

Historically, and even today, most microgrids have been built under some form of government sponsorship. Military sites and public institutions account for the majority in capacity terms. On a project count basis, there are many more—smaller—examples of microgrids, but often these are research projects or utility pilot programs. As yet there are only a handful of commercial microgrids in operation in the US.

Business case: reliability is still king

In terms of grid-connected microgrids, the rationale has always been energy surety. If the grid goes down, the microgrid islands itself from the surrounding network and continues serving local loads with local generation. This made sense for essential facilities like hospitals or defense installations, but not much else, at least until recently.

Reliability is now on everyone's mind, particularly in the wake of major storms and the prolonged outages that come with them. Following Sandy, many New Jersey residents were left without power despite having functional solar systems on their roofs. The reason: the systems could not be isolated from the grid, thus creating an unsafe condition if they were energized. At the same time, facilities that had backup generators learned a hard lesson after several days with regard to fuel dependence: no fuel means no power.

Sandy also made clear that the definition of "critical infrastructure" must extend to facilities like grocery stores and gas stations if people are to go five, seven or ten days without electricity.

For utilities, there are other benefits associated with microgrids. They can defer the need for new generation or transmission upgrades, facilitate the integration of renewable energy sources, and even create a new source of revenue. But the most compelling element of the microgrid business case remains reliability.

The role of energy storage

At the same time that microgrids have attracted new attention, energy storage has undertaken major advances. The two trends are inter-related. One third of operational microgrids in the US include some form of battery storage, and nearly all of them were commissioned in just the last four years. Given the falling cost of lithium-ion batteries in particular, it seems likely that most future microgrids will have a storage component.

While even diesel fuel can be considered a form of energy storage, there are other storage technologies that offer particular operational advantages (e.g., replenishment via a grid connection vs. a fuel delivery system). For example, while batteries are good for storing large amounts of energy to be discharged at a later time (e.g., extending the hours a solar array can deliver power), flywheels are uniquely suited to balancing power systems moment to moment. Unlike batteries, flywheels do not degrade with each cycle and can therefore perform their vital storage function while extending the life of batteries within the microgrid.

We can expect to see further refinement of storage in microgrid applications. Storage has a business case of its own that includes a range of applications, some of which potentially create a revenue stream for the system owner:

- Smoothing output from intermittent resources like wind and solar
- Balancing supply and demand minute to minute
- Load shifting / price arbitrage
- Backup power
- Providing frequency regulation or voltage support services back to the grid

Most of these advantages would be as applicable in a microgrid context as they are in the case of a freestanding grid storage device.

Microgrids have a lot to offer for utilities as well as end customers, and could form the basis of the decentralized grid of the future.

Industry trends

The falling cost of energy storage, not to mention solar PV systems, is making microgrids more economically viable every day. In addition, the more inclusive concept of reliability post-Sandy has expanded the microgrid's traditional user. This is of particular relevance in the United States where, as Navigant's Peter Asmus notes, the average outage time per year hovers at around 120 minutes compared to just 10 minutes in other industrialized countries. Further, while our peer nations are reducing their numbers, the US figure is increasing.

On the technology side, several trends are evident. PV systems are getting cheaper and now feature integrated smart inverters that simplify the challenge of grid connection. Microgrid control systems are becoming more robust. There is also an increasing awareness of the value of system optimization, engineering the microgrid in a holistic way at the outset versus simply procuring the cheapest components and integrating them after the fact.

9AAK10103A5253

In terms of the market, utilities are beginning to get into the game. Central Hudson Gas & Electric recently filed a rate case for microgrids citing two primary goals: avoiding the cost of grid upgrades and offering an opt-in premium service that provides customers enhanced reliability.

But, the microgrid market is still in its infancy. Indeed, a substantial portion of the projects in the pipeline today are intended for research purposes. Microgrids represent a significant disruption both to traditional utility business models and the regulatory environment in which they operate. With no standards for project financing and a lack of commonly used performance metrics, utilities are developing their cases and frameworks for rate reimbursement on an ad hoc basis.

Barriers to growth: it's all about regulation

As in many other industries, the technology supporting microgrids has advanced much faster than the regulatory framework that governs them. In fact, some of the rules that impede growth in the sector date back to the earliest days of the power industry.

For example, third-party sales of power are prohibited in many markets while in others (e.g., California) utilities are prohibited from owning generation assets without some kind of special dispensation. At the federal level, utility regulation stipulates that any power supplier whose network crosses a public street is by definition an "electric corporation," subject to all of the same regulations that traditional utilities operate under. Utility interconnection rules also present a hurdle for microgrids as they vary from one location to another.

Addressing these barriers will support the expanded use of this valuable technology.

Where we're headed

In terms of the development of microgrid markets, GTM Research sees two parallel paths, to which we've added further definition:

1. The retrofit or expansion of "traditional" microgrids (typically industrial co-generation and campus/institutional systems) to become islandable systems with more flexibility and perhaps more functionality (e.g., selling ancillary services back to the grid); and
2. New microgrids, built using a combination of renewable generation and storage, taking advantage of advances in control technology and system-wide optimization.

Reliability, in the broadest sense, will remain the main driver for microgrid development, but the integration of renewable energy sources will play an increasingly important role. A robust business case is vital to utilities seeking to include microgrid development in their rate base, and that will include deferred investments in generation or distribution assets as well as meeting legislated targets for renewable energy.

Ultimately, the market needs clarification. Regulations must be rationalized to allow microgrids, whether utility-owned or otherwise, to realize their full potential. This will create a more stable climate for investment in the sector, which will in turn spur further advances in component systems based on particular application requirements.

With these policy adjustments, microgrids could form the building blocks of a decentralized future grid that is both cleaner and more reliable than the one we know today.

9AAK10103A5253

For more information please contact:

Jim Creevy
Sr. Director of Government Affairs
ABB Inc.
1455 Pennsylvania Avenue NW
Washington, DC 20004
jim.creevy@us.abb.com
Office: 202-639-4063
Mobile: 703-282-4910

www.abb.com