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Powering up the neighborhood grid

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A strategic entry plan for the microgrid business

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Executive summary

Microgrids, the small technological complexes that can supplement or replace a central power grid, have been very much on the radar of many industrial suppliers and manufacturers for the past few years. After hearing that these neighborhood-sized grids might become the next big thing to serve concentrated geographic areas such as industrial parks, hospitals, military bases, university campuses, or retail malls, many utility and supplier companies have had microgrids on their strategic agenda. However, industry players have found that eager customers aren't materializing as quickly as some recent studies have suggested they would. For the supplier companies getting into this space, it has been a major challenge to break past the early demo or proof-of-concept projects.

Yet many executives in the industrial manufacturing sector, as well as those who head utility companies that seek to benefit from selling and servicing microgrids, recognize that this segment of the power industry has strong growth potential. Competitors are testing the markets for this early-stage technology but no clear leaders have emerged, so there is still an opportunity to build early market share. It is also a business fraught with uncertainties. There are risks involved in developing and managing costly and highly technical microgrids that third-party industrial suppliers need to assess. As with most early-stage technologies, it is difficult to separate hype from material (and near-term) prospects.

Even without certainty on the market prospects, however, a well-crafted scenario-based strategy will increase the likelihood of making prudent investments in this line of business. In this report, based on our work with many industrial supply companies as well as their utility customers, we examine some of the underlying drivers affecting adoption and share our perspectives on what strategic choices suppliers should consider to increase their chances of greater market adoption and, thereby, profitability.

There are three key strategic factors that should be in place: standardization, the ability to offer a microgrid as a total solution, and alignment among the manufacturer, the customer, the utility company, and the regulators and other authorities. When these three strategic elements are combined with an effective design in sync with the needs of the market, companies can reduce high entry costs and uncertainties and reap the benefits of their flexibility.

Ready for growth

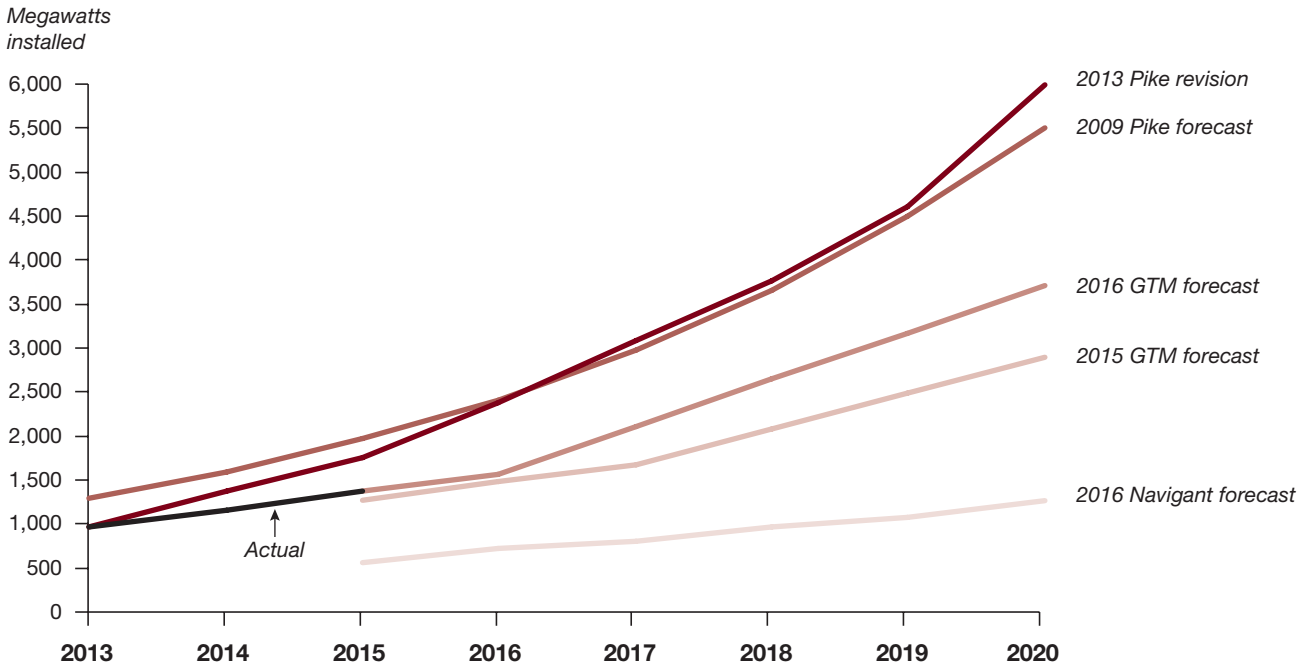
Leading industrial manufacturers including ABB, General Electric, Hitachi, Lockheed Martin, Schneider Electric, and Siemens have all established microgrid businesses in the last few years, developing the capabilities and technologies that utilities or others will need to install microgrid systems. A significant draw for manufacturers has been a series of forecasts indicating that microgrids can be an important growth market. According to a 2016 report from the electricity research firm GTM Research, microgrid spending has the potential to deliver a compound annual growth rate of more than 20 percent. And recently, the idea of setting up more microgrid systems has acquired government support. In April 2016, the U.S. Senate passed a broad energy bill that included a requirement for the Department of Energy to establish a program to promote microgrid systems. In 2015, New York State, which has been one of the leaders on microgrid mandates at the state level, established a program called Reforming the Energy Vision. This year the New York State Energy Research and Development Authority released a request for proposals for community microgrid development that included incentives and regulatory changes to promote cleaner, more affordable, and more efficient energy systems.

The U.S., which has been the global leader among microgrid users, has just over 1,000 megawatts of microgrid power in deployment — an estimate based on studies from GTM Research that project a steady increase between 2015 and 2020, with operational capacity of 2,855 megawatts and a market value of more than US$3.5 billion by the beginning of the next decade (*see Exhibit 1, next page*). Microgrids serve confined geographic clusters such as military bases and university campuses, with high concentration in areas of the Northeast, California, Nevada, Colorado, New Mexico, and Texas. (See “Where the microgrids are,” page 14.)

Their purpose is to enhance the larger power grid’s reliability by serving peak loads on demand for relatively self-contained customer groups. For these customers, microgrids need to have the ability to isolate themselves, and then reengage with the larger grid when the situation has changed. Military bases, for example, need to be able to

Exhibit 1

Cumulative microgrid installations (actual and forecast, U.S.)



Source: GTM Research; Pike Research; Navigant Research; Strategy& analysis

separate themselves from the macrogrid under certain defined conditions, such as power outage, demand response curtailment (an agreement with a utility to reduce load on the macrogrid at peak power times in exchange for a payment), or expectations of sustained high power price.

Microgrids as we know them today emerged in the mid-2000s as an extension of local generating sources. From that beginning, the lack of turnkey, off-the-shelf systems made the costs prohibitive for many organizations, and that continues to be the case. Although the damage from Hurricane Sandy in 2012 led to a surge of interest in microgrids in the Northeastern U.S. that has continued, in many other parts of the world, weather-related disasters are not perceived as costly enough to justify "gold plating" the grid, and customers are not uniformly pushing for microgrid technology. In many cases, customers see it as one more bill to pay.

Companies that manufacture microgrid components or provide enabling services are banking on a growing number of niche markets around the world, along with better economies of scale as interest grows. Because microgrids can easily harness renewable energy as their source of generation, increased concerns about climate change and large-scale natural disasters have contributed to the perception that the demand is likely to grow. Compared with central station generation, this "neighborhood grid" offers greater reliability, the potential for lower emissions, and adaptability to local needs. The idea is that with these advantages, microgrids could become a basic business model for power and utility companies for both commercial and community/residential areas. At the same time, there might be a need for a certain amount of consumer education to prove that well-designed microgrids can lead to better energy management and shared costs, along with greater reliability. If suppliers can coordinate effectively and bring down system costs, then microgrids can compete with traditional backup power. If not, customers (reasonably) will opt for stand-alone backup generators.

Most customers employ microgrids mainly for reliability and secondarily for sustainability.

Most customers employ microgrids mainly for reliability and secondarily for sustainability. The ability to mix in renewable resources is valuable, but technically it can be accomplished without a microgrid — for example, through rooftop solar panels. But the ability of microgrids to integrate, store, and distribute energy to and from multiple sources enables them to fulfill energy requests when the centralized grid suffers from heavy demand, such as during peak usage hours or extreme temperatures, and to select the optimal source of power (e.g., solar, natural gas, or wind) when times are tough, when options are limited, and even when there is a surfeit of energy available. They can lower costs by kicking in during a heat wave, when the peak

pricing is high, for example — a feat that even residential solar panels have not always been able to perform. Unlike pure backup systems, microgrids can coordinate control with the central grid to anticipate such events, and act instantaneously without significant interruption of service. Such a system allows a quality-of-service premium offering to customers that require such services. Microgrids' modular and flexible architecture, together with smart technology, makes it possible for them to optimize energy collection, storage, and delivery — thus opening up new revenue streams for microgrid providers.

As opportunities increase for investment in these smaller grids, however, so do the challenges inherent in them — especially in effectively integrating these local systems with one another and with the traditional centralized grid.

How to win with microgrids

Broadly speaking, three kinds of companies are involved with microgrids. Large incumbents such as Siemens, ABB, and Schneider are developing technology for them, and smaller upstarts are building business models around new software-based offerings in grid management, renewables, and related infrastructure. In addition, system integrators package the discrete components into a specific customer product. And there are, just as broadly, six ways to participate in the value chain when it comes to being part of the microgrid business: component manufacturing, systems engineering, system integration, installation and configuration, testing and certification, and operations and maintenance (*see Exhibit 2, next page*).

The large and small suppliers are critical catalysts for making microgrids work. Like many industrial suppliers, these groups can profit by amortizing the costs of their research and development across a broad group of customers. The best customers are those with self-contained institutions that need reliable power, such as hospitals, schools, or small manufacturers. For those customers, microgrids can be a highly effective solution. Another participant is sorely needed, however: the utility companies. Traditional utilities can play a crucial role in expediting market adoption. They can diversify their traditional centralized grid operations with microgrid participation as an alternative service offering and revenue stream. If suppliers are able to partner with power utilities, there is a greater possibility of unlocking the customer base to decentralized generation without the risk of losing the customer accounts.

Electric utility companies have responded with a mix of caution and opportunistic activity. Some utility companies may consider microgrids a threat to their traditional business model. Within utility territories, about 70 percent of microgrid deployments are developed and owned by independent third parties that use mandates established by local laws, which generally require power utilities to allow third parties to connect and feed electrical power back into the overall grid. But microgrids don't necessarily pose a threat to large utility companies;

Exhibit 2

The microgrid value chain

Component manufacturing	Systems engineering	System integration	Installation and configuration	Testing and certification	Operations and maintenance
– Design, manufacture, and assemble generators and panels (combined heat and power, solar); design and manufacture storage, electric vehicle chargers, load controllers, inverted relays, controller platforms, etc.	– Design overall microgrid system – Develop microgrid control and operating philosophy	– Assemble, engineer, integrate, and deliver component subsystems into a customized working system	– Install components and/or system – Develop configuration settings and populate database	– Develop test plans and procedures – Facilitate and review factory and site acceptance testing	– Provide ongoing operations and maintenance of microgrid system, power equipment, and support systems

Note: Descriptions represent a typical player; exceptions may exist. Value chain may also vary by market segment.

Source: Strategy& analysis

indeed, they can become a new source of rate base or even, over time, a valuable non–rate base revenue source while building customer loyalty.

Investors realize that when manufacturers of microgrid systems and utility companies adopt a common strategy and set up ongoing partnerships, they can profit and win. Standardization around a single interoperable platform is key, as is offering a full package of services. Services might include energy arbitrage, backup power generation congestion relief, spinning reserve, and frequency regulation, all of which can be managed by a standard platform that could be easily monitored, repaired, and updated. On the other hand, taking a highly individualized, idiosyncratic approach to integration does indeed make a microgrid platform difficult and costly to maintain and upgrade.

Some manufacturers may decide to shape the market as early movers by designing platforms, technical standards, and ecosystems. Other manufacturers may choose to follow the market after uncertainties have been reduced. It is easier for the leaders of a company to decide which role to play, however, once they've examined the three main components that need to be in place: standardization of technology, a "total solutions" approach that will foster future growth, and the right kind of alignment with the utilities.

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Standardization and interoperability. The companies that become early movers in the microgrid market will need to develop the systems and standards that make a plethora of diverse products compatible. Microgrids require the interworking of multiple hardware and software components across different generation sources, storage, controllers, and user application technologies. Making them work together in an integrated manner is a significant challenge. The industry currently lacks mature technical standards and interworking protocols that allow for a common "plug and play" platform. Consequently, customized systems engineering and integration efforts consume 40 to 60 percent of total project costs.

Manufacturers need to find solutions that minimize site and customer requests for specific customizations. A focus on efficiency, reusability, agile product development, and modular products helps drive seamless interoperability. Electric power utilities may end up leading the way simply because they will need interoperable solutions if they want to move forward.

Offering a total solution. The current microgrid value chain is served by a fragmented set of manufacturers and service providers. Those who get into the business now have an opportunity to become one-stop providers, pulling the fragments together for their customers so that they can order the microgrid that has been manufactured from one

source — in many cases, the customers' local utility company — and rely on that same source for all questions, servicing, and upgrades. Those who find it's more viable to be a supplier to a solutions provider will need to wait a few years for the solutions providers to set up shop.

Despite a reduction in equipment and fuel costs for generation and storage, overall system costs remain high. Many of the microgrid components are still not produced, operated, or maintained at a scale favorable for manufacturing economics. Addressing site-specific conditions and customizing and integrating best-of-breed technologies for each deployment significantly adds to overall system deployment costs. Integration of diverse components and systems adds legal complexities in the form of liabilities and performance warranties. Additionally, multiparty legal agreements, high transaction costs, and overall contract complexity decrease commercial efficiency.

The answer is a total solutions approach from a primary supplier paired with a reputable and well-coordinated partner network to ensure a cost-effective and technology-leading offering — akin to an engineering, procurement, and construction contract used commonly in turnkey power plant construction. With the right modular design and turnkey technologies, embedded with software and "Internet of Things"–style sensors, this approach can overcome many of the barriers for the end market. Such an approach also provides possible value chain extensions and offers alternative business models such as "microgrids as a service" and bundled operation and maintenance services to drive market efficiency. With this approach, manufacturers can reduce costs and increase gains by clearly identifying their strategic positioning and determining the specific business model to employ with channel partners, original equipment manufacturers, and stakeholders.

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Aligning with utilities. Today, electric power companies are assessing their potential roles with microgrids: First, whether to help enable microgrid growth in their territories or to resist it, but also, if they do choose the enabling route, whether to build, own, and operate the system or become partners in third-party deployments. Given that utilities have distinct advantages in areas such as field operations, asset management, regulatory relations, grid control, and customer billing, the nature of utility participation will have a significant bearing on microgrid adoption and growth.

In the United States and Canada, local and state or provincial regulatory jurisdictions will govern utilities' positions to a great extent. Regulated utilities historically have been granted rights and privileges that are not available to private parties: For example, franchise rights allow utilities, but not private parties, to manage exclusive networks in the territories they serve (at least for non–Department of Defense applications). Since

non-utility companies face such barriers in entering into community microgrids, utilities are the natural candidates to exploit these opportunities. Utilities also benefit from their unique role in being able to facilitate integration with the grid, as well as from their familiarity with local jurisdictions' regulations and laws. Manufacturers, unfamiliar with local regulations and laws, would require extensive groundwork prior to establishing a footprint.

Utilities have a different set of challenges. Building and owning microgrids may involve cost recovery through the regulatory rate base. Making the case that a microgrid yields benefits to the entire system will require a significant amount of detail. Otherwise, it will be hard to claim that benefits to the community justify the costs. One utility trying to build such a case is Central Hudson Gas & Electric, a local utility headquartered about 60 miles north of New York City. With the supplier NRG Energy, it has built a microgrid in Frost Valley, a resort area where the YMCA maintains a large summer camp. As they seek support from local regulators, the companies claim that these investments will offset spending on line upgrades and help strengthen the overall grid for future hurricanes like Sandy. In such cases, there might be a rationale for including the costs in the rate bases.

But this rationale will not apply to other deployments, and each region will have its own case to make, depending on specifics. Manufacturing companies can target utilities as potential strategic partners by understanding, anticipating, and appreciating the utilities' position related to participation, products, and services.

Where the microgrids are

At Fort Carson in Colorado Springs, Colo., photovoltaic panels and diesel generators are linked together to provide power to a U.S. Army base with 14,000 people. A similar system is in place at Joint Base Pearl Harbor–Hickam in Hawaii, with a stated goal of operating with 100 percent renewable energy by 2046. On the isle of Eigg, off the coast of Scotland, hydropower and wind turbines provide full-time electricity to the 95 residents. New York University has natural gas turbines and heat recovery steam generators that supply electricity and heat to 22 buildings on its downtown campus. The University of Chile has supplemented the diesel generator in a remote Andes village called Huatacondo with photovoltaics, wind turbines, and batteries. You can find similar systems attached to the Santa Rita Jail outside San Francisco, and Hangzhou Dianzi University in the Chinese coastal city of Hangzhou. Grids are also providing power at the headquarters for Tecnalia, an R&D consultancy based in Spain.

All of these systems are microgrids, serving a precise geographic area as a "neighborhood" power grid — in some cases as the main grid, in others as a backup source. Also known as "distributed energy platforms," microgrids are stations that integrate different power sources, with the advantage that they can be connected to, or disconnected from, traditional centralized grids on demand. Natural gas generators, fuel cells, solar cells, and wind farms may be distributed nearby in a local area and integrated with storage assets. Princeton University's system, for example, includes district heating and cooling, chilled water, thermal storage, a 5.4-megawatt solar photovoltaic farm, and an advanced control system. The facility serves a campus community of 12,000 people with heating, cooling, and electricity across about 150 buildings and about 9.5 million square feet. Its capacity falls within the range of the most effective microgrids, which is from about 2 to 40 megawatts.

The Northeastern U.S. is fertile ground for microgrid growth for many reasons. A large portion of U.S. GDP is generated in the region and a large percentage of the nation's population lives there. The region has concentrated load pockets, expensive electricity, transmission constraints, and high barriers to siting large-scale generation and gas transmission lines. However, more than anything else, it is the management of extreme weather that has brought attention to the need for more stable energy solutions. Hurricane Sandy, for example, caused about $65 billion in total damages, including outage-related losses. Subsequently, political support grew for electric grid resiliency in New York and New Jersey. High-priced initiatives, such as the $1.2 billion energy program operated by the Public Service Enterprise Group in New Jersey, include microgrids as a resiliency solution in targeted areas with critical loads or with favorable economics — hospitals, public safety facilities, and high-value commercial areas.

Conclusion

When it comes to microgrid market participation, it is necessary to have a clear path to profitability. Though the emerging technologies of the alternative energy field are promising, investors have been overly optimistic about them in the past, and have lost some gambles. Rooftop solar, fuel cells, energy storage, electric vehicles, and customer data analytics all have generated attention and excitement, but the companies offering them haven't always had (or built) the capabilities needed to ensure mainstream adoption and a sustainable business model. This has created healthy skepticism as to whether the technology is grounded in technical and business realities. The skepticism reflects the importance of the strategies we recommend.

Some companies, when they take a sober look at the investment involved, will be hard-pressed to make a case for microgrids right now. They will be persuaded to try them only if the economics become more solidly beneficial. However, many others see that the negative perceptions are likely to change. Over time, it will become clearer which locales or segments are good potential sites and which are not, and utility and regulator confidence will rise. The pace of adoption will vary as a result, across regions and utility jurisdictions. Suppliers can work through the high levels of geographic variability and place bets strategically to balance investments, risks, and overexposure. Their broad experience will help hone their judgment.

Utilities, suppliers, and customers alike have to filter their incoming information. Hype has a high signal-to-noise ratio. Companies will need to guide their strategic focus, particularly when their industries are inundated with new technologies and applications. If you are a supplier or a utility, you should be able to find the most appropriate approach, with the right resources, timing, and targeted outcomes. These are still the early days of microgrids. There is tremendous opportunity, indeed, for companies to make their mark and win. So, too, is there risk. The ability of a company to engage its capabilities strategically will determine the likelihood that it will successfully navigate that risk.

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