White Paper

How Utilities Can Be Microgrid Leaders

Why Microgrids Open Doors to Future DER Opportunities

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Introduction

Microgrids are not new. What is new is the sophistication of controls and digital communications that allow for integration of more diverse distributed energy resource (DER) options. Armed with these novel advanced digital controls, microgrids help utilities organize DER assets systematically, unlocking new value such as increasing renewables' hosting capacity, providing resilience to critical facilities and communities, and providing grid network benefits. In short, microgrids are a building block for utilities to reimagine their place in the electricity supply value chain by leveraging DER resources to serve their customers in new and exciting ways.

New sophisticated digital control platforms allow microgrids to address the need for utilities to manage increased generation and load complexity on distribution and transmission systems. This white paper elucidates that value proposition, using a case study with Portland General Electric (PGE) and a use case from San Diego Gas & Electric (SDG&E) to illustrate the synergy possible with this opportunity. In the process, new business models for utilities are highlighted, positioning them to play a leadership role in building microgrid market momentum. As PGE is discovering, microgrids offer benefits for the utility itself as well as its customers.

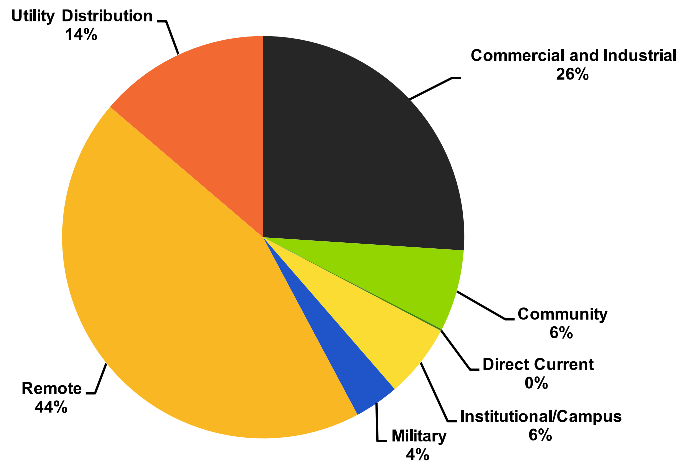
In the microgrid space, the role of utilities has long been unrecognized. Many early microgrids were deployed by utilities. The entire electric utility industry traces back to microgrids developed by Thomas Edison in the 19th century, when the electric utility industry was competitive and focused on customized and localized energy systems. Though the industry switched to a "bigger is better" mentality aligned with tightly regulated monopolies, we are now heading back to the future. In 2021, the amount of DER capacity coming online globally will exceed the amount of capacity coming online from large centralized power plants. Over time, the gap between these two sources of energy services grows, and in favor of DER assets spanning generation, load, energy storage, and EVs.

Microgrids today are more flexible and scalable than ever before. As utilities chart a new course to address the transformation of the energy systems globally, microgrids provide a tool to achieve multiple and fundamental goals, raising the possibility of emerging as a new customer service to help them meet four fundamental pillars guiding the utility of the future:

- Public Safety
- Reliability
- Cost-Efficiency
- Renewable Energy Integration

Chart 1 shows historical market shares for different microgrid market segments. As of 2020, utility distribution microgrids (which Guidehouse Insights defines as microgrids sponsored by utilities and are designed to support the distribution network) rank third in total capacity. The role of utilities is underrepresented by this data since many early remote microgrids were also deployed by utilities in regions such as Australia, a unique microgrid market that will be addressed in a subsequent white paper.

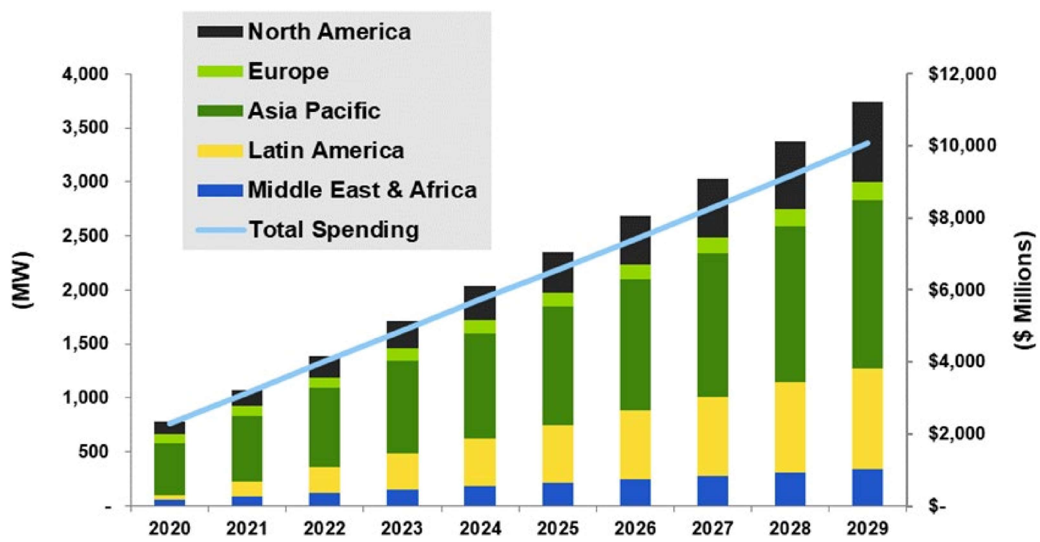
Chart 1 Major Microgrid Market Segments, World Markets: 3Q 2020



(Source: Guidehouse Insights)

Investments in utility microgrids are expected to exceed $10 billion annually by 2029 (see Chart 2).

Chart 2 Utility Microgrid Capacity and Implementation Spending by Region, World Markets: 2020-2029



(Source: Guidehouse Insights)

However, to realize this growth, utilities need to reinvent themselves with microgrids serving as the foundation for the future grid. They will need resilient and sustainable energy systems designed to accommodate the rapid growth in DER while creating new revenue streams under new business models that allow utilities to remain integral to the energy market transformations underway. When a utility deploys a microgrid, it is moving toward a future of networkwide DER integration by resolving reliability issues on the larger distribution grid while targeting resilience to critical facilities or communities.

Behind-the-Meter or Front-of-the-Meter Microgrids?

The increasing frequency of power outages and the challenges inherent in successfully integrating larger amounts of DER into utility distribution networks around the world force utilities to confront the limits of traditional grid infrastructure. Utilities can no longer delay developing new platforms to deliver reliable energy to their customers. These consumers are increasingly becoming prosumers by installing or participating in programs that harvest value from DER assets they own or from assets installed under an energy as a service (EaaS) contract.

More utilities are shifting strategies to include microgrids, whether deployed with DER assets behind the meter (BTM) or in front of the meter (FTM). To date, the focus of the industry has been on BTM deployments, primarily driven by third-party developers. These BTM systems are well-established, and often serve college campuses, commercial and industrial enterprises, or military bases. The utility does not directly control the resources, in most cases, and the primary value proposition for the host site generally is resiliency, lower costs, and potential grid service revenues.

If a utility deploys a BTM microgrid, it can participate in the precise location of the microgrid to maximize its value and help shape decisions on the microgrid DER resource mix.

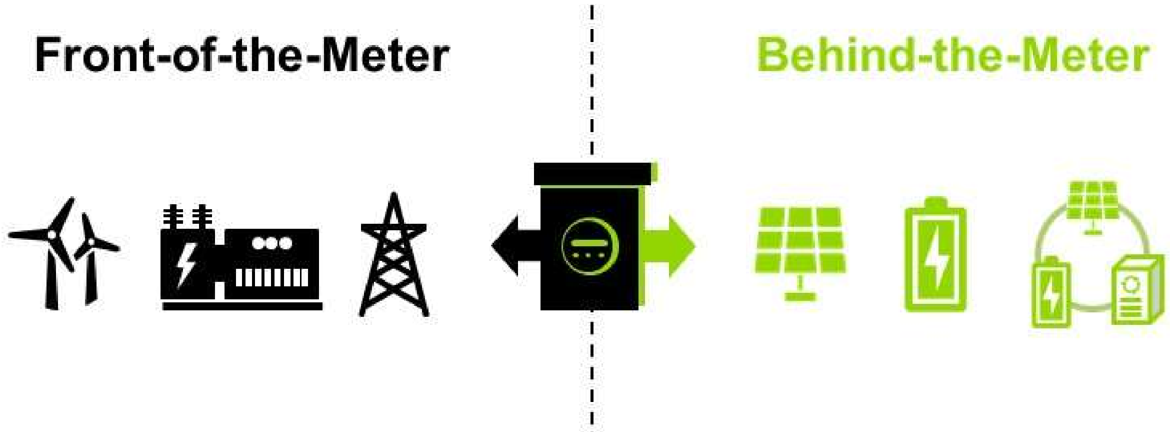
Utilities can also deploy a BTM microgrid. Unlike many systems, the goals of such utility projects would not be limited to optimizing the economics of DER assets for a single site. Instead, they would provide value to a community or its critical facilities. Like all microgrids deployed by utilities, these projects help support the larger utility grid. Third-party BTM microgrids often do the same, but that outcome is often an afterthought and dependent upon a regulatory framework that provides a path to additional value creation. If a utility deploys a BTM microgrid, it can participate in the precise location of the microgrid to improve its value and help shape decisions on the microgrid DER resource mix. Microgrids can become a tool in an updated utility toolkit offering new and innovative products to its customer base. More specifically, microgrids represent a way for utilities to offer resilience, enhanced customer services, and improve operational effectiveness. These services will only become more essential as extreme weather and natural disasters increase in frequency and duration.

An FTM microgrid is a more novel design and is a configuration that only a utility can deploy. This can be viewed as a classic architecture standing up a utility distribution microgrid, a microgrid whose primary function is orchestrating DER assets to increase reliability by optimizing distribution networks. Though rare, FTM microgrids represent an opportunity for utilities to foster innovation and render value on both sides of the meter, but with a primary focus on its core business. This new concept goes beyond the traditional BTM microgrid model. FTM microgrids are a building block for the modern grid because they deliver benefits above and beyond resiliency.

Utility performance often hinges on System Average Interruption Frequency Index and System Average Interruption Duration Index scores. Thanks to extreme weather events and wildfires, customers are aware that the reliability of their electricity service has been decreasing in many jurisdictions. Advanced metering infrastructure and other smart meter-based approaches aim to elevate service to the entire grid. BTM microgrids take a more targeted approach, relying upon islanding a subset of customers from the larger grid to offer different levels of service. However, if a utility deploys an FTM microgrid, the fundamental value proposition shifts. Rather than focus on the needs of a single customer or a select group of customers, the microgrid can reinforce reliability in problematic areas while bolstering reliability for the overall grid. Similarly, it can also use a broader pool of assets to resolve renewables integration challenges while reducing overhead costs attached to the management of the distribution network.

The increased deployment of both BTM and FTM DER assets requires new utility strategies and business models. Microgrids are a great first or second step on the journey toward grid modernization, setting the stage for even wider scale DER management system (DERMS) projects designed to provide active power management across isolated feeders or an entire utility's service territory.

Figure 1 Front-of-the-Meter and Behind-the-Meter Microgrids



(Source: Guidehouse Insights)

Consider the following benefits of this modular approach to grid modernization:

- **Resiliency:** Power outage rates in the US are increasing, a microgrid allows key customers like critical facilities to have power during emergencies.
- **Reliability:** With targeted resiliency, microgrids help increase overall reliability of the system by limiting customers without power and providing support where it is most needed on the grid.
- **Regulatory Compliance:** Microgrids can help utilities meet a variety of policy mandates, including reliability metrics, carbon reductions, energy storage target mandates, and customer-facing programs and distributed renewable energy portfolio standards.
- **Near-Term Financial Benefits:** A microgrid can deliver immediate financial benefits via services such as demand charge abatement for BTM customers, including local government or other critical facility customers.
- **Long-Term Financial Benefits:** Microgrids can reduce overall ratepayer costs by displacing the need for traditional system upgrades as a non-wires alternative. The microgrid can also shift and modulate demands on the grid, improving overall operational efficiency. Over the longer term, these microgrids can also generate new revenues by providing grid services to wholesale markets. These opportunities vary widely around the world. Even within the US, opportunities depend on market structures, state regulation, and the status of regional wholesale markets. Over the longer term, these opportunities will increase in volume and frequency as resource portfolios evolve to a cleaner and more variable mix of renewable energy resources.

BTM Microgrid Case Study: PGE

The hurricanes on the East Coast and wildfires on the West Coast are the primary drivers for adoption of microgrids in critical facilities and communities. Earthquakes represent another, potentially more devastating threat to grid reliability. Today, no technology can predict exactly where or when a major earthquake may happen.

It was the threat of an earthquake that prompted PGE to move forward with an innovative microgrid in Beaverton, Oregon. The city lies within the Cascadia Subduction Zone, a fault with the potential to be exposed to an 8- to 9-point earthquake. (The most severe form of an earthquake is rated at a 10.) The last earthquake to occur was in 1700. It stretched from Vancouver, British Columbia, down to the states of Washington and Oregon and on into northern California. The earthquake also resulted in a catastrophic tsunami in Japan. While it is impossible to predict earthquakes, the likelihood of another major earthquake is a certainty.

The site of this BTM utility microgrid is the Public Safety Center for the City of Beaverton, which houses the police and emergency management departments and provides essential community services. The Beaverton Public Safety Center's peak load is approximately 200 kW. To facilitate adequate supply and resiliency, the microgrid integrates the following DER assets:

- A 250 kW/1,000 kWh Powin Energy battery storage system (BESS)
- 300 kW of solar PV
- 1 MW diesel standby generator

All three DER assets are coordinated by the PXiSE microgrid controller. The project is designed to increase renewable energy generation with solar PV providing 40% of annual electricity production.

Under the partnership with the City of Beaverton, the PGE-owned battery supplies grid services during normal blue-sky grid operations and the City of Beaverton receives community resilience at the Public Safety Center during emergencies. The BESS can discharge to the utility grid to provide frequency regulation services. It also supports voltage at the feeder level by charging or discharging in response to system-level needs. During an islanding event, the microgrid prioritizes the solar PV and battery assets to increase consumption of carbon-free resources. It can also receive support from a standby diesel generator in the event of a sustained outrage when emergencies arise. The PXiSE controls make it possible to provide seamless islanding for the Public Safety Center for 21 days.

PGE is paving the way for a new utility business model that supports community resilience, efficient integrated grid operations, and enhanced partnerships between utilities and critical facility customers.

PGE is paving the way for a new utility business model that supports community resilience, efficient integrated grid operations, and enhanced partnerships between utilities and critical facility customers. The innovative approach of having the utility own the BESS and the local government own the solar and diesel ensures a clear division of assets that allows the utility to prioritize BESS usage for grid services under normal operations. PGE's business model approach and its technical approach to the Beaverton Public Safety Center project are replicable, scalable models that can be pursued by other utilities nationwide. PGE's integrated resource plan points to similar systems supported by same business model to be deployed throughout its service territory. Justifying a microgrid project can be difficult for customers to do on their own if based solely on the benefits to a single site. By combining the benefits at the local site and on the utility's system, a microgrid project can become more financially viable—and a valuable community asset.

FTM Microgrid Use Case: SDG&E

Initiated by SDG&E in 2013, the Borrego Springs microgrid[1] was the first utility-owned, grid-tied community microgrid in the US. SDG&E is building on its findings from Borrego Springs to upgrade its system with high speed, advanced controls technology with the goal of stabilizing ongoing microgrid operations and transitioning to 100% renewable assets at the site.

Beyond Borrego Springs, SDG&E is expanding its microgrid portfolio to serve desert communities in high risk wildfire areas as part of its Wildfire Mitigation Plan. These FTM microgrids located at Ramona Air Attack Base (CAL FIRE's aerial firefighting base in San Diego County), Cameron Corners, Shelter Valley, and Butterfield Ranch/Agua Caliente will take advantage of local renewable energy generation capacity and provide additional renewable energy generation and battery storage to drive community resilience.

Microgrids are a critical tool maintaining power continuity when Public Safety Power Shutoffs are necessary during high risk weather conditions to reduce the risk of catastrophic wildfires. To improve the benefits during normal operations, the fleet of microgrids can support load shifting during peak power events.

All four sites will have PXiSE microgrid controls deployed as a local area distribution controller and communication networks enabled to support remote control, visibility, and supervisory operation to all microgrids from SDG&E's distribution control center. Using these FTM microgrids, SDG&E can effectively manage and control resources in remote communities, which is critical for timely, safe, and reliable operations.

[1] SDG&E News Release, "SDG&E to Upgrade Borrego Springs Microgrid to 100% Renewable Energy," July 31, 2020.

Next Steps for Utilities: Moving from Microgrids to DERMS

Utilities can reinvent themselves to prepare for an Energy Cloud future with the following five steps.[2] Microgrids can serve as a gateway for further exploration of new platforms, new business models, and new customer programs and services.

Step One: Develop Both a Near- and Long-Term Microgrid Strategy

Utilities are great at planning. Why not apply this expertise to develop a thorough microgrid strategic plan looking out 3, 5, and 10 years out into the future? Zero in on near-term potential wins. How will microgrids fit into long-term planning and operations? Account for BTM and FTM applications pending regulatory approval for these use cases. Microgrids are a geographically discrete project that utilities can act on today to drive operational efficiency, support integration of renewable DER assets, and enhance resilience of the targeted facilities and customers. These characteristics make it a great first step to achieve long-term grid modernization initiatives such as DERMS.

Step Two: Identify Key Distribution Network Resiliency Sites

Utilities should analyze their service areas to identify potential sites for microgrids to bolster regional reliability and support critical facilities. These sites may include hospitals, police stations, fire stations, clean and wastewater treatment facilities, senior housing, and disadvantaged communities. Map out existing DER assets that could have planted seeds for future microgrids. This will reduce the upfront costs. Investigate other host site quirks to identify easy opportunities—projects where available assets and a lack of regulatory barriers enable quick deployments. For FTM applications, utilities should consider areas within their distribution systems that feature high penetrations of solar PV, batteries, and EVs. These are sites where a microgrid could alleviate existing network constraints or shift excess supply to other substations or feeders. Other prime FTM applications are remote or end-of-line communities or areas with increased risk due to environmental or potential natural disasters.

Step Three: Quantify the Potential Business Opportunity for Microgrids

Explore the economics of other utility projects and seek collaborations to replicate mutually beneficial business value models. Quantify the unrecognized value embedded in microgrids in the form of resiliency. Based on the sites identified in step two, create an estimate of the potential business opportunity for microgrids that exist within the service territory. Based on this data, find partners, with the most important decision being the controls. Think outside the box. Could microgrids be offered under an EaaS to critical facility customers? How can microgrids help support utility grid modernization and digitization business goals?

Step Four: Know Your Regulators

Many investor-owned utilities have seen their proposals to rate base microgrids rejected by state regulators. Know the rules before designing any project. What lessons learned from projects deployed elsewhere in the world could apply to your specific regulatory regime? How can microgrids help meet state policy objectives such as energy storage mandates, renewable portfolio standards, or non-wires alternatives? It is this latter policy that has been a primary driver behind utility rate-based microgrids.

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[2] Guidehouse, *Energy Cloud 4.0*, 1Q 2018.

Work with regulators (and lawmakers) to tap government funds to fill-in where rate-based investments might face regulatory obstacles and delays.

Step Five: Consider Microgrids a Stepping-Stone to DERMS

Microgrids pair well with DERMS. They feature different purposes and capabilities. Microgrids are distinguished by the functionality of islanding. DERMS views the world of DER assets from an active power management perspective, focusing on FTM optimization in many cases. FTM distribution microgrids are a natural stepping-stone to DERMS, enabling the extraction of maximum value from collocated DER assets. Microgrids focus on a particular static set of DER assets located within confined boundaries, whereas DERMS provides a networkwide layer of DER control designed to maintain the stability of an entire utility service territory. DERMS views the world from the vantage point of a utility, so there is a natural synergy. Utilities are uniquely positioned to leverage the capabilities of microgrids and DERMS. Why? With the right digital platform, they can reach DER both BTM and FTM. Gaining access to both sets of resources creates a bridge. Dual usage of a single platform to manage both microgrid and DERMS functionality offers the possibility of a complete end-to-end solution for utilities.

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Scope of Study

Guidehouse Insights prepared this white paper, commissioned by PXiSE, to provide insights, case studies, and advice to utilities looking to transform themselves to address growth in DER assets populating their distribution networks. Whether the primary driver is resiliency or a long-term DER management strategy, this white paper offers a roadmap for utilities to explore both BTM and FTM microgrids. It summarizes the key elements of success for a microgrid program, noting the important role of digital controls in meeting the needs of customers and their utilities. It is the first of two white papers commissioned by PXiSE, the second will also be published in 2020 and will focus on DERMS.

Sources and Methodology

Guidehouse Insights' industry analysts use a variety of research sources in preparing research reports and white papers. The key component of Guidehouse Insights' analysis is primary research gained from phone and in-person interviews with industry leaders including executives, engineers, and marketing professionals. Analysts are diligent in ensuring that they speak with representatives from every part of the value chain, including but not limited to technology companies, utilities and other service providers, industry associations, government agencies, and the investment community.

Additional analysis includes secondary research conducted by Guidehouse Insights' analysts and its staff of research assistants. Where applicable, all secondary research sources are appropriately cited within this report.

These primary and secondary research sources, combined with the analyst's industry expertise, are synthesized into the qualitative and quantitative analysis presented in Guidehouse Insights' reports. Great care is taken in making sure that all analysis is well-supported by facts, but where the facts are unknown and assumptions must be made, analysts document their assumptions and are prepared to explain their methodology, both within the body of a report and in direct conversations with clients.

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