MICROGRID KNOWLEDGE SPECIAL REPORT

Microgrids for the Retail Sector

Your competition is in the dark, but you've got power

by Peter Maloney

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Executive Summary

Disruptive events such as hurricanes, wildfires and extreme storms appear to be on the rise. And with natural disasters come power outages.

Businesses lose billions of dollars every year from loss of power. When those businesses are retail stores, the community also suffers. Food and water become scarce. Essential goods are difficult to find. And it can be hard to get around if gasoline is unavailable.

Further, customers lose confidence in businesses when they close during normal business hours. In today's digital economy, customers expect convenience and instantaneous service.

Many retailers use only backup generators as a safeguard, but backup generators can fail without regular maintenance.

Microgrids are a more reliable source of backup power that also provide a range of electrical services for the grid. Furthermore, microgrids have become affordable for many businesses via as-a-service contracts. That means retail stores do not have to make a large capital outlay to secure a reliable backup system.

Microgrids are a solution to a problem that shows no sign of going away.

Power outages cost the U.S. economy about $44 billion a year.

Businesses take the biggest hit. Although they comprise only 10% of electricity customers, businesses shoulder 70% of the costs.

Lawrence Berkeley Laboratory

Chapter 1

Why Electric Reliability is so Important for the Retail Sector

Hardly a day goes by without the United States facing a new threat to its electric reliability—whether it is hurricanes, heat waves, snowstorms, or wildfires.

The threats come not only from nature's onslaughts, but also equipment failure, such as the July 2019 transmission relay malfunction that left about 72,000 customers in the dark in Manhattan. Everyday events, like car accidents or hungry squirrels, can cause power outages too.

The U.S. Energy Information Administration reports that outages nearly doubled from 2016 to 2017. In total, the nation saw 3,526 blackouts that affected 27 million people, according to Eaton's Blackout Tracker.

With such threats come a rising tide of damages and losses. For example, Hurricane Harvey knocked out 10,000 MW of generating capacity and left hundreds of thousands of customers on the Texas Gulf Coast without electricity for days. Estimates put losses from the 2017 storm at $125 billion.

Overall, power outages cost the U.S. economy about $44 billion a year, according to Lawrence Berkeley Laboratory. Businesses take the biggest hit. Although they comprise only 10% of electricity customers, businesses shoulder 70% of the costs. Unfortunately, power outages are growing in both frequency and duration.

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Reliability Rules

In today's digital economy, communities require access to continuous power. Electric reliability is crucial for government offices, first responders and essential services, such as police and fire departments. Lives can hang in the balance if equipment fails at a medical facility. Critical infrastructure, such as water pumping stations and wastewater treatment plants, require uninterrupted power to keep cities safe, dry and sanitary.

But when retail operations lose power, communities often feel the most immediate impact. With local stores shuttered, food and water become hard to secure. Travel is restricted since gas pumps do not work. Delay occurs in repairing homes and buildings with tools and materials difficult to secure.

Customers have come to rely on retailers to keep them comfortable and safe. So, if they expect a store to be open and find it closed, they may seek another alternative and lose confidence in that retailer.

"The retail industry is being held to higher standards by today's consumer. In fact, retail plays an increasingly essential role during storms as a 'safety net' for the community. Not only can a grocery store, gas station, convenience store, or pharmacy provide essential goods—water, food, gasoline, medicine—but it can serve as a refuge, a place to shelter, recoup and reconnect with loved ones," said Allan Schurr, Chief Commercial Officer at Enchanted Rock, a microgrid development company. "Consumers expect to buy what they need, when they need it, even if conditions make it difficult for the retailer to provide these goods."

A sign on the door that the power is out sounds increasingly like 'the dog ate my homework.'

Financial Losses

For some retailers, even a few minutes of downtime can lead to tens of thousands of dollars of lost revenue. E-commerce giant Amazon, suffered a technical glitch on July 18, 2019 that knocked its website offline for about 13 minutes, causing the online retailer to lose about $2.6 million in revenue. That translates to $203,577 per minute.

In a 2018 study, Frost & Sullivan found that 18% of businesses took a financial hit of $100,000 or more from their worst power outage in 2017, and 19% sustained costs of $50,000 or more.

Those costs accrue in a variety of ways. Outages may decrease employee productivity or lower the rate of unturned inventory, which can have a lingering effect on financial performance. An abrupt shutdown of power may damage data from computer systems—or worse cause its loss. Other types of equipment may become damaged, particularly now when even the most basic machines come loaded with computer controls.

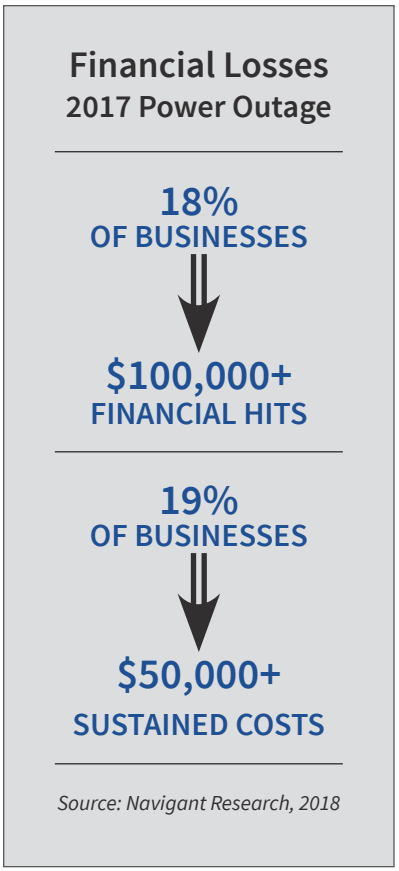
Solutions

Retailers may feel powerless in the face of rising threats to their electric service. While they cannot control the weather or many other events that cause grid disruptions, they can take control of their own power supply. There are solutions—such as microgrids.

Retailers equipped with microgrids offer an important public service when communities are most vulnerable. Designed to keep the power flowing when the central grid fails, microgrids offer retail operations a way to ensure customer retention and stable earnings, even as Nature batters land and sea.

Microgrids have been around for decades, but they are now growing in use as our Internet-based economy becomes increasingly dependent on electricity.

In the next chapter, we will explain how microgrids work and why they offer retailers so much more than backup generation.



"Consumers expect to buy what they need, when they need it, even if conditions make it difficult for the retailer to provide these goods."

Allan Schurr, Chief Commercial Officer at Enchanted Rock

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Chapter 2

How Retailers Can Increase Electric Reliability

With threats to electric reliability increasing, it is easy to understand why power outages worry retailers. So what are the solutions?

The most obvious is a backup generator. While this may seem like an expedient solution, procuring backup generators is costly and complex. Their purchase requires sizing analysis, engineering, building permits, construction, and routine maintenance that includes inspection, loaded testing, and fuel conditioning if they use diesel.

Failure to adequately maintain backup generators will create operational problems that a retailer may not discover until it is too late. Backup generators sit idle for most of the year, only running during emergency operations. Because of this infrequent operation, maintenance is sometimes skipped, making backup generators less likely to work when needed and far less reliable than a microgrid. In contrast, microgrids frequently interact with the grid, so they undergo constant testing and conditioning, increasing the likelihood they will work during an emergency.

The Heart of a Microgrid

It is important to understand what a microgrid is and how it functions. As the name suggests, a microgrid is a smaller version of the electric power grid installed on-site at the user's facility.

When designed for resiliency, a microgrid's defining characteristic—what makes a microgrid a microgrid—is its ability to operate in isolation from the surrounding grid. A grid-connected microgrid 'islands' from the central grid when it senses a disruption, such as a power outage. The microgrid then activates its system to supplant the lost grid electricity.

Islanding occurs via a microgrid controller, the technology at the heart of the microgrid, which allows the microgrid to interact with the central grid. When it senses a problem on the grid, the controller sets up the activities to ensure power flows to its host from the on-site system. Retailers are able to maintain continuous operations, despite severe weather or other grid threats.

A microgrid also can provide advantages to a retailer by interacting with the grid during non-emergencies. For example, the microgrid may sell services to the grid or leverage changes in pricing, which can produce a revenue stream or offset microgrid costs.

A microgrid can serve a single building, a business campus, a college campus, a military base or even a community.

A microgrid's defining characteristic is its ability to operate in isolation from the surrounding grid.

The size of a microgrids depends on the host's need for critical power supply. A microgrid can serve a single building, a business campus, a college campus, a military base or even a community, like the Bronzeville microgrid in Chicago.

Microgrids can be powered by a variety of energy sources. It is common for them to employ some combination of solar panels, wind turbines, energy storage, combined heat and power and backup generators. The microgrid's use or purpose dictates the type of resources incorporated. Each resource has its pros and cons.

For example, if a microgrid is built predominantly to achieve renewable energy goals, solar panels with batteries are a common power source. However, these systems present limitations when it comes to electric reliability. During a storm-caused outage, cloud cover can prevent solar panels from generating electricity. For example, Kauai in Hawaii has a growing array of solar farms. On July 21, 2019, the island experienced an outage, when a cable on a diesel generator failed. Due to lack of sunlight, they struggled to meet demand for backup power.

Battery storage can provide backup power, but it is limited. Most batteries are designed to discharge for two to four hours, and batteries with discharge capabilities above four hours are incrementally more expensive.

But including solar-storage within a microgrid, coupled with other resources, offers a way to overcome its reliability drawbacks.

Another drawback of batteries—one often not considered—is the extensive space required to house them.

Diesel engines have been a traditional resource included in microgrids. Their portability, scale and durability make them an attractive option, but they also have drawbacks. For example, they are expensive to buy and costly and difficult to maintain. If maintenance is not done properly and consistently, they fail to start when needed. Diesel engines create more noise and pollution than alternatives, emitting higher levels of carbon dioxide, nitrogen oxide (NOx), sulphur dioxide and particulate matter. The diesel supply chain can become extremely challenged during severe weather events. Limited supply amid increased demand, coupled with the hazards of flooding or downed trees, can prevent diesel delivery trucks from reaching customer sites.

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Modern generators fired by natural gas, on the other hand, provide the benefits of a diesel engine while avoiding the pitfalls. For example, natural gas is delivered through robust underground infrastructure that remains unaffected by above-ground risks and disturbances. Other benefits of natural gas generators include being durable, able to scale, and flexible. Some natural gas generators easily ramp up and down to meet fluctuations in load without harming the engine. Additionally, gas-fired combustion produces less carbon, less NOx, and lower particulates than diesel combustion. Natural gas generators are quieter to operate, so can be located in close proximity to businesses or neighborhoods.

Operating a Microgrid

Some retailers rightfully worry that owning and operating a microgrid forces them into a business they are not familiar with—the power industry. Fortunately, the microgrid industry has devised ownership models that address this problem. The microgrid-as-a-service approach gives retailers the reliability benefits of a microgrid while relieving them of the ongoing maintenance and operational requirements.

In the same way the microgrid controller makes microgrid operations seamless and smooth, the microgrid-as-a-service model alleviates the burden of microgrid ownership for the retailer.

The next chapter explores microgrid-as-a-service more fully.

Chapter 3

Benefits and Barriers to Microgrid Deployments

Always-on power is important in the retail sector for a range of reasons. Without electric resiliency, retailers cannot provide their services for the community.

- **Access to food and water** can become limited as perishable items spoil without the proper temperatures
- **Pharmacies** cannot fill prescriptions, which delays patients' access to critical medications; items like temperature-sensitive medicines and baby formula become unusable
- **Gas pumps** at convenience stores are unable to function, restricting travel or ability to evacuate in the case of a long-duration outage
- **Home improvement and lumber stores** cannot provide community members with necessary safety and repair tools
- **Distribution centers** are inoperative, creating delays in the supply chain of retail stores

Retailers can avoid these problems by installing microgrids. So, why don't all retailers have microgrids? Some barriers still exist—although they are beginning to tumble.

Cost is a common barrier—or at least perceived to be one. Microgrid costs have fallen in the past several years, and the trajectory continues downward. Navigant Research estimates overall costs for microgrids have declined by 25% to 30% since 2014.

The No or Low-Money Down Option

In recent years, microgrids have become more affordable with the emergence of no or low-money down financing options.

The model is known by various names, such as microgrid-as-a-service, energy-as-a-service, and reliability-as-a-service. The retailer secures the benefits of a microgrid but is spared from making a capital outlay or taking on the risks of ownership and maintenance. In broad terms, a third-party finances, owns and manages the microgrid system. The retailer pays a fee for the services the microgrid provides.

The as-a-service model now accounts for 81% of microgrids deployed globally, according to Navigant Research. The microgrid industry adopted the approach from the solar industry, which has used it for more than a decade. In fact, the model often is credited for the rapid growth of residential solar installations.

Under the 'as-a-service' model, the retailer enjoys microgrid benefits at a fraction of the total cost of ownership. The developer is able to keep the cost low because of future revenue streams from dispatchable grid services.

Return on Investment

The microgrid-as-a-service model attracts third-party investors because they can earn a return on their investment by leveraging tax credits and other incentives. The microgrid also can earn revenue or achieve savings by:

- ✓ Selling the microgrid output into energy markets when the on-site generators are not needed by the retailer
- ✓ Participating in utility demand response programs—again when the on-site generators are not needed by the retailer
- ✓ Managing energy use in a way that reduces certain utility demand charges to business customers

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Aggregation Advantages

Retailers sometimes have concerns about the size of backup systems. A small retailer may not use enough electricity to support the economies of scale necessary to reap the full financial benefits of the microgrid, particularly when it comes to selling its services to the grid.

Fortunately, microgrid-as-a service opens the ability for the microgrid owner to contractually aggregate the output of multiple microgrids, even if they are spread out geographically.

By aggregating a collection of microgrids, a third-party owner can layer revenues and increase microgrid value as they sell a variety of energy products and services to local utilities and the wholesale power market.

The microgrid offers valuable services to the grid because its controller monitors grid conditions and acts upon the data. The entities that run wholesale power markets, Regional Transmission Operators (RTOs) and Independent System Operators (ISOs), need a variety of products and services to continuously balance the supply and demand of electricity in real time. Those services include frequency regulation, voltage support, spinning reserves and operating reserves.

A single microgrid at a retail store might be too small to effectively offer products and services into the wholesale power market. But an aggregation of microgrids can achieve the required output to bid services into the market.

Managing such energy transactions is not a core competency of most retailers. However, that is not a concern with a microgrid-as-a-service contract. The third-party owner manages the transactions.

Installing a microgrid might seem out of reach or too formidable to a retailer, but by leveraging microgrid-as-service, a retailer can avoid the pitfalls of capital expenses and property ownership and gain electric reliability and cost reduction.

Microgrid-as-a service opens the ability for the microgrid owner to contractually aggregate the output of multiple microgrids, even if they are spread out geographically.

Due to these advantages, microgrid use is on the rise.

The next chapter looks at how microgrids emerged as an option for retailers and provides real-world examples.

Chapter 4

Who Uses Microgrids and Why

Declining costs and new financing models put microgrids within reach for a variety of businesses and institutions. But early on the military and research universities paved the way with the technology.

In the United States, the military's use of microgrids grew out of strategic initiative to improve its energy security. The Army has made microgrids part of its energy planning as it strives to make military installations capable of operating for two weeks without grid power. Microgrids help ensure electric supply to military installations should a natural disaster or cyberattack disrupt the power grid. They also offer a way for the military to reduce fuel deliveries in vulnerable outposts.

Some of the most advanced microgrids in the U.S. are at universities, among them Princeton University, the University of Texas at Austin and the University of California, San Diego. Research universities could lose years of laboratory work if critical facilities, such as refrigeration units, are knocked out by a power outage. Therefore, they are highly focused on energy reliability. Additionally, the self-contained environment at colleges and universities provides a good environment for the growth of microgrids. Universities often produce their own heat and cool air, which is a perfect application for a microgrid that incorporates a combined heat and power plant.

Hospitals are also obvious candidates for microgrids. Hospitals typically use 2.5 times as much energy as a commercial building of the same size, and loss of power at a hospital could have dire, life threatening consequences.

Many jurisdictions enforce regulations that require hospitals to have backup generators with on-site fuel storage. Unfortunately, these backup systems do not always perform when needed, which was the case during Superstorm Sandy in New York City in 2012. Hospitals, such as Bellevue Hospital, New York University's Langone Medical Center, and Coney Island Hospital, were forced to evacuate hundreds of patients when backup generators and other electrical systems failed. The problem, in part, is that backup generators sit idle most of the time. So, despite regular testing, they can fail when needed most. On the other hand, microgrids include a generation source that operates on a regular basis, so its status is always known.

The military, universities and hospitals continue to install and use microgrids. But the business sector is the industry's latest frontier as data centers, retail stores, resorts, manufacturers and other businesses adopt the technology.

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In some markets demand charges account for as much as 50% of a business' electric bill. So microgrid use offers the possibility of significant savings.

Microgrids also allow retailers to avoid the direct costs associated with loss of electricity. Outages result in lost business, damaged equipment, and spoilage of products that require controlled temperatures, such as food and pharmaceuticals.

Growing Use of Microgrids by Businesses

In 2017, commercial and industrial microgrids captured just under 20% of spending on microgrid installations. By 2026, that share of spending is expected to grow to at least 35%, according to Navigant Research. In fact, the consulting firm reported a near quadrupling of the energy capacity from microgrids used by businesses from 2016 to 2017.

Businesses are turning to microgrids not only for backup generation but also to reap the additional benefits the microgrid-as-a-service model affords.

Consider the hefty utility demand charges that some stores pay. The charges are based on a company's energy use during periods of peak demand on the grid. By using microgrid power during these periods, rather than grid power, a store can reduce what it pays in demand charges. In some markets demand charges account for as much as 50% of a business' electric bill. So microgrid use offers the possibility of significant savings.

Microgrids also allow retailers to avoid the direct costs associated with loss of electricity. Outages result in lost business, damaged equipment, and spoilage of products that require controlled temperatures, such as food and pharmaceuticals. The U.S. government puts the annual cost of weather related outages to the nation's economy at $18 billion to $33 billion.

In addition, businesses that withstand power outages create loyal customer bases. When customers know they can rely on retailers to provide services despite area outages, they are more likely to return when conditions are normal.

For all these reasons, a growing number of retail organizations are turning to microgrids. Here are some examples:

- In **Texas**, Enchanted Rock has installed more than 100 microgrids through its *Integrated Reliability On Call (iROC)* offering for companies, like Buc-ee's, a large convenience store chain. Enchanted Rock's natural gas generators are located at customer sites, and the microgrids sell output to the wholesale market, which allows Buc-ee's to pay a small fee that is a fraction of what it would otherwise cost for a microgrid installation. (Also see *Chapter 5: H-E-B as a Community Hero during Hurricane Harvey*.)
- In **New York**, many retailers have turned to microgrids. In Brooklyn, the Whole Foods uses a microgrid that allows community members to gather during a power outage to charge phones, connect with family members, and purchase hot food. The TWA Hotel at JFK Airport also installed a microgrid to save money and achieve grid independence. New York City's economic development arm is funding the installation of 11 microgrids at a variety of businesses across the city.
- Home Depot stores in the **Northeast** also used microgrids to keep power flowing and stores open during a Summer 2019 heat wave that knocked out electricity to the neighbors.
- In **Ontario, Canada** a study is underway for a microgrid at a business technology park designed to accommodate 1.2 million square feet of office space on 120 acres.
- A pharmaceutical warehouse in **Santa Barbara, California** installed a microgrid to provide medicine and medical supplies for disaster relief. In Chino, California a Honda parts center installed a microgrid that allows it to meet California's zero net energy goals.

These are just a few examples of businesses that are protecting their bottom line with microgrids.

The next chapter offers an in-depth look at a grocery store chain that discovered the competitive advantage of its microgrids when a hurricane crippled the Houston area.

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Chapter 5

H-E-B as a Community Hero during Hurricane Harvey

The Texas-based H-E-B grocery store chain served by Enchanted Rock's microgrids exemplifies the comprehensive benefits of a microgrid backup solution in a retail setting.

Among retail businesses, grocery stores are especially vulnerable to power outages. They have freezers full of food that must be kept at sub-zero temperatures, prepared foods that will spoil quickly if not kept at the correct temperature, perishable foods such as dairy, fish and meat that must be properly cooled and, often, a pharmacy with temperature sensitive medicines.

Even relatively short power outages can be costly to grocers. Federal government guidelines recommend discarding any perishable foods, such as meat, fish, poultry and eggs, that have been held at temperatures above 40 degrees Fahrenheit for longer than two hours. The value of perishable foods runs anywhere from about $400,000 to $900,000 at a single store, according to a report from Western Illinois University.

> "After those previous storms, H-E-B said, 'That's enough. We need to have a way to have power generation permanently installed.'"
>
> Thomas McAndrew, CEO of Enchanted Rock

In addition, losses from power outages are commonly not covered by insurance. Although some policies cover perishables with a spoilage rider, grocers still tend to face high losses because most insurance policies have a 12- to 24-hour waiting period. Contrarily, most spoilage occurs within the first three hours after an outage.

Faced with the potential of high outage-related losses, H-E-B needed a solution. The grocery chain was founded at the beginning of the 20th Century, and it has grown into an enterprise with $23 billion in annual sales and more than 370 stores in the U.S. and Mexico. Forty-five of the stores operate in the Houston area, which is especially vulnerable to outages caused by the high winds and flooding from storms sweeping across the Gulf of Mexico during hurricane season.

H-E-B Houston area stores had experienced intermittent power outages, according to George Presses, H-E-B Vice President of Fuel and Energy. The stores needed a reliable backup power system that would keep them up and running "without any interruption to our partners, customers or communities due to a weather event or a general, short term grid outage," Presses said.

Previously, H-E-B had a fleet of mobile diesel generators that were dispatched on trucks during outage events. However, the grocery chain faced the typical drawbacks of diesel generators when flooding and downed trees and power lines prevented the trucks from being deployed where they were needed.

H-E-B recognized their need for a more reliable solution, so the company approached microgrid developer, Enchanted Rock.

"After those previous storms, H-E-B said, 'That's enough. We need to have a way to have power generation permanently installed,'" said Thomas McAndrew, CEO of Enchanted Rock said.

Enchanted Rock's solution was to permanently install a natural gas microgrid using the resilience-as-a-service model, where Enchanted Rock owns the equipment and H-E-B pays the fuel costs and a small service fee.

In 2016, H-E-B partnered with Enchanted Rock to install microgrids at 45 of H-E-B's Houston area stores using their reliability-as-a-service model. Enchanted Rock's resiliency microgrids run on natural gas, which has a robust underground supply chain that rarely becomes disrupted.

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With Enchanted Rock, H-E-B's entire facility is backed up, meaning the store functions normally despite area outages. The microgrids were designed to keep refrigerators and freezers running, the lights on, and cash registers functioning during grid outages. H-E-B stores can stay open and provide the public with food, emergency supplies and even shelter.

H-E-B was fortunate to have the microgrids commissioned before Hurricane Harvey hit Houston in August 2017 as the storm knocked out power for 300,000 Texas utility customers. Enchanted Rock uses a 24/7 Network Operations Center to monitor the electric grid, so the company knew when to island H-E-B microgrids from Houston's main power grid. As Harvey made landfall on the Gulf Coast, the stores began receiving power from the microgrid's on-site generators. Eighteen H-E-B stores received full-facility backup power for five consecutive days during the storm.

Because H-E-B has a goal of being community-focused, the grocery chain decided to expand the agreement to over 100 MW of additional locations across Texas and, eventually, to all its Texas stores. With this agreement, most H-E-B grocery stores will have full electrical reliability and will be able to serve the community during both major and minor power outages. As of August 2019, Enchanted Rock provides microgrid backup power to 114 H-E-B stores.

One of these H-E-B microgrid stores is in Kingsville, Texas about 35 miles south of Corpus Christi. In June 2019, a massive storm swept across Kingsville, leaving 9,600 residents without power during one of the hottest weekends on record. Most of the businesses in the area were forced to close as community members endured the heat. However, the Kingsville H-E-B was powered by Enchanted Rock for 39 consecutive hours, providing residents with a convenient place to cool off and purchase food, water and other necessities.

Founded in 2006, Houston-based Enchanted Rock is a leader in electric reliability as-a-service, and the company has brought unmatched resiliency through its microgrids to the retail sector. Its customers enjoy over 99.999% combined reliability. In 2010, Enchanted Rock became the first company in Texas to provide utility grade backup power as a service. Enchanted Rock now has commissioned over 350 MW of backup generation, actively manages 295 MW of capacity, and has over 100 MW of backup generators under construction.

Conclusion

In a digital society, power failure is increasingly costly for retail operations. It wreaks havoc on temperature-sensitive inventory, revenue streams, customer loyalty and efficient business operations. And unfortunately, grid disturbances are all too common.

Microgrids offer a solution to an intensifying problem. When the power is out, especially following a storm, customers truly need the services retailers provide. Stores with microgrids can stay up and running and distinguish themselves among their competitors as a resource the community can count on. Through the microgrid-as-a-service offering, retailers have a cost-effective option for the resiliency they need.

In a world where power outages are increasing in occurrence and destruction, retail businesses must be equipped to protect themselves, their customers and their communities.

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About Enchanted Rock

Founded in 2006, Enchanted Rock, Ltd. builds and operates cost effective resiliency microgrids that help companies efficiently manage the risk associated with electricity interruptions. In 2010, ERock became the first in Texas to provide utility grade backup power as a service. The company is responsible for the design, project management, installation, and commissioning of 280 MW of distributed generation, including 160 MW of Distributed Power Generation projects and 120 MW of customer reliability systems. The company currently has 85 MW of customer resiliency microgrids under construction. ERock is the only distributed energy company combining expertise in energy market integration, control technologies, and construction, translating into more reliable and less expensive backup power for customers. ERock serves a wide range of industries including grocery stores, senior living facilities, travel centers, cold storage facilities, car dealerships, higher learning institutions and critical manufacturing facilities.

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