The Affordable Microgrid: Securing Electric Reliability through Outsourcing

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Executive Summary

The number of widespread power outages caused by the hurricanes of 2017 and nor'easters of 2018 were the latest reminders of the fragile nature of the grid across North America. With the risks of storms, fires, human error and potential cyberattacks ever present, more and more businesses and institutions have shown interest in microgrids and the enhanced electric reliability they provide. Microgrids are local power generation resources that may be coupled with storage and controllers supplying power to a facility when the grid is down. However, some [businesses and institutions] find the upfront cost and operational complexities too daunting to go at it alone.

This report introduces an innovative approach—reliability-as-a-service—that reduces the capital costs for microgrid customers and puts their operations in the hands of experts. Universities, business parks, research institutions, manufacturers and hospitals are but a few examples of enterprises deeply dependent on reliable electricity that are now turning to microgrids to ensure their power stays on during a crisis—without excessive cost or hassle.

In this report we compare the cost of power outages with the associated economic value of electric reliability. We explain the benefits of affordable microgrid services using natural gas as fuel, and detail how microgrids can leverage wholesale power markets during normal operations, enhancing their value proposition and strengthening the broader electric grid. We also discuss why these grid services become increasingly important as the electric grid becomes more and more dependent on renewable energy to generate power.

Finally, we offer real-world examples of how microgrids, using the reliability-as-a-service model, performed in Texas during Hurricane Harvey, keeping the lights on in stores and service stations for both customers and first responders in an otherwise darkened landscape.

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Chapter 1

Introduction

2017 proved to be one of the most destructive on record for North American power grids. Hurricanes, wildfires and an 11-hour outage at the world's busiest airport—Atlanta—validated the message that many in the microgrid industry have put forward for the last several years: Our interconnected grids are vulnerable. And 2018 started out with more of the same as winter storms and nor'easters impacted tens of millions of people.

Storms, fires, equipment failure, cyberattacks and human-caused outages can impact any part of the electric grid. Harm is particularly apt to come to the 6.3 million miles of distribution line that connects homes and businesses to the grid. Falling trees and heavy winds can bring down overhead lines and leave customers in the dark. The Department of Energy estimates that 90 percent of power disruptions occur because of problems on these wires. This statistic makes a strong argument for microgrids and other forms of onsite energy that deliver power without relying on miles of overhead wire.

However, as vicious as the storms of 2017 and early 2018 were, a successful cyberattack on the grid could be even worse. Not surprisingly, hackers and foreign enemies see the grid as a prime target, and government officials and utilities have warned of frequent attempts to undermine its cybersecurity. A cyberattack is particularly worrisome because it may not be as easy to fix as storm damage. Line workers from other utilities and states help repair poles and string new wire following a storm—which hastens recovery. But such teams would do little good in a cyberattack where needed fixes are buried in computer code.

As digitization increases, reliable electricity becomes ever more important. Our businesses, governments and households cease to function when the power goes out. We cannot work. We cannot produce and distribute food. We cannot undergo modern-day health-care procedures. We cannot dispose of trash and waste. We cannot communicate; our cell phones no longer work.

Installing a microgrid before calamity

Microgrids need to be an integral part of any pre-emptive storm hardening or business resiliency planning. Communities appreciate such foresight when severe storms occur. In New Jersey, Princeton University became a rare beacon of light during the 2012 Superstorm Sandy. Because of its microgrid, the campus became a place of refuge for police, firefighters, emergency-services workers and local residents.

More recently, during Hurricane Harvey microgrids installed by Enchanted Rock (ERock) kept power flowing at a group of affected grocery stores and mega travel centers. Thanks to the microgrids, these enterprises remained open in a landscape that had otherwise become an electricity desert. Storm-weary Houston residents were able to buy fuel and supplies and one store even acted as a base for rescue workers. *(See Chapter 6 for more details.)*

It is important to note that it doesn't take severe weather and natural disasters to cause a power outage. Prolonged outages can occur daily because of falling tree branches, wild animals, equipment malfunction and human error. For example, routine construction and maintenance on a sunny Friday afternoon in February 2018 led to a power outage that lasted over 7 hours in a busy Houston area. ERock's microgrid powered an H·E·B Grocery in this area for the entire outage, preventing the loss of store revenue and inventory. Perhaps even more important, remaining open when most businesses in the area are closed increases customer trust and loyalty.

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Knowing that reliable electric service is critical, what's holding us up from installing microgrids more quickly? Why aren't we taking advantage of this insurance policy?

Microgrid considerations

The problem is that many of us face several questions as we try to decide if a microgrid is right for our operation.

- Is the microgrid worth the cost—what's the value of resiliency to my operation?
- Is the microgrid truly reliable—for how long and under what conditions?
- What kind of microgrid should I choose—especially if I am trying to meet certain availability, efficiency or environmental goals?

Moreover, nascent market conditions can undermine the microgrid value proposition. Still relatively new, many of today's microgrid projects lack replicability and standardization. They tend to be one-off, customized projects that can be expensive. If you're not a microgrid developer, installing and operating an onsite energy plant can seem daunting. You have other priorities; other places to focus your time, attention and resources.

Fortunately, the microgrid industry is evolving quickly and business models are emerging that make microgrids an attractive proposition for multiple applications.

Why we wrote this report

Produced by Microgrid Knowledge in partnership with ERock, this report describes one innovative business model, called reliability-as-a-service, as a way to secure the benefits of a microgrid without the upfront costs or headaches of becoming a power plant developer, owner and operator.

We believe this report will be particularly valuable for cold storage facilities, petrochemical plants, retail stores, critical process manufacturers, senior living and hospitals, grocery stores, major universities, data centers, public sector or government agencies, communities and others concerned about the cost of power outages. To that end, we welcome you to download this special report, "The Affordable Microgrid: Securing Electric Reliability through Outsourcing" free of charge, and to widely distribute the link.

Chapter 2

What is the monetary value of electric reliability to your operation?

It is difficult to calculate what a power outage costs an economy or even an individual business. Losses tend to be determined in retrospect, after a storm or other calamity. They represent our best estimates of inputs, such as lost worker productivity, manufacturing disruptions, lost inventory or lost consumer purchases. Most of those losses are not recoverable. And, potentially more damaging, they affect customer confidence, which can result in the erosion of future revenues.

The numbers may not be exact, but they are substantial. A digital economy suffers mightily when it loses its most basic feedstock, electricity.

The 2017 hurricane season was particularly expensive. Estimates put Hurricane Harvey losses alone at $125 billion, making it one of the most costly natural disasters in U.S. history. The storm knocked out 10,000 MW of generating capacity, according to the U.S. Energy Information Administration, and it left hundreds of thousands of customers without electricity along Texas' Gulf Coast.

One storm can have a tremendous effect.

Who suffers most from outages

Some businesses face steeper losses than others. Eight key U.S. market segments studied by energy consultant E Source forfeit about $27 billion per year due to power outages. On a more granular level, the E Source report found that manufacturers tend to suffer the most from long outages, followed by financial service companies, healthcare, and grocery stores. These industries also face significant losses during short outages. Consider a car manufacturer that makes about 1,200 cars a day: The cost for each car is roughly $50,000. That means just one day offline costs the factory $60 million.

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Industries dealing with perishable products, from food to pharmaceuticals, are also vulnerable. In one dramatic example, the loss of power in Puerto Rico in the wake of Hurricane Maria resulted in shortages of medical supplies such as IV bags and some drugs. Puerto Rico pharmaceutical manufacturers produce about 10 percent of all drugs consumed by Americans, according to the U.S. Federal Drug Administration.

Food products are perishable at any stage along the supply chain, from manufacture to sale. In Winchester, Virginia, HP Hood installed a 15-MW microgrid at its 150-million gallon milk processing plant as insurance against outages. For Hood, even a brief loss of power could result in the plant shutting down for up to 12 hours to clean and re-sterilize equipment.

The Department of Defense reported 127 outages of eight hours or longer in 2015, at a cost of $179,087 per day.

Loss of power is more critical at hospitals and military installations, where interruption of electrical service can be life threatening. The Department of Defense reported 127 outages of eight hours or longer in 2015, at a cost of $179,087 per day. The toll can be even higher at medical installations. Healthcare organizations face average costs of $690,000 per outage, according to a Ponemon Institute/Emerson Network Power report. Add in the potential for the loss of life, and that calculation becomes imponderable.

Valuable data for risk officers

Retrospective studies aside, risk officers increasingly want to know what an outage might cost their business. The figure is useful in determining if a microgrid is a wise investment.

Traditionally, understanding outage costs also helps a business determine if it makes sense to shut down when the grid is under strain and energy prices spike. A planned outage is much less costly to a business than an unplanned outage. For example, if the price of electricity spiked to $200/MWh, a manufacturer of cast iron may decide it is not economic to continue to operate, so they shut down for the day and pick up where they left off the next day.

On the other hand, there are certain processes that are costly to stop and start. The cost could be high for a plastic manufacturer to shut down until the next day and have to clean cold plastic out of molds. Or an oil and gas producer working on tight margins could shut down to avoid electric price spikes but it might take the producer days to get back online. As a result, the producer's customers might lose business because they can't fulfill their contracts. Over time, the oil and gas firm could save money, but it could also lose customers. In that case, the value of going without power has both short-term benefits and long-term costs.

"It is an education process for businesses to understand the implication of interrupted operations," said Thomas McAndrew, founding partner, president and CEO of microgrid developer ERock.

Under normal circumstances, this is what a business would do. However, reliability-as-a-service providers take on the responsibility of economic and system volatility, so that customers reap the benefits and are not burdened with making day-to-day decisions on when to disconnect from the grid or how to recover from an outage.

No simple way exists to determine the value of reliability. Every business is different and operates under a unique set of circumstances. In some cases, the value of reliability could be as simple as the temporary loss of a process. Often, however, the value extends beyond the obvious.

"It is an education process for businesses to understand the implication of interrupted operations," said Thomas McAndrew, founding partner, president and CEO of microgrid developer ERock. "By jointly analyzing previous events, or reviewing data from similar organizations, we try to put a price on grid interruption, to make the decision much easier."

What will it cost to avoid the loss?

Once a business determines the cost of losing power, logical questions follow: What will it cost to avoid this loss? Is the investment worth it? What does a microgrid cost? Where do we find the expertise to build and operate a microgrid?

In the next chapter we explain why a microgrid can be affordable when it is offered through a reliability-as-a-service model.

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Chapter 3

What is the affordable microgrid?

Microgrids are often customized to meet the needs of the host, whether it is a municipality, hospital, retailer or manufacturer. Because each organization's needs are unique, it is difficult to compare costs across different installations.

For example, population and technology density in an urban setting can increase engineering costs. They can also involve more lengthy and difficult regulatory proceedings, also raising costs.

Compounding the problem is a reticence on the part of microgrid developers to divulge costs out of competitive concerns.

In a recent report GTM Research put advanced microgrid costs in a range from $1,100/kW to $4,400/kW, with university and island microgrids at the lower end and remote community and commercial microgrids on the higher end.

One important price trend, however, is that microgrid component costs—such as energy storage systems and control technologies—are falling as demand is increasing. In addition, natural gas, which fuels many microgrids, has experienced historically low prices in recent years

What drives microgrid costs?

Overall, three main components drive microgrid costs: generation, infrastructure and automation or control. Generation assets are usually the highest cost in a microgrid, but this varies depending on whether the microgrid installation is a greenfield project or is being built on top of, or in addition to, existing infrastructure. The controller is usually the smallest cost component, but it is also one of the components that is more affected by economies of scale. A controller for a 10-kW system will be cheaper than a controller for a 100-kW system but will comprise a higher percentage of the project's budget.

The microgrid's purpose, usually driven by customer needs, determines the optimal design that affects costs. GTM Research expanded its definition of microgrids to include basic as well as advanced microgrids. Basic microgrids have only one distributed energy resource (DER), usually a natural gas or diesel generator. In contrast, advanced microgrids use multiple DERs, such as generators, renewables and storage, as well as a sophisticated management system to serve multiple buildings and optimize loads effectively. The expansion of the definition resulted in GTM adding 1,500 microgrids to its database, bringing the total number of operating microgrids to 1,623.

A theme common to both basic and advanced microgrids is their ability to island, or disconnect, from the central grid and use their own energy assets to provide power to their customers for at least 24 hours. However, 24 hours of power would not be sufficient after a significant weather event. For example, after Hurricane Harvey, ERock powered 21 sites across Houston for as much as 105 hours.

As the microgrid market grows, the array of business models also expands. GTM estimates that about 58 percent of microgrids will be basic—built for customers who want resiliency but don't have the experience or expertise to address regulatory and market complexities with an advanced microgrid.

These customers also may be put off by making a high upfront capital expenditure in their energy plant. They are not energy developers by nature, and a microgrid's expense may deter from their core needs.

Reliability-as-a-service

A business model growing in popularity allows customers to have the benefit of a microgrid—energy reliability—without the high upfront costs and hassle of developing and operating their own. Called "microgrid-as-a-service" or "reliability-as-a-service," the model contracts with a third party that covers the project's capital and operating costs in return for predictable service fees over time. This approach has proven key to growth in other energy markets, among them solar and energy efficiency, because it is a familiar approach: Customers are accustomed to paying for their energy monthly via utility bills.

ERock uses this model, which it calls On Demand Electric Reliability. ERock installs natural gas-fired generator microgrids on customer sites. Texas Microgrid, financed by an investment from Basalt Infrastructure Partners, owns the microgrid, and ERock operates and maintains the system for the life of the agreement. This arrangement lessens the financial burden on the customer as operation and maintenance expenses are one of the largest components of ongoing costs.

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When customers are not using backup power, ERock aggregates the unused generation into a virtual power plant to provide energy and ancillary services to the bulk power grid or local utility in exchange for receiving cost offsets applied to the microgrid system. By selling back to the grid, ERock is able to reduce the cost for the customer to about 10 percent of the cost of ownership of a standard natural gas system and 20 percent of a standard EPA Tier 2 emissions diesel system. ERock's frequent grid interactions both reduce cost and increase reliability, as they provide constant testing and conditioning for the gensets. ERock operates by the principle "run often, run loaded."

The affordable microgrid

"We are different than other microgrid developers," McAndrew said. "They are looking to finance the microgrid solely based on customer payments. We are looking to finance the microgrid on market-based grid services and then minimize the customer payments significantly."

That makes ERock's model the most affordable solution with the highest reliability in the marketplace, he added.

ERock used that model for a deal with Buc-ee's, a chain of Texas convenience stores. The first phase covers 10 Buc-ee's stores, but the chain eventually intends to use ERock's microgrid reliability service at all locations.

ERock has also used the model in an agreement struck with H·E·B, a Texas based chain of 350 grocery stores. The initial phase covers 105 stores across Texas and continues to grow. The natural gas-fired microgrids allowed more than a dozen affected stores to remain in service when Hurricane Harvey knocked out conventional power to the area.

"It is a model that fits well for other customers that value reliability," said Clark Thompson, founding partner and chief technology officer at ERock. In addition to large grocery store chains, he cited health care services, regional hospitals, elderly care facilities, and data centers as likely beneficiaries of On Demand Electric Reliability.

In the next chapter, we explain the benefit of using a microgrid that operates on natural gas when employing the reliability-as-a-service model.

What is an ERock microgrid?

An ERock microgrid uses natural gas-fired generators, installed on the premises of a business, and configured via software into a microgrid. ERock manages the microgrids from its remote operations center in downtown Houston.

When the microgrid senses a power outage occurring on the electric grid, it automatically "islands" or disconnects the store from the grid and starts the natural gas generators. The changeover happens so seamlessly, those inside the store are unaware the grid has lost power and the electricity is now coming from the quiet, onsite generators.

When power is restored, the microgrid reconnects the store—again in a fashion invisible to anyone inside the building. There is no momentary outage or blinking lights as the store moves from being served by its onsite generators back to the central grid.

When the customer is not in need of the backup power, ERock aggregates the generators to provide service to the grid and earns revenue doing so. For example, ERock watches for sudden changes in the market and turns on its fast responding generators when there is a need for power in the market. This revenue can benefit the microgrid host site in the form of reduced service charges.

Thomas McAndrew, ERock president and CEO, points out that using the generators in this way offers benefits beyond cost. Because ERock operates the generators frequently—not just when there is a disaster—they can ensure that the generators are in good operating condition at all times.

This is no small point; it illustrates the difference between a microgrid and a simpler backup generator. A microgrid typically operates often. A backup generator, on the other hand, is called upon to operate only in an emergency. Unfortunately, too often businesses find that when an emergency occurs, their backup generator isn't working.

ERock also ensures reliability for the stores by using natural gas as a fuel. Natural gas is not only cleaner than diesel—a common fuel for backup generators—but it also is delivered via underground pipeline, where it is protected from extreme weather events.

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Chapter 4

Why a natural gas-fired microgrid?

Reliability and resiliency are often listed among the top drivers of installing a microgrid. To meet those goals, however, it is important to consider what will power the microgrid's assets.

Microgrids can have a variety of generation sources, including combustion generators, combined heat and power (CHP), flywheels, fuel cells, energy storage, solar panels and wind turbines.

Because of its widespread availability, diesel has been the traditional solution for engine reliability, whether for backup generators or as part of a resiliency microgrid. But even this workhorse fuel has its limits related to operating cost, availability and environmental impact.

"A resiliency microgrid has to have an infinite fuel source behind it, otherwise that resiliency is really not there.

– Thomas McAndrew, ERock

In particular, during Hurricane Harvey diesel supplies chain was extremely challenged. Many of the nation's largest refineries closed, leading to widespread gasoline and diesel shortages across Texas. Even when diesel was available for purchase, extreme flooding, debris and downed trees and power lines often prevented delivery trucks from reaching sites that had run out of their supply.

Furthermore, when fuel delivery is possible after a major weather event, National Guard units have the right to commandeer fuel trucks destined for commercial and industrial customers.

By the same token, a solar-plus-storage microgrid does not solve the problem. The sun did not come out for five days as Hurricane Harvey battered the Houston area. From a resiliency standpoint, solar panels, even those backed by load-shifting batteries, were not able to perform as first the sun failed and then the batteries.

These problems have not gone unnoticed at ERock. "A resiliency microgrid has to have an infinite fuel source behind it, otherwise that resiliency is really not there," said McAndrew.

82 percent of installed capacity is driven by fossil fuels; of this, about 60 percent is diesel and 40 percent is natural gas, according to "US Microgrids 2017: Market Drivers, Analysis and Forecast."

This points to a key advantage of natural gas over other energy sources during hurricanes, as natural gas is transported by underground pipelines that remain unaffected by severe weather.

While diesel is still the number one microgrid fuel source, natural gas is number two and closing. Specifically, 82 percent of installed capacity is driven by fossil fuels; of this, about 60 percent is diesel and 40 percent is natural gas, according to "US Microgrids 2017: Market Drivers, Analysis and Forecast," published in November 2017 by GTM Research.

Reliability of natural gas

Today, the U.S. natural gas distribution system spans a network of about 3 million miles of pipelines, according to the U.S. Energy Information Administration (EIA), including about 1.5 million miles of low pressure, local distribution pipelines.

Most of those pipelines are underground, which puts them out of harm's way from extreme weather events.

Natural gas also enjoys an inherently more resilient distribution network of about half a million producing wells in 30 states, and unlike electricity, can be stored on a large scale. It also moves slowly enough to be re-routed to bypass problems and potential disruptions, even through high pressure pipelines.

Fewer than 100,000 natural gas customers experienced disruptions in 2016, while 8.1 million Americans experienced power outages, according to the EIA. During the hurricanes that submerged Houston and swept up the East Coast in 2017, virtually no gas outages were reported. In fact, a plentiful supply of natural gas met existing contracts and filled spot market needs, according to the Natural Gas Supply Association. While many customers relying on overhead power lines suffered outages, natural gas demonstrated its reliability and versatility.

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Hydraulic fracturing has caused natural gas prices to drop 47 percent compared with what the price would have been prior to the drilling revolution in 2013, according to a Brookings Institute report.

The supply of natural gas has also expanded rapidly in the past decade thanks to new sources made available from tight shale formations. Using hydraulic fracturing to reach into these formations made the United States the world's top producer of natural gas and oil in 2016 for the fifth straight year, according to the EIA.

That flood of gas has also lowered prices. Hydraulic fracturing has caused natural gas prices to drop 47 percent compared with what the price would have been prior to the drilling revolution in 2013, according to a Brookings Institute report. As a result, natural gas consumers have seen their bills drop $13 billion annually from 2007 to 2013. According to EIA projections, natural gas prices will remain relatively flat, about $5 per million British thermal unit (MMBTU) from 2030 to 2040. Current prices are around $3/MMBTU.

Natural gas as a clean fuel

As an alternative to diesel fuel, natural gas also delivers an environmental bonus in the form of lower nitrogen oxides (NOx) emissions. ERock's gas generators permit for <<0.14 lb/MWh NOx emissions, with an emission rate of less than one percent of a standard Tier 2 diesel generator and less than four percent of a standard Tier 4 diesel generator.

ERock calculates that they have avoided 13,651 lbs of NOx emissions under the assumption that a typical Tier 2 diesel generator would have emitted 13,686 lbs of NOx over the same period. Assuming degradation, in less than a year ERock's natural gas microgrids have emitted 34.65 lbs of NOx during reliability runs.

All in all, a resilient microgrid powered by a gas-fired engine can provide a continuous supply of power with lower emissions and at competitive prices. Gas-fired engines are also among the most efficient forms of generation available. And, with the right design, they can be sited within a relatively small footprint meeting local air quality and noise requirements.

Equally important, a natural gas microgrid is a flexible asset that can be deployed quickly on the grid, unlike solar power or a CHP plant. This allows for the integration of renewables to the grid, as quick-start capacity can balance the grid when renewables are intermittent. As a result, the microgrid can provide various wholesale market services, as we'll explain in the next chapter, that support renewable energy.

Chapter 5

Leveraging wholesale markets to create the affordable microgrid

Gas-fired microgrids offer operational flexibility that is crucial to today's electric grid and complex power markets.

Growing levels of renewable energy penetration are changing the nature of power markets, particularly in competitive wholesale markets. That is especially true in Texas, where 90 percent of the electricity consumed in the state flows through the Electric Reliability Council of Texas (ERCOT).

ERCOT is an independent system operator (ISO) which, like a regional transmission organization (RTO), acts as a clearinghouse between electricity supply (generation) and demand (load). ISOs and RTOs are not-for-profit organizations that manage and operate wholesale power markets but do not themselves own any generation or transmission assets.

ISO participants typically include a wide variety of power producers, from operators of coal-fired and gas-fired plants to wind farms and nuclear power plants. They also include load serving entities, such as regulated distribution utilities.

Seven ISO/RTOs in the United States and three in Canada serve about 60 percent of North America's electric load. Some serve a single state such as California or New York. Most are regional, such as PJM Interconnection, the largest among them, which serves 13 states and the District of Columbia.

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Wholesale power markets and microgrids

The basic mechanism of an ISO/RTO is the day-ahead market. Rules vary by region, but in general generators bid into the day-ahead market. The grid operator then ranks the bids and dispatches the generators from the lowest to the highest priced until all forecast load is filled.

In addition to a day-ahead market, ISO/RTOs can oversee markets for a variety of other functions that are needed to continuously balance supply and demand of electricity. These ancillary services include services referred to as frequency regulation, spinning reserves and operating reserves.

When large amounts of surplus wind energy enter the grid, prices can go negative due to excess power availability. When the wind suddenly dies, the grid may run short on power. Traditional fossil fuel generators cannot ramp up quickly enough to meet the near-instant demand for power.

Wholesale markets across the country have seen growing levels of renewable energy penetration, particularly Texas. Last spring, ERCOT hit a record with wind power supplying just over 48 percent of load. The Southwest Power Pool also set a record with wind power supplying nearly 44 percent of load.

While high levels of wind power may be good for the environment, their unpredictable nature can create challenges on the smooth operation of the grid. When large amounts of surplus wind energy enter the grid, prices can go negative due to excess power availability. When the wind suddenly dies, the grid may run short on power. Traditional fossil fuel generators cannot ramp up quickly enough to meet the near-instant demand for power.

In ERCOT, the growing presence of wind power combined with price volatility has made it tough for many traditional power plants to operate profitably. A total of about 5,625 MW of fossil fuel capacity in ERCOT (enough to supply the Austin and San Antonio, Texas metropolitan areas combined) is scheduled to be retired or mothballed in 2018. Even new, modern gas-fired combined-cycle plants, such as Panda Energy's Temple plant, have had difficulty operating in this challenging market. In April 2017, Panda filed for bankruptcy court protection for the plant.

"When we sell to the grid, we respond very quickly to help buffer the intermittent nature of wind and solar, thus enabling continued growth of these renewables and decarbonization of electricity."
– Thomas McAndrew, ERock

With the closing of these power plants, the Department of Energy (DOE) introduced a Notice of Proposed Rulemaking (NOPR) that would provide cost recovery for coal and nuclear plants that keep fuel on site. The NOPR was rejected by the Federal Energy Regulatory Commission (FERC), as there was no evidence to support the claim that these traditional power plants aid in grid resiliency. FERC Commissioner Richard Glick, however, acknowledged microgrids as a technology that does.

Resiliency is a defining feature of microgrids and industry leaders are actively discussing the benefits they can provide for the nation's energy markets.

"ERock builds and operates ultra-clean and quiet resiliency microgrids specifically to provide electricity for critical services when the transmission and distribution cannot deliver," McAndrew said. "We own and operate these microgrids, providing electrical resiliency as a very affordable service by maximizing revenues from selling to the electric grid, thus minimizing the price to our customer. When we sell to the grid, we respond very quickly to help buffer the intermittent nature of wind and solar, thus enabling continued growth of these renewables and decarbonization of electricity."

Innovative microgrids could be the answer our power grid is looking for.

Microgrids can operate both within the grid and independently of it. McAndrew said ERock has adapted its business model to fit the economics of the modern wholesale market by looking beyond average wholesale market prices and at the more granular price opportunities created by intermittent resources. Hence, the operational flexibility of a gas-fired engine is an important consideration in the modern electric power market.

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How microgrids operate during price spikes

When continuously monitoring the wholesale power market, it becomes apparent that the "average price is made up of a lot of negative price periods and frequent price spikes," McAndrew said.

For example, ERock's microgrids at the 105 H·E·B grocery stores across Texas allow the stores to remain in business when the surrounding grid goes down. During normal operation, however, ERock sells the output from the generator into ERCOT's energy and ancillary service markets, and offsets its capital and operating costs.

H·E·B food retailer

Founded in 1905, H·E·B. is one of the largest independently owned food retailers in the United States. H·E·B serves families all over Texas and Mexico in 155 communities, with more than 340 stores and over 100,000 employees. The company has won the retailer of the year award from Progressive Grocer Magazine because of its industry contribution, industry leadership, achievements with social responsibility and sustainability, community leadership, executive stewardship and corporate culture.

Any individual microgrid at one of the H·E·B stores may be small, but by aggregating them, ERock creates a virtual power plant that, with the assistance of software controls, can watch for sudden changes in market conditions. Hence, a simultaneous spike in load and drop in wind production could indicate a need for fast responding generation.

ERock's generators can respond more quickly than the fastest, centralized quick response generators, and much faster than the traditional natural gas combined cycle plants that provide much of ERCOT's baseload fossil generation, according to McAndrew. ERock's generators also respond more quickly than competing generators used for the same purpose, with response times as fast as one minute compared to five minutes for a comparable Wartsila generator. When market conditions change, ERock turns off its virtual power plant.

The ERock model beyond Texas

So far, ERock has employed its model in its home turf of Texas, but the company says it can work in many other parts of North America—and the world. As a result, ERock has begun expanding into other power markets.

Perhaps most important, the ERock approach—reliability-as-a-service—offers universal appeal to a range of potential microgrid customers, including retail stores, manufacturers, business parks, institutions and communities. ERock's affordable microgrid brings them microgrid reliability with little capital expenditure and a predictable energy cost over time.

In the next chapter, we profile stores that kept the lights on during Hurricane Harvey using ERock microgrids.

Chapter 6

Profile: how microgrids served Texas during Hurricane Harvey

Hurricane Harvey left Texas with $125 billion in damages, record rainfall, flooding that displaced 30,000 people, and destruction of more than 200,000 homes and businesses.

After the Category 4 Hurricane struck Aug. 25, 2017, Houston looked like little more than an inland sea dotted with islands, according to the New York Times.

In all, the hurricane caused 91 confirmed deaths.

But even as Harvey made its name as one of the most destructive storms in U.S. history, second only to Hurricane Katrina, there was some good news. Twenty-one grocery stores and gas stations were able to continue to provide food, fuel and water to beleaguered storm victims.

Those who found the H·E·B. and Buc-ee's stores open were probably unaware that they were witnessing the demonstration of a technology—the microgrid—that energy insiders believe will help keep us safe as climate change leads to increasingly severe weather.

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Buc-ee's travel centers

Founded in 1982, Buc-ee's operates travel centers — stores and fueling stations — at 40 locations in Texas and Florida. The company is noted for operating the world's largest convenience store, a 67,000 square feet space in New Braunfels, Texas.

Buc-ee's is in the Guinness World Record for world's longest car wash, a 225-foot-long facility at its Katy, Texas store.

As more than a quarter of a million homes and businesses struggled in the dark, three Buc-ee's and 18 H·E·B. stores were affected and still had power, thanks to ERock. In doing so, the stores were able to serve as an important community resource.

The Texas-based microgrid company describes its mission as "keeping businesses in business by ensuring electrical reliability." But it did more than that as flood waters poured into Houston. ERock also discovered it was inadvertently in the business of helping rescue workers stay in business too.

Trying to coordinate rescue efforts during a power outage is a daunting task. Fortunately, workers found an electrified base of operations from which they could work: A Buc-ee's store in Katy, Texas, still open because of its ERock microgrid. The region was heavily flooded, and many residents were forced to evacuate. But a National Guard unit, a search-and-rescue team and several state agencies were able to operate out of the store.

"Buc-ee's was honored to host the first responders and national guardsmen at our Katy store during the recent disaster caused by hurricane Harvey. We were confident that our ERock generators would keep the lights on," said Jeff Nadalo, Buc-ee's General Counsel.

Conclusion

Electricity is increasingly important to our safety and well-being as digital technology governs more and more of our world. But severe storms, wildfires and cyberattacks threaten to undermine the reliable flow of electricity. The time has come for more widespread implementation of the affordable microgrid.

The reliability-as-a-service model innovation leads the way for affordable microgrids by minimizing upfront capital costs for businesses and institutions that seek greater reliability. This model has the potential to make electrical resiliency accessible to 100x the number of commercial, industrial and institutional customers, while allowing the integration of renewable energy sources — reducing economic and community impact like never before.

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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