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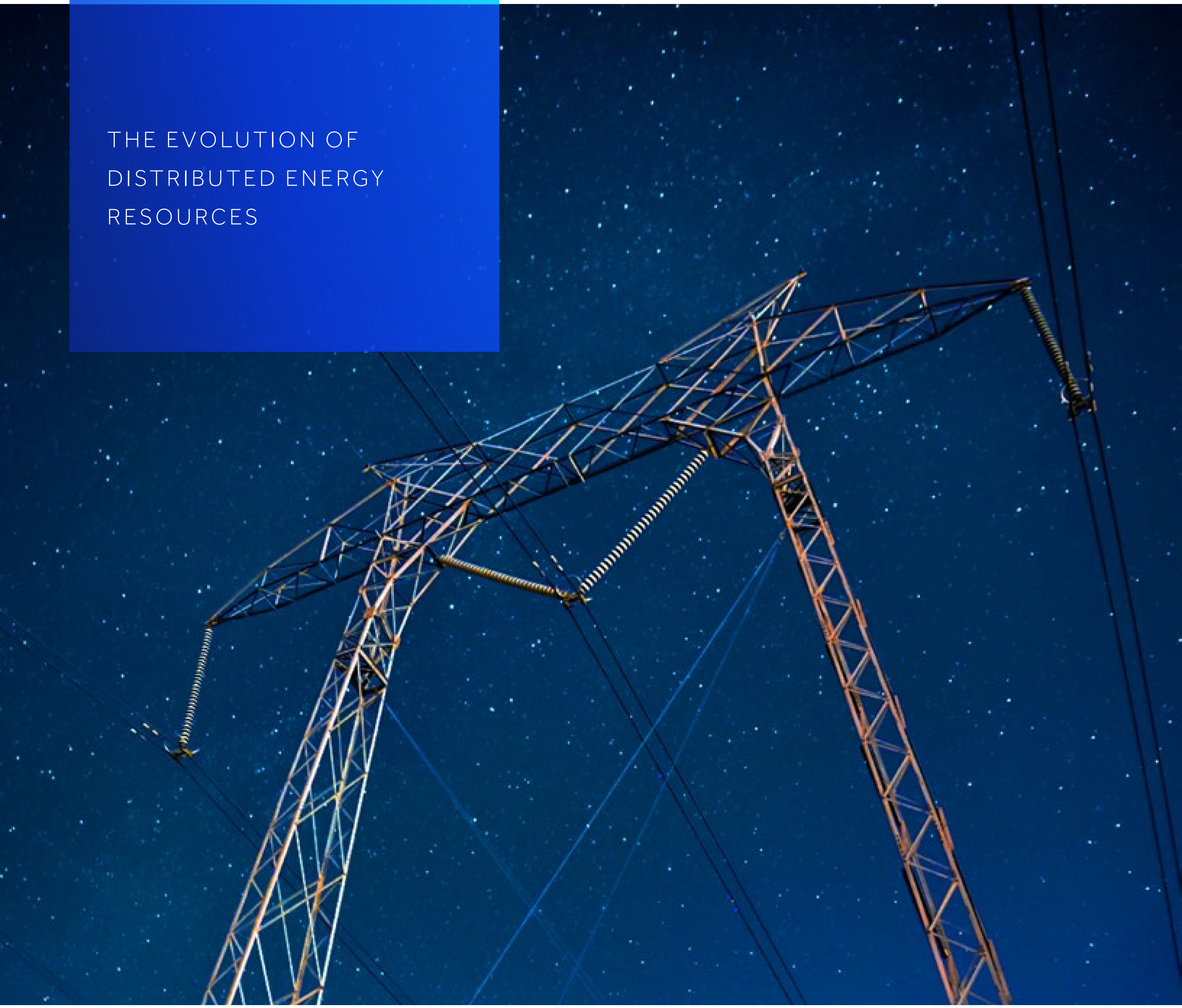
THE EVOLUTION OF DISTRIBUTED ENERGY RESOURCES



What the Rise of Local Energy Means for Businesses, Institutions, and Communities

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Overview

How the Energy World Is Changing

In the words of Pittsburgh Mayor Bill Peduto, we will enter a time soon when we no longer make our morning toast with energy sent from a power plant hundreds of miles away. Peduto is describing an evolution toward a more decentralized power grid, a shifting away from electricity delivered via large central power plants and long transmission lines.

The new paradigm calls for use of local resources, such as rooftop solar, small natural gas generators, and microgrids that combine several electricity solutions. Rather than being in another city or even state, these are resources located within neighborhoods, businesses, college campuses, hospitals, and government complexes—near the communities they serve.

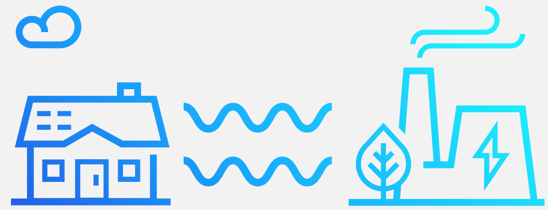
The proximity of consumption prevents loss of electricity as it travels over wires. This translates into greater efficiency, which in turn can lower energy costs while achieving more sustainable power.

But the significance of this reconfiguration extends beyond geography. It can change who's in charge of electric power. Once almost solely the domain of utilities, electricity now can be generated and controlled by independent companies, as well as those who use it. Consumers and businesses can produce their energy and, in some cases, sell their excess back into the market, as once only energy companies could do.

How did this shift come about and what does it mean for energy-intensive organizations? Who is eligible to participate in the local energy revolution? What are the advantages and the challenges? Is it better to go it alone or seek expert assistance?

This report makes plain the complexities involved in capturing DER benefits. Some of the most significant advantages occur within wholesale energy market transactions, a complex arena best pursued with guidance from experts in the space. Fortunately, specific contractual arrangements and programs now exist that allow organizations to reap the rewards of DERs without the headaches.

"The Evolution of Distributed Energy Resources: What the Rise of Local Energy Means for Businesses, Institutions and Communities" is timely, given the pace of change in energy technology and lack of knowledge among energy users about new possibilities. Meant to help educate businesses and organizations, this report is available as a free download, courtesy of NRG. We welcome you to share the link widely.



Written for decision-makers within businesses, communities, and institutions, this special report offers perspective on the forces transforming the grid—regulatory, market, and technological. Low energy prices, competitive energy markets, and technological advances present a historic opportunity for energy consumers to take "ownership" of their power. Why do this? Under the right circumstances, if the grid goes down, the power would likely stay on for customers with local energy. Moreover, use of local energy opens opportunities to improve energy efficiency, price management, and sustainability in ways not available with conventional power.

While energy industry insiders are well aware of these changes, many energy consumers are not. For those managing large energy budgets, such as commercial operations, industrial facilities, hospitals, and universities, this can mean money left on the table. Microgrid Knowledge produced this report, sponsored by NRG Energy, Inc., to help these sectors understand the suite of new energy options.

This five-chapter guide explains local energy— also called distributed energy resources (DERs)—with a focus on microgrids and nanogrids: what they are and offer, how they gained importance, and how they can be managed within wholesale markets to leverage maximum value. Chapter 1 explains terms and dives under the hood of microgrids—the most complex of DERs. Chapters 2-4 then look at the evolution of DERs from a technology, regulatory, and market perspective. And finally, Chapter 5 discusses how these forces led to today's market opportunity.

Chapter 1

Lifting the Lid on Local Energy

DERs represent a departure from the conventional electric grid because of their proximity to the customer and the way they function. To grasp DERs and their significance, it's important to first understand the grid.

In the U.S., an interconnected, centralized grid delivers electricity from about 7,300 power plants through 160,000 miles of high-voltage power lines and millions of low-voltage lines to about 145 million customers.

Distributed energy sits at a different position on the grid—not at the center, but along the edges, close to customers. Common DERs are fossil fuel generators, solar, rooftop wind, combined heat and power (CHP), fuel cells, energy storage, microgrids, and nanogrids.

Most DERs in the U.S. are connected to the grid. They typically run when doing so is less expensive than buying power from the grid. DERs also provide power and services to the grid—in return for payment—when the economics warrant.

These exchanges can occur because of advancements that allow DERs to do more than just generate power. With the addition of new software and controls, these tools make energy management more versatile, flexible, reliable, and cost-effective.

Among DERs, microgrids are particularly important as they offer some of the greatest benefits and are increasingly an option for decision-makers.

Microgrid: A complex form of DER

A microgrid is a complex form of DER, or rather, a self-reliant organization of several DERs. Its generation, storage, and customers are all contained within a discrete geographic footprint while its energy is organized by a master software controller. (Note: Nanogrids operate in a similar fashion, but generally serve a smaller footprint, typically one building.)

Microgrid operators set controls to accomplish goals desired by the customer, including lowest possible energy price, greatest system efficiency or reduced emissions.

Equally important, the microgrid serves as a form of backup electricity. When a power outage occurs, it can "island" or disconnect from the grid and employ its on-site generators to ensure electricity flows to the host buildings.

Not just backup power

A mistaken notion is that a microgrid serves merely as backup generation during a power outage. Unlike a backup generator, a microgrid can run 365 days a year, managing multiple internal resources. This makes it more reliable than backup generators. During Superstorm Sandy, critical facilities including hospitals discovered too late that their backup generators did not work. Since a microgrid runs often, malfunctions are discovered more quickly and can be repaired before a crisis.

What's inside a microgrid?

Microgrids can vary widely in size. A microgrid may generate enough power for a few homes or an entire community. Some begin small and later, add more generation resources. A microgrid can easily scale to its host's needs.

A microgrid's internal resources can vary tremendously as well. Some include only renewable energy; others contain traditional fuel generators; many are a combination. Common resources include natural gas and diesel generators, solar panels, wind turbines, fuel cells, and even sometimes electric vehicles. Microgrids also increasingly include energy storage.

A microgrid's generation mix depends on a range of factors, including the host's energy goals, operational parameters, and accessibility to a particular fuel. Another consideration is the host's need for thermal energy. Early microgrids, as well as many newer systems, use CHP if they require large amounts of heating or cooling. CHP uses the heat byproduct of electricity generation to produce steam, hot water or space heating or cooling for a practical purpose—to heat or cool a building or serve a manufacturing process. Because it uses one fuel source to produce two forms of energy, a CHP system is highly efficient.

In addition to generation resources, a microgrid contains infrastructure such as wires, cables, switches, piping, and transformers to distribute energy from source to host. Digital sensors and actuators imbue the system with data-gathering and sharing capabilities, as well as real-time response and management abilities.

Microgrid controllers—sometimes called the "brains of the microgrid"—manage and optimize its working software and DERs.

Microgrid intelligence

By coupling algorithms and instructions embedded in software and communications systems, controllers sit at the intelligent core of a microgrid platform.

Microgrid controllers manage the system's generation resources, load requirements, frequency, voltage, and connection to the central grid. These software-based devices balance generation and load, and respond to any changing conditions. In an advanced microgrid, one master controller provides primary management while several secondary controls serve specific functions.

Controllers range in function and features depending on the project's scale and scope, as well as the client's budget, needs, and expectations. The simplest microgrid controller may integrate a single on-site source of power —a natural gas-fueled generator, for instance—and balance its output with internal load.

Microgrid controller capabilities can get much more complex from there. Advanced controllers continuously monitor and balance on-site generation with internal loads and utility grid power.

New, more intelligent controllers integrate predictive analytics software. They can identify problems and issue instructions that prevent costly and hazardous system failures. Some include weather forecasting so operators are aware of available solar or wind power. Others can identify the potential for storms, helping its operators prepare ahead of time and ensure they have the fuel supply and workers present in the instance of power outages that would necessitate a microgrid island. The most sophisticated can forecast electricity and fuel pricing and optimize resource use. Based on their pricing analytics, they may choose to use grid power, internal resources or some combination of both at any given time.

The following examples show where microgrid controllers realize benefits.

Conserve energy

The central grid is under strain or an outage has occurred. Sensing a problem, the microgrid islands from the main grid and serves host buildings with internal generators. However, the on-site production is insufficient, so the controller begins "shedding load"—reducing electric consumption by switching off devices, equipment or entire buildings not crucial. Such shedding also may occur when prices are high as a way to save on cost.

Maximize clean energy

The controller may be programmed to maximize use of renewable energy when it's available. The microgrid may rely on solar panels during the day when sunlight is plentiful. It may even store some energy in batteries. Then, during evenings it will discharge the batteries. When the charge is spent, it may then turn on its natural gas generators.

Manage price

Electricity prices vary throughout the day and night. Some advanced microgrid controllers monitor price forecasts and choose the combination of resources—grid or internal—that offer the best price at any given time.

Selling to the grid

Depending on the rules of the local grid operator, the microgrid might also sell power and services, such as system balancing, voltage and frequency control, and spinning reserve, back to the grid. The microgrid may also participate in demand response—curtailing its use of grid power during periods of high demand—in return for compensation.

> *What is demand response? Electricity customers participate in demand response by reducing their usage during peak periods. Customers may take a range of actions, from dimming lights to rescheduling work shifts to relying on on-site generators. In return, they receive financial compensation.*

In addition to intelligently managing energy, the controller helps realize another crucial microgrid benefit: the ability to supply highly reliable power as described next.

How does a microgrid ensure reliable power?

Placing generation near the consumer enhances electric reliability, since there is less chance for the flow of electricity to be disrupted by a damaged wire along the path. But this technology goes a step further.

The microgrid's ability to island during a power outage is one of its hallmark features. In island mode, the microgrid essentially operates autonomously and relies on internal generators to serve its host.

As a cost-saving measure, a host may require only critical needs be met within its buildings—perhaps the emergency room of a hospital or freezers in a food processing plant. The microgrid serves the most important functions first and then works sequentially down a list of lesser priorities.

Newer, advanced systems make the switch between grid and island mode seamlessly; those inside the buildings are unaware of this electricity shift.

When microgrids come to the rescue

Microgrids have kept the power flowing during storms and disasters many times in recent years. Here are a few examples:

- Puerto Rico experienced nationwide outages after Hurricane Maria hit on September 20, 2017. Dozens of microgrids were quickly developed to power certain critical facilities and remote areas. Those microgrids proved their worth when a contractor's truck severed a main utility line on April 18, 2018. The island again plunged into darkness, except for facilities and neighborhoods served by microgrids.
- Californians beyond the reach of wildfires sometimes feel repercussions from power outages when utility equipment is destroyed. Such was the case in Sonoma Valley, where Stone Edge Farm Estate Vineyards and Winery operates a microgrid. When the surrounding grid went down, the microgrid transitioned into island mode for 10 days, allowing the farm to continue irrigating its 16 acres. Eventually staff were forced to evacuate, but they continued to operate the microgrid remotely.
- When Superstorm Sandy knocked out power to 8.1 million people in 2012, several microgrids continued to function, most notably in New York and New Jersey, where hospitals and universities were early adopters of the technology.

Who uses microgrids?

Given their ability to keep power flowing, it's not surprising microgrid development is on the rise. Their importance grows as society becomes increasingly electricity dependent and power outages threaten safety. Economics also are spurring microgrid development. The cost of microgrid components has been dropping, opening the opportunity to more organizations.

It's clear why these organizations would install microgrids, considering the reliable power and sophisticated energy management they offer. But what forces brought the energy world to this point—and what else might customers expect as technology advances?

We answer these questions in the next chapters.

Chapter 2

DER Technology Comes of Age: Smart and Sophisticated

Distributed generation used to be simple. Put a generator in a building basement or solar panels on a roof and the job was done.

But today's DERs do more than produce generation. As microgrids demonstrate, they've become sophisticated management tools for complex combinations of energy resources and can provide a range of new price, environmental, and system efficiency benefits.

How did this growth in digital intelligence and management capability come about?

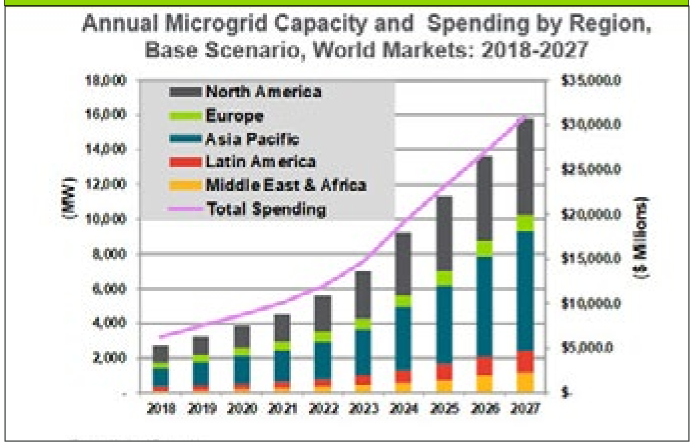
The path to smart DERs started a couple decades ago, when demand response was a relatively new tool to curtail peak demand on an overtaxed power system. Early on, interruptible rates served as a key enabler for demand response, providing incentives for customers to reduce electricity use. In that scenario, curtailment was driven by radio controls and pagers, relatively primitive technology by today's standards. As electronics and controls advanced, demand response systems became capable of more automated and precise two-way communications between the grid and individual devices, or loads, on the system.

Adding innovation to demand response

Technological advances in DERs and their controls, combined with key regulatory changes (see Chapter 4), spurred further innovation and opened new markets in demand response.

Organizations began to realize they could also participate in demand response programs by combining a backup generation source with battery storage and linking them together with advanced electronic controls. Rather than reduce business operations or dim lighting, they could instead curtail use of grid power with an on-site generator. From the grid operator's perspective, the action produces the same result— the customer consumes less power when the grid is overtaxed.

HOW FAST WILL GLOBAL MICROGRID MARKET GROW?



Navigant forecasts that the annual market for microgrids will grow from about 3 GW in 2018 to 16 GW by 2027.

This approach also opened a new way to minimize utility demand charges. Such charges can be onerous for large energy users because they are set based on their electric usage during a high-cost peak period. By reducing usage at the right time, the organization could lower the charges. Operating on-site generators during this time is one way to do so.

Evolution of microgrids

The next step was to use more than one generation resource and manage them for greatest economic flexibility. An early microgrid—although it wasn't yet called that—tended to use a CHP plant that could operate either independently or connected to the grid. Another variation paired the CHP plant with a second form of generation, often a fossil fuel backup generator.

Later, solar photovoltaics (and sometimes wind turbines) began to appear in the microgrid generation mix. This trend intensified with a decline in renewable energy costs, coupled with the drive by organizations to achieve sustainability goals.

Energy storage became the latest addition as battery prices fell. Batteries also proved to be effective energy management tools, charged when electricity prices are low and discharged when prices are high. While batteries are the most common form of storage, a microgrid may also use thermal storage, which can employ a range of mediums such as ice, earth, and concrete to capture and store heating and cooling.

Innovation leads to growth

A market research report from Deutsche Bank predicts that in 2018, the amount of new distributed generation may exceed the amount of new central generation globally. The report estimates that the current 1 GW DER market could grow to over 40 GW by 2022, and by 2023, distributed generation could supplant the need for 320 GW of large-scale power plants. The increase in DERs will, in turn, drive the need for intelligent distribution networks comprised of nanogrids, microgrids, and virtual power plants, according to the report.

The path ahead

Despite their growth, DERs and microgrids face barriers to wider adoption. For example, a microgrid with only diesel generators may risk exceeding legal emissions limits if it runs too long. Financial and regulatory barriers in certain cases may also inhibit DER adoption. Expert opinion varies on the relative importance of those barriers.

Distributed resources plans (DRPs) can lay the groundwork for integrating DERs into a utility's grid, by delineating hosting capacity on the grid, providing locational values for DERs, and streamlining interconnection procedures.

A white paper by consulting firm West Monroe Partners found that:

- 61 percent of utility executives identified capital and financial constraints as the top barrier to DER adoption
- Only 46 percent of those executives identified regulations as a barrier
- 61 percent of regulators identified inadequate regulations as the top barrier
- Only 33 percent of the regulators saw capital and financial constraints as a problem

This gap in perception highlights some of the challenges the microgrid industry faces in prioritizing reforms that will lead to wider DER adoption.

On the financial side, the lack of long-term offtake contracts raises concern. Much of the wholesale electric power in the U.S. is bought and sold on the short-term or spot market, an arena sometimes long on volatility and short on revenue that financiers seek.

On the regulatory front, many states lack clear policies on DER integration with the grid. That's starting to change. Several states, notably California and New York, have adopted policies aimed at DER integration. Similar policies have also been put in place at the federal level (see Chapter 5) with more in the works.

Formal state requirements for utility adoption of distributed resources plans (DRPs) also assists DER development. DRPs can lay the groundwork for integrating DERs into a utility's grid, by delineating hosting capacity on the grid, providing locational values for DERs, and streamlining interconnection procedures. In a white paper, the Lawrence Berkeley National Laboratory noted that eight states have adopted some form of DRP requirement for their investor-owned utilities.

Microgrids and DERs have come of age, offering sophisticated technology and services that energy users both need and want. It is now a matter of regulation, markets, and business models catching up. As we'll see in the next three chapters, this is already happening.

Chapter 3

The Market Evolution of DERs

Government incentives have heavily shaped DER growth over the last two decades, particularly for renewable energy and energy storage. But DERs are increasingly being built for other reasons as well, some readily quantified in markets and others involving human comfort and safety.

The advent of net metering about three decades ago marked a pivotal point for DERs. Through net metering, a utility pays customers for the solar energy they generate but do not use. This tends to happen midday when solar power is often plentiful, but household energy use is low. The policy spurred rooftop solar installations as 40 states instituted the programs. For years, the residential solar market experienced an annual growth rate of 50% or more according to the Solar Energy Industries Association.

But for utilities, net metering meant loss of revenue that they argued would lead to an undue burden on lower-income ratepayers. As they saw it, those who could afford solar panels would buy less utility electricity, leaving a smaller number of customers—those who could not afford solar panels—covering utility fixed costs.

Concerned about looming rate inequity, state regulators began reforming net metering rules about three years ago. Some states, such as Hawaii, rescinded net metering, while Arizona began to impose fixed charges on new solar customers. This trend continues as more states reconsider their net metering rules.

As a result, policymakers and solar power companies began devising new ways to value solar power and other DERs.

Shift in business models ushers in microgrids and DERs

The loss of net metering has proven to be a boon for energy storage. More organizations have begun pairing storage systems with their solar installations in what's known as solar plus storage. Doing so takes some of the sting out of losing net metering by creating a new, favorable economic model. Solar plus storage can be used to avoid or reduce demand charges and to arbitrage the difference in electricity prices between times of peak and low demand.

Following this model of leveraging markets and pricing, even more revenue opportunities are emerging for the microgrid and other DERs.

It turns out that a microgrid has several distinct potential revenue streams. These include price arbitrage opportunities—leveraging internal resources against real-time electricity prices to achieve the lowest cost mix of energy resources at any given time. A microgrid also can sell ancillary services to the grid. For example, it might provide frequency regulation service by injecting or absorbing energy to maintain the grid's critical balance between supply and demand. Or the microgrid might offer standby power—known as spinning and non-spinning reserves—that grid operators require should a generation source fail.

In addition, microgrids are increasingly valued as grid management tools. They can be used to smooth out the intermittency of renewable energy resources such as wind and solar power, quickly injecting power if cloud cover diminishes generation from a utility solar plant, for example.

Microgrids and other DERs also are used as non-wires alternatives (NWAs). A good example of an NWA is New York's Brooklyn Queens Demand Management (BQDM) project. Instead of spending $1 billion on a substation upgrade, Consolidated Edison (ConEd) is seeking a mix of microgrids, energy efficiency, demand response, and energy storage to fulfill its need.

In addition, DERs and microgrids can be used as an alternative to building new transmission and distribution (T&D) lines, which is what Arizona Public Service did when it installed a battery storage system instead of rebuilding about 20 miles of T&D lines to serve the small community of Punkin Center.

Valuing DERs

Determining DER value in the above examples is fairly straightforward; markets set the prices. Valuing another benefit—energy reliability and resilience—is not so simple, yet may be the primary reason an organization installs a microgrid.

What is the difference between energy reliability and energy resilience? Energy reliability refers to the ability to avoid power outages. Energy resiliency describes the ability to bounce back quickly from an outage.

Whether it is wildfires in the west or hurricanes in the east, recent experience has demonstrated great need for a reliable backup to grid power.

For example, it took more than 10 days to restore electricity to 350,000 customers after fires ravaged California's wine country last year. Utility customers in Florida had a similar experience when Hurricane Irma knocked out power to 4.4 million customers. Puerto Rico's electric grid still reels from the effects of Hurricane Maria many months later.

These events add to the urgency for greater energy resiliency, a need that took sharp shape in late 2012 after

Superstorm Sandy knocked out power to parts of New Jersey and New York for two weeks. Public awareness grew about the value of microgrids and DERs when certain universities, hospitals, and communities remained online as others around them were in the dark.

In Lower Manhattan, New York University's CHP plant kicked in and kept power flowing to 22 buildings until Consolidated Edison restored power. NYU estimated that under normal circumstances the plant would save between $5 million and $8 million a year in energy costs. Sandy was not normal, but it validated the value of the plant.

The same was true in the Bronx where Co-op City, the largest single residential development in the U.S., maintained power from its on-site microgrid even as the surrounding neighborhoods went dark.

It is difficult to quantify the value for these New Yorkers of having light and heat through the storm, let alone to first responders. However, we do have a sense of the overall price to the economy when an electric outage occurs. For example, a U.S. government report has estimated that weather-related outages from 2003-2012 cost $18 to $33 billion annually.

How does an organization apply that number to its operation, especially for an unpredictable outage that will occur at some unknown date?

This inability to value energy reliability and resiliency creates confusion for organizations that wonder if they are paying too much by installing a microgrid to keep power flowing.

But the lesson seems to be taking hold even without hard numbers, and investment is being made in energy reliability and resiliency. GTM Research forecasts that U.S. microgrid investment will reach $12.5 billion by 2022. And states such as California, Connecticut, New Jersey, and New York are all ramping up investments in DERs and microgrids. In California, for instance, the state recently awarded $51.9 million to 10 microgrid projects. New York has established the NY Prize, a competition program to distribute $40 million for microgrid development.

Many reasons—from energy reliability to conservation — encourage microgrids and DERs, but frequently it becomes a dollar-and-cents decision. Fortunately, business models are emerging that offset a microgrid's cost based on its market play without placing a price on reliability. Regulatory changes also bolster the industry, as described in the next two chapters.

Chapter 4

The Rise of Microgrids and DERs: Out of Competition Came Innovation

The policies behind the DER flourish go back to the passage of the Public Utility Regulatory Policies Act (PURPA) of 1978.

PURPA was the legislative response to oil price shocks. The law aimed to foster energy independence by creating incentives for greater efficiency in the electric power sector. It also provided incentives for small wind generators, hydropower plants, and CHP.

Because CHP is highly efficient and saves on fuel, PURPA's authors wanted to encourage its development by independent, market-driven entities. They created a rate mechanism known as avoided costs and amended the Federal Power Act with what became known as "the PURPA put." This guaranteed a developer that if its project met PURPA requirements, the utility had to buy the output at the avoided cost determined by state regulators.

The new language ensured 1) a market for electric power and steam produced by small power plants; and 2) that those plants would be paid a fair rate.

Proof competition works

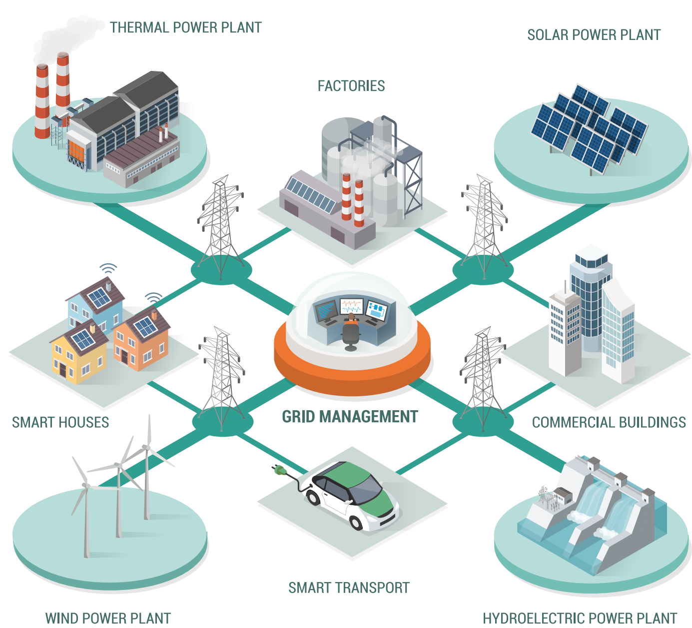
No one at the time dreamed the idea would take off as it did, but applications to build PURPA plants flooded utilities in several states. Initial projects included small hydro plants, wind farms, and waste coal plants. Eventually, natural gas-fired plants came to be included.

Viewed as proof that competition could work in the electric power sector, PURPA became a wedge in the door of the electric utility monopoly. To widen the crack, Congress passed the Energy Policy Act of 1992 (EPAct 92), which created open access on transmission lines and a new class of generators to compete with utilities to build new power plants. EPAct 92 also instituted a production tax credit for wind power plants.

The Federal Energy Regulatory Commission (FERC) followed EPAct 92 with two orders to further open markets. Order 888 in 1996 required vertically-integrated utilities to provide universal access to their transmission systems via an open access transmission tariff. Order 2000 in 1999 mandated the creation of competitive wholesale markets by the formation of regional RTOs and ISOs.

These two laws, combined with the FERC orders, in effect deregulated the electric power industry. A century-old monopoly business became competitive. Now two-thirds of U.S. electricity consumers receive power that flows through competitive wholesale markets.

Less competition exists on the retail level. Retail choice—the ability of customers to choose energy suppliers—became a state-by-state decision. States in the Southeast, and to some extent the Southwest and parts of the Midwest, did not embrace retail choice. Those that did were in New England, the Northeast, the Mid-Atlantic and some in the Midwest. California embraced deregulation, but after the 2000-2001 energy crisis, walked back on some elements. The result is a patchwork of regulated and deregulated states.



Laying the groundwork for DERs in wholesale markets

Deregulation also laid the groundwork for a wide range of new services in the power sector, such as demand response. And by instituting retail choice—the ability for customers to switch electricity suppliers—deregulation created a new energy business: the competitive retail supplier. This helped electricity customers become comfortable with buying electricity from a company other than their traditional utility.

By offering customer choice and freeing various players to participate in electricity markets, these events served as precursors to today's microgrid and DER opportunities.

The renewable portfolio standard (RPS) became the most effective of the state-level incentives. An RPS mandates that a certain percentage of utility sales in the state be derived from renewable energy sources.

The competitive markets continued to grow with the production tax credit (PTC) instituted in EPAct 92, spurring a boom in wind power development. Later, the federal government added a tax incentive for solar, launching its rapid growth and eventual integration into microgrids.

The Energy Policy Act of 2005 pushed restructuring even further, rescinding the 1930s era Public Utility Holding Company Act and weakening PURPA to reflect the prevalence of competitive markets. It also mandated that utilities institute net metering.

Soon a combination of federal and state level incentives opened the door to a DER boom. The renewable portfolio standard (RPS) became the most effective of the state-level incentives. An RPS mandates that a certain percentage of utility sales in the state be derived from renewable energy sources. A total of 29 states plus the District of Columbia now have RPS mandates, and eight states have non-binding renewable energy goals.

Hawaii's RPS is the most ambitious, requiring that the state be powered with 100 percent renewable energy by 2045. Several other states also have robust RPS targets. For example, California and New York both have a 50 percent by 2030 target. Most states meet RPS targets have with wind power.

Policies are still being worked out, but the net result is a power market that offers DERs more potential revenue sources than ever before.

FERC moved to open markets more in 2008 by issuing Order 719, which allows demand response to participate in the wholesale competitive power markets on an equal footing with generation. FERC followed that with Order 745, on how demand response resources are compensated in the wholesale power markets.

To adapt the wholesale power markets to the latest technological changes, FERC issued Order 841 in February 2018. This directed RTOs and ISOs to remove barriers to participation by energy storage resources in competitive wholesale power markets. FERC also opened an inquiry into the integration of aggregated DERs in wholesale power markets.

Some of those policies are still being worked out, but the net result is a power market that offers DERs more potential revenue sources than ever before.

In the early days of electric competition, supporters said it would lead to technology innovation and better services for energy customers. Today microgrids and intelligent DERs show the predictions were correct, particularly under new business models that have emerged, as discussed in the next chapter.

Chapter 5

How Customers Can Get Full Value from Microgrids and DERs

A push-and-pull between government energy policy and technological evolution helped promote today's microgrid markets. Those who understand the changes—and how to maximize opportunities—stand to gain the most from local energy.

Government pushed technological innovation via incentives and a gradual opening of wholesale markets. This led to greater production, economies of scale, and falling prices. And that in turn led to even wider DER penetration.

Now technology, is shaping the government, as software capabilities, electronic controls and energy storage advance faster than regulation. Federal and state regulatory agencies are scrambling to understand and react to the trends, exploring questions about the value of DERs, how to give them a fair position in markets, and what role, if any, utilities should play.

At the same time, the government is creating new mandates for renewable energy—requirements that add cleaner but also less consistent energy resources to the grid. Solar and wind energy ebb when the sun is not shining or wind is not blowing. So other sources of energy must balance supply and demand. Microgrids can receive monetary compensation for providing this service.

Energy companies with extensive market experience understand not only where these changes are leading, but also how to maximize them now for customers. For microgrid technology, in particular, the opportunities are substantial, as microgrid operators increasingly use the technology for energy arbitrage and sale of services into a competitive wholesale market.

That changes the business equation for the microgrid industry. When a microgrid is used as more than backup power—and instead becomes a means to cut costs and generate income—payback can be quicker.

Still, due to wholesale market complexity, even a flexible microgrid may face barriers to full use of its assets. Each of the RTOs and ISOs in North America have rules and regulations that require a level of sophistication from participants. A business that does not specialize in energy is likely to become overwhelmed if it tries to navigate these markets on its own.

Fortunately, the industry is now adopting financial models pioneered by the energy efficiency and solar industries when they faced similar problems.

Expert management and no upfront costs

Both the energy efficiency and solar industries grew by offering contracts that spared customers from paying upfront equipment costs and assuming operational risk. Instead, they employed a third-party ownership model.

For microgrids, this means a third party owns and operates the equipment, ensuring it serves the customer properly. Through this model, the customer pays only for the energy and related services. Revenue or savings from the microgrid can help offset customer costs.

The emergence of asset-backed demand response

Out of these approaches, a new and sophisticated model has evolved, what NRG calls asset-backed demand response (ABDR). With a third-party ownership structure, ABDR is initially built around use of on-site natural gas generators, with the intent of adding additional resources over time, such as energy storage and solar.

NRG deploys and manages all aspects of the microgrid: design, construction, installation, ownership, and operation. If the customer already has generators on-site, NRG can take ownership. The customer pays no upfront costs for the microgrid system; instead, the asset is backed by NRG.

Ideally, market revenues mean the customer pays no fee and benefits from a lower and more stable energy spend. Any form of customer fee only makes sense if the customer was going to buy the generators outright.

So with the ABDR solution, the customer receives highly reliable energy without making a capital outlay. The customer pays only a fee for service, which NRG works to offset via demand response, market arbitrage, and other revenue streams, using its deep expertise in wholesale power markets and electricity pricing. One of the largest independent power production companies in the U.S., NRG owns and operates 30,000 MW of generation assets and trades regularly in wholesale energy capacity and markets. The company also serves three million business and residential customers on the retail level.

The ABDR model moves beyond just microgrid operations. NRG focuses on the customer's entire energy spend, looking for opportunities to generate revenue or achieve price stability.

This approach achieves cost stability for a customer not only through demand response, but also by finding ways to modify the timing and amount of grid power the customer uses, what's known as load shaping. NRG operates the microgrid generators to configure usage into a pattern attractive to wholesale power suppliers. This positions the customer to capture better supply pricing. As part of the ABDR package, NRG also procures supply for the customer, structuring contracts based on price and the customer's risk tolerance. In doing so, NRG acts as a complete energy management provider—not just the microgrid owner and operator.

"ABDR draws a range of benefits from a microgrid. Clearly, this isn't something a customer with a microgrid can do independently. Gaining these benefits requires a partner experienced in power markets and asset operation who can apply knowledge and take on risk for the customer. This is what NRG offers," said Robert Hanvey, Vice President of Strategy and Business Development at NRG. He added, "With this approach to microgrids, your energy system becomes more than an insurance policy; it's a financial tool."

As sophisticated as ABDR may sound, it's only the beginning. According to Hanvey, the next phase of the DER evolution has begun with the cutting-edge virtual power plant (VPP), microgrid cluster, and a distributed asset control system (DACS).

Next: The VPP, microgrid cluster and DACS

What if your DER could act in concert with DERs operated by others? Could economies of scale or other advantages be achieved? The short answer is yes. This is where the VPP, microgrid cluster, and DACS come into play.

Advanced software intelligence can coordinate the operations of multiple DERs and sometimes multiple microgrids, even those with multiple system owners. Working together, DERs and microgrids can achieve better efficiencies and leverage market opportunities not necessarily available to them if they act alone.

A VPP aggregates multiple DERs and orchestrates their operation via a central control system. It is a collection of intelligently controlled DERs—ranging from microgrids to home energy management devices—that together serve the grid the same way a power plant would. Consider a scenario where the grid needs one megawatt because it is under strain. Several natural gas generators, linked together contractually but sited at separate businesses, might simultaneously activate by a master controller to generate one megawatt for their hosts. This would remove one megawatt of demand on the grid—which has the same effect as adding one megawatt from a power plant. Hence, the aggregation of generators "virtually" produces power and receives financial compensation for providing the grid service.

A microgrid cluster is a similar concept. Via sophisticated controllers, multiple microgrids communicate and exchange services to improve efficiency or price or achieve other predetermined goals. Today, microgrid clusters are being tested for neighborhoods, universities, and businesses. Some futurists envision microgrid clusters becoming the primary source of U.S. electricity with the main grid acting as a backup.

DACS Defined

A DACS is a software management system that performs critical functions, such as facility optimization and portfolio management, to drive maximum value from resources.

For example, a DACS constantly monitors and collects facility and market data to forecast facility load, market conditions, and DER asset availability. Based on business rules, the assets are scheduled or dispatched in real time to optimize revenue and savings opportunities. The DACS may uncover and implement ways to better manage bills, enhance reliability, provide services to the grid for compensation or undertake other activities that benefit its host. Assets can be controlled either directly by the DACS or via third-party control systems such as energy management systems or microgrid control software.

A DACS must be scalable to unlimited end-points and be able to interface with diverse and widely dispersed assets to create a portfolio that can be integrated with the grid. It also must be able to manage the portfolio to meet changing requirements, both from the grid and from the individual facilities and assets comprising the portfolio.

DACS programs are known for their ability to analyze and improve system functioning. Using near real-time data, algorithms automate decisions to optimize assets. The algorithms are then layered into portfolios. Frequent performance reports further improve business decisions.

Conclusion:

Where the DER Evolution Brings Us Today

After years of technological, regulatory, and market advancements, microgrids have arrived as a natural outgrowth of the quest for reliable and localized power.

These mini-power plants not only supply backup power, but also serve as a financial asset. In addition, local energy gives consumers a new, empowered status. They are no longer just buyers; they can be producers and market players as well.

Such sophistication not only brings greater market benefits, but also demands a deeper understanding of energy markets and technology.

None of this is simple, of course, but that's where an expert energy partner comes into play, one with a deep understanding of energy technology and markets. For the savvy organization that forms such a partnership, new opportunity awaits.

About NRG Energy, Inc.

At NRG, we're redefining power by putting customers at the center of everything we do. We create value by generating electricity and serving nearly three million residential and commercial customers through our portfolio of retail electricity brands. A Fortune 500 company, NRG delivers customer-focused solutions for managing electricity, while enhancing energy choice and working towards a sustainable energy future. More information is available at www.nrg.com. Connect with NRG on Facebook, LinkedIn and follow us on Twitter at @nrgenergy.