2018
Black & Veatch
Strategic Directions

ELECTRIC REPORT

About This Report

Last year, the annual *Black & Veatch Strategic Directions: Electric Report* addressed how the electric industry is adapting to change in the face of growing renewable energy, an uncertain regulatory environment and a pressing need to invest in aging infrastructure.

This year, the report takes a step further. It investigates the progress made by the industry as it continues to evolve into its future self, but it also addresses new areas: a rapidly changing customer base, commercial defection from the grid, advanced technologies and a changing regulatory landscape, to name but a few.

Earlier this year, in a move designed to help enhance competition while promoting greater efficiency, the Federal Energy Regulatory Commission (FERC) established Order 841 to effectively open the power market for battery storage. This order comes as states lay down significant governmental and regulatory decisions that will impact electric utilities and other new market participants going forward.

Meanwhile, enabled by greater flexibility and a growing emphasis on energy efficiency and sustainability, cities, states and large corporations are announcing their own ambitious plans to invest in renewable energy and alternative generation in a bid to declare their energy independence. It's an exciting time, full of opportunity, evolution and change.

We welcome your questions and comments regarding this report and Black & Veatch services. You can reach us at **MediaInfo@bv.com**.

Sincerely,

ED WALSH | President, Black & Veatch's Power Business

JOHN CHEVRETTE | President, Black & Veatch Management Consulting

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Executive Summary

THE NEW ENERGY ECONOMY

By John Chevrette

The energy ecosystem is changing, driven by the advent of distributed clean energy, increased competition from new technologies and service providers, the evolving expectations of customers, and new opportunities for serving those customers. As the traditional business model changes, utilities are seeking new opportunities for revenue as they establish themselves as the "Preferred Energy Partner."

But getting there is another story, requiring a comprehensive category of innovative products and services that will define the future of revenue generation in the energy space. Today, opportunities appear limitless, enabled by renewable technologies, enhanced connectivity behind/beyond the meter, and mobile-optimized products and services.

The questions that electric utilities should ask themselves are not new, but they are taking on a heightened sense of impact as utilities enter a more competitive retail market:

- Do you have a clear roadmap for how your organization will grow earnings?
- What is your strategy for addressing potential competition?
- What are your existing market solutions lacking?
- Is your organization well-positioned to explore new/alternative business models?
- What value does your organization put on innovation?

***John Chevrette** is President of Black & Veatch management consulting and works closely with clients to address key challenges affecting today's electric, water and gas utilities. Chevrette has more than 20 years of industry consulting experience and has worked with domestic and international clients in the electric utility, energy technology, gas pipeline, telecommunications and water industries.*

The balance, or tug of war, between highly reliable service and innovation products is an ever-present reality for both investor-owned and municipal utilities.

The answers are complex and multifaceted. Reliability and resilience still are the cornerstones of the industry and top of mind for all customer classes. Natural disasters regularly serve as compelling events and constant reminders of how delicate our critical infrastructure can be — not to mention the security-based risk, both cyber and physical that are constantly in the back of all our minds — in this hyper-connected world we live in.

There isn't a technology "silver bullet" to remedy what the power industry is facing, but as traditional infrastructure is replaced or hardened and the Internet of Things (IoT) solutions residing at grid edge becomes closer to scalable reality, a final consideration tempers the pace of change - cost.

The balance, or tug of war, between highly reliable service and innovation products (that are cost-effective and perceived as high value by both customers and regulators) is an ever-present reality for both investor-owned and municipal utilities. No one wants to see their electric bill increase, and many customers make rational decisions to install solar and batteries, and to participate in demand-side management or energy efficiency programs to mitigate these costs.

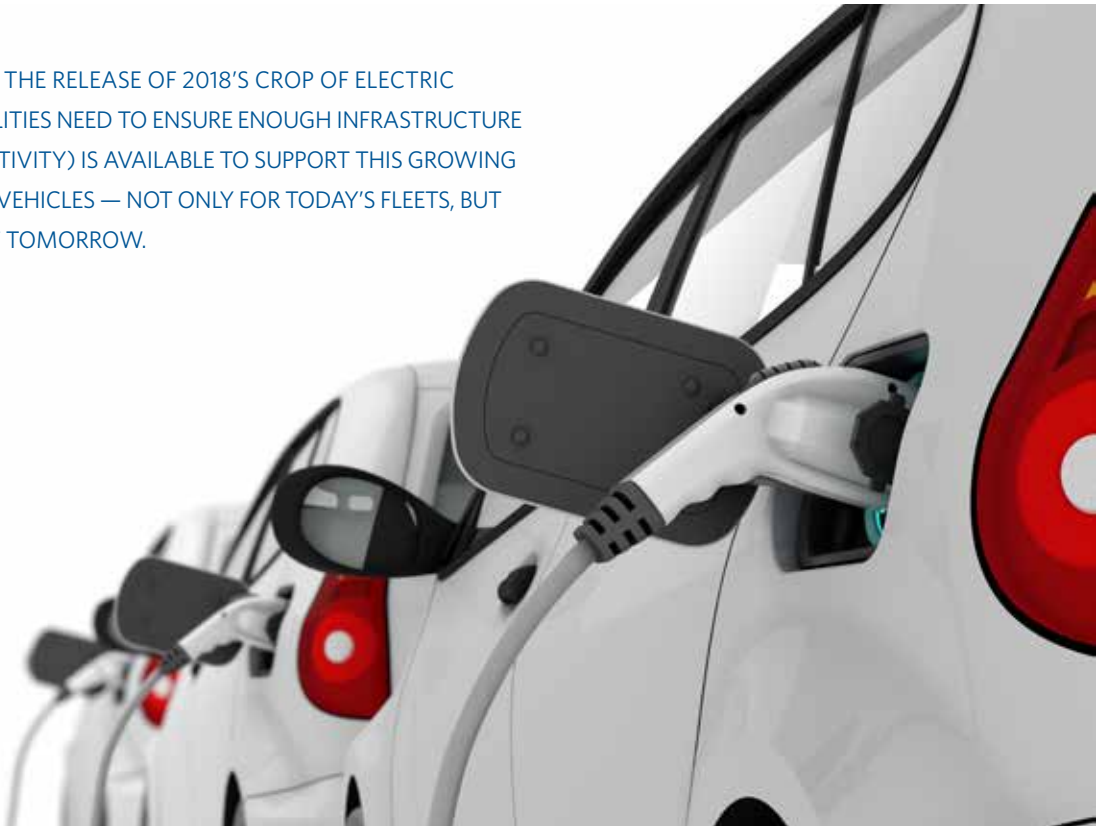
But as more customers move toward adopting distributed generation, the issue of who should bear the cost of maintaining central generation, transmission and distribution becomes an even greater debate. Most customers still rely on a traditional utility to serve at least a portion of their daily energy demand, and nearly all require their utility to serve as a provider of last resort.

This means very little critical infrastructure can truly be retired — quite the opposite really. As more advanced and emerging technology comes online, the grid must evolve to handle the changing load conditions with a level of intelligence not expected even a decade ago. This means that utility and regulators must work together to design the following rate structures that reward and mirror the cost associated with the time of demand: fixed charges that fairly reflect the level of service a customer requires; and incentives to support customers' sustainability goals.

But the trick is to accomplish this without shifting undue burden to the utility, which relies heavily on the utility's ability to change the very core of its business, becoming an agile market operator rather a highly regulated monopoly.

These themes, and many more, are explored in this year's report.

HASTENED BY THE RELEASE OF 2018'S CROP OF ELECTRIC VEHICLES, UTILITIES NEED TO ENSURE ENOUGH INFRASTRUCTURE (AND GRID ACTIVITY) IS AVAILABLE TO SUPPORT THIS GROWING NETWORK OF VEHICLES — NOT ONLY FOR TODAY'S FLEETS, BUT THE FLEETS OF TOMORROW.



The Future of Energy

The concept of "new energy" has ushered in a global movement dedicated to clean energy technology and innovation. Today more than ever, we're seeing experts from all sectors — academia, finance, corporations, utilities and tech incubators — come together in combined efforts. Rapid change is afoot in the marketplace, grid systems and business models, raising the question: What does the future hold?

Integrating Renewables

Utilities increasingly are turning to solar and wind to generate power, but concerns linger over the potential for renewable energy sources, with their inherent uncertainty and variability, to adversely impact today's grid. Just a few years ago, the industry predicted that the grid could handle only 30 percent of its power from renewables; today, we're seeing integration on a much larger scale.

Grid Mod Progresses, But Gaps Remain

Transitioning traditional networks to a smarter grid has been going on for a long time, but the last five years have seen the industry really crank up its investment in grid modernization efforts. Buoyed by data showing the reliability of automation and the operational efficiency of smart grids, states with formal programs increasingly are giving utilities the green light to advance while providing blueprints for other regions to follow suit.

Non-Traditional Clients Impact the Grid

Maturing technologies and a growing emphasis on energy efficiency and sustainability are leading organizations to manage more distributed energy resources (DER) than in the past. Armed with more flexibility behind the meter, companies are becoming increasingly energy independent, with industrial parks, colleges and universities, hospitals, military installations and government facilities becoming the most common applications for DER.

Microgrids Enable Distributed Energy Resources

The growth of DER and microgrids continues to improve energy-supply scenarios for data centers, military installations and disaster-relief operations, and other industries such as

airports and schools are taking note. Fueled by an enthusiasm for energy cost savings, sustainability, reliability and resilience, the market has never been more robust or ready to embrace these new technologies.

Energy Storage and Natural Gas

The cost of energy storage has fallen to the point where the power generation industry is moving from pilot projects to full deployment. Driven by demand and a recent Federal Energy Regulatory Commission (FERC) order designed to integrate storage into the power market, new scenarios are emerging that pair storage with conventional gas turbine generation to improve performance. In a way, gas turbines and renewables are beginning to solve each other's problems.

Energy Storage Electrifies Renewables

Energy storage technology has been advancing for decades, backed by a growing awareness that storage holds the key to unlocking the world's energy future. As storage technology makes strides toward integrating electricity from any source into a more resilient and reliable grid, we are growing closer to fully understanding the potential of storage to radically transform energy markets. Today, energy storage is proven and ready for business.

Utilities Work to Integrate Electric Vehicles

Last year saw utilities in planning mode as they worked to better understand aggregated charging; this year, utilities are putting those plans into practice as they launch pilot programs. Hastened by the release of 2018's crop of electric vehicles (EVs), utilities need to ensure enough infrastructure (and grid activity) is available to support this growing network of vehicles — not only for today's fleets, but the fleets of tomorrow. From planning for increased load and charging, to taking steps to harmonize this need with grid operations, utilities have a long road ahead of them.

The New Power Grid

Power delivery has undergone significant change over the past 40 years, but no shift will be greater than the one that lies before us. While the obligation to deliver power to customers in a safe, reliable fashion is as important today as it was a century ago, there is little resemblance to how those goals will be achieved. Utilities now face the realities of new players, new access to generation for consumers and ever-aging infrastructure. The era of change is upon us.

A New Approach to Capital

Historically, capital allocation has focused primarily on replacing aging infrastructure. Today, the game has changed, from the partial and unpredictable generation of DER to the influx of new technologies such as microgrids, EVs and energy storage. On the governmental and regulatory front, states are making momentous decisions that will significantly impact how utilities operate. This type of market disruption is forcing utilities to apply new thinking and address capital differently.

Combined Heat and Power Offers Opportunity

The benefits of combined heat and power (CHP) are known, and the technology is recognized as having great potential to dramatically increase American electricity generating capacity. Aside from helping to achieve national energy requirements, CHP has emerged as an important potential component of well-designed microgrids, providing local grid security and resiliency in the event of catastrophic power outages.

Construction Gets Innovative

Once famously slow to embrace technology, electric utilities are awakening to the power of innovation, from deploying drones to relying on robotics and implementing outside-the-box construction practices. As technology continues to reign supreme, with the shift to decentralized,

digital grids and the broadening appeal of increasingly affordable solar power systems, power suppliers no longer have the luxury of resisting change.

Conclusion

Plunging costs of solar power and growing concerns of climate change are inspiring ranks of the largest private and Fortune 500 companies to pursue aggressive renewable energy goals for sustainability, cost effectiveness and resiliency. This has left utilities with the sobering question of whether to significantly invest in green infrastructure to keep these large customers or watch large, rate-paying customers defect, taking considerable revenues with them.

In this industry, which has long been viewed as moving at a glacial pace, such pressures should be a pressing clarion call for engagement between utilities and the regulators whose constructs often lag behind advances in technology and customer expectations.

Renewables Drive Change

THE FUTURE OF ENERGY

By Jeremy Klingel, Jason Abiecunas and Lou Graving

The concept of "new energy" has ushered in a global movement dedicated to cost-effective sustainability, clean energy technology and grid innovation. Today more than ever, we're seeing stakeholders and industry giants from all sectors — finance, manufacturing, retail, utilities, technology, even academia — come together in combined efforts.

As recently as a few years ago, renewable energy, distributed energy resources (DER) and battery storage were considered little more than glorified science projects. But today, these former buzzwords are top of mind from both infrastructure and commercial investment perspectives.

We are seeing three trends gain momentum in driving the movement: the swiftly falling cost of wind and solar technology, improvements in battery storage from both a technological and economic perspective, and rampant growth of electrification, driven by the proliferation of electric vehicles (EVs).

So what does the future hold for the future of energy, specifically, for the next-generation power market?

A CHANGING CUSTOMER BASE

Two major evolutions in customer demand will shape the future of energy going forward.

First, the traditional utility customer is changing. Utilities no longer are sitting on the sidelines hoping customers will just be happy that their bill is predictable and the air conditioning is operational. Instead, utilities proactively are investing in technology to enable unique programs and services that will allow them to better understand and serve their customers, as well as meet their obligation to maintain and modernize the grid.

Jeremy Klingel *is a Senior Managing Director for Black & Veatch management consulting, where he is responsible for developing and delivering the market strategy regarding end-to-end grid-related initiatives for electric utilities. Klingel has led more than two dozen smart grid development projects.*

Jason Abiecunas *is the Director of Distributed Energy Resources at Black & Veatch. With more than 15 years' experience, Abiecunas leads a team that delivers sustainable, resilient and cost-effective distributed energy solutions to address a wide range of power issues and enable our clients to capture new business opportunities.*

Lou Graving *is a Vice President and Director of Utility Scale Renewable Energy in Black & Veatch's power business. He is responsible for pursuing and capturing major projects, project delivery innovation, strategic resource alignment with growth markets and operational efficiency.*

At the same time, both municipal and investor-owned utilities are coming to terms with the impact DERs will have on their traditional business models and the ability to operate a reliable grid given the added complexity of DER. For example, utility powerhouse Duke Energy submitted $7.8 billion to modernize grid infrastructure by upgrading traditional transmission and distribution to improve reliability and resilience and also to pilot emerging technologies that could play an integral role in what the grid of the future may look like.

Second, the overall customer base is changing, literally becoming a different ecosystem. Customers are now potential competitors, and the concept of accessible, distributed energy is bringing new entrants into the market. Large financial, commercial and industrial (C&I) customers now see energy as a viable business, and they are looking at renewables, DER and storage from a deeper angle than just corporate social responsibility.

C&I customers are actively targeting market share, in addition to their own capacity needs. They are looking at critical questions such as the following: How can we add sustainable resources? Better manage bills? Improve reliability and sustainability at our sites? Offer additional products and services to our customers outside of our core business?

Today, it is more than just buying green power purchase agreements; the focus is on discovering new ways to drive profitability to a multi-dimensional bottom line. This is the new reality.

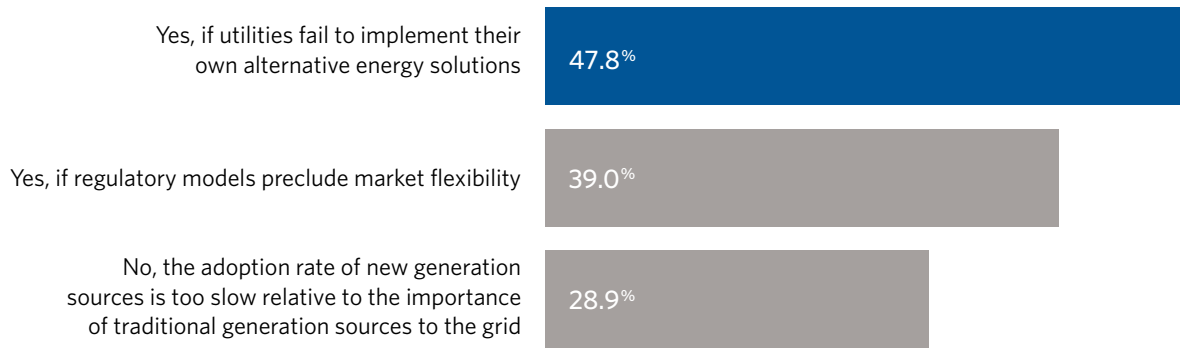
FACING DOWN THE DEATH SPIRAL

Perhaps the largest issue disrupting utility leaders' sleep is the foreboding "utility death spiral" — the ugly Catch-22 that occurs when more and more customers switch to self-generation and drop from the traditional grid, except for the need of a provider of last resort. Which, in turn, makes power more expensive for remaining customers (unless fixed infrastructure costs can be equitably recovered), thus making self-generation even more attractive.

Nearly three-quarters (71 percent) of utilities see the death spiral as a real, potential outcome. According to results from the *2018 Strategic Directions: Electric Report* survey, such a situation would occur if utilities fail to implement their own alternative energy solutions, or if regulatory models preclude market flexibility *(Figure 1)*.

FIGURE 1

Do you perceive this "utility death spiral" as a real, potential outcome? (Select all that apply)



Source: Black & Veatch

Although utilities can fully intend to work with their customers (both mass market and C&I) to deliver more reliable service while reducing costs, the reality is that utilities still bear significant fixed costs. A real market need still exists for conventional generation because renewables are intermittent, not to scale in many cases and not quite to grid parity on marginal cost.

The death spiral will be particularly worrisome for utilities with small service areas that have relatively high rates, especially as renewables continue to get less expensive and more prolific. There is immense value in connecting DER to the utility network, and it is a natural fit for utilities to deploy DER as part of their resource mix, but this won't happen equally across the board; some will adapt easily, while others will not or cannot.

To survive, utilities must figure out whether they can offer their customers something compelling from an economic development standpoint.

Survey results show that reliability is still key, followed by cybersecurity, aging infrastructure and long-term investment *(Figure 2)*.

But second- and third-tier priorities are becoming more interesting. For example, what products and services are available to customers? What can utilities do to enhance reliability without incurring additional cost? Could a utility help a customer build a microgrid on-site that can be used for capacity, backup generation or demand response?

If utilities can prove that they are willing to serve customers in such a way, negotiating with and presenting a business case to regulators would be much easier. Enabling such unique offerings as performance-based rates, community solar and solar-plus-storage for all customer sizes can assist in shifting the utility model enough to slow down the proverbial downward spiral in earnings.

Building a marketplace for distributed energy will be a critical step.

FIGURE 2

Please rate the importance of each of the following issues to the electric industry using a 5-point scale, where a rating of 5 means "Very Important" and a rating of 1 means "Not Important At All." (Please select one choice per row)

	Top Issues Over the Last Five Years				
Rank	2014	2015	2016	2017	2018
1	Reliability (4.58)	Aging infrastructure (4.52)	Reliability (4.56)	Reliability (4.69)	Reliability (4.65)
2	Environmental regulation (4.41)	Reliability (4.38)	Cybersecurity (4.37)	Cybersecurity (4.52)	Cybersecurity (4.49)
3	Cybersecurity (4.26)	Environmental regulation (4.38)	Environmental regulation (4.37)	Aging infrastructure (4.31)	Aging infrastructure (4.28)
4	Aging infrastructure (4.23)	Cybersecurity (4.33)	Aging infrastructure (4.36)	Environmental regulation (4.30)	Long-term investment (4.23)
5	Economic regulation (4.22)	Aging work force (4.12)	Long-term investment (4.13)	Long-term investment (4.29)	Physical security (4.18)

Source: Black & Veatch

Incredible opportunity is ahead — not only to embrace sustainable, green power but to save money and increase resilience across all operations.

BUILDING A MARKETPLACE

Developing a market mechanism where "transactional energy" can reside — and utilities can bid — would help ensure grid parity by getting ahead of critical issues such as intermittency.

The early energy storage marketplace offers a preview. The market was originally crowded with vendors, to the point that it was unsustainable; however, many vendors could not scale and ultimately fell out. Companies either will fall out because they can't meet the demands of a broad-based and complex market, or those companies with great technology will get acquired. In addition, as large, global companies enter the market, we may see an enormous amount of consolidation in the next three to five years.

The marketplace concept is something the industry needs to address. But what would that market look like? How do we create it? What platform is it built on? In short, utilities would need to be incented to create an environment where more clean energy is used.

To make that happen, standardization will need to take hold, and this will be a fundamental change. Because everyone wants to be proprietary, a prevailing lack of standardization has hobbled the industry more than helped it. Standardized energy system infrastructure would allow for less custom engineering, and more plug-and-play designs — another big shift for all involved.

Creation of a marketplace will take time, but it is entering the conversation at a very high level with C&I customers and utilities. No matter the outcome, expect to see the truly sustainable, armed with technology that is fully automated and scalable, to rise to the top.

LOOKING AHEAD

The conversation is changing, but chances are slim that the impact will be seen today. Billions of dollars won't be spent on behind-the-meter batteries in 2018, and not in 2019 or 2020. At this point, the ripples of this new movement will be felt three, five, even 10 years down the road.

Even with that time line, however, incredible opportunity is ahead — not only to embrace sustainable, green power but to save money and increase resilience across all operations. Five years ago, the concept of new energy was an expensive proposition, asking utilities and customers to pay more for power than they would have otherwise, but today there is a business case AND a positive return on investment. That is a powerful statement.

Renewables Drive Change

INTEGRATING RENEWABLES IN THE GRID: A SNAPSHOT OF PROGRESS

By Ryan Pletka and Mark Manley

Renewable energy has achieved a level of integration in the U.S. power grid that would have been unthinkable 10 years ago. Two recent milestones illustrate how this progress came about.

The first occurred on April 28, 2018, when use of renewable energy on California's power grid reached 73 percent of demand. Many factors had to fall into place to achieve this degree of penetration: it happened in the spring when wind, hydro and solar output were all high; it was in a state with energy policies that strongly encourage renewables; and it lasted only for an hour or so. But it shows what is possible: that renewables can occupy more than a token spot on the power grid and can even play a leading role.

The second milestone happened in Colorado, where Xcel Energy announced that it had received bids from energy developers to supply solar and wind-generated electricity — with battery storage included — at a lower cost than conventional generation. While Colorado's supportive regulatory environment helped make this a reality, the major takeaway is that in 2018, renewable energy at utility scale can not only be price-competitive with fossil fuels, but it can even cost less.

U.S. POWER GRID MORE RENEWABLE READY THAN MANY THOUGHT

Just a few years ago, there were predictions that 30 percent of power from renewables was all the grid could easily handle and that anything more would have significant consequences. However, recent events have shown that it is possible to integrate much higher levels of renewable energy without large negative effects. Part of the reason

***Ryan Pletka** is the Associate Vice President for Growth and Innovation at Black & Veatch and a founding member of Black & Veatch's Growth Accelerator team, whose mission is to drive rapid, sustainable growth for the company. Pletka's responsibilities include identifying new trends, evaluating emerging technologies, developing new business models and establishing partnerships with internal and external entrepreneurs.*

***Mark Manley** is a manager for Black &Veatch management consulting, where he focuses on energy infrastructure transactions. Manley works on renewable energy, battery storage and electric vehicle projects, assisting investors and operators with technical due diligence.*

is that the growth has been incremental, typically a few percentage points a year, allowing grid planners to adjust as needed. It's also because of the emergence of technologies and techniques that help incorporate fluctuating power from renewables into the grid.

With the right tools and guidance, utilities can manage that variability successfully, even on a massive scale.

FACING DOWN TODAY'S REGULATORY, ECONOMIC BARRIERS

Many technical challenges (such as forecasting) associated with integrating renewable energy into the grid have been addressed. In addition, prices have dropped sharply — a trend that continues. The result is a different set of challenges than a few years ago, when there was more uncertainty over whether these projects could work, along with concerns over their financial toll.

Every state has a unique set of resources, market structures, energy priorities and policies that affect the economics of a project. Project developers must evaluate this landscape of factors and choose a strategy that makes business sense.

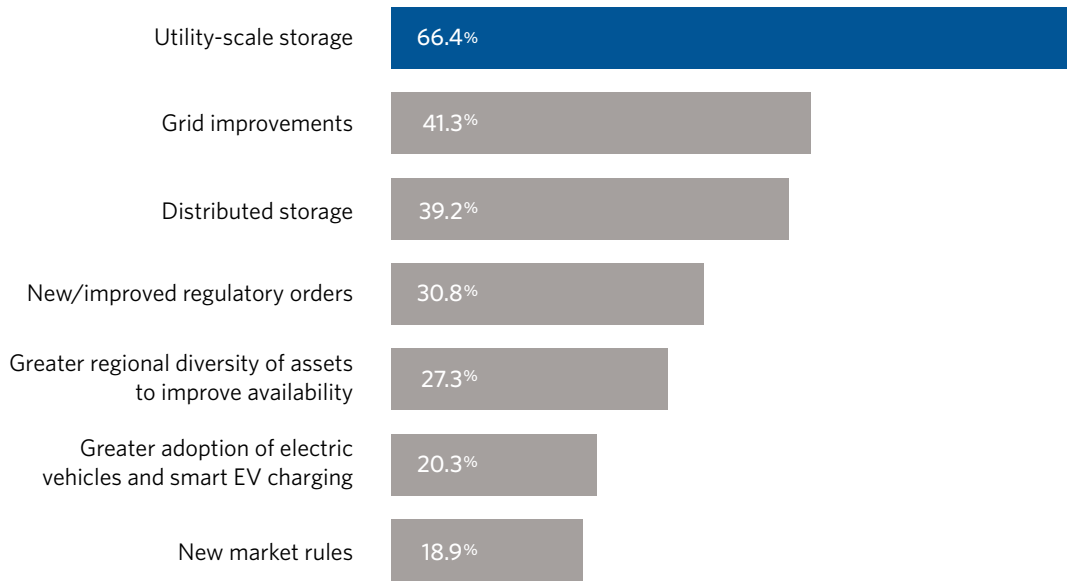
Findings from the *2018 Strategic Directions: Electric Report* survey reveal what energy professionals are thinking as they plan and build their renewables projects. When asked to choose the best options for renewable integration, utility-scale energy storage was the preferred choice at 66 percent, with grid improvements a distant second at 41 percent *(Figure 3)*.

The dropping cost of storage technology is good news for utilities because high prices long have been a challenge to integration efforts. Today's lower costs are enabling much more competitive offerings, as seen in the Colorado example.

It should be noted that there are ways to address intermittency that do not require lots of new equipment, transmission lines or capital. For example, rather than balancing supply and

FIGURE 3

Where do you see the best options for utility-scale renewable integration? (Select up to three choices)



Source: Black & Veatch

demand hourly, doing it every five minutes or less could be considered. More accurate forecasting of wind and solar output is another option, as is changing the way power producers are penalized or incentivized for over- or under-generation.

While these are admittedly partial measures, changes in rules or polices can help grid operators respond to output fluctuations with minimal investment.

Respondents also were asked what system improvements they recommend. A variety of tools are available to help utilities deal with the variability of renewables, including demand management, storage management, real-time monitoring and rapid cutover solutions to meet a sudden drop in output.

The most popular choice was quick response resources, selected by 56 percent of survey participants, followed closely by load control devices (51 percent) and advanced system control devices (48 percent) *(Figure 4)*.

Utilities typically use a combination of the resources listed. The fact that survey participants are aware of these capabilities is encouraging, suggesting at least basic knowledge of practical details required to make the integration work.

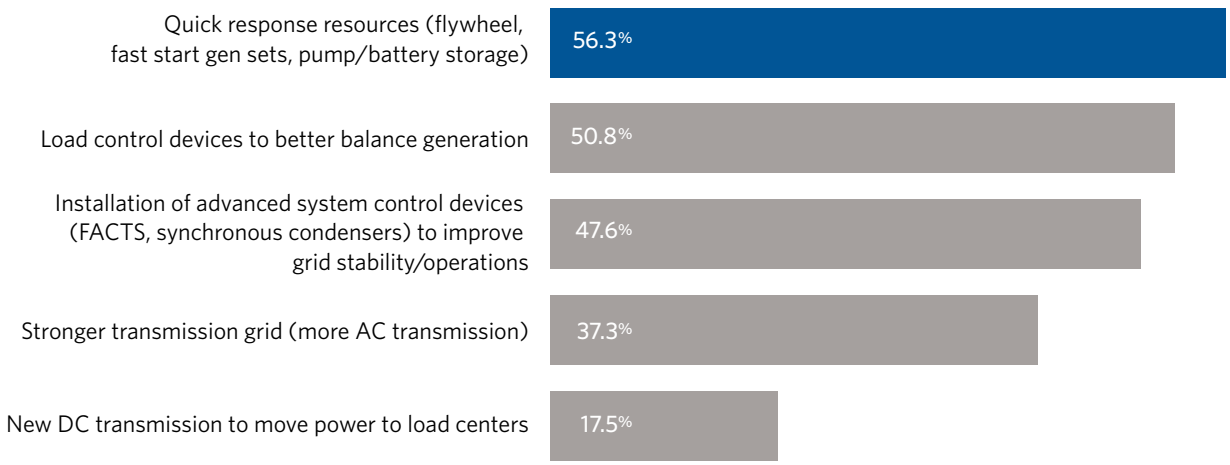
MORE PROGRESS TO COME

Technology is available that allows large-scale renewables to better integrate into the existing grid while accommodating for the inherent variability. Financial viability is determined on a case-by-case basis by weighing regulations, weather patterns and competition and doing what makes economic sense. Considering the previous uncertainty over whether this integration was even possible, this marks major progress.

More dramatic changes are on the horizon. Some utilities have started long-range planning for 100 percent renewables, looking ahead at what changes will be necessary in 10 or 20 years. To get there, they will have to address a new class of challenges for generating, storing, distributing and managing power without falling back on fossil fuels.

FIGURE 4

What system improvements would you recommend to better enable integration? (Select all that apply)



Source: Black & Veatch

Renewables Drive Change

GRID MOD SEES GAPS IN PROGRESS; BLUEPRINTS NEEDED FOR THOSE LAGGING BEHIND

By Dave Hulinsky, Forrest Small and Ben Edgar

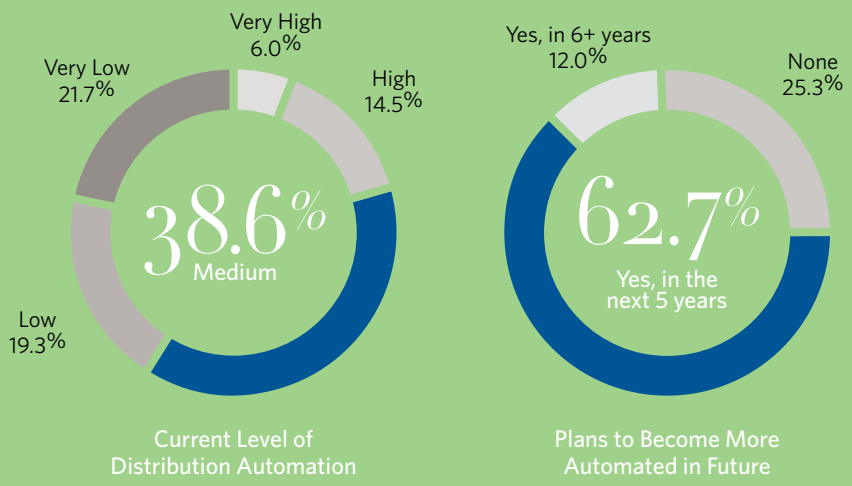
Grid modernization is getting into gear across the country as electric utilities continue to work to automate distribution and smarten the grid. Buoyed by validating data, states such as California, New York, Illinois and Massachusetts are leading the way, providing blueprints for other regions to follow.

Transitioning traditional networks to a more technically advanced grid has been going on for a long time, but the last five years have seen the industry crank up its investment in automation technologies. Data showing the reliability of automation and the operational efficiency of smart grids have encouraged further investment, while states with formal programs continue to give utilities the green light to advance.

According to the *2018 Strategic Directions: Electric Report* survey, most utilities are employing or plan to employ some level of smart distribution system. Forty-one percent consider themselves at a low or very low level of automation, while 39 percent were placed at a medium level *(Figure 5)*. Of those still in the planning stage, two-thirds (63 percent) hope to become more automated in the next five years *(Figure 5)*.

FIGURE 5

Which of the following situations is true for your organization regarding smart distribution systems?



Source: Black & Veatch

David Hulinsky *is a Utility Telecommunications and Automation Director for Black & Veatch. He focuses on providing integrated grid modernization solutions for utilities, specifically advanced automation and telecommunication systems to improve the scalability, reliability and efficiency of the grid. He has led some of Black & Veatch's largest turnkey grid modernization projects.*

Forrest Small *is a Senior Managing Director for Black & Veatch management consulting. He leads the Distribution Modernization and Customer Experience service offering. Small specializes in grid modernization strategy and planning and works closely with utilities in grid modernization and transformation programs across North America.*

Ben Edgar *is a Business Development Manager for Distributed Generation at Black & Veatch. He serves as a trusted advisor to electric utilities, assisting with strategic planning and master planning. Edgar specializes in complex utility infrastructure projects, transmission system planning and analysis.*

However, one-fourth of respondents have absolutely no plans for future automation, which is not necessarily a measure of their support for technical advances but rather the likely scenario of smaller, more rural operations where a smart grid investment does not make good business sense.

But for most utilities covered in this report, the main pillars of grid modernization plans continue to be the need to improve infrastructure and the ability of the utility to be secure and communicate. Nearly two-thirds say reliability and hardening improvements are the main motivators for modernization, while 56 percent point to security and their network communications *(Figure 6)*. Unsurprisingly, improving efficiency was right behind, with 44 percent noting it as a key goal of the planning.

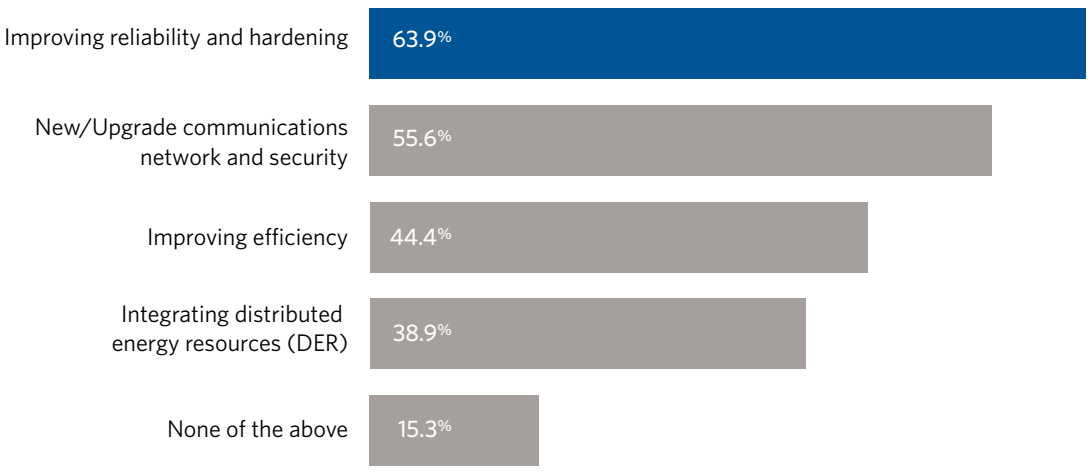
A big factor contributing to hardening efforts are the reactions to last year's wildfires and seawater intrusions as the result of drought and hurricanes. For example, utilities are replacing burned out wooden poles with metal ones; in the coastal flood zones, protections are being put in place around substations at risk of periodic flooding. As these changes take place, utilities are being pushed to improve resiliency by installing the latest technologies.

Grid modification planning for utilities has meant taking on a lot of new technology, especially in the segments of grid operation that have become popular for improvement. A little more than half of respondents indicated electrical asset and automation upgrades are getting the most attention, followed by network and security communications systems upgrades (55 percent). About a third of survey respondents reported feeder and pole replacements and upgrades to advanced distribution management systems (ADMS) as key components of their distribution segment.

The traditional utility pole offers one example of how change is taking place. Today's poles are

FIGURE 6

Which of the following are specifically included in your grid modernization plans for electric distribution within the next 5 years? (Select all that apply)



Source: Black & Veatch

no longer the wooden behemoths of the past; instead, technical advances have transformed the pole into a high-tech platform of big data, sensors and large-volume communications.

This evolution has streamlined efforts for operators. In the past, four separate crews could be deployed to conduct automation upgrades, reconductoring pole replacement, communications and the third-party pole attachments. Now utilities are encouraged to take an integrated approach, relying on one contractor to handle and coordinate the construction, maintenance and management of each pole.

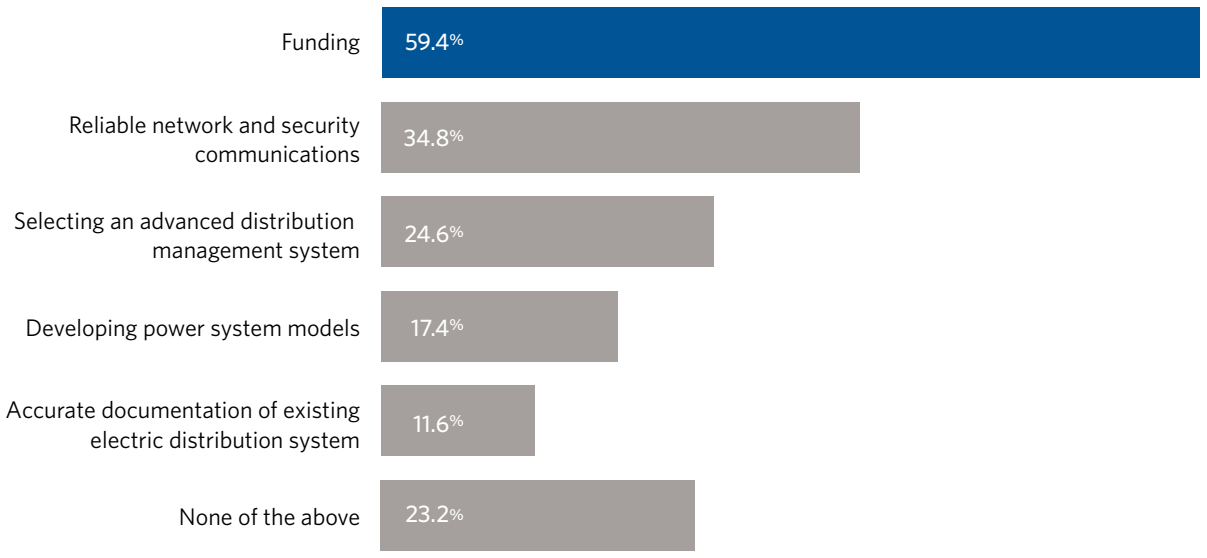
However, the biggest challenges remain money and reliable security. Fifty-nine percent say funding is the biggest barrier to modernization, while 35 percent point to implementing and operating reliable network and security communications, such as transitioning to IP and wireless LTE networks as the chief obstacle *(Figure 7)*.

A quarter of respondents said selecting an ADMS was the pressing challenge, and — to a lesser degree — developing power system modules and documenting the existing electrical distribution system.

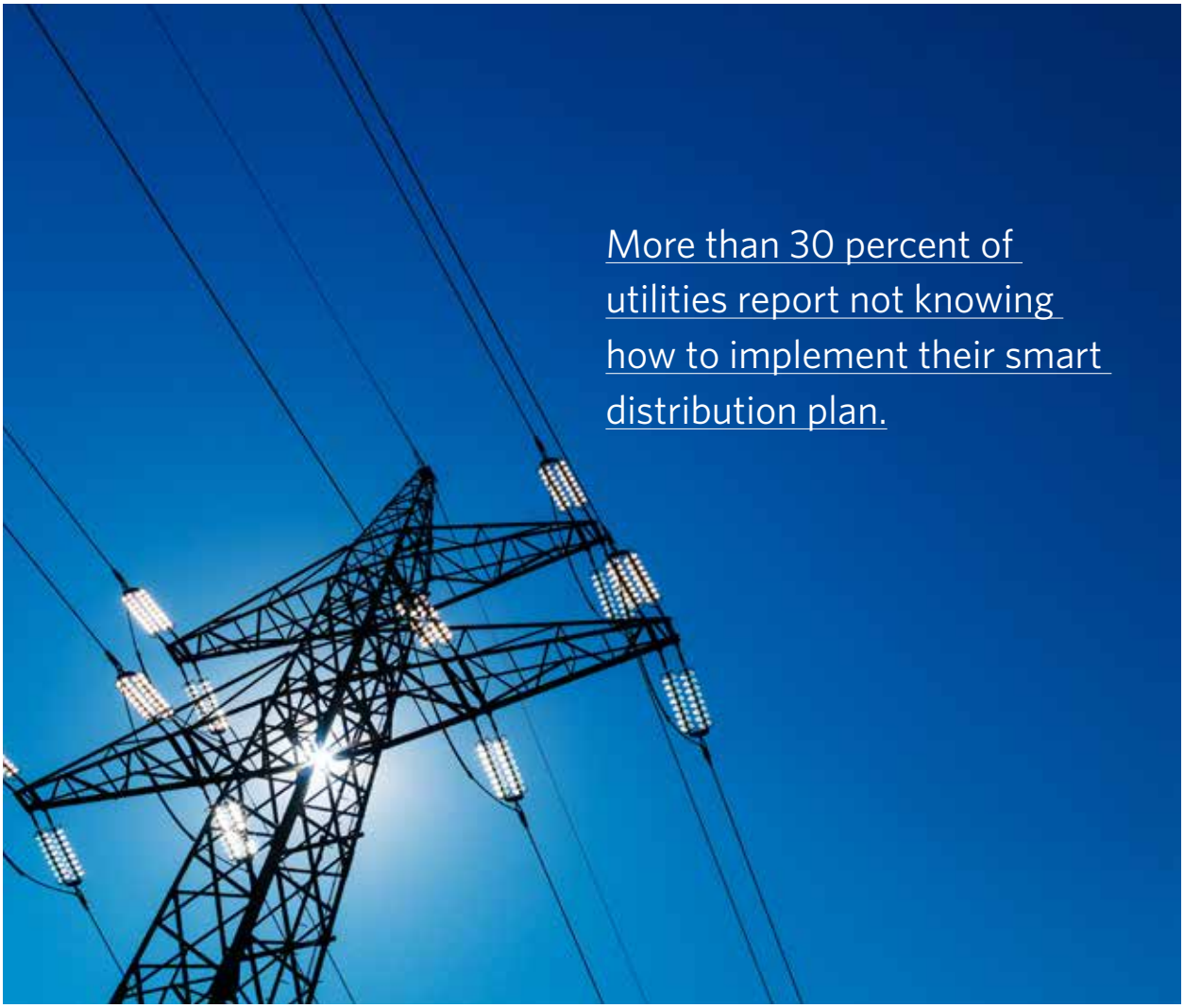
Survey results show that utilities believe they can do the upgrades themselves, with 31 percent planning to "self-perform" their smart distribution system. Twenty-three percent plan to use a project management office (PMO) contractor, 19 percent an "other third party" and 18 percent an engineering, procurement and construction (EPC) contractor to do the work.

FIGURE 7

What are your biggest challenges in implementing smart distribution systems? (Select all that apply)



Source: Black & Veatch



Southern California Edison (SCE) stands out as a star in the development of its smart grid. Supported by robust state programs and servicing a sophisticated customer base with high environmental priorities, the utility's planned grid modernization work focuses mainly on the distribution system that begins at the substation and continues down the lower voltage lines to the user.

With its eye squarely on the goal of increasing power reliability by way of significant grid upgrades, SCE has made several grid modernization investments. Along with upgrading its distribution hardware, cables and poles, the utility is making updates to accommodate new technologies such as smart inverters, which will allow for the two-way flow of solar energy.

It also is making sure its power system adoption is compatible with future California policy related to energy storage, electrical transportation demands and renewable energy.

Many utilities want to move in the same direction as SCE, but they don't know how to do it. According to the survey, more than 30 percent reported not knowing how to implement their smart distribution plan. Many utilities in this situation have spent the last five years or so in research and development and pilot phases, but they don't know what to do first, or how to execute.

These questions will be answered as more utilities emerge from smaller starter projects and additional funding is secured. The industry may still be in its early days of grid modernization, but enough traction has taken place to give many utilities a starter set of the best practices.

Renewables Drive Change

NON-TRADITIONAL THIRD-PARTY CLIENTS IMPACT ENERGY DISTRIBUTION

By Tim Catlett, Steve Rupp and Ben Edgar

Maturing technologies and a growing emphasis on energy efficiency and sustainability are leading organizations to manage more DER than in the past. Bolstered by more financial and mechanical flexibility behind the meter, companies are becoming increasingly energy independent and investing more in alternative generation, storage and energy efficiency.

As a bonus, being able to sell the energy they create has also lowered power bills while opening up new streams of revenue.

The success of DER applications depends heavily on the type of facility. According to responses to this year's *Strategic Directions: Electric Report* survey, the industry sees large-scale facilities that require enormous amounts of power to be the best venues for DER. When asked to rank these facility types, more than half (54 percent) pointed to industrial parks/industrial facilities, followed by academic campuses and universities, military installations and government facilities, and hospital/healthcare facilities *(Figure 8).*

***Tim Catlett** is a Managing Director within Black & Veatch's power business. Catlett has more than 21 years of experience in comprehensive large-scale utility program and project management business and operating/information technology system implementation. He specializes in the business transformation and technical integration of grid-related investments for electric and gas utilities.*

***Ben Edgar** is a Business Development Manager for Distributed Generation at Black & Veatch. He serves as a trusted advisor to electric utilities, assisting with strategic planning and master planning. Edgar specializes in complex utility infrastructure projects, transmission system planning and analysis.*

***Steve Rupp** is a Managing Director at Black & Veatch Management Consulting, where he develops and leads project teams that provide consulting and engineering services to the electric utility industry. Rupp has more than 30 years' experience working with utilities of all sizes to manage complex projects, including developing and implementing smart grid technologies and managing the impacts of distributed generation on transmission and distribution systems.*

Transitioning traditional networks to a more technically advanced grid has been going on for a long time, but the last five years have seen the industry crank up its investment in automation technologies.

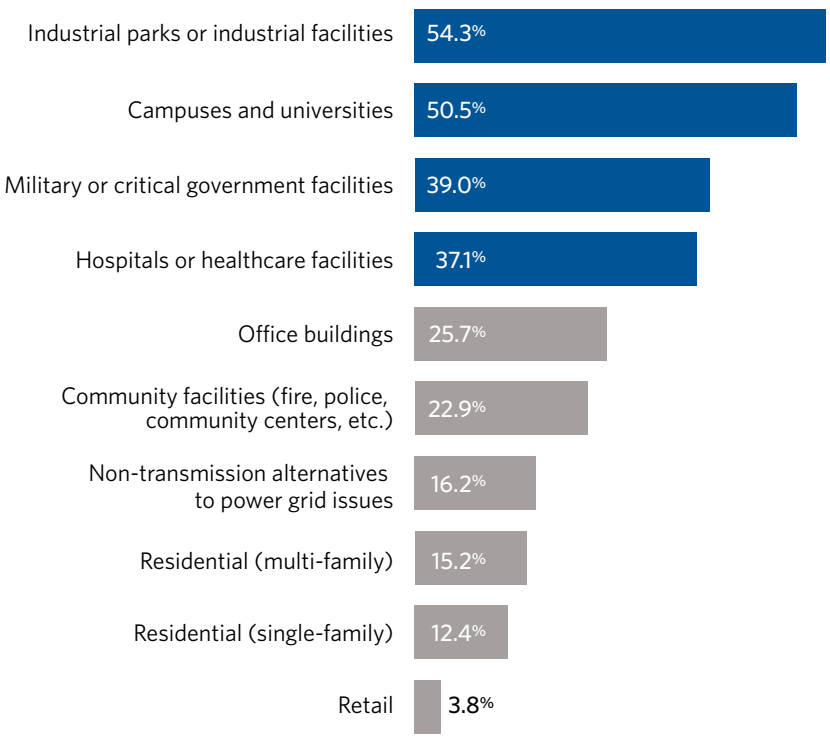
On the flip side, smaller facilities with less energy needs may not be the best candidates, appearing near the bottom of the list. Fifteen percent said DER has a place in residential, multi-family homes, 12 percent said single-family homes, and 4 percent said retail locations.

Although entry into DER can be prohibitive for many reasons (e.g., enormous upfront costs to invest and the technology's notorious intermittency), these technologies still are being driven heavily by organizational commitments to sustainability. In fact, about half of survey respondents said it is their organization's (or their customer's organization) commitment to sustainability that is the main reason they are involved with DER or microgrids.

But the survey suggests that the industry faces a long road ahead before using DER becomes mainstream. When polled on their plans to develop, own or operate any DER (including microgrids), 43 percent said no or they do not know if it's something they will

FIGURE 8

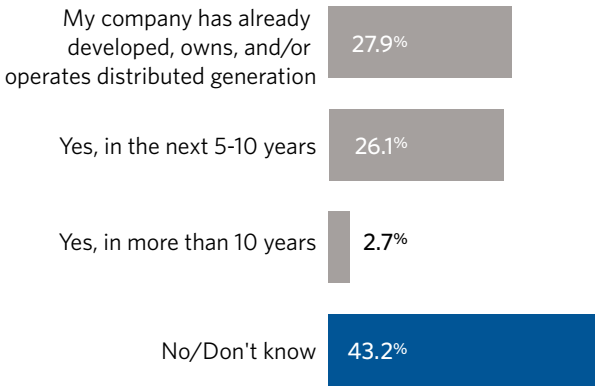
What do you see as the best applications for distributed energy resources? (Select top three choices)



Source: Black & Veatch

FIGURE 9

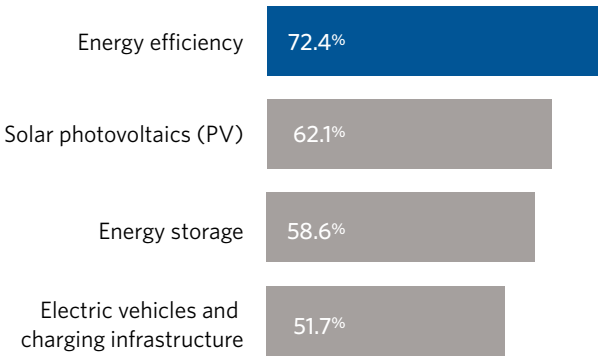
Does your company plan to develop, own, and/or operate distributed energy resources, including microgrids? (Select one choice)



Source: Black & Veatch

FIGURE 10

Which behind-the-meter distributed energy resources technologies is your organization actively involved in developing or promoting? (Select all that apply)



Source: Black & Veatch

invest in, 28 percent already are developing, own or operate distributed generation, while 26 percent plan to do in the next five to 10 years *(Figure 9)*.

Of those organizations actively developing or promoting DER technologies, nearly three-quarters (72 percent) said they are actively investing in energy-efficient measures such as efficient appliances, LED lightbulbs, smart thermostats, weatherization or new system technology that can help managers better manage their energy loads *(Figure 10)*.

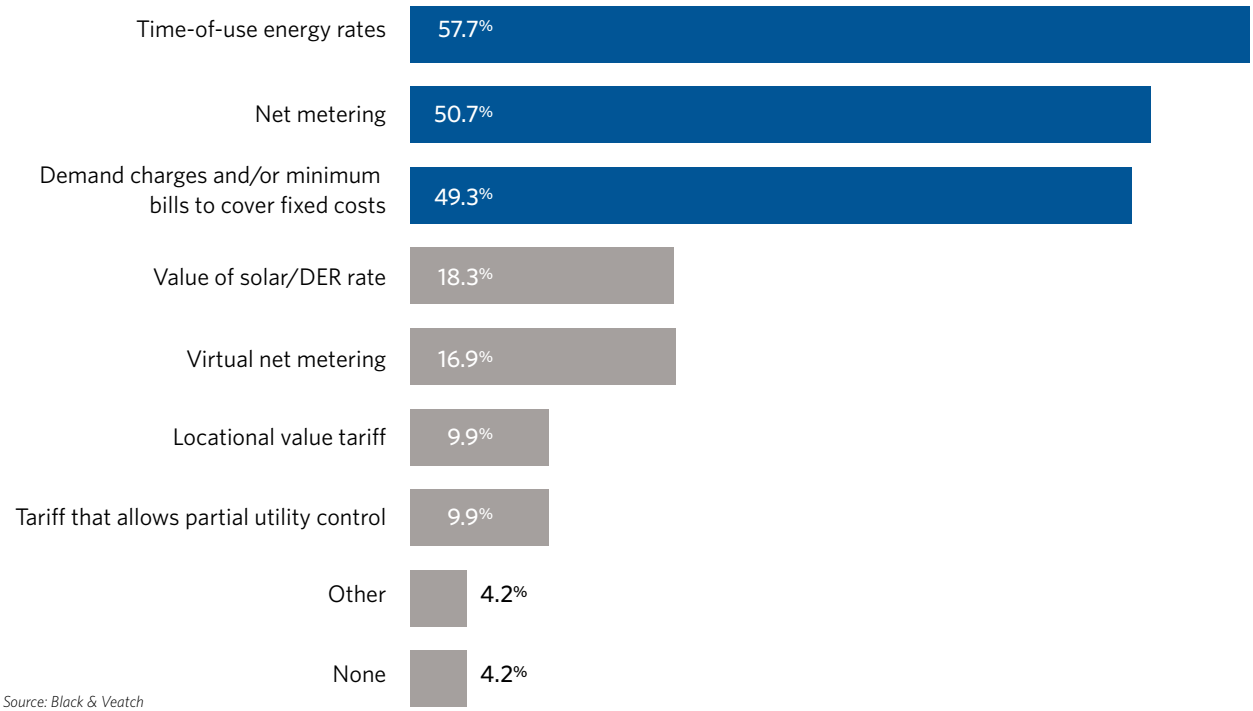
Making a significant mark in the results was "electric vehicles and charging infrastructure," which 52 percent said is a technology in active use as the growth of energy storage and EV charging networks become more prominent in the electric market. Experts believe the solar industry has become more saturated but will continue to grow, but that energy storage and EV markets will continue to expand.

Just as change and innovation have taken place in hardware and software, the new frontier of DER has created new opportunities to buy and sell electricity, especially as the cost of making electricity now can be tracked minute by minute.

One of the trending DER-specific rate structures is "Time of Use," which allows the utility to have less financial risk in the production of its power. Based on power availability and usage throughout the grid, the utility can calculate and set rates practically by the minute. The third party also gets the benefit because the technology makes them more educated and capable of planning their electrical use accordingly to keep costs down.

FIGURE 11

What type(s) of DER-specific rate structures, if any, would your organization prefer to offer or take advantage of? (Select all that apply)



Source: Black & Veatch

More than 57 percent of survey respondents said they would prefer to offer or take advantage of Time-of-Use energy rates, while just over half found net metering appealing *(Figure 11).*

DER activity continues to take place primarily in the pilot or demonstration project arena, where subsidies have made financing possible while giving new technologies a venue to develop and fine tune. More than 40 percent of respondents described their DER investments as demonstration or test projects, while more than 20 percent said DER was no part of their investment plans.

The survey results also hint at the growing significance of behind-the-meter revenue sources, with three-quarters of respondents seeing revenue opportunity behind the meter. Only about 18 percent of respondents believe there is no opportunity for revenue behind the meter.

Experts believe this shows that the attention going on behind the meter from a DER perspective is not trivial. The level of revenue anticipation among respondents is significant. Of the non-utility responders, there is more automation and attention to demand response while looking to create revenue for their companies.

On the utility side, these results validate that even with a monopoly on their customer base, they must find new revenue sources by pushing more products and services to their users. They must start thinking more like traditional businesses than traditional utilities and take more risk on products and services that are tied to a profit and loss statement rather than a rate base.

With organizations taking on a lot more energy functions with the increase of new technology and power generation hardware, the survey

NEARLY THREE-QUARTERS OF ORGANIZATIONS ARE ACTIVELY INVESTING IN ENERGY-EFFICIENT MEASURES SUCH AS EFFICIENT APPLIANCES, LED LIGHTBULBS, SMART THERMOSTATS, WEATHERIZATION OR NEW SYSTEM TECHNOLOGY.

revealed a large gap between the amount of DER in play and the use of distributed energy resources management systems (DERMS) that help manage it via computer software.

According to the survey, only 1 percent of respondents are actively using DERMS, with another 7 percent testing a portion of their system. However, more than 60 percent have no plans for installing a DERMS or don't know if they ever will. Experts attribute the gap to many organizations deciding to start managing their DER in a piecemeal fashion or independently, which can be extremely difficult and overwhelming.

Before DER activity grows further, utilities must examine the barriers that continue to stand in the way of progress. Not surprisingly, funding and the cost of technologies remain the biggest obstacles blocking DER growth. More than half of respondents (56 percent) cited the "economics of DER," while 55 percent named the price of DER technologies as their biggest barrier.

Experts believe that to keep investment in DER healthy, financial subsidies will need to remain a key part of the financial equation. Otherwise, investment in DER and overall pace of the market could suffer.

The Evolution of Distributed Energy

ONCE RESERVED FOR CRITICAL INFRASTRUCTURE, DISTRIBUTED ENERGY RESOURCES COME TO THE MASSES

By Jason Abiecunas and Wes Denton

From a municipal airport in Chattanooga, Tennessee, to a school district in Salinas, California, microgrid projects are popping up across the country, fueled by the desire for energy cost savings, sustainability, reliability and resilience.

Applications of this technology, which typically includes renewable energy, energy storage, fossil fueled generation and load management, can be spotted in critical infrastructure installations such as data centers, military installations, college campuses, office parks and airports. But given microgrids' unparalleled ability to deliver backup power during an outage and reduce energy costs for a broad swath of the market, these early examples are just the tip of the iceberg.

NEW RULES ARE CHANGING THE GAME

The use of microgrids is expected to skyrocket over the next few years, driven by a broad variety of regulatory and economic factors.

For example, the California Energy Commission just passed a new building code that requires all homes constructed after 2019 to have built-in solar power. Builders are required to either provide individual homes with solar or build a shared system for a collection of homes. Once all the homes in a newly constructed subdivision or neighborhood are equipped with solar, it makes sense to add microgrid storage that would deliver backup power in case of an outage. Right now, no other state is considering a rooftop solar mandate, but pending California's experience, other sun-soaked states eventually may follow suit.

***Jason Abiecunas** is Associate Vice President, leading the Distributed Energy Resources business line at Black & Veatch. With more than 15 years' experience, Abiecunas leads a team that delivers sustainable, resilient and cost-effective distributed energy solutions to address a wide range of power issues and enable our clients to capture new business opportunities.*

***Wes Denton** is a Managing Director for Black & Veatch's Data Centers business, where he specializes in planning, design, construction and operations and maintenance of data centers, mission critical facilities and associated infrastructure programs worldwide. Denton has more than 20 years of experience in business operations and management.*

Even electric utilities that may have initially viewed alternative energy as a threat now see distributed, renewable and microgrid energy resources as a transformative opportunity.

In another significant development, earlier this year the Federal Energy Regulatory Commission (FERC) took action (FERC Orders 841 and 845) to remove barriers to entry for energy storage technologies in U.S. power markets. The new rules are designed to "enhance competition and promote greater efficiency in the nation's wholesale electric markets and will help support the resilience on the bulk power system," according to FERC.

Observers say the new rules will open the floodgates for energy storage companies to compete in wholesale power markets. One research report predicts that energy storage will become competitive with gas-fired peakers in five to 10 years. In certain applications, such as ancillary services or peak shaving, energy storage is competitive with fossil-fueled alternatives now.

The FERC decision is expected to spur innovation that should translate into further price declines.

CORPORATE COMMITMENTS

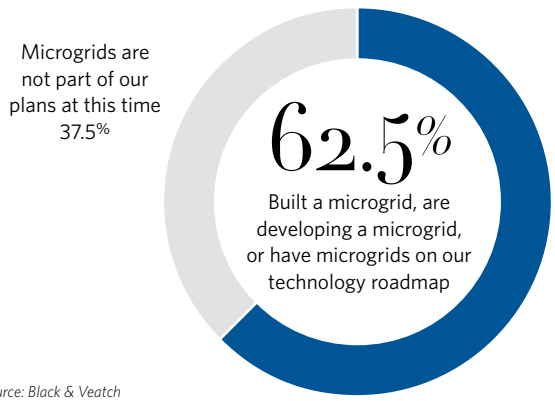
On the demand side of the equation, the business community is making a strong commitment to alternative energy. Under the RE100 banner, more than 120 multinational giants — including Apple, Walmart, Bank of America, General Motors, JPMorgan Chase & Co., Starbucks, eBay, Kellogg's, Johnson & Johnson, Hewlett-Packard and Iron Mountain — have announced a goal of 100-percent renewable energy.

In April, Apple announced that all of its global data centers, retail stores and offices in 43 countries are 100 percent powered by renewable electricity, either from solar or wind power.

Many of these companies are generating their own energy through rooftop solar and buying renewable-based power from offsite grid-connected generators. In a recent survey of RE100 participants, companies said that in addition to the environmental benefits, the business case for switching to renewable energy is strong. Sustainable energy is now more than environmental policy, it is a competitive advantage.

FIGURE 12

Which of the following best describes how active your utility is with microgrids? (Select one choice)



Source: Black & Veatch

UTILITIES RESPOND TO OPPORTUNITY

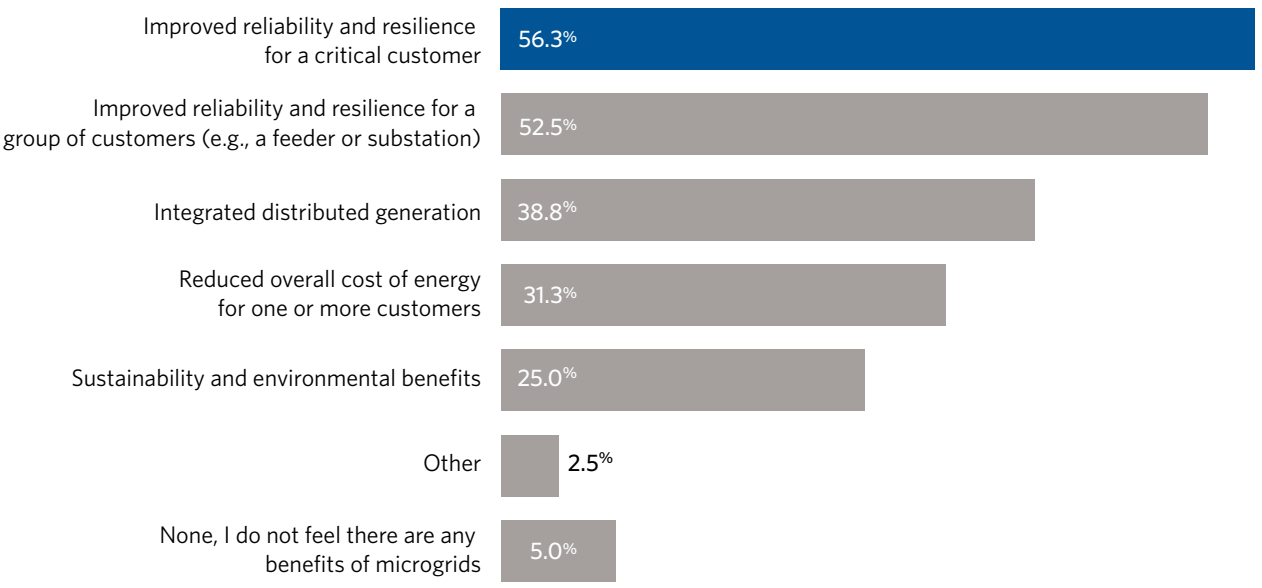
Even electric utilities that may have initially viewed alternative energy as a threat now see distributed, renewable and microgrid energy resources as a transformative opportunity.

The majority of utilities (62 percent) who responded to Black & Veatch's *2018 Strategic Directions: Electric Report* survey either have built a microgrid, are developing a microgrid or have included microgrids on their technology roadmap *(Figure 12)*. Thirty-eight percent said that microgrids are not part of their plans at this time.

When utilities were asked about the benefits of microgrids, improved reliability and resilience came out ahead, followed by integrated distributed generation, reduced cost of energy and environmental benefits *(Figure 13)*.

FIGURE 13

What do you feel are the major benefits of microgrids? (Select all that apply)



Source: Black & Veatch

In a noteworthy development, two Pennsylvania utilities (PECO Energy and Duquesne Light) recently testified in favor of a bill that would allow utilities to build public-purpose microgrids that would provide power to essential services in the event of a successful cyberattack. Duquesne Light plans to build a six-building microgrid at its headquarters in Pittsburgh, Pennsylvania.

In addition to hardening utility facilities, utilities also are seeing microgrids and DER as a way to better serve their customers, offer a broader range of services and support sustainable growth of the utility business.

EARLY DEPLOYMENTS PAVE THE WAY

Early adopters are providing a first look at the major drivers behind the technology, as well as what deployments can look like in terms of partnerships and technologies involved.

The Chattanooga Airport, for example, has a solar array that currently supports 85 percent of the airport's energy needs. The airport is in the process of building a solar-storage microgrid comprising two 250 kilowatt (kW) batteries and all related equipment and software to help integrate this generation. To execute this feat, the city is partnering with Oak Ridge National Laboratory and the University of Tennessee-Knoxville.

In Salinas, California, the Santa Rita Union School District is taking advantage of state incentives to deploy solar photovoltaic and energy storage at six sites. The project is based on a behind-the-meter energy storage system.

And in San Diego, the Miramar Marine Corps Air Station is establishing its own energy network to keep operations going in the event of a regional blackout. Black & Veatch and Schneider Electric are providing design and construction support on the project, which is scheduled to be completed in 2018.

These three projects, although diverse across industry, are all in pursuit of the same goals: increase reliability and resilience against power outages, incorporate renewable energy, lower energy bills, and allow operations to continue if the utility power grid is compromised or damaged.

FROM PILOTS TO PROLIFERATION

Although enthusiasm for microgrids continues to grow, we are still in the early stages of the movement, and there are challenges that need to be addressed. One of the largest issues stems back to how the traditional energy grid was designed – built for one-way traffic, from the energy generation source to the customer.

In the new world of DER and microgrids, utilities need to upgrade their distribution network so that it has the intelligence and capability to take advantage of smart meter data and can accommodate and load-balance these new behind-the-meter generation sources that will be sending electricity back to the grid at certain times of the day.

Making the widespread deployment of DER and microgrids a reality also will depend heavily on cooperation between municipalities, utilities, customers, regulators and manufacturers. When polled on who should be the dominant owner/operator of microgrids in the future, survey respondents overwhelmingly pointed to partnerships between utilities, non-utilities and the public.

The Evolution of Distributed Energy

ENERGY STORAGE PROVES KEY TO DELIVERING NATURAL GAS ADVANTAGES

By Alap Shah

***Alap Shah** is a Vice President and Director of Technologies and Services Areas in Black & Veatch's power business. He has more than 20 years of experience serving as Thermal Performance Section Leader and Turbine Technologies Manager. Shah has worked closely with major turbine original equipment manufacturers such as General Electric, Siemens and Mitsubishi Hitachi Power Systems Americas in various turbine technologies assessments and several first-of-a-kind turbine technology launches for Black & Veatch.*

The cost of energy storage has fallen to the point where the power generation industry is moving from demonstration projects to full deployment. Driven by demand and a federal order designed to nurture broader adoption of storage capabilities, practical applications of energy storage are emerging that are competitive with conventional solutions.

In addition, continued annual reductions in the cost for storage will reveal more and more applications where energy storage makes economic sense. A great example can be found in the performance optimization of gas turbines.

In recently establishing Order 841 to integrate energy storage into the power market, FERC declared the order would "enhance competition and promote greater efficiency in the nation's electric wholesale markets, and will help support the resilience of the bulk power system." While many initially ascribed storage's primary value to the capture of renewable energy and subsequent grid resilience, new scenarios are emerging that pair storage with conventional gas turbine generation to deliver more rapid response, milder ramp rates, fewer starts and stops, and emissions reductions.

In a way, gas turbines and renewables are beginning to solve each other's problems.

New scenarios are emerging that pair storage with conventional gas turbine generation to deliver more rapid response, milder ramp rates, fewer starts and stops, and emissions reductions.

Gas turbines have long played a central role in helping supply meet demand, given their ability to quickly flex up or down to demand peaks and dips. But their efficiency is diminished when running under or above optimal load. Meanwhile, the rise of renewable energy sources promises to reduce our carbon footprint, but they also carry hazards for utility managers because their variability and intermittency complicate load-balancing and grid-planning efforts.

Enter the battery storage-augmented gas turbine, in which storage performs as a kind of reserve that springs to life to smooth and optimize turbine performance levels.

ENERGY STORAGE GAINS MOMENTUM

Southern California Edison and General Electric recently retrofitted a 50 megawatt (MW) gas turbine with a 10 MW lithium-ion battery energy storage system (BESS). The system now has faster response, both starting and ramping. In 2017, American Electric Power and the Finnish company Wärtsilä added a 4 MW BESS to a hydroelectric plant. New revenues are generated with the faster response in the PJM market for two forms of ancillary services, having closed the gap for responsiveness to command signals.

In 2018, AES Corporation won a power purchase agreement (PPA) tender from Southern California Edison for 1,284 MW of combined cycle capacity with 100 MW of BESS capacity. Greater performance from the system allowed lower PPA prices. The combined cycle plant is expected to come online in 2020, with the BESS to follow in 2021. Projected reductions in capital costs for the BESS enabled this success.

Black & Veatch recently worked with a client and a power electronics supplier to design and build a 4 MW BESS, retrofitting it to the client's existing multi-megawatt solar photovoltaic facility. Energy storage is a common element of Black & Veatch work in distributed generation, particularly in microgrids.

Other companies who have announced storage plus conventional generation include NextEra Energy, Southern Company, Siemens and Aggreko, among others.

ENERGY STORAGE BENEFITS

Benefits can be accrued by design for new builds and for repowering builds, as well as by retrofitting an operating asset with some form of storage technology. For the foreseeable future, lithium-ion BESS will provide the lowest capital cost option. Other battery technologies such as "flow batteries" store more energy for longer durations than lithium-ion with little or no capacity degradation. Other storage

technologies such as mechanical flywheels and supercapacitors can also improve conventional generation technology operation.

Direct, revenue-based benefits can be accrued in locations where the energy market has established requirements that embrace the performance attributes of energy storage. Energy storage projects can be rate-based in states where the public utility commission has decided to allow that, typically on a project-by-project basis. Indirect benefits of many kinds can be accrued because of the flexible operating envelope of lithium-ion BESS. Intangible benefits become relevant when they are important to the stakeholders for a project *(Table 1)*.

The market appears to be embracing storage-turbine projects. Energy storage plus peaking gas turbines are seen as the most likely pairing in the next two to three years, followed by energy storage plus combined-cycle units, according to survey respondents *(Figure 14)*.

Energy storage options tied to gas turbines provide key advantages across a range of potential deployments:

- **Option 1 - Starting and ancillary services:** A BESS rated for 10 MW could substitute for a static frequency converter that brings the combustion turbine (CT) unit up to crank speed until the unit starts. When not in use, the BESS can participate in ancillary services markets,

TABLE 1

Sample Energy Storage Benefits Relative to Combustion Turbine Assets

Direct Benefits	Indirect Benefits	Intangible Benefits
When called to run: Immediate power production from the BESS while the turbine starts, garnering spinning reserve revenue by otherwise non-spinning assets **When not in operation: Participation in ancillary services markets, generating revenues of otherwise stranded assets with no emissions or fuel costs**	O&M reduction - BESS can provide rapid load following allowing the CT to run under more favorable conditions, steady state or ramp less severely thus reducing wear and tear Life extension - As longer duration BESS decline, two- or four-hour BESS systems can avoid start/run cycles of less than the BESS duration, reducing damage accumulation	Lower NOx, CO2 - More favorable operating conditions, which reduces emissions Rapid deployment - MW-scale BESS have been deployed in less than 100 days, from agreement to deployment

Source: Black & Veatch

providing power quality services and accruing revenue as the local energy markets allow. If additional energy storage duration is added, the BESS can absorb operational high-ramp-rate demands, reducing wear and tear and lowering operating and maintenance costs.

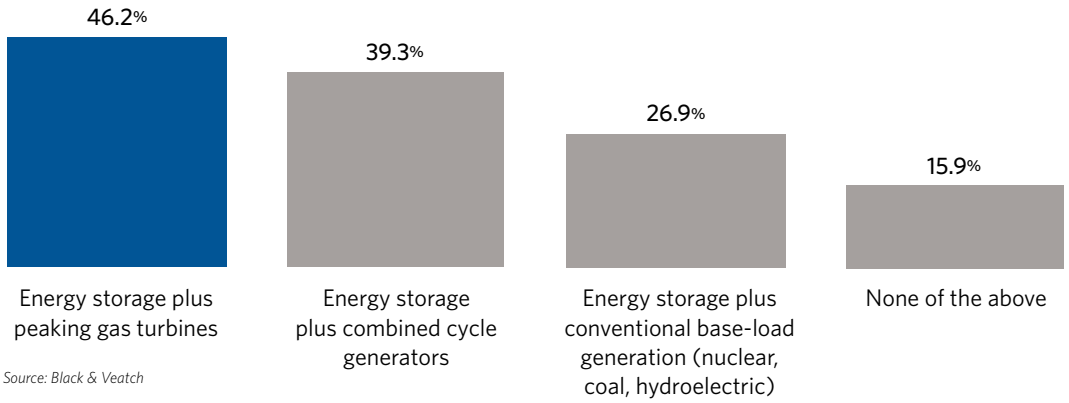
- **Option 2 - Spinning reserve and ramp mitigation:** When not called to operate for the CT, the BESS can participate to a greater extent in ancillary services markets, providing power quality services and accruing revenue as the local energy markets allow. Additionally, the BESS can absorb operational high-ramp-rate demands.
- **Option 3 - CT life extension:** An optimally sized BESS with a MW capacity between the first two options would have an energy storage duration of one to four hours. Such storage would be designed to be sufficient to avoid turbine operation when short-duration run times are forecast for the CT. The reduction in the number of starts/stops of the turbine can translate to a longer operating life (years), reduced operations and maintenance and reduced emissions. The BESS would also protect the unit from starts that would need very short run times, also extending the calendar life of the unit.

FROM DEMONSTRATION TO DEPLOYMENT

Energy storage is inexpensive, and the age of demonstration projects is over. Practical applications of energy storage have emerged that are competitive with conventional solutions. Continued annual reductions in the cost for storage will reveal more and more applications where energy storage makes economic sense.

FIGURE 14

Which of the following pairings do you foresee gaining acceptance in the next 2-3 years? (Select all that apply)



Source: Black & Veatch

The Evolution of Distributed Energy

ENERGY STORAGE EVOLUTION ELECTRIFIES THE FUTURE OF RENEWABLES

By Frank Jakob

Bolstered by decreasing costs and strengthening regulatory support, demand for renewable energy is increasing as wind and solar photovoltaics continue to become more prominent contributors to utilities' generation and revenue mix. As enthusiasm for renewable energy grows, wind and solar remain hampered by how much energy can be stored when generated to be used subsequently when energy is needed.

Intermittency and periodicity are two of the largest barriers to fully embracing renewable energy as a viable alternative to traditional generation. Renewable power may not be available when needed, or too much power may be generated when it is not. This feature of renewable power has spawned a growing need for robust energy storage that can smooth out this cycle, effectively harnessing the time-varying and geographically distributed energy supply and improving electricity availability and resilience.

Storage systems can address capacity constraints, improve power quality and reliability and allow utilities to effectively increase the amount of renewable electricity generation on the grid.

***Frank Jakob** is a Technology Manager for Energy Storage at Black & Veatch and has more than 25 years' experience working in energy systems. Jakob has led efforts ranging from front-end concept and product design to demonstration and pilot plant production of advanced energy systems.*

GROWING INTEREST

Although widespread adoption of storage technology is in the early stages, utilities are cultivating a growing interest. More than half of respondents to the *2018 Strategic Directions: Electric Report* survey either are running energy storage pilot programs or have energy storage on their technology roadmap. Additionally, 16 percent are developing energy storage pilot programs, while 12 percent have deployed a full-scale energy storage program *(Figure 15).*

According to GTM Research and the Energy Storage Association's newly released *U.S. Energy Storage Monitor 2017 Year in Review,* the United States deployed 100 megawatt-hours (MWh) of grid-connected energy storage in the fourth quarter of the year, marking a cumulative 1,080 MWh deployed between 2013 and 2017. GTM Research expects that the U.S. market will almost double this total in 2018 alone.

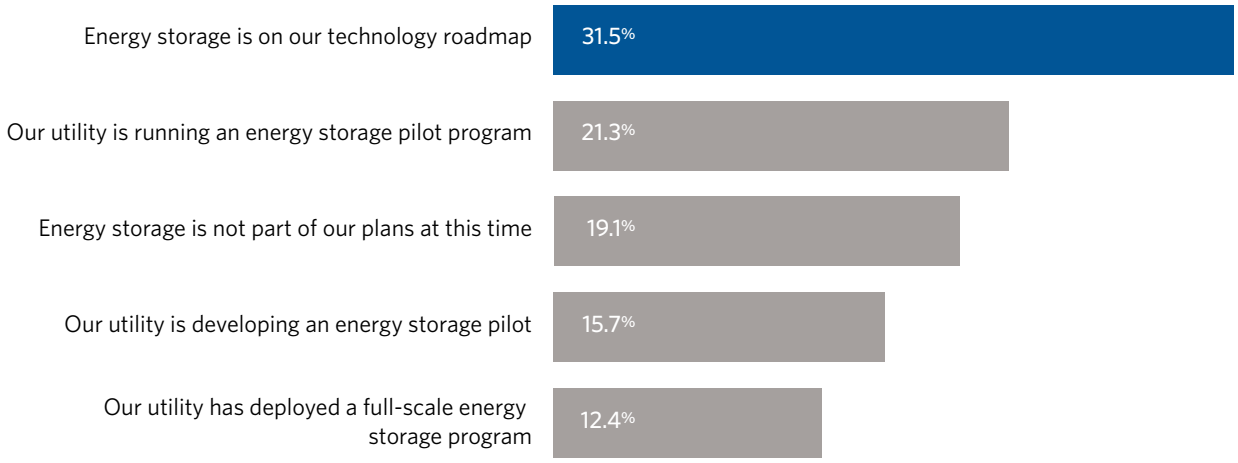
A CHANGING REGULATORY OUTLOOK

Despite uncertain policy questions in Washington, D.C., states, regions and agencies continue to rally around renewable energy initiatives, increasing the need for viable energy storage solutions.

California and Hawaii have risen to the forefront as leaders in renewable energy and energy storage. California's Public Utilities Commission has mandated that the state's three investor-owned utilities install 1,325 megawatts (MW) of energy storage by 2020.

FIGURE 15

Which of the following best describes your company's activity related to energy storage? (Select one choice)



Source: Black & Veatch

And just recently, California's energy regulators passed a building code requiring most new, low-rise residential homes constructed after 2019 to have built-in solar-powered energy systems, making it the first state to go down this path. Hawaii continues to work toward its goal of attaining 100 percent green energy among its electric companies by 2045.

In February 2018, FERC ordered the removal of barriers to the participation of electric storage resources in energy services markets. This is a landmark effort to enhance competition and promote greater efficiency in the nation's wholesale electricity market. This decision is significant because it enables energy storage providers to buy and sell in wholesale markets at wholesale prices.

Efforts are spreading beyond California, with regions such as the Pacific Northwest and New England, along with the states of New York and New Jersey, implementing legislation and tax incentives to promote renewable energy and energy storage solutions.

ENTHUSIASM GROWS AS PRICES DECLINE

Just as DVDs, high-definition televisions (HDTV) and computers seemed cost prohibitive when they first came to market, advancing technology and market competition soon brought down prices, making them accessible to most consumers. We can expect to see energy storage follow suit.

Today, the price of energy storage continues to drop, part of which can be attributed to the electric vehicle industry driving battery cell production to a much greater extent than stationery energy storage. Spurred by the rise of EVs, lithium-ion batteries are declining in cost to the point where they are moving into broader, more price sensitive markets. For example, Tesla's battery at the Hornsdale Power Reserve in South Australia was paid $790/MWh to absorb excess electricity from the power grid.

In the United States, Tucson Electric Power entered into a power purchase agreement with a 100 MW solar and 30 MW/120 MWh battery for approximately 4.5 cents per kWh. This project benefits from the fact that if a battery charges mainly from solar, it can receive the same 30 percent tax credit as the solar itself.

Increased demand, spurred by electric customers who are saving money on their electric bills, is also driving down the cost of storage. Traditionally, utilities levied a demand charge on C&I customers based on the monthly maximum power draw, and in certain regions, those charges are significant. But now we're seeing energy storage begin to offer solutions. When building or facility electric systems are attached to battery storage, the latter can help offset peak power demand on the grid, preventing it from seeing the peak power draw.

This helps spare customers the high costs associated with peak demand electricity consumption, such as on summer afternoons, when air conditioners are pumping and manufacturing is in full swing, or on winter mornings, when households crank up the heat.

BATTERIES LEAD THE NEXT FRONTIER OF ENERGY STORAGE

In addition to solid state batteries, suppliers are attempting to create classes of batteries with improved attributes over lithium. These new flow batteries use liquid instead of solid cells, and as a result, can hold a much longer charge by virtue of the size of the tanks storing the liquid. In addition, flow batteries do not suffer the cycling degradation attributed to lithium-ion batteries.

According to this year's survey results, however, novel storage technologies such as long duration flow batteries, as well as high cycle life flywheels, are still not gaining broad acceptance; 44 percent of respondents were neutral on the importance of these technologies, and only 7 percent found them very important.

The data indicate that electrochemical batteries lead the way among respondents, of whom 63 percent see the technology as increasingly instrumental on the grid. This is followed by

pumped hydro, ultra-capacitors, thermal, compressed air, hydrogen, mechanical flywheels, synthetic natural gas and liquid air *(Figure 16)*.

MOVING BEYOND THE EARLY ADOPTERS

Today, energy storage is where solar was five to 10 years ago: bolstered by a lot of innovation and new startups, but with little standardization, lots of conflicting data and a lack of information as to what the technology actually represents. This confusion makes it challenging for developers and utilities to proceed to widespread adoption and for engineers to accurately size and specify storage systems.

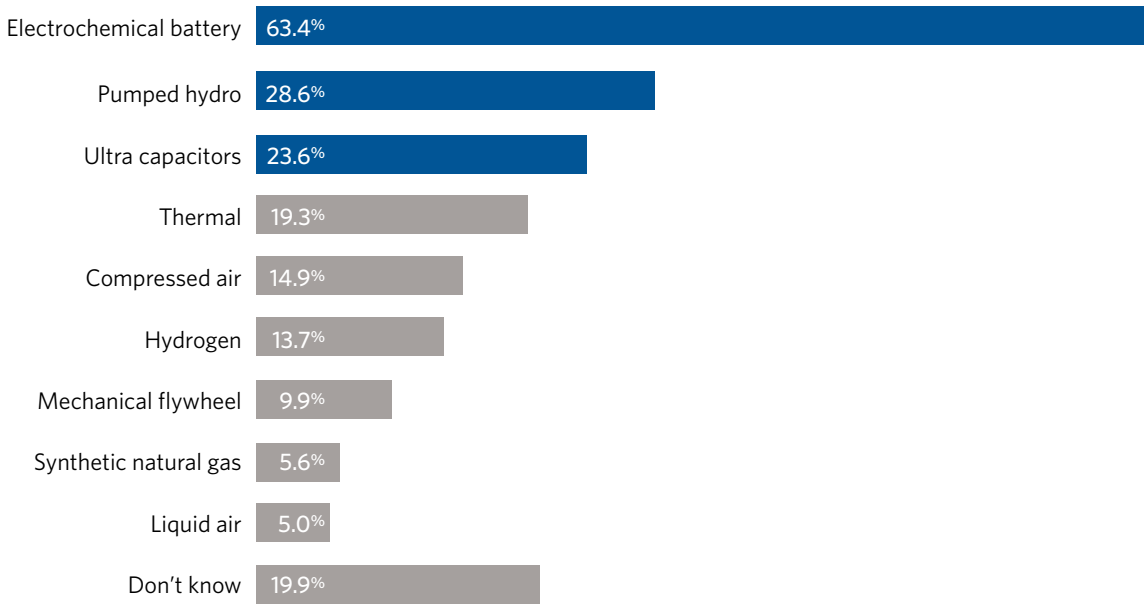
In addition, while costs are clearly dropping, storage solutions and renewable energy in general remain less economical than their next best alternatives for many firms and utilities. But increased competition, increased manufacturing and new regulatory controls should bring prices down further, even as tax incentives make it easier for developers and utilities to monetize offerings.

Optimistically, more than half of respondents in this year's report said they see renewable energy resources becoming the primary source of generation of electricity in the United States within the next decade. This illustrates that the skepticism and reluctance of years past have finally given way to major line items — and in some cases, actual deployments — on utilities' technology roadmaps.

Widespread traction is clearly gaining momentum, driven by technical innovation, regulatory acceptance, economics and environmental benefits.

FIGURE 16

What types of energy storage do you foresee being instrumental in the grid of the future (a stable, reliable, resilient grid)? (Select all that apply)



Source: Black & Veatch

The Evolution of Distributed Energy

ELECTRIC VEHICLE ADOPTION MOVING UTILITIES TO PLAN FOR A ZERO-EMISSIONS FUTURE

By Maryline Daviaud Lewett and Rick Azer

Separated by decades of progress and technology's endless march, it's easy to think electric vehicles share little heritage with their internal combustion forebears. But even as they bookend the automotive spectrum, today's EVs are much like the first automobiles in one important respect: When the first cars were made, they had an outsized dependency on infrastructure. Without a robust system of roads (let alone highways), what was the incentive to buy?

Fast forward to 2018, and the comparison comes into sharper focus. Original equipment manufacturers (OEMs) are speeding their moves toward electric vehicles, even as questions persist over whether charging infrastructure can support wider adoption of EVs by consumers and accommodate corresponding power demands on the grid.

Recent years have seen more utilities in planning mode as they worked to better understand aggregated charging. In 2018, utilities are putting those plans into practice as they launch pilot programs. Hastened by the release of 2018's crop of EVs (the Chevy Bolt, Tesla's Model 3, the Nissan Leaf, etc.) and the announcements of a plethora of new EVs planned for 2019, we see a growing sweet spot of customer adoption as more Americans are sold on EVs. Regulatory moves are also part of the equation, as states such as California adopt climate change mandates that encourage EV adoption.

***Maryline Daviaud Lewett** is Director of Business Development for Black & Veatch's Transformative Technologies business. She is responsible for sales and partnerships in distributed infrastructure, sustainable and CleanTech transportation, and engineering, procurement and construction services of electric vehicle charging infrastructure networks, fuel cell vehicle filling infrastructure networks, and behind-the-meter energy storage.*

***Rick Azer** is Associate Vice President for Black & Veatch and a founding member of the company's Growth Accelerator. Azer commercializes new technologies and service offerings that extend the company's position as a leader in critical human infrastructure. His project portfolio includes a nationwide network of high-power electric vehicle charging stations, hydrogen fuel filling stations, stationary storage and smart city infrastructure.*

Now comes the difficult work to ensure enough infrastructure — and grid modernization — to support this growing network of vehicles. How are utilities planning for increased load and charging? What steps are they taking to harmonize this need with grid operations?

SOLVING RANGE ANXIETY

Among the main challenges in hastening broader EV adoption is customer perception of miles traveled, range and reliability. Some vehicle batteries are moving past the 200-mile-per-charge barrier, solving one problem. But what about broader availability of EV infrastructure? Range, vehicle price and lack of publicly available charging infrastructure rank as the biggest obstacles to increased EV adoption, survey respondents told us *(Figure 17)*.

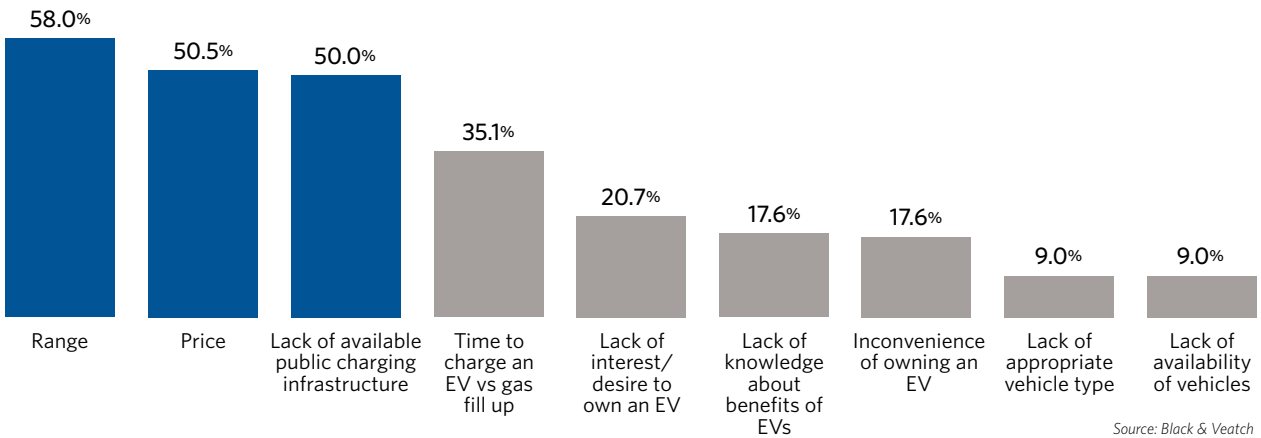
These sentiments reflect challenges often cited by customers: Where can I charge my car, and will I have to charge every day? How long does it take to charge with a Level 2 versus a DC charger? Do I have to wait in line? How much will it cost?

A major hurdle was cleared earlier this year when Electrify America detailed its national DC fast-charger network, the nation's largest public DC fast-charging network (Black & Veatch was one of two companies selected by Electrify America to design and build the charging station sites). This new DC charging network is a strong complement to existing public infrastructure such as the EVGO network, and the ChargePoint, ClipperCreek, Volta and Greenlots stations found in many public and private parking lots.

Electrify America's ultra-fast EV chargers are the first certified cooled-cable 150- to 350-kilowatt (kW) chargers deployed in North America, capable of delivering enough energy for up to 20 miles of range per minute — seven times faster than today's 50kW DC chargers. Black & Veatch is currently supporting site development services across the U.S., as

FIGURE 17

What are the largest obstacles to increased passenger electric vehicle (EV) adoption in your area? (Select up to three responses)



Source: Black & Veatch

well as performing engineering, permitting and construction of DC Fast Charger electric car charging station sites in the Pacific Northwest, Northern California, Southern California, Mountain, Central, Midwest, Southeast Central and Southeast regions. The large number of charging sites will open unprecedented options and raise convenience for motorists.

GRID ANXIETY?

Wider EV adoption rates are raising new questions about the readiness of our grid.

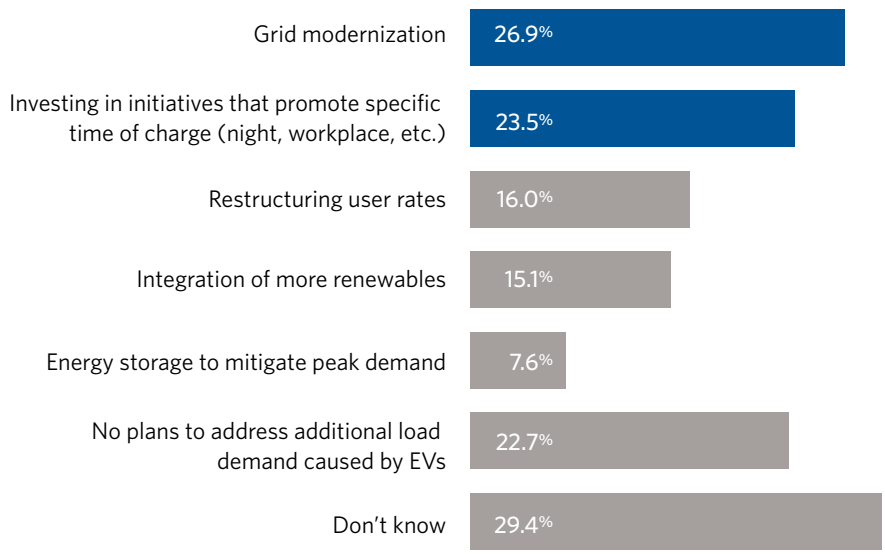
Presuming a significant growth rate, the U.S. Department of Energy (DOE) has estimated that there will be 21 million plug-in EVs on the road by 2030. That growth is motivating new planning and solutions among utilities, which must consider where they can reliably predict and control load related to increased charging stations, some of them high-power. Without adequate planning and investment, charging stations could tax the grid and bring about unplanned distribution grid investments to deal with transformer upgrades, brownouts or costly repairs.

In addition, the traditional business model of utilities as the sole power generator is being upended by the emergence of end-customer and private company-owned renewable technology generation, like solar and wind, as well as other DER and energy management solutions. However, utilities are recognizing that with proper planning, these disruptive technologies can be turned into new streams of revenue.

Many utilities have begun the planning process, with survey respondents saying grid modernization and programs that encourage customer charging during specific times will be important to managing additional load demand brought on by EVs *(Figure 18)*. A thoughtful approach to grid modernization can help utilities meet growing energy needs, balance supply and demand, and integrate renewable energy generation. It also can provide grid services and help fund new grid and charging infrastructure by providing additional revenue.

FIGURE 18

How do you plan to manage the additional load demand on the grid caused by EV adoption? (Select all that apply)



Source: Black & Veatch

While the DOE's 2030 timeframe seems like a long way off, these capital-intensive upgrades require careful coordination and have long lead times for approvals, engineering, permitting and construction. As more EVs hit the streets, utilities should move now to plan for their impacts on their systems, along with the market deregulation brought by state-level public utility commissions (PUCs).

GRID MOD THROUGH UNIQUE PRICING STRUCTURES

We increasingly see that as the EV market matures, utilities are understanding the need for more renewable energy. If they want to avoid the problems associated with peak demand, it follows that solar produced during the day can deliver the excess supply needed for daytime charging.

In California, one challenge is the mismatch between peak production from solar energy — which occurs between 11 a.m. and 3 p.m. — and peak EV charging time, which is typically overnight. This has produced a midday energy surplus that EV cannot take advantage of. To remedy this, charging network providers could install charging stations at workplaces and business parks, and adjust rates to encourage midday charging. Such actions would directly impact and shape consumer behavior and charging patterns. Investor-owned utilities (IOUs) in California have been exploring such rate adjustments.

Various other types of grid modernization can help mitigate impacts. One such method is managed charging — often referred to as "smart charging" — that occurs when the utility signals the network to reduce charging levels if a high-

In much the same way, widespread EV charging infrastructure will be foundational to fulfill the promise of zero-emissions transportation.

load event is occurring on the grid. Or, in situations where there is a surplus of energy, utilities can signal the network that charging load can be increased. Battery storage is also a key strategy, as it drastically reduces the amount of power consumed from the electrical grid during peak times, while freeing up capacity for other uses.

Pricing signals also can influence charging behavior and balance energy supply from renewable energy resources. In addition, other types of distributed generation powered by conventional fuels, such as micro-turbines, fuel cells, combined heat/power systems and energy storage can be integrated with EV charging at a local level.

THE ROAD AHEAD

Henry Ford's Model T changed the fate of passenger vehicles through a revolutionary production strategy that put the car within reach of buyers. That, in turn, helped spur the build-out of roads — and later, highways — that would fulfill the promise of the automotive industry.

In much the same way, widespread EV charging infrastructure will be foundational to fulfill the promise of zero-emissions transportation. So, too, will be the moves we make to accommodate the added demand of expansive, high-power charging and DER grid impacts, which will happen concurrently.

To prepare for and realize the benefits of a zero-emissions future, stakeholders such as cities, utilities and private enterprises like automakers and medium- to heavy-duty vehicle OEMs must work together on planning, designing and building systems to accommodate their corresponding power demands. Standards must also be deployed and implemented to maximize equipment utilization. Much great work is underway, and there is more to come.

The Changing Face of Power

THE NEW POWER GRID: OBLIGATIONS IN THE ERA OF CHANGE

By Robert Mechler

Robert Mechler, P.E., *is a Regional General Manager and Director of Transmission & Distribution (T&D) Project Development for Black & Veatch. With more than 30 years of experience in the power delivery sector, Mechler specializes in the planning, engineering, construction and maintenance of power delivery systems. He has been involved with transmission regulatory policy and unregulated wholesale and retail electric markets.*

To effectively map out the current and future states of power delivery, it's imperative to discuss what the landscape looked like in the past. Understanding the evolution of any industry typically requires a healthy dose of historical context, and making sense of today's energy grid is no exception.

Throughout the majority of the electric power era's first 100 years, the power supplier and the consumer had a simple relationship: electric utilities supplied the power, and the public promptly consumed it. The utilities were bound by an obligation to serve the customer, to provide reliable power and to do so safely; for the most part, they delivered on that promise.

This was the way of the world for much of the 20th century, but as desire for a free-market approach gained traction with the introduction of the Public Utility Regulatory Policies Act (PURPA) in 1978, the industry started to unbundle and restructure. The obligations to serve remained, but as more players became involved, the complexities of operating the grid began to multiply.

Today, four decades into this transformation, we continue to see new players, new opportunities and new challenges, but we also see the

same focus on meeting fundamental obligations. The results from the *2018 Strategic Directions: Electric Report* survey reveal what's driving utilities today, and help paint a picture of what the future of our energy grid may look like.

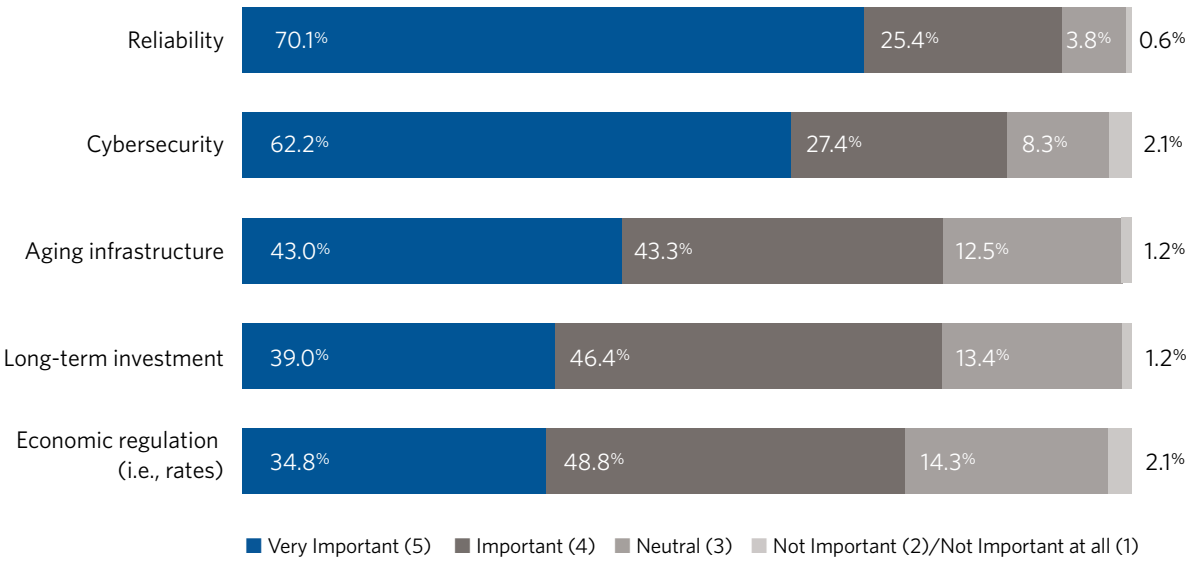
When asked about critical issues facing the modern electric industry, utilities pointed to familiar challenges – grid reliability (96 percent), cybersecurity (90 percent) and aging infrastructure (86 percent) as important or very important issues *(Figure 19)*.

These responses have consistently ranked among the top concerns for the industry for the past five years. Reliability lies at the heart of providing consistent service to consumers — whether the grid is under attack from rogue cyber hackers, or facing potential component failures on equipment that has reached the end of its useful life. This reliability challenge has only become more complicated as the grid continues to integrate with emerging technologies.

With 54 percent of respondents expecting third parties to either be "likely" or "extremely

FIGURE 19

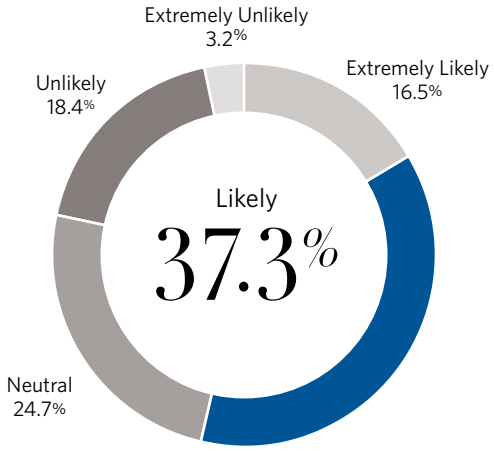
Please rate the importance of each of the following issues to the electric industry using a 5-point scale, where a rating of 5 means "Very Important" and a rating of 1 means "Not Important At All." (Please select one choice per row)



Source: Black & Veatch

FIGURE 20

How likely is the risk of third parties entering your market(s) and providing alternative energy solutions to your customers? (Select one choice)



Source: Black & Veatch

likely" to enter the market and supply power to customers, the grid must be reconfigured and enhanced *(Figure 20).*

Transmission owners have been addressing these changes for several years. Driven by a variety of new rules — evolving regulatory changes on traditional fossil fuel plants, new renewable portfolio standards, new technologies in energy storage and new competitive mandates from FERC — electric utilities have responded by actively engaging with customer-based behind-the-meter solutions and investments in the grid. Nearly 50 percent of utilities say they are actively working with their customers on alternative energy solutions and with regulators to enable sound investments.

Utilities who are not adapting to this new energy grid world could face significant economic challenges, often referred to as the "utility death spiral." In fact, more than 70 percent of survey respondents view this scenario as a plausible outcome if utilities either fail to implement their own alternative energy solutions or if regulatory models preclude market flexibility.

Time is of the essence for utilities to adapt. Nearly a quarter of the respondents believe utilities have already begun feeling the effects of the "death spiral," with another 61 percent believing that if they haven't already, they will within the next 10 years.

These changes and challenges seem to be placing traditional electric power utilities at a crossroads, though it's likely that big changes to the grid itself won't be too abrupt. Instead, we have seen the slow unbundling and continued consolidation of investor-owned utilities across the United States over the past 20 years, including the acquisition of well-established U.S. utilities by international companies. With generation becoming more diverse in

New technologies such as local battery storage, self-supply solar and the introduction of new system paradigms such as microgrids and smart grids have begun to change the face of the traditional power grid.

an expanding wholesale market, ownership of transmission and distribution infrastructure has become an attractive investment avenue for utilities and others because of the consistent rate of return.

Further, new technologies such as local battery storage, self-supply solar and the introduction of new system paradigms such as microgrids and smart grids have begun to change the face of the traditional power grid. These new opportunities and challenges will likely necessitate a shift in how customers pay for their power. To mitigate the effects of the death spiral and remain a viable investment option, utilities will need to seek changes in their regulatory compact to allow them to better accommodate innovation while still maintaining reliability.

In an industry with more than 130 years of history, including four decades of fundamental transformational changes, we now find ourselves at a new pivot point. Traditional utility business models are slowly changing. New players are entering the market in all sectors of the industry and are introducing new, innovative technology and applications. The industry is increasingly embracing new ideas on how to produce, store, transport and use electricity. We are witnessing an investment resurgence in an aging infrastructure that needs to reconfigure and expand to meets its obligation of delivering safe, secure and reliable electric power.

The Changing Face of Power

OLD CAPITAL ALLOCATION STRATEGIES REQUIRE NEW THINKING

By Judy McArdle, David Price and Russell Feingold

The electric utility industry is in the middle of a transformation that has no precedent. Historically speaking, delivering electricity was relatively simple; utilities generated power and provided it to customers over a one-way delivery system. Companies requested, and utility regulators granted, periodic rate hikes to cover infrastructure upgrades while providing a reasonable rate of return on that investment.

Today, the game has changed, and there's no tested roadmap on how to handle the partial and unpredictable generation of electricity by customers through rooftop solar and other DER. There's no blueprint for how utilities should view technologies such as electric storage or microgrids, and as of now, there is no way to accurately predict the impact of EVs and charging stations on the distribution grid.

IT'S A NEW GAME

On the governmental and regulatory front, states are making momentous decisions that will significantly impact electric utilities and other new market participants: Witness California requiring solar power on all new homes after 2019, or New York effectively restricting utilities from entering the DER market. The federal government is weighing in as well by implementing new rules to open the market for battery storage, while cities, states and large corporations are all announcing their own ambitious goals for using renewable energy to have more control over their electric power requirements.

***Judy McArdle** is Senior Managing Director of the Advisory and Planning Service Offering within Black & Veatch management consulting. The advisory and planning team comprises rates and regulatory practice for electric, gas and water rate studies; market analysis and integrated resource planning practice; and independent engineering for all types of electric generating technologies.*

***David Price** is a Senior Managing Director for Asset Management in Black & Veatch management consulting. Price has more than 25 years of management, strategy, product development, delivery and operational experience in the utility consulting, systems integration and software industry.*

***Russell Feingold** is Vice President of Black & Veatch management consulting and head of its Rates & Advisory Group. With a broad range of project and managerial experience in the energy and utilities industries, he specializes in pricing, competitive market analysis, regulatory planning, policy development and strategic business planning.*

This type of market disruption is changing the game for utilities, which requires them to address capital allocation in a different way than in the past. Historically, capital allocation has been focused primarily on replacement of the utility's aging infrastructure, but today, it is critical that utilities apply new thinking to a relatively stable and predictable process from the past.

This situation is exacerbated by a current lack of real market definition at a regional and local operating level on which companies can build their respective grid and distributed generation strategies and plans.

Thus, absent this clarity of direction, utilities need to develop a working model of the market and the players in it for themselves to assist with predicting what may happen, and then align their capital allocation strategies to support those predicted outcomes and assumptions.

Here are some questions utilities should ask themselves during this process:

- What is the role of the grid operations business considering the emerging new energy markets?
  - What new market processes, operating models and business requirements result from this role?
- What new types of companies will become players in the electric utility grid market of the future?

- Should our organization also create new businesses targeted at the new roles and opportunities in the future market?
- On the basis of a view of the grid of the future, which services and functions might need to be regulated versus unregulated?
  - For example, will metering and billing eventually be decoupled from the power delivery function?
  - Can new value-added services based on the more granular customer data collected through the company's smart meter capabilities be enabled?

In answering these types of questions, companies can begin to introduce specificity into their capital allocation decisions within the context of their predicted market models and outcomes and their desired future position within and outside their current geography and services footprint.

One way to deploy capital in support of an externally facing strategy would be to enter a new market sector or geography, for example, evolving and deploying capital into the global distributed energy market. Hong Kong-based CLP (formerly China Light and Power) is creating unregulated subsidiaries that are looking to enter a variety of markets, including smart cities, DER, microgrids and data centers.

Another specific capital deployment strategy would be an incumbent grid operator investing in upgrading the physical and technological infrastructure to enable the emerging new energy marketplace. A good example would be Newark-based Public Service Enterprise Group (PSE&G), which just announced plans to invest billions of dollars in just such a program, or Exelon, which is working on its Grid of the Future program to create "the smart, resilient grid of the future, capable of two-way communication, and supportive of new and renewable sources of energy."

Introducing specificity into the goals and outcomes related to any capital allocation strategy can represent a challenge for many utilities whose processes have largely lacked this level of granularity in the past. For example, many utilities have yet to address the commercial, market operations and long-term business impact of DER and incorporate their analyses into new capital investment or reallocation strategies as part of their long-range business plans.

TAKING A PROACTIVE APPROACH

PSE&G is taking a leadership position with its recent announcement of plans to invest between $14 and $17 billion over the next five years in an infrastructure program that addresses its aging infrastructure and the modernizing of its distribution grid.

In the wake of Hurricane Sandy, which devastated the New Jersey coast in 2012, PSE&G is making reliability and resilience its top priorities. PSE&G also intends to invest $2.5 billion in energy efficiency and other programs that will reduce customers' energy bills and combat climate change, plus another $300 million in building EV charging infrastructure and $100 million in building utility-scale energy storage systems.

PSE&G estimates that its proposed energy efficiency program will generate approximately 5,000 jobs over the six-year life of the program, reduce carbon emissions by 24 million tons and reduce energy use by 40 million MWh of electricity and 675 million therms of natural gas.

With the significant capital investment reflected in these types of utility plans, it is to be expected that details of the plan could be subject to greater review and scrutiny by the utility's stakeholders and regulators in evaluating the cost-effectiveness and anticipated benefits of the plans.

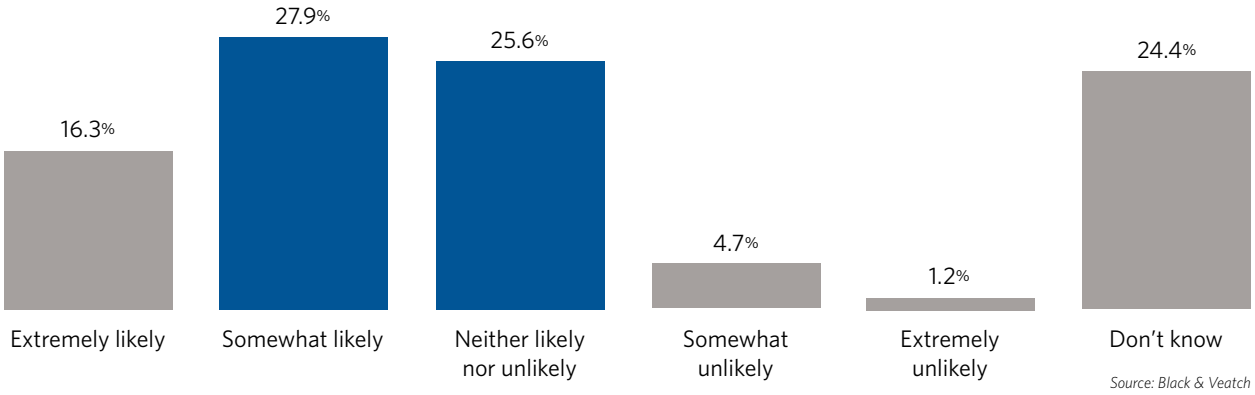
According to the *2018 Strategic Directions: Electric Report* survey, 16 percent of respondents said it was "extremely likely," while 28 percent said it was "somewhat likely," that state utility regulators will require the incumbent distribution utility to provide a stronger economic justification than in the past for infrastructure capital investments necessary to modernize its distribution grid *(Figure 21).*

Many unresolved questions remain about how DER integration into the grid will play out over time. But there is no question that electric utilities must modernize their infrastructure to allow the two-way flow of electricity, while efficiently storing and managing these energy resources. Investments will not be limited to the deployment of EV charging infrastructure but will also require upgrades to the power grid's communications and data networks.

Developing a strategic plan for capital allocation amid all of this uncertainly is not an easy exercise. But now is the time for electric utilities to begin thinking about long-term capital allocation planning in the context of a changing energy marketplace.

FIGURE 21

How likely is it that regulators will require utilities to provide a stronger economic justification for capital investments required for grid modernization? (Select one choice)



Source: Black & Veatch

The Changing Face of Power

COMBINED HEAT AND POWER OFFERS EFFICIENCIES, OPPORTUNITY

By Andrew Trump

***Andrew Trump** is a Director of the Rates & Regulatory Advisory Group within Black & Veatch management consulting, where he focuses on capital investment, risk and business valuation assessments. Trump provides comprehensive investment analysis of technologies, energy markets and regulatory reform dynamics within the realm of grid modernization and energy infrastructure opportunities.*

The benefits of combined heat and power (CHP) generally are well established, and the technology is recognized as having great potential to improve large industrial process efficiencies while contributing to grid resilience.

Conventional electricity generation systems waste a great deal of energy through the discharge of heat into the atmosphere, and even more is wasted when electricity is distributed to distant industrial and commercial end users. CHP, on the other hand, makes productive use of the waste heat that is generated as part of the thermal processes.

As a result, CHP can lower the overall energy demand of a large facility and, under some circumstances, dispatch additional electrical energy to the distribution grid. In doing so, CHP "can achieve efficiencies of over 80 percent, compared to 50 percent for typical technologies (i.e., conventional electricity generation and an on-site boiler)," according to the EPA website.

Today, we are seeing a growing interest in CHP because of low natural gas prices, an aging fleet of industrial equipment, growing sophistication in process controls, enhanced need for reliability and resiliency in industrial operations, and interest from utilities and facility operators in investment in distributed energy projects.

One emergent CHP capability was brought to light during Hurricane Sandy in late 2012, where the value of highly localized grid support became apparent.

COMMITTING TO CHP

Broadly speaking, by improving total process efficiencies and potentially dispatching additional electrical energy, CHP can improve domestic energy security, reduce carbon dioxide emissions, increase energy efficiency and resiliency and lower facility operating costs. Under the right circumstances, these benefits help build a strong case to press forward with CHP development.

In 2012, the Obama administration backed efforts to promote CHP by setting the goal of achieving 40 gigawatts (GW) of new, cost-effective CHP by 2020. This has helped to put a focus on the technology, but a combination of better distributed CHP packages, low natural gas prices, enhanced requirements for operational resilience and positive economics of CHP investments has helped to spur development of CHP projects.

One emergent CHP capability was brought to light during Hurricane Sandy in late 2012, where the value of highly localized grid support became apparent. CHP is now identified as an important potential component of well-designed microgrids that can provide local grid security and resiliency in the event of major and sustained power outages, especially if it can provide a "black start" capability.

[1]Fairfield University Press Release, November 2, 2013.

[2]Kelly, Morgan, "Two Years after Hurricane Sandy, recognition of Princeton's microgrid still surges," Princeton University, October 23, 2014.

[3]Wald, Matthew, "How NYU Stayed (Partly) Warmed and Lighted," NY Times blog, November 5, 2012.

SETTING PRECEDENT DURING HURRICANE SANDY

During October 2012, Hurricane Sandy hit the Mid-Atlantic coast, unleashing destruction and wreaking havoc from Trenton, New Jersey, to eastern Connecticut.

Principally because of flood damage, power was knocked out for days. However, some major institutions such as universities and colleges in New Jersey, New York and Connecticut retained electricity because their microgrids with CHP systems at their core kept these installations running throughout the storm.

The College of New Jersey in Ewing Township operated without interruption after disconnecting from the local grid. In Fairfield, Connecticut, 98 percent of the city lost power for an extended period while the central university's facilities were down for five hours, and the library maintained power.[1]

Stony Brook University, a campus of 24,000, was down for less than one hour, while Princeton University experienced no loss of power after disconnecting from the grid.[2] The Washington Square campus of New York University (NYU) did not suffer any loss of power, but campus housing, which was not attached to the university's CHP system, was down for a lengthy period.[3]

In similar ways, CHP facilities in area hospitals proved their worth. Long Island's South Oak Hospital operated seamlessly during Sandy. Knowing that the grid was most likely going to fail, hospital leaders disconnected in advance as they heard of the impending outage. In fact, prior experience with a 2003 blackout, and its reliance on its CHP facility at that time, had them prepared for Sandy. In Connecticut, Danbury Hospital kept its vital functions operating during the whole of the storm.

In contrast, NYU's Langone Medical Center's non-CHP backup system failed, forcing the facility to relocate over 200 patients while waiting for restoration of power.

In the water industry, New Jersey's Bergen County Utilities Authority kept its sewage treatment facility operating during and after the storm. Running on biogas, its continued operation reduced risk of water supply contamination for the 550,000 residents who rely on this facility. In other areas affected by Hurricane Sandy, water authorities invoked orders to reduce consumption; in still other areas, raw sewage infections occurred.

A common thread through these CHP success stories is also reliance on natural gas as the fuel of choice. During Hurricane Sandy, many backup diesel-fueled systems failed when trucks replenishing diesel fuel were unable to reach generators. The natural gas supply network proved to be much more resilient, and this experience has changed how many institutions, including the federal government, view fuel selection for backup and critical power systems.

THE PATH FORWARD: CHALLENGING MISPERCEPTIONS

From the experiences of the customers and facility owners who were able to ride out the worst of Hurricane Sandy's impacts because of the grid resiliency benefits afforded by CHP, their choices to invest in CHP appear wise in hindsight. Total process efficiencies, emissions and costs are lowered, while at the same time the risk of the loss of grid services in the event of a major outage are reduced. However, misperceptions remain, and the perception of the overall value of CHP by policymakers, planners and others is still a work in progress.

Responses to the *2018 Strategic Directions: Electric Report* survey suggest a division between highly positive and negative responses to questions regarding policy strength and value perception.

Nearly half (42 percent) of survey respondents indicated strong or modest support for CHP development, with either policies and rules in place that outline how CHP can contribute to utility and regional energy goals, or growing interest in developing those policies and rules *(Figure 22)*. Nearly one-third said there is weak or no support, while one-third expressed no knowledge of the state of CHP, which suggests the need for education and a possible model for improved policies and understanding of the value proposition for CHP.

SIZE, SCALE AND GRID INTEGRATION

CHP can be an effective and economic solution for small commercial facilities with loads as small as 20kW to large industrial complex with loads exceeding 500MW. Teams today are studying and deploying CHP technology across this spectrum with a range of technologies including fuel cells, reciprocating engines, and combustion turbines.

The value of policy coordination, and a resulting framework of well-crafted rules and regulations, cannot be underestimated in achieving greater integration of CHP into the grid. For example, a good and useful application of fair backup and standby rates is important to ensure that the participation of the CHP-based resource is carried out in a reasonable and fair way.

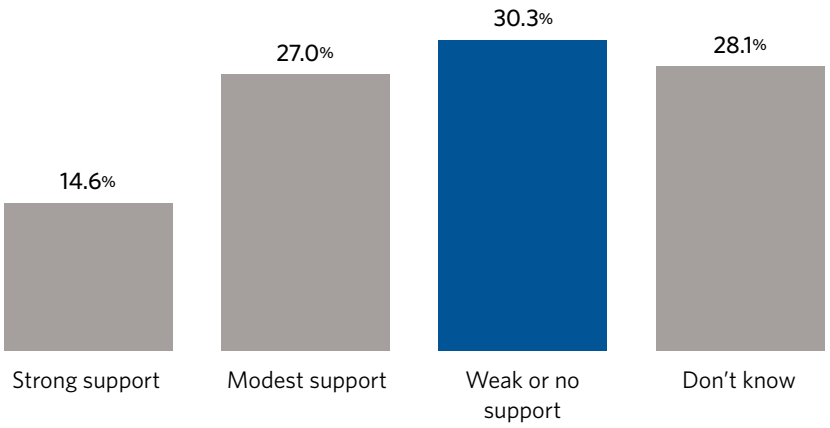
CHALLENGES TO CHP DEVELOPMENT

According to the report survey, 40 percent of respondents point to high project startup costs as the largest challenge to CHP development, followed by too much uncertainty in the energy market (34 percent) and a need for stronger

FIGURE 22

How would you rate the strength of the policies and rules in place to support combined heat and power (CHP) development in your service area? (Select one choice)

Source: Black & Veatch



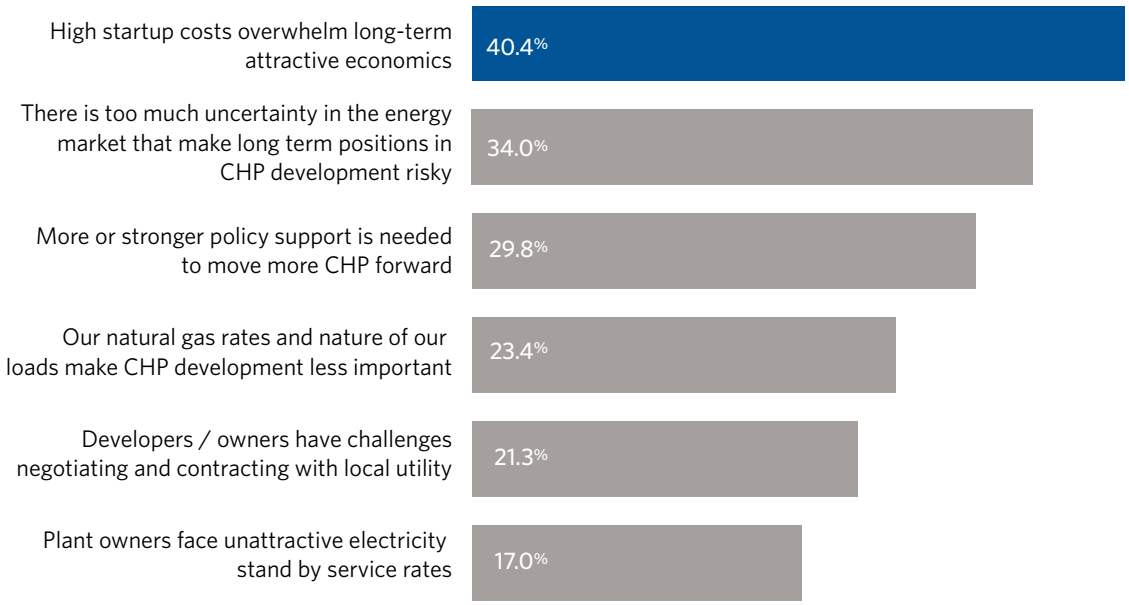
policy support (30 percent) *(Figure 23)*. These responses may reflect the high degree of site-specific customization that is typical of CHP installations. Additionally, nearly a quarter (23 percent) said that when natural gas prices are low, CHP development seems less attractive.

Selling back into the grid depends on policies permitting it. Improving permitting policies will be a major guidepost in creating a positive regulatory environment for CHP development.

Overall, the technologies that underlie CHP opportunities will continue to evolve and progress, and the focus of facility owners to secure efficient and reliable electrical and thermal energy will continue at a relentless pace, ensuring that the future is bright for more CHP development. But there is significant room for policy innovation to ensure that CHP opportunities are optimized and maximized to capture other benefits. Arranging rules that permit the fair and appropriate selling back to the grid requires additional attention in ways that balance interconnection and support costs with grid resiliency benefits.

FIGURE 23

What are the major challenges to CHP development in your service area? (Select up to three choices)



Source: Black & Veatch

The Changing Face of Power

FROM DRONES TO SENSORS: INNOVATION GAINING SWAY AMONG ELECTRIC UTILITY LEADERS

By Jim Doull

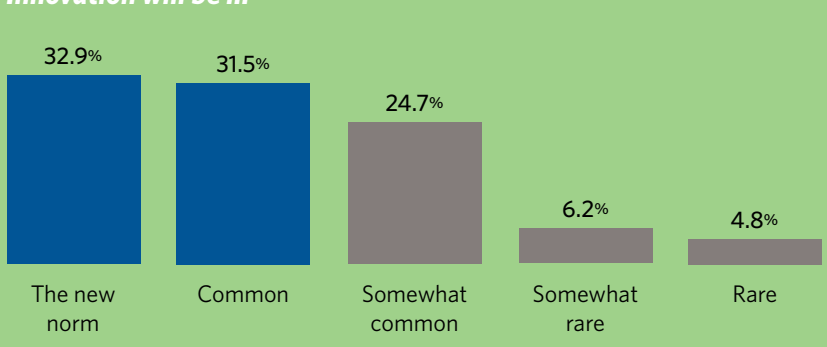
***Jim Doull** is Executive Vice President of engineering, procurement and construction (EPC) in Black & Veatch's power business in the Americas, Europe, the Middle East, India and Africa. He leads oversight of all facets of large-scale EPC projects, including safety, strategy, recruitment of new business and project execution.*

With their infrastructure graying and renewable energy posing growing threats to their customer bases and bottom lines, electric utilities are awakening to the power afforded by dynamic advances in construction, from the deployment of drones to innovative construction practices. Amid the prospect of a continued shift to decentralized, digital grids and the broadening appeal of increasingly affordable solar power systems, electricity suppliers no longer have the luxury of resisting change or delaying the adoption of next-generation power delivery.

Such a realization has become strikingly clear in the results from the *Black & Veatch 2018 Strategic Directions: Electric Report* survey, with one-third of respondents acknowledging that construction innovation over the next half decade will not only be expected, but become the new norm as utilities tactically work to fix or replace their aging infrastructure *(Figure 24)*.

FIGURE 24

As utilities work to repair and replace graying systems in the next five years, do you expect to see more innovative approaches that would help optimize ROI? (Select one choice)



Source: Black & Veatch

A similar percentage of respondents believe that acceptance of forward-thinking approaches will be common, further reflecting the allure and importance of innovations viewed as vital in addressing a customer base with an ever-widening buffet of power options. That heightened recognition comes as utilities ramp up investments in transmission and distribution networks while padding their mix of renewable energy and DER, eager to bolster reliability and resilience in an evolving power grid landscape.

Taken a bit further, nearly half of respondents reported separately that they consider their utility's approach as innovative in building out infrastructure, while an additional 15 percent rated themselves a step higher at "very innovative" *(Figure 25).*

That's no small finding in a sector long labeled as seldom creative or innovative: "Why would I modify this ball when it's been round forever." Complexities of and disruptions in the marketplace — everything from the surging popularity of DER to shifting expectations by consumers who now are savvier and demanding — may be pushing utilities to finally consider shucking the bindings of the status quo and, with regulators permitting, proactively make the investments necessary to smartly, and even courageously, modernize.

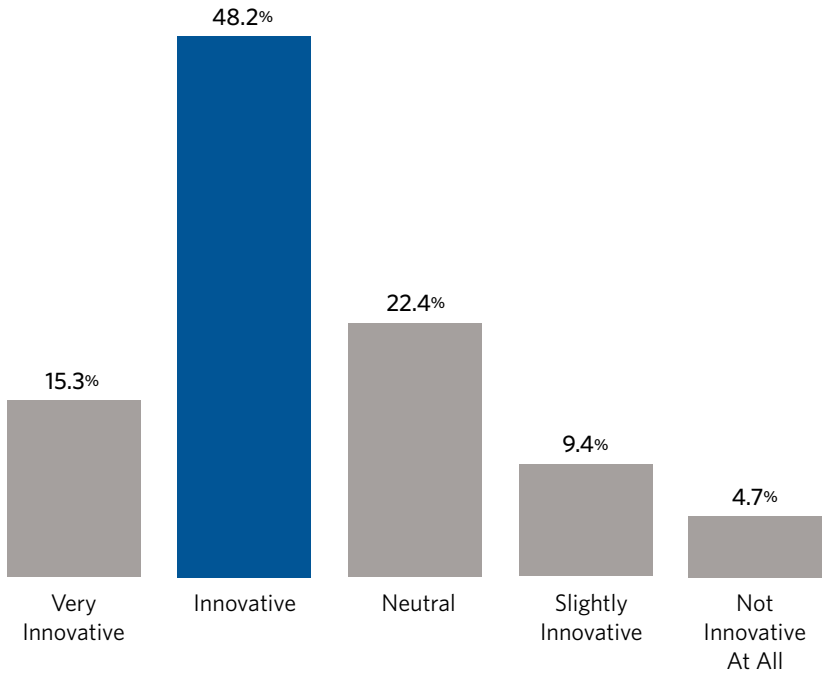
PORTLAND PROJECT ILLUSTRATES INNOVATIVE ENGINEERING

After more than a decade of planning as part of an $83 million project, Oregon's Portland General Electric (PGE), the power provider to more than 800,000 regional customers, went about replacing an 80-year-old substation near the city's downtown and the Willamette River to ensure reliable power. By PGE's estimation, the ambitious effort was crucial in supplying sustainable power to a downtown core it called "the nerve center of the region's business and government and a hub for education, transportation and tourist attractions."

FIGURE 25

How innovative is your utility when building out infrastructure? (Select one choice)

Source: Black & Veatch



The challenge was installing more than a mile of new 115 kilovolt (kV) cross-linked polyethylene cables — replacements to some undersea lines dating to the 1950s — that would link one of the utility's substations to the new Marquam Substation, along the way spanning the new Tilikum Crossing Bridge, which is widely popular among buses, trains, pedestrians and cyclists.

Black & Veatch engineers and PGE ran the cables, each with temperature-sensing technology, under a dozen lanes of Interstate 5, hooking up with the Marquam site on a nub of land between two freeways and skirted by roads, homes and heavily-treed parkways. The buildout also involved raising a street and boring beneath Interstate 405 four 235-foot-long tunnels that would eventually house underground transmission lines to the new substation, supplying the PGE energy grid that serves Portland's downtown.

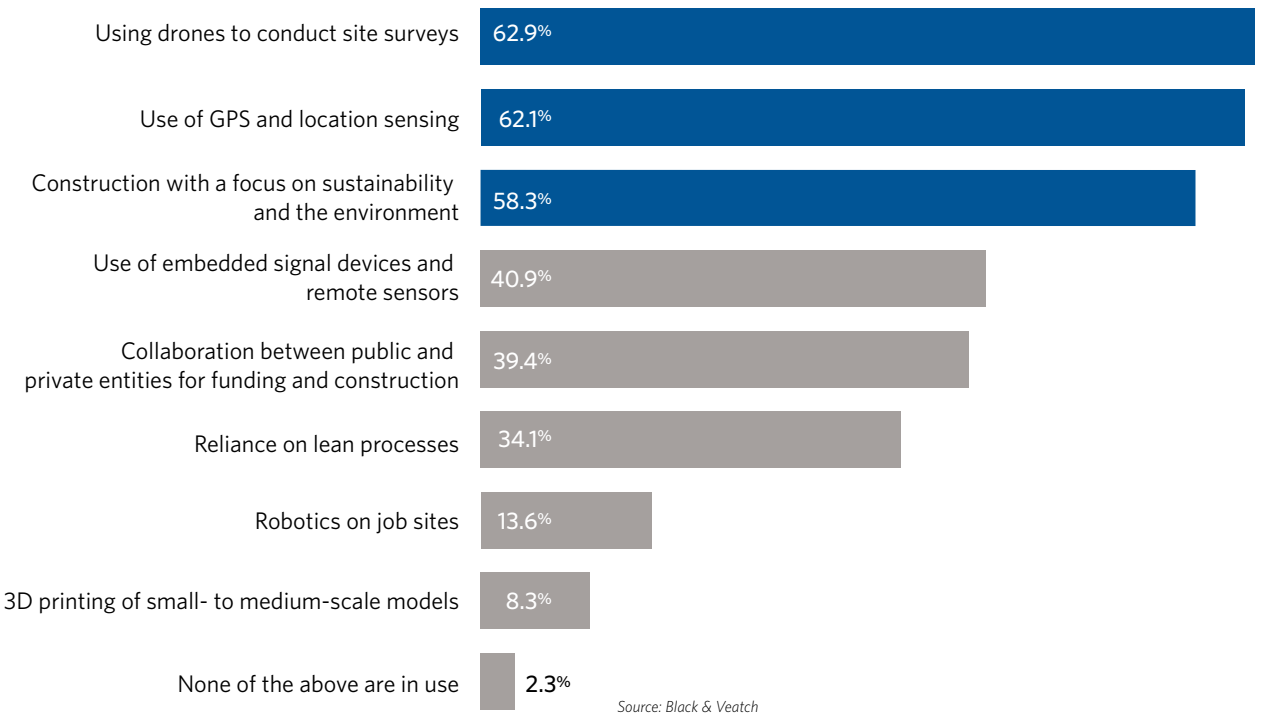
DRONES PROVE VALUE AS INFRASTRUCTURE EYE IN THE SKY

For decades, since utility poles were first conceived, it's been the lasting image: An electric company's lineman meticulously scales the slender, rounded tower of wood to get a look at transmission lines and their hardware that only eagles could otherwise enjoy. With unmanned aerial vehicles (UAVs), known colloquially as drones, such labor-intensive, potentially perilous work is rapidly turning more obsolete as airborne application of the technology widens.

According to Black & Veatch's survey, nearly two-thirds of respondents say their region deploys drones for site surveys, narrowly topping the use of global positioning systems (GPS) and other location-sensing means as innovations being harnessed in power infrastructure construction *(Figure 26)*.

FIGURE 26

Which of the following innovative approaches to power infrastructure construction are being utilized in your region? (Select all that apply)



Source: Black & Veatch

WITH UNMANNED AERIAL VEHICLES, KNOWN COLLOQUIALLY AS DRONES, LABOR-INTENSIVE, POTENTIALLY PERILOUS WORK SUCH AS SCALING POWER POLES TO INSPECT OR REPLACE TRANSMISSION LINES IS RAPIDLY TURNING MORE OBSOLETE AS AIRBORNE APPLICATION OF THE TECHNOLOGY WIDENS.

Although currently limited by federal airspace rules requiring drones to always be in the operator's line of sight, utilities have turned to UAVs to inspect power lines and capture high-definition images or video of the insulators and other key assets, sparing a worker from the livelihood's underlying dangers of ascending a pole, boiler or smokestack or requiring the use of pricey helicopters or planes for such a peek.

The upshots are quicker responses, an enhanced safety record, increased frequency of inspections, real-time assessments of replacement needs and more data that can be analyzed for the clearest possible picture of risk management. FirstEnergy showed that UAVs offer an environmental bonus. The Ohio-based electric utility uses drones to inspect the nests of protected and highly territorial birds of prey, including ospreys and eagles, atop utility poles and other electric equipment. FirstEnergy and wildlife officials plan to team up later in 2018 to use the drone footage to identify and build new nesting platforms for the birds, far from electrical equipment.

On the construction front, drones have performed admirably with otherwise treacherous jobs such as providing wetland overviews and evaluating various stages of buildouts, offering visual verifications and validations that bolster a project's cost efficiencies. Black & Veatch, a proven global industry leader in applying drone technology, has performed many successful visual line-of-sight flights over dams, transmission lines, solar fields and streams as part of a stream-restoration project. (The company also was recently tapped to support the Kansas Department of Transportation in a Federal Aviation Administration pilot program that explores whether evolving rural drone applications merit easing federal restrictions of their use.)

Location-sensing devices such as GPS have also proven their resource-management worth for utilities as replacements for human surveyors, given that such things as transmission towers and wind turbines need to be installed in precise locations. Builders often lean on GPS to pinpoint use of their earth-moving equipment or backhoes. The accuracy and speed of location-sensing devices are at a premium, with the added benefit of more efficient operations of heavy machinery cutting emissions and stoking environmental stewardship.

Construction with an eye for sustainability and the environment remains among the top-of-mind challenges in the industry, with 58 percent of respondents saying their region has applied that approach.

Other innovations remain relatively slow to come despite their acknowledged potential. The Black & Veatch survey showed that just one-third of the respondents reported that their infrastructure buildout involved lean construction, meant to stoke worker output and flow by employing such things as just-in-time delivery while ridding a project of any wasteful tasks. Such a method strives to optimize value for all of a project's stakeholders by lowering costs, limiting delays, accelerating the completion time and emphasizing safety.

In the meantime, a sliver of survey respondents (8 percent) said they were making use of 3D printing of small- to medium-scale models. That marks a surprising lack of acceptance of a tool often viewed as beneficial in making project designs more vivid and for ensuring its viability, with users able to see how even subtle mockup changes can have a cascading effect on the overall design. These models can save money by averting costly changes or corrections in the actual construction.

In an industry being reshaped by the rise of renewables and burgeoning consumer choices, utilities must continue engaging customers to meet their demand for new technology and a lower carbon footprint, reinventing along the way their dynamic with regulators in a bureaucratic framework to produce impactful change. Black & Veatch can assist in that, having long helped clients assess their system needs, craft generation alternatives and help design modifications. Now more than ever, the rapidly changing energy landscape demands agility by utilities, and those that resist innovation do so at their own peril.

Global Perspectives

TRANSFORMING SOUTHEAST ASIA'S ENERGY SECTOR: OPPORTUNITIES AND CHALLENGES

By Mitesh Patel and Jim Schnieders

Nations in Southeast Asia are working to balance energy security, environmental sustainability and economic competitiveness at a time when the financial sector is looking for bankable energy projects in which to invest. The region's industrial growth in recent years has encouraged economic growth and urbanization that has expedited its consumption of energy.

The Institute for Energy Economics and Financial Analysis and the International Energy Agency (IEA) project that, by the year 2040, the energy needs of the 10 Association of Southeast Asian Nations (ASEAN) member states could grow by as much as 80 percent, as the region's economy triples and its population rises by almost 25 percent to 760 million. The demand growth would be equivalent to 14 percent of all global energy demand.

To support this growth, the region urgently needs easily available and affordable energy, as well as universal electricity access.

INCREASING POWER GENERATION CAPACITY

One strategy to address rising electricity demand is to increase generation capacity. This would serve the growing urban middle class, which is increasingly demanding home appliances and cooling, marking not only a shift in quality of life but also a growing assumption that power is affordable and reliable.

The IEA also expects demand to double in the industrial sector, driven by the growth of industries at the core of the region's

Mitesh Patel *is Managing Director of Black & Veatch management consulting in Southeast Asia, India and the Middle East, where he leads project development and transaction advisory services for Asia and the Middle East. He advises lenders, investors, developers and authorities on investment and risk management of power (thermal and renewable) and water sector projects.*

Jim Schnieders *is Executive Vice President and Managing Director for engineering, procurement and construction projects in Black & Veatch's power business in greater Asia and Country Manager for Black & Veatch in Indonesia. Armed with extensive experience working on large international power projects, he also manages the local Black & Veatch entity in Indonesia as President-Director for PT. Bina Viktori Indonesia.*

Even though baseload fossil fuel generation will remain necessary for the foreseeable future, the opportunity lies in deploying microgrids to help integrate intermittent renewable energy with fossil-fueled power to deliver a stable and widely accessible power supply.

economic activity. By 2040, the IEA projects that power generation capacity will more than double to 565 GW, with coal and renewables accounting for almost 70 percent of new capacity.

By 2040, the IEA anticipates renewables will account for the largest share of installed capacity (nearly 40 percent), but coal will still have the biggest role in the generation mix (40 percent). Seventy percent of new coal-fired capacity will use high-efficiency supercritical or ultra-supercritical technologies.

A CHANGING CLIMATE CHANGES PERSPECTIVE

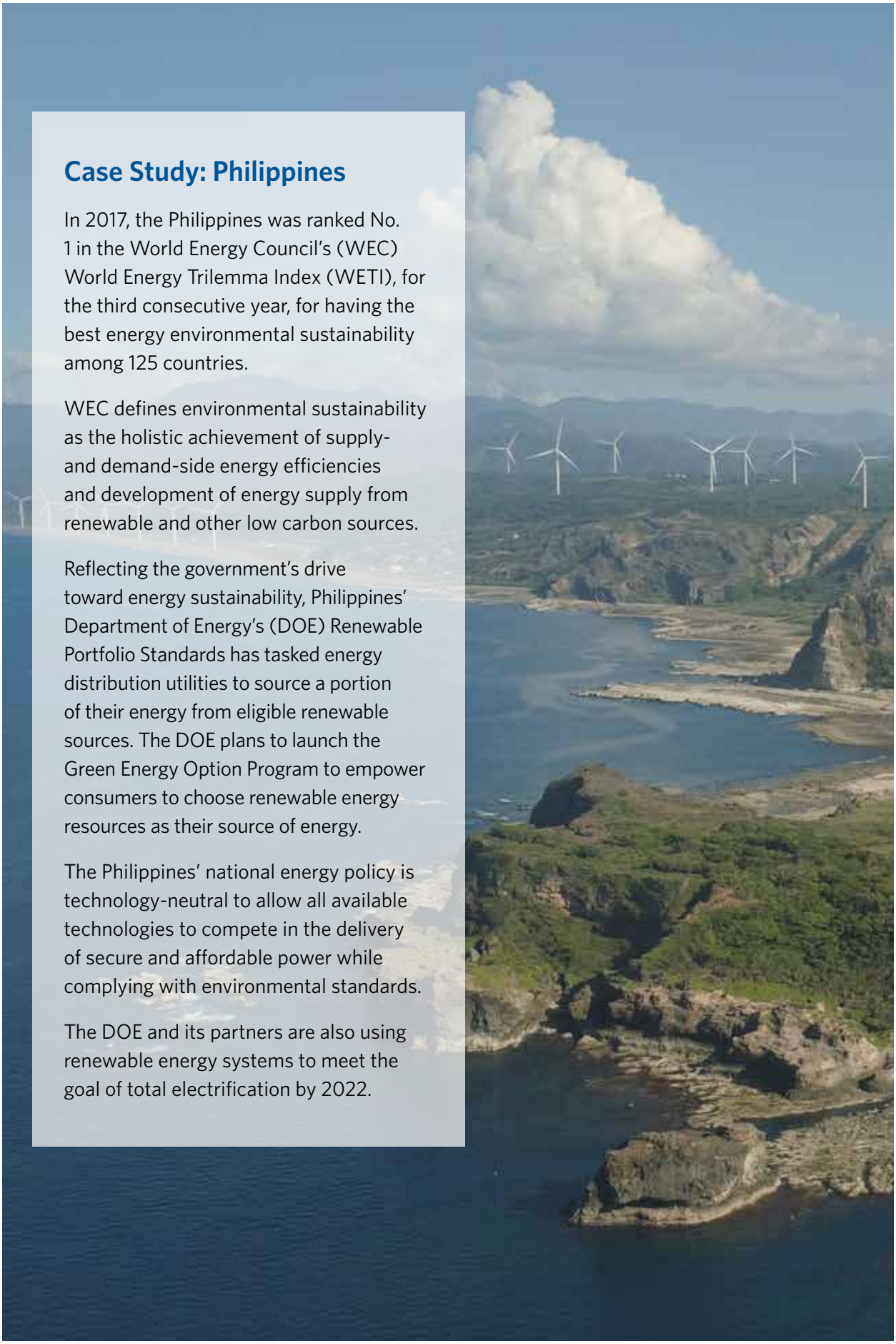
In its search for affordable and available fuel sources, the region cannot ignore climate change. Indeed, much of Southeast Asia's population lives in low-lying coastal regions that are vulnerable to flooding and typhoons caused by changing weather patterns.

According to the ASEAN Centre for Energy, the region's renewable energy sources include biomass in Thailand, geothermal potential in Indonesia and the Philippines, and wind power potential in Thailand, the Philippines, Vietnam and Indonesia.

Located near the equator, the region has good solar potential, and the decreasing cost of wind, solar and energy storage is making renewables an increasingly viable investment option. This ability to integrate more renewable energy should help ease the tension between the need for more energy and the need to manage greenhouse gas emissions.

Significant investments in renewable energy would allow the region to balance out its current power generation portfolio, which skews heavily toward fossil fuels. Another benefit is that renewable energy sites are smaller in scale than conventional coal power stations, allowing for diffused placement on island nations.

Even though baseload fossil fuel generation will remain necessary for the foreseeable future, the opportunity lies in deploying microgrids to help integrate intermittent renewable energy with fossil-fueled power to deliver a stable and widely accessible power supply.



Case Study: Philippines

In 2017, the Philippines was ranked No. 1 in the World Energy Council's (WEC) World Energy Trilemma Index (WETI), for the third consecutive year, for having the best energy environmental sustainability among 125 countries.

WEC defines environmental sustainability as the holistic achievement of supply- and demand-side energy efficiencies and development of energy supply from renewable and other low carbon sources.

Reflecting the government's drive toward energy sustainability, Philippines' Department of Energy's (DOE) Renewable Portfolio Standards has tasked energy distribution utilities to source a portion of their energy from eligible renewable sources. The DOE plans to launch the Green Energy Option Program to empower consumers to choose renewable energy resources as their source of energy.

The Philippines' national energy policy is technology-neutral to allow all available technologies to compete in the delivery of secure and affordable power while complying with environmental standards.

The DOE and its partners are also using renewable energy systems to meet the goal of total electrification by 2022.

IMPROVING UNIVERSAL ENERGY ACCESS

Currently, 65 million people in Southeast Asia do not have access to electricity, making universal electricity access a critical goal. In spite of that, the growth in renewables is encouraging.

According to the International Renewable Energy Agency (IRENA), in 2016, Thailand became the first Southeast Asian nation to rank among the top 15 solar power generators worldwide. The region's desire for energy development can be seen through its policy framework upgrade, fossil-fuel consumption subsidies reform, increased regional cooperation and encouraged investment in renewable energy.

Emerging countries such as Indonesia and the Philippines are exploring the use of renewable energy to achieve goals of universal access to electricity. Incorporating renewable energy into the mix will give people living in remote areas the opportunity to rely less on expensive and polluting diesel generators, while bringing the region closer to achieving the United Nations Sustainable Development Goals and fulfilling the commitments of the Paris Agreement.

These countries are considering off-grid solutions, such as solar mini-grids and microgrids, to provide power to island communities and remote areas where expanding the existing grid is often economically unviable. In 2017, the World Bank reported many of Indonesia's 6,000 inhabited islands use power from diesel-powered or small hydro-powered mini-grids, and a few are retrofitted with solar photovoltaic (PV) systems to avoid using high-cost diesel fuel.

According to IRENA, half of the Philippines' power grid is powered by coal, while natural gas and renewables account for more than a fifth of the energy supply; oil accounts for the rest. The country expects its energy consumption to triple to 67,000 MW by 2040 and, as a result, is accelerating its renewable energy deployments to address this growth in demand.

ATTRACTING INVESTMENT

The IEA forecasts that Southeast Asia requires at least $2.7 trillion in energy investments by 2040. To meet these increased capacity targets, the region needs to attract large investments from the private sector and international financial institutions.

Attracting the appropriate investment will depend largely on the incentives available to investors as well as their perceptions of risks.

Investors today are more rigorous in assessing and pricing risk, and they're quicker to switch asset allocations in response to changing circumstances, including perceptions of a country's long-term potential.

Japanese developers typically focus on traditional project financing and equity, while Chinese companies invest through engineering, procurement and construction (EPC) contracts. For renewable energy projects, Chinese developers often act as suppliers for equipment such as solar panels.

The opportunity to attract investment to the region lies in improving policy and framework certainty, greater efficiency and transparency, and smoothing out the permitting process while ensuring that projects are bankable. Opportunities are also available in reviewing existing policy and regulatory perspective to manage renewable power sources and battery storage together with traditional baseload generation, ensuring grid stability.

To achieve this, Southeast Asian governments are offering feed-in tariffs and considering reverse auctions. With a feed-in tariff, utilities and power distribution companies are obligated to buy renewable electricity from eligible participants. The World Bank explains that the cost-based prices enable diverse projects to be developed and allow investors to obtain a reasonable return on investments. In 2012, Thailand became one of the first countries to offer feed-in tariffs to solar developers.

Reverse auctions have also been considered to regulate renewable energy prices. In a reverse auction, sellers (such as generators) allow large consumers or distribution companies to bid for power contracts. The lowest offer is the winner. Policymakers find auctions attractive because they promote competition, push prices down and result in lower tariffs to end users.

INVESTING IN RENEWABLES TODAY FOR TOMORROW

Cheaper renewable energy, together with increased efficiency measures and growing innovation in on- and off-grid energy storage systems, will hopefully make it possible for the region to achieve universal access to a reliable energy supply by the 2030s.

The appropriate energy mix for each community will depend on its resource distribution, distance from existing demand centers and population density — but perhaps more important is the need for a flexible and pragmatic approach to governing energy access, which will help facilitate incorporating different forms of energy into the mix.

Increased competitiveness in the renewable energy market will likely lead private developers to look for new growth areas. This, in turn, could lead to more investment in distributed energy and microgrids, improving quality of life on Southeast Asia's archipelagos.

Global Perspectives

UK CAPACITY AUCTIONS: TREATING THE SYMPTOMS, NOT THE CAUSE

By Peter Hughes

***Peter Hughes** is Director of Business Development for Black & Veatch Europe. He is responsible for the company's development strategy, as well as sales and marketing activities in this region. He has extensive experience in gas-fired generation asset construction.*

Great Britain's energy market, once the envy of free-marketers after Margaret Thatcher ended decades of nationalization in the 1980s, is once again under the spotlight — for all the wrong reasons.

The current Prime Minister, Theresa May, is fond of referring to the UK's "broken energy market." While she may use the phrase to justify a cap on consumer energy bills, she could just as easily apply it to the failure of successive governments to encourage the building of new power plants.

As old coal and aged gas and nuclear power plants head toward decommissioning, the UK faces the possibility of a shortfall in its future electricity supply that cannot be plugged by intermittent renewables alone.

The capacity market mechanism is meant to eliminate this risk.

The capacity market auctions allow power plant owners and developers to bid for fixed payments, either one year or four years ahead. In return, they ensure the capacity is available when the grid needs it.

At first glance, results from the latest T-4 auction to secure capacity in four years' time appear to suggest the UK energy market is in perfect health. The grid secured the 50.4 GW of reserve capacity it was looking for in 2021/22 at the bargain basement price of £8.40 per kilowatt (kW).

Unfortunately, a closer examination of the results reveals that, far from being in good shape, the prognosis for the future appears bleak.

Unfortunately, a closer examination of the results reveals that, far from being in good shape, the prognosis for the future appears bleak.

THE RESULTS

February's T-4 auction secured 50.4 GW of capacity; this was dominated by existing generating capacity.

The big winners were owners of existing gas-fired power plants, which accounted for much of the 43.3 GW of existing capacity to secure payments (more if the refurbished capacity is counted).

While coal-fired plants have been successful in previous auctions, just two sites secured capacity this time around, leading some to speculate that many UK coal-fired power plants will need to close because they are economically unviable without the support of capacity payments.

Demand side response (DSR) — where large industrial facilities agree to cut their energy demand at the grid's request — also fared well. There were 46 MW of proven DSR and 1,160 MW of unproven DSR to secure capacity payments. Electricity interconnectors with Europe, both new and existing, accounted for 4.6 GW of capacity to secure payments.

Just 767 MW of new generating capacity managed to secure payments — 1 percent of the total capacity secured and a new low for these auctions, which have been running since 2014.

TREATING THE SYMPTOMS

This 767 MWs of new capacity came from small-scale, low-cost gas engines. Instead of being a solution that addresses the cause of a future energy shortfall — a lack of large-scale, flexible and highly efficient capacity to replace what is being lost over the next few years — the T-4 capacity market auctions now appear to be delivering a "sticking plaster" strategy.

Rather than encouraging investment in technologies such as the latest combined cycle gas turbines (CCGTs), the auctions encourage short-term solutions that do little to improve the UK's long-term security of supply.

The auctions are run on a descending clock basis, in which the payment is incrementally reduced until the government secures the level of capacity it requires, at the lowest price possible. This puts new power plants at an immediate disadvantage. They have to factor in millions of pounds in construction and equipment costs that existing and small-scale operators do not.

To put the latest T-4 auction clearing price of £8.40/kW into perspective, the price in the previous T-4 auction in December 2016 was £22.50/kW, a figure that proved too low to support construction of new CCGTs.

Nearly two-thirds of the 23.8 GW of capacity that entered the most recent T-4 auction, but dropped out before it reached the £8.40/kW clearing price, came from potential new power plants. Over 11 GW of this was from potential new CCGTs, showing that while there is appetite to build these facilities, the capacity market mechanism is currently incapable of supporting them.

SECURITY OF SUPPLY

This inability to encourage new power plant construction also fails to address energy security.

At present, the UK is relying on an intermittent mixture of renewables, aging technologies (inefficient by modern standards), demand reduction and interconnectors with mainland Europe to replace the capacity that will be lost by the closure of all its domestic coal power plants and older nuclear and gas facilities.

This leaves the UK vulnerable to energy shortages, especially as new nuclear power plants are unlikely to be ready in time before the last coal plants close in 2025. To protect the UK against blackouts, the government needs to start prioritizing energy security, especially in light of Brexit.

Electricity interconnectors with other European nations were highly successful in February's auction. New-build interconnectors accounted for 2.2 GW of this capacity, and the reason they were able to bid so competitively is that they received financial support from both the European Union (EU) and the UK energy regulator, Ofgem.

Britain leaving the EU places a question mark both over these interconnectors' financial viability at £8.40/kW and how secure a source of electricity supply they truly are.

The Centre for Policy Studies has warned that a growing reliance on interconnectors will leave Britain exposed to supply disruptions and price spikes led by developments in the rest of Europe. Others point out that while the UK may be closing its coal plants by 2025, interconnectors enable it to keep using coal power via plants in mainland Europe.

Changes must be made to the capacity market mechanism if it is to meet its goal of keeping the UK's lights on. A good place for the government to start would be to prioritize energy security and the types of technology that can be successful in the auctions.

It is difficult to predict what the UK government will do next to adjust the process. But UK energy supply will remain in a vulnerable condition without further intervention.

INCENTIVIZING THE WRONG TECHNOLOGY

The capacity market is funding existing coal, aged CCGT and a fleet of gas and diesel reciprocating engine plants. Nobody can deny a modern, low-carbon, flexible, new-build CCGT is more efficient and better for the environment than these technologies. However, because of EU rules on state aid, which promote technology neutrality, the government has shied away from favoring one type of technology over another.

But if it is serious about building new capacity and meeting environmental targets, the capacity market process needs to find a way of distinguishing between participants, rewarding high levels of availability, efficiency and flexibility with lower emissions.

Such a move is not without precedent. The UK's Contract for Difference scheme supports renewable energy generation and sets different payment rates according to whether a technology is "established," such as onshore wind and solar, or "less established," such as offshore wind and tidal energy. This move away from technology neutrality was approved by the EU.

It is not hard to imagine classifications in the next auction applying different clearing rates for "efficient" and "less efficient" technologies.

FINDING A CURE

Prioritizing security of supply and efficient technologies are just two bold solutions that the government might consider if it wants the capacity market to be fit for its purpose.

Whatever the solution, it is likely to be complex: Is it a separate capacity auction that includes new build capacity exclusively? Or, is it modifying the existing process to be more selective on technology?

It is difficult to predict what the UK government will do next to adjust the process. But UK energy supply will remain in a vulnerable condition without further intervention.

It appears an urgent second opinion is required since the treatment so far has produced some unwelcome side effects, without offering a long-term cure.

Closing Commentary

***Ed Walsh** is President of Black & Veatch's power business and is responsible for overseeing and implementing strategies, processes and tools to further enhance the company's service offerings and continued growth.*

AS LARGE CORPORATIONS GO GREEN, UTILITIES ARE FEELING THE LOSS

By Ed Walsh

It's been a headache-inducing nexus of active regulation, distributed energy and environmentalism for some electric utilities. Plunging costs of solar power and growing concerns of climate change are inspiring swelling ranks of the largest private and Fortune 500 companies pursuing not only aggressive renewable energy goals for sustainability purposes but also cost effectiveness and resiliency.

With that confluence, utilities are facing the sobering question of whether to significantly invest in green infrastructure to keep these large customers and risk controversial rate cases, or watch helplessly as that caravan of large, rate-paying customers defects, taking considerable revenues with it. The latter scenario could inspire other customers to follow suit, raising the prospects of higher bills as significant fixed costs are spread across a smaller population, creating additional financial burden for the end user and lower customer satisfaction for the energy provider.

In this industry long viewed as moving at a glacial pace, often at the speed required by regulation, such pressures should be a pressing clarion call for engagement between utilities and the regulators whose constructs often are lagging behind advances in technology,

Such an ambitious switch to alternative electricity sources can give companies greater control over their energy costs and bolster their competitiveness. It also can shave their carbon footprints by being emissions-free.

the growth of alternative generation (renewable energy resources) and customer expectations. The current situation, at a time of growing energy options for businesses, offers electric utilities an opportunity to make the case to would-be defectors, that the existing infrastructure offers power that's more cost-effective and quicker to market than buildouts of DER.

While some large companies have said they'd power a portion of their operations with renewable energy, many others have insisted they are taking an all-or-nothing approach by installing their own solar arrays, wind farms, energy storage, microgrids and other resources. A "RE100" listing by The Climate Group and CDP (formerly the Carbon Disclosure Project) shows that more than 120 companies have announced plans for their electricity to come entirely from renewable resources as part of a global corporate leadership initiative.

Those moving the needle include some of the corporate world's most recognizable names and admired brands: Walmart, IKEA, Apple, General Motors, eBay, Procter & Gamble, Facebook, Starbucks, Google and Hewlett-Packard. Heavyweights in banking, insurance and brewing also are creating roadmaps heavily reliant on renewables for their energy futures.

Other companies are going the route of Power Purchase Agreements (PPAs) — particularly beneficial in that while they don't require massive upfront capital investments, they offer the prospect of lower energy costs.

RENEWABLES GIVE BIG COMPANIES GREATER COST CONTROLS, REDUCED CARBON FOOTPRINTS

Such an ambitious switch to alternative electricity sources can give companies greater control over their energy costs and bolster their competitiveness. It also can shave their carbon footprints by being emissions-free — a movement that resonates with the public at a time of growing appetite for clean energy and of worries about climate shocks. All of it is against the backdrop of a proliferation of energy-devouring data centers, which exemplify significant load growth and opportunities by developers of such sites to build their own on-premises microgrids or other DER in the pursuit of clean, sustainable energy.

As Black & Veatch's *2018 Strategic Directions: Electric Report* bears out, electric utilities are taking notice. According to a survey of more than 300 industry leaders, nearly half of respondents (48 percent) considered the electric industry's

future as potentially catastrophic if utilities don't adopt their own alternative energy solutions. Nearly four in 10 said such a gloomy fate awaits if regulatory models preclude market flexibility.

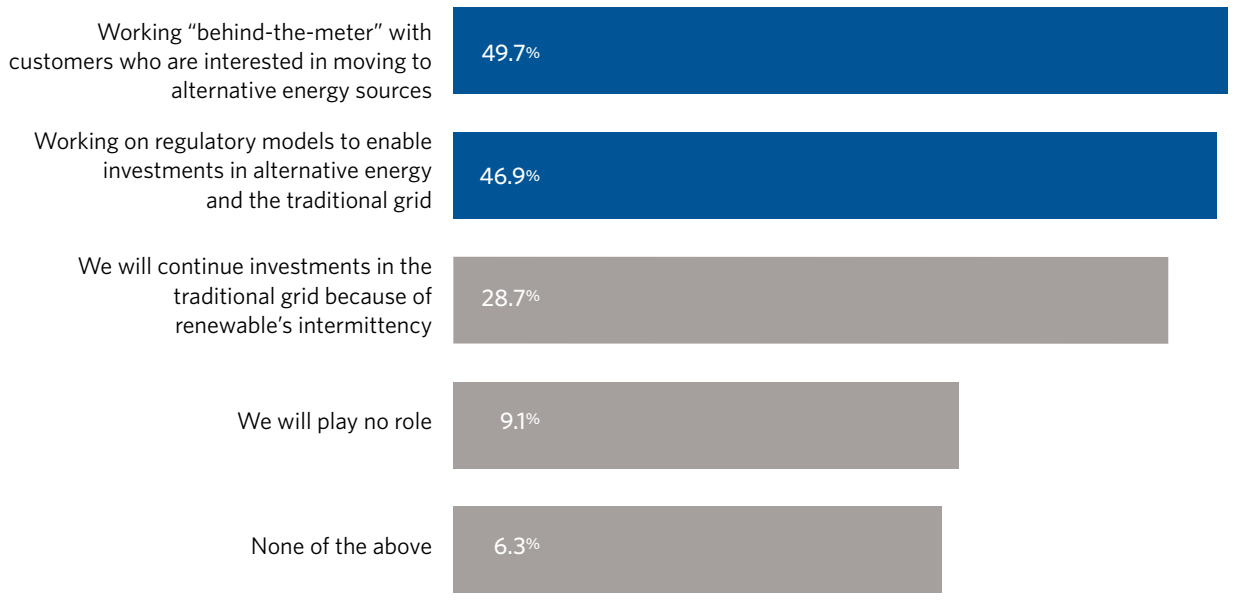
Separately, the survey, which again found reliability at the forefront of the industry's importance, found that half of the respondents said they see themselves working behind the meter with customers interested in moving to alternative energy sources, followed closely by efforts to secure regulatory models enabling investments in the traditional grid and alternative energy sources *(Figure 27)*.

CALIFORNIA LEADS THE CHARGE WITH SOLAR MANDATE FOR NEW RESIDENCES

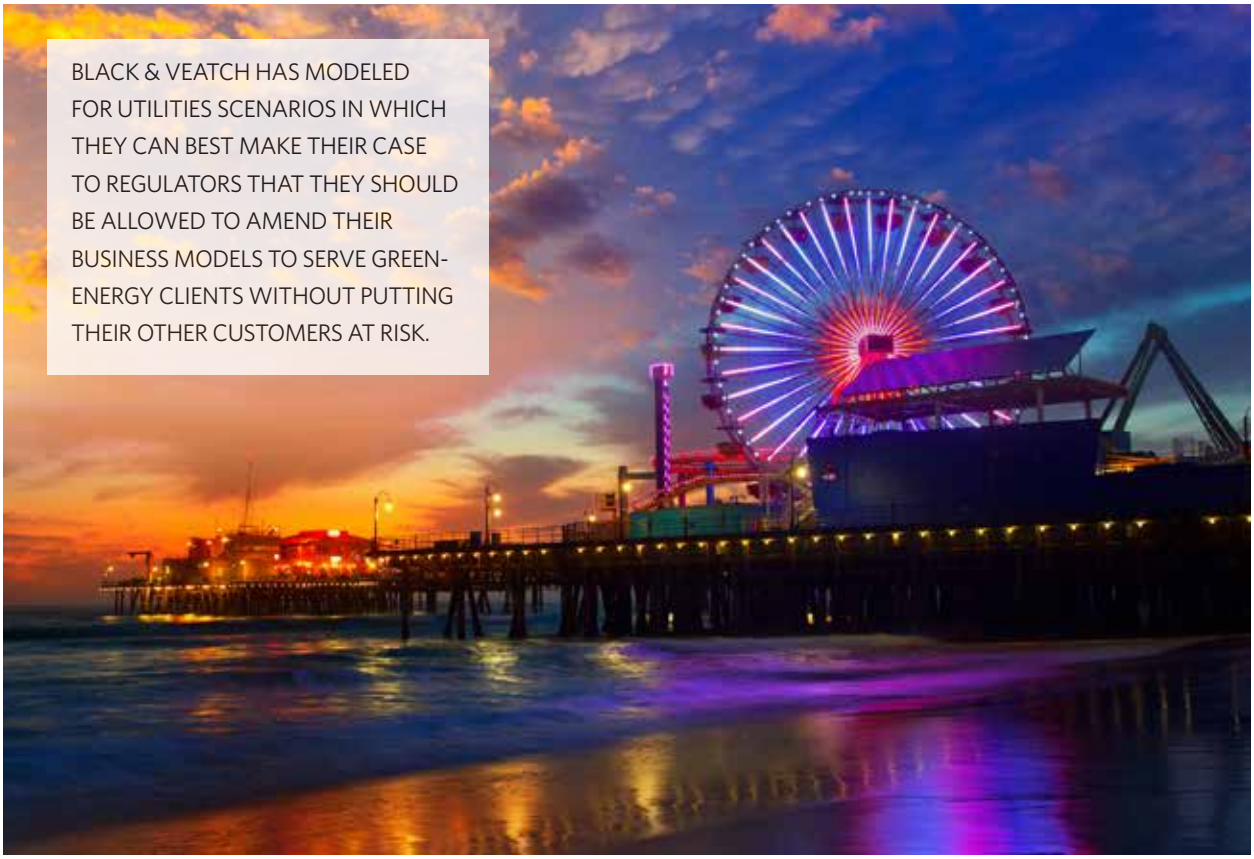
While navigating their alternative energy options, companies generally consider three legs to the project stool: Does it make economic sense, does it increase reliability and resilience, and does it contribute to the business' sustainability? Each can drive the decision-making, with many treating microgrids or DER as more of an insurance policy against outages than as a capital project. Timing for these questions is ripe, given the continued decline of the cost of renewables and batteries.

FIGURE 27

What role(s) do you see yourself playing in the alternative energy solutions space? (Select all that apply)



Source: Black & Veatch



BLACK & VEATCH HAS MODELED FOR UTILITIES SCENARIOS IN WHICH THEY CAN BEST MAKE THEIR CASE TO REGULATORS THAT THEY SHOULD BE ALLOWED TO AMEND THEIR BUSINESS MODELS TO SERVE GREEN-ENERGY CLIENTS WITHOUT PUTTING THEIR OTHER CUSTOMERS AT RISK.

Some states are forcing a faster, sweeping adoption of renewable energy on the residential front. In California, for instance, energy regulators this year passed a new building code requiring most newly constructed, low-rise homes constructed after 2019 to have built-in solar-powered energy systems, making that state the first to adopt such a mandate. That California Public Utilities Commission edict promotes on-site generation and clean energy while launching the state closer to its goal of cutting its carbon footprint in half by 2030.

All the while, California's chief utility regulator, Michael Picker, warned this year of a potential statewide energy crisis spurred by scores of customers defecting from utilities and getting power from rooftop solar panels, self-generation, community choice aggregators (CCAs) that contract directly with generators, or other non-utility sources. Given the CCAs' ever-increasing share of California's power load, Picker's commission added that as much as a quarter of the state's energy demand may be sourced outside of utilities by the end of 2018. The commission called on legislators and stakeholders to help tackle challenges confronting the state's energy future and reliability.

"If California policymakers are not careful, we could drift slowly back into another predicament like the energy crisis of 2001," Picker said in releasing a report about the state's "electricity market transformation" and the need for dialogue about it.

California weathered an energy crisis at the start of this century, but "now we are effectively decentralizing and reshaping electric markets through dozens of different decisions and legislative actions," the commission wrote. "The major conclusion of the research about California's history and the other jurisdictions studied is that we need a clear long-term vision for our regulatory framework that provides a lasting, stable platform that goes beyond short-term fixes."

Across the landscape, utilities are looking to modernize their grid by relying on more renewables — and, in turn, potentially curbing the frequency of defections by green-minded businesses. In Michigan alone, Consumers Energy — the state's biggest energy provider, with 1.8 million electric customers — announced in June that it will eliminate its use of coal to generate electricity by 2040 and increase its use of renewable resources, from 11 percent now to 43 percent by 2040. The company said "it is seizing a once-in-a-generation opportunity to reshape Michigan's energy future."

Still, utilities must sell regulators on the prudency of such investments. Those overseers, after all, watch closely to ensure that ratepayers aren't paying more than they should and that everyone gets equal access to reliable power.

A similar scene is playing out across the globe, propelled by considerable drops in costs of solar power components in recent years. The International Energy Agency reported in June that investment in new renewables-based power capacity, at $297 billion, remained the largest area of electricity spending in 2016, the last year such figures are available. That outlay, while down 3 percent from the previous year, still outpaced spending on traditional energy sources such as coal, natural gas and nuclear power.

UTILITIES, REGULATORS MUST BE PROACTIVE IN DIALOGUE

With regulators' help, utilities must be nimble in making changes that align with growing clean-energy mandates. Failing to do so could drive away sizable commercial and industrial clients (large electricity consumers) with the financial means to turn to renewables or distributed generation. Those defections from the grid inadvertently would make the system more expensive by spreading its fixed costs among fewer customers and adding to the network's complexity.

Making a meaningful difference would require profit-driven utilities and the regulators who monitor them to reinvent their dynamic. Utilities must successfully balance what they're able to do in a bureaucratic framework with being agile enough to adjust to a changing energy landscape. Conversely, regulators must have open minds and a deep awareness of DER trends and the consequences of when utilities are forced to watch from the sidelines as some of their largest customers set new courses.

Black & Veatch has modeled for utilities various scenarios in which they can best make their case to regulators that they should be allowed to amend their business models to serve green-energy clients without putting their other customers at risk. With outside engineering and consulting, utilities can assess their exposure to and potential fallout from client shifts to renewable energy. That assessment then may be followed by presenting for regulatory consideration a plausible, comprehensive game plan that accounts for assets such as rooftop solar or backup generation.

Rather than wait for regulators to change the rules of the game, utilities are better served by opening a constructive, data-driven dialogue that outlines how they can reliably supply reasonably priced clean energy to both corporate and rank-and-file customers. Doing so further cements the utility's leadership position in front of, and behind, the meter.

2018 Report Background

The *Black & Veatch 2018 Strategic Directions: Electric Report* is a compilation of quantitative and qualitative data and analysis from industrywide surveys. This year's online survey was conducted from 2 May 2018 through 14 May 2018 and reflects the input of more than 300 qualified utility, municipal, commercial and community stakeholders.

A total of 343 qualified utility, municipal, commercial and community stakeholders completed a majority of the survey. Because the survey was administered online, the amount of self-selection bias is unknown; therefore, no estimates of sampling error have been calculated. The following figures provide additional details on the participants in this year's survey.

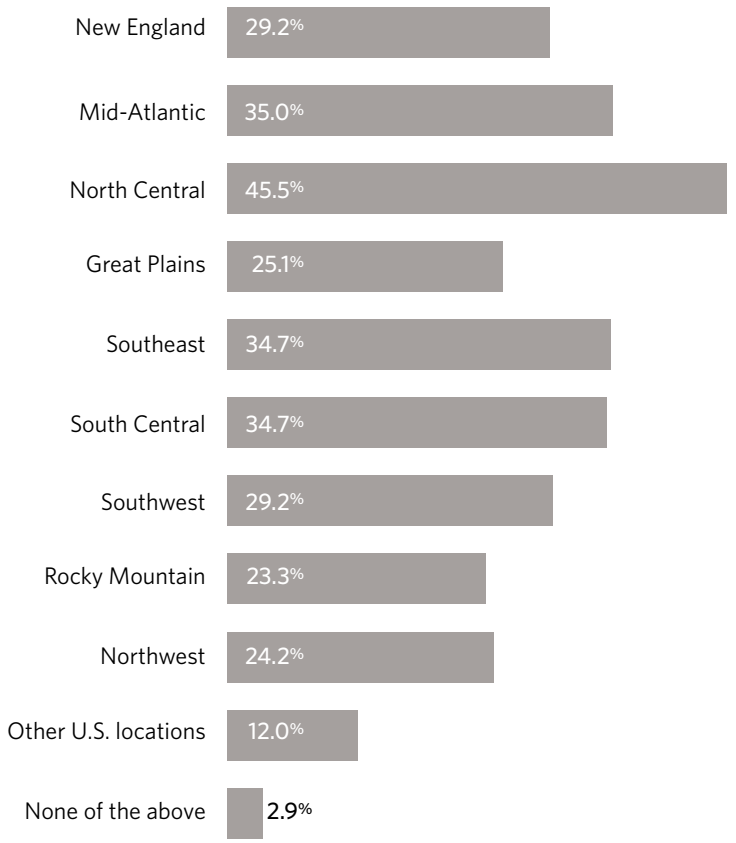
INDUSTRY TYPE

Does your organization distribute, transmit, generate, retail or sell electricity? (Select one choice)

YES 72.9% | NO 27.1%

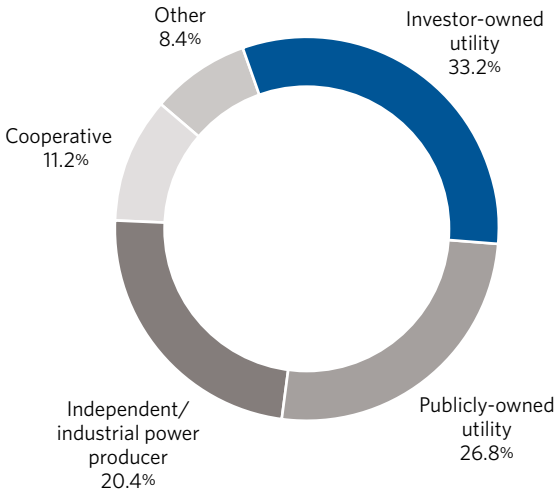
PRIMARY BUSINESS REGION

In which regions of the United States is your organization located and/or provides services? (Select all that apply)



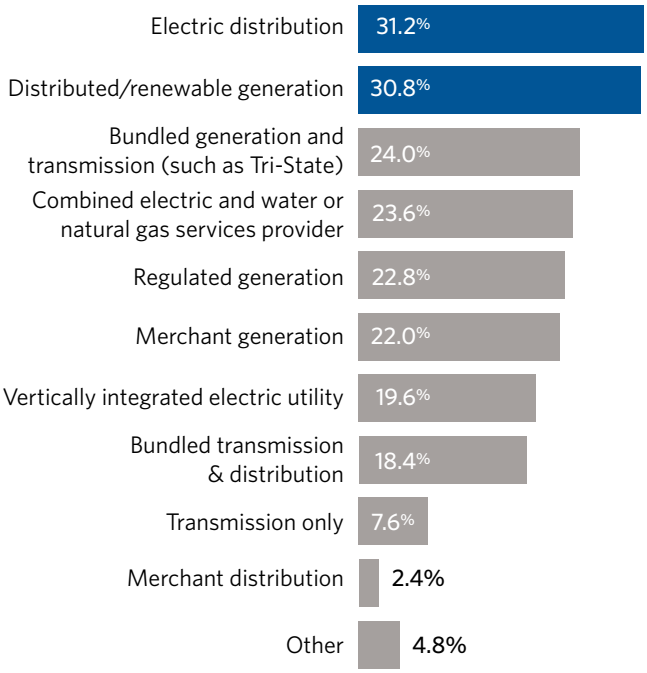
ELECTRIC SERVICES PROVIDER TYPE

Which of the following best describes your organization? (Select one choice)



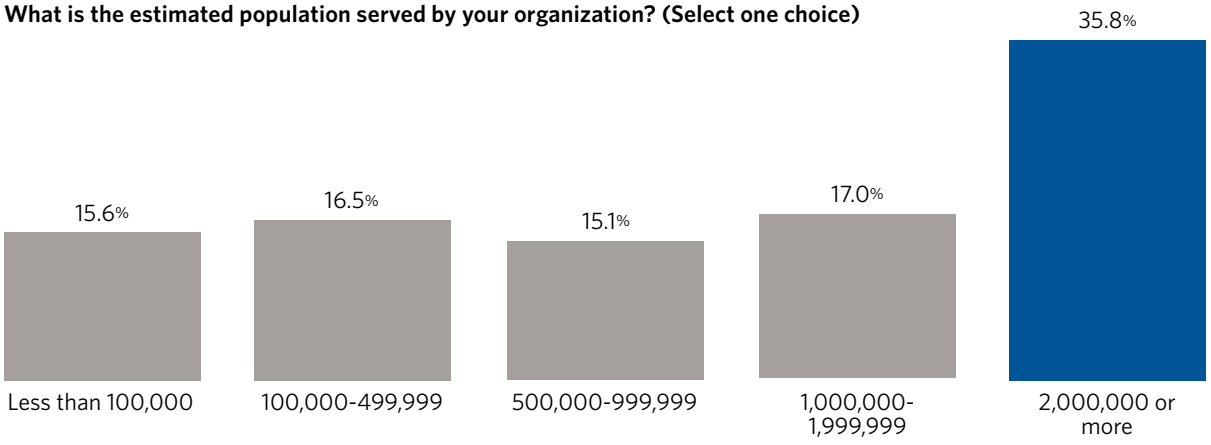
ELECTRIC SERVICES PROVIDED

What service(s) does your organization provide? (Select all that apply)



ELECTRIC SERVICES PROVIDER TYPE

What is the estimated population served by your organization? (Select one choice)



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P +1 913 458 2000 | **E** MediaInfo@bv.com | **W** bv.com