

2020 Black & Veatch
Strategic Directions



Smart Utilities Report



About This Report

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The story is a familiar one — the utility landscape is changing, and utilities are striving to move forward into a rapidly modernizing world even as they continue to remain challenged by outdated regulatory and business models.

Built on expansive industry data collected in its *2020 Strategic Directions: Smart Utilities Report* annual survey of electric, water and natural gas utilities, Black & Veatch looks beyond individual efforts to take a more holistic view of what it means to deliver the promised grid of the future.

After having surveyed more than 600 qualified utility, municipal, commercial and community stakeholders, there's no doubt that change is afoot. Last year, utilities pointed to budget constraints, competing priorities, and regulatory hurdles as the top three barriers to modernization.

This year, although these barriers still command the top spots, the percentages have dropped across the board, suggesting that these barriers are now considered less significant than in the past.

This hints at what we're seeing throughout the marketplace. Although utilities may have once considered these barriers insurmountable, steady forward progress proves they are not impossible. This year's *Smart Utilities Report* explores all these issues, and more.

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

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2020 Report Background



The background of the page is a photograph of a crowd of people at what appears to be a trade show or conference. A large, semi-transparent blue circle is overlaid on the upper portion of the image. Overlaid on the entire image is a white, intricate network diagram consisting of numerous overlapping circles and lines, resembling a complex web or a utility grid. The text is centered within the blue circle.

Executive Summary

**Communications Networks
Are Key to Delivering the
Grid of the Future**

By John Janchar



ABOUT THE AUTHOR

John Janchar is the president of Black & Veatch's telecommunications business, including public networks, private networks, connected communities, and transformative technologies lines of business.

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Distribution modernization is inevitable as advances in energy production, storage and control give rise to a new energy marketplace happening at the local distribution level. This evolving landscape leaves utilities questioning how they can maintain the reliability, efficiency and security of their operations, while managing two-way power flows and the influx of digital devices and distributed energy resources (DER).

Black & Veatch's *2020 Strategic Directions: Smart Utilities Report* provides analyses on this and other major trends that are playing out — and reshaping — how utilities see the grid of the future, one that is sustainable, reliable, resilient and digital.

According to the report's annual survey of electric, natural gas and water utilities, respondents see improved reliability, operational efficiency and concerns about aging infrastructure as driving distribution modernization efforts. Last year, the industry named increased monitoring, control and automation capabilities as the primary driver; this year, that response fell to fourth place.

Things have changed since the smart grid was first mentioned. Initially comprising primarily smart metering programs, today's smart grid must accommodate the densification of digital devices across the grid to improve reliability and support the advancement of DER. But truly delivering the grid of the future will require more than just integrating a laundry list of shiny new features and technologies — it will require that utilities implement a sweeping shift toward digitalization, embracing and investing in the

The modernized grid of tomorrow must be built on a strong communications network that takes into consideration all the necessary applications ...

organizational transformation and large-scale integrated communications networks that will bring it all together.

Going forward, fully integrated communications infrastructure will be critical to support utilities' demands for reliability and efficiency. This means not only upgrading the operational assets — the poles, wires, distribution switches and regulators — but also implementing advanced communications systems capable of supporting millions of digital devices required for the future distributed utility system.

The modernized grid of tomorrow must be built on a strong communications network that takes into consideration all the necessary applications — the automation, analytics, asset management and security — that enable a robust utility operation.

To achieve this, one-third of survey respondents said they plan to spend more than \$200 million to modernize their distribution infrastructure over the next three years, while 30 percent plan to spend \$50 million to \$200 million, and one-fifth of respondents will spend \$10 million to \$50 million. The industry should expect to see communications infrastructure comprise a growing chunk of this investment.

Interestingly, survey respondents see three groups leading this effort: operational technologies, IT/communications, and security/privacy. From an organizational standpoint, this makes sense; these groups

are uniquely positioned to connect a utility's traditionally siloed departments and serve as the catalyst to encourage utilities to adopt new technologies.

But that's not to say barriers to modernization don't exist. Budget concerns remain No. 1, along with managing competing priorities, regulatory hurdles and a lack of resources and expertise. Paying for these upgrades will be the biggest future challenge. Not only do utilities have to find the funding, but they must accurately understand and capture the total capital infrastructure investment.

But once utilities achieve these steps — and find the appropriate resources and expertise and make the necessary investments in communications — they will be in a much better position to see smart distribution infrastructure come to fruition. The *2020 Strategic Directions: Smart Utilities Report* touches on all these topics and much more.

- **Grid Modernization.** The move to the digital grid is upon us, propelled by the promise of new technologies, devices and speed. Survey data shows that utilities are “all in” on grid modernization plans, and regulators are slowly moving in that direction. But the key to turning vision into reality comes down to next-level planning to truly enable decentralization.
- **Advanced Distribution Modernization.** Tight budgets are keeping many utilities from deploying comprehensive distribution

modernization solutions. While cost concerns are understandable, much is at stake: Outdated mechanical breakers that have been the hallmark of today's aging infrastructure are testing grid resilience, as are increasing amounts of DER on the grid.

- **Integrated Systems Planning.** For decades, utilities have operated in silos, with each department focused on its own corner of the business, not sharing information, processes or tools. But that's changing, and utilities today are starting to break down silos and operate more cross-functionally as they work to meet the challenges of DER and non-wires alternatives to traditional utility resources.
- **Network Management.** Increasingly complex and proprietary systems make network management a giant headache for system operators. With more and more devices being installed on these systems, 24/7 network operations centers and security operations centers are rapidly gaining favor; however, end-to-end network management strategies to unify these investments will be critical.
- **Private Networks.** Utilities value owning their own assets, and that holds true for network communications. Our survey shows sustained interest in the deployment of private fiber as a communications solution to support distribution automation. But respondents remain concerned that their existing wireless infrastructure isn't meeting coverage and capacity needs and also cited obsolescence and lack of original equipment manufacturer (OEM) support.
- **The Future of 5G.** The promise of next-generation 5G connectivity is expected to hasten wide-scale adoption of the Internet of Things, introducing new technologies that offer untold benefit. But implementing 5G at scale will require extensive collaboration — particularly among carriers and utilities, not

to mention local communities, state and local permitting policies, regulators and technology integrators.

- **Resilience Planning:** Power and water providers are dedicating themselves to rooting out their assets' biggest vulnerabilities. Today, utilities not only are embracing data, but they're using it to strengthen assets while making them more cost-efficient and sustainable. Resilience goes a long way toward assuring ratepayers that they can count on their utilities to respond in economically, environmentally and socially responsible ways.
- **Cybersecurity:** U.S. utilities are on guard, painfully aware that hackers intent on disrupting electric and water plants always lurk. This vigilance is essential as the nation's power networks become more integrated and complex, given the proliferation of DER and the industry's embrace of internet-connected sensors. And to little surprise, utilities are getting wise to the need to beef up their defenses.
- **Risk Management for Transmission and Distribution:** Under the constant threat of significant disruption from record-setting weather events, utilities are wrestling with how to manage risks to ensure reliable service. Regulators, shifting customer expectations and environmental compliance may be driving a lot of the discussion, but utilities aren't sitting idle; instead, they are migrating to risk-based management programs in an attempt to keep the lights on. ○



Grid Modernization

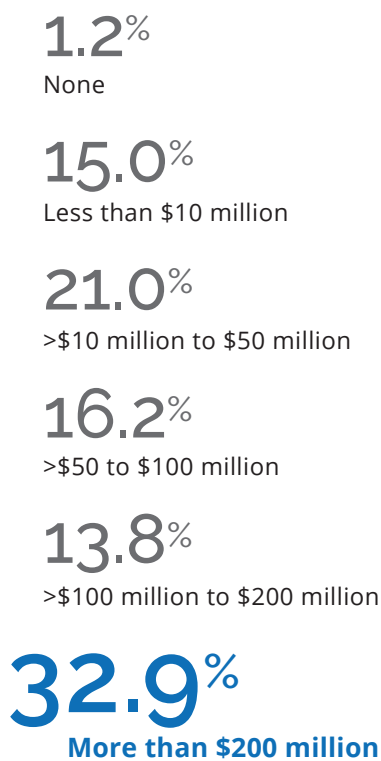


Figure 1

How much capital do you plan to invest in modernizing the distribution system over the next three years?

(Select one choice).

Source: Black & Veatch



Grid Modernization Goes Mainstream, Reliability Is Primary Goal

By Sarah Densmore, Kevin Ludwig and Jeff Mehlin

Power sector players got a jolt in January 2019 when Virginia utility regulators rejected the \$6 billion grid modernization rate case proposed by Dominion Energy. This “no” followed similar decisions in Kentucky and North Carolina from the previous year. Despite such setbacks, results from Black & Veatch’s *2020 Strategic Directions: Smart Utilities Report* survey show that utilities are “all in” on grid modernization plans, and it looks like regulators are moving that way, too.

When asked how much capital they plan to invest in modernizing the distribution system over the next three years, one-third of survey respondents said more than \$200 million. That figure is up from 21 percent of respondents who answered the same question one year ago (*Figure 1*).

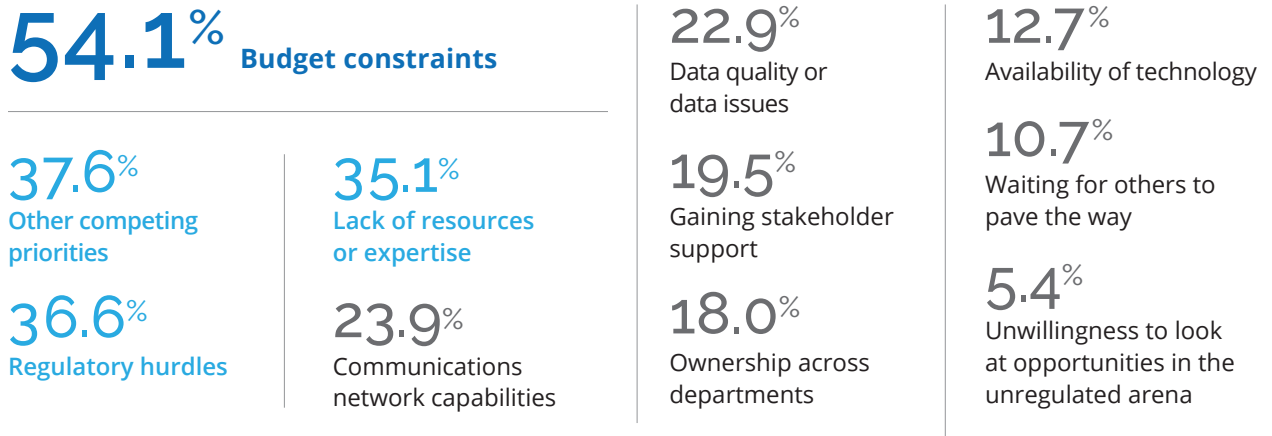
The increase likely reflects the maturing of grid modernization efforts and greater attention to distribution grid resiliency. What was once a “nice to have” has quickly transformed into a “must” in today’s evolving utility landscape. During the past five years, utilities were hard at work evaluating innovative technology and running pilots. Now, they’ve secured funding or earned regulatory approval to move forward with a renewed focus on distribution investments.

That’s likely why fewer barriers to modernization show up in this year’s survey results. In the *2019 Strategic Directions: Smart Utilities Report*, nearly two-thirds — 63 percent — of survey respondents named budget constraints and competing priorities as their biggest roadblocks, while nearly half, or 48 percent, pinned regulatory hurdles as a problem.

Figure 2

What are the top three barriers your utility is facing to enable smart distribution infrastructure?

Source: Blach & Veatch



This year, 54 percent said budget constraints were troublesome — a nine-point reduction — while only 37 percent named competing priorities and regulatory issues as their grid modernization headaches (Figure 2). A lack of resources went up from one year to the next, rising from 29 percent in 2019 to 35 percent this year, indicating that utilities are on the move and need people to handle the work.

Key drivers of grid modernization remained much the same between the 2019 and 2020 surveys. This year, two-thirds of respondents said “improving reliability” was a key catalyst, while 43 percent picked improving operational efficiency as well as addressing aging infrastructure, and 39 percent cited the need to increase monitoring, control and automation capabilities (Figure 3).

Figure 3

What are the top three drivers for modernizing your electric distribution system?

Source: Blach & Veatch

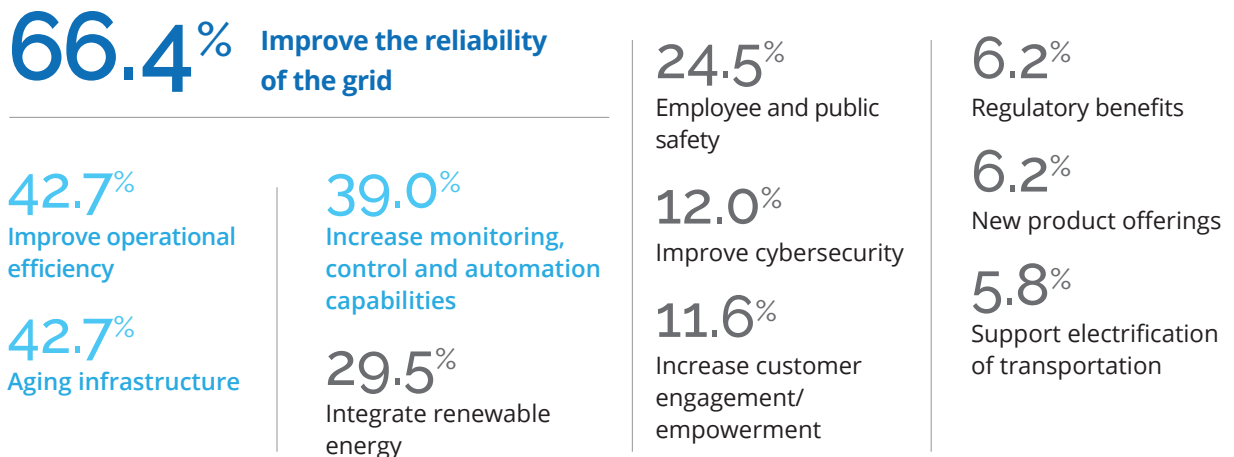
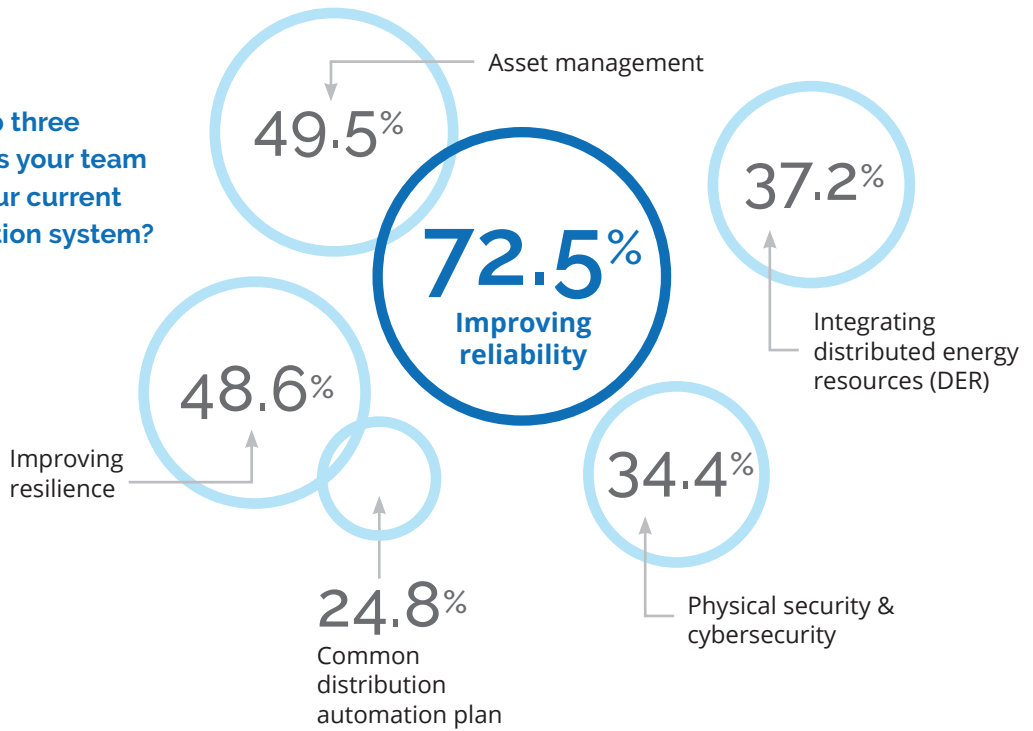


Figure 4

What are the top three major challenges your team is facing with your current electric distribution system?

Source: Black & Veatch



In addition to reliability being a key driver for grid modernization efforts, it is no surprise that reliability also tops the list of challenges utilities feel they are facing. Nearly three-quarters (73 percent) of survey respondents named it as a major hurdle, followed by asset management (50 percent) and resilience (49 percent) (Figure 4). Resilience refers to a utility's ability to identify and address vulnerabilities that could leave customers without power.

Why is reliability taking center stage? One reason is climate change. Last year, a report from the U.S. Energy Information Administration (EIA) found that average power outage duration nearly doubled between 2016 and 2017, and major storms seemed to be behind these longer service interruptions.

"The future of grid stability may be more tied to weather and climate than modernization, as

EIA data paints a picture of an electric system struggling in the face of growing storms," [a Utility Dive article](#) noted about the EIA findings.

A recognition for more robust efforts to proactively improve the grid against the increased magnitude and frequency of major storms has surfaced legislatively in Florida, where the Public Service Commission has introduced Senate Bill 796 (Public Utility Storm Protection Plans) to the Florida Legislature. While efforts to toughen their assets against storms are not new to utilities, this new legislation allows investor-owned utilities to recover costs for such action outside of their rate case, offering greater flexibility. Storm hardening leads to a more resilient system better equipped to keep power flowing when the next hurricane hits and minimizes restoration times.

Along with storms, climate change has contributed to an increase in wildfires, which

some California utilities now consider an existential risk. One utility is installing new reclosers on overhead line systems, replacing older electromechanical technology with new microprocessor technology that facilitates remote operation and will allow the utility to disable protection functions during fire events.

Climate change isn't the only driver of reliability concerns. Customers also are a focus, and many utilities are transforming their business models to those more customer-centric. A century ago, if a customer lost power, the lights went out. But today's lifestyle is built on electricity — it powers our irrigation systems, mobile phones, smart thermostats, air conditioners, hairdryers, TVs, computers and other electric-dependent assets. With more customers' lives relying on electric-enabled technologies,

expectations for minimal (nonexistent) interruptions are much higher. Electricity permeates every corner of our lives.

Not surprisingly, when this year's survey asked respondents which technologies are most important to managing the distribution system, many of the top answers were consistent with this focus on reliability.

Supervisory control and data acquisition (SCADA) applications — the power system's eyes and ears — ranked No. 1. Without them, utilities don't have visibility into anything on their networks, so it's not surprising that nearly half of respondents named that as the chief technology for effective distribution operations (Figure 5).

Figure 5

Which technologies or initiatives do you feel are most important to managing your distribution system?

Source: Black & Veatch

47.7% Supervisory control and data acquisition

40.7% Advanced metering infrastructure

33.7% Fault location isolation & supply restoration

31.3% Automated circuit breaking devices

30.5% Advanced distribution management system

24.3% Cybersecurity

22.6% Distributed energy management system

18.1% Customer information systems

16.9% Demand response management system

14.0% Conservation voltage reduction and voltage/VAR

9.1% Field area networks

7.4% None of the above



Figure 6

To what extent are the following organizational groups involved in the distribution modernization discussion at your utility?

Source: Black & Veatch

	Are involved	Not involved, but should be	Not involved, and don't need to be
Operational technologies	86.3%	8.6%	5.1%
IT/Communications	79.9%	10.6%	9.5%
Security/Privacy	79.7%	11.3%	9.0%
Transmission	74.7%	9.3%	16.0%
CIO	64.7%	15.4%	19.9%
Generation	40.2%	15.5%	44.3%

Advanced metering infrastructure, another technology that delivers visibility and intelligence, earned a nod from four of every 10 of respondents, and about one-third named technologies that impact restoration capabilities.

All Together Now

When looking at modernization projects, are utilities pulling the right players into planning talks and deployment teams?

Survey responses would indicate that, yes, they are. Utilities need cross-functional teams for multiple reasons: Insight, impacts, investment trade-offs all come to light when representatives from key groups within a utility come together in the same room (Figure 6).

This cross-functional input is especially important with the increased volume of

distributed energy resources (DER) on the distribution system, including those that may not be utility-owned. Worse, many of these DER are variable because they're driven by the sun or wind, which boosts the need for flexibility, volt/volt-ampere reactive (var) support, load shifting, and greater visibility and forecasting capabilities. With the deployment of new and innovative technologies, operations teams no longer can rely on just themselves to make decisions; there is an increased need for input from other departments such as information technology (IT), telecommunications and cybersecurity.

Traditional generation has remained relatively constant with fewer impacts on the distribution grid, and survey results reflect utility understanding of this.



Figure 7

Please indicate the horizon(s) your organization uses in documenting a strategic vision for growth.

Source: Black & Veatch



The planning horizons noted in survey responses also reflect the years already spent in grid-modernization efforts. Right now, more than two-thirds — 69 percent — of respondents are using a one- to seven-year planning framework for documenting their strategic visions (Figure 7).

As noted earlier, much of the work done in the past five years was foundational, with utilities focusing on studies, pilots and business case development.

Most utilities have multiple technology implementations and initiatives already in the works. Grid modernization is no longer something utilities are working toward but has become a critical, ongoing effort that is dynamic and much evolving. Pushing planning horizons beyond the seven- to 10-year point may, therefore, deliver diminishing returns on the time and resource investment. Technology continues to evolve — and so will grid modernization activities. ○

ABOUT THE AUTHORS

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United They Stand: DER and Non-Wire Alternatives Are Pulling Utility Teams Together

By Heather Donaldson, Stuart McCafferty and Dr. Soundrapandian Sankar

Ask anyone who's been in the utility world for a while, and they'll assuredly tell you: most utilities have operated in silos, separate groups focused squarely on their own little corner of the business. The silo mentality thrives when members of one department don't share information with other departments, operate with separate goals, use different tools, and follow different processes than those folks across the hall.

Utility managers have been wringing their hands about silos for decades. Now, at least when it comes to planning, utilities are starting to break down those silos and operate more cross-functionally. Here's why: They must if they want to successfully meet the challenge of distributed energy resources (DER) and non-wires alternatives (NWA) to traditional utility resources.

Awareness of this reality shows up in responses to Black & Veatch's *2020 Strategic Directions: Smart Utilities Report* survey. When asked how their organizations rated the importance of integrated planning, nearly half (46 percent) of respondents said, "very important" and another 37 percent replied, "extremely important" (Figure 8). Add these responses to the ones who said it was slightly or moderately important, and 96 percent of survey respondents think planning teams should include representatives from a variety of functions, including transmission, distribution and resource planning.

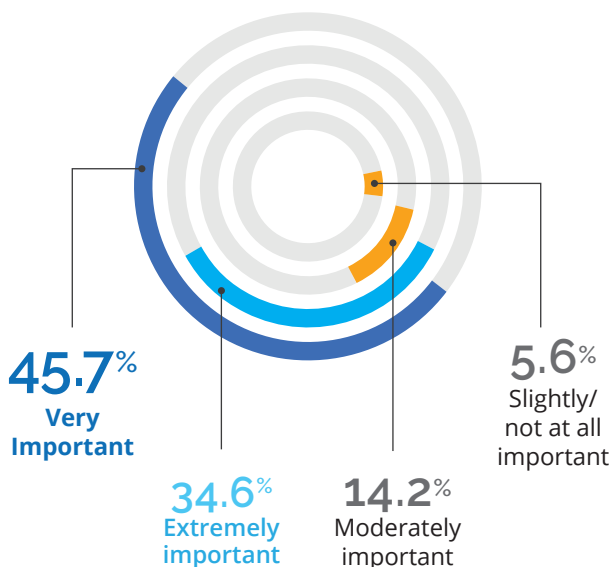
This cross-functional collaboration is a non-traditional approach in the utility world, but it's an important shift. Supply resources, once only

on the transmission system, are now also on the distribution system in increasing numbers. These distributed resources typically rely on highly variable solar or wind as their fuel source and, in some cases, are customer-owned. These conditions require utilities to evaluate and adapt system planning and operating capabilities to ensure reliability, support customer choices, meet regulatory requirements and progress toward corporate sustainability goals. Now more than ever, it is essential for utilities to implement an integrated system planning capability.

Figure 8

How is your organization viewing the importance of integrating its planning functions (e.g., transmission, distribution and resource planning)? (Select one)

Source: Black & Veatch



Joining Forces

It's clear utilities are starting to see the importance of integrated planning. More than half (53 percent) of survey respondents said their organizations have "mostly integrated planning functions." Another 39 percent have started the integrated approach, and 5 percent recognize the need (Figure 9).

Utilities also are operating with planning horizons that reflect both transmission and distribution needs to some extent. Planning horizons need to look at timing from two perspectives: the time to need, and the time to build and maintain optionality as long as possible. Maintaining optionality helps mitigate the risk of stranded costs by over-investing in assets. Most utilities outside California — where transmission projects can take 15 years — can finish siting, permitting and construction in fewer than 10 years on transmission projects.

Distribution planning looks out five years, which is the typical time to build a substation. However, most distribution investment decisions are made in the nearer term, about one to two years ahead. Nearly half (48 percent) of respondents

look four to seven years out in strategy building, which means these construction realities are showing up in utility planning horizons.

The Forces Uniting Them

What's driving the need for integrated planning? DERs, which are turning out to be both a challenge and an opportunity. Utility departments must unite to leverage that opportunity.

Now there are five primary criteria that utility managers must accommodate in planning efforts. These include delivering safe, reliable power, an electric utility's main function. Affordable power is important, too, and traditional planning is about figuring out how much load and generation you expect on your system and making sure you can support that load at the best price possible.

Now, however, clean power is becoming increasingly important. [The U.S. Energy Information Administration's November 2019 Short-Term Energy Outlook](#) forecasts that U.S. power sector electricity generation from renewables other than hydropower —

Figure 9

Where is your organization in terms of your journey to integrate its planning functions?

(Select one)

Source: Black & Veatch

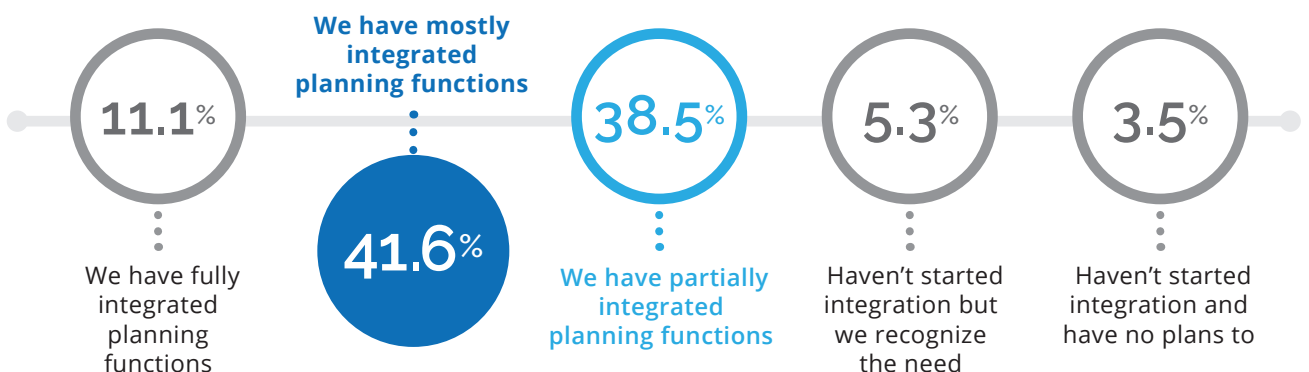




Figure 10

On a scale from 0 to 5, to what degree are non-wires alternatives being considered at your utility? (Select one)

Source: Black & Veatch

5 23.8%
We consider non-wires alternatives as part of our standard operating procedures

4 13.9%
Cost studies/pilot programs are underway

3 10.6%
Cost studies/pilot programs are being planned

2 21.9%
We are just beginning to consider non-wires alternatives

1 9.9%
Has previously been considered but no plans for implementation

0 19.9%
Not being considered and have never been considered

principally wind and solar — will grow from 408 billion kilowatt hours (kWh) in 2019 to 466 billion kWh in 2020. Because wind and solar resources have intermittent generation, flexibility will become more important, too. That is, utilities will need fast-ramping resources to manage sudden shifts in wind or solar power output.

Finally, resiliency is a key issue addressed by utility planners, and climate variability is making a resilient grid ever more vital. According to the U.S. Global Change Research Program, heat waves across the U.S. have generally become more frequent in recent decades, and tree ring data suggest that the drought in the western U.S. over the past decade represents the driest conditions in some 800 years, which is bad news for utilities in the West battling wildfire threats.

The rest of the country won't fare better, though. These same scientists who produce climate assessments for the U.S. government also say heavy downpours have increased 30 percent compared to figures from the 1901 to 1960 averages in the Northeast, Midwest and upper Great Plains. "There has also been an increase in flooding events in the Midwest and Northeast, where the largest increases in heavy rain amounts have occurred," the [climate assessment team says on its website](#). And, hurricanes have seen a "... substantial increase in most measures of Atlantic hurricane activity since the early 1980s," the scientists note.

Whether they're facing heat, storms or wildfires, utilities must push resilience up in planning.

Given these criteria, utilities increasingly are looking at non-wires alternatives (NWA) options that may offer more cost-effective solutions than traditional resources. Resiliency could be augmented via microgrids. Flexibility may come from remote or customer-sited batteries. And clearly, utilities are seeing this. Nearly one in four (24 percent) consider NWAs as part of standard operating procedures, while another 46 percent are beginning to consider or are piloting studies (Figure 10).

Regulators are looking at non-wires solutions, too. In some areas, like California, sustainability goals drive that focus. In the East, New York's Reforming the Energy Vision (REV) initiative has launched several NWA opportunities, including Consolidated Edison's (ConEd's) Brooklyn Queens Demand Management project, which helped the utility defer a \$1 billion traditional investment with just over \$500 million in demand management and traditional resources (Figure 11).

Figure 11

On a scale from 0 to 5, to what degree are non-wires alternatives being considered at your utility? (Select one) by region.

Source: Black & Veatch

0 or 1

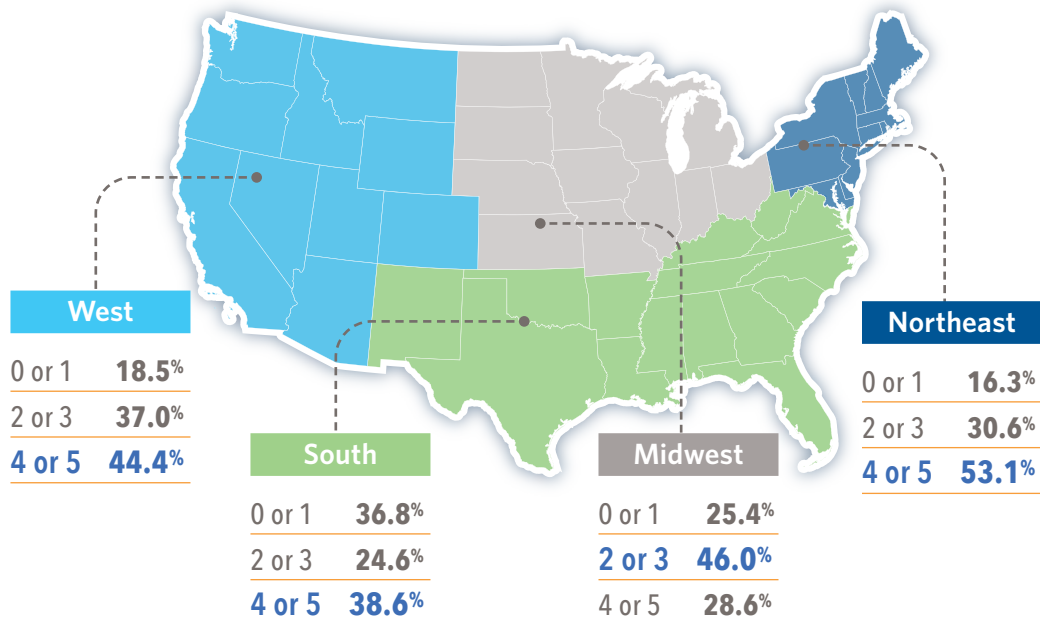
No plans for consideration or implementation

2 or 3:

Beginning to consider OR plan cost studies/pilot programs

4 or 5:

Cost studies/pilot programs underway OR they are part of standard operating procedures



Regulatory pressure on the U.S. coasts and Hawaii explains why NWA solutions are closer to being adopted in the Northeast and West, while utilities in other areas of the country are just starting down the NWA path.

Ahead, NWAs could well become more prevalent. After all, climate change is becoming a national imperative. This past year, 62 percent of U.S. survey respondent told Gallup researchers that the government is doing too little on the environment, and similar concern showed up in a Pew Research Center's 2018 survey, in which 67 percent of Americans said the U.S. government "wasn't doing enough to reduce the effects of global climate change."

At the same time, coal plants are under fire. "Between 2010 and the first quarter of 2019, U.S. power companies announced the

retirement of more than 546 coal-fired power units, totaling about 102 gigawatts (GW) of generating capacity," notes the U.S. Energy Information Administration.

"Plant owners intend to retire another 17 GW of coal-fired capacity by 2025. Another trend: Electric vehicle adoption is on the rise. BloombergNEF (BNEF) expects "annual passenger EV sales to rise to 10 million in 2025, 28 million in 2030 and 56 million by 2040," according to the BNEF 2019 Electric Vehicle Outlook. "Sales of internal combustion passenger vehicles have already peaked, and may never recover unless EV growth falters," the BNEF analysts stated in their report.

These circumstances will influence regulatory decisions and infrastructure requirements at the local and national level. This survey

Figure 12

Are there policy or other drivers (economic, social, etc.) requiring your organization to consider non-wires alternatives in your transmission and/or distribution planning functions? (Select all that apply).

Source: Black & Veatch

32.7%

No, no such drivers exist today and don't foresee them

29.1%

None today but we expect those drivers to soon impact our considerations

22.4%

Regulatory policies exist that require us to consider NWA

12.8%

Economic drivers exist that require us to consider NWA

12.8%

Other drivers exist that require us to consider NWA (such as societal benefit or customer demand)

shows two-thirds of survey respondents saying they see drivers happening now or ahead that will prompt their utilities to consider the NWA approach to meeting system needs (Figure 12).

NWAs offer one way utilities can add more renewables, thereby supporting sustainability goals. They'll also help with reliability and resiliency. This is a major driver behind the New York REV initiative that Gov. Andrew Cuomo launched as a comprehensive energy strategy for the Empire State. NWAs provide cost savings, too, as seen in the ConEd Brooklyn Queens project, which was designed to defer a \$1.2 billion substation investment with a \$200 million program. And, NWAs are flexible — a must for a greener grid.

That's why NWAs will continue to grow in importance, as will integrated system planning. Distribution, transmission, and resource mix will all be impacted by DER and NWAs. Utilities know it, and their planning approach is evolving accordingly. ○

ABOUT THE AUTHORS

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Advanced Distribution Modernization Can Smooth the ‘Changing Physics’ of the Grid

By Leslie Ponder and Tracy Swalley

Let's face it: The old days were much simpler, when the flow of power from the utility to end-user was, for the most part, a straight line. There were challenges, but there wasn't much getting in the way between baseload power generation and the light switch.

Those days are gone. The influx of distributed energy resources (DER), electric vehicles and the resulting multi-directional power flow — sometimes from customer to utility (e.g., rooftop solar) — has flipped the script, even if one immutable truth remains: Your customers expect their power to always be on. Without a systematic approach to distribution modernization, these new technologies raise the potential for trouble on the grid, taxing our aging distribution infrastructure and putting the customer relationship at risk.

Advanced distribution modernization sees utilities rapidly adopting digital technologies such as sensors, automated line switches,

reclosers and regulators, plus advanced remote monitoring to give themselves more control and faster response to power flow issues. Applications such as fault location isolation and service restoration (FLISR) can be used to automatically detect, locate and isolate faults to limit the number of customers impacted and reduce restoration times, both key measures for reliability. Grid reliability and efficiency were top drivers for modernization efforts, according to respondents to Black & Veatch's *2020 Strategic Directions: Smart Utilities Report* survey.

Advanced grid programs such as volt/volt-ampere reactive (var) optimization dynamically and autonomously optimize voltage and reactive power to help utilities reduce peak demand, system losses and/or energy consumption and improve power quality and grid stability. The combination of distribution automation (DA) and analytic software offers expanded grid monitoring and management capabilities.



Figure 13

Do you currently or expect to monitor or control third-party-owned distributed energy resources that are connected to your distribution system?

(Select one)

Source: Black & Veatch

19.4%

Yes, we currently monitor AND control third-party-owned DER

38.9%

Yes, we currently monitor third-party-owned DER

9.7%

We don't currently but are planning to monitor AND control third-party-owned DER

13.9%

We don't currently but are planning to monitor third-party-owned DER

18.1%

No, we don't monitor or control third-party-owned DER and have no plans to do so

These adaptations are necessary at a time when the evolution of power generation and delivery is changing the physics of the grid. Firm generation sources such as coal and nuclear are giving way to cleaner yet intermittent and often volatile sources, many of which are controlled but not owned by the utility (Figure 13). These intermittent resources produce voltage swings that need to be monitored, resolved, forecasted and planned for.

The distributed nature of utility assets is a significant factor as utilities plan for reliability and resilience, with 52 percent of respondents saying increases in their distributed asset portfolios will require communications network improvements (Figure 14).

We also can't forget about the data flow accompanying this historic shift. In a matter of just a few years, our grid has gone from producing a teacup's worth of data to an ocean. Devices provide the data that tells the story of our systems, and utilities are challenged to connect data from different sources, much like advanced metering infrastructure (AMI) connects with supervisory control and data acquisition (SCADA), to produce actionable information that can improve power quality, reliability and operational efficiency, and reduce cost.

Resource constraints remain critical inhibitors of comprehensive distribution modernization solutions, with more than half of survey respondents to Black & Veatch's *2020 Strategic Directions: Smart Utilities Report* citing budget, followed by competing priorities and regulatory hurdles.

Concerns about cost are understandable. Much of distribution modernization will involve taking a largely mechanical grid and digitizing it. Outdated mechanical breakers that have been the hallmark of today's aging infrastructure have been operating for 30 to 50 years, but new DER are testing the grid's limits, wearing out breakers and raising risk.

For example, during sunny summer days, solar arrays may produce more distributed energy than the system can use. If that load on the grid isn't balanced, power would return upstream through the substation and back into transmission, which causes instability that cascades into rolling blackouts. Utilities need a more robust grid with remote control and monitoring capability that features asset management health checks and moves operations and maintenance into a proactive approach rather than the outdated reactive mode.

In addition, Black & Veatch is seeing some utilities break their distribution feeders into switchable segments that allow

Figure 14

How do distributed assets factor into discussions about reliable and resilient communications?

Source: Black & Veatch

52.4%

The increase in our distributed asset portfolio will require improvements to our communications network

23.3%

The increase in our distributed asset portfolio will not require improvements to our communications network

15.5%

We aren't planning for additional distributed assets but are seeking communications network improvements

8.7%

We aren't planning for additional distributed assets and are not seeking communications network improvements

automated rerouting of power around faults. For this approach, AMI proves particularly valuable, because along with delivering data (i.e., consumption data and power-quality metric), AMI can enable time-based rates and targeted load shedding to deliver a non-wire means of deferring grid upgrades and investments.

That ability may be why AMI ranked a close second to SCADA on the priority list. Newer AMI meters can provide high-quality data because strategic meter placements around the distribution system can serve as bellwethers to voltage spikes or dips. Using data to analyze blink counts can identify feeders with high transient outages so that crews can investigate the cause.

Now that fuses and other tie points are being automated to SCADA, AMI and FLISR, most if not all device and application solutions will require advanced telecommunications systems and data analytics. It will be critical for organizations to chart an upgrade course that accommodates a diverse and ever-evolving grid — paired with ways to analyze and act on what these devices are telling us. ●

ABOUT THE AUTHORS

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Tracy Swalley is a director for projects within private networks of Black & Veatch's telecommunications division. With more than 35 years of professional engineering experience within energy, construction, information technology (IT) and telecommunications, he has a wide control and electrical engineering background that ranges from detailed design on power plants and manufacturing facilities to high-level expert testimony on control systems.



Networks

Figure 15

Do you plan to increase the number of communicating devices throughout your service territory in the next five years? (Select all that apply).

Source: Black & Veatch

45.0%

Substation automation devices

42.5%

AMI devices

37.5%

DA or DMS

28.3%

Field force automation devices

24.2%

Land mobile radio devices

15.0%

No, we have no plans to increase communications devices in the next five years

'Manager of Managers': Rise of Distributed Devices Drives Call for Network Management Solutions

By Mark Burke and Joe Zhou

Millions of devices are measuring and sometimes controlling the health of our utility networks, and millions more are coming. As distributed resources drive rapid, increasing demand for data-intensive grid management to ensure high-quality, reliable and resilient power delivery, ask yourself this question: How are you keeping up?

Led by a utility's approach to network management, the path from convention to optimization will be critical to our grid's digital transformation. Data from the *2020 Strategic Directions: Smart Utilities Report* survey finds that utilities are gaining a deeper understanding of data's potential to reshape how they find anomalies, perform asset management and use analytics to make smarter planning and operational decisions.

It's clear that holistic network management strategies will give utilities the best chance to truly understand and act on the stories their data is trying to tell them. Two key trends found in the report demonstrate the need: Devices on utility systems are proliferating at a high rate, and utilities are actively planning the deployment of 24/7 network operations centers (NOCs) and security operations centers (SOCs) meant to ensure protection and rapid response to issues affecting grid performance.

The Rise of Data

From substation automation, advanced metering infrastructure (AMI) and distribution management systems (DMS) to field-level automation, survey respondents told us they are planning device additions in their bid to glean more information from their networks, with substation automation and AMI devices leading the way (Figure 15).

Nearly one-third of respondents indicated they have migrated from synchronous, time-division multiplexing to packet-based internet protocol (IP) to improve data transmission efficiency and flexibility (Figure 16).

Network Operations Centers on the Front Line

But data collection eventually must lead to data management. Leading utilities have started developing integrated network management systems (INMS) to act as a “manager of managers” that deliver aerial-like views of all the devices and services being delivered by the network. Security controls and monitoring, provisioning, network surveillance and ongoing performance measuring are key benefits of this holistic approach.

Typically, an INMS is housed in a network operation center, which is becoming a 24/7 tactic of choice for utilities to manage all this information and address the frequently inopportune timing of system failures (Figure 17). Often, NOCs are integrated with element management systems (EMS).

Security Concerns

High-profile hacking episodes only underscore the need for strategic network management solutions. The geographically distributed nature of device-related upgrade projects, along with the sheer volume of devices going on the network, increases the opportunity for cybersecurity breaches and, thus, the challenge utilities face to meet them (Figure 18).

Today’s network management systems are built with alarm mechanisms and other quick-response technologies to mitigate risk. Furthermore, utilities are starting to evaluate, plan and build cybersecurity operations centers (CSOCs) specifically designed for operational technologies. Operational technology (OT) CSOCs will be tightly integrated with the utility power network and communications network operations and may be separated from the corporate and information technology (IT) CSOC operations. This is partially driven by both the need for compliance and for an increased level of security capabilities.

Figure 16

Have you migrated from synchronous TDM-based networks to packet-based IP based networks to improve data transmission efficiency? (Select one).

Source: Black & Veatch

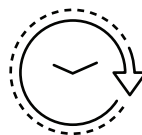
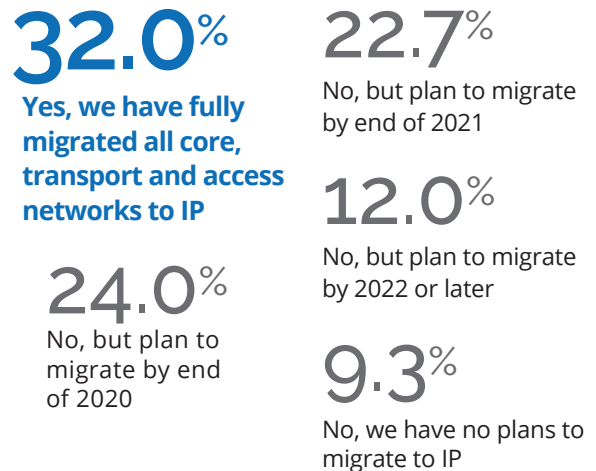


Figure 17

Do you have a centralized Network Operations Center? If so, how does it operate? (Select one)

Source: Black & Veatch

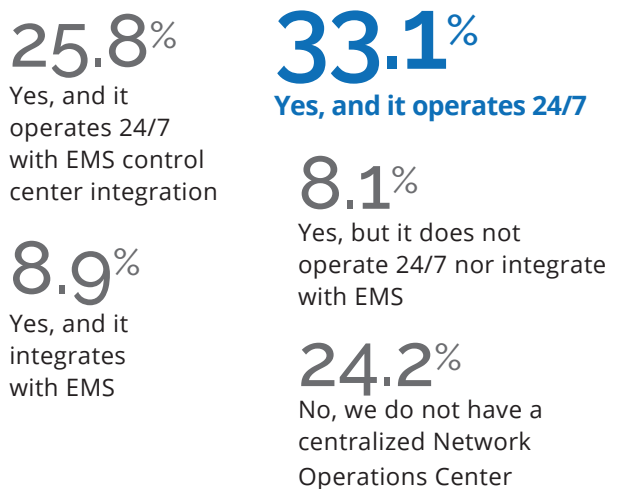
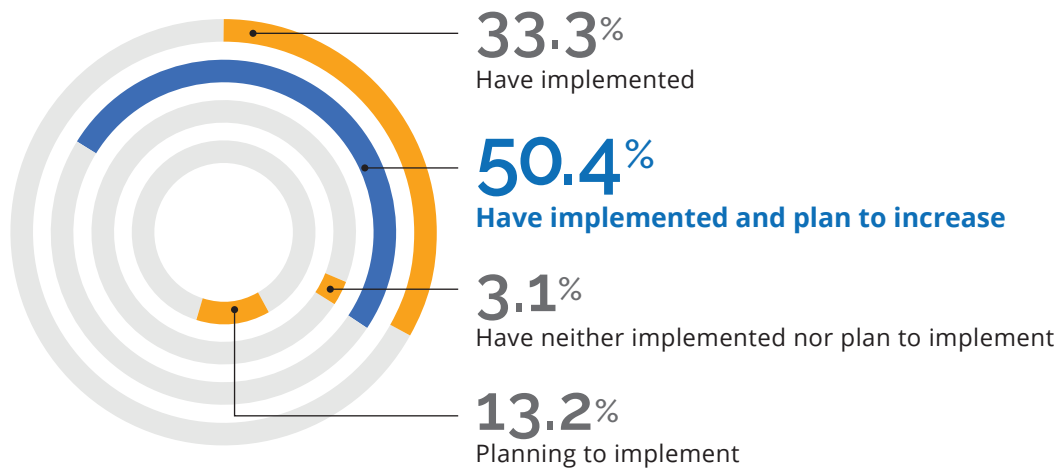


Figure 18

Have you implemented or plan to implement active cybersecurity monitoring of communication and data devices? (Select one)

Source: Black & Veatch



Closing the Gaps

The era of digitalized utility networks has arrived, with the grid moving massive amounts of power and information at high speeds. Pressure from customers for maximum uptime and resilient power are pushing utilities to modernize their systems. Network intelligence strategies involving AMI, distribution automation (DA), substation automation and other technologies offer great potential for insights about system state, asset health, customer habits and potential cyber anomalies.

But foregoing a comprehensive network management plan carries risk. Staffing and budget constraints frequently compete with customer demand, meaning in-house solutions often can outpace staff skill sets and resources. Can your team manage these new and larger data flows? And is it ready for the inevitable risk of opening new points of entries for bad actors on your network?

Answers to those questions start with how these systems can be managed to understand the performance and security gaps, and close them before they threaten the customer relationship. ○

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Joe Zhou is senior managing director at Black & Veatch Management Consulting, where he leads the business technology architecture offering group that includes security and resiliency, asset management and analytics to provide innovative and insightful consulting services to asset-intensive industries, such as power, oil and gas, and water. Zhou has more than 25 years of experience enabling business transformations with digital technologies and leading business practices.



Figure 19

Are you currently planning to upgrade your communications network infrastructure? (Select one)

Source: Black & Veatch

44.1%

Yes, we are currently planning or upgrading both wireless and fiber networks

23.7%

Yes, we are currently planning or upgrading our wireless networks

10.8%

Yes, we are currently planning or upgrading our fiber optics networks

21.5%

No, we are not currently planning or upgrading our communications infrastructure

The Call Is Coming from Inside the House: Private Utility Networks Bring Efficiency, Control and Reliability

By David Hulinsky and Rick Schmidt

Reliable communications networks are crucial to allow utilities to deliver an uninterrupted supply of power to customers. With high-speed wireless technology at the fore, and the addition of hundreds of new field applications that require communications networks — including Long-Term Evolution (LTE) — a digital utility is built on communications that extend to the edge. Converged networks employing IP-advanced private wireless networks enable these systems to become more efficient and extend deeper into the distribution system, where they're most needed.

Massive investments made by utilities underscore this emerging priority; organizations no longer are content to outsource their communication network needs to publicly available carriers. Utilities are bringing the networks in-house via fiber optics, wireless and spectrum control in giant steps forward for reliability.

Nearly three-quarters of respondents to Black & Veatch's 2020 *Strategic Directions: Smart Utilities Report* survey have their own private communication networks. But interestingly, the survey data indicates that many believe their current communications network infrastructure to be inadequate. As a result, many respondents are busy planning to upgrade either their wireless or fiber-optic setups, or both (Figure 19).

What's driving this concern and, ultimately, this new investment? Respondents indicated worry that current wireless infrastructure isn't meeting coverage and capacity needs. Obsolescence and lack of original equipment manufacturer (OEM) support is another concern (Figure 20).

Survey results show that over three-quarters of respondents have sites connected by fiber (Figure 21). Many organizations plan to deploy private fiber in the coming years as their communications

Figure 20

Which of the following are concerns you have with your current wireless network infrastructure?

Source: Black & Veatch

	Extremely concerned	Very concerned	Moderately concerned	Slightly concerned	Not concerned at all
Doesn't meet coverage requirements	4.4%	18.9%	33.3%	24.4%	18.9%
Doesn't meet capacity/performance requirements	6.6%	31.9%	22.0%	25.3%	14.3%
Obsolescence, infrastructure no longer supported by the OEM/vendor community	12.2%	22.2%	15.6%	27.8%	22.2%
Lack of knowledge of location and condition of assets	3.3%	10.0%	25.6%	24.4%	36.7%

solution to support distribution automation, and we see no evidence in the market to suggest upgrades will slow any time soon. When it comes to selecting digital technologies, utilities need to dig into the network requirements of each application, carefully assessing latency, bandwidth, coverage and security requirements.

This information helps pinpoint whether existing infrastructure can support long-term requirements or needs network upgrades. When designing the private wireless networks, utilities need to check the availability of the wireless spectrum and whether there is existing infrastructure that can be leveraged. Above all, the private wireless network needs to be flexible and scalable to evolve alongside the utility.

Consider the backhaul or wireless network for distribution automation (DA), advanced metering infrastructure (AMI), distributed energy resources (DER) and other field telemetry programs. Today, a combination of communications technologies is being used. Most utilities have some type of backbone or wide-area network (WAN) connecting their tower sites, offices, data centers and transmission substations with a ring topology high bandwidth, low latency and 99.999 percent reliability backbone.

We expect this configuration, usually comprising fiber optics and licensed point-to-point microwave, to continue, expand and become even more robust. For the next tier of the network connecting distribution substations, small operation centers, AMI collectors located in the feeders, DA and DER points, a variety of communication alternatives can be expected from commercial cellular, worldwide interoperability for microwave access (WiMAX) 802.16s at 700 megahertz (MHz), 900 MHz point-to-multipoint (PMP), unlicensed 900 MHz, 2.4 gigahertz (GHz), 5.8 GHz point-to-point (PTP) and mesh.

In the past year or so, a breakthrough technology surfaced with the protocol of 802.16s for wireless backhaul, especially in large utility service territories with a lower density of smart utility devices. We can expect significant efforts by large utilities to secure spectrum in the coming years.

We also can expect private LTE and 5G solutions to enter the utility marketplace in a big way. Private LTE, in particular, aligns with the industry's shift to utility-owned networks, as it can be thought of as an efficient way to handle the backhaul communications of distribution supervisory control and data acquisition (SCADA), DA, AMI, DER and other

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Rick Schmidt is a managing director for Black & Veatch Management Consulting. Schmidt led the growth of Power System Engineering's utility automation and communications practice from startup to market leadership within the cooperative and municipal electric utility sector. He is experienced with utility telecommunications, smart grid automation programs and strategic technology planning.

Figure 21

What percent of your sites are connected or supported by the following technologies?

Source: Black & Veatch

	Less than 20%	20% to 80%	More than 80%
Fiber optic cable	22.4%	52.3%	25.2%
Microwave communications	56.7%	34.0%	9.3%
RF/WiMAX	65.2%	21.7%	13.0%
3G/4G LTE-leased wireless	30.9%	53.6%	15.5%
Leased line 2Wire/4Wire or T1	48.9%	40.4%	10.6%
Serviced by legacy SONET transport	60.0%	27.1%	12.9%
DWDM transport	69.0%	20.2%	10.7%

field applications. To accomplish this, the utility needs to identify an acceptable spectrum and purchase LTE base station equipment. The advantages of private LTE include the following:

- The ability to manage to the desired reliability and security level while building coverage to meet utility needs.
- More control over the product life cycle.
- Economy of scale by reducing the number of disparate networks to manage.
- Selection from several standards-based LTE endpoint manufacturers, which allows a more "plug and play" environment.
- Potentially lower maintenance costs compared to a variety of other communication alternatives.

Today's smart utilities understand the value of owning their communication networks. For those who don't, think about it this way: Because utilities own their own assets, many could not imagine leasing their transmission and distribution infrastructure. They own these assets to maintain control. Communications, in many ways, is as critical of an asset as the utility can own and operate: If your communications go down, your applications go down. ○



5G Implementation Comes Down to Communication, Collaboration

By Gary Johnson and Scott Nichols

There's no doubt that the lure of 5G digitalization is strong. This wave of next-generation connectivity is expected to usher in exciting new opportunities such as wide-scale adoption of the Internet of Things (IoT), along with all its innovative new technologies that promise to change how we live, work and play.

The advent of 5G holds benefit for a myriad of groups. Carriers could see new opportunities for revenue as their role grows across the IoT ecosystem. Utilities would benefit from improved communication capabilities and collaboration with carriers. Communities that support 5G could see improved quality of life along with higher revenue and employment.

Industries that embrace 5G now — such as in energy and transportation — could reap significant cost efficiencies.

But setting the allure of 5G aside, the truth is that implementing 5G at scale will require extensive collaboration — particularly among carriers and utilities, not to mention local communities, state and local permitting policies, regulators and technology integrators such as Black & Veatch.

Divided Perspectives on 5G

According to Black & Veatch's *2020 Strategic Directions: Smart Utilities Report* survey, utilities are divided about how they view telecommunications

Figure 22

Which of the following most accurately describes how your utility perceives 5G attachment on your infrastructure? (Select one).

Source: Blach & Veatch

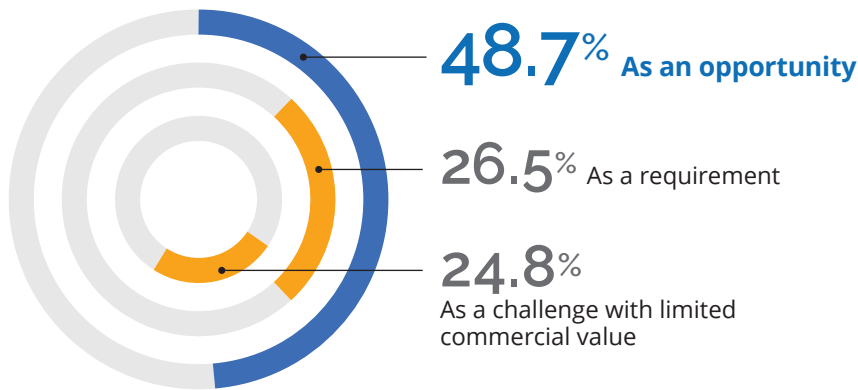
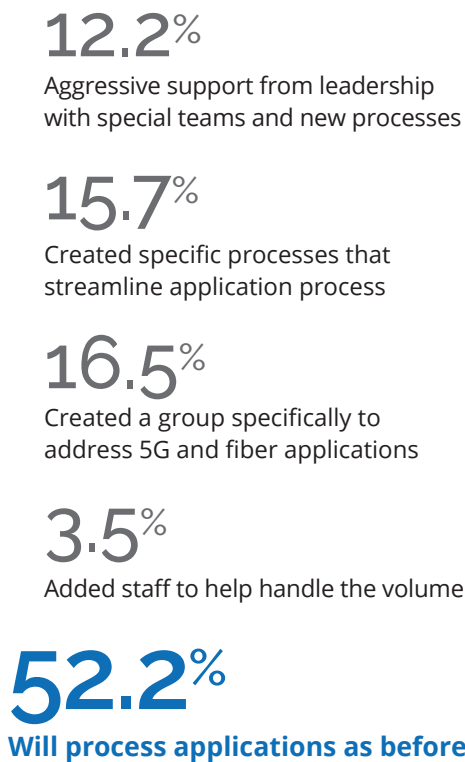


Figure 23

What steps has your utility taken to prepare for the increased volume of 5G and fiber broadband attachment applications? (Select one).

Source: Blach & Veatch



companies attaching 5G equipment such as small cell facilities or distributed antenna systems to their infrastructure.

Roughly half (49 percent) of respondents see 5G attachment as an opportunity, bolstered by promises of upgraded infrastructure and improved communication capabilities, not to mention new partnerships with carriers. But of those who responded otherwise, opinions are split as to whether such attachments are a requirement or a challenge with limited commercial value (Figure 22).

There's no doubt that the issue is complex and multi-sided, and as requests for attachments rise, electric utilities are finding themselves facing increasingly complex challenges.

To handle the increase in attachment applications, a combined 48 percent of respondents said they are actively preparing, either by creating a group specifically to address 5G and fiber applications (17 percent), creating new processes to streamline the application process (16 percent), or enlisting "aggressive support" from leadership (12 percent).

But the remaining 52 percent said they plan to process applications as before, without implementing any additional considerations (Figure 23).

Interestingly, results varied by region. The West and the South presented as the more optimistic regions, with 57

percent in both regions seeing 5G attachment as an opportunity. But of those that disagreed in the South, 28 percent said they see it as a challenge with limited commercial value. This is unsurprising, given the conservatism displayed by Southern utilities when it comes to rate setting.

The Northeast also views 5G attachment primarily as an opportunity (47 percent), followed closely by requirement (40 percent). The Midwest was relatively moderate in its

split, with 39 percent choosing opportunity, 31 percent seeing it as a challenge and 29 percent as a requirement (Figure 24).

One Midwestern utility, Municipal Electric Utilities of Wisconsin, [makes its position clear on its website](#), stating: “We have concerns about safely accommodating wireless attachments on our poles and are skeptical that 5G technology actually will be deployed in the small communities most municipal utilities serve.”

Figure 24

Which of the following most accurately describes how your utility perceives 5G attachment on your infrastructure? (Select one).

Source: Black & Veatch

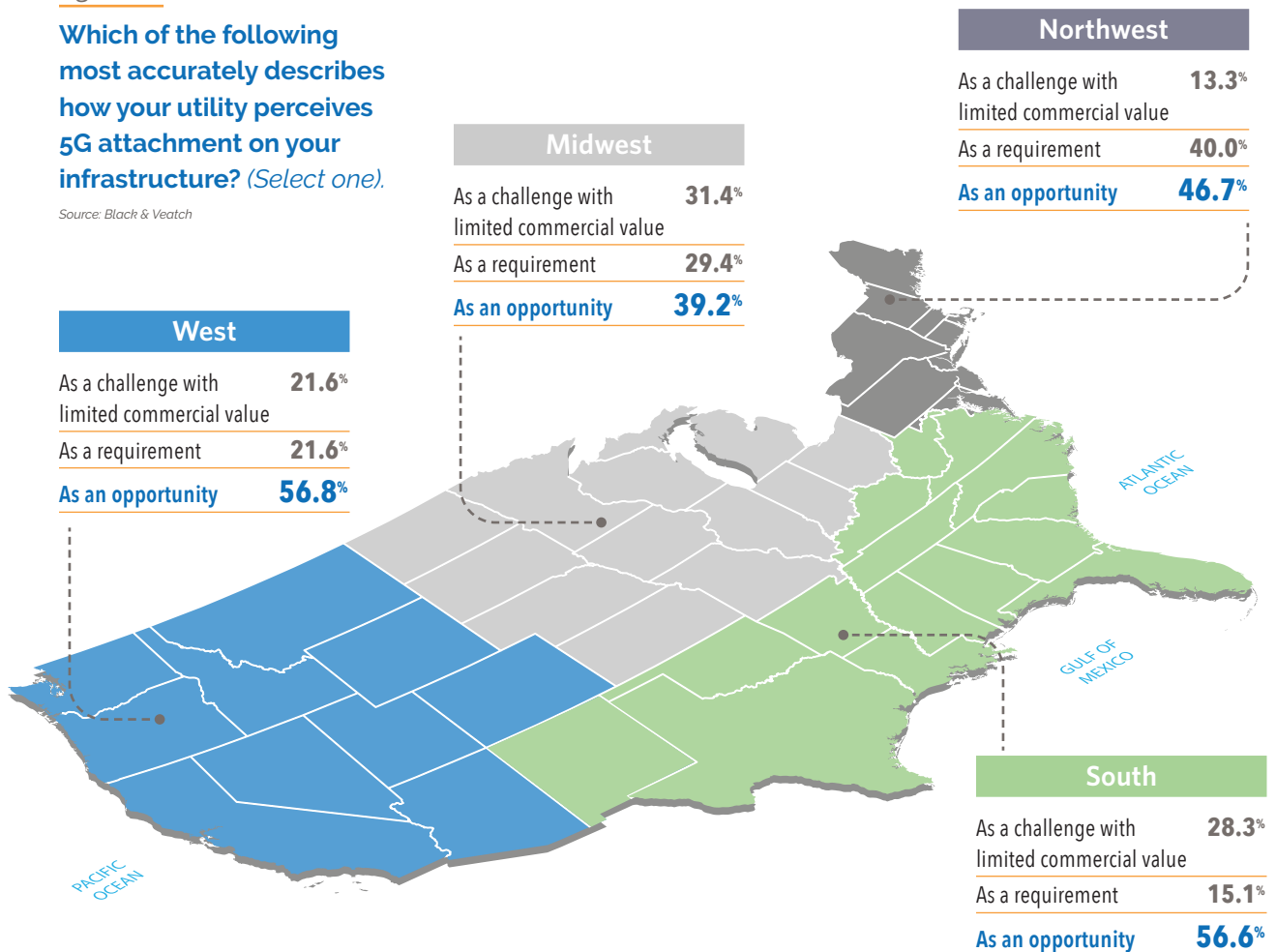
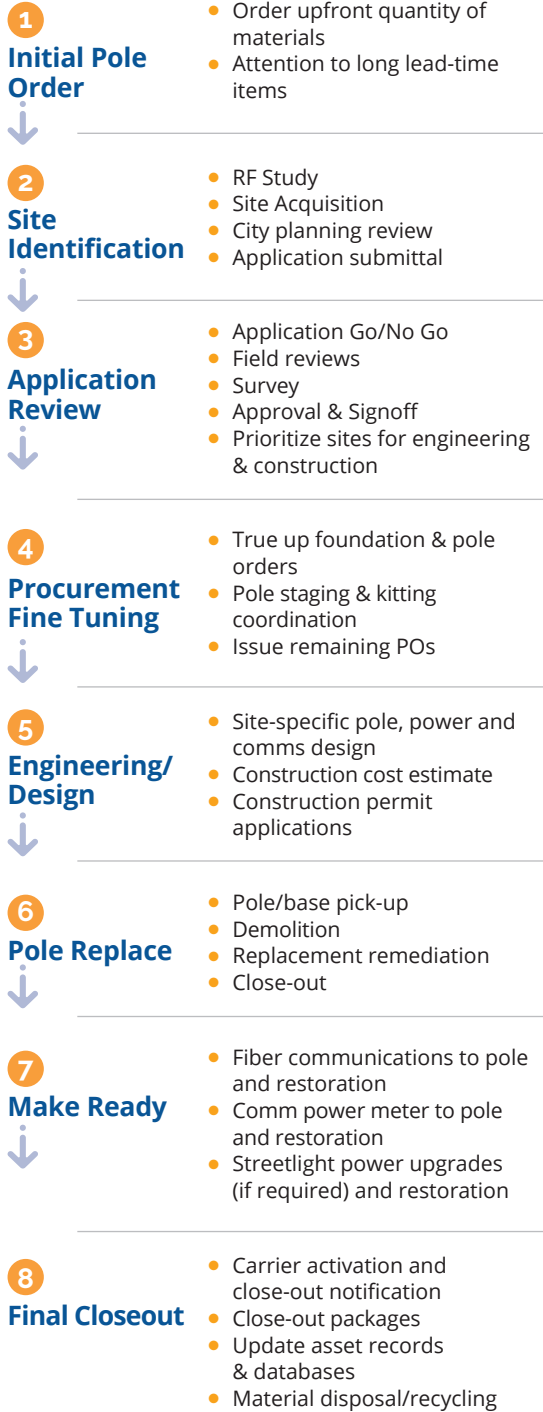




Figure 25

5G Implementation Process Flow



Overcoming Challenges

5G implementation is a complicated, multi-stage process that relies on the enthusiastic participation of all parties. Figure 25 provides a high-level overview of the stages and players who need to be involved. A technology integrator such as Black & Veatch can offer unparalleled support in these steps, particularly when it comes to alleviating pressure while still letting carriers and utilities maintain process and control.

All too often, carriers run into a wall when they try to work directly with utilities. It's no secret that the two groups boast very different cultures, each with their own approaches, methodologies and strategies.

Carriers move fast, particularly when it comes to 5G implementation. 4G networks already are straining to meet current capacity demands, and carriers are working to expand their networks as quickly as possible — both to meet customer demand and to get ahead of the competition.

The century-old electric utility industry is extremely process-driven. Rate-setting and other regulatory reforms are important drivers when it comes to making strategic decisions and deploying new technologies, and utilities must work toward a long-term balance.

But several examples of successful partnerships exist, demonstrating that it is possible for carriers and utilities to navigate a collaborative path forward. Over the past two years, AT&T, Sprint and Verizon all successfully launched standards-based 5G deployment plans in more than a dozen major U.S. cities. T-Mobile recently announced that it will roll out its nationwide 5G network in early December 2020.

How can carriers and utilities duplicate this success?

Communication Is Key

This grand shift toward digitalization and 5G implementation will come down to communication — specifically, the need to communicate with, and across, the utility. Currently, utilities have no way to address the influx of 5G expansion. Carriers must help utilities recognize and understand the opportunity presented by 5G and, more importantly, begin to treat it as such.

Carriers also need to demystify how the revenue is going to work, and outline areas where utilities can benefit from cost savings. For example, carriers are often willing to replace utilities' aging assets with new and upgraded infrastructure at their own expense, saving utilities and municipalities on replacement and upgrade costs. Utilities rarely have to build anything; they just need to be open to working with carriers.

Collaboration Plays a Role


Successful 5G implementation needs to be approached holistically, not on an ad hoc basis. The effort cannot be disjointed. Every utility has its own hurdles, and each one has a different starting point.

Preventing inertia means getting everybody into the same room. The team promoting 5G as a great opportunity needs to talk to the regulatory and customer management teams and to the carrier team that deals specifically with 5G attachments. Even within the utility itself, leadership needs to empower management to make decisions related to 5G implementation. This collaboration — and these relationships — will be critical to making 5G implementation a success.

The Work Has Only Begun

5G digitalization offers a path to advanced business and industry processes, founded on a breakthrough communications network and digital infrastructure that will evolve alongside future demands and technology innovation.

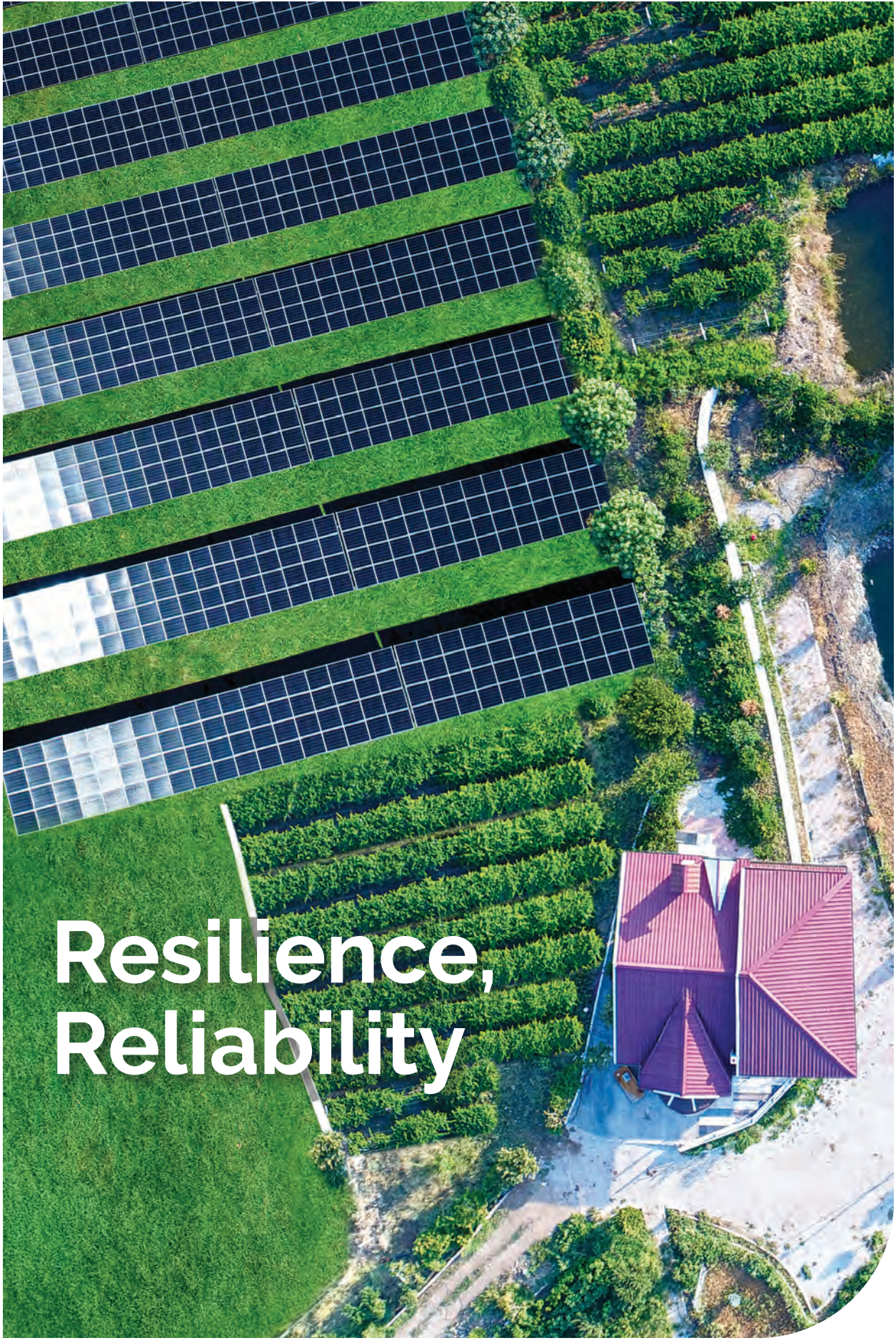
But the work to implement 5G at scale has only begun. Between 2020 and 2021, we expect to see mass standards-based 5G rollouts, with a fully optimized 5G standard by 2022. If momentum continues along this path, estimates peg 5G connections in the U.S. at 190 million by 2025.

To help streamline the process, carriers and utilities must agree to work together, and establishing clear communication and collaboration channels will be critical to this effort. A technology integrator such as Black & Veatch can help leverage the benefits of digitalization by integrating technologies and building partnerships that help advance innovation, all while offering untold benefits to the communities it serves. 

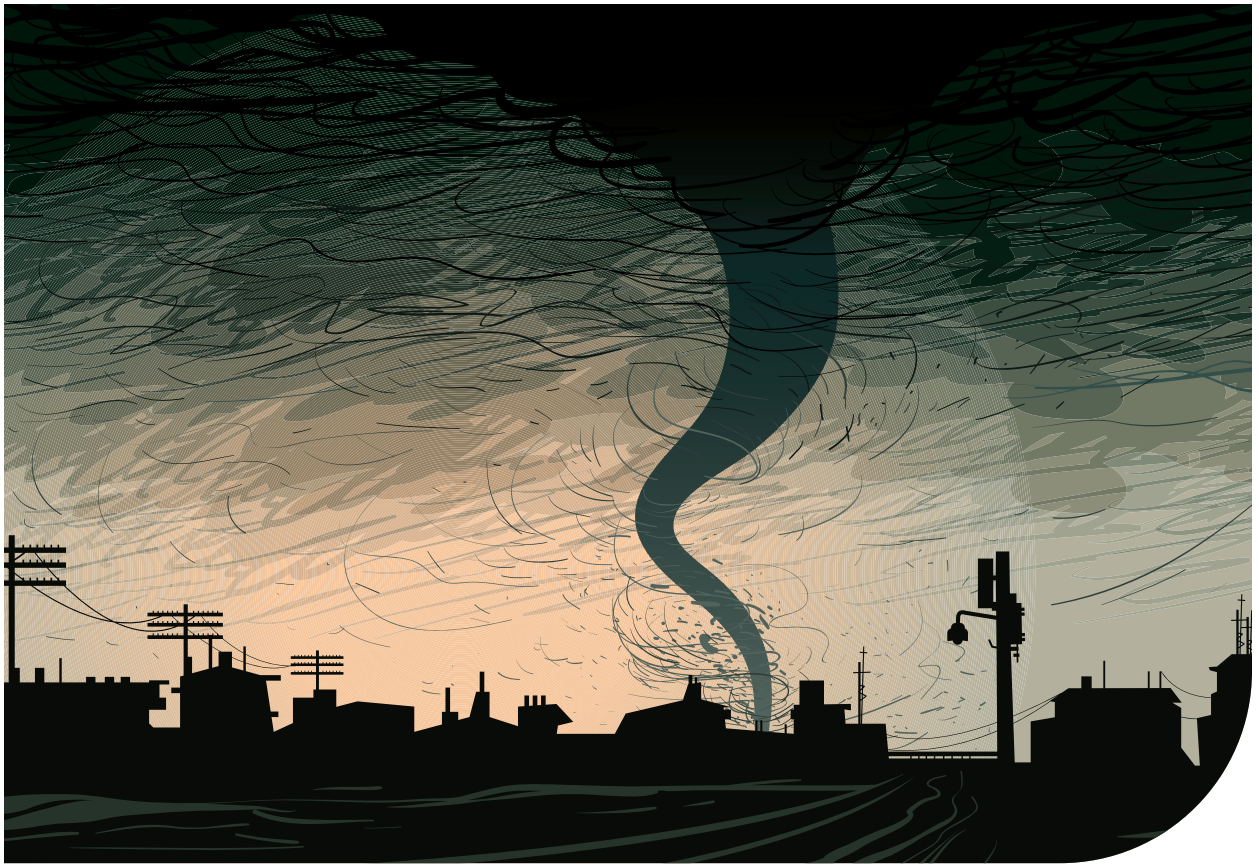
ABOUT THE AUTHORS

Gary Johnson is a regional sales director with Black & Veatch's telecommunications business. For more than a decade, Johnson has helped utilities realize their goals for a smarter, more-intuitive grid through telecommunication and automation solutions.

Scott Nichols is a regional sales director with Black & Veatch's telecommunications business. With more than 25 years of experience in both the owner and consultant roles, he is responsible for building and maintaining client relationships, leading project execution work teams and serving the needs of utility partners.



Resilience, Reliability



For Utilities, the Road Map to Resilience Must Be Focused, Holistic

By Ann Bui, Richard Campbell, Phil Carroll and Kevin Ludwig

As climate change continues to flex its catastrophic muscle, a storm is brewing for U.S. utilities. The scourge of extreme weather events — prolonged droughts, pounding hurricanes and deluges blamed for unprecedented flooding — are joining wildfires as challenges that have utilities scrambling to harden their assets to provide the resilience that consumers and regulators demand. Unrelenting threats of cyberattacks and the rising number of technologies that increase the load and strain on infrastructure assets add to the complexity.

These calls to prepare for climate change and build resilience against extreme weather events and the multitude of other daily events in

today's utility world are stretching already thin budgets. But utility industry leaders in the U.S. and abroad are innovating at an unprecedented pace, reinventing how technology is used to solve the challenges.

Power and water providers increasingly are dedicating themselves to rooting out their assets' biggest vulnerabilities, embracing their data's immense value by mining and translating it, strategically using third-party communications carriers and strengthening assets with moves that ultimately make operations more cost-effective and sustainable. They're also doing it because it's simply good for business, assuring ratepayers that they

Utilities always must be mindful that the greater the technological dependency, the more incumbent it is upon operators to know both how to scuttle trouble and to respond properly when those bad things happen.

Figure 26

Have you assessed your systems for “single points of failure”? (Select all that apply).

Source: Black & Veatch

20.0%

Have addressed them and have built in redundancy

46.5%

Are currently addressing areas we've identified by executing projects

19.6%

Have identified areas but are not prioritizing them with projects

7.8%

Currently performing a system assessment

3.5%

Planning a system assessment

8.3%

Have not conducted an assessment

can count on their utilities to serve as diligent stewards of the responsibilities placed upon them – and who respond in economically, environmentally and socially responsible ways.

Data from Black & Veatch's *2020 Strategic Directions: Smart Utilities Report* survey shows that stakeholders are doing the necessary self-assessments despite their reputations for being slow-moving and conservative, scoping out potential “single points of failure” that could trigger cascading events. Nearly half (47 percent) of respondents say they are addressing issues they've identified, while an additional 20 percent say they've already mitigated those concerns and built-in redundancies (Figure 26).

Still, sleuthing problematic vulnerabilities — methods such as hiring experts to test a system's defenses — should be part of a holistic examination of operations, including consultation with infrastructure experts. Utilities always must be mindful that the greater the technological dependency, the more incumbent it is upon operators to know both how to scuttle trouble and to respond properly when those bad things happen.

The key is to keep current with technology and to get over the mindset that if it isn't broke, don't fix it. This is increasingly important as microprocessor-based technology is widely deployed in infrastructure, bringing a pace of technological change evolving at light speed in comparison to incumbent systems that had been state of the art since the evolution of critical infrastructure. The survey makes clear that utilities have serious worries about shortcomings with their wireless technology. Even as the dawn of 5G approaches — and utilities and enterprises alike ponder ways to maximize that — roughly four of every 10 respondents cast themselves as extremely or very concerned about the sufficiency of their wireless capacity

Figure 27

Which of the following are concerns you have with your current wireless network infrastructure?

Source: Black & Veatch

	Extremely/very concerned	Moderately concerned	Slightly/not concerned
Doesn't meet coverage requirements	23.3%	33.3%	43.3%
Doesn't meet capacity/performance requirements	38.5%	22.0%	39.6%
Obsolescence, infrastructure no longer supported by the OEM/vendor community	34.4%	15.6%	50.0%
Lack of knowledge of location and condition of assets	13.3%	25.6%	61.1%

or performance. One-quarter offered similar assessments over whether their wireless systems meet their coverage requirements (Figure 27).

Still, the majority deems itself in a spectrum from moderately concerned to not concerned, perhaps reflecting their comfort with 3G or even 4G technology. Results were similar according to population served (Figure 28). The trouble lies when that technology fades away, and investments are needed to ramp up to 5G.

With the cavalcade of data mined by utilities — and increasingly used to inform their decisions — it makes sense that they welcome outside help to warehouse it, confidently relying on the cloud to spare the expense of buying enough servers as repositories.

Figure 28

Which of the following are concerns you have with your current wireless network infrastructure? Percent selecting moderate, very or extremely concerned by population served.

Source: Black & Veatch



	Less than 500,000	500,000-1,999,999	2,000,000 or more
Doesn't meet coverage requirements	50.0%	60.0%	59.0%
Doesn't meet capacity/performance requirements	54.2%	70.0%	62.5%
Obsolescence, infrastructure no longer supported	37.5%	55.0%	56.4%
Lack of knowledge of location and condition of assets	37.5%	25.0%	51.3%

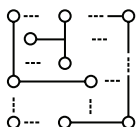


Figure 29

How reliant are your operations on third-party communications carriers?

(Select one).

Source: Black & Veatch

14.4%

Use only private network

49.2%

Use some external network but only for non-critical services

24.6%

Use all external network but build in redundancy

11.9%

Completely reliant on external network

Put more simply, it just makes it all more manageable.

Utilities are being strategic with how much they lean on third-party communications carriers. Just half of the survey's respondents report that they only use an external network for non-critical services, while one-quarter use them but have redundancies (Figure 29).

Offloading things onto third-party carriers isn't a trend likely to fade out any time soon for non-critical data. For critical applications, however, utilities continue to see advantages to managing a private network to ensure security and to eliminate prohibitive costs with leasing communication infrastructure to support critical business elements. This infrastructure choice may evolve as communication needs to be extended further into the distribution infrastructure as smart grid applications penetrate the marketplace. ●

ABOUT THE AUTHORS

Ann Bui is a managing director with Black & Veatch Management Consulting, with more than 30 years of experience specializing in financial and business advisory services. She consults with clients on diverse topics ranging from how to bridge the utility-customer narrative gap to aligning a utility's strategic objectives within a digital world.

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Phillip Carroll is a program manager of utility automation for Black & Veatch's telecommunications business. In this capacity, Carroll leverages his years of experience in the electric energy industry by assisting service providers in modernizing and bringing resiliency to an aging grid. His focus is on the integration of communication technologies to support grid modernization and automation of power distribution infrastructure.

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Utilities Must Constantly Be on Offense in Cat-and-Mouse Game Against Hackers

By Mike Prescher and James Yang

The industry's embrace of internet-connected sensors — in short, digital transformation — expands its vulnerability through a much broader “attack surface.”

For power suppliers wanting to be vigilant about the threat that hackers pose to the grid, a March 2019 intrusion may have been a benign warning about vulnerability. When hackers disabled a Utah-based renewable energy developer's control system for about a dozen solar and wind farms in the West, the grid's operators were left blinded for more than 10 hours to those 500 megawatts of generation sites. Thankfully, no outages resulted.

It was the latest salvo in an evolving but unceasing chess match between U.S. utilities and the mischief-minded who are eager to disrupt, using a keyboard as their weapon. Each is trying to think two moves ahead of the other, with utilities disadvantaged by the fact that the rules keep changing.

With the influx of distributed energy resources (DER), power grid and communications networks are becoming more integrated and complex, uniquely challenging utilities and widening their exposure to those seeking to maliciously exploit them, or simply disrupt them. The industry's embrace of internet-connected sensors — in short, digital transformation — expands its vulnerability through a much broader “attack surface.”

Without question, utilities understand the risks and have staved off sizable disruptions, in part thanks to the North American

Electric Reliability Corporation’s (NERC) critical infrastructure protection (CIP) guidelines that have proven to be good road maps toward what should be a more proactive, robust and holistic approach to securing critical infrastructure.

As hackers grow more sophisticated, utilities know they must do likewise. Black & Veatch’s *2020 Strategic Directions: Smart Utilities Report* survey finds that utilities are embracing the need to enhance their cyber defenses. With the uptrend of adopting cloud computing and packetized Internet Protocol (IP) networks in the operations technology (OT) telecommunications environment, utilities acknowledge that a formal, robust network and security operations center (NOC/SOC) becomes a new common denominator of cyber defense.

This more proactive pursuit of an enhanced monitoring-and-response cybersecurity posture comes as these new IP packet-oriented requirements compete against other legacy considerations, including that pesky thing called aging infrastructure.

Cyber Monitoring: Not Just for the Big Kids Anymore

Faced with the need to modernize, utilities are prioritizing, making it unsurprising that two-thirds of respondents named reliability a major driver in their efforts to upgrade. Roughly four of every 10 survey takers cited quests to bolster operational efficiency, address aging infrastructure and increase monitoring, control and automation. Just 12 percent of respondents said cybersecurity is among their top priorities.

But when asked separately whether they’ve implemented or plan to put into action active cybersecurity monitoring of communications and data devices, eight of every 10 respondents said they either have adopted such measures or have done so with plans to bolster them.

But the good news is that two-thirds of the largest utilities say they expect to increase their cybersecurity safeguards going forward. And most respondents, utilities both big and small, say they have a plan for cyber oversight (*Figure 30*).

Figure 30

Have you implemented or plan to implement active cybersecurity monitoring of communication and data devices? (Select one) by population served.

Source: Black & Veatch

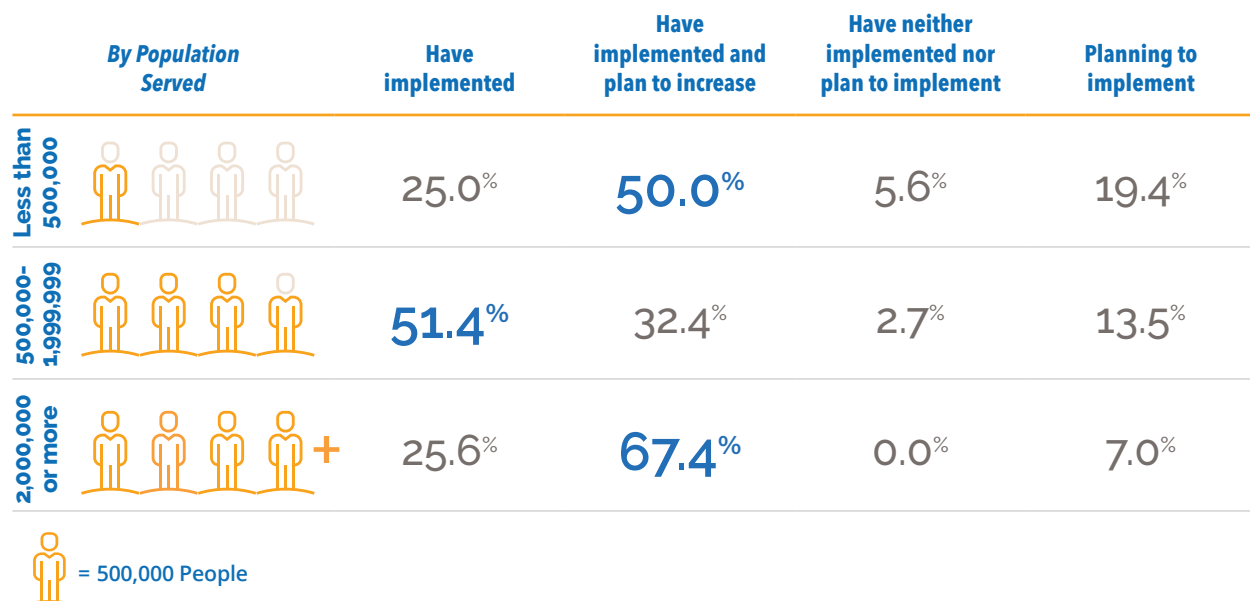
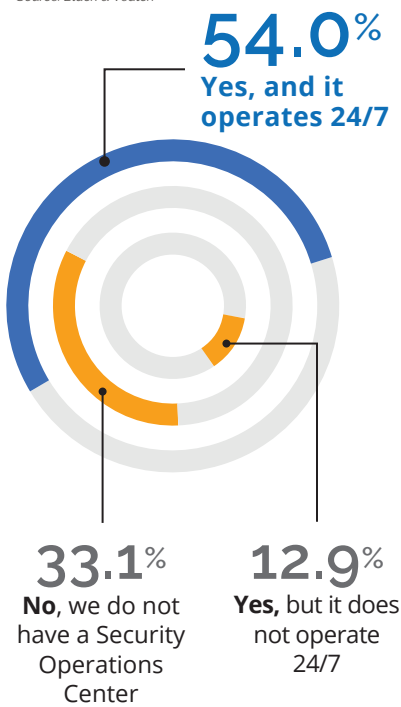


Figure 31

Do you have a Security Operations Center? If so, how does it operate? (Select one).

Source: Black & Veatch



Options for stepping up cyber defenses can take many forms, not the least of which are in-house SOC dedicated to preventing, detecting and responding to cyber threats and hacking incidents. Such investments — ideally positioned in tandem with, but isolated from, any NOC — help utilities better safeguard their critical infrastructure and highly sensitive operational information. This offers utilities more control over their security monitoring, incident response and communications with regulators and law enforcement entities.

Creating a SOC — or some form of internal security operations capabilities — can be time-consuming and expensive, which often leads to security monitoring being outsourced. In either case, the survey shows that utilities value the concept, with more than half of respondents saying they have turned to that measure and it operates around the clock (Figure 31).

Utilities serving populations of more than 500,000 are overwhelmingly the ones with SOC that work 24/7, perhaps because they're better equipped to fund them, and they exist in areas where more qualified resources are available (Figure 32).

Figure 32

Do you have a Security Operations Center? If so, how does it operate? (Select one) by population served.

Source: Black & Veatch

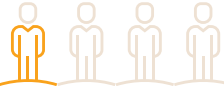



By Population Served	Yes, and it operates 24/7	Yes, but it does not operate 24/7	No, we do not have a Security Operations Center (SOC)
 Less than 500,000	20.6%	14.7%	64.7%
 500,000-1,999,999	60.0%	14.3%	25.7%
 2,000,000 or more	79.1%	14.0%	7.0%
 = 500,000 People			



Figure 33

When does your utility plan to place operations technology applications in a cloud service environment? (Select all that apply).

Source: Black & Veatch

37.5%

We already have some aspects of operations in a cloud environment

17.0%

We are currently moving some operations to a cloud environment

5.4%

We plan to move some operations in the next year

12.5%

We plan to move some operations in the next two or three years

31.3%

No current planning for this

While such responses are commendable, none of them reflect the extent to which each of those SOCs is truly effective, or whether they have shortcomings. Are there multiple dedicated, full-time people assigned to that cybersecurity role? Are they fully qualified? Is that worker regularly reviewing logs? Is there intrusion monitoring and detecting?

Another thing to ask: Why do one-third of respondents have no SOC at all?

Perhaps it's simply a matter of budget, given that nearly two-thirds of respondents at the nation's smaller utilities (which serve fewer than 500,000 residents) say a SOC isn't part of their game plan. There also may be some connection with smaller electric utilities having fewer NERC-CIP-rated "high" and "medium" assets and systems.

Among Utilities, Cloud Demand Is Looking Up

Black & Veatch's survey shows that more and more utilities are applying concerns to cloud computing as they work to get sensitive information off-premises in a secure manner, store it protectively while the data is at rest and control access while it is off-site. More than half of the respondents say they've already moved or are in the process of moving some operations to the cloud, while nearly one-third say they're content staying on the sidelines (Figure 33).

But exactly what utilities feel comfortable storing in the cloud depends on who you ask. More than half of respondents from utilities serving at least 2 million residents say they'd consider moving any service or application to a cloud environment, while four of five respondents from utilities covering populations of 500,000 to 2 million say they only would consider cloud services for NERC-CIP low-impact or noncritical services (Figure 34).

Whatever the case, utilities benefit by having fuller awareness of what storing potentially sensitive data about their electric grids in the cloud may create in terms of additional vulnerabilities and associated business risk. Cloud-using utilities that don't meet NERC-CIP requirements for encryption — in transit and at rest — may face greater exposure and higher risk and, by extension, the potential for punishing regulatory fines.

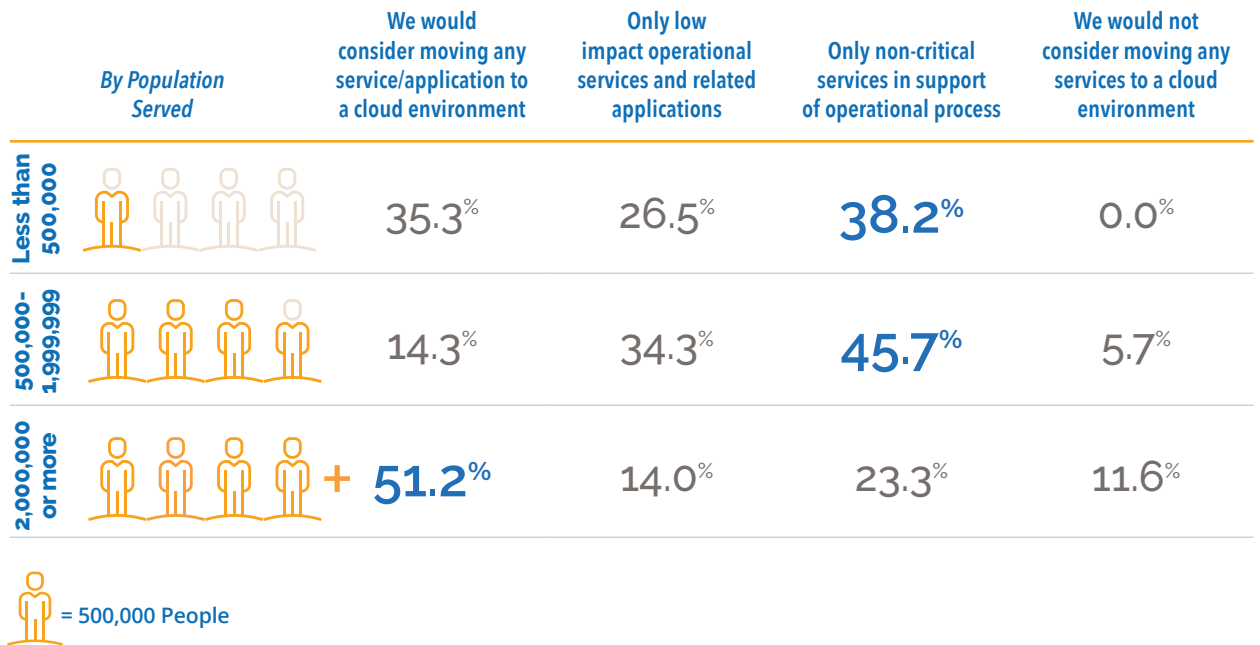
Best Cyber Posture: Keep Moving the Ball Downfield

As the cyber landscape grows more complex and treacherous, utilities don't have the luxury of standing pat. They shouldn't hesitate to consult trusted advisors with tested telecommunications experience to quickly but

Figure 34

What kinds of services would you consider moving to a cloud environment? (Select one) by population served.

Source: Black & Veatch



thoughtfully develop, shore up or expand their risk-management approaches, which should include layered defenses, enhanced monitoring and reliable system redundancies.

The bottom line is that simply sustaining the status quo should be as much of an enemy as hackers themselves; cyber defenses must be flexible and match the pace of digital change.

“Whatever the issue, we all must be clear-eyed about cybersecurity threats and not rest on our laurels,” Neil Chatterjee, the Federal Energy Regulatory Commission’s chairman, wrote in an October 2019 guest column for *Fortune*. “The electric grid is far more secure than it was a decade ago. But know this: Our adversaries will not rest. Neither can we.” 

ABOUT THE AUTHORS

Mike Prescher is a network and cybersecurity architect for Black & Veatch’s telecommunications business and is responsible for data network infrastructure architecture design and implementation. He has provided consultative expertise to Fortune 500 companies and utilities across North America on network design, operations and support methodology, application performance optimization and very large-scale implementation projects.

James Yang is a senior information and communications technology subject matter expert. He has orchestrated telecommunication master plans and execution road maps for government agencies and top utility companies.



Key Risk Evaluations of Assets by Utilities Focus on Regulation, Evolving Customer Expectations

By Paul Bowman, Matt Kirchner, Chris Klausner, Arron Lewis and David O'Connor

With great power comes great responsibility, meaning it falls to utilities to ensure that their transmission and distribution (T&D) assets can — and will — perform at the appropriate reliability and safety levels while continuing to meet regulatory and environmental standards.

So, what are utilities doing to manage risk while still providing reliable service amid the surge in distributed energy resources (DER) and the constant threat of significant weather-related disruptions in an age of record-setting events? In many ways, that comes down to a simple premise: Regulators, customer satisfaction and shifting expectations are driving a lot of risk for utilities.

State government oversight of electric utilities is enjoying increasing sway, pressing power

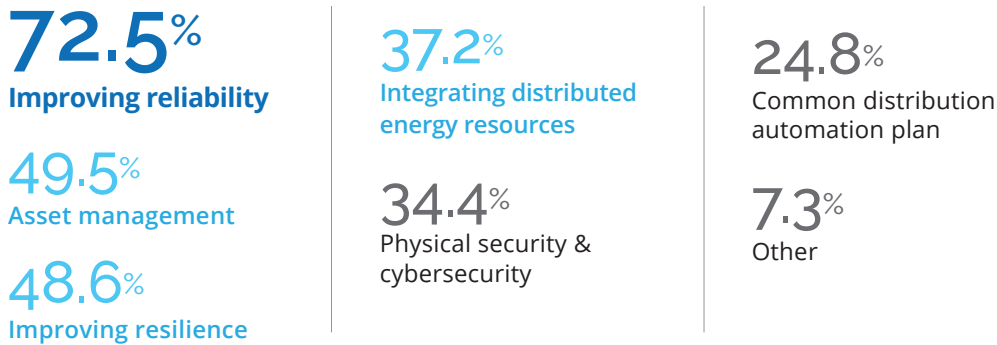
providers to modernize at a time when sources of renewable energy are casting a widening shadow among a citizenry demanding cleaner, greener ways to keep their lights on. States are imposing new mandates on utilities to accommodate that sustainability trend. Regulators and governmental agencies are making certain that utility defenses account for the potential threat of cyberattacks and physical security breaches meant to disrupt the grid.

Even as infrastructure continues to age and renewable energy sources grab a bigger footprint, regulatory matters ultimately drive a lot of the decision-making among utilities. Respondents to Black & Veatch's annual survey of utility companies, regardless of their size, pointed to regulation as the chief risk their organization must manage, followed at a considerable

Figure 35

What are the top three major challenges your team is facing with your current electric distribution system? (Select up to three choices).

Source: Blach & Veatch



distance by issues that often can compel regulatory action: customer expectations, environmental compliance, technological change and natural events related to such things as storms or climate change (See Figure A, page 47).

As more utility customers migrate toward DER, regulators are flexing their oversight muscles to ease that transition. For example, in early 2018 the Massachusetts Department of Public Utilities authorized the commonwealth’s utilities to invest \$220 million in grid modernization efforts over the ensuing three years to upgrade their distribution systems to enhance efficiency, ostensibly ensuring that ratepayers get the most reliable service at the lowest possible cost.

Given that, maybe it’s not surprising that nearly three-quarters of respondents cited improving reliability as the top challenge with their electric distribution system. Nearly half also pointed to asset management and improving resilience (Figure 35).

Overall, utilities believe they’re keeping pace in their understanding of enterprise-level risks, with more than 90 percent of respondents

grading themselves as anywhere from average to industry-leading on that front, while just 9 percent grade themselves as below or well below average. The overall showing appears commendable, considering the unprecedented levels of change in technology and consumer influences — and regulatory responses to both — taking place in the industry (See Figure B, page 47).

Throw in the fact that two-thirds of respondents considering their T&D system’s reliability and safety to be in the top 25 percent, two questions arise: What’s the metric by which the utilities are measuring themselves, and are they dangerously overconfident?

When it comes to adopting or developing a risk-based management system for their T&D assets, utilities — largely the biggest ones — appear to be ahead of the curve. Nearly half of respondents (47 percent) already have such an effort running, while one of every five respondents say they’re implementing one. Ten percent say they’re drafting plans (See Figure C, page 47).

Risk Survey

BY POPULATION SERVED



Less than 500,000



500,000-1,999,999



2,000,000 or more

Figure A, What are the top three risks that your organization must manage?*

Population Served	Regulatory	Customer expectations	Technological change	Environmental compliance	Market competition	Political	Nature (storms, climate change, etc.)	Labor	Shareholder
Less than 500,000	60.2%	43.2%	38.6%	27.3%	14.8%	25.0%	32.2%	29.5%	6.8%
500,000-1,999,999	55.1%	30.6%	24.5%	44.9%	26.5%	20.4%	22.4%	22.4%	14.3%
2,000,000 or more	66.2%	33.8%	33.8%	25.7%	13.5%	28.4%	40.5%	13.5%	21.6%

Figure B, How well do you think your organization assesses enterprise-level risks?***

Population Served	Industry leading	Above average	Average	Below/well below average
Less than 500,000	1.0%	46.0%	45.0%	8.0%
500,000-1,999,999	8.0%	38.0%	38.0%	17.0%
2,000,000 or more	15.0%	44.0%	36.0%	4.0%

Figure C, Which of the following statements best reflects the current risk-based T&D asset management program at your organization?***

Population Served	We are currently operating a program	We are implementing a program	We are designing or planning to design a program	We have interest in a program but have no plans	We have no interest in such a program
Less than 500,000	23.5%	29.4%	11.8%	26.5%	8.8%
500,000-1,999,999	49.2%	21.3%	19.7%	6.6%	3.3%
2,000,000 or more	56.2%	18.0%	16.9%	7.9%	1.1%



= 500,000 People

*Select up to three

**Select one

Source: Black & Veatch

Figure 36

How effective are the following approaches in assessing risk failure of your T&D assets?
(Rank from 1-most effective to 5-least effective).

Source: Black & Veatch

	First	Second	Third	Fourth	Fifth
Analyzing root cause and lessons learned from prior failures	39.0%	26.0%	16.2%	14.3%	4.5%
Prior maintenance data and trending	14.3%	23.4%	34.4%	17.5%	10.4%
Visual, hands-on inspections and testing	24.7%	20.8%	15.6%	12.3%	26.6%
Operational data analysis and predictive modeling	16.9%	11.0%	24.7%	39.0%	8.4%
Gathering industry data and participating in working groups on the topic	5.2%	18.8%	9.1%	16.9%	50.0%

The potential upshot is tremendous, considering that such self-evaluations may help utilities make the case to regulators in rate cases for capital improvements. But because such programs vary in detail and quality, it's unclear how well they use the system's data to fully inform operators about their assets.

When it comes to ways to assess the veracity of their T&D assets, utilities prize letting history be their guide. Two-thirds of respondents say that analyzing the root causes and lessons learned from prior failures was either the first or second top pick. Visual, hands-on inspections and testing took first or runner-up among 45 percent of survey-takers (Figure 36). That may be the most effective approach — and the most challenging to scale up to the number of assets because utilities simply don't have enough employees to optimally carry it out. ●

ABOUT THE AUTHORS

Paul Bowman is the product director of activity management solutions for Atonix Digital, where he manages solutions to improve the execution of projects across distributed infrastructure.

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Chris Klausner is a senior managing director with Black & Veatch Management Consulting, where he provides technical advisory services and direction to clients for planning and transaction-related engagements.

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Closing Commentary

The background of the page is a vibrant, futuristic cityscape at night. The sky is a deep blue and purple, transitioning into a bright orange and yellow glow at the horizon. In the foreground, there are numerous glowing orange and yellow light trails that curve and swirl, creating a sense of motion and energy. Overlaid on the cityscape are various digital wireframe and grid patterns in shades of orange, yellow, and blue, suggesting a high-tech or data-driven environment. The overall aesthetic is modern and technological.

Delivering Resiliency as a Service

By Jeremy Klingel

ABOUT THE AUTHOR

Jeremy Klingel is a Global Distributed Energy business line leader for Black & Veatch's power business. Klingel has more than 23 years of experience, including the past four years with Black & Veatch Management Consulting. He has led more than two dozen smart grid development projects and has driven the operational road map behind advanced distribution management and end-user experience.

When it comes to grid modernization, where utilities want to spend money — and where they have approval to spend money — are not the same thing. Under today's regulatory models, utilities typically do not have a way to recapture all the fixed costs required for critical upgrades. This can mean the choice between keeping the lights on today and preparing the grid for the challenges of the future.

But that's changing, and the days of utilities being the provider of last resort to any and all customers are coming to an end. It's simply not practical to tell utilities that they must maintain a great expanse of aged infrastructure while simultaneously restricting their ability to generate returns on their assets, even as self-generation continues to have a material impact on their revenue.

Regulators expect utilities to be forward-thinking in the current dynamic market while also offering shareholders a return on investment. The quickest answer? Resiliency.

Resiliency as a Service

In November 2019, the Florida Public Service Commission held a hearing to finalize recently adopted rules that break out resiliency services from traditional rate-making. The new rules change how resiliency projects are financed by authorizing a new rate-payer surcharge.

This means that utilities can move ahead with large-scale resiliency projects — in Florida's case, undergrounding power lines to make them more resilient to hurricanes — without having to wait for funding.

This ruling could change the game when it comes to how utilities manage resiliency. Instead of being mandated to include storm hardening and resiliency measures in their filings, utilities can fund these measures separately, helping to streamline the process. This doesn't mean utilities are prevented from including resiliency in their standard rate cases, but it will remove the burden of doing so.

There's no doubt that connectivity offers an incredible benefit to electric service providers, but when it comes to cybersecurity, increased connectivity equals increased vulnerability

In Florida, this surcharge will be passed on to the rate payers, but utilities shouldn't underestimate the customer's ability to understand how their dollars will help keep the lights on by reducing the number and duration of power outages. Customers will experience the tangible benefits, knowing that by putting power lines underground, the next hurricane isn't going to wipe out an entire distribution network.

The Florida ruling sets the stage for what could come next, paving the way for utilities to develop a different stream of revenue by offering "resiliency as a service" (RaaS).

RaaS can take several forms, from the traditional, such as covering the cost of moving the distribution network from aerial to underground, to the advanced, such as paying for advanced metering infrastructure and distribution automation (DA). The idea isn't completely out of left field. Five years ago, we saw this take place with energy efficiency and demand response, which provided utilities with a similar opportunity by offering cost recovery for incenting customers to use less of their commodity. It was a little counterintuitive, but it ended up working.

Connectivity = Vulnerability

Connectivity is the buzzword of the day. There's no doubt that connectivity offers an incredible benefit to electric service providers, but when it comes to cybersecurity, increased connectivity equals increased vulnerability. As utilities become more distributed, they'll also become more susceptible to cyberattack.

To combat this, utilities need to reevaluate cybersecurity, and consider it from a new perspective, far beyond today's North American Electric Reliability Corporation (NERC)-critical infrastructure protection (CIP) requirements. RaaS could mean extending cybersecurity protections out to large commercial and industrial customers and, perhaps even more importantly, extending across the supply chain and focusing on who they're doing business with. This is exemplified in the 2014 data breach involving the theft of 40 million Target customers' credit and debit card information, which was initiated through vulnerabilities in how one of their heating, ventilating, and air conditioning contractors was accessing Target's internal network.

This will require a major shift in mindset, as today's cybersecurity conversations tend to revolve around the threat posed by malicious nation states. But the biggest threats are internal — the easiest way to hack the grid is to do so from the inside. Utilities are well-positioned to reap some type of return or value-added service from not only securing the grid but also by selling resiliency to their largest customers.

Smarter Grid Management

California and its wildfires remain top of mind, driving questions about utilities' resilience after a catastrophic event. As the industry continues to dive deeper into the conversation on DA and self-healing grids, one of the most promising aspects of RaaS will be the ability to control the grid with surgical precision.

In early October 2019, as a precautionary measure to prevent additional wildfires, Pacific Gas and Electric Company shut off service to nearly 800,000 customers, causing massive disruption. Because of a lack of available DA assets and technology, the utility was not equipped to take a smaller, more targeted number of customers off-line.

Given today's climactic shifts, it's likely the force and frequency of events such as the California wildfires, flooding in the Midwest, increasing strength of hurricanes in the Southeast and drought in the West will only continue. Utilities need to connect the dots and invest in the necessary technology — the hardware, software and general system upgrades — that would allow them to operate in a more distributed, localized manner to remedy these issues.

Such a move would enable a utility to target a much smaller percentage of its customers to prevent more widespread damage. This strengthens reliability and resilience while providing natural cost savings. Although this doesn't make the wildfire, flood or storm any less daunting, it does make it more manageable.

Opening the Market

All too often, when the industry talks about "delivering the grid of the future," the conversation centers on platforms, the connected grid and digitization of the grid. But what does a truly distributed energy marketplace look like? This is the missing link, but it is also where it starts to get interesting,

because this interconnectedness means that utilities can participate in the orchestration.

To date, utilities have been limited by regulators when it comes to what assets they can own and what they can control. For example, when considering battery storage in California, some of the early assembly bills questioned whether San Diego Gas & Electric and Southern California Edison should be allowed to own these assets, even though they would be responsible for operating them. What incentive does this give these utilities to take on additional liability and operating costs, without giving them additional assets to spread out the costs, and possibly generate a return?

This is why the Florida decision is so important. This is not to say that utilities should maintain a monopoly; they should not be the only ones allowed to own these renewable, distributed, non-wires alternative assets, backup generation, microgrids or battery energy storage. An open market should be created, where utilities can add value by pulling these disparate assets together and securing them through RaaS, thereby delivering increased availability, predictability and reliability.

There's no doubt that the policies regulating the electricity market must change. Regulators need to open up the marketplace, and utilities need to be able to get off the sidelines and participate. Yes, creating this new marketplace will bring additional assets online, but the asset type is irrelevant. The orchestration that goes into pulling it all together — creating this new market, helping the end customer and getting the industry to the point where we truly have a functioning next-generation grid — is where the grid of the future really lies. ●



2020 Report Background

The Black & Veatch *2020 Strategic Directions: Smart Utilities Report* is a compilation of data and analysis from an industry-wide survey. This year's survey was conducted online from 11 October 2019 through 25 October 2019 and reflects the input of 627 utility, municipal, commercial and community stakeholders.

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

Which, if any, of the following utility services does your organization provide? (Select all that apply).

Source: Black & Veatch

71.0% Electric Services: Provides electric services, distributes, transmits, generates, retails or sells electricity

30.9% Natural Gas Services: Provides natural gas services, produces, gathers, transports, distributes, or sells/trades natural gas

23.0% Water Services: Provides water services, including water, wastewater or stormwater services

11.6% We provide other types of services

JOB FUNCTION

What job function do you currently hold within your company? (Select one choice).

Source: Black & Veatch

17.1% Vice president or executive

33.7% Director, supervisor or manager

25.2% Engineer or operator

24.0% Other

POPULATION

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

Source: Black & Veatch

10.3% Less than 100,000

18.1% 100,000-499,999

14.6% 500,000-999,999

15.3% 1,000,000-1,999,999

41.7% 2,000,000 or more

PRIMARY BUSINESS REGION

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

Source: Black & Veatch

New England 14.6%

Mid-Atlantic 23.6%

North Central 37.2%

Great Plains 13.9%

Southeast 28.2%

South Central 22.3%

Southwest 13.3%

Rocky Mountain 11.8%

Northwest 12.3%

Other U.S. locations 4.9%



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