SMART CITY/
SMART UTILITY REPORT
2017

# STRATEGIC DIRECTIONS

BUILDING A WORLD OF DIFFERENCE®

BLACK & VEATCH

# ABOUT THIS REPORT

The Black & Veatch *2017 Strategic Directions: Smart City/Smart Utility Report* investigates the progress made by communities and utilities as they continue their evolution toward smarter infrastructure. Around the globe, cities and utilities are beginning to see tangible results from preliminary efforts and are gaining confidence in what a smart city can be.

Municipalities are starting to understand the power of data and how it can foster and support master planning, and how a roadmap can define, drive and ultimately enable smart city initiatives. Utilities are working to integrate advanced technologies—such as evolving to accommodate distributed energy resources (DER) and improving network connectivity—to determine a successful path forward in a changing landscape.

Most importantly, communities and utilities are coming to the understanding that proactive data management—from collection to visualization and analytics—is critical to the smart city movement because it will allow them to prioritize efforts, commit funding and allocate resources in a tactical manner.

The *2017 Strategic Directions: Smart City/Smart Utility Report* also discusses potential hurdles that may impede success. For example, key gaps remain in the areas of planning, funding and technology through data management that will force governments and utility providers to revisit how they approach these efforts.

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

Sincerely,

JOHN CHEVRETTE | President
Black & Veatch's management consulting

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# INTRODUCTION

## TECHNOLOGY AND PLANNING UNLOCK THE POWER OF SMART CITIES AND UTILITIES

By Fred Ellermeier and John Janchar

Holistic and scalable smart systems depend on two critical behaviors—embracing technology to make systems as efficient as they can be and increasing stakeholder engagement. To fully realize the smart city and smart utility promise, cities and utilities need to create a network of digital infrastructure. It is only by embracing advanced technologies and communications that operations will become more reliable, efficient and secure while allowing for the maximum return on investment.

Advanced digital infrastructure provides the foundation for the processes, services and applications that will enhance citizen experiences and elevate our cities and utilities to optimal production and service levels. Understanding data—how to collect it, how to use it and how to monetize it—will also be a crucial component to unlocking the full potential of smart integrated infrastructure.

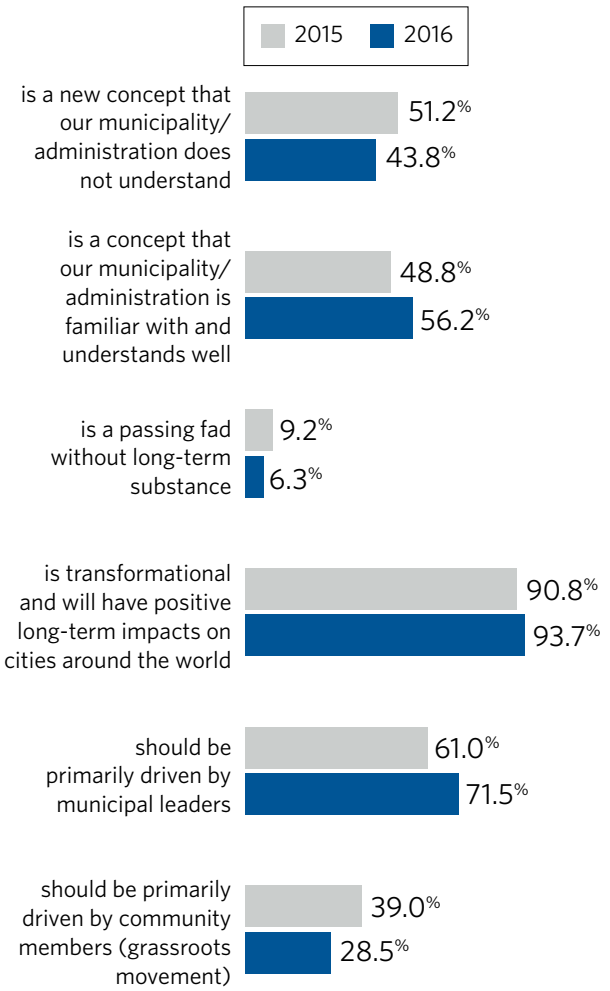
Black & Veatch's *2017 Strategic Directions: Smart City/Smart Utility Report* details the progress being made by cities and the utilities that run their critical infrastructure. Key gaps remain in the areas of planning, funding and data management that will force government leaders and service providers to rethink how they approach these initiatives.

## INCREASING ENGAGEMENT IN SMART CITIES

Survey responses in this report show that the vast majority of municipalities (94 percent) view the smart city movement as transformational and capable of bringing positive, long-term impacts to cities around the world (Figure 1). However, efforts to implement comprehensive smart city and smart utility efforts remain stymied due to well-known barriers such as budget constraints and limited resources and expertise.

FIGURE 1

**Listed below are several opposing statements related to "smart city" initiatives. Please select the statement you agree with most. Please skip the question if you do not know. (Municipalities Only)**




*Source: Black & Veatch*

This year's report addresses many different yet interlocking pieces of the smart city ecosystem—featuring not only city services but also the strides utilities are making in modernizing grid infrastructure. Utilities, with their vast communication networks and growing automated systems, are betting on digitization to deliver reliable and efficient service.

**Prepping for the Future with Master Planning:** Municipalities clearly endorse long-term planning but remain stagnant when plotting the future of their smart city initiatives. Community leaders continue to be daunted by smart city efforts, and as a result, these initiatives tend to be rejected in the face of competing priorities. Developing a comprehensive master plan based on data could alleviate many of these concerns. Although survey results show that less than one-third of respondents consider data management to be critical to their smart city initiatives, data analytics and visualization will be crucial to building a master plan—and ultimately, to the long-term success of any smart city model.

**Distribution Modernization:** A utility's active monitoring and control of its assets can transform the way it performs. Two-thirds of survey respondents say they are planning to use smart monitoring to perform maintenance programs—suggesting a new norm for utilities. To effectively manage this transformation, utilities need to be prepared to create a collaborative environment between all major stakeholders. Close coordination between operations, information technology (IT) and asset management groups is critical to developing a comprehensive system plan.

**Historically, the electric grid was designed for one-way power flow, but today, utilities have to manage multiple power resources from solar, wind, energy storage, digitalization and electric vehicles (EVs) and other distributed generation sources.**

The Cost of Becoming Smart:
This year's survey reveals a familiar pain point for cities—an understanding of smart city benefits but a lack of money to get them off the ground. While respondents recognize that investing in the smart city model will ultimately reduce operating costs, only a small percentage of cities believe they can self-fund. That said, the clear advantages of going "smart" are forcing municipalities to think creatively about funding. Today, many view public-private partnerships (P3s) as a potential solution alongside tax increases, advertising revenue and monetization of infrastructure and data.

Grid Modernization:
The promise of the smart city relies on a smarter grid. Historically, the electric grid was designed for one-way power flow, but today, utilities have to manage multiple power resources from solar, wind, energy storage, digitalization and electric vehicles (EVs) and other distributed generation sources. Distribution automation can help manage these, though implementing the technology at scale can become daunting and complex without the right expertise.

### Connected Transportation:

Cities are growing, populations are increasing and transportation infrastructure must evolve. Survey data shows a rising acknowledgement of the important role that alternative fuels and electrification can play in transforming how people and goods are moved across cities. Personal transit remains a top priority among survey respondents, along with the evolution of medium-duty fleets to alternative fuels and the electrification of mass transit. While transportation holds the potential to be one of the most disrupted sectors in the smart city, transportation-related technologies are currently lagging behind other advancements being pursued by communities and utilities, such as network sensors, data capture and cloud computing (Table 1).

### Public Safety:

The evolution of the public safety sector will greatly impact smart city initiatives as we move into the future. Interoperability is no longer just a buzzword; communities are reaping the benefits as technological advances change how first responders, government officials, public agencies and transportation fleets communicate. For example, FirstNet, the national public safety broadband network currently being procured by the First Responder Network Authority, will be the first of its kind. While initially designed solely for data transmission, FirstNet will feature voice, video and photo transmission when fully complete.

### Smart Street Systems:

Smart street systems are creating opportunities to generate additional value from existing municipal assets. Connected components such as street lights, interactive kiosks, traffic sensors and other smart features can be leveraged to serve multiple purposes. Infrastructure can now be fitted with Wi-Fi capability to provide a constant flow of information about its surroundings. Environmental data, public safety monitoring and measurement and augmented traffic data can all help improve the efficiency of cities. Utilities see the benefits—a year ago, smart street systems were placed in traditional financing buckets; today, many look to fund this technology through P3s or alternative financing strategies where the ultimate revenue stream would more than recover initial investments.

### Workforce Management:

A key element of workforce management is the ability of the water, electric and natural gas utilities to attract new employees while retaining and retraining their current staff. Survey data showed that while most utilities are seeking to outsource their operations, the vendor market that provides outsourcing options is likely to consolidate. Utilities and vendors face the challenge of adapting to new operating models and processes across multiple parties when delivering high-quality work and asset data.

TABLE 1

**Which of the following technologies do you believe will be most important in the advancement of smart cities/ communities? (Select top three choices)**

| | By Organization Type | |
|---|---|---|
| | Government/Municipality | Smart Services Providers |
| Remote sensing and metering | 71.9% | 63.2% |
| Big data analytics | 50.8% | 65.3% |
| Cloud computing | 34.6% | 36.8% |
| Autonomous vehicles or EVs | 36.2% | 30.5% |
| Artificial intelligence (e.g., machine learning, cognitive computing) | 30.3% | 36.8% |

*Source: Black & Veatch*

Utilities are shifting to accommodate DER—which are becoming increasingly prevalent as part of the smart city ecosystem—by evolving to accommodate wider deployment and associated effects on the grid.

Operationalizing DER:
Distributed and off-grid resources are also changing today's utility landscape. Utilities are shifting to accommodate DER—which are becoming increasingly prevalent as part of the smart city ecosystem—by evolving to accommodate wider deployment and associated effects on the grid. According to survey responses, utilities expect non-utility-owned DER assets to eventually provide efficiencies such as peak load reduction, peak shifting and voltage support. Not everyone, however, will see the same benefits right away—organizations that are exploring new business models that include long-term planning and real-time load balancing will be best positioned to take advantage of this model.

Capital Planning for Utility 2.0:
Utilities have been talking about "Utility 2.0" for a long time, and it looks like it may have finally arrived. For more than a decade, service providers have been putting assets in place to generate actionable data, and only a fraction of utilities are replacing outdated or broken systems without upgrading the capacity of the equipment. For those that are investing in smart infrastructure, decisions are being made primarily on a cost-benefit perspective. It's crucial to evaluate what customers want in order to understand how to target investments.

Building Out IT/OT Networks:
Network connectivity will unlock utilities' ability to collect data and proactively monitor performance, thereby optimizing smart grid deployments. However, the majority of utilities are struggling to deploy a private or public communication infrastructure to support their IT and operational technology (OT) services. Utilities recognize the critical need to invest in this area, but few have invested in building out their own communications and network system infrastructures. As a result, they rely heavily on third-party telecommunications providers and end up paying for recurring operating expenses.

## LOOKING TOWARD THE FUTURE

Questions and variables remain, but we may be nearing an inflection point that will signal when—not if—communities fully adopt smart city models. Nearly 40 percent of survey respondents anticipate widespread adoption and implementation of the smart city initiatives across the United States in the next six to 10 years.

Obstacles remain, and city and utility leaders continue to confront a skeptical public whose understanding of smart city initiatives may lag their own. But when stakeholders partner for progress—and engage the public to reach an understanding of how technology and planning can unite once-disparate infrastructure systems—our communities and quality of life will prosper.

Foresight, collaboration and even a little audacity will help realize the promise of the smart city. City and utility leaders are in the right place at the right time to champion and lead this "smart" revolution.

# SMART CITIES

## HOW "VALUE" CAN HELP FUND SMART CITY EFFORTS

By Clint Robinson

Black & Veatch's *2017 Strategic Directions: Smart City/Smart Utility Report* reinforces lessons learned in the past year—although governments and municipalities believe strongly in the smart city model, they continue to struggle to fund these efforts. According to survey data, only 16 percent of municipalities can self-fund a smart city initiative, a little over a third cannot, and the primary sentiment reflected an ambiguity or replied "don't know."

Municipalities face a grim reality when it comes to funding smart initiatives through traditional routes. Relatively weak local economies, little to no appetite for raising additional revenue for smart city activities and a skeptical understanding of how these initiatives add value hinder buy-in.

However, at this point, the advantages of the smart city evolution are extensive, and municipal leaders need to embrace all viable opportunities to generate funding, even those that are non-traditional and "outside the box."

Municipalities and smart service providers strongly believe that financing through public/private partnerships (P3s) will bring smart cities to life. Three-quarters of survey respondents consider P3s to be the most effective financing model for smart city initiatives (Table 2).

TABLE 2

**What would be (or is) the most effective financing model for "smart city" initiatives? (Select all that apply)**

| | By Organization Type | | |
|---|---|---|---|
| | Government/ Municipality | Smart Services Providers | Total |
| Public/private partnerships | 67.6% | 83.8% | 74.5% |
| Government grants/subsidies | 52.2% | 51.5% | 51.9% |
| Tax incentives | 39.0% | 45.5% | 41.7% |
| Property taxes | 5.1% | 23.2% | 12.8% |
| Only municipal funds | 8.1% | 8.1% | 8.1% |
| Only private funds | 4.4% | 7.1% | 5.5% |

*Source: Black & Veatch*

The advantages of the smart city evolution are extensive, and municipal leaders need to embrace all viable opportunities to generate funding, even those that are non-traditional and "outside the box."

Respondents chose government grants/subsidies and tax incentives as the second and third most effective financing models. While these are all solid funding options, their popularity suggests that municipalities are reluctant to invest in themselves and are more receptive to relying on third-party investors.

Surprisingly, a scant 5 percent of municipalities—compared to nearly a quarter of smart service providers—would look to property taxes to finance smart city initiatives. This reticence toward increasing taxes could mean that cities do not fully understand the value proposition behind these initiatives. If this is the case, cities should be educated to better understand the value, not only for their own gain but also to eventually "sell" the concept to taxpayers.

Municipalities should also investigate opportunities to balance costs with long-term revenue generation through their smart city efforts.

The majority of combined survey respondents (49 percent) pinpointed tax revenue from increased economic development as the most realistic opportunity to generate municipal revenue from smart city initiatives (Table 3). This might reflect an "if we build it, they will come" mindset, in that smart cities can be heralded as economic attractions, making them better places to live, do business and visit, driving increased economic development and generating revenue for the local economy.

TABLE 3

**Which of the following do you see as the most realistic opportunities to generate municipal revenue from "smart city" initiatives? (Select two choices)**

| | By Organization Type | | |
|---|---|---|---|
| | Government/ Municipality | Smart Services Providers | Total |
| Additional tax revenue from increased economic development | 45.9% | 53.3% | 49.1% |
| Data monetization | 27.1% | 51.5% | 37.5% |
| Leasing access to community-owned assets | 34.6% | 41.4% | 37.5% |
| Ad revenue | 18.8% | 17.2% | 18.1% |

*Source: Black & Veatch*

Rather than viewing smart city initiatives as an added burden and extra cost, perhaps they should reframe the issue and ask themselves, can we make smarter decisions with our existing capital infrastructure?

Perhaps most surprising is that only 18 percent of respondents believe advertising revenue could be used to successfully generate municipal dollars. Some cities may have ordinances and policies in place that ban this type of advertising or respondents may not fully understand how advertising can generate a realistic new revenue stream. For example, a system of ad-supported kiosks could fund an entire capital project.

Last year, Kansas City, Missouri, began experimenting with smart technologies that yield revenue. In May 2016, the city began installing a system of 25 interactive outdoor kiosks along the downtown streetcar route. Designed to display advertising, the kiosks are meant to provide new funding for the city's Visit KC economic development initiative and the Kansas City Streetcar Authority. The city is also pursuing applications such as smart parking and smart streetlights that can bear immediate returns from the installation of 125 smart streetlights along a two-mile stretch downtown.

So what else can cities do? Municipalities would serve themselves well to consider forming strategic partnerships with companies and providers that can enable them to begin the approach to a smart city. The city of Chula Vista, California, has set aggressive goals to become more efficient through the improved use of energy, water, communications and other critical infrastructure elements. In 2015, the city hired Black & Veatch to help realize its smart city vision and develop the city's plan for incorporating smart infrastructure while promoting quality, curbing costs and collaborating with multiple stakeholders.

Municipalities might also want to consider shifting their perspective. Rather than viewing smart city initiatives as an added burden and extra cost, perhaps they should reframe the issue and ask themselves, can we make smarter decisions with our existing capital infrastructure? Can we increase the value of our capital projects by making them smarter? A world of opportunity exists to leverage the value inherent in smart city applications, and cities should take a critical look at projects to decide how they are going to make them smarter, more sustainable and more resilient.

# SMART CITIES

## SMART STREET SYSTEMS MOVING FROM WHITEBOARDS TO NEIGHBORHOODS

By Jennifer James and Steph Stoppenhagen

Once considered the purview of Jetsons-era futurescapes, smart street systems have made the transition from science fiction to real city council planning agendas. Sensor-laden Wi-Fi kiosks, smart streetlights, EV charging stations and integrated urban mobility systems are generating rising interest as cities demand greater connectivity, resource efficiency, enhanced public safety and more effective municipal service delivery. Communities of all sizes are exploring pilot programs, leveraging low-cost data capture devices, and implementing more expansive and capable communications networks to move toward a more connected future.

Given the rapid pace of change in 2016, it can be hard to believe that only a few years have passed since advanced street systems began their move from the concept stage to initial city deployments. In 2015, only 12 percent of *Strategic Directions: Smart City/Smart Utility Report* survey respondents indicated they were piloting a smart city program. In 2016, that number rose to 19 percent. This shift has coincided with further penetration of smartphones and the evolving mobile app economy that is changing consumer expectations for what is and what is not possible from traditional service providers.

Widespread efforts by municipalities to fund a variety of community improvement programs through creative financing approaches also represent a critical step toward broader smart system adoption. As municipalities and their residents grow more comfortable with public/private partnership efforts and alternative financing vehicles, traditional direct, taxpayer-funded initiatives are giving way to smart programs that increasingly leverage external capital.

Among the systems most important to invest in first, it is not surprising that core major infrastructure functions are identified versus smaller programs such as lighting, waste and kiosks (Table 4). What is interesting is that the some of the latter items are projects that municipal respondents see as more important compared to vendors.

TABLE 4

**What do you see as the TOP THREE most important systems in a "smart city" program to invest in first? (Select three choices)**

| | By Organization Type | |
|---|---|---|
| | **Government/Municipality** | **Smart Services Providers** |
| Smart electric grid | 39.7% | 50.0% |
| High-speed data network | 44.5% | 33.3% |
| Smart water systems | 42.1% | 33.3% |
| Smart transportation | 35.9% | 42.2% |
| Smart buildings | 33.5% | 43.1% |
| Public safety networks/monitoring systems | 26.3% | 17.6% |
| Renewable/distributed generation/microgrids | 15.3% | 24.5% |
| Smart street lighting | 20.6% | 10.8% |
| Smart waste systems | 17.7% | 14.7% |
| Interactive kiosks/community information systems | 5.7% | 8.8% |

*Source: Black & Veatch*

Connected components such as streetlights, kiosks and other smart furniture that use integrated sensors can generate more opportunities to leverage their real estate to serve multiple purposes.

Historically, budget constraints or the lack of awareness, familiarity or concern over alternative financing methods discouraged municipalities from pursuing foundational smart city programs (Figure 2).

FIGURE 2

**What are the TOP THREE hurdles that must be overcome to enable utility, city/community or campus systems to be managed in a smarter, more integrated way? (Select three choices)**


*Source: Black & Veatch*

Yet, the growing success of alternatively funded connected kiosks, smart streetlights and EV charging pilots are changing outlooks as more smart city Requests for Proposals (RFPs) require financing as a core element. From Black & Veatch's experience, the biggest difference in RFPs over the last year is the role of financing mechanisms and potential monetization of assets to provide added revenue streams.

## OPPORTUNITIES TO GENERATE REVENUE FROM SMART CITY INITIATIVES

Service providers can generate revenue streams or help fund city infrastructure projects to sustainably reduce costs while enhancing customer experiences to drive municipal planning efforts. For example, smart-connected streetlight systems are creating opportunities to generate additional value from existing municipal assets (Figure 3).

Connected components such as streetlights, kiosks and other smart furniture that use integrated sensors can generate more opportunities to leverage their real estate to serve multiple purposes. The ubiquitous light pole can now add Wi-Fi capacity to provide a constant flow of information on its surroundings. Environmental data, public safety monitoring and augmented traffic data can all help improve city operations' efficiency. In addition, they provide a foundation for municipal high-speed data systems that can help bridge the digital divide.

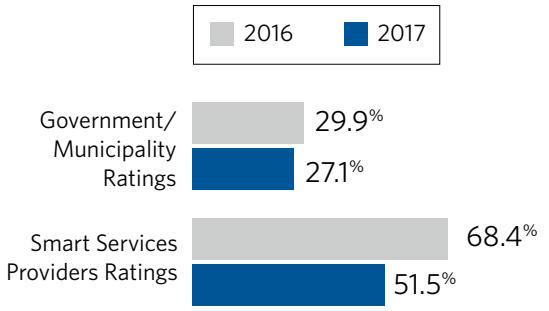
It is our expectation that across municipal departments, the shift from "like-for-like" replacement is near its end as the "multi-purpose everything" mindset becomes entrenched.

Street lighting systems, in particular, are attractive to municipalities because energy and maintenance cost-savings can provide immediate impact on the budget and be augmented with revenue-generating or enhanced service options.

Street systems will also evolve in response to rapid growth in the sharing economy and the continued global trend towards urbanization. For instance, the potential for fewer owned vehicles and more ride sharing options will cause cities to rethink parking challenges. In many cities today, residential units with associated parking receive premium consideration over those without. But, in the future, on-site parking may be less of a concern due to changing patterns of car ownership, autonomous vehicles, ride sharing, and pushing the behavior of no-car household. Modern transportation services like Uber, Lyft and BMW's ReachNow will help drive street system design towards multi-purpose utility and smart mobility.

FIGURE 3

**Which of the following do you see as the most realistic opportunities to generate municipal revenue from "smart city" initiatives? (Ratings for "Data Monetization" by organization type shown)**




*Source: Black & Veatch*

**Modern transportation services like Uber, Lyft and BMW's ReachNow will help drive street system design towards multi-purpose utility and smart mobility.**

# SMART CITIES

## FOR SMART CITIES, WHAT COMES FIRST: THE BUDGET OR THE PLAN?

By Mike Bossom and G. Scott Stallard

Strained budgets may be holding back many municipalities whose leaders understand the benefits of smart city systems but lack the money to support them. Yet, a question is emerging that potentially turns that notion on its head: How can a city know what it can't afford until it identifies what it needs?

The story of smart city system adoption is almost always a tale of two overarching visions. One approach appears to save money and demonstrate the promise of advanced technology through gradual upgrades, such as smart street lighting or electric vehicle charging stations. Another strategy takes the longer view, using root-level master planning to holistically rethink a community's energy, water and other critical infrastructure from the ground up.

As governments consider where to spend their smart city funding, they may initially center on the critical building blocks of a smart city but often become subject to short-term budget priorities. To this point, responses to the *2017 Strategic Directions: Smart City/ Smart Utility Report* survey suggest a vexing conundrum: What comes first, the budget or the plan?

## OBSTACLES ON THE SMART CITY PATH

Primary barriers inhibiting wide adoption of smart city systems grew in the year since Black & Veatch last surveyed cities, utilities and other stakeholders. Budget constraints, a lack of resources and expertise, and policy hurdles kept their top three positions as the tallest hurdles for organizations, with each issue appearing to gain more traction with respondents (Table 5). Concerns about convincing skeptical stakeholders and overcoming short-term mindsets were again named significant issues as well.

Many concerns are often tied to planning, or they are connected to the absence of a plan — a comprehensive roadmap that strategically plots the way forward by determining a community's goals. Following such a roadmap allows systems to be planned and built to integrate and scale, taking advantage of the ways data can make infrastructure more efficient and help operators make better decisions.

Single-point improvements can provide quick demonstrations of the smart city promise, but they frequently fall outside a more panoramic approach that considers how otherwise disparate systems can work together. Will pilot programs sync well with other upgraded systems in the future? Will they create duplicated costs that would likely be eliminated as part of a broader approach?

TABLE 5

**What are the TOP THREE hurdles that must be overcome to enable utility, city/community or campus systems to be managed in a smarter, more integrated way? (Select three choices)**

| | By Organization Type | |
|---|---|---|
| | Government/Municipality | Smart Services Providers |
| Budget constraints | 79.8% | 55.4% |
| Lack of resources or expertise | 56.3% | 59.4% |
| Policy hurdles | 33.7% | 36.6% |
| Gaining stakeholder support | 31.3% | 31.7% |
| Ownership across departments | 24.0% | 35.6% |
| Short-term mindset | 25.0% | 21.8% |
| Technology availability | 18.3% | 28.7% |
| Time constraints/other priorities | 18.8% | 15.8% |

*Source: Black & Veatch*

**Municipalities are clearly interested in the advantages of long-range planning. More than half of respondents engaged in smart city initiatives said they were creating roadmaps for their implementations, while 46 percent were conducting pilot projects.**

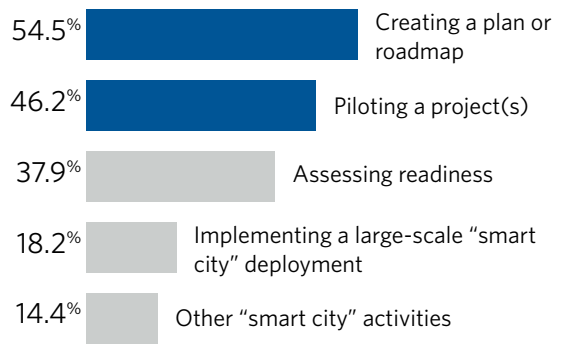
Longer range strategies—steeped in a three-stage approach of planning, design and implementation—overcome this uncertainty by allowing organizations to consider complex future scenarios and set priorities that match their goals and projected financial health. They can also provide a blueprint for meeting mandates or self-determined goals tied to efficiency and emissions reduction.

For example, Black & Veatch has worked with Hawaiian Electric (HECO) to help plan for its distributed energy future and meet the state's ambitious renewable portfolio standard goal that all electricity sales come from renewable sources by 2045. HECO is analyzing its options and reviewing all the ways that stakeholders can be encouraged to adjust their habits, such as customer programs, incentives and cost structures that could encourage wider adoption of efficient or green technologies. Significant amounts of advanced planning will be required so that flexible and resilient generation and transmission and distribution systems are in place to accommodate the increasing wind/solar generation required to meet the state's goal.

Municipalities are clearly interested in the advantages of long-range planning. More than half of respondents engaged in smart city initiatives said they were creating roadmaps for their implementations, while 46 percent were conducting pilot projects (Figure 4).

FIGURE 4

**Which of the following "smart city" activities is your municipality/administration participating in? (Select all that apply)**




*Source: Black & Veatch*

Smart transportation strategies efficiently move people and goods across cities. Distributed energy resources capture and convey sustainable power sources and reduce our carbon footprint. Underpinning it all are complex telecommunication networks allowing each of these diverse systems to talk and share actionable information.

Data management will be a crucial building block of these plans, although its consideration ranked surprisingly low among survey respondents. Less than one-third of respondents cited data analytics and visualization as critical to smart city initiatives, but opting out of active data management carries risk.

Reporting analytics are key to short-term operations and maintenance, and predictive analytics use historical and current data and forward simulations to help operators better understand their assets and plan for long-term capital expenditures. Cities and utilities should create a master plan that not only identifies applications, but also the systems that support those solutions.

Much of the smart city discussion centers on how communities exit the "from" state of basic delivery of critical services toward the "to" state in which energy, water, transportation and communications are integrated building blocks operating in harmony. Advanced water management technologies can bring resilience to otherwise strained systems. Smart transportation strategies efficiently move people and goods across cities. Distributed energy resources capture and convey sustainable power sources and reduce our carbon footprint. Underpinning it all are complex telecommunication networks allowing each of these diverse systems to talk and share actionable information.

Fulfilling the promise of integrated networks will depend on a deeper level of planning. The future of smart cities hinges on it.

# SMART CITIES

## SMART CITIES REQUIRE SMARTER, FULLY MODERNIZED PUBLIC SAFETY TECHNOLOGY

By Paul Scutieri

As the communication technologies leveraged by the public safety sector advance, the intersection with smart city initiatives becomes all the more inevitable. Technological advances afforded by broadband long-term evolution (LTE) networks have changed how first responders, city and county officials, public agencies and transportation fleets communicate and gather data to better serve their communities. Additionally, the national public safety broadband network currently being procured by the First Responder Network Authority (FirstNet) could revolutionize public safety communications altogether. Although initially designed for data transmission only, when fully completed, it will also provide voice, video and photo transmission, vital for first responders to operate more efficiently.

### SMART PUBLIC SAFETY TECHNOLOGY

Next-generation LTE applications are helping increase efficiency for first responders and other agencies. The deployment of broadband LTE will eventually make it possible to transmit voice, data, pictures and video in real time. As these applications integrate with other "smart" efforts, public safety professionals can more efficiently protect and deliver services to their communities. These communication modernizations should synchronize with other technological advancements that increase levels of service delivered to constituents.

Public safety departments typically rely on land mobile radio (LMR) systems, many of which are now operating at end-of-life status. Agencies are beginning to shift to LTE applications used to meet citizen expectations and increase first responder effectiveness. Of the respondents in the *2017 Strategic Directions: Smart City/ Smart Utility Report* survey, 39 percent reported that they are currently using LTE applications, with many likely still in pilot phases. Although respondents acknowledge that LMR systems will continue to be in operation for several more years, this year's survey indicated there are already owners getting in front of the curve and modernizing to new LTE technologies sooner rather than later. The eventual retirement of LMR will continue at a slow pace because of factors that present barriers to migration, such as bureaucratic concerns, cultural resistance, financial challenges and technological limitations.

Of the communities already utilizing LTE technology, the vast majority (73 percent) noted mapping as the top application implemented. Mapping, also known as geographic information system (GIS) mapping, provides real-time location-based services for first responders. Reliable GIS mapping is critical for rapid incident response and dispatch. Other leading applications included work order management (47 percent) and database searches (40 percent).

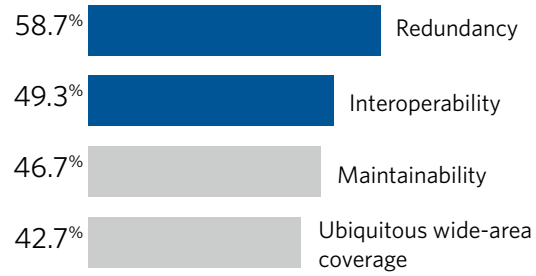
## REDUNDANCY, RESILIENCY AND INTEROPERABILITY KEYS TO NEXT-GENERATION PUBLIC SAFETY COMMUNICATIONS

To best reap the benefits of next-generation data applications, many systems will require updates or replacements. Organizations planning to make these investments listed high-speed data networks, system redundancy and interoperability as their top priorities. These features were also named the most critical elements of a resilient and reliant public safety communications system (Figure 5). As public safety functionality grows as a smart city initiative, efforts can tie into community resilience programs, listed by 32 percent of survey respondents as a major force driving the adoption of smarter technologies and data analytics.

Maintainability was listed as the third most critical element of a resilient and reliant public safety communications system. Many agencies are already in the process of transitioning from a legacy system, such as Enhanced Digital Access Communication System (EDACS), to a newer technology such as Association of Public-Safety Communications Officials-International (APCO) Project 25 (P25). Although LMR and LTE technology will continue to coexist for quite some time, many older LMR systems are no longer supported by their manufacturer. With some system parts no longer available or difficult to find on the market, many system owners resort to acquiring aftermarket resources. As they plan for the modernization of these systems, organizations are pursuing systems that can scale and support their community's long-term goals. However, procuring a new LMR system can be an expensive and complex process, and this reality is reflected by survey responses that do not point to a clear industry standard for doing so (Figure 6).

FIGURE 5

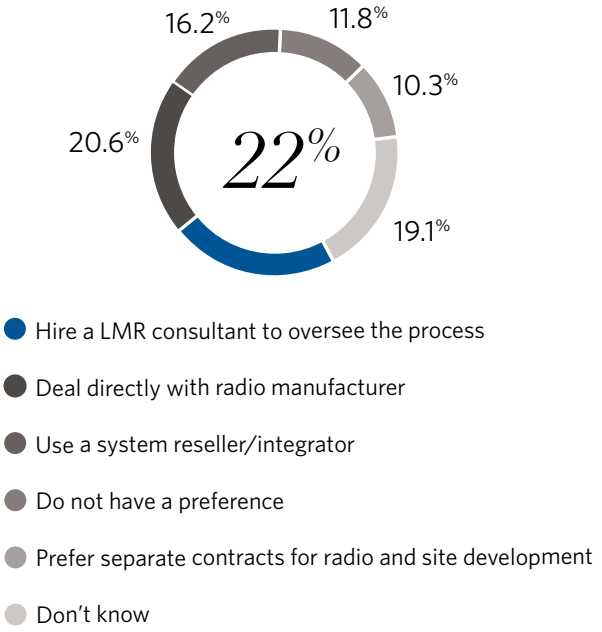
**Which of the following do you feel are the TOP THREE most critical elements of a resilient and reliant public safety communications system? (Select top three choices)**




*Source: Black & Veatch*

FIGURE 6

**How does your community prefer to procure new Land Mobile Radio (LMR) systems? (Select one choice)**




*Source: Black & Veatch*

In the past, communities have worked directly with radio manufacturers and leaned heavily on their system recommendations. Many of these systems were designed to last only 10 to 15 years and are now more than 20 years old, compromising their performance and capabilities. Transitioning to a new system when the breadth of technology providers has multiplied has also become a more daunting task. Some agencies prefer to partner with a consultant that can assist with the entire project from the RFP process to full-scale deployment and subsequent long-term maintenance. For example, a consultant can conduct a needs assessment to help ensure that all community interests are taken into consideration, as well as evaluate current infrastructure.

Black & Veatch recently assisted Oakland County, Michigan, with LMR infrastructure planning by analyzing the county's public safety communications needs and developing a new system roadmap. Working with a specialized consultant can ensure current systems and new technical requirements are taken into consideration comprehensively and can provide better informed investment options.

Transitioning to a new system when the breadth of technology providers has multiplied has also become a more daunting task.

## FIRST NATIONWIDE PUBLIC SAFETY BROADBAND LTE NETWORK FOR FIRST RESPONDERS

Given the pressure on municipalities to provide highly reliable and interoperable communication services, the topic of financing models is not surprisingly garnering increased attention. More than half (55 percent) of survey respondents specified that the most preferred model to fund public safety communications is government grants. The development and procurement of FirstNet could be shaping this outlook.

The government-funded, multi-year initiative is the result of 9/11 Commission recommendations, and its anticipated contract award may point to communities' increasing uncertainty about how some agencies should budget in the short term. The national network is estimated to cost in excess of $20 billion to $30 billion and will present significant opportunities to increase interoperability and improve safety and security for first responders. These factors have been listed as the top drivers for cities or communities to adopt FirstNet after it is available.

On the other hand, 40 percent of respondents surprisingly indicated they do not know anything about FirstNet. Possible theories for this lack of knowledge could stem from limited publicity directly from FirstNet, especially toward the federal/state/local government/municipality participants, of whom made up more than half (56 percent) of the participants who responded to the survey's public safety-related questions. When a contract team is officially awarded, it is anticipated that knowledge of the program will increase as agencies become better educated on implementation options. Further, as FirstNet's efforts to build out begin and communities are increasingly affected, more exposure and widespread engagement should be expected.

Even before FirstNet is deployed, community networks will continue to play a critical role in smart city initiatives and planning. As cities become more interconnected, significant gaps in public safety communications can be addressed to increase redundancy, resiliency and interoperability to improve safety for first responders and the constituencies they protect. It is imperative that public safety agencies partner with, and are in alignment with, community leadership to ensure that smart city planning takes public safety communications and interoperability into account to benefit communities' long-term safety and security needs.

**As cities become more interconnected, significant gaps in public safety communications can be addressed to increase redundancy, resiliency and interoperability to improve safety for first responders and the constituencies they protect.**

# SMART CITIES

## SMART CITIES WILL DEPEND ON SMARTER MOVEMENT OF PEOPLE AND GOODS

By Maryline Daviaud Lewett and Paul Stith

Zero-emission technologies are rapidly maturing within the transportation industry. This market growth is propelled by broadening public adoption and increasing confidence that alternative fuels will be critical to efforts to reduce greenhouse gas emissions. Total operational costs and economics will drive adoption. In smart city initiatives, electrification of the personal vehicle, fleet and mass transit sectors is becoming an important tool for city officials and utilities as they reimagine how people and goods move sustainably across the urban environment.

Sales of EVs are surging. Combined with growing optimism that EVs will account for an increasing share of the personal vehicle market as batteries become cheaper and carry a longer range, cities may need to raise their game in two key areas. They must accommodate citizen demand for alternative fuel infrastructure and work with utilities and stakeholders to maximize the value and flexibility of increased electrification in transportation.

More than 40 percent of respondents engaged in smart city initiatives ranked EVs (light, medium and heavy vehicles) as among the most important technologies in the advancement of smart cities in this year's *Strategic Directions: Smart City/Smart Utility Report* survey, recognizing EVs and clean energy infrastructure as essential components of a sustainable city (Table 6). Through DER management, renewable energy production and storage and demand response, cities and utilities will be able to effectively control EV charging impacts, lower charging costs and stabilize grid loads to help slash greenhouse gas emissions. And, as the market for electric-powered personal passenger vehicles matures, smart city advocates are turning their attention to applying similar changes to medium- and heavy-duty fleets as well as mass transit vehicles.

TABLE 6

**Which of the following technologies do you believe will be most important in the advancement of smart cities/ communities? (Select top three choices)**

| | By Municipalities Participating in "Smart City" Related Activities | |
|---|---|---|
| | "Smart City" Activity | No "Smart City" Activity |
| **Remote sensing and metering** | 66.2% | 75.7% |
| **Big data analytics** | 48.6% | 52.3% |
| **Cloud computing** | 35.1% | 34.2% |
| **Autonomous vehicles or EVs** | 41.9% | 32.4% |
| **Artificial intelligence (e.g., Machine learning, cognitive computing)** | 31.1% | 29.7% |

*Source: Black & Veatch*

**Communities gain greater value from their networks when systems are integrated, managed and optimized holistically. Integrating grid resources (microgrids, adaptive street lighting and energy storage) and transportation assets (cars, public transportation and autonomous vehicles) increases the flexibility and resiliency of each system.**

## OVERCOMING THE FINANCIAL BARRIER

Growing EV sales are providing new potential revenue streams for electric utilities, as the business case for accommodating EV growth comes into sharper focus. Fully electric vehicles and plug-in hybrids have become fixtures on roadways, and utilities can profit from this lucrative market. Key to this growth will be the development of the infrastructure that develops around the vehicles to fully realize their benefits.

Communities gain greater value from their networks when systems are integrated, managed and optimized holistically. Integrating grid resources (microgrids, adaptive street lighting and energy storage) and transportation assets (cars, public transportation and autonomous vehicles) increases the flexibility and resiliency of each system.

Smart transportation is being advanced through integrated sensors, analytics and telecommunications into public transportation and city systems that deliver actionable information. This communications network establishes a platform for real-time transportation schedules, smart parking, traffic control, safety and other smart applications.

Funding remains an imposing hurdle, however. Upfront costs can be daunting and will likely require cities and utilities to think creatively about financing. Utilities must work with regulatory bodies such as public utility commissions to access funds that are justified as benefiting all ratepayers. Additionally, federal and state agencies are dedicating funding to support alternative fuel infrastructure deployment.

One emerging trend is the exploration of upfront funding via "green banks," which are typically quasi-public financing groups that pursue the wide adoption of clean technologies through private investments. Such banks typically lend upfront infrastructure costs that are paid back over time in line with the recurring operational cost reductions. Other approaches may leverage the fiscal savings of one initiative, such as light emitting diode (LED) streetlight retrofits, energy efficiency or other technology investments that free up operating capital that can be invested in electrification. In turn, transportation electrification will generate additional operational savings.

For large fleet operators—whether public or private—these future operational savings can provide a powerful funding mechanism on their own. By leveraging internal or third-party financing, these fleets can accelerate their clean transportation initiatives.

Unique partnerships offer examples of non-traditional funding and collaboration approaches. Black & Veatch recently partnered with Volta, which provides free, sponsored EV charging stations to address the growing need for cost-effective, sustainable and scalable smart infrastructure.

Volta is deploying free public charging stations at high-traffic retail sites selected specifically to drive exponentially greater-than-industry average utilization, community engagement and outreach, ultimately catalyzing increased EV adoption. The industry is also seeing automotive original equipment manufacturers (OEMs) investing in car-share and shuttle programs, which will further drive demand.

## TRANSPORTATION'S IMPORTANT ROLE IN THE SMART CITY

Many aspects of smarter transportation and the electric grid are driving interest among cities, utilities and fleet managers. They must work together to understand total generation capacity and account for the influx of DER along with the overall energy use and predicted draws from the grid. In addition, they must consider EV charging locations and stationary, energy and mobile storage, as well as the movement of goods (via ports, rail, trucks and delivery), vehicle-grid integration and communications to stabilize the grid and bring clean energy sources to market.

Efficient urban transportation involves many stakeholders, from the vehicle OEMs and utilities to cities, software solutions and service providers, charging network operators, fleet operators and zero-emission drivers. It also requires robust communications and infrastructure deployment of sensors,

analytics and telecommunications into public transportation and city systems to deliver actionable information.

As clean transportation and energy networks advance, they will converge into connected transportation and logistics systems. Data from vehicles, mobile applications and multiple smart structures—sensors, electric charging stations, hydrogen filling stations, traffic management operations, smart meters, signal control and parking space management—will be aggregated and analyzed to facilitate system cooperation within a smart city framework.

The layout and trajectory of a progressive and sustainable smart transportation grid employs many moving parts, and planning them—as well as financing them—will require cross-sector collaboration on a scale not yet experienced by many cities. The potential return, in terms of revenue and the long-term environmental and social sustainability of our cities, will more than justify the effort.

The layout and trajectory of a progressive and sustainable smart transportation grid employs many moving parts, and planning them—as well as financing them—will require cross-sector collaboration on a scale not yet experienced by many cities.

# SMART UTILITIES

## UTILITIES NEED TO EXPLORE NEW APPROACHES IN ATTRACTING NEXT GENERATION OF WORKERS

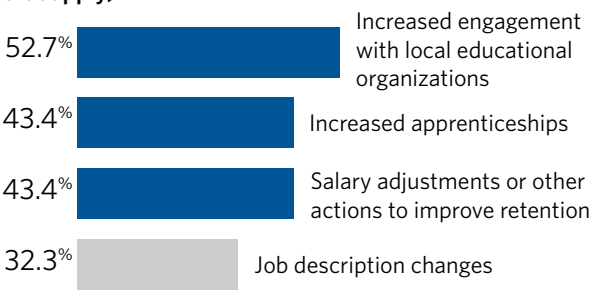
By David Price and Jim Nightingale

A key element of a successful workforce management strategy is a utility's capability to attract new professionals while retaining and developing their current staff. Eighty-three percent of respondents to the *2017 Strategic Directions: Smart City/Smart Utility Report* survey identified this as a major challenge for their operations over the next 10 years.

Only 32 percent of respondents plan to make job description changes to help address this issue, which is a cost-effective way to start managing this challenge (Figure 7). Utilities today are competing with other businesses to attract and retain a talented workforce, with a new generation of job seekers desiring greater meaning in the work they do beyond simply executing an assignment. These candidates are looking for a compelling picture of how their role is meaningful to the utility's strategy and how it benefits the company's customers.

FIGURE 7

**What are your organization's plans to train and develop your own workforce in the next five to 10 years? (Select all that apply)**




*Source: Black & Veatch*

For example, Black & Veatch is currently working with a client to retool processes and their supporting job roles in a part of the company that has significant retention issues. These issues stem from a combination of the customer-facing requirements of the role, combined with the experience level of the individuals assigned to the team. This particular business unit oversees the critical services of installing new infrastructure in one of the fastest growing cities in the United States, putting more weight on its workforce setbacks.

To improve retention, the company needed to implement new, more responsive processes, but also re-engineer the perceptions for roles within that business unit to be seen as more attractive. Prior to this effort, the growing demand for infrastructure from their customer base, which included supermarket chains and large subdivision developers, has caused significant issues for the utility meeting these customers' expectations. This, in turn, led to negative repercussions from utility regulators and other stakeholders in their service area.

Only 32 percent of respondents plan to make job description changes to help address this issue, which is a cost-effective way to start managing this challenge.

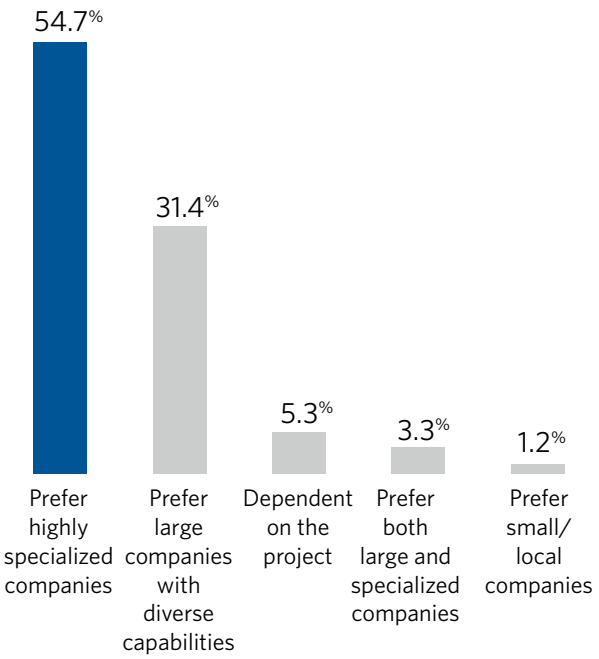
## UTILITY PREFERENCE FOR THIRD-PARTY VENDORS

The survey respondents' view of third-party vendors they prefer presents a potential business opportunity for utility service providers. A vendor able to combine the depth of a highly specialized company with those of a large company with broad capabilities could create the ideal profile for this market sector (Figure 8).

This company could be a global or national entity with divisions focused on specific areas. Creating such an entity would present major organizational challenges, but the company would provide an attractive choice for 86 percent of the market. The survey responses suggest there may be a future trend where the highly specialized vendor companies make a move to consolidate over time to build business volume.

FIGURE 8

**In working with third parties, do you prefer a select group of large companies or a portfolio of specialized firms? (Select one choice)**




*Source: Black & Veatch*

## WORK SYSTEMS SOFTWARE SOLUTIONS FOR SMALLER UTILITIES

The survey shows that 32 percent of small utilities do not have a formal system in place to generate, track and complete work. This is likely due to the costs of acquiring enterprise solutions such as Oracle, SAP or Maximo. One possible solution for these utilities would be to seek a software solution aggregator that can pool groups of utilities that all agree to use the same system in exactly the same way.

For example, a third-party could purchase a software solution and create an offering for smaller utility organizations. These utilities would be charged a monthly or annual fee and be provided with access to a higher level of sophistication, in terms of process and capability, than they would ordinarily be able to obtain. Such a solution would require the users to adopt the work processes provided without customizing them for individual needs. However, users would benefit from the cost and operational benefits this type of solution could provide.

Overall, the survey respondents confirmed the widespread impact and consequential concerns that the aging workforce is producing across all types of utilities in the market. With utilities seeking more outsourcing for their operations, the vendor market is likely to consolidate to meet growing demands for scale combined with depth of capability. The challenge for utilities and vendors alike will be to evolve new operating models and processes that support a distributed process across multiple parties to deliver the quality of work and asset data that current and future business and regulatory requirements demand.

Looking forward, utilities should seek to band together across water, electric and natural gas service areas in seeking economical software solutions for processing, generating, tracking and completing work while providing quality critical asset and performance data.

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# SMART UTILITIES

## SMART GRID AND MICROGRIDS: THE HARD SOLUTION FOR ASIA'S AT-RISK MEGACITIES

By Andrew Woods and Sherri Jett

Asia experiences more natural disasters than any other region in the world and its many densely populated coastal cities are vulnerable to weather disasters such as storms and floods. Small investments today in emerging smart grid and microgrid solutions will save these ever-expanding cities' resources while critically improving the resilience and recovery of life in times of human tragedy.

# The United Nations estimates that natural disasters cost cities more than US$250 billion. If cities fail to build their resilience, this cost could rise to US$314 billion by 2030.

Floods, earthquakes and cyclones have wreaked havoc across Asia—killing people, wiping out homes and livelihoods, and leaving economies in distress. The region occupies 30 percent of the world's land mass, but has experienced 40 percent of the world's disasters over the past decade, resulting in a disproportionate 80 percent of the world's disaster deaths[1].

In addition, Asian cities are experiencing a population growth that is more than double the size of the urban migration in Europe and America. The Pearl River Delta in China (which includes the cities of Guangzhou, Shenzhen, Foshan, Dongguan and the neighbouring Hong Kong) has overtaken Tokyo as the world's largest urban area in both size and population with more inhabitants than countries such as Argentina, Australia or Canada.

The United Nations estimates that natural disasters cost cities more than US$250 billion. If cities fail to build their resilience, this cost could rise to US$314 billion by 2030.

From the humanitarian crisis caused by Typhoon Haiyan (Yolanda) in the Philippines in 2013—which killed at least 10,000—people to the impact of Typhoon Soudelor cutting power to 4.85 million homes in 2015 (Taiwan's largest ever blackout), tropical storms regularly devastate life, economies and hamper developmental progress throughout the region. Even relative "near misses" such as last October's Typhoon Haima caused major economic challenges, costing Hong Kong alone an estimated HK$5 billion in lost business.

Hurricane Sandy in the United States provided many lessons and insights into electric grid management and recovery. The 2012 storm ravaged multiple urban areas across the country's East Coast, knocking out power to more than 25 million people across 21 states and causing an estimated US$70 billion of damage in eight states alone. The damage was so extensive that it took utilities two weeks to fully restore power.

[1] Centre for Research on the Epidemiology of Disasters

**In addition to system-wide improvements through data-rich smart grids, "islanded" microgrids—which are disconnected and separated from the main grid—can literally keep the power going on a smaller and more localized level. This is critical for many public service facilities such as schools, universities and hospitals.**

A key component of a utility's resilience is the effectiveness of its communications systems and the management of its smart data. Electric utilities need to gain greater visibility on the street, as well as at the operations-center level when the grid is compromised. Identifying the cause for failure early and precisely is critical to recovery. Pinpointing problems and estimated repair times in public communications can also aid significantly, helping to allay fears and confusion in troubling times.

In addition to system-wide improvements through data-rich smart grids, "islanded" microgrids—which are disconnected and separated from the main grid—can literally keep the power going on a smaller and more localized level. This is critical for many public service facilities such as schools, universities and hospitals, as well as keeping the city's wheels in motion by preventing the severe disruption of production at many large businesses.

The U.S. has invested in building out its smart grids and microgrids and saw returns on these efforts during the destruction of Hurricane Sandy. A number of success stories emerged after Sandy hit—Midtown Community School in the city of Bayonne, New Jersey, had a solar back-up system that kept the power running, allowing dozens of local residents to take shelter and sleep in a warm and dry school hall. On a larger scale, the University of Princeton (also in New Jersey) kept the power running for residents, emergency workers and crucial facilities on campus.

In the aftermath of the hurricane, New York was the first to launch a clean energy program aimed at spurring distribution of low-carbon community microgrids state-wide. This initiative has gained rapid momentum across the nation, with a total of 124 microgrids with combined capacity of 1,169 MW up and running across the U.S. as of July 2015.

While capital costs are associated with adding renewable energy or other captive power solutions to the generation mix, those who are able to invest upfront capital will realize overall cost savings.

Black & Veatch recently built and now operates its own microgrid at its world headquarters in the Midwestern United States. Although its scale pales against the needs of Asian megacities, its integration of hybrid power generation technologies offers a window into how otherwise disparate energy sources coalesce to efficiently provide reliable electricity. The system is composed of 50kW of solar photovoltaic generation, two 65kW natural gas-fired microturbines with the ability to capture and use waste heat (combined heat and power), a 100kW/100kWh lithium-ion battery energy storage system (BESS), EV charging stations, and a geothermal well field that helps maintain comfortable temperatures year-round. The system is also integrated with the building management system to enable transitions from grid-connected to "island" operation by matching generation with building load.

Such "island" operation solutions could prove invaluable for municipals, private developers and large electric customers to improve the reliability and resilience of their power supplies in difficult times.

The Philippines and Indonesia are two of the top five countries hit by the highest number of disasters in the world. Both of these Southeast Asian economies continue to experience robust economic growth while investing in their cities' power infrastructure. While capital costs are associated with adding renewable energy or other captive power solutions to the generation mix, those who able to invest upfront capital will realize overall cost savings. Several mining companies in Indonesia have already established hybrid generation solutions onsite.

Depending on the specific location and availability or suitability of renewable resources, it has been shown that low- to medium-penetration renewable power systems can be integrated with diesel power to meet 10 to 30 percent of the mine's energy demand. This results in a direct fuel cost savings and a reduction in the number of fuel deliveries required. The mining operation will realize more certain energy cost forecasting, offsetting the upfront capital cost and, critically, a lower risk of operation downtime. Such adoption by mine operators could set the template for other large or critical users to follow suit as the national grid continues to build out and develop.

A 2015 World Energy Council report, *The Road to Resilience: Managing and Financing Extreme Weather Risks,* identified the sharing of best practices in electric grid management and recovery as a critical factor in attracting finance. The report cited an "an information vacuum which is reducing the ability of both the energy and finance sector to properly price the investment risk presented by increased extreme weather."

Demonstrating the role that island microgrids can play during disasters will help secure more investment into these emerging and resilient power solutions in the region.

# SMART UTILITIES

## LONG-TERM PLANNING CRITICAL TO LEVERAGING DER INVESTMENTS

By Jeremy Klingel

Distributed energy resources (DER) are becoming a key component of the modern power grid, affecting all aspects of utility operations and business processes from resource planning to customer service, regulatory requirements and distribution system needs. As DER proliferates and many customers begin to exercise more control over how and where their energy is produced, utilities have a responsibility to plan ahead and ensure that they make appropriate infrastructure investments to optimize benefits for all stakeholders.

As more DER are interconnected and become active participants in the provision of grid services, traditional utility distribution systems must evolve into more dynamic and integrated networks capable of handling two-way power flow and rapid exchange of information. However, this evolution will take time and coincide with the logical replacement of aging infrastructure to create a more decentralized, interoperable and intelligent network of systems within the "smart city" construct. To be successful, smart city planning and the execution of distributed infrastructure must involve collaboration with utility leaders in power, water and telecommunications.

## OPERATIONALIZING DER

Among DER technologies, distributed solar photovoltaic (PV) usually comes to mind first, but a wide range of technologies exist within the DER category with widely varying technical characteristics and costs—distributed wind generation, battery storage, electric vehicles, demand-side management (DSM), combined heat and power (CHP), fuel cells and microturbines.

In many cases, the most logical place to start may be with the most cost-effective DER to develop: demand response (DR). DR is becoming a central point of customer engagement via behavioral energy efficiency programs, direct load control and internet-connected devices such as smart thermostats. DR can serve as an effective alternative to expensive "peaker plant" investments, or it can help maintain reliability as aging coal and nuclear plants retire.

Energy storage is also gaining attention as an integral component of the operationalization of DER because it has the potential to provide a variety of grid services. Storage can increase the value of solar PV by allowing stored solar energy to be transmitted to the grid during peak demand and when wholesale prices are highest. Storage also helps microgrids match generation and load without relying on the larger grid and can also be implemented at the substation level to improve reliability and resilience in areas prone to outages.

When exploring investments to enable greater DER deployment, utilities selected the following as the top options: enabled sensors, supervisory control and data acquisition (SCADA) (42 percent), demand response management systems (DRMS) (39 percent) and new modeling tools to incorporate DER into resource and distribution planning (35 percent). These findings signal that utilities are seeking to not only monitor DER impacts but also optimize grid benefits. New power distribution investments should also include smart sensors, voltage and frequency regulation, and smart inverters to control the bilateral flow of energy between DER and the grid.

If DER introduce power back into the grid, utilities will also need to assess the value of that added capacity, and there has been significant debate about how DER should be valued. Traditional net energy metering for solar PV allows customers to receive the full retail rate for energy exported to the grid, but with kilowatt-hours (kWh) no longer being created equal, factors such as peak demand need to be taken into account.

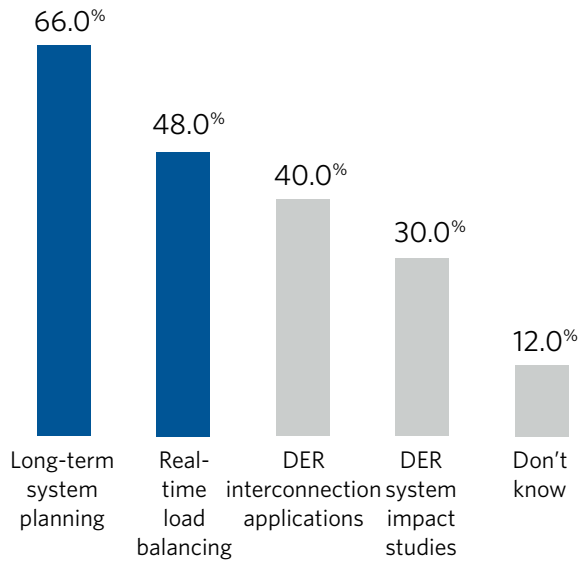
DER growth is prompting many jurisdictions to investigate more dynamic rate structures that vary over time (i.e., time-of-use rates) and location. Utilities are rightfully concerned about recovering their fixed costs from customers who generate DER but still rely on the grid and, in some cases, are pushing for more fixed charges, such as minimum bill amounts or the demand charges commonly applied to commercial customers today. Utilities will need to establish a framework that allows DER owners to be fairly compensated for the grid benefits they provide while still paying an equitable portion of utility service costs.

## ADDING RELIABILITY TO THE GRID

The U.S. Department of Energy estimates that approximately $1.5 to $2 trillion will be spent by 2030 to modernize the grid, simply to maintain reliability. If the grid is not prepared to support DER, reliability could be jeopardized, so effective stakeholder collaboration is critical to ensuring that this investment is spent tactically. To support future DER growth, 66 percent of survey respondents are considering automated long-term system planning applications, making stakeholder collaboration vital to bringing the right experts together from utilities and DER vendors to synchronize planning assumptions and methods (Figure 9).

FIGURE 9

**What business or operational processes are your organization considering to support future technology investments? (Select all that apply)**




*Source: Black & Veatch*

New DER interconnection platforms can largely automate and exponentially accelerate the interconnection approval process, allowing more rapid and widespread DER deployment and improving customer engagement.

Real-time load balancing (48 percent) and DER interconnection applications (40 percent) were other major priorities to support future technology investments, and leading vendors are providing software tools to streamline the DER interconnection process. The largest utilities in California receive 10,000 to 15,000 DER interconnection applications per month, so they are working diligently to process those applications as efficiently as possible while still avoiding the negative operational impacts that these new technologies will have on the distribution system.

Each application requires technical screening, and in areas of high DER penetration, manual power flow modeling and system hosting capacity studies are required to determine any potential impacts on system reliability. Traditionally, these studies were conducted manually by distribution engineers and could take many months. New DER interconnection platforms can largely automate and exponentially accelerate the interconnection approval process, allowing more rapid and widespread DER deployment and improving customer engagement. Tying the DER interconnection platform together with long-term system planning tools and real-time load balancing tools, such as DER Management Systems (DERMS), allows utilities to standardize data across departments for more integrated grid planning and operations.

## TACKLING DEPLOYMENT CHALLENGES

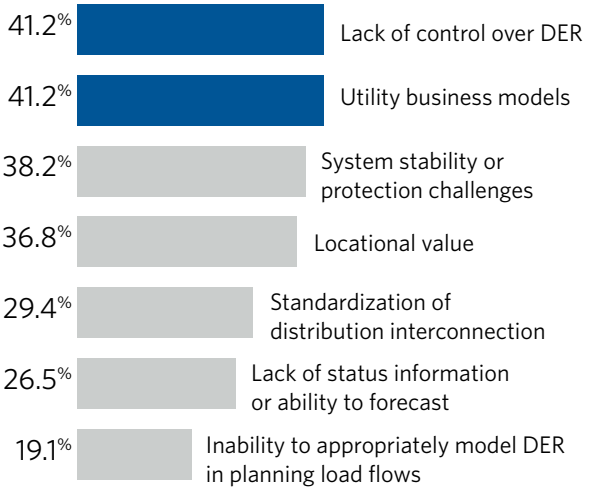
Traditional utility business models are based on a linear power delivery system from a predictable centralized generation source; revenues are earned either from the sale of electricity or from investment in utility-owned infrastructure. This model is changing dramatically—utilities will need to rely on DER they do not own and to better understand changing customer behaviors. With increased distributed energy use, utilities will also need to adopt more flexible and forward-looking business models to maximize value or earn revenue from DER directly. Survey respondents expressed concerns about these issues, listing lack of control and utility business models as the most significant challenges to supporting a higher penetration of DER (Figure 10).

As early as 2020, nearly half (47 percent) of survey respondents expect to see peak load reduction/peak shifting from non-utility-owned DER assets, although DER are still seen as a wild card to many utilities. However, regulators and policymakers in leading states such as California, New York and Hawaii are mandating that electric utilities incorporate DER into their planning and operations and explore new business models. Other states will likely follow, so taking a proactive approach could be beneficial.

Managing the impacts and maximizing the benefits of DER on the electric grid is one of many challenges facing smart cities and will require careful planning to achieve the most economical solutions. Synchronizing infrastructure investments across industries and consolidating communication networks can lead to cost savings and constructive sharing of information. Utilizing the same infrastructure backbone for DER management in the power industry and in the water and telecommunications sectors of a smart city will help manage all available resources to benefit citizens and achieve sustainability goals.

FIGURE 10

**What do you see as the most significant challenges to supporting a high penetration of distributed energy resources (DER) into your electric distribution system? (Select all that apply)**




*Source: Black & Veatch*

# SMART UTILITIES

## GRID MODERNIZATION: UTILITY 2.0 HAS ARRIVED, BRINGING OPPORTUNITY AND CAUTION

By Jeff Buxton and Will Williams

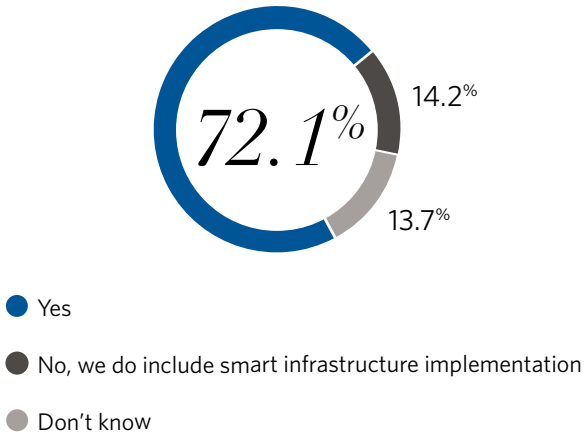
For years, utilities have struggled to define the more responsive operational systems and customer-centric performance models that would trumpet the arrival of Utility 2.0. Lacking a singular event marking the shift, it seems more likely a steady, incremental advance through technology deployments, analytics and a focus on customer engagement represents the path towards a continually evolving future state. As we have seen with the progress to date, further advances will require continuing coordination within utilities, their regulators and customers to ensure a sustainable path forward.

The *2017 Strategic Directions: Smart City/Smart Utility Report* finds many service providers wrestling with the need to update aging systems to support the transition to a Utility 2.0 model. From electricity and water to natural gas utilities, service providers have been deploying data collection and transmission sensoring equipment for years. In fact, only 14 percent of respondents indicate they do not include smart infrastructure implementation as part of their repair and replacement programs and/or capital plans (Figure 11).

Among the various benefits of greater system intelligence, 67 percent of survey respondents indicate they plan to use smart monitoring to inform smart maintenance. A core tenant of Utility 2.0 is the idea that automation and data-driven operational and maintenance decisions become the new norm.

FIGURE 11

**Is your organization including smart infrastructure implementation as part of its repair and replacement programs and/or capital plans? [Electric and water utilities] (Select all that apply)**




*Source: Black & Veatch*

Yet, for many service providers a key question remains: How are system updates prioritized and now that many intelligent assets are in place, what do we do with the information they're producing?

Like many businesses, the opportunities to reduce operational costs inform utility capital deployment planning. Industry leaders and functional groups must look beyond simply the opportunities to create operational efficiencies to examine what customers want, system integrity and security concerns and other key operational factors to understand how to target investments. Forty percent of respondents indicated they are waiting for assets to wear out before upgrading—suggesting adherence to the old adage, "If it ain't broken, don't fix it."

Forty percent of respondents indicated they are waiting for assets to wear out before upgrading—suggesting adherence to the old adage, "If it ain't broken, don't fix it."

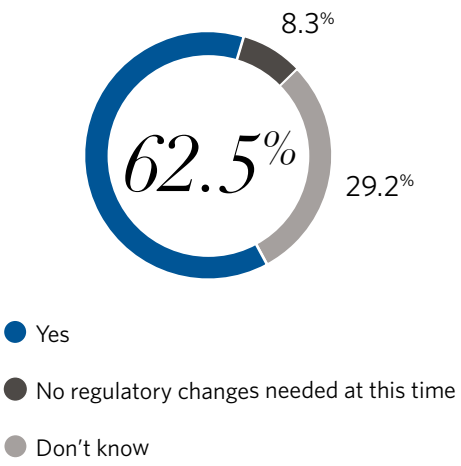
Too often though, utility capital investment programs and maintenance schedules aren't tied to their overall data monitoring strategy. Even in instances where smart assets are being deployed, only in 33 percent of cases are they being included as part of an overall information upgrades strategy. This creates scenarios where operationally sound yet functionally "dumb" assets remain in place.

To alleviate these issues, departments responsible for customer service, distribution operations and asset management must work closer. These functional groups, in conjunction with the Chief Information Officer's (CIO's) office, need to collaborate to balance the different, and occasionally competing uses of the information generated by the digital utility data system. Failure to enhance cross-functional collaboration severely limits the likelihood of developing a comprehensive data management strategy.

The key concern for utilities is that with greater DER penetration, the flow of energy is not reflective of the cost basis for distribution.

FIGURE 12

**Does your organization require changes in the regulatory structure to encourage DER implementation? [Electric, investor-owned utilities]**




*Source: Black & Veatch*

## DISRUPTION OF THE ELECTRIC SECTOR ACCELERATES

Electric distribution remains a highly regulated industry overseen by often powerful legislative and regulatory bodies. Yet, the accelerating pace of transformation in the electric services market has begun to expose gaps in the traditional regulatory framework and the business model that it creates for utilities.

In fact, serious questions exist as to whether these gaps will properly support and incent the desired "utility of the future" where third parties comprise an increasingly large percentage of distribution network and the distributed utility must properly plan for and recover the needed capital investments.

The key concern for utilities is that with greater DER penetration, the flow of energy is not reflective of the cost basis for distribution. More than 60 percent of utilities expect DER to significantly impact them, and most are trying to incorporate future DER planning into their system roadmaps. Similarly, nearly two-thirds of investor-owned utility respondents stated changes in the regulatory structure will be needed to encourage DER implementation (Figure 12).

## CHANGES IN THE REGULATORY STRUCTURE NEEDED TO ENCOURAGE DER

It is not surprising that most respondents from investor-owned electric utilities indicated that changes are needed in the regulatory structure to encourage DER. In many states, the growing penetration of DER has created new business challenges for electric utilities, DER customers and providers, and utility regulators.

To find common ground and align the interests of utility shareholders and customers, much time and effort has been devoted in rate cases and regulatory proceedings to understand and analyze the load characteristics of DER customers. Analysis of the operational characteristics of the utility's distribution grid and ability to integrate the more variable generation sources, the opportunity for storage and the more controllable loads into the grid help form the framework to derive the proper pricing concepts for DER customers. This allows regulators to both minimize cross-subsidies between customer groups and fairly recognize the value of DER, and properly incent the support for third-party participation.

Utilities are seeking a fair and equitable pricing method to properly reflect the actual costs to serve DER customers and the value of DER to the utility grid. No longer is the flow of energy reflective of the cost basis for distribution. For example, distribution utilities must invest in all of the wires, meters, switches, etc. that help manage power flows and ensure reliability, regardless of whether a customer uses 1 KW or 1 MW.

Utilities argue that if they spent money to connect homes and upgrade their systems, there has to be some evolution of the revenue recovery model. Connection fees, demand rates or higher fixed rates for lower usage levels are among solutions being considered. To achieve these goals, revenues recovered through rates from DER customers should be based upon the actual costs those customers cause the utility to incur and/or avoid, so the utility can continue to fund grid investments without creating negative rate impacts to customers without DER facilities.

## THE FUTURE IS HERE

Current outreach efforts reflect a major shift in mindset as incumbent providers are reaching out to their competitors. In the past 24 months, Black & Veatch has seen a number of leading edge utilities move rapidly to include DER providers in their efforts to help plan and manage system-wide energy flows. However, for all the talk of "death spirals" and start-up service providers, electric utilities continue to push forward with a range of new initiatives to support the influx of renewable energy and other non-utility provided DER.

Though the approaches may vary by location, there is growing acknowledgment that the continuation of "smart" investment in distribution assets and broader participation of third party assets will move Utility 2.0 further along its maturity curve.

# SMART UTILITIES

## EMBRACING SMART GRIDS IN SOUTH AFRICA

By Webb Meko

The impact of natural disasters on power grid resilience is increasingly gaining attention worldwide. Adapting lessons learned from high-profile incidents that have occurred elsewhere for the African continent, where energy supply is already intermittent, may provide opportunities to enhance the region's energy system reliability through smart grid infrastructure solutions.

Hurricane Matthew, the Category 3 hurricane that impacted the U.S. Southeast in 2016, brought the value of system stability and smart grids into sharp perspective by demonstrating that a proactive multi-year, multi-billion dollar utility grid modernization program paid off for utilities and their customers. Despite high winds and flooding, the vast majority of power outages were restored in less than 24 hours—a valuable case study indicating that Africa and other developing regions can benefit from smart grid technology. Embracing similar proven approaches will help boost grid resilience and empower communities to better manage long-term power supply.

## WHAT MAKES A GRID "SMART"?

As power grids modernize globally, electric transmission and distribution systems are being designed to improve grid reliability, integrate DER and improve operational efficiency. In the U.S., survey responses from the *2017 Strategic Directions: Smart City/Smart Utility Report* indicate the primary drivers of grid modernization plans include broader smart meter deployments, updating and automation of distribution and substation infrastructure as well as improved cyber and physical security capabilities.

Smart grids also allow utilities to integrate DER into the grid by using real-time data analytics and controls to balance supply and demand to achieve energy efficiency goals. Despite initial hesitation, many utility service providers are realizing they have more to gain financially and otherwise from embracing smart solutions, including long-term cost-savings and more flexibility diverting excess power to large-scale industrial and manufacturing consumers.

Optimized grids also prove to be smart capital investments that can help readily absorb the effects of unpredictable natural disasters, extreme weather events, and other catastrophic occurrences in order to sustain system operability.

## COMBATING UNPREDICTABLE WEATHER CHALLENGES

South Africa ranks 33rd of the countries most affected by climatic events in 2015, according to Germanwatch's Global Climate Risk Index 2017. Four other African countries also featured prominently in the ranking: Mozambique (first) followed by Malawi (third), and Ghana and Madagascar (both ranked eighth). According to environmentalists, this is not surprising as the continent crosses multiple climate zones, making weather unpredictable across regional areas. Extreme weather can cause power surges that may lead to transformer explosions or other unexpected outages, which are particularly impactful in areas with limited access.

Such abnormal weather patterns, in tandem with a continued expected increase in power demand over the next 15 years, means African governments must continue to attract or deploy available funds to implement various solutions that will help accelerate energy access and fortify the region's existing power grids. Estimates for the Sub-Saharan African region alone are anticipated to require an additional $300 billion in infrastructure investment to increase access to power and reliability—of which smart grids could be beneficial.

## OPPORTUNITIES TO INNOVATE

The shift from traditional energy models to more modern, decentralised versions can be daunting for some who are not accustomed to decentralised systems. Finding ways to harmonise both centralised and decentralised power remains an issue for many regions where the absence of sound contractual frameworks and enforcement do not raise investor confidence in some locations.

To some extent the general level of resistance to smart grids in Africa and other regions is reflected in a World Energy Council 2016 Report, where decentralised systems have "moved from priority action to critical uncertainties." Trepidation around decentralised energy business models are not limited to the African continent—the report also reflects the need for North American and European governments and power utilities to adapt traditional business model thinking for decentralised system inclusion. Complemented by smart grids, a better balance of renewables and conventional energy and reliable energy supply will result.

Botswana reached an energy milestone in August 2016 by introducing its Energy Regulatory Bill. The bill provides the legal framework to facilitate Independent Power Producer (IPP) participation that will help enhance the country's energy system from accelerated development and completion of critical projects. It will also enable IPPs to charge tariffs under the approval of independent regulators. This development has been cited as a positive development by credit ratings agency, Moody's, with the belief that this will help address the country's energy deficit in the future.

African governments must drive smart grid uptake by creating an attractive and well-regulated environment for investors, detailing guaranteed returns on investment, amongst other factors. Successful integration of smart grid technologies must also consider the benefits of a programmatic versus project-to-project based approach given the economic and environmental benefits for utilities and customers and holistic risk management advantages.

## MAKING HEADWAY IN AFRICA

There have already been successful movements towards decentralised power and smart grids in Africa. The Western Cape Province in South Africa is a good example of pioneering smart grid technologies. GreenCape, a non-profit organisation led by the Western Cape Government to support the development of green economy, undertook business case projects in the Drakenstein, Saldanha Bay and Witzenburg municipalities between 2013 and 2014.

These projects tested the feasibility of smart grid advancements, barriers and the uptake of related technologies—as well as the accompanying economic development opportunities. Smart grid technologies varied from smart metering to substation metering and embedded generation into the municipality's processes. Benefits derived from these case studies included outage management, demand response, customer enablement and asset management. Challenges were identified and addressed along the way, including the shortage of necessary technical skills to drive smart grid implementation at the municipal level in addition to existing smart technology value and risk perceptions.

The Western Cape Government continues to drive smart grid progress and push for decentralised power through tariff incentives for businesses and households that generate their own energy and contribute to the grid. The province also continues to engage the national government on further possibilities of procuring energy directly from IPPs.

In South Africa's Gauteng Province, the Ekurhuleni Municipality has been utilising a metering system to manage water and electricity use and supply. The project is moving towards implementing smart metering which would provide more accurate and actionable data for proactive energy management. Advanced metering infrastructure systems can assist with demand-side management measures and, ultimately, mitigate the effects of electricity generation capacity shortages.

Elsewhere on the continent, Ethiopia is an African smart grid story-in-the-making. The country's transition to a middle income country by 2025 includes plans to bolster its energy supply with the increased use of multiple naturally-available renewable applications such as hydroelectric, wind, solar and geothermal sources. Moreover, the country is also further evolving and fortifying its transmission system in order to incorporate smart grid technology, and additional renewable energy and fossil resources.

## SUPPORTING A GROWING MARKET

Hurricane Matthew's disruption to the Southeast U.S. power grid successfully demonstrated the resilience of smart grids in tough weather conditions, something African countries will also greatly benefit from given the increasing occurrence of disruptive events in the region. As an integral part of smart utilities and the smart cities' movement, smart grids are beginning to be recognised worldwide for their ability to add stability and resilience to the grid while also helping to manage excessive energy supply.

If widely deployed, smart grid technology can support economic development in the African market. Yet, financing, creating a viable business model, as well as firm support from the region's government, are critical for progressing these and other vital initiatives across the continent. Additionally, an integrated and comprehensive program approach can ensure that smart grid investments benefit from its advantages, meeting all stakeholders' energy management goals.

# GRID MODERNIZATION

## SHIFTING TO A DIGITAL GRID TAKES SYSTEMWIDE GRID MODERNIZATION

By Edward Sutton

We are at the dawn of the Fourth Industrial Revolution, defined by its velocity and volume, scope and scale, and systems impact. The foundation of this new era is squarely built upon the success of the "digital grid." The first three revolutions —defined by the introduction of steam and mechanization, electricity and computing, respectively—all had profound societal impacts, but they lacked the exponential rate of technological breakthroughs and complexity that define the fourth.

Modernization is the vehicle to the digital grid and is defined not only by analog conversion, embedded computing and communications but also by a holistic disruption of all aspects of the energy landscape. Business models, governance and societal interaction converge in a socio-technical future that has as much opportunity as risk. The dependence of all other industries on electricity further embodies the need for strategic approaches to ensure the digital grid's success.

The implications of this converged state are far-reaching and can offer insight to utilities, new energy players and technology innovators. Three paradigms begin to emerge that and can provide clarity to achieving an effective grid modernization strategy:

1. Systems Thinking
2. Managing Complexity
3. Service Orientation

## SYSTEMS THINKING

The basis of systems thinking is that the whole is greater than the sum of the parts. From this viewpoint, it can be seen that the relationships or connections between the parts drive the true value of the system. From here it becomes clear that the objective of the system is not dependent on what those parts are, as much as what they can achieve together. Therefore, OT and IT convergence can be seen as an inalienable facet of the digital grid, and the bridge to it is systems thinking.

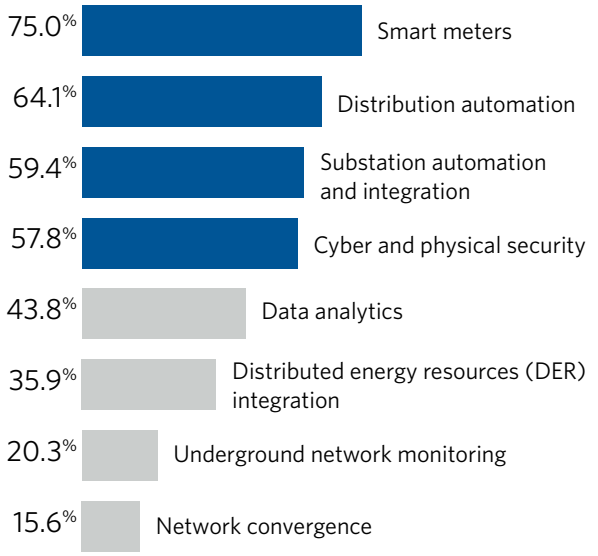
For a long time, many utilities associated the smart grid with computer-enhanced meters or Advanced Metering Infrastructure (AMI), and today, smart meters still represent 75 percent of use cases for grid modernization. However, distribution automation, substation automation and cybersecurity collectively account for a majority of utilities' grid modernization efforts. This represents the transition to the era of the digital grid and a major shift in priority and investment (Figure 13).

Creating a digital grid is essential to building a system of multi-way power and information flow needed to implement flexible and scalable grid operations. Digital technology exists today for a variety of uses, including renewable integration, increased monitoring and control capabilities, analyzing data for intelligent insight and action, and improving customer interaction and engagement.

Deployment of this new technology and subsequent operations and maintenance will only increase in complexity. Utility systems will interact with consumer systems, prosumer systems will influence grid planning and reliability, and the collective whole will have to adjust to a new norm in managing a larger number of assets. This means connections and complexity will rise exponentially with the modern times.

FIGURE 13

**What are the primary use cases of your Grid Modernization strategy/plan? (Select all that apply)**




*Source: Black & Veatch*

**When these data are presented in a meaningful and useful manner, it not only helps with efficiency and reliability, but assists with key decision-making in real time.**

## MANAGING COMPLEXITY

The crux of the problem is not that the technology is unavailable, but the task can become daunting when trying to implement at scale. The priority must be managing complexity and volatility. Digital distribution automation systems drive a massive onslaught of data—potentially thousands of data points needing integration. When these data are presented in a meaningful and useful manner, it not only helps with efficiency and reliability, but assists with key decision-making in real time.

Due to the complexities of deploying at scale, Black & Veatch has been working on a solution, a new software program called SEKOIA. The GIS-based single source of data uses mapping to help utilities manage the vast amount of data into a system-based asset life cycle platform. In SEKOIA, every asset owned by utilities is displayed on a map, so that clicking on the location allows immediate searching for information. SEKOIA drives a four-dimensional view—including time—that is more actionable, than just scrolling through numbers on a page.

SEKOIA is built on top of the company's ASSET360™ data analytics platform. It is contained in a cloud-based environment and is available securely anywhere with an internet connection, making it ideal for mobile operations. The platform captures, integrates and analyzes data and defined key performance indicators, such as field data, drawings, schedule, budget, resources and quality metrics, and combines them with massive-scale project management and controls. This creates a holistic view of a system's performance to guide day-to-day operations, decision-making and real-time scenario planning.

## SERVICE ORIENTATION

The electron at the end of the tunnel still shines brightly. Systems thinking and managing complexity are innately human qualities. The modern age is as much industrial revolution as it is human evolution, and with this maturity come new value streams.

One of the new value streams is service-oriented architecture, which embodies software structure to the business model, from governance to policy. Services are the capitalization of the other two paradigms and provide the basis for the valuation of the Fourth Industrial Revolution and our digital grid.

The modern age is as much industrial revolution as it is human evolution, and with this maturity come new value streams.

# GRID MODERNIZATION

## EPIC INVESTMENT TRENDS IN SMART DISTRIBUTION SYSTEMS

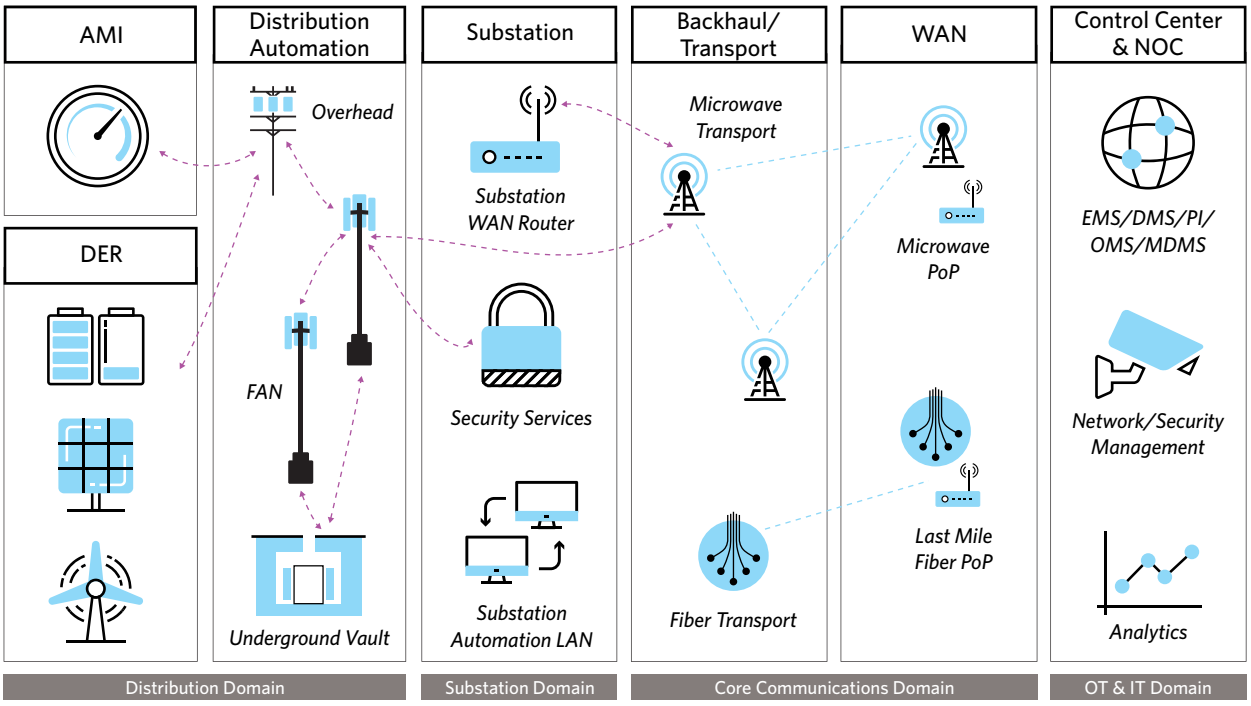
By David Hulinsky

For more than 100 years, electric utilities worldwide made relatively few investments to electric distribution networks; focusing primarily on generation and transmission infrastructure. As such, the traditional electric distribution system—comprised of a passive network of poles, wires, transformers and capacitors—delivered power to commercial, industrial and residential customers in largely the same manner for decades. While this network served its purpose well, its unidirectional architecture did not provide system operators with the ability to monitor or obtain any visibility into the actual performance of their systems. Today, expectations have changed.

Historically, most utility capital investments focused on regulated generation and transmission assets that provided the basis for customer rates structures and returns. But the growing interconnectivity within utility assets and networks now requires a more holistic approach to planning, and many regulators are requiring utilities to invest in distribution under similar reliability mandates to those governing generation and transmission markets.

Increasing electric distribution reliability and overall quality will require an active network, a "smart distribution system." A smart distribution system is an integration of automation and communication systems as primary components to support the end-to-end operations and analytics of the electrical distribution grid. Electric distribution is no longer a passive network of poles and wires.

SMART DISTRIBUTION SYSTEM: ACTIVE NETWORK

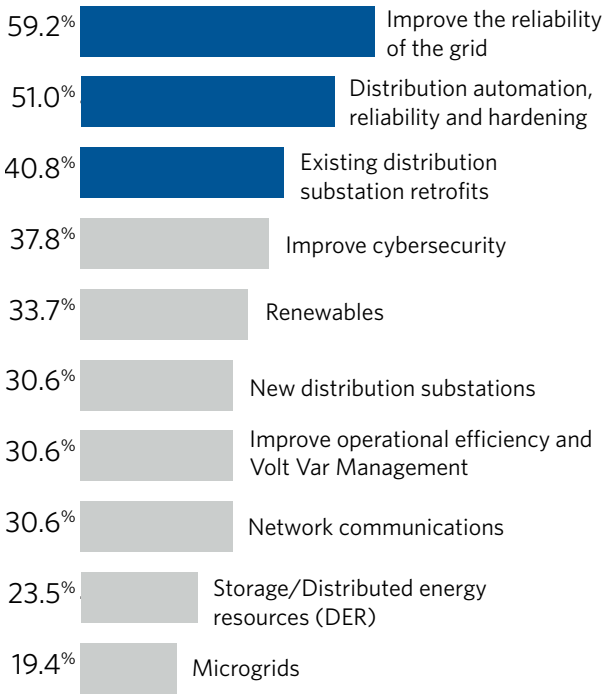



*Source: Black & Veatch*

Nearly 60 percent of *Strategic Directions: Smart City/Smart Utility Report* survey respondents identified the need to improve the reliability of the electric distribution grid as their leading investment driver for distribution grid modernization. Most of the drivers that respondents selected at 30 percent or higher require foundational automation and communication systems like cybersecurity and renewables, to fully realize the benefits of investment (Figure 14).

FIGURE 14

**Many utilities are investing in Grid Modernization that is focused on electric distribution systems. What are the drivers for modernizing your electric distribution systems? (Select all that apply)**




*Source: Black & Veatch*

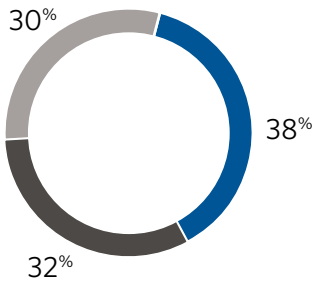
## SYSTEM-WIDE CAPITAL PLANNING

With the benefits of smart grid investments widely acknowledged, the age of most existing distribution infrastructure creates significant challenges for electric utility planners. According to the American Society of Civil Engineers, 60 percent of the six million distribution miles within the U.S. have surpassed its life expectancy of 50 years. Due to the age of this infrastructure, a fundamental shift in mindset and investment planning will be required to meet regulators' reliability mandates and improve the overall quality, efficiency and security of the distribution system. These systems were typically repaired as necessary, but the advent of two-way, interactive communication and automation technologies has made traditional like-for-like replacement a thing of the past.

Some utilities have started taking the necessary steps to meet these mandates. More than 60 percent of survey respondents will spend more than $5 million and approximately 20 percent will spend over $50 million implementing grid modernization efforts in the next three years (Figure 15). These figures are consistent with a recent Harris & Williams Co. report that projects over $500 billion will be required to replace aging distribution infrastructure to meet the mandates through 2030.

FIGURE 15

**Aggregate Smart Distribution System Spending For The Next Three Years**




*Automation and communications are primary components to smart distribution systems*

- Less than $5 million
- $5 to $20 million
- More than $20 million*

** Approximately 20% of utilities plan to spend more than $50 million*

*Source: Black & Veatch*

## HOW TO CLOSE THE FUNDING GAP

As noted throughout this report, greater integration between utility systems, converging regulatory mandates and rising customer expectations are forcing utilities to pursue system-based approaches to planning, implementation and asset operation.

This creates a need to invest a massive amount of capital, which public utility commissions (PUCs) and other regulatory authorities are reluctant to shift entirely to ratepayers. In May 2016, the American Society of Civil Engineers calculated a $50 billion funding gap for electric distribution systems alone. To address this shortfall, service providers are increasingly looking to P3s to provide alternative financing options.

Though widely used across Europe and Australia's water sectors, or to finance many toll roads, P3s are taking a more active role in approaching electric utilities and offering to invest in their infrastructure assets. These groups seek to invest in utilities by way of performance contracting and other concession agreements. They provide equity to invest in system improvements to make assets more reliable and efficient, and receive a portion of the overall savings provided to the asset owner.

P3s are early in their development cycle, but the growing financing gap is driving greater consideration of alternative financing to assist utilities in meeting their performance mandates. When outages or other events happen, utility operators require more information available to them and their customers. Energy usage and quality, outage maps, customer service and billing are moving into the geospatial digital age of analytics. Internally, utilities are shifting their orientation to the customer versus simply focusing on supplying power for the rate payer. To achieve this, next generation service providers will require smart distribution systems as integral parts of their DNA.

# GRID MODERNIZATION

## MAXIMIZING SMART GRID DEPLOYMENTS THROUGH COMMUNICATIONS AND NETWORK INFRASTRUCTURE

By Rick Tyrell and Mike Prescher

The future of electric utilities is tightly bound to their ability to provide automated distribution of electric services. To support these evolving intelligent delivery systems, reliable high performance Internet Protocol (IP) data communications are required. Today's utility communications networks consist of two distinct parts: Information technology (IT) and operational technology (OT), with the IT network supporting the business operations and the OT network supporting electric service delivery operations.

By building communications networks that can more tightly integrate business drivers and goals with the day-to-day load demand for their customers, utilities are taking the initial steps toward integrating the smart grid with smart cities. The foundation for both utility systems integration and smart grid/smart city integration is the communications network.

Today, a majority of utilities are struggling with deploying private or public communications infrastructure that can effectively support both IT and OT services. According to the *2017 Strategic Directions: Smart City/Smart Utility Report*, only nine percent of utilities deemed their current communications networks "adequate" to support future needs and requirements for grid modernization. Half of the respondents stated that their systems are "close to adequate," and that they are currently working to update them.

Some utilities approach the modernization challenge by continuing to evolve their existing infrastructure, which often consists of two independently operated networks supporting IT and OT. Others are attempting to use advanced capabilities in IP networking infrastructure equipment and applications to logically control the boundaries between business and delivery operations.

Both approaches can provide value and advantages that support future smart grid strategies. The report also reveals that almost three-quarters of respondents identify supervisory control and data acquisition (SCADA) and distribution automation backhaul as major areas for investment (Figure 16).

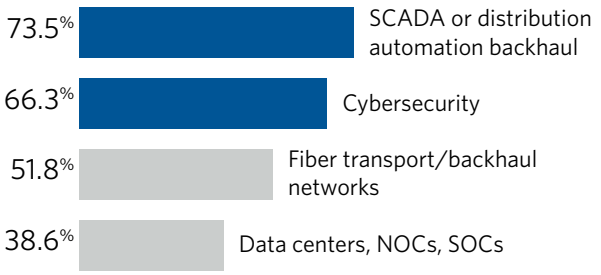
Responses indicate a clear trend and preference for infrastructure solutions that promote further integration of communication between substations and control centers. This approach allows operators to efficiently and reliably manage the network infrastructure and obtain the analytics required for monitoring and controlling today's advanced distribution automation systems. All of these aspects allow utilities to extract the highest levels of efficiency to support their daily operations and customer demand.

While recognizing the need for communications network modernization, some utilities have resisted building out their own private communications infrastructure. This resistance is partly due to the substantial capital investment required and current reliance on third-party telecommunications providers. However, relying on leased networks involves recurring operating expense (OPEX) costs significant enough to warrant serious consideration for investing in privately owned and operated infrastructure strategies.

Utility communications networks often rely on a combination of different communications technologies (Figure 17).

FIGURE 16

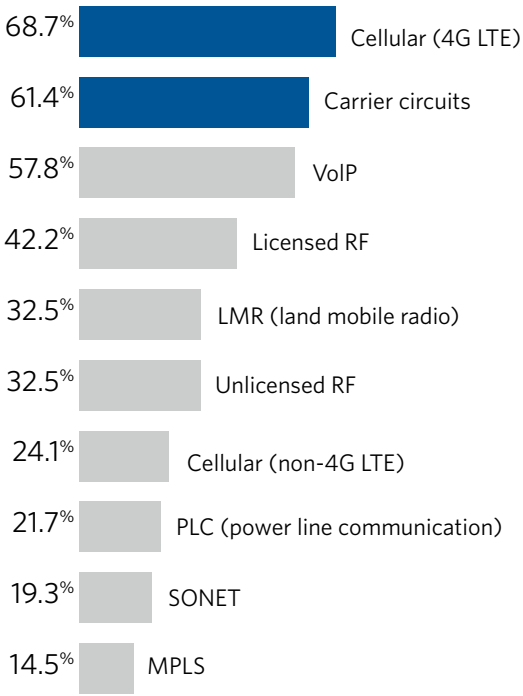
**Many utilities are investing in their private communications network infrastructure. What do you believe are the major areas for investment? (Select all that apply)**




*Source: Black & Veatch*

FIGURE 17

**What type of communications technologies are currently in use by your utility? (Select all that apply)**




*Source: Black & Veatch*

If a utility does not make a deliberate and careful telecommunications master planning effort, the road to building out communications and IT/OT network infrastructure can be a bumpy one.

The results of Black & Veatch's survey indicate that 69 percent of respondents are using cellular (4G LTE) networks, 61 percent are relying on carrier circuits and 42 percent are using licensed radio frequency (RF), with some reliance on land mobile radio (LMR), unlicensed RF, cellular (non-4G LTE) and power line communication (PLC), among others. Almost half of survey respondents (49 percent) said they are struggling with interoperability issues arising from integrating multiple technologies and vendor solutions into their current communications network, while 48 percent are dealing with challenges related to obsolete or end-of-life communications network infrastructure.

Utilities would benefit from investing in private network infrastructure in a myriad of ways, certainly from the reduction of extensive OPEX charges from telecommunications providers. Operating privately-owned communications infrastructure also frees up the business to more rapidly adjust to "sun setting" technologies, improve monitoring and support visibility, and more actively pursue virtualization. Given the ever-increasing rate of technology change, the best option is to create a flexible network with true value engineering benefits to both business management and delivery operations. Ideally, utilities would like to have both private and public options – to have the convenience and reliability of a provider, while having the highly customizable capabilities a private network can bring.

If a utility does not make a deliberate and careful telecommunications master planning effort, the road to building out communications and IT/OT network infrastructure can be a bumpy one. For instance, the physical communications network infrastructure is only a subset of what is required. Since U.S. utilities must adhere to security requirements, such as the North American Electric Reliability Corporation (NERC), utilities must pay close attention to the logical data flow impacts of their solution choices, not just the physical impacts and construction costs. This year's survey reveals that 62 percent of utilities view network security and regulatory compliance

**Black & Veatch also provides gap analysis, solutions analysis and roadmap planning assistance, which can turn a master plan into a fully deployed, intelligent and sustainable network solution.**

as a leading challenge, and 66 percent identify cybersecurity as a major area for investment moving forward.

Although NERC already requires certain levels of security for different types of distribution substations, utilities must be aware that if they build out a private communications infrastructure, they will have to meet different requirements and implement compliant physical and logical security solutions as well.

For utilities that want to pursue and take advantage of the capital expenditure savings inherent in network virtualization and/or any IT/OT integration, close attention must be paid to logical design and sustainment planning. Limited resources and personnel add yet another layer of challenge to implementing new communications and network infrastructure technologies. Thirty-two percent of utilities say they do not have adequate network staff and communications expertise in-house. The majority of respondents (67 percent) rely on a communications network support team of less than 10 professionals; looking ahead, only 54 percent plan to expand their staff in the next five years. With such limited staff, building out a private network infrastructure with extensive logical network communications control requirements will prove to be challenging.

Black & Veatch, for example, has many clients working to unify all the various systems present in their current infrastructure. Black & Veatch assists them in their efforts to strategize about their telecommunications master planning. This includes conducting current and future state assessments of the utility's energy management system network and overall telecommunications architecture components, helping to ensure optimum business and delivery operations.

Black & Veatch also provides gap analysis, solutions analysis and roadmap planning assistance, which can turn a master plan into a fully deployed, intelligent and sustainable network solution. Together, these assessments and analyses provide vital information in support of strategic plans for consolidation, integration, modernization, and deployment and activities that make up the essential foundation necessary to transform into a smart utility.

# CLOSING COMMENTARY

## COLLABORATION, CREATIVITY AND PLANNING WILL DEFINE SMART CITIES

By Fred J. Ellermeier

The rise of smart cities will rely on the ability of stakeholders to collaborate, engage citizens and act on data. Partnerships are hard at work and planning is under way to overcome the legacy of siloed services, focus on integrated systems that will ultimately be more adept at delivering critical services, empower communities and elevate our quality of life.

From Barcelona, Spain, to Boston and San Diego to Singapore, lofty conceptualization has given way to tangible advancements that harness the power of information across connected systems. Analytics tools give leaders the power to rationalize costs, benefits and risks of project options against multiple scenarios and stakeholder objectives. The smart city concept is truly one of an ecosystem, driven by partners who develop roadmaps that define, and ultimately enable, the smart city vision.

These ecosystems mirror those found in nature; richer information supports more diverse and more effective strategies and behaviors. But such a panoramic approach has not yet fully ignited a smart city revolution. Many cities and utilities remain on the sidelines, kept there by perceptions that smart city technologies are distant and expensive.

Each of those barriers can be overcome by carefully considering some key components of a smart city.

## A CHIEF INNOVATION OFFICER TO OVERSEE THE URBAN EVOLUTION

Cities are poised to be the centers of technological deployment. Many are already driving advancements in smart transportation, and initiatives are taking root that use advanced data networks to connect citizens to their cities through real-time and responsive information. Maintaining this momentum, however, will require smart city champions— voices for this new infrastructure who see the larger nexus connecting data with critical infrastructure.

Smart city projects need to be directed from the senior city official level; mayors, city managers, chancellors and governors should be the voices calling the disparate stakeholders to rise up and work together to reach the smart city imperative. Such officials need a leader who will help develop and champion the vision; someone who understands the technology and the ecosystem and can navigate and produce solutions. The smart city landscape benefits greatly from the position of the Chief Innovation Officer who can work across the whole landscape to deliver the vision.

Just as power and water utilities require leaders who are intimately familiar with those sectors, so should a city have someone to oversee the smart city transformation. Many cities, such as Austin, Texas, and Kansas City, Missouri, have hired Chief Innovation Officers, central leaders who network, message and become a prominent voice in the smart city ecosystem to spearhead the planning for the city's future.

## BECOMING OPEN SOURCE

By considering smart cities in an "open source" context, leaders can leverage advanced technology and allow innovation to take place, all the while maintaining a transparent approach that places public understanding and benefit at the center. Light poles and street corners take on new life as networked hot spots. Connected kiosks and beacon technologies convey vital information and do so through open data platforms that allow systems to talk freely with each other without the inhibitions of proprietary software.

Many cities, including Chicago and Singapore, are adopting an open-source philosophy to their initiatives, and these cities are becoming technology incubators. City planning that looks at infrastructure as isolated systems and relies on proprietary technologies risks slowing the adoption of technological advancement. Compounding this problem, cities are also at risk when they rely too heavily on codes and standards that were written for a different time and purpose.

This kind of innovative thinking is unleashing fascinating and useful initiatives that demonstrate the smart city promise. For instance, the city of Chicago recently launched what it calls a "fitness tracker" through which vital information on traffic patterns, air quality and other measurements flows from light pole-mounted sensors. Data collected through the sensors ultimately land on the city's website, giving residents real-time views that can inform daily decision-making, such as whether that day's air quality is suitable for walking to work or taking the train.

## ENHANCING THE GRID TO ADAPT WITH RAPIDLY EMERGING TECHNOLOGIES

The electrification of transportation (personal, commercial and mass transit) and adoption of distributed energy resources has put sustainability within the reach of cities. Without active planning and management—with data capture at the center—these technologies threaten to destabilize the grid. Having a long-range vision coupled with data-driven planning can put utilities in front of the impacts by giving them room to drive system upgrades and modify rates, customer engagement programs and operations.

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**Within the smart city ecosystem, the innovative thinking that elegantly knits together technological and financial solutions that work in concert to solve some of the largest urban issues must be applauded.**

## CREATIVE FINANCING

Smart city projects often clash with in-the-moment budget priorities, such as aging infrastructure, deteriorating roads and even a demanding public, who is likewise struggling to attain a better quality of life. This struggle is genuine, and the money required to pursue smart solutions to these problems often outstrips today's budgets. For example, a city's necessary but budget-squeezing upgrade of aging streetlights and related infrastructure could prompt the city to explore traditional funding routes, such as increasing taxes or issuing bonds—two methods that require a business and public appetite to support.

Increasingly, municipalities are seeking creative thinking. Last year, one major California city issued a Request for Proposals for a city infrastructure upgrade. In essence, the request was a courageous invitation that said, "We want the upgrade. We have no money to contribute, but we have assets and a willingness to listen to your best ideas." Within the smart city ecosystem, the innovative thinking that elegantly knits together technological and financial solutions that work in concert to solve some of the largest urban issues must be applauded.

A potential dual-purpose creative solution exists: The operational savings and revenue streams generate not only support for the upgrade but also provide additional—and scalable—fundamental smart city infrastructure. Such strategies can work for all cities when modified to fit their particular profile and needs. This solution also demonstrates the value of tossing aside convention and pursuing radically different approaches to explore and test.

## A PANORAMIC PERSPECTIVE

In some cases, smart cities can suffer from "innovation frustration" where new technology is both beneficial and problematic. However, information sharing and collaboration enable industry stakeholders to better understand innovative and disruptive technologies.

There is room in the ecosystem for both top-down vision and community-sourced innovation. Armed with advanced technology, innovative financing and strategic integration of critical systems, cities are marching toward a safer and more sustainable future. The bidirectional flow of data between the citizens and the city will provide opportunity for real-time decision-making for both parties. As these systems learn, refine and adapt, cities will provide new and more robust benefits to their diverse inhabitants.

# THE BLACK &VEATCH ANALYSIS TEAM

## INTRODUCTION

Fred Ellermeier is a Vice President and the Managing Director of Black & Veatch's Smart Integrated Infrastructure (SII) business. This business leverages distributed infrastructure development capabilities with a high-end analytics platform to address the areas of asset management, operational efficiency, reliability and sustainability for a wide variety of clients. With more than 20 years of experience, Ellermeier is an expert in energy management, energy optimization and sustainable design practices.

John Janchar is Executive Vice President of Public Networks & Private Networks for Black & Veatch's telecommunications business and leads the public networks, private networks and public safety service lines. He is responsible for establishing the strategic direction of the business, as well as new business development, client engagement, operations and project execution. Janchar has been a leader in the telecommunications industry for more than 20 years and helped grow the company's business from inception. Black & Veatch's telecommunications business provides vertically integrated solutions to both public and private network clients around the world.

## SMART CITY

Clint Robinson is Associate Vice President of Black & Veatch's Government Affairs team and works collaboratively with professionals within Black & Veatch's businesses, industry stakeholders, association partners and consultants to build relationships with government officials to achieve Black & Veatch's overall global growth strategies. Robinson has more than 32 years of experience as a registered professional engineer. He is currently engaged with the U.S. Conference of Mayors, the National League of Cities, the Edison Awards Steering Committee and the American Council of Engineering Companies as a business partner participating in discussions on sustainable, resilient smart city concepts.

Jennifer James is the Smart Cities Solution Lead for Black & Veatch's SII business. She works with internal domain experts, clients and industry partners to advance smart infrastructure and analytics solutions that enable city systems to be planned and managed more holistically and sustainably.

Steph Stoppenhagen is the Smart Cities Business Development Manager for Black & Veatch's SII business. She is recognized as a technology solutions expert, strategizing with clients to deliver value from smart infrastructure, networks and data. Her successes include creating consortiums to deliver complex, integrated smart city programs and products. She was responsible for developing  a technical mapping team of solar experts that defined a patented methodology called SAFE™ Method (Solar Automated Feature Extraction) which automates the process of examining the photovoltaic potential of rooftops/ reduces the time to analyze this potential by 75 percent.

Mike Bossom is a Smart Cities and Solution Lead for Black & Veatch's SII business. He has more than 20 years of technical and leadership experience from wireless network performance, engineering, design and operations to analytics applications and integration. He has directed the teams' radio frequency engineering, network performance, operations and technology migration for 2G, 3G and 4G wireless networks. His experience also includes end-to-end analytics consulting, data modeling, visualization, statistics and real-time complex event processing.

G. Scott Stallard is a Vice President within Black & Veatch's SII business, leading development and commercialization efforts for its ASSET360™ Data Analytics platform. In this role, Stallard leads Black & Veatch efforts in developing the cutting-edge, industry leading analytics needed to address challenges and opportunities induced by increased operational complexity, widespread adoption of digital technologies and the opportunity to leverage large quantities of data.

Paul Scutieri is the Sales Director for Public Safety within Black & Veatch's telecommunications business. In this position, Scutieri leads business development initiatives including identifying, cultivating and managing client support relationships and developing direct-to-system owner support opportunities. He previously managed RF communications for the New York State Statewide Wireless Network with Harris Corp. He currently serves on two Association of Public-Safety Communications Officials-International (APCO) committees: the Emerging Technology Committee and the APCO Historical Committee.

Maryline Daviaud Lewett is a Business Development Manager for Black & Veatch's SII business. She is responsible for sales and partnerships for alternative fuel and behind-the-meter energy storage initiatives, which focus on disruptive technologies such as smart transportation, smart city applications and distributed infrastructure. Daviaud Lewett has extensive expertise in business development and team management in the software and hardware green technology, life sciences and energy sectors.

Paul Stith is a Solution Lead for Black & Veatch's SII business, specializing in sustainable transportation and energy storage solutions. He has experience in building policies and relationships with key agencies and partners where grid interactive electric vehicles and energy storage assist in solving pressing energy challenges.

## SMART UTILITY

David Price is Senior Managing Director for Asset Management in Black & Veatch management consulting. He has developed utility products and solutions currently in use by utilities in North America and Europe. Price has 30 years of experience in management, strategy, product development, consulting, delivery and operations in the utility and enterprise solutions markets. He is an expert in work and asset management, field operations, energy market operations, meter data management, and smart grid systems and processes.

Jim Nightingale is a Director in Black & Veatch management consulting. He focuses on the energy and utilities industries including water, electric, gas distribution, and the oil and gas industry both upstream and downstream. His background is in asset management, system implementation, organizational transformation and customer service in those industries. Nightingale manages complex projects requiring a combination of organizational and change skills and deep functional expertise.

Andrew Woods is Black & Veatch's Indonesia Deputy Country Manager. In addition to supporting Indonesia's target to narrow its electrification gap, Woods is leveraging Black & Veatch's global expertise in water, telecommunications and smart city services to expand the infrastructure solutions the company provides in Indonesia. Before moving to Jakarta, Woods helped lead Black & Veatch efforts to develop wireless telecommunications infrastructure across the United States.

Sherri Jett is Black & Veatch's Distributed Generation Southeast Asia Lead supporting Indonesia's electrification growth targets. Jett draws on Black & Veatch's global expertise in conventional and renewable power, microgrid/hybrid, smart grid and smart city services to expand the infrastructure solutions the company has provided in Indonesia for more than 40 years. Before moving to Jakarta, Jett was a Project Manager for Black & Veatch's Power Generation Services business line, providing new and retrofit power generation services to clients in America and around the globe.

Jeremy Klingel is a Power Industry Executive Management Consultant for Black & Veatch management consulting, where he focuses on the design and implementation of customer-facing, distributed energy resources and critical infrastructure programs. Klingel has led over two dozen smart grid development projects. His expertise includes developing and delivering market strategies for electric utilities on grid-related initiatives and helping utilities optimize operations.

Jeff Buxton is an Executive Consultant with Black & Veatch. He has more than 30 years of industry experience with particular expertise in strategic business planning, technology roadmapping, deployment and organization planning, and regulatory support.

Will Williams is an Associate Vice President in Black & Veatch's Asset Management practice. He has more than 20 years of experience in asset management planning, including asset failure analysis, risk assessment, performance benchmarking, maintenance optimization and business change management, among other areas. Williams is based in Atlanta.

Webb Meko is a Regional Business Development Manager for Black & Veatch South Africa. He has provided technical expertise, management and advisory services for more than 20 years to South African and international clients in the energy sector within Africa. Meko's areas of expertise include power system planning and electrical power system design, electrification, project management, program management, feasibility studies, private power projects development and power plant maintenance.

Edward Sutton is a Principal Consultant and Systems Manager focused on grid modernization. His multifaceted background, rooted in power systems and critical infrastructure, has cultivated his present work in developing system-level solutions to the complex problems facing utility clients. He has thorough experience in leading and managing, from concept to completion, a wide array of complex power system and emerging technology projects. His experience ranges from legacy system integration to system-of-systems conceptualization and architecture.

David Hulinsky is the Utility Telecom Director for Black & Veatch's telecommunications business with 20 years of industry experience. Hulinsky's areas of expertise are thorough knowledge of electric and telecommunication systems and managing complex projects. Hulinsky has also successfully led some of Black & Veatch's largest utility communications and grid modernization projects for leading utilities, such as SDG&E, Hydro One, CPS Energy, United Illuminating and NV Energy.

Rick Tyrell is a Network Architect for Black & Veatch's telecommunications business, where he is primarily responsible for data network infrastructure design and implementation. Tyrell's varied project experience centers primarily on wired and wireless internet protocol (IP) networks while applying best practice principles for secure data transmission, high availability and virtualization.

Mike Prescher is a Network Achitect for Black & Veatch's telecommunications business and is responsible for data network infrastructure architecture design, while applying best-practice principles for secure data transmission, high availability and virtualization. He has provided consultative expertise to Fortune 500 companies and utilities across North America involving network and application systems designs, many involving implementation projects utilizing multi-protocol label switching technologies.

## CLOSING COMMENTARY

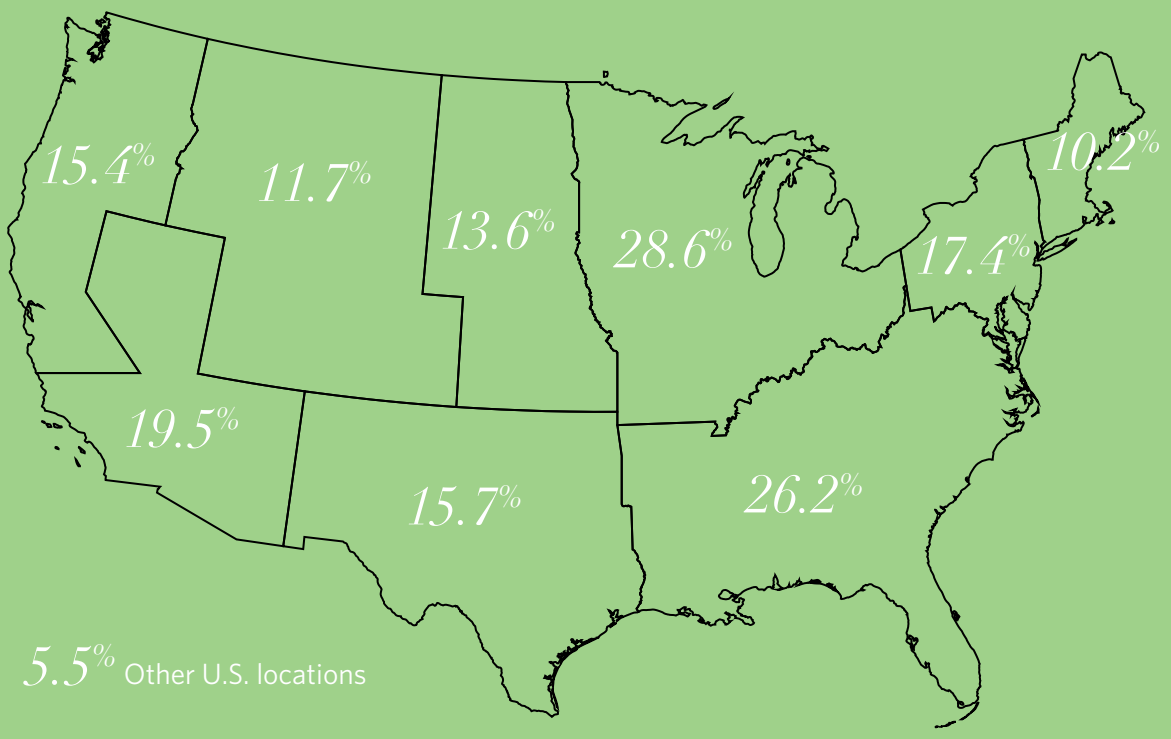
Fred Ellermeier is a Vice President and the Managing Director of Black & Veatch's SII business. This business leverages distributed infrastructure development capabilities with a high-end analytics platform to address the areas of asset management, operational efficiency, reliability and sustainability for a wide variety of clients. With more than 20 years of experience, Ellermeier is an expert in energy management, energy optimization and sustainable design practices.

# 2017 REPORT BACKGROUND

The annual Black & Veatch *2017 Strategic Directions: Smart City/ Smart Utility Report* is a compilation of data and analysis from an industrywide survey. This year's survey was conducted online from 19 October 2016 through 4 November 2016.

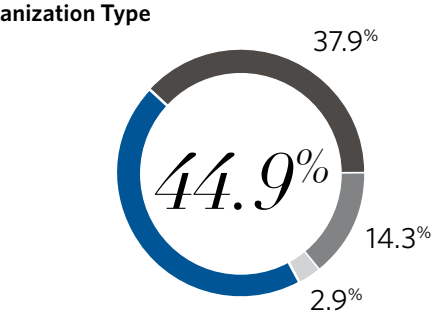
A total of 741 qualified utility, municipal, commercial and community stakeholders completed a majority of the survey. Because the survey was administered online, the amount of self-selection bias is unknown, therefore, no estimates of sampling error have been calculated. The following figures provide additional details on the participants in this year's survey.

**Primary U.S. Business Region**




*Source: Black & Veatch*

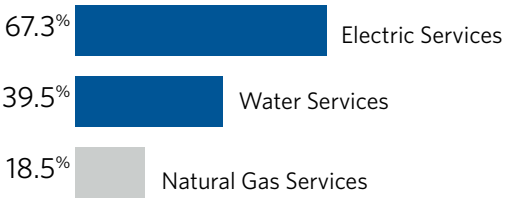
**Organization Type**




- Federal/State/Local/Government/Municipality
- Electric, Water or Natural Gas Services Provider
- Smart Services Provider
- Public Safety Agency/Department/Organization

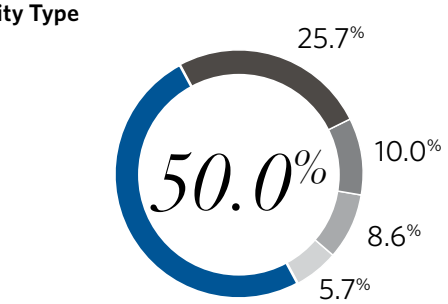
*Source: Black & Veatch*

**Utility Services Provided**




*Source: Black & Veatch*

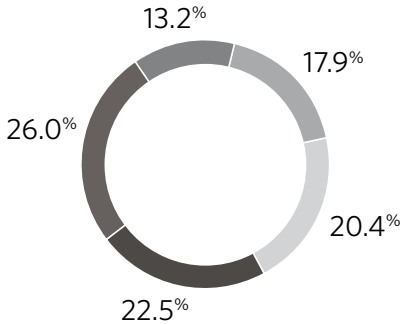
**Utility Type**




- Public or government-owned utility
- Investor-owned utility
- Independent/industrial power producer
- Privately held corporation
- Other

*Source: Black & Veatch*

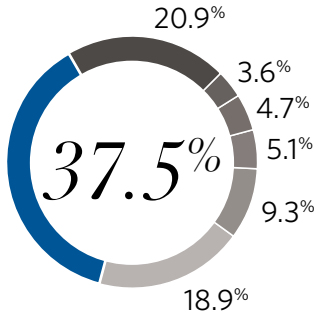
**Population Served**




- Less than 100,000
- 100,000-499,999
- 500,000-999,999
- 1,000,000-1,999,999
- 2,000,000 or more

*Source: Black & Veatch*

**Job Function**




- Director, Supervisor or Manager
- Engineer or Operator
- Scientist
- Consultant or Analyst
- Support Staff
- Other
- Executive or Government/Municipality Leadership

*Source: Black & Veatch*

# LIST OF FIGURES /TABLES

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