From power generation and delivery to water and telecommunications, the systems that manage and deliver our world’s most critical resources are undergoing a stark transformation. Led by growth in renewable energy, the global push toward sustainability is disrupting outdated business models. High-speed networks are moving staggering amounts of information that simultaneously create opportunity and vulnerability. Meanwhile, enterprise and utility leaders are thinking holistically to manage and integrate once disparate infrastructure silos that must now work together to achieve real sustainability.

To capture this transformation, Black & Veatch is proud to release the 2020 Strategic Directions: Megatrends report, which analyzes years of our Strategic Directions survey data to explore and illuminate some of the most striking and consistent trends across the water, power, telecommunications, natural gas, commercial and industrial (C&I) and manufacturing industries.

Black & Veatch collected data from thousands of professionals across those markets to identify emerging trends in sustainability, renewable energy and distributed infrastructure, data analytics and cybersecurity, and integrated execution. The result is a report that reflects these trends and maps what’s next. To learn more, go to bv.com, or download recent Strategic Directions reports at bv.com/reports.

The Black & Veatch Insights Group
In Race to Sustainability, Technologies and Trusted Teams Can Help You Break the Tape

With the March of Renewables, Electricity Sector Latest Industry to Undergo Transformation

Data Analytics: Threading the Needle of Risk and Reward

Integration Is Key From Data Management to Construction, But Can It Happen?
In Race to Sustainability, Technologies and Trusted Teams Can Help You Break the Tape

By Ajay Kasarabada, Luke Oehlerking and Brian Sifton

When Kenyan marathon great Eliud Kipchoge crossed the finish line at 1:59:40 in Vienna in late 2019, crashing through one of sport’s once-unbreakable barriers by covering the distance in less than two hours, skeptics pounced. He had help, after all: There were no competitors. He picked just the right day, with just the right conditions. Handpicked world-class pacers ran the road with Kipchoge, forming a protective bubble around him to thwart drag. Nutrition was handed to him in stride.

But strip away those “advantages,” and what remained was a runner who needed everything his wiry frame could summon to average 4-1/2 minutes a mile for 26.2 miles. And, since it was Kipchoge’s second such attempt, anything slower than 1:59:59 would raise fresh debate about humankind’s physiological wall.

So what can Kipchoge’s feat teach us about sustainability and climate-proofing our world’s most essential resources? The parallels are plenty. Just as Kipchoge received critical support, companies need the intake of new technologies and renewables hardware that are falling in cost and growing in capability. And as Kipchoge needed pacers, enterprise organizations need partners who can help navigate the complex landscape of meeting their sustainability commitments while making it profitable.
Above all else, breaking through barriers requires a plan. Coaching. The right tools. Ongoing support.

Increasing global temperatures, catastrophic storms, frequent wildfires and agonizing drought cycles are setting off alarms about the future of our most crucial resources. And they’re driving urgent conversations about how organizations who haven’t been convinced of the value of sustainability can reverse course. Sustainability is the central question confronting the world’s critical human infrastructure, followed closely by “how” and “how much?”

For CEOs, chief financial officers and other organizational leaders who turn these questions over in their minds, it’s not that simple. Aligning the triple bottom line principles of people, planet and profit may sound idealistic, but are those things inherently in conflict?

The hard truth of enterprise sustainability is that return on investment (ROI) matters. Many corporate leaders perceive that sustainable infrastructure — things like renewable energy, microgrids and smart water solutions — is costly. A clear trend found in Black & Veatch’s ongoing Strategic Directions report series — built on surveys of leaders across the power, water, telecommunications and commercial and industrial (C&I) sectors — is concern about the upfront cost of water and/or energy sustainability solutions.

For instance, a recent survey of commercial, industrial and manufacturing leaders found budget constraints and upfront costs as the top challenges to their sustainability aspirations, followed closely by regulatory environments and uncertainty around ROI (Figure 1).

When we asked that same audience to rank how they evaluate their approach to energy investments, sustainability ranked quite low against economic feasibility and quality of power — a strong signal that while leaders are outwardly interested in sustainability, they’re privately worried the numbers don’t add up (Figure 2).

Perhaps it’s time to recycle some old notions about the affordability of sustainability.

The most basic driving force behind new energy is the explosion of practical possibilities that new technologies create. Solar photovoltaic (PV) costs continue to fall, sitting below $1 per watt as of late 2019 and projected to decline by at least 10 percent over the next five years. Battery storage prices also are dropping, and the Internet of Things (IoT) is delivering new ways for system operators to leverage data analytics to better understand their networks and equipment and find anomalies before they become outages or leaks.

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**Figure 1**

**What is the biggest challenge for your organization to pursuing water and/or energy sustainability solutions?** *(Select one choice).*

Source: Black & Veatch

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.2%</td>
<td>Budget constraints and/or upfront costs</td>
</tr>
<tr>
<td>22.0%</td>
<td>Complex regulatory compliance</td>
</tr>
<tr>
<td>15.6%</td>
<td>Uncertain return on investment</td>
</tr>
<tr>
<td>13.4%</td>
<td>Higher priority issues that surpass sustainability programs</td>
</tr>
<tr>
<td>12.4%</td>
<td>Limited staff resources</td>
</tr>
<tr>
<td>11.3%</td>
<td>Lack of support/understanding sustainability measures</td>
</tr>
</tbody>
</table>
Every day, we’re working with clients to determine how best to leverage and apply technologies such as hybrid power generation, locally reliant microgrids and more to create win-win situations that simply weren’t options before now. Many of those clients have big plans. But with budgets and shareholder value at stake, they understandably start small.

So, where do you start?

Bringing the pieces together can appear overwhelming. And admittedly, solar arrays, wind farms and microgrid projects aren’t simple plug-and-play applications — but meeting sustainability goals is a compelling reward, with benefits that often ripple outward.

After completing thousands of successful and innovative projects, we know success is a function of being able to balance three different contributions:

1. Planning and execution.
2. A big-picture view and an eye for details.
3. Deep knowledge of legacy systems and the newest technology.

It was this kind of start-small, think-big approach that recently led to one of the largest, enterprise-level sustainability programs ever undertaken. Black & Veatch recently helped one of the world’s largest and most influential financial institutions implement an ambitious renewable energy program — which included the adoption of local distributed solar, at scale — to meet its 100-percent renewable energy goals.

This institution understood that sustainability is a long play, and it understood the advantageous business impacts of a long-term, programmatic approach to renewable energy. Lowered costs. Resilience. And, perhaps most of all, meeting the rising demands of the marketplace, where customers and clients are considering sustainability commitments as they make choices about their energy consumption and with whom they do business.
The project included the full life cycle of distributed rooftop solar and microgrids and became an end-to-end relationship that included everything from project development, program management, engineering, procurement and construction to operations and maintenance of the systems. By the time the program is completed, it will be nothing short of one of the financial sector’s most emphatic endorsements of the viability of renewable energy.

Larger organizations are the ones most likely to have established sustainability goals and associated performance metrics. Responses to our C&I survey found that the smaller the organization, the less likely it would have sustainability benchmarks (Figure 3).

Among those organizations setting sustainability goals, roughly half were tied to energy and water use combined (Figure 4a-b).

The range of tools for meeting sustainability goals has never been so robust. Today’s options range from renewable energy and battery storage to hydrogen fuel cells and the electrification of fleets and heavy-duty vehicles. Tomorrow likely will see technologies such as advanced carbon capture and electrified air transport. But it’s important to remember that sustainability starts with a plan, one that factors in cost and stakeholder value — as well as how sustainability investments are monetized. For instance, are there verification systems in place to give you credits or digital current that can be traded with others to generate revenue?

Those plans also must consider the larger societal imperative: A recent report from The Intergovernmental Panel on Climate Change revealed the planet has until 2030 to “bend the curve” related to atmospheric carbon and methane emissions.

### Figure 3

Does your organization have environmental sustainability goals and associated performance metrics? (Select one choice).

<table>
<thead>
<tr>
<th>By Number of Employees</th>
<th>Yes</th>
<th>No, but we are developing</th>
<th>No, and not developing</th>
</tr>
</thead>
<tbody>
<tr>
<td>500-999</td>
<td>55.8%</td>
<td>36.4%</td>
<td>7.8%</td>
</tr>
<tr>
<td>1,000-1,999</td>
<td>57.1%</td>
<td>38.1%</td>
<td>4.8%</td>
</tr>
<tr>
<td>2,000-4,999</td>
<td>75.0%</td>
<td>15.0%</td>
<td>10.0%</td>
</tr>
<tr>
<td>5,000+</td>
<td>92.3%</td>
<td>5.1%</td>
<td>2.6%</td>
</tr>
</tbody>
</table>

Source: Black & Veatch

By Number of Employees

<table>
<thead>
<tr>
<th>= 1,000 People</th>
</tr>
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</table>

The project included the full life cycle of distributed rooftop solar and microgrids and became an end-to-end relationship that included everything from project development, program management, engineering, procurement and construction to operations and maintenance of the systems. By the time the program is completed, it will be nothing short of one of the financial sector’s most emphatic endorsements of the viability of renewable energy.

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There are opportunities for businesses of all sizes to make progress, regardless of where they are on their journey to sustainability — whether that's piloting a new program, scaling up an existing program or increasing their ambitions as technologies continue to come down in price.

Every big change happens with a plan, a small start and the right tools. Are you ready to get started?

**ABOUT THE AUTHORS**

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**Luke Oehlerking** is Manager of Commercial Solar with Black & Veatch’s global distributed energy team. He has led the development of innovative business areas focused on energy storage, microgrids and residential and commercial rooftop solar. He actively works with clients to help them meet their sustainability goals with a variety of on-site or distributed solar photovoltaic, energy storage and microgrid solutions.

**Brian Sifton** is a member of the Growth Accelerator, Black & Veatch’s corporate innovation group. Working at the intersection of sustainability, strategy and innovation, he manages the company’s corporate sustainability program and strategic vision. Sifton also manages Black & Veatch’s annual programming for “intrapreneurs” — employees passionate about innovation in sustainable infrastructure, who receive the resources, training and coaching necessary to pilot new businesses at Black & Veatch.
With the March of Renewables, Electricity Sector Latest Industry to Undergo Transformation

By Dave Leligdon, Jeremy Klingel and Dean Siegrist

For all of the positives, renewable energy and applications that change how and when energy is used — from electric vehicles (EVs) to energy storage — are rattling the conventional power industry, propelling its transformation. But headwinds, including rigorous regulations and consumer expectations of reliability, may make the process feel like a bridge too far instead of a once-in-a-century opportunity.

Like many major evolutions, the process is slow but certain to move forward. And in an increasingly digital world and ever-morphing consumer landscape, utilities should take notice just how quickly in this generation that business models can and have changed.

That happens when disruption collides with the forces driving sustainability. Consider that Wall Street, once defined by traders who shouted and signaled transactions in crammed pits known as “the floor,” is far more sophisticated and virtual, with buying and selling now possible by anyone with just a keyboard and internet access. Ridesharing services such as Uber and Lyft have enjoyed a meteoric rise, elbowing into the domain of taxi services while dawning the age of the gig economy and the “uberpreneuer” – ordinary people making cash on the side by using their cars as cabs.

Television has been transformed by rapidly shifting consumer preferences and viewing behaviors made more complex and competitive by streaming devices, platforms and services. Apple’s rollout of its pioneering iPhone launched a global telecommunications arms race, using do-everything, palm-sized gadgets. Additionally, legal streaming services — such as Spotify, Pandora and Tidal — now define a music scene once dominated by vinyl and compact discs, helping lift that industry out of years of doldrums.

Through it all, the consumer and user experience are true north.
The backdrop in which the electric industry, roughly 130 years old, now finds itself is filled with challenges and opportunity. Surveys show many stakeholders believe a “utility death spiral” fanned by advancements in distributed energy resources is taking place with things such as microgrids, rooftop solar units and EVs — and consumers demanding cleaner, cost-effective energy forcing the outcome. That’s if the industry doesn’t adopt alternative energy solutions or if regulations fail to allow flexibility. Or both.

As environmental and climate concerns grab more global attention, there’s little debating that renewables are going to be the cornerstone of tomorrow’s power generation — and that technology transforming the electric industry is reshaping how consumers both use energy resources and interact with their utilities. It’s in that vein that the electricity sector and businesses alike need to show they’re serious about clean power and collaborate on energy solutions for increasingly urbanized societies, rendering discussions about “off-the-grid” approaches much less relevant.

**Solar Power Grabs Widening Spotlight**

The Renewable Energy Policy Network for the 21st Century, in its yearly look at the market, recently revealed that renewables globally are outgaining fossil fuel and nuclear capacity combined, representing one-third of the world’s installed capacity.

Looking ahead, the Energy Information Administration (EIA) expects generation of renewable energy to spike to nearly half of global electricity generation in the next three decades, with solar’s share growing fastest among renewables. Forbes recently reported that in the coming 30 years, $10 trillion to more than $15 trillion will be funneled into solar and wind energy, depending on the percentage of incremental power that these renewables supply. Energy storage — key to fully harnessing intermittent power generation — is predicted to become a $20 billion annual market.

Electric utilities and commercial and industrial stakeholders are taking note. In a recent Black & Veatch survey of hundreds of respondents for the company’s *2019 Strategic Directions: Electric Report*, slightly more than one-quarter of them (27 percent) expect distributed energy and renewables to dominate utility service offerings in the next five years. That number spikes to 45 percent on a 10-year horizon and 55 percent when forecasting 15 years out. *(Figure 5)*

**Figure 5**

How much do you agree or disagree with each of the following statements relative to the future of distributed energy resources (DER)? *(Select one response per row).*

Source: Black & Veatch

| DER will dominate utility service offerings in the next five years |
|---|---|---|
| Agree | Neither agree nor disagree | Disagree |
| 38.1% | 26.7% | 35.2% |

| DER will dominate utility service offerings in the next ten years |
|---|---|---|
| Agree | Neither agree nor disagree | Disagree |
| 45.2% | 35.0% | 19.8% |

| DER will dominate utility service offerings in the next 15 years |
|---|---|---|
| Agree | Neither agree nor disagree | Disagree |
| 54.8% | 37.3% | 7.9% |
The reasons for the renewables surge are legion: policies increasingly favoring renewables, regional load growth and declining costs of technology ranging from the photovoltaic panels to the high-capacity batteries that store that energy.

That raises the question: In this dynamic moment in the history of power supply, are the keepers of the grid — that complex web that zips power from electricity generators through substations and on to homes and businesses — responding? Put another way: As solar, wind and distributed generation steadily encroach on traditional power generation, are utilities committing to upgrade a dated system to accommodate renewables and two-way energy flows that come with them?

**Electric Industry Recognizes Threat, Potential of Renewables**

Without question, there’s an understanding in the industry of the growing sway of renewables. When asked recently for their biggest concern for tomorrow’s grid development, electric industry respondents to the Black & Veatch survey overwhelmingly — 70 percent of roughly 700 saw this question — cited a generation mix with fewer traditional baseload units and more utility-scale renewable sources. By a lesser margin, respondents also pointed to regulatory lags in addressing needed system changes and the lack of qualified workers to architect and run the more complex system (Figure 6).

Separately, three-quarters of respondents see adoption of alternative behind-the-meter energy options as a threat to the utility business model, either if regulatory models preclude market flexibility or if utilities fail to implement their own alternative energy solutions. Utility business models must be allowed to evolve.

**Businesses Rethinking Energy Options**

The changing energy landscape — with renewables gaining a widening footprint as they approach price parity with power from the local utility — is prodding businesses to rethink how they use and manage electricity. For utilities

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**Figure 6**

*With the growing complexity of the grid, its operation and maintenance, what are the three biggest concerns for future grid development? (Select up to three choices).*  
*Source: Black & Veatch*

- **70.4%** Generation mix, with fewer traditional base load units and more utility scale renewable sources
- **43.0%** Regulatory lag in meeting the needs for system changes
- **37.5%** Lack of qualified workers to engineer, maintain and operate the more complex system
- **28.8%** Lack of sufficient transmission facilities and system control assets
- **27.8%** Increases in DER (behind-the-meter resources)
- **25.8%** Long-term reliability of DER
- **15.4%** Safety for energy professionals and the public with greater dispersed resources
Beyond the environmental benefits of switching to renewable energy, leaders believe the business case for green energy is strong, demonstrating that these companies are listening to the rising chorus by the citizenry for better environmental practices by commerce and industry.

that don’t notice or react, bad news comes in a single word: defections. Sustainability-minded companies are migrating toward the cheapest form of renewables or a basket of green energy options that gets them a reasonable cost of power. The catalyst is that businesses have a deeper menu of ways to satisfy their appetite for power, and they may see renewable energy — chiefly solar — consistent with their sustainability goals.

Some large companies have said they’d power some of their operations with renewable energy, while many others are going all in by installing their own solar arrays, energy storage, microgrids and other resources. A “RE100” listing by The Climate Group and what was formerly the Carbon Disclosure Project shows that more than 120 multi-national companies — many in the C&I sectors — plan for their power to come entirely from renewables as part of a global corporate leadership initiative.

Many of these companies are generating their own energy and buying renewable-based power from off-site, grid-connected generators. Beyond the environmental benefits of switching to renewable energy, they insist the business case for green energy is strong, demonstrating that these companies are listening to the rising chorus by the citizenry for better environmental practices by commerce and industry. Yet progress is slow, very little renewable generation is on-site or localized, and the pressure to see an economic return is beginning to build.

So what does that mean for utilities and those they serve? Lacking agility in making changes that align with growing clean energy and decarbonization mandates could drive away sizable commercial and power-hungry industrial clients who have the financial means to turn to renewables or distributed generation on their own. Such defections from the grid inadvertently would make the system more expensive by spreading its fixed costs among fewer ratepayers and adding to the network’s complexity.

As consumer demand again reshapes the energy marketplace, utilities can make their investments more valuable by using monitoring, control and automation technologies to unlock the full potential of grid assets for greater reliability, efficiency and security. This includes renewables and two-way communication on the grid, giving utilities and consumers more control and insight into everything from the grid to power generation options and bill management.

Renewables Gain Growing Favor Among Regulators
As coal-fired generation continues to fall out of favor, new plants powered by cleaner-burning natural gas are drawing growing scrutiny in favor of renewables.
In the spring of 2019, Indiana regulators unanimously rejected a proposal by electric and natural gas utility Vectren — a division of CenterPoint Energy — to replace three coal plants with an 850-megawatt (MW) gas facility, concluding the new site could become a stranded, uneconomic asset as customer demand changes, energy storage matures and the cost of renewables fall. Regulators also questioned whether the new plant would “serve to foster utility and customer flexibility in an environment of rapid technological innovation.”

CenterPoint’s Lynnae Wilson said in a statement that while “the case was filed at a time of significant changes in generation technology,” regulators have directed the utility “to increase our focus on the benefits of a more diverse resource mix.”

“As we demonstrated in our case, economic and reliability factors are driving a transition from coal-based generation and the selection of replacement resources will continue to be our focus,” wrote Wilson, CenterPoint’s chief business officer for its Indiana electric utility business.

In the Southwest, the Arizona Corporation Commission in 2019 extended its ban on constructing new natural gas plants generating at least 150 MW in the state. That comes as Arizona weighs a grid modernization plan calling for 80 percent of the state’s electricity to come from zero-carbon sources — renewables — and coal by mid-century, along with a target of 3,000 MW of energy storage by 2030.

**Onus on Utilities to Get Current With Renewables**

Consumers, equipped with increasingly sophisticated technology and no longer content with arms-length relationships, are demanding real-time, transparent engagements with their utility. And, along with a growing number of businesses, they’re demanding power in cleaner, greener ways.

The onus of being nimble is thrust onto electricity providers, who admit flexibility to adapt to what’s coming is atop their wish list. More than half of Black & Veatch’s survey respondents said that when it comes to identifying the most essential
For power producers, the opportunity rests in adopting technologically sophisticated, cost-competitive and bankable engineering, procurement and construction (EPC) solutions that focus on integrating the complex grid, modernizing the vast infrastructure and putting reliability at a premium. Persistent regulatory questions will remain, requiring the industry to work collaboratively with their government overseers, among other things, to minimize rate impacts.

The push and pull of cost and consumer choice that reshaped the music, phone and television industries are taking aim at power generation and delivery.

The lesson is that time waits for no one, not even an entrenched business model that, despite sustaining electricity for so many decades, suddenly has competition compounded by mounting pressure to commit to a more renewables-focused grid.

**Figure 7**

What tools or resources are most essential for the planning, engineering, construction, operation and maintenance of a more complex grid? (Select up to three choices).

Source: Black & Veatch

55.1%

Innovative system designs that allow for more flexibility in system configurations

53.2%

Better modeling and forecasting data and programs

45.7%

More real time telemetry and control devices (SCADA)

42.8%

Staff training and development in new systems

36.7%

Risk identification tools and mitigation options

14.7%

Access to consultants who have experience with an ever-changing, complex grid

**ABOUT THE AUTHORS**

Dave Leligdon is a Senior Vice President and Global Renewable Energy business line leader for Black & Veatch’s power business. Leligdon has led the renewables business since September 2018 and has more than 30 years of experience with energy, water and wastewater facilities in multiple regions around the globe.

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

Dean Siegrist is Associate Vice President of Black & Veatch’s Transformative Technologies business. In this role, Siegrist leads the business that provides the vertically integrated services of site acquisition, design, permitting, construction and operation of distributed infrastructure with a focus on sustainable transportation. He works with vehicle original equipment manufacturers, utilities, transit agencies, cities and emerging transportation service providers to plan and build infrastructure for the electrification of transportation.
Data Analytics: Threading the Needle of Risk and Reward
By Andrew Chastain-Howley, Matt Kirchner and Joe Zhou

There’s no doubt that the technological advances of the past decade — artificial intelligence, cloud-based software, autonomous equipment, drones, remote sensors, mobile devices, machine learning and virtual reality — have improved operational efficiency, productivity and resiliency, moving us into the digital age faster and farther than we ever imagined.

Twenty years ago, these technologies seemed more at home in the pages of a science fiction novel than in a utility’s control room or on a construction or mining site. But today, these innovations come together under the umbrella of the Internet of Things, with its cloud-based ability to collect, process, manage and analyze extravagant amounts of data.

Analytics Strengthen Digital Intelligence
Across all industries and sectors, forward-thinking organizations are using data to inform a new sense of “digital intelligence” that balances technological opportunity with safety and security.

Data is everywhere, and our digital footprint is only growing larger. Digital information, exchanged at staggering rates, is actionable and predictive, giving operators better oversight of their assets. Paired with digital analytics platforms, digitalization offers incredible amounts of situational awareness, better monitoring, more accurate diagnostics and faster response rates.

Rather than remaining trapped in the reactive posture of the past, scrambling to respond to situations at hand, organizations now have the
tools to proactively plan and assess, positioning themselves for a more resilient and sustainable future. Those who don't risk being left behind, overtaken by the agile.

The growing reliance on data analytics to manage assets is a continuing theme throughout Black & Veatch’s ongoing Strategic Directions report series, which are based on extensive surveys of utility and commercial and industrial leaders. A recent survey of water utility leaders, for example, found that two-thirds of them are exploring or have deployed smart technologies, while nearly three of every 10 respondents — 28 percent — have turned to cloud-based software, up from just 10 percent last year.

Of the more than 500 individuals surveyed, a combined 64 percent see their investment in digitalization as positive in that it has helped enable improved asset performance (Figure 8).

The power of predictive analytics is significant across power, water and telecommunications. For instance, industrial water plant managers can deploy advanced sensors able to reveal previously undetectable changes in infrastructure performance. These technologies, in tandem with predictive analytics, will help industrial water facilities anticipate equipment issues and failures, as well as build a roadmap to improved maintenance and programmatic equipment replacement.

A major industrial client recently approached Black & Veatch with a vexing challenge, asking us to monitor its mechanical infrastructure and water and wastewater systems. Power systems and feedwater were the initial concerns, but as the system analytics were developed, it became obvious that the system also could manage some of the industrial processes. Data is consistent in these circumstances, as long as subject matter expertise is available to develop the initial calculations and understand the workflow. Such software platforms can be utilized across the industry from the water supply to the wastewater effluent discharge and almost everything between.

But with these heightened opportunities comes heightened risk, and now organizations are facing a classic Catch-22: With every new device...
added to a network — every remote sensor, iPad, drone or autonomous vehicle — the more vulnerable that system becomes to outside intrusion.

This new world of increased connectivity is introducing new vulnerabilities, and organizations must balance technological opportunity with safety and security.

Digital Intelligence Backed by Security
As these new levels of digitalization and IoT continue to embolden and shape our modern lives, cybersecurity postures are coming under intense scrutiny by security professionals, regulators and the federal government, who have seen firsthand how pervasive — and crippling — cyberattacks can be.

Few cybersecurity professionals and regulators haven’t lost sleep over the thought of a large-scale cyberattack on critical American infrastructure. Instances of such attacks include the hackers who infamously shut down the Ukrainian power grid in 2015, affecting 250,000 people, or those who hacked and attempted to sabotage a Saudi petrochemical plant in 2017.

More recently, hackers have begun weaponizing ransomware and using it to attack municipal computer systems and data networks.

In October 2019, CNN reported that over the previous 10 months alone, 140 local and state governments, police stations and health care providers fell prey to and had been held hostage by ransomware attacks, released only upon payment of hundreds of thousands of dollars in Bitcoin. These attacks have paralyzed networks in Atlanta, Baltimore, several Florida cities and towns, the Georgia courts system and even the email and baggage systems at Cleveland Hopkins International Airport.

There’s no doubt that illicit individuals and anonymous groups will continue to use cyberattacks to disrupt operations, damage equipment, compromise sensitive data and threaten lives. Utilities, with their complicated infrastructure and core services, acknowledge their vulnerabilities — a 2018 study by financial services group KPMG found that 48 percent of power and utility executives expect a cyberattack to be inevitable.

To combat this, security professionals, regulators and the federal government are considering every option to stem the tide of cyber warfare. So it’s no surprise that an ongoing theme in Black & Veatch’s Strategic Directions reports is that U.S. utility leaders view cybersecurity processes, procedures, governance, technology and overall threat management to be a leading industry concern.
The Weakest Links in the Cybersecurity Chain

The magic of IoT and data analytics lies in their intricate systems of connected digital devices. But because these manufactured devices connect directly to sensitive networks, organizations need to prioritize supply chain risk management. More specifically, they need to implement security controls to decrease the risk that a malicious actor could install malware or backdoor access directly onto these devices.

Organizations should know their manufacturer and ensure that security is part of the manufacturing process. If supply chain risk management appeared on a spectrum, it would look something like this: On the safest end, organizations use trusted manufactures with complete control over the manufacturing process and chain-of-custody controls. On the opposite, more dangerous side, equipment gets crafted in an unknown factory using unknown chipsets, firmware and software that the end user has no visibility into or control over. With no optics into the manufacturing process, these untrusted devices present great risk when connected to sensitive networks.

The more practical approach — somewhere on the middle of the spectrum — is to partner with well-known, trusted suppliers who abide by published and auditable supply chain security programs. Such suppliers have established physical security at all facilities, logical security for production systems, production certifications, a strict scrap handling process that prevents counterfeiting protection labels, and security technology such as smart chips and security labels that prevent unauthorized tampering.

Human error presents a more complicated issue. The ransomware attacks that crippled those municipalities and civil services started with what appeared to be an innocent email. But that instant the intended recipient — an unsuspecting employee — clicked the link inside, it unleashed a chain of events that allowed hackers to quickly take control.

With each ransomware attack born from a single click, human error continues to be a major vulnerability in the cybersecurity chain. For example, nearly half of the electric utility leaders — 47 percent — believe that cybersecurity training and education programs will play a critical role in mitigating human error, according to a recent Black & Veatch survey (Figure 9).

Managing and optimizing security products and platforms ranked second, according to 46 percent of respondents. Considering that human error is inevitable, cybersecurity professionals can offer a backstop by installing backend email protection systems to disable or remove unsafe links.

Figure 9
What will be your top issues or needs with regards to cybersecurity and physical security within the next five to 10 years? (Select up to three).

Source: Black & Veatch

46.5%
Security education and training

46.0%
Managing and optimizing security products and platforms

35.0%
Endpoint management and vulnerabilities

33.6%
Retaining cybersecurity talent to design and administer programs

26.5%
Maintaining compliance
Protecting access through access controls will also help shore up defenses. Of the options presented, nearly one-third of survey respondents named access control as the largest vulnerability when it comes to ensuring cyber and physical security (Figure 10).

Access control means both physical access (where someone physically enters a facility) and logical access (where someone obtains remote access to a networked system). Organizations can control physical access through background checks, risk assessments and permissions-based badging and control logical access through user-level authentication controls, two-factor authentication and even advanced technologies such as biometrics.

For utilities and industries using computers to control their systems through supervisory control and data acquisition (SCADA), one additional method of cybersecurity is to further separate the data from the source. Using one-way data feeds with no connectivity for remote access is an important step for the analytics industry, as it will help unlock operational intelligence at reduced risk. If you cannot control a system, it becomes a lower grade target. Data breaches are still a big issue that needs to be guarded against, but they are not generally as catastrophic if the control link is removed.

Data Delivers Great Things, if We Are Smart
Technology is changing the game rapidly, but the threat of cyber intrusion will only grow stronger. To navigate through these challenging times, organizations need to arrange their data analytics and cybersecurity strategies around digital intelligence designed to keep data safe, secure and protected.

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Integration Is Key From Data Management to Construction, But Can It Happen?

By Kevin Cornish

What is the most complex machine in the world? Is it: A) a transcontinental electric grid B) an international communications system or C) interconnected water systems?

The answer, of course, depends on who you ask, but as they evolve from century-old — and occasionally millennia-old roots — today’s critical infrastructure service providers are grappling with a range of forces that can redefine their businesses and the world we live in. Adapting their organizations to a more distributed, data-driven world is key to their futures, if they can harness new, integrated approaches to asset management, capital planning and how things get built.

So how do utility service providers address the oxymoron that is distributed integration? This is not just a power industry problem. Power grids certainly are shifting rapidly from centralized generation and one-directional power flows to a widely distributed, two-way grid, metered and automated across countless points. This shift towards the edge is found across infrastructure classes.

To unleash the transformative power of 5G wireless technology, telecom service providers must adapt the physical plant of their networks to include more and different access points from the standard, tower-driven model while working within

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a complex regulatory web to lock down spectrum. Similarly, water service providers must learn more about the condition of their assets from source to consumption to ensure greater reliability and resilience in the face of population and climate challenges. And everyone must address the challenges of capital constraints and regulatory burdens.

**Headlines versus the bottom line**
Over the past year, much of the public focus has shifted towards future state planning and market disrupting technologies like microgrids, digital water applications and the Industrial Internet of Things (IIoT). Yet, according to recent Black & Veatch *Strategic Directions: Smart Utility Report* data, service providers indicate the renewal and rehab of aging assets represents the largest challenge in the asset management lifecycle (Figure 11).

The focus on existing assets is consistent with nearly a decade of responses in our Strategic Directions reports relating to the electric industry (dating to 2011) and the water industry (to 2012) in which respondents chose aging infrastructure as the most challenging issue facing their industries.

**Program Planning**
With the reliability of traditional utility services being brought into focus by powerful storms, large-scale fires and rising customer service expectations, the rollout of projects to enhance resilience and improve operational efficiency continues. Some such technologies, including advances in Information Technology (IT), Operational Technology (OT) and Artificial Intelligence (AI) are accelerating the blurring of lines between traditional organization silos.

But despite positive sentiment, integrated planning is yet to be viewed as a key concern. When weighed among top industry issues, it rated eighth of the top 10 issues among respondents for our 2019 water report, and it failed to make the list in our 2019 electric report.

This latter point could reflect utilities’ emerging shift from integrated resource planning (IRP) to integrated system planning that takes...
interdependencies into greater consideration. But, contrast this with data from the commercial and industrial sector, where nearly half of respondents indicated they expect to complete the implementation of smart manufacturing processes within the next five years (Figure 12).

In contrast, water and electric utilities continue to recognize the importance of devising integrated programmatic approaches that cut across functional areas, but they may struggle with implementation (Figures 13-14).

**Data Integration**

One of the biggest challenges facing data scientists of all stripes is the tendency to confuse causation with causality. Does the data demonstrate that a series of events or actions “caused” an outcome, or simply contributed to the outcome? (Did Person A eat the lunchroom T oday In 5 Years

---

**Figure 12**

*What is your organization doing today and in the next five years with regards to smart manufacturing? (Select one).*

<table>
<thead>
<tr>
<th></th>
<th>Today</th>
<th>In 5 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully implemented these practices</td>
<td>14.7%</td>
<td>45.5%</td>
</tr>
<tr>
<td>Began to implement these practices</td>
<td>50.0%</td>
<td>27.3%</td>
</tr>
<tr>
<td>Beginning to consider implementing these practices</td>
<td>23.5%</td>
<td>18.2%</td>
</tr>
<tr>
<td>Not considering implementing these practices</td>
<td>11.8%</td>
<td>9.1%</td>
</tr>
</tbody>
</table>

---

**Figure 13**

*How is your organization viewing the importance of integrating its water planning functions (e.g., sourcing, treatment, conveyance, distribution)? (Select one)*

*Source: Black & Veatch*

- 43.8% Very Important
- 38.8% Extremely Important
- 11.3% Moderately Important
- 6.3% Slightly/not at all important

---

**Figure 14**

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

*Source: Black & Veatch*

- 45.7% Very Important
- 34.6% Extremely Important
- 14.2% Moderately Important
- 5.6% Slightly/not at all important
As data becomes the new gold of utility operations, understanding the difference is critical to making informed decisions across functional areas, as well as in driving greater integration across capital planning and project execution.

2020 will find many electric service providers launching second- or third-generation automated metering infrastructure (AMI) and distribution automation (DA) programs capable of providing system data and expanding control capabilities. This contrasts with a water industry that has taken a more gradual approach to raising the profile and embrace of Digital Water, though over the past 18 months, water service and solutions providers have highlighted Digital Water programs at key global leadership events and technology forums such as Singapore International Water Week (SIWW) and many more.

As the results of more pilots become available generating positive results, expect an acceleration of digital water programs. However, the business case remains less robust when compared to electric utilities for many water utilities, though water scarcity has emerged as a real driver to the improved water and customer usage information at the core of AMI.

Many water utilities also face demand growth, which is necessitating finding new water sources in regions such as the American Southwest where they are just not available — so improved conservation and water management becomes key.

Walking the political tightrope of rate increases, much room for improvement and investment remains as just over 5 percent of recent water report survey respondents indicate robust, fully integrated approaches to data management versus one-third identifying siloed data lacking integration (Figure 15).

This is in stark contrast to C&I respondents, where optimizing operations via data analytics was the top area of concern (Figure 16).

Another area that will continue to plague data integration programs in coming years are the disparate systems, different formats and turf battles that slow progress. For example, the long-term lifecycle management of IT/OT systems remains a challenge. The alignment of operational control SCADA systems and customer systems can be problematic as ownership of the systems and the data produced often falls under the jurisdiction of multiple parties, including security professionals not tied directly to either function.

Figure 15

Which of the following statements best describe the data management strategy at your organization? (Select one).

Source: Black & Veatch

5.3% Robust, fully integrated approach

57.4% Strong, and getting stronger, but not fully integrated

33.0% Data largely still in silos and not integrated

4.3% Collecting little data and not leveraging
Integrated Project Delivery
Consolidation impacts every industry. The engineering, construction and design space is not immune to market dynamics, but the consolidation of several historic market participants and decisions by others to exit the long-standing lump-sum engineering, procurement and construction (EPC) approach to project delivery raised some eyebrows over the past few years. While all parties involved in the design and construction of projects seek to manage financial risk exposure, there is a sense that the pendulum to offload as much risk as possible has swung too far.

According to 2019 Water Report data, outcomes from lump-sum EPC projects generated less satisfaction and represented the least likely delivery model to be chosen (32 percent, versus construction management at risk, 17 percent) by those expressing a preference (Figure 17).

Figure 17
Are there any delivery methods you would not choose for future projects? (Select all that apply).
Source: Black & Veatch

<table>
<thead>
<tr>
<th>Method</th>
<th>Most Concerned 8-10</th>
<th>Neutral Concerned 4-7</th>
<th>Least Concerned 1-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lump sum design-build</td>
<td>32.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction management at risk</td>
<td>17.2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(guaranteed maximum price)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Progressive design-build</td>
<td>13.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction management/General</td>
<td>6.6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>contractor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would be open to all of these</td>
<td>56.6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>methods</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 16
On a scale of 1 to 10, please indicate how concerned your business is about each of the following topics. (Select one response for each row)
Source: Black & Veatch

<table>
<thead>
<tr>
<th>Topic</th>
<th>Most Concerned 8-10</th>
<th>Neutral Concerned 4-7</th>
<th>Least Concerned 1-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimizing operations via</td>
<td>39.0%</td>
<td>53.5%</td>
<td>7.5%</td>
</tr>
<tr>
<td>data analytics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rising energy costs</td>
<td>40.0%</td>
<td>46.5%</td>
<td>13.5%</td>
</tr>
<tr>
<td>Sustainability</td>
<td>36.5%</td>
<td>49.0%</td>
<td>14.5%</td>
</tr>
<tr>
<td>Communications/IT costs</td>
<td>29.0%</td>
<td>61.0%</td>
<td>10.0%</td>
</tr>
<tr>
<td>Water scarcity</td>
<td>29.0%</td>
<td>42.5%</td>
<td>28.5%</td>
</tr>
<tr>
<td>Rising water costs</td>
<td>25.5%</td>
<td>45.0%</td>
<td>29.5%</td>
</tr>
</tbody>
</table>
While certain municipal regulations can prevent design-build project delivery approaches, shareholder pressure will continue to be a factor in the pursuit of future lump-sum EPC projects (Figure 18).

**Successful integration takes integration**
From data integration and program planning to how projects move from concept to construction, 2020 will continue to see utilities grapple with fundamental shifts across their worlds. In each facet, there is great excitement and enthusiasm centered on the potential to transform utility operations and drive sustainability, resilience and bottom-line performance.

But in each case, it’s clear that leadership will have to work hard to overcome the traditional organizational and market hurdles, as well as human nature-driven turf challenges that prevent innovation, strategy and action from getting into the same room.

It is clear that overcoming these challenges to unlock the potential of a truly integrated organization requires a vision and a defined strategy on how to realize the vision. Recognizing that business as usual is no longer an option given rapid market disruption, individual teams and project groups need to see their alignment to the vision in order to drive effective, approaches and buy-in. Whether working to standardize the usage of the IT solutions, evaluate program planning or explore new approaches to project delivery, teams must work across traditional lines to deliver effective outcomes or get left behind.

<table>
<thead>
<tr>
<th>Delivery Type</th>
<th>Very successful</th>
<th>Moderately successful</th>
<th>Slightly successful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction management/General contractor</td>
<td>66.0%</td>
<td>30.9%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Progressive design-build (paid throughout process)</td>
<td>61.4%</td>
<td>34.3%</td>
<td>4.3%</td>
</tr>
<tr>
<td>Construction management at risk (guaranteed maximum price)</td>
<td>53.1%</td>
<td>42.9%</td>
<td>4.1%</td>
</tr>
<tr>
<td>Lump sum design-build (paid up front)</td>
<td>38.5%</td>
<td>42.3%</td>
<td>19.2%</td>
</tr>
<tr>
<td>Other</td>
<td>33.3%</td>
<td>50.0%</td>
<td>16.7%</td>
</tr>
</tbody>
</table>

*Source: Black & Veatch*
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