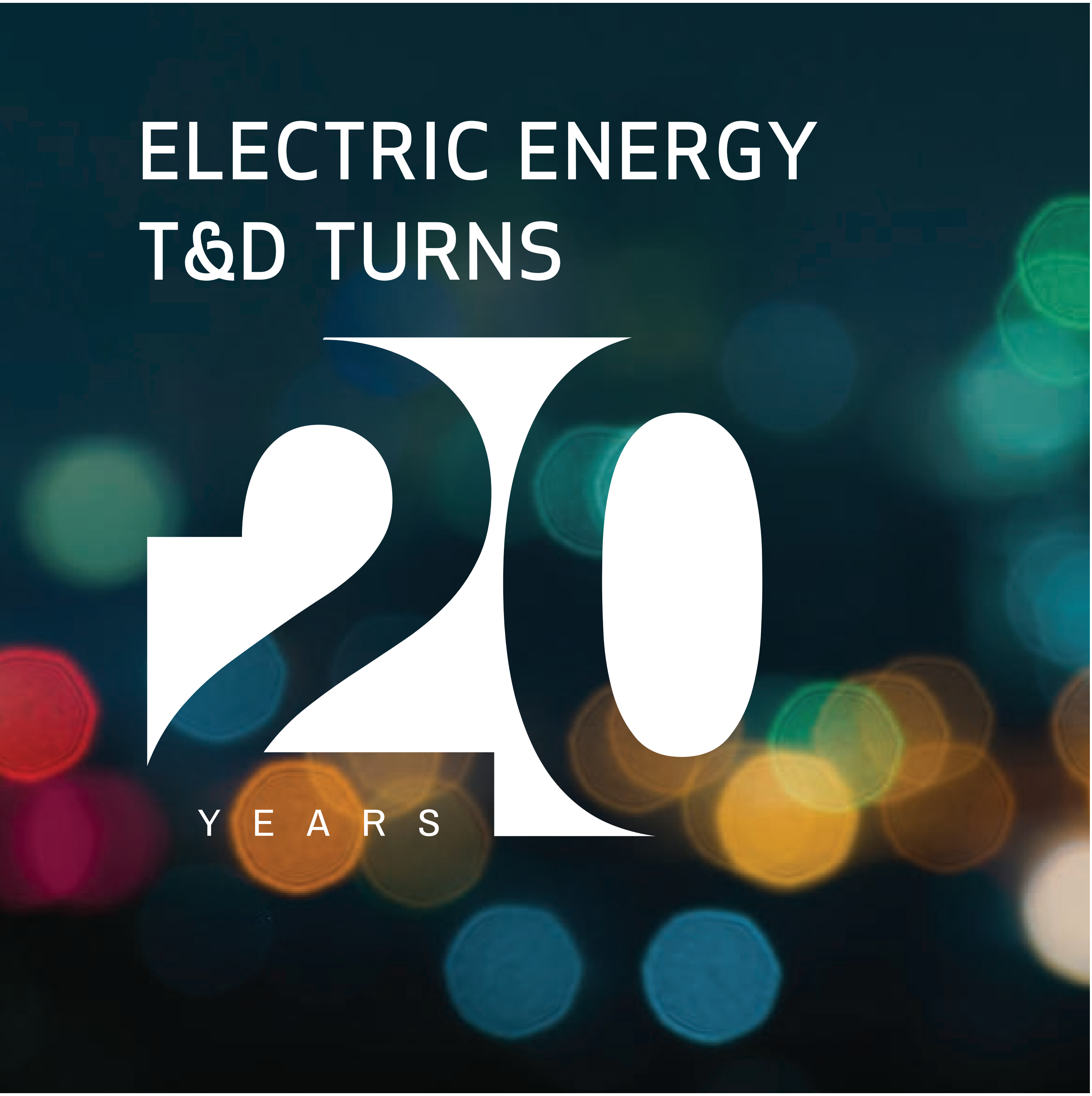
EET&D MAGAZINE

20 YEARS

September/October 2018 Issue 5 – Volume 22



EET&D MAGAZINE

September/October 2018 Issue 5 – Volume 22

04
INDUSTRY NEWS

12
POWER POINTS

DISRUPTIVE TECHNOLOGY: IS IT A BAD THING? | Elisabeth Monaghan

If you search the internet for examples of disruptive technology, several, if not most of the results will include those that have already begun to impact the energy industry. AMI, IoT, AI, AR, DERMS, CRM, machine-based learning and EV's are a small sampling of technology that has disrupted how energy is produced, distributed and consumed.

14
THE GRID TRANSFORMATION FORUM

EXPLORING THE FUTURE OF DSM: THREE GUIDELINES FOR CONNECTING CUSTOMER-SIDE AND GRID-SIDE RESOURCES | Mike Ballard and Tanuj Deora

If you ask a utility executive with a few decades of experience under his/her belt what s/he thinks about the current state of our industry, chances are you'll hear them say that this is one of the most transformational times in its history.

18
GREEN OVATIONS

A SYSTEM OF SYSTEMS APPROACH TO DERS INTEGRATION – MORE HOLISTIC THAN DERMS | Dan Garvey

DERMS are offered as a solution to the current and future challenges posed by distributed energy resources (DERs) but are yet to be a proven solution capable of managing the growing number of heterogeneous metered and behind-the-meter DERs that will grow into the hundreds of thousands.

24
SENSORS AND SENSIBILITY: HOW IOT NETWORKS CAN MAKE GRIDS SMARTER | Dave Christophe

Power utilities worldwide are in the midst of significant transformations as they gear up to adapt to new market forces, an evolving regulatory environment and the introduction of distributed renewable energy sources (and the disruptions they bring).

28
PREPARING FOR FUTURE ENERGY DEMANDS WITH SMART GRID TECHNOLOGY | Nick Nakamura

To keep up with today's demands and the future growth of the grid, our aging infrastructure will need to be modernized to optimize power delivery and reliability.

34
61850 WHAT ARE YOU WAITING FOR? | Bruce Milschiltz

61850 delivers a comprehensive toolkit of best practices for substation automation and other application domains. It's the only non-proprietary international standard that addresses substation control at protection speeds. It also makes it easier to move data from the grid edge, where many sensors and other devices reside.

39
THE IMPORTANCE OF 5G FOR UTILITIES | Jeffery Torrance

The evolution of wireless networks toward 5G, the next generation of cellular technology, brings exceptional communications capabilities for utilities and opens new opportunities for collaboration with mobile network operators.

42
AUTOMATED MONITORING FOR INSPECTIONS AND CONDITION-BASED MAINTENANCE- PART III: INDUSTRIAL IOT NETWORKS | Richard Harada & Edgar Sotter

There are a number of choices to consider when connecting sensors in the field to a network. Different networking technologies offer varying amounts of speed, throughput, range, resiliency, privacy and security.

48
GUEST EDITORIAL 1

THE TRANSFORMATIVE POTENTIAL OF TABLETS AND SMARTPHONES FOR THE NEXT GENERATION ENERGY WORKFORCE | Ajay Jawahar, Jamison Roof, and Elizabeth Metzger

Tablets and smartphones are fundamentally improving utility field operations, as these lightweight, powerful and intuitive devices are perfectly suited for seamless integration into on-the-go field operations.

52
GUEST EDITORIAL 2

THE SECRET SAUCE IS SPELLED A-N-A-L-Y-T-I-C-S | Mike Smith

What does delivering value via a digital utility look like? A glimpse into some leading use cases provides some ideas of how this is happening today and will accelerate in the future.

56
GUEST EDITORIAL 3

USING TRANSACTIONAL COMMUNICATIONS TO ENGAGE CONSUMERS | Chris Chronis

It might seem counterintuitive to think people still spend significant time poring over statements and bills. However, transactional documents, such as monthly bills, are still important and widely read, both in digital and paper formats.

60
GUEST EDITORIAL 4

A NEW, DECENTRALIZED ENERGY PARADIGM IS NOT JUST ON ITS WAY, IT'S ALREADY HERE | David Martin

DERs are fast-becoming the norm. Electricity generation is no longer just being pushed out from a centralized location but generated closer to points of consumption by renewables that are becoming far cheaper to implement.

64
THE BIGGER PICTURE

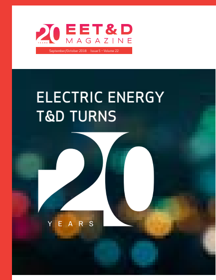
DOE's BETTER BUILDINGS FINANCING NAVIGATOR 2 | Maria T. Vargas

To provide better information for end users, the Department of Energy (DOE) recently released version 2.0 of the Better Buildings Financing Navigator. This online tool helps public and private sector organizations.

68
POWHERFUL FORCES

MICHELE NEGLEY – CLEARESULT | Elisabeth Monaghan

Meet Michele Negley, senior vice president of CLEAResult's South Region. With more than 20 years of experience in the energy sector, she has seen how dramatically the industry has grown. We are pleased to introduce her to *EET&D* Magazine readers for this, our 20th-anniversary issue.



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ELECTRIC ENERGY MAGAZINE IS PUBLISHED 6 TIMES A YEAR BY:
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electricenergyonline.com

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C2
TALLMAN EQUIPMENT

01
OSI
OPEN SYSTEMS INTERNATIONAL, INC.

05
SYSTEMS WITH INTELLIGENCE

07
HASTING

09
NOVATECH PROCESS SOLUTIONS

10
RTDS TECHNOLOGIES

11
S&C ELECTRIC COMPANY

13
EASI-SET BUILDINGS
TECH PRODUCTS

23
LAMINATED WOOD SYSTEMS, INC.

32
OMICRON ELECTRONICS

70
MITSUBISHI ELECTRIC

72
MEGGER
POWER ON

C3
CIGRÉ CANADA
CANADIAN NATIONAL COMMITTEE

C4
DOBLE

SEMPRA ENERGY ONLY U.S. UTILITY NAMED TO 2018 DOW JONES SUSTA INABILITY WORLD INDEX

September 2018

Sempra Energy (NYSE:SRE) has been named to the 2018 Dow Jones Sustainability World Index - the only U.S. utility that qualified for the index. Sempra Energy also was named to the 2018 Dow Jones Sustainability North America Index for the eighth consecutive year.

Both Dow Jones Sustainability indices recognize top companies based on environmental, social and governance data.

"Conducting our business in a responsible and sustainable way is critical to our growth," said Dennis V. Arriola, chief strategy officer, executive vice president of external affairs and South America, and chief sustainability officer for Sempra Energy. "Energy plays a unique - and growing - role in people's lives. We are committed to providing greater access to clean, affordable and diversified sources of energy for the markets we serve."

This year, Sempra Energy scored in the 100th percentile in seven categories for the Dow Jones survey, including risk and crisis management, supply chain management and labor practice indicators, among others. The company's progress in those areas, and other environmental, social and governance metrics, are outlined in Sempra Energy's 10th annual corporate sustainability report, released earlier this year.

> *"I congratulate Sempra Energy for being included in the Dow Jones Sustainability World and North America indices."*
>
> – Manjit Jus, head of ESG ratings for RobecoSAM.

> *"Companies that compete for a coveted place in the DJSI challenge themselves to continuously improve their sustainability practices and we are pleased to see that the number of companies that commit to achieving measurable positive impacts continues to rise."*

Established in 1999, the Dow Jones Sustainability indices are compiled annually by S&P Dow Jones and RobecoSAM, a sustainable investment specialty firm. They were the first organizations in the world to track the financial performance of companies that lead their respective industries in managing environmental, social and governance issues. The indices serve as benchmarks for investors who integrate sustainability considerations into their portfolios.

The World Index tracks the performance of the top 10 percent of the 2,500 largest companies in the S&P Global Broad Market Index. Similarly, the North America Index evaluates top companies in various industries in North America, with 140 companies named to the list this year, including seven utility companies.

Sempra Energy includes San Diego Gas & Electric, Southern California Gas Co., Oncor Electric Delivery Co., SempraLNG & Midstream, IEnova, Sempra South American Utilities and Sempra Renewables.

Sempra Energy, a San Diego-based energy services holding company with 2017 revenues of more than $11 billion, is the utility holding company with the largest U.S. customer base. The Sempra Energy companies' approximately 20,000 employees serve more than 40 million consumers worldwide.

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MORE THAN 100,000 PG&E CUSTOMERS UPDATE CONTACT INFORMATION, SIGN UP FOR EMERGENCY ALERTS, PREPARE FOR WILDFIRES AND EXTREME WEATHER

September 2018

Pacific Gas and Electric Company (PG&E) customers are responding to the energy company's call-to-action to update their contact information, as part of a campaign encouraging customers to have a plan for the growing threat of climate-driven extreme weather and wildfires.

To help educate customers from Bakersfield to the Oregon border, PG&E has mailed letters and postcards and sent emails to more than 570,000 homes and businesses served by electric lines that run through high fire-threat areas. The company is informing customers that it may be necessary for PG&E to temporarily turn off power as a last resort for safety if extreme fire danger conditions occur.

More than 100,000 PG&E customers so far have updated their mobile numbers, email addresses and other contact information so PG&E can communicate with them through important wildfire safety alerts.

> *"With the 2018 wildfire season off to the worst start in 10 years, we all need to be better prepared to stay emergency-ready and keep our families and friends safe"*
>
> – Laurie Giammona, PG&E Senior Vice President and Chief Customer Officer.

"We are asking our customers who live in or near high fire-threat areas to be sure we have their latest contact information so we can do our best to reach them in advance of a potential Public Safety Power Shutoff event."

The Public Safety Power Shutoff program is one of many additional precautionary safety measures that the company is putting in place as part of its Community Wildfire Safety Program, intended to further reduce wildfire threats and strengthen communities for the future.

Wildfire Safety Alerts

Extreme weather threats can change quickly. PG&E's goal, dependent on weather and other factors, is to send customer alerts through automated calls, texts and emails at 48 hours, again at 24 hours, and again just prior to shutting off power.

In addition to notifying customers directly, PG&E will provide outage updates and information through community channels such as social media, local news, radio and the pge.com website.

Importantly, these advance notifications are for a potential Public Safety Power Shutoff event to help reduce the risk of wildfire during the most extreme fire danger conditions. But loss of power can happen for a variety of reasons like storms or emergency response and there is no advance notice when PG&E needs to turn off power at the request of a first responder agency due to an active wildfire or other emergency response situation.

How Customers Can Take Action

PG&E thanks those customers who have taken action to ensure they will receive its wildfire safety alerts. For customers who have not yet confirmed or updated their contact information, PG&E strongly encourages everyone to do so by logging on at pge.com/mywildfirealerts or by calling the PG&E contact center (1-866-743-6589).

Customers can visit pge.com/wildfiresafety to enter their address and find out if their home or business is served by an electric line that may be turned off for safety during high wildfire threats (click on "Check Your Address" under the "Shutting Off Power For Safety" tab). Customers will also find tips on preparing their own emergency plans.

NYPA'S INDUSTRY LEADING R&D LAB TO USE DIGITAL SIMULATION OF THE NEW YORK POWER SYSTEM TO TEST ADVANCED GRID TECHNOLOGIES

September 2018

The New York Power Authority (NYPA), the largest state public power organization in the nation, will test, model and develop innovative solutions for energy systems at its world-class research and development facility - the Advanced Grid Innovation Laboratory for Energy (AGILe) - at its White Plains headquarters. With expertise and support from the Electric Power Research Institute (EPRI), the lab will simulate the impacts of new technologies before they are deployed on New York's electric grid, allowing NYPA and other research participants to evaluate their effects on system reliability, performance, and resiliency. The research aims to also help renewable resources come online more quickly and integrate more effectively to the New York state grid.

"AGILe will allow researchers to more quickly model the system and identify any potential issues - especially as more renewable energy sources, like wind, solar, and energy storage, are brought online," said Gil C. Quiniones, NYPA president and CEO. "AGILe's ability to simulate how new technology will interact with our transmission system will solidify NYPA and New York State as leaders in grid modernization and create models for other utilities to use in their power systems across the country."

The first phase of development at the lab, scheduled to be complete by the end of 2018, involves the creation of a digital, real-time simulation model of the entire New York State transmission system. Once the model is complete, researchers from government, industry, and academia will be able to use advanced computing methods to simulate the implementation of new technologies for better forecasting and planning and to assist with the commercialization of emerging technologies.

AGILe will focus particularly on advanced transmission applications, cybersecurity solutions, sensors, substation automation, and power-electronics controller technologies.

"This is part of the industry-leading effort to make wind, solar, storage and customer resources (like flexible loads, batteries and electric vehicle charging) all part of an integrated grid. We are very excited to coordinate the research at the AGILe lab with the overall integrated grid research at EPRI," said Mark McGranaghan, EPRI's vice president, distribution and energy utilization.

The initiative also will foster collaboration and research with other participants in the state's energy sector to strengthen infrastructure, improve efficiency, and encourage expanded use of renewable energy resources. In a memorandum of understanding, the New York transmission owners and other key energy leaders in the State have all agreed to conduct collaborative research with NYPA at AGILe. Approximately $20 million has been approved for implementation and lab activities so far.

An essential component of NYPA's Vision 2020 Strategic Plan, AGILe advances NYPA's digital transformation and furthers Governor Andrew M. Cuomo's Reforming the Energy Vision (REV) strategy by informing new and innovative ways to build a smarter, cleaner, and more reliable power grid.

NYPA owns and operates approximately one-third of New York's high-voltage power lines. These lines transmit power from NYPA's two large-scale hydroelectric generation facilities, connecting more than 6,000 megawatts of renewable energy into New York State's power grid.

"As our grid continues to evolve --- as we get smarter, cleaner, more data-intensive --- we need faster, more secure systems to get the most from our data and from our grid; we can make better decisions in real-time, and ensure safe, reliable, affordable, and environmentally responsible power delivery for the benefits of New Yorkers, and consumers and society as a whole."

– Alan Ettlinger, director of Research Technology Development and Innovation at NYPA.

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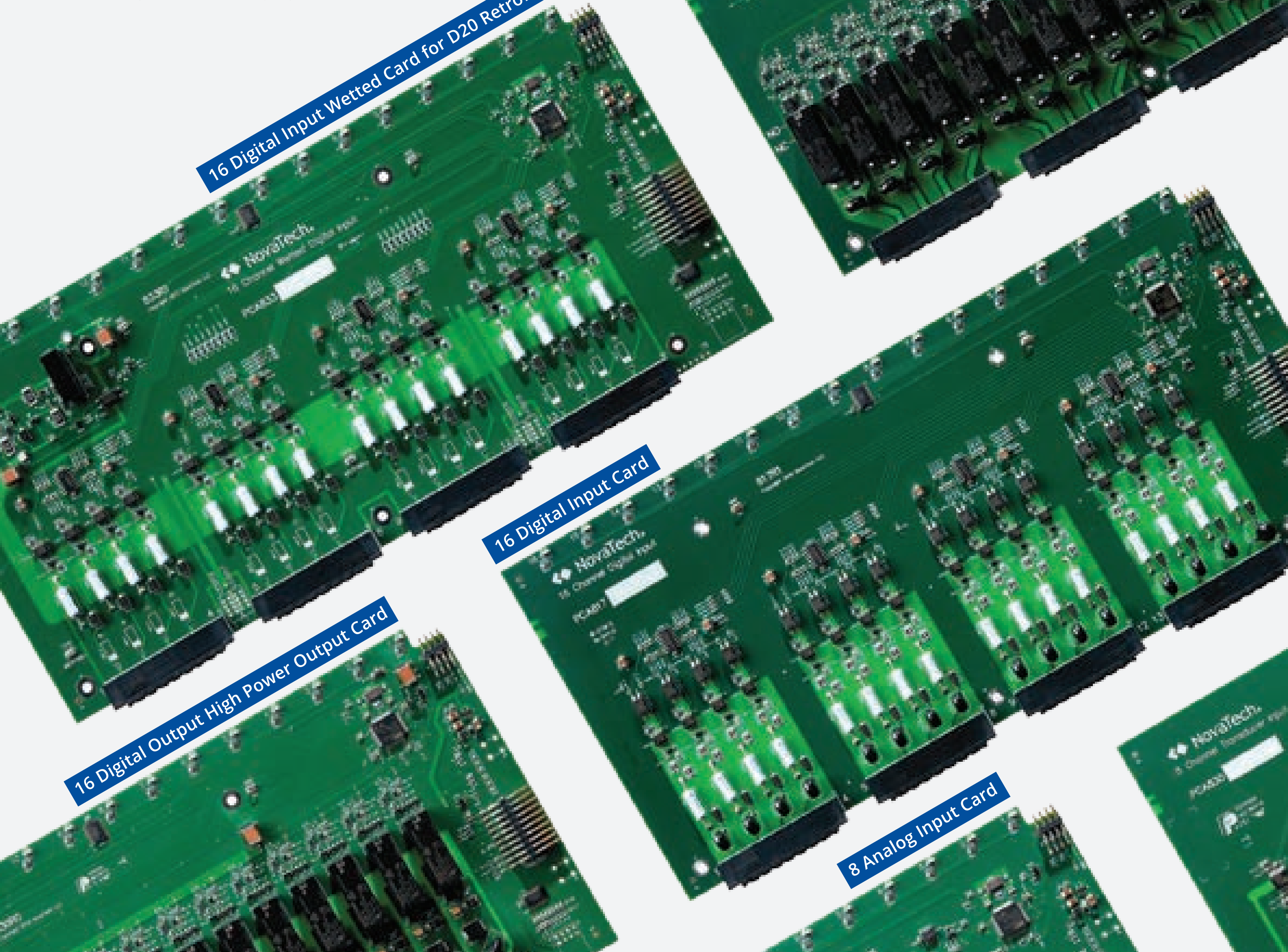

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FINGRID'S OPEN DATA - PLATFORM HAS IMPROVED ITS USER FRIENDLINESS

September 2018

Fingrid's open data platform has improved its usability based on the user feedback received.

Fingrid opened an open data service as the first European transmission system operator in the beginning of 2017. There are more than hundred different datasets about the Finnish electricity system and the electricity market which is shared in the service for everyone and free of charge. Now the usability of the service has been developed based on the user feedback received.

According to the users, the Application Programming Interface (API) of the service has worked very well. The usability of the manual user interface had room for improvements and it was hoped to be developed. Users of the service were interviewed to specify development needs of the user interface.

The most important development targets were the ability to download excel files and to combine multiple data sets to the same file at once. These features are now added to the service. In addition, the descriptions of the data sets have been improved.

Further development of the service will continue on the basis of customer feedback. Kindly send your opinions and suggestions to ***avoindata@fingrid.fi***

The site can be found at ***https://data.fingrid.fi/en/***


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DISRUPTIVE TECHNOLOGY:
IS IT A BAD THING?

ELISABETH MONAGHAN
Editor in Chief

In the year-and-a-half, I have been with *EET&D* Magazine, I have learned more about technology in the energy space than I did in the 20 years I spent working in the tech sector. Many of the articles we have published since I came on board have addressed the most of this technology has been introduced within the past few years. Today's technology comes at us so fast; utilities have to ramp up quickly to understand it, even if it is technology they don't intend to adopt any time soon, if ever.

Clayton M. Christensen coined "disruptive technology" in 1995. The term is a fitting way of describing emerging technology in the energy sector. If you search the internet for examples of disruptive technology, several, if not most of the results will include those that have already begun to impact the industry. AMI, IoT, AI, AR, DERMS, CRM, machine-based learning and EV's are a small sampling of technology that has disrupted how energy is produced, distributed and consumed.

We have published several articles in *EET&D* that talk about DERs (Distributed Energy Resources). When writing about multiple DERs, some of our contributors have referred to them as "DERs," while others used "DER." I attempted an online search to find the proper way to reference more than one DER. The first results were in German and had nothing to do with distributed energy. DERs may not be the at the top of the disruptive technology list, but based on how many of in our industry are working with them, it won't be long until DERs are more widely-accepted and more disruptive, which means we may see a consensus on how to refer to the plural of DERs.

In this issue of the magazine, a number of the articles are about DERs, beginning with The Grid Transformation Forum column by Mike Ballard with Oracle's Utilities and Tanuj Deora with SEPA. In their article, Ballard and Deora explain how, over the next few years, some customers are expected to invest more in energy efficiency and DERs than utilities will. This is due, in part, to better-informed customers, who have higher expectations, which is likely to have an impact on utilities. Those utilities who remain open-minded about the transformations the industry is undergoing, rather than viewing DERs as encroaching on their territory, will be better able to create value-added services for their customers.

Dave Christophe with Nokia shares his observations on the impact of new technology on utilities. Not only must utilities around the world accept the dynamic nature of new technology, but they must also prepare for its arrival, including the disruptive proliferation of DERs.

David Martin, who is the co-founder of Power Ledger, writes in this issue about the role DERs play in Australia, and how they could affect the energy sector worldwide. According to Martin, DERs may challenge everything we know about the energy industry, but they also could be the answer to clean and affordable electricity for both emerging economies and "energy-poor" populations.

In his article, Dan Garvey with PowerRunner also talks about the emergence of DERs and specifically, the U.S. power sector's response to them. Garvey writes, that in in 2020, California will require new homes three stories or higher to incorporate DERs into their design. With these requirements in place, will it pave the way for other states to follow suit?

As utilities respond to the latest technology trends, they must be address cyber and physical security issues, embrace renewable energy, be vigilant about maintaining and replacing aging infrastructure and remain current on regulatory issues. That is a lot to juggle.

This is where industry experts like Michele Negley with CLEAResults come in. Negley, whom we profile in our "Powherful Forces" column, provides the experience and intelligence to help utilities navigate the disruption by designing and implementing energy efficiency programs.

Based on the different approaches our industry experts take, it is clear DERs are neither universal nor will they be uniformly integrated. It may take time for the power sector to comprehend all that DERs have to offer. To some, DERs may remain a competitive threat, but like it or not, DERs are making their presence known.

One of the most significant challenges utilities face is the changing role of energy consumers. Today's utilities must acknowledge the customers' increasing demand to control how and when they use energy. There is an abundance of roadmaps, benchmarks and strategies covering energy providers and their customers. Consulting companies have cropped up to help utilities do a better job of delivering an enhanced customer experience. In this issue, PA Consulting takes this a step further, focusing on Nextgen fieldworkers and their ability to respond quickly to customers. As the article explains, when fieldworkers in remote locations are equipped with smartphones or tablets, they can communicate immediately when customers or colleagues need them.

As we enter the fourth quarter of 2018, we will see the inevitable lists of technology trends coming our way. Whether or not any of the technology is disruptive, I believe the energy community, diverse as it is, has the industry experts and offers the resources necessary to make sure we are prepared to ride that wave.

If you would like to contribute an article or if you have an idea about interesting technology, solutions, or suggestions, please email me at ***Elisabeth@ElectricEnergyOnline.com***.

Elisabeth

EXPLORING THE FUTURE OF DSM:

THREE GUIDELINES FOR CONNECTING CUSTOMER-SIDE AND GRID-SIDE RESOURCES

MIKE BALLARD AND TANUJ DEORA

If you ask a utility executive with a few decades of experience under his/her belt what s/he thinks about the current state of our industry, chances are you'll hear them say that this is one of the most transformational times in its history. The traditional utility value chain, which once placed customers at the edge of the grid, has been completely redrawn with customers squarely in the center. What's fueling this change is a steep rise in customer expectations, the accelerated customer adoption of Distributed Energy Resources (DERs), and the recognition of new opportunities to monetize grid resources. In some cases, customer investments in energy efficiency and DERs are even expected to eclipse utility spending in those same areas over the next few years[1].

With the growth of technology investments also comes a deluge of new data about customer energy consumption and behaviors, which has amplified the impact of demand side management (DSM) programs. As the Smart Electric Power Alliance (SEPA) illustrated in its 2017 Utility Demand Response Market Snapshot, there are several efforts underway to better coordinate energy efficiency (EE) and demand response (DR) programs at the utility level through combined program offerings, incentives, marketing, and services[2]. Undoubtedly this level of alignment will have many positive outcomes, but we believe it's the convergence of grid-side and customer-side resources that will truly shape the future of DSM.

In order to capitalize on this opportunity, we have developed three key guidelines for utilities to consider:

- DER programs can be designed and deployed to deepen customer engagement and expand value-added services
- Customer programs that are flexible in time, scale, and location can serve as non-wire alternatives to help balance increasingly volatile distribution networks
- Utilities with an open-minded approach toward new roles and best practices will benefit from new ways to generate returns from grid and customer investments →

First, utilities will need to recognize DER programs as prime channels through which to engage and empower customers to take control of their energy use. Once perceived as threats to the utility ecosystem, DERs are now viewed as assets that can be centrally modeled and leveraged for the betterment of the grid. Whether it's smart thermostats, solar panels, electric vehicles or storage solutions, utilities have an important role to play in the management of these assets, the insights that they provide, and the customer experience that they enable. For example, PG&E, whose utility website was ranked as the best energy company website in North America in 2017 by E Source[3], recently launched a set of web widgets to provide solar customers with greater visibility into their net electricity generation and consumption along with their net energy metering credits and charges. This offering enhances the overall solar user experience and fortifies the utility position within that relationship.

Second, utilities should leverage more customer programs that can be deployed on demand, at scale, and in targeted locations to help balance the grid. As Navigant noted in its 2018 research report Utility Customer Engagement Through DSM, "Grid management is expected to increasingly rely on customer interactions to manage multiple aspects of electricity generation, distribution and consumption including the when of electricity consumption"[4]. One utility that has embraced this construct is National Grid, whose innovative behavioral demand response program in the town of Clifton Park, NY called Peak Time Rewards, allows the utility to alert customers of upcoming peak events through emails and social media. These notifications, which are sent out to eligible customers within the territory, provide tips for shedding and shifting load and utilize behavioral science to encourage participation. After each peak event, customers receive information on their load curtailment and that performance is translated into points, which can be exchanged for gift cards. In the first season of the program, 58 percent of National Grid Clifton Park customers used less energy in at least one peak event when compared to a predictive model. This ability to manage customer behavior within the context of load balancing, and to do it without expensive programs that require installed measures, is critically important to the future of DSM.

Third, utilities will need to be open to working with new partners, breaking down traditional silos between grid-side and customer-side teams, and ultimately rewriting best practices for the industry. For example, SDG&E has taken a proactive approach to the proliferation of new rooftop solar and other utility scale DERs that feed into its distribution grid by creating real-time forecast models. Given the potential impact of these resources on operations, SDG&E has built multi-dimensional profiles that incorporate the location, weather, solar incidence, condition of use and other attributes that may be unique to DER assets. This allows the utility to account for "hidden load" and create optimal switching plans, which results in more reliable distribution operations and a better customer experience.

A key enabling technology that allows utilities to find and deliver value from grid and customer investments is data analytics. Best practices applied from other industries – whether on the consumer side by companies like Amazon and Lyft, or on the operational side – offer a great head start for how to deploy these established capabilities quickly. The returns from these applications are very quick compared to more traditional investments. For example, utilities may leverage data analytics in revenue protection, which employ machine learning algorithms to identify repetitive and evolving theft behaviors. This enables utilities to discern theft from meter malfunctions, shorten investigation cycles, and improve efficiency with limited resources.

This evolution of DSM, particularly the embrace of DERs, will involve redefining industry terms and writing new standards to reflect modern day applications. At this year's DistribuTECH conference in San Antonio, SEPA hosted a session with 200 industry experts, all focused on developing new standards for Distributed Energy Resource

Management Systems (DERMS), and some of the most intense conversations of the day were between smaller stakeholder groups trying to nail down more precise definitions for common terms. SEPA's Chief Innovation Officer, Sharon Allan, described this challenge, "As we begin to change our grid and have much more distributed energy connected on the system, it changes the way we operate and it changes the demands on the system, and it changes, really, the design points… We recognize that implementing standards — and ensuring they keep up with technology — is an ongoing enterprise"[5].

We see tremendous potential in emerging technologies and a more customer-centric approach to the grid. The utilities that can seamlessly integrate customer-side and grid-side resources while effectively engaging customers will lead the evolution of DSM and lay the foundation for a new century of growth.

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ABOUT THE AUTHORS:

Mike Ballard is the vice president of industry strategy for Oracle's Utilities Global Business Unit. Ballard has global responsibility for defining utility strategy for adopting emerging technologies such as Artificial Intelligence, Internet of Things, Blockchain and Mobility. He joined the Oracle Utilities' Industry Strategy team from EDF, one of Europe's largest energy companies, and has been delivering IT solutions to the utility sector for more than 20 years. Ballard's experience covers generation, distribution and retail utilities, including significant involvement in the deregulation of the UK energy market. At Oracle, Ballard works with utilities worldwide to help prepare for the diverse changes and challenges facing each country and market. Using these global insights,Ballard is able to share global trends and best practices and to direct Oracle Utilities product strategy to deliver market-leading solutions dedicated to the utilities industry.

Tanuj Deora joined SEPA in January 2015 to lead SEPA's research, advisory, communications and programs teams. His previous experience includes wind energy project development, research and design engineering, product management, business development and financial analysis for over a decade of experience in renewable energy after starting his career in the chemical industry. Deora served in the cabinet of Governor John Hickenlooper as director of the Colorado Energy Office and earlier served as a Peace Corps volunteer in Jamaica working on community and environmental health projects. Deora has also served as an advisor to the Rational Middle Energy Series and on the boards of the Colorado Renewable Energy Trust and Renewable Energy New England. He lives in Washington, DC with his family, and enjoys the outdoors, live music, Texas Longhorn sports and the occasional overseas trip when not attempting to maintain his 80-year-old house.

GREEN OVATIONS

A SYSTEM OF SYSTEMS APPROACH TO DERS INTEGRATION – MORE HOLISTIC THAN DERMS

DAN GARVEY

There is a considerable amount of buzz in the industry about the promise of a distributed energy resource management system (DERMS). It has been referred to by some as *"the most far-reaching transformation in terms of design and implementation."* DERMS are offered as a solution to the current and future challenges posed by distributed energy resources (DERs) but is yet to be a proven solution capable of managing the growing number of heterogeneous metered and behind-the-meter DERs that will grow into the hundreds of thousands.

DERMS have functional benefits, but they are just a component of the interim and long-term solution. The broader *"far-reaching transformation"* has to be a system-of-systems solution that is capable of modeling every service point and every asset on the distribution system. This includes aggregate DER asset models from multiple DERMS platforms to create localized load and generation curves that feed the advanced distribution management system (ADMS) power flow analysis. The modeling of DERs by a DERMS is only one component of the local distribution system model. As more and more behind-the-meter DERs, such as renewable generation, electric vehicles, energy storage and load control devices, are deployed, the more critical it will be to model every asset on the system.

The Train Has Left the Station

A few years ago, I did not foresee a future in which there would be a solar panel on every house and an electric vehicle in every driveway. And I still don't. Yet the recent regulations, building codes, manufacturing production trends and the rapid adoption of these heterogeneous, distributed and sometimes mobile DERs are having an indisputable impact on the current electric distribution system. →

Building codes are starting to incorporate more than just energy efficiency standards to include smart thermostatic communications protocols and even DERs consideration for new construction. Beginning in 2019, all thermostats installed during new construction starts in California will have to be able to receive an advanced demand response through the open automated demand response (OpenADR) protocol. These smart thermostats, like Nest, Ecobee, Honeywell and others, will enable the control of behind-the-meter smart devices. There are no mandates that currently require demand response participation, but enabling the OpenADR protocol behind-the-meter opens the gateway to utility or third-party control of smart appliances and other DERs. In 2020, all new homes three stories or higher in California, will have to incorporate DERs into their design. This new building code requirement is the first of its kind, and if both of these California building codes are adopted across the country, then we will see an increased adoption, or in the case of building codes, requirements to include DERs into new construction and renovations.

And as manufacturing costs and production trends continue to drive down the price of DERs and increase the availability and options to consumers, the deployment of DERs will move from *the early adopter* phase into *mass-market* participation. Consider the recent news about Tesla meeting its production target of 5000 electric vehicles per week, along with announcements from most of the global auto manufacturers indicating their commitment to EV production, and one can see the sea change ahead. Many believe that this is the beginning of a broader transition across the entire transportation industry. The International Energy Agency forecasts 125 million electric vehicles on the road worldwide by 2030.

Continued gains in battery technology are the key driver to this transition. A byproduct of this research – continued cost decreases in batteries – makes the economics of on-site and even residential behind-the-meter energy storage more likely in the near future. How long before we see a 5kW battery at Home Depot in place of the pad mount generator set?

The adoption of these technologies is occurring during a period where household spending on electric utility service as a percentage of monthly household expenditures is the lowest it has been since 1959. As Steve Mitnick, editor-in-chief of *Public Utilities Fortnightly*, outlines in a recent Today's *Public Utility Fortnightly* digital column, "Electric bills were 1.36 percent of consumption expenditures in the second quarter this year." Clearly, the consumer adoption of these expensive new energy technologies is not driven solely by economics.

This groundswell change in consumer habits is influenced by broader social and environmental factors that speak to a growing segment of the population. More importantly, as a consumer-driven transformation, the train has left the station. As outlined above, utilities have little influence over how and when consumers use their product and what new technologies they may adopt.

Changing consumer habits, growth in and lower costs of DERs, declining costs of energy storage and more statewide renewable energy policies all lead to the inevitable reshaping of the power industry. As the grid transforms into a bi-direction transactive platform, utilities need to develop the systems capable of managing distribution system power flow to maintain the fidelity of the grid.

Death by a Thousand … NO, a Million Cuts

While some utilities have deployed DERMS in pilots to help manage the growth of DERs, in reality, a DERMS might be a stopgap measure that provides only some visibility and control over larger DERs. Its limitations are considerable and analogous to only controlling the schedule of express trains that share the same tracks as local service trains. Without full visibility of how all assets are performing, you can't maintain a safe and reliable system. With reliability remaining job number one for utilities, less than full visibility could lead to "blue sky" outages due to uncoordinated DER performance… and that won't fly with customers or regulators. No one wants to see a train wreck! Modeling and scheduling larger DER assets only – as DERMS do – is an incomplete solution. To gain full visibility across the system, every asset, down to the service point and including behind-the-meter assets, has to be modeled.

As more behind-the-meter DERs are installed on the system and more homes open their home area networks to utility or third-party control of thermostats, water heaters and other smart appliances, the cumulative and localized impact of these micro assets have to feed into the hour-to-hour distribution power flow analysis. Current DERMS manage hundreds or maybe a few thousand DER assets disbursed across the system. As consumers continue to adopt behind-the-meter appliances and DERs, modeling and managing millions of assets will be essential. The DERMS will continue to be an input to the power flow analysis, but only if it can provide next-hour localized asset models and schedules. Localized distribution power flow has to be capable of modeling millions of metered assets, behind-the-meter assets and the aggregate grouping of assets by phase, circuit, transformer, etc., to ensure the safe and reliable operation of the system.

It is not enough to model hundreds or thousands of DERs across the system. Modeling every asset, including millions of service points, provides system operators with the granular visibility needed to ensure the fidelity of the grid.

> Localized distribution power flow has to be capable of modeling millions of metered assets, behind-the-meter assets and the aggregate grouping of assets by phase, circuit, transformer, etc., to ensure the safe and reliable operation of the system.

Operating Closer to the Rails

The need for more localized modeling is driven by hour-to-hour locational energy supply requirements and capacity constraints. As the electric grid begins to shift from a primarily centralized generation platform to a more decentralized distributed generation platform, scheduling energy and managing capacity on local circuits will become more critical.

As mentioned previously, in order to reliably integrate the deployment of potentially millions of micro assets into the distribution grid, utilities have to develop modeling capabilities that forecast near-real-time system requirements on every circuit to ensure there is sufficient electric energy and capacity to serve all customers. These local circuit requirements – energy, the net volumetric consumption in kWh and capacity and the magnitude or cumulative demand in kW at any moment in time – are crucial determinants to ensuring grid fidelity.

Scheduling energy on an hourly basis with wholesale markets will have to include modeling the performance of all assets, with or without DERs, on the distribution system. This bottom-up approach to modeling provides utilities with the capability of determining the hourly net load requirements for every circuit by simply aggregating the hourly forecasts for each asset on the circuit.

Unlike energy, capacity is a physical constraint, a demand limit determined by manufacturer nameplate equipment ratings on higher level system assets, such as transformers. This physical limitation is a critical operational threshold that, if exceeded, could affect all downstream assets (customers) and, potentially, customers on adjacent circuits. System planners continually review the loading on these critical assets to ensure sufficient capacity to manage peak demands.

But across the country regulators and utilities have been adopting a new approach to system planning: locational resource planning or non-wire alternatives (NWA). As an alternative to costly capital investments to increase physical system capacity, system planners are modeling the effect that downstream energy efficiency and load shifting programs, along with DERs incentives and time-of-use rates, can have on reducing hourly peak demand on upstream assets.

Locational resource planning alternatives can defer capital investments in system assets and help to increase capacity utilization, but also present a looming risk. With less headroom in capacity, we are asking system operators to run "closer to the rails." The capacity limits on critical system equipment become more important on NWA program circuits. The performance of all downstream assets, especially those variable assets that are incentivized to reduce demand during peak capacity periods, has to be modeled and forecasted in next-hour frequency to provide grid operators with the actionable information needed to avoid overloading on critical system assets.

The Confluence of Technologies – Enabling Platforms

The wave of innovation hitting the electric utility industry is a disruptive force that is changing a century-old industry that was, for most of that century a vertically integrated, uni-directional system. The new and emerging technologies available to consumers are drastically changing the operational and business models in ways that were not possible to conceive at the turn-of-the century. At the same time, utilities are faced with an onslaught of disparate data growing minute-by-minute. Utilities need to harness this big data to manage the proliferation of DERs and the evolving energy IoT platform.

Complementing advances in digital communications and controls in information technology are helping utilities manage these disruptive end-use technologies. An energy IoT platform is evolving, and as utilities gather data from behind-the-meter devices, advanced meter infrastructure (AMI), advanced distribution management systems (ADMS) and other OT & IT data sources, enterprise solutions are needed to unlock operational and commercial value from this big data. →

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Measurement data from energy IoT smart devices, including meters, inverters, appliances and thermostats provide utilities with information that can be used to assess the deployment and value of DERs on each circuit and to optimize the physical and economic value of these assets. However, the data can only be made actionable and intelligent for utility operations if it can be processed and presented in near-real time. Some utilities have adopted costly colocation strategies using Hadoop distributed file system architecture, centrally located data warehouses or data lakes to manage the growing big data. These solutions require the replication of data and increased data latency, thereby reducing the source data's value to the enterprise, particularly operations. An optimal solution is to minimize the replication of source data and leverage a data virtualization layer to pull disparate data into a real-time operational platform.

Data virtualization allows utilities to integrate data from disparate sources, such as AMI, DERMS, EV chargers, ADMS, etc., without replicating the data, to create an enterprise virtual data layer that supports grid operations, system planning and commercial evaluation of all DER assets across the system.

As noted earlier, the need for near-real-time data is essential to providing system operators with the visibility needed to ensure the fidelity of the grid. Therefore, data latency has to be minimized when processing data. Data virtualization does not wholesale replicate downstream source data, thereby minimizing data latency and providing actionable information to grid operators. Data virtualization also provides strong data management features which ensure data integrity, security and auditable. This functionality is not only critical to the operational integration of DERs, but also in the validation of DER performance and transactional settlement. This business platform is a keystone to integrate and extract the full value potential of the modern asset distribution grid.

The Emerging Transactive Energy Platform

The GRIDWISE Architecture Council (GWAC) defines transactive energy as, *a system of economic and control mechanisms that allows the dynamic balance of supply and demand across the entire electrical infrastructure using value as a key operational parameter*. A system is defined as *a set of connected things or parts forming a complex whole*. In the case of the electric distribution system, the *set of connected things* must include all micro assets that form the *complex whole*.

This is the shortcoming of DERMS. It is a disaggregated top-down modeling platform that only considers the impact that large DER assets have on the distribution system and does not incorporate how the performance of DERMS controlled DER assets and localized micro assets will affect individual circuit performance. An aggregate bottom-up approach that models every asset on a circuit is the best method.

> This system of systems platform will pull data from DERMS, EV charging stations, volt-VAR optimization (VVO) platforms and near-real time AMI data to model hour-to-hour, circuit-by-circuit system requirements.

System of Systems with Data Virtualization

Utilities need a transactive energy platform capable of integrating data and models from other systems to provide load and generation forecast data for every asset on the distribution grid, with the spatial and temporal granularity required to support operational decision management. This bottom-up approach provides utilities with aggregate asset forecasts by circuit, substation or other spatial attributes to analyze the impacts of DER assets on other grid assets. The platform must be able to dynamically model local resource requirements based upon actual historical and forecasted load, as well as any DER performance data for each local circuit. This system of systems platform will pull data from DERMS, EV charging stations, volt-VAR optimization (VVO) platforms and near-real time AMI data to model hour-to-hour, circuit-by-circuit system requirements.

> Data virtualization allows utilities to integrate data from disparate sources, such as AMI, DERMS, EV chargers, ADMS, etc., without replicating the data, to create an enterprise virtual data layer that supports grid operations, system planning and commercial evaluation of all DER assets across the system.

While DERMS are part of the solution to managing DERs on the grid, a much broader system of systems approach with a configurable data virtualization layer is the optimum solution for modeling a transactive energy platform. Utilities need a holistic view of the distribution grid in which every asset is modeled for near-real time performance.

Consider the Following Scenario

There will come a time when solar panels or other self-generating and energy storage units are required as part of every new home or more likely, offered by home builders as additional features that get rolled into a first mortgage. That same home may also be fitted with fast=charging electric vehicle outlets in the garage. More than likely the home will have a home area network with smart thermostats and security system controlled by a mobile device. Is this scenario five years out, ten years out? How long can you wait?

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SENSORS AND SENSIBILITY:

HOW IoT NETWORKS CAN MAKE GRIDS SMARTER

DAVE CHRISTOPHE

The rapid emergence of the Internet of Things (IoT) technologies and strategies has captured the interest and imagination of utilities. IoT offers the potential to transform a wide range of grid operations, such as asset management, predictive maintenance, self-healing functions, fault detection, fault localization, dynamic line rating, security, isolated worker protection and much more. But what are the practical implications of IoT for utilities?

The idea of applying IoT to utilities isn't entirely new; this shift is part of an evolution that is well underway, and in fact, pre-dates the use of the term IoT. Power utilities worldwide are in the midst of significant transformations as they gear up to adapt to new market forces, an evolving regulatory environment and the introduction of distributed renewable energy sources (and the disruptions they bring).

To make their grids "smart," power utilities need to understand what is happening on all parts of their network, all the time. To accomplish this, utilities need a wide array of sensors and other connected devices deployed throughout their grids to provide various kinds of intelligence. This intelligence can then be used to monitor and optimize grid performance, and ultimately help deliver a better experience to customers.

At the heart of this process are communications networks, which effectively serve as the "central nervous system" of the grid, connecting hundreds of thousands, or ultimately, even millions of sensors deployed throughout their transmission and distribution infrastructure. These sensors, in turn, gather and share information to support rapid and often automated decision making.

To manage the transmission and processing of all this data, the communications network needs to reach much farther out in the grid than ever before, connecting with, characterizing and orchestrating each of these devices. This is the role of the field area network (FAN), which utilities rely on to provide the connections between the multitude of sensors and other connected devices and the "smart" part of the network, where data can be processed, and decisions can be made.

This decision-making capability is particularly critical as utilities seek to address a key challenge created by the rapid introduction of distributed renewables – matching supply and demand to manage the "duck chart," a curve named after it its duck-like shape. The duck chart documented the timing imbalance between peak demand and the production of renewable energy in California throughout a given day. Essentially, utilities would see a dramatic oversupply of power from solar sources in the early afternoon, but relatively low demand. Demand would then increase dramatically in the late afternoon as people returned from work and school, only to see supply dropping as available solar energy diminished. →

You might ask what a mismatch between energy supply and demand in California has to do with IoT networks and smart grids elsewhere. The reality is that any utility that is making use of renewable sources is going to face the challenge of how to manage demand in the face of supply that varies dramatically based on time-of-day, weather changes, seasonality and a host of other factors. Real-time insights into the performance and behavior of the grid are essential to managing this challenge. Utilities can use FANs – connected to an extensive and diverse array of sensors - to extend intelligent distribution automation out into the grid, enabling them to match supply and demand more effectively, while maintaining a stable and reliable grid.

How does this work in practice? In one example, utilities can use phasor measurement units (PMUs) to perform synchronized, real-time measurements of remote points on the grid, checking as often as 30 times a second. This is an essential element of any grid-wide stability assessment, and FANs play a critical role in providing the linkages necessary to gather and process the needed data. This, in turn, gives utilities actionable intelligence on the performance of their grid that they can use to optimize operations.

Clearly, FANs play a central role in supporting grid operations, and their importance is certain to grow as IoT strategies mature and build-outs mature. It is important to note, however, that not all FANs are created equal. In fact, historical approaches to FAN deployment to date may actually hinder efforts to support more intelligent distribution models, undermining efforts to make grids smarter.

Over time, many utilities have built individual FANs to support specific applications, often based on proprietary technologies, or perhaps using unlicensed or lightly licensed spectrum. They may have one FAN for line monitoring, another for advanced metering infrastructure (AMI), another again for synchrophasor measurement (assessment of aggregated data from PMUs). In some cases, these FANs were each built using discrete networking technologies.

As a result of this, many utilities have multiple communication network silos that need to be monitored, managed and maintained individually, something that will become increasingly burdensome as utilities deploy more and more new applications. This approach can lead to higher operations and maintenance cost while making inter-operation and coordination between different applications on the grid more difficult, if not impossible – not exactly the "smart" approach.

> **"In addition to delivering secure, reliable and scalable communications links, this converged network infrastructure can facilitate smooth inter-operation between discrete applications, which can help to make the grid more responsive, which is a key goal of smart grid strategies."**

Utilities do have alternatives. One strategy gaining considerable currency is the deployment of a converged FAN based on industry-standard technologies. By using LTE mobile broadband technology, coupled with Internet Protocol/Multi-Protocol Label Switching (IP/MPLS) infrastructure, utilities can move to a truly future-proof network that can address their networking requirements far into the future. Such a converged network can support multiple grid applications simultaneously, providing each with the levels of priority, performance and security tailored to its unique requirements.

In addition to delivering secure, reliable and scalable communications links, this converged network infrastructure can facilitate smooth inter-operation between discrete applications, which can help to make the grid more responsive, which is a key goal of smart grid strategies.

For many utilities, the move from individual silos to a converged FAN is not so much a leap as an incremental step. Power utilities around the world have already begun the transition to IP, with many taking advantage of the benefits of a managed-IP approach by deploying IP/MPLS to support their wide area network (WAN) requirements. By adding LTE to their capability set, they can quickly and seamlessly extend the capabilities of IP/MPLS wirelessly from the WAN to the FAN. In this way, utilities can link up devices in the field with the control and management systems that are already in place in substations and operations centers.

As important, because they are standards-based, these converged networks can also support the evolution of future technologies such as 5G and accommodate popular emerging IoT technologies such as low-power, wide-area (LPWA) wireless access. These networks can also support connectivity over some unlicensed or lightly licensed spectrum such as Citizens Broadband Radio Service (CBRS), which has become available for use in the U.S.

Ultimately, what utilities need are broadband connections that can reach anywhere and everywhere and support the rapid growth of machine-to-machine communications and the dramatic increases in field devices of all kinds (sensors, IEDs and more) that characterize the IoT. This will provide the required communications foundation for greater automation and transformation to new business models. Utilities need networks that will expand and adapt to meet their needs as the demands of the market shift and evolve, offering a path to a future that is almost within reach.

ABOUT THE AUTHOR:

Dave Christophe is director of energy solutions marketing at Nokia, where he focuses on the role of modern communications for grid operations and as a foundation for an evolving utility business. Christophe also puts some of his "energy" into enabling oil, gas and mining companies to modernize their communications networks, and to helping water utilities apply advanced ITC solutions to their water distribution and hydro-electric generation operations.

PREPARING FOR FUTURE ENERGY DEMANDS

WITH SMART GRID TECHNOLOGY

NICK NAKAMURA

For more than 100 years, power grids have fueled growth in the U.S., enabling numerous technology revolutions. Today, power grids across the country are being challenged to keep up with the demands of the 21st century. By 2030, our nation's energy usage is expected to grow 30 percent, according to the Energy Information Administration. Our aging infrastructure, combined with the growth of distributed energy resources (DERs), is more prone to power outages and incurring electrical disturbances that affect power quality. These factors have a significant impact on the ability to provide a sustainable and reliable grid for the future.

To keep up with today's demands and the future growth of the grid, our aging infrastructure will need to be modernized to optimize power delivery and reliability. Smart grid components in the distribution network such as reclosers, sensors, distribution automation and Supervisory Control and Data Acquisition (SCADA) communications can provide utilities with the tools needed to address these challenges, providing grid resiliency and reliable power to their consumers.

Electricity on Demand

Utilities across the U.S. have been installing smart grid devices at a record growth rate and are being challenged to utilize these assets to complement their smart grid strategy. The utilization of reclosers aligns with this strategy, providing more reliable power throughout the distribution network, thus improving reliability indices such as SAIDI and CAIDI. Traditionally, reclosers have been used to automatically restore power when temporary faults occur. Today, utilities have been further leveraging reclosers by implementing distribution automation schemes and increasing deployment based on a number of customers, a specified distance of distribution line and a specified amount of generated power from DERs. These strategies have proven to further optimize grid resiliency and reliability.

The question remains: how can assets in the distribution system be further optimized to complement strategic initiatives, such as improving grid efficiency and power quality? Initiatives such as volt-var optimization (VVO) and conservation voltage reduction (CVR) have proven to improve grid efficiency by reducing peak demand, distribution line losses and carbon emissions. Smart grid sensors, such as metering class voltage sensors, are an essential tool in providing the data needed for these programs and enable utilities to make critical decisions and adjustments to the grid. Installing metering class voltage sensors on a recloser can continue to leverage the capability of the recloser by serving as a metering point. A recloser used as a metering point serves as a dual-purpose protection and metering device designed to improve two common initiatives: improving system reliability and improving grid efficiency. →

Nuclear Power Plant
Thermal Power Plant
Control Center
Hydro Power Plant
Solar Power Plant
Wind Power Plant

Reliable Reclosers & Sensors that Improve Grid Efficiency

With smart grid initiatives, the growth of DERs and the drive to maximize visibility on the grid, there is a growing need for utilities to maximize reliability, resiliency and power efficiency. Some utilities are deploying more reclosers to maximize reliability in the grid. One common methodology has been installing reclosers based on number of customers. A traditional method utilized one recloser installed for every 1,800-2,000 customers. Today, many utilities have analyzed system performance with the benefits of new smart grid technology and determined that one recloser for every 400-500 significantly improves grid reliability. Additionally, utilities have determined a strategy around deploying one recloser for a specified distance, such as three – to – four miles, or for a specified amount of generated power from DERs, such as 2-3MW when deployment of DERs is applicable. Implementing the combination of these strategies maximizes grid reliability.

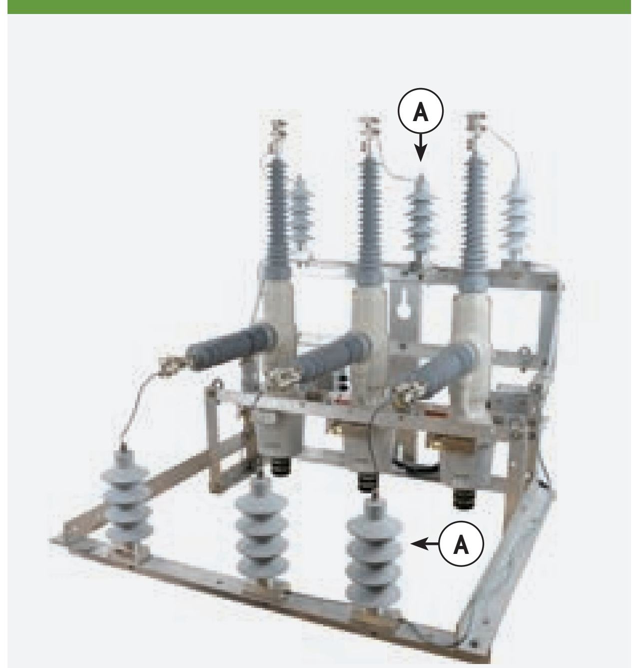
The number of DERs is expected to double in the next five years, driving more inverters and potential power quality issues that are of interest to monitor to maintain grid stability and efficiency. Power quality issues that should be considered in DER applications are high orders of harmonics and harmonic distortion. These can cause undesirable effects on the grid such as increased transformer, capacitor, motor or generator heating, misoperation of electronic equipment such as protective relays and incorrect readings on meters. DERs, such as solar farms, can be configured with an intertie switch that will enable switching between the solar farm and utility sources. In these intertie applications, highly accurate sensors can be utilized to monitor power quality coming from DERs, such as harmonics, and provide utilities with system information that can support making important decisions.

Power quality can further be addressed with the implementation of VVO and CVR, which are proven methods to address the health and efficiency of the energy on the system. VVO can assist in improving power quality by providing accurate voltage and current data for utilities to make decisions such as switching capacitor banks. CVR promotes energy conservation by reducing voltage, which displaces costly grid generation. When voltage is reduced during peak load periods, there is a resulting reduction in peak demand. The voltage reduction equates to fewer line losses and more efficient use of energy. Additionally, when there is less demand for generation, less coal is burned, resulting in a reduction in carbon emissions. To comply with the requirements needed to execute these power quality initiatives, utilities seek to achieve voltage sensing measurements in real time that have a less than one percent error with an expectation of 0.5 percent error tolerance.

Compared to traditional voltage transformers used for metering class voltage accuracy, today's voltage metering sensors are lightweight at less than 10lbs, utilize low energy inputs that are less than 10VAC for linemen safety, have higher basic impulse level (BIL) ratings, require no calibration and are easy to install. There are several voltage sensor solutions on the market; however, very few are 0.5 metering class accuracy (0.5 percent voltage accuracy) while being tested to industry standards. Additionally, these voltage sensors are typically sourced for the end user to integrate directly into the distribution system or onto a device in the system (i.e., such as a capacitor bank or recloser), rather than coming configured as a plug-and-play, pre-packaged solution.

When packaging high accuracy voltage sensors with a recloser into one pre-packaged device, it can be utilized to execute VVO & CVR programs while also serving as a versatile recloser. SCADA-enabled devices require communications equipment that needs to be commissioned, involving engineering and operator time and associated expenses. When devices such as reclosers and metering points are consolidated into one device, these SCADA commissioning expenses are cut in half. Additionally, many utilities value receiving a complete integrated system with pre-installed accessories and wiring from a single supplier, as opposed to sourcing and

RECLOSER PRE-CONFIGURED WITH HIGH ACCURACY VOLTAGE SENSORS



A) Metering Class Accuracy Voltage Sensors integrating all of the components together themselves. This packaged solution adds convenience and reduces the labor time and expense associated with installing capital equipment into the distribution system.

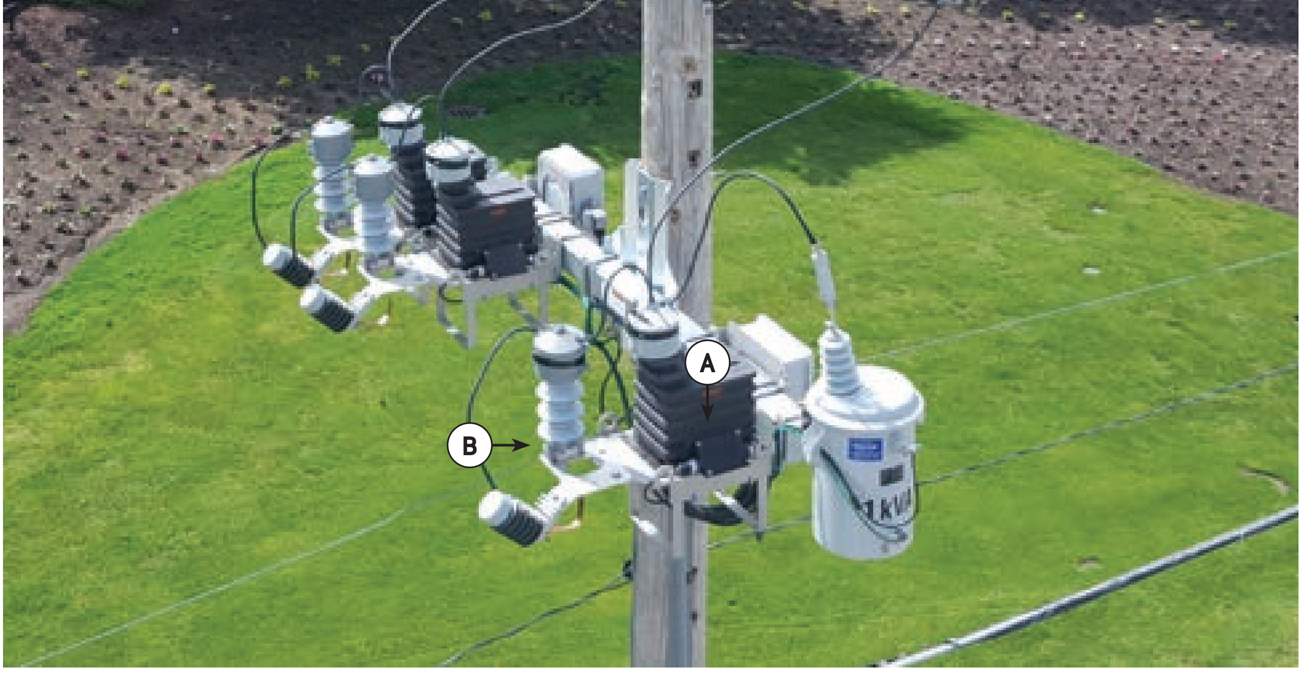
In the event a permanent fault occurs on the system, implementation of distribution automation can drastically reduce the impact, minimizing the number of customers affected by the outage. Through distribution automation, the system becomes more dynamic and can be custom configured to automatically detect a fault, isolate the fault and restore power to the non-faulted segment through fault detection, isolation and service restoration (FLISR) schemes. Isolating the segmented faulted lines and the restoration of power to the non-faulted segment display benefits in grid resiliency or a way of "self-healing" so outages are only limited to the source of the problem. Smart grid sensors can assist by providing the information needed to determine a system fault or outage. When combining sensor measurements with automated switching in an intelligent system, response is optimized, and power can be rerouted to most customers in a matter of seconds or less. The flexibility of programming intelligent protection relays to meet specific system requirements in these schemes demonstrates the effectiveness of the "smart grid" and how technology has impacted and improved reliability in the modern grid.

In these distribution automation schemes, reclosers with intelligent relays, sensors and communications are configured to be used in several different switching applications, such as a traditional recloser, a sectionalizer, and a normally open tie switch that interfaces with two sources. This application versatility compliments asset management by utilizing one device that serves all these different functions rather than having a dedicated device for each. Furthermore, incorporating the same platform makes the installation and commissioning process more seamless, from the linemen installing the equipment to the relay engineers and SCADA operators confirming the communications equipment is operating properly.

Distributing Smart Data

With energy demand and DER deployment increasing, our aging electric infrastructure is being pushed passed its design limits. Utilities have realized how important smart grid devices are to modernizing the grid, enabling the delivery of electricity that is more reliable and efficient. According to the Edison Foundation Institute for Electric Innovation, last year, utilities invested a projected $35 billion in distribution grids. Increasing grid efficiency and integrating DERs could save an estimated $36 billion annually by 2025, according to the Department of Energy. →

TRADITIONAL VOLTAGE TRANSFORMERS WITH METERING CLASS ACCURACY VOLTAGE SENSOR



A) Traditional Metering Class Accuracy Voltage Transformers **B)** Metering Class Accuracy Voltage Sensors

Investing in smart grid devices is one of the first steps in moving toward a digital distribution grid. Real-time, optimized control of devices that can provide information for VVO and CVR initiatives allow the system to rapidly address power quality issues. Rapid response enhances the grid's ability to more effectively integrate wind and solar generation. Integrating more renewable energy helps reduce the reliance on fossil fuels and decrease our carbon footprint. Smart grid devices, such as reclosers and sensors will help play a key role in reducing outages and incorporating renewable energy that is critical to support the energy grid of the future.

Potential Environmental Risks

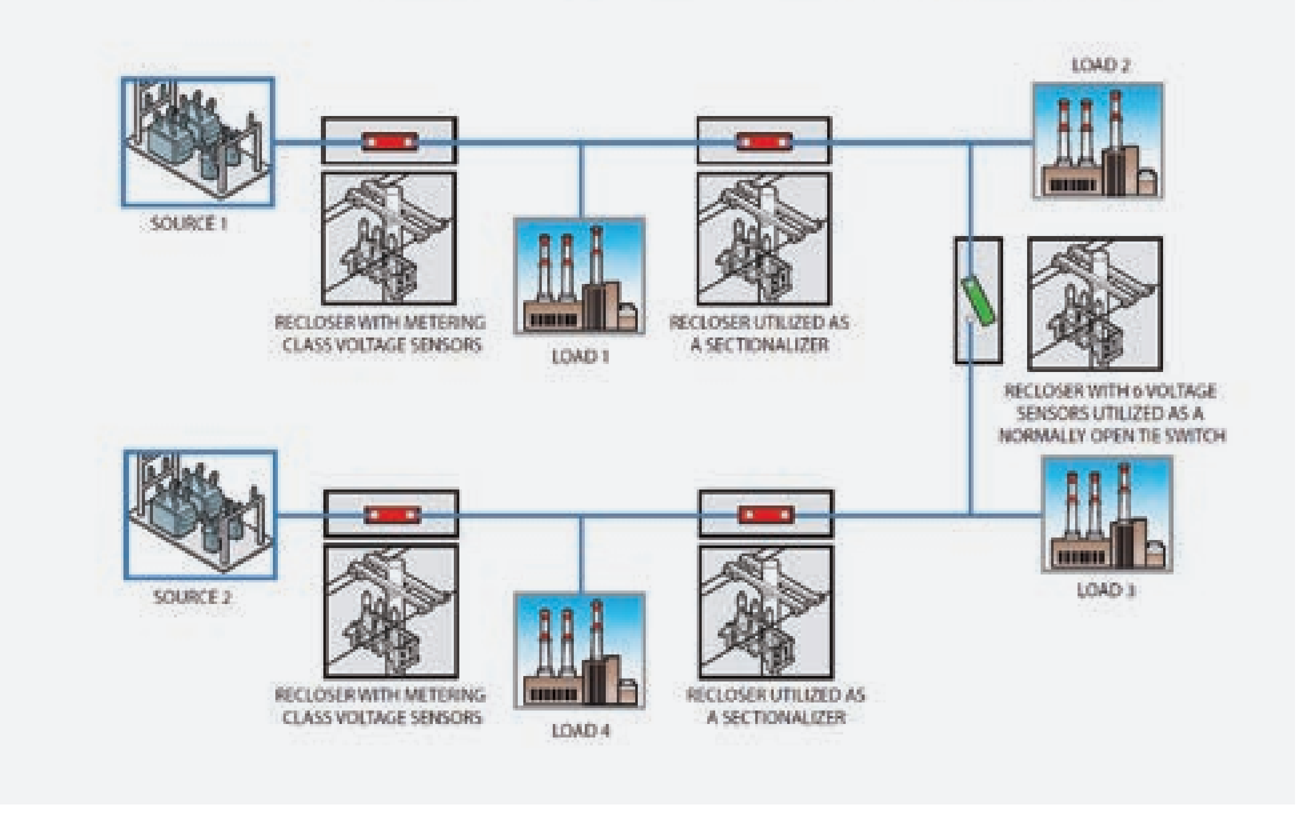
Reluctance to modernize our grids can have a major impact on our planet. According to the Department of Energy, environmental studies show that U.S. carbon emissions are expected to rise from 1700 million tons of carbon per year today to 2300 million tons of carbon by the year 2030.

For utilities to truly diminish their carbon footprint, they need to incorporate renewable power into our grids but doing so can be challenging. It involves more communication, adapting to two-way power flow, optimizing efficiency, and turning traditional utilities off, turning solar or wind power on and back the other way. Smart grid sensors can monitor wind and solar power, providing information to regulate fluctuations with demand response. They can alert the grid when the sun is down or if there is no wind to manage the fluctuation.

With the increase of green energy from power companies to solar panels on our homes and businesses, there will be more power fluctuations which will require more sensors to communicate and keep our grids running effectively. The same study by the Department of Energy shows that utilities, through implementation of energy efficiency programs and renewable energy sources, we would not only slow the growth of carbon emissions, but actually reduce our carbon emissions to below 1,000 million tons of carbon by 2030.

> **Power outages and line losses are not only an inconvenience but also cost Americans $150 billion annually, according to The Department of Energy.**

VERSATILITY OF A RECLOSER IN A DISTRIBUTION AUTOMATION SCHEME



Tomorrow's Grid Will Demand Devices that Provide More Reliability and Accurate Data

To keep up with our rising energy demands, utilities continuously need to improve power quality and increase reliability to run an efficient power delivery grid. Power outages and line losses are not only an inconvenience but also cost Americans $150 billion annually, according to The Department of Energy. The combination of reclosers and high accuracy voltage sensors in the distribution system enables utilities to effectively meet these reliability and power quality needs, providing the data needed to make critical decisions and adjustments to the grid. Installing metering class sensors on a recloser can assist in maximizing the flexibility and application versatility of the recloser allowing utilities to enhance grid reliability, resiliency and power quality as well as reduce peak demand, distribution line losses and carbon emissions. Additionally, with the growth of (DERs), there are more interties and potential power quality issues that may need to be monitored. The expected rise in smart grid installations will continue to increase grid intelligence and reliability, enabling utilities to meet the increase of energy demand while maintaining a resilient grid. By investing in smart grid devices such as reclosers and sensors today, we are allowing our aging infrastructure to meet the energy needs of the future.

ABOUT THE AUTHOR:

Nick Nakamura currently serves as sr. product engineer for Sensors and has previously held positions as product manager for Overhead Switchgear and sr. engineer for Aftermarket Support. Nakamura held earlier engineering roles in the printed circuit board, food, and pharmaceutical industries and is a PMMI certified trainer. Today, he is busy with projects working with product development on new, innovative technologies and products. Nakamura is also involved in professional organizations including the IEEE Switchgear Committee and is an IEEE PES member.

IEC 61850 WHAT ARE YOU WAITING FOR?

BRUCE MUSCHLITZ

Since its release in 2003, IEC 61850, a standard that defines communications protocols for intelligent electronic devices associated with power systems, has been rapidly adopted by utilities around the world. Nearly 100 percent of European utilities use this standard, but very few do so in North America. Here in the U.S., lack of adoption generally centers on the perceived risks of moving to IEC 61850 and a limited view of the technology's benefits.

That's short-sighted because 61850 delivers a comprehensive toolkit of best practices for substation automation and other application domains. It's the only non-proprietary international standard that specifically addresses substation control at protection speeds, making it a great choice for utilities working hard to modernize their transmission and distribution systems. It also makes it easier to move data from the grid edge, where many sensors and other devices reside.

This article covers why utility engineers in North America might want to give this standard another look.

A Way of Life

IEC 61850 was designed by leading substation automation experts throughout the world to simplify the process of automation. It is much more than a communication protocol; it is a way of life, a standard that goes beyond describing how data is transferred and received. It defines how data is executed and stored, and it covers device specifications, such as surge withstand, temperature, electromagnetic interference (EMI) and other factors.

Back in 1996, when the IEC Technical Committee 57 began work on an automation standard to replace the IEC 60870-5 set of standards, the group had the following high-level goals:

- Expand the protocol standard to become a comprehensive automation standard
- Use existing standards where possible, specifically Ethernet and MMS
- Establish a well-designed object definition methodology
- Incorporate a machine-readable configuration language for all aspects of the automation
- Facilitate high-speed peer-to-peer communication for distributed control system that was not a master-slave approach
- Integrate conformance testing requirements

The resulting IEC standard released in 2003 accomplished all of the goals. Specifically, 61850 includes the following major features:

- Support for project management (signal names, top-down design, testing aspects)
- A machine-readable configuration language (XML)
- Simplified representations of physical apparatuses and their operations
- Mappings to protocols (ISO 8606 MMS and 802.3 Ethernet)
- A publish-subscribe mechanism for peer-to-peer communication (GOOSE)
- A method to digitize data close to the source (Sampled Values)
- Conformance testing methodologies →

Given these features, 61850 allows for high-level design with sufficient detail for use as a procurement document, plus it lets engineers prepare a final configuration containing the as-built model of the complete system. This final configuration file can be used to automatically generate documentation and for it to be input into simulation and test devices.

IEC 61850 attempts to create a "step-by-step cookbook" for the construction of automation systems. Cookbooks contain ingredients as well as well-defined parameters, such as standard measurements – a cup, a teaspoon, etc. – and well-defined activities, such as creaming butter or baking at 375 degrees. If you didn't have such details, you couldn't bake a uniform cake repeatedly. That's one of the main advantages IEC 61850 offers. Like a cookbook, it is a comprehensive resource of well-defined automation parameters, activities and terminologies.

In addition to its flexibility, consistency and breadth, IEC 61850 specifies a well-defined and machine-readable configuration language that can be used during all stages of the automation system design. It facilitates definition of the physical equipment, such as breakers, busbars and instrument transformers, lists supported services and objects and outlines the final as-built functional and communication systems including signal flows.

Advantages of IEC 61850 Over Legacy Protocols

The traditional workflow for power automation systems inhibits innovation. That's because the traditional approach used in the U.S. aims to minimize differences between the previous automation system and the current iteration. In contrast, the IEC 61850 approach accommodates the needs of the larger system, including enterprise-level systems, and it also focuses on functionality.

IEC 61850 accomplishes this by decomposing the requirements of the larger system and codifying a design philosophy, which simplifies engineering efforts. Legacy protocols such as Modbus and DNP3 mostly focus on the data transfer portion of the automation system. IEC 61850 expands beyond the data, which lets the user design automation systems based on what should be done as opposed to how the data should be transferred.

In addition, the standard establishes a consistent naming convention for signals and data objects. The standard spans from the central system database to individual signals and objects within each device. Because of this consistency, it is much easier for systems at various levels to aggregate information from individual devices. For example, the IEC 61850 name for Phase A-to-B Volts is identical for any 61850 device with that piece of data.

As another example, aggregating total power consumption is simply a matter of adding the 61850 values of "TotW." Typically, what happens now is that data coming out of a device must run through multiple translators associated with various devices before it gets to the enterprise system that actually deals with the data. Just as communication changes when a group of children plays "whisper down the alley," this oft-translated data may lose some detail by the time it reaches the enterprise system. This is because almost every protocol is slightly different. Pieces of information in the source protocol may have no representation in the destination protocol. When that happens, the data gets dropped, and some data detail may be lost in translation. IEC 61850's consistency eliminates the translation steps.

Support for a variety of methods to transfer data values is yet another advantage of this standard. It facilitates traditional polling by object (the "pull" model) as well as spontaneously generated data (the "push" model). The push model is further divided into data that is published only if interesting, such as alerts or exception reports, and data that is published on a periodic schedule. The push model can dramatically reduce the communications bandwidth compared to the pull models of traditional protocols.

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IEC 61850 communications can be of two types: point-to-point as well as point-to-multipoint. The first type is used for the flow of data between two pre-defined devices. Point-to-multipoint communication comes into play when a single piece of information needs to be conveyed simultaneously to multiple recipients, typically at very high speeds.

The standard was designed for extensibility in that future capabilities are fully backwards compatible with previous equipment versions. This feature is important to protect prior investments in automation. For example, older 61850 products can accommodate protection functions that were defined after the release of the older product. Such extensibility also allows vendors to offer capabilities beyond what is written in the standard as product differentiators.

A final major advantage of 61850 is the ability to define the "wireless substation" where information is digitized at the source and placed upon the main communication network for all devices to use. IEC 61850 uses Generic Object-Oriented System Event (GOOSE) messaging, which is designed to be vendor independent, as well as sampled values (SV) to transport the analog voltage and current information throughout the system. This allows most pieces of equipment to use only a single power connection and an Ethernet port without the tangle of device-to-device wiring. It eliminates the manual, error-prone wiring work and documentation required in legacy approaches require.

Why "No" Should Be "Yes"

The IEC 61850 concept has been criticized in many ways. The first criticism is that the standard is very large and difficult to learn. That's true. The first edition of 61850 contained 14 parts with about 1,500 pages. The 2009 version contains over 40 parts with many more pages. Still, this volume of information is a necessity to describe enough detail to accomplish the cookbook approach.

IEC 61850 has also been criticized for using cryptic names instead of point numbers.

The naming rules for 61850 use well-defined, but short abbreviations to name data objects. For example, "MMXU1.PPV.phsAB.cVal.mag.f" is the name of the dead-banded voltage primary magnitude on a 3-wire delta power system from phase A-to-B. While not exactly human-readable at first glance, each of the components is well-defined. In contrast, legacy protocols such as DNP3 might indicate the same information as "Analog-Input point number 352," and engineers would be sent scrambling to consult the individual product documentation to determine where the corresponding data scaling factors are located.

Likewise, the IEC 61850 configuration language is very complex and difficult to read. But, the language is meant for information exchanges between computer applications and isn't meant to be changed by humans. Tools exist that can convert this language into human-readable form.

> **Clearly, there are plenty of benefits in 61850 to counteract perceived disadvantages. That's why it is time for U.S. engineers to give this standard a second look and, better yet, a try.**

Another perceived disadvantage of 61850 is the rapid pace of the standard's evolution. This is the same set of "growing pains" that all standards experience. However, it is a particular concern to automation systems that are expected to be in service for a longer time span than a single version of the standard. The only solution, which has also been adopted, is to strive for both forwards and backwards compatibility.

Some users balk at the rigidity of the 61850 approach to substation design and believe that there are parts of 61850 that do not need to be followed. On the contrary: The full benefits of 61850 are only realized when adherence to the standard is followed throughout the design. For example, users may wish to bypass the portion of the configuration that assigns the network addressing within the System Configuration Description (SCD) file because this was not needed in legacy systems. However, this seemingly small change to the 61850 cookbook results in a system where verification of device address assignment is impossible, leading to possible failures in the operational system. It also complicates diagnosis of problems during maintenance. Furthermore, an estimation of traffic volumes using the SCD file becomes impossible.

Ultimately, the design rules of 61850 reduce the effort of generating valid automation configurations. 61850 eliminates the need for error-prone manual spreadsheets to transfer information between systems. It defines a method to communicate from the end device all the way to the central database without modification. While the standard has a steep learning curve, it eliminates work, complexity and the risk of manually introduced data errors in the end. The key to managing complexity is to use appropriate tools that can hide the complexity.

The standard also cuts the risk of construction errors because, if fully implemented, all point-to-point wiring can be eliminated. Since wiring faults in automation systems contribute a significant number of failures, the reliability of the system increases dramatically. What's more, both SV and GOOSE inherently contain "heartbeat" signals that allow the automation system to self-monitor for faults and place themselves into safe mode when equipment failures occur.

Clearly, there are plenty of benefits in 61850 to counteract perceived disadvantages. That's why it is time for U.S. engineers to give this standard a second look and, better yet, a try.

For users new to 61850, the migration might look very difficult, but there are ways to mitigate the risks. Two approaches have been successfully used by US utilities: "baby steps" and a full 61850.

The baby-steps approach is essentially cherry-picking the easy-to-use features and extending an existing automation system. For example, a GOOSE scheme can be employed to provide interlocking of control decisions and the controls can be implemented in 61850 as point-to-point requests. This has the advantage that only very small parts of 61850 need to be understood to successfully implement. The disadvantage of this approach is that it is very easy to take shortcuts to the standard 61850 configuration system that will result in a later possible re-design.

The full-61850 approach involves a deep dive into the 61850 standard to build a completely new automation system for a new application. This requires a major commitment by the user and a full understanding that the first (and second and maybe third) implementation of 61850 will be more expensive than the corresponding legacy system. This technique, however, has the advantage of avoiding false starts and revealing the full power of 61850 in the first implementation.

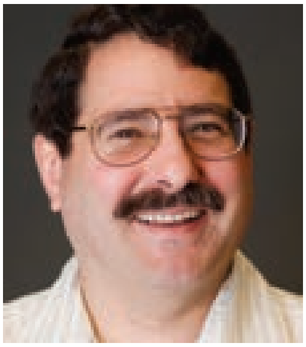
The cost savings of the wireless substation, along with the wider range of protection and control applications utilities can implement with 61850, raise this standard beyond conventional legacy techniques. 61850 delivers true interoperability and supports seamless device integrations. It may take some study up-front, but it will save utility engineers time and trouble on the back-end.

> **What are you waiting for? Isn't it time you looked at 61850 for your substation automation projects?**

ABOUT THE AUTHOR:

Bruce Muschlitz is a research engineer at NovaTech with more than 20 years experience in project leadership and utility communications protocols. He is heavily involved with industry/national/international standards groups and chairs the UCAIug testing committee which is responsible for maintenance of the IEC 61850 device conformity testing program.

Muschlitz earned an MS in Electrical Engineering from Lehigh University. He is a senior member of IEEE, as well as, a member of the DNP3 Technical Committee, UCA International Users Group Technical, a member of IEC TC 57 on working groups 10 (IEC 61850) and 17 (Distributed Energy Resources), CIGRE, various IEEE PES committees, and is a founding member of the Smart Grid Interoperability Panel.



THE IMPORTANCE OF 5G FOR UTILITIES

JEFFERY TORRANCE

The need for higher efficiencies, security and better user experience is driving the adoption of the Internet of Things (IoT) into a number of industrial and smart cities applications. Utilities' communications are among the most demanding applications in terms of wireless reliability and coverage. Networks need to cover their entire service territories including challenging locations such as remote rural areas and deep inside apartment, basement and office buildings. Millions of devices have to be connected with an extreme degree of reliability and security – satisfying strict demands for performance, low-latency and reliability to support a wide variety of use cases going from smart metering to real-time fault management and direct load control.Newer cellular technologies including **LTE IoT** today and **5G** tomorrow are designed not only to better interconnect people, but also to interconnect and control machines, objects, and devices. They will deliver new levels of performance and efficiency that will support a broad set of industries including utilities. 5G is not just about multi-Gbps peak rates, it also brings ultra-low latency, high reliability & massive IoT scale – allowing utilities to tap into these new capabilities could enhance customer satisfaction, reduce operational costs and improve the resiliency of their service. →

> The evolution of wireless networks toward 5G, the next generation of cellular technology, brings exceptional communications capabilities for utilities and opens new opportunities for collaboration with mobile network operators.

What is 5G?

5G is the fifth generation mobile network which has been designed from the beginning for a broader scope than previous generations. Like 4G LTE, 5G is also OFDM-based and will operate based on the same mobile networking principles. However, the new 5G NR (New Radio) air interface will further enhance OFDM to deliver an improved degree of flexibility and scalability.

In general, 5G use cases can be broadly categorized into three main types of connected services:

- **Enhanced Mobile Broadband:** 5G is expected to deliver peak data rates up to multiple Gbps. A technology company based in San Diego, CA, has created a 5G modem that is designed to achieve up to five Gbps in downlink peak data rate. Multi-Gbps speeds and the enhanced capacity could allow utilities, for example, to rapidly push large firmware images to address critical security issues in smart meters.
- **Mission-Critical communications:** 5G is expected to eventually enable new services with ultra-reliable/available, low latency links – for use cases such as remote control of critical infrastructure. This could allow utilities, for instance, to remotely send commands to distribution devices to change their configurations or to control their operations in real-time, with an end-to-end message latency down to 1ms.
- **Massive Internet of Things:** 5G will connect a massive number of embedded sensors over 50,000 per cell per single carrier through the ability to scale down in data rates & more efficient protocols including new low power modes. This could allow the network to support a high density of control and monitoring equipment as well as smart meters – far beyond the usual thousands of devices per square kilometer required by utilities in urban areas.

5G has the potential to transform utility communications, but there is no need to wait for 5G NR to fully proliferate to start realizing some of its benefits. 4G LTE already provides great coverage and many foundational services essential to 5G. To address the growing demand of connecting low-complexity, low-power devices to the wide-area mobile network, LTE IoT was introduced as part of the latest 4G specifications. It is a suite of two narrowband technologies, eMTC (AKA LTE Cat-M) and NB-IoT, that scale down device complexity to enable low cost sub $5 modules, maximize battery life enabling greater than 10 year battery life for gas & water meters, extend range by up to 20db enabling connectivity in basements and increase device density to over 50,000 per cell per carrier.

Addressing Coverage, Future-proofing, Reliability and Security

Today's cellular networks have large footprints covering nearly 100 percent of the population many regions. Building such a level of coverage with 5G will likely take some time. To reap the upcoming benefits of 5G without waiting for coverage to expand, utilities could utilize multimode systems that support all major cellular technologies simultaneously, from 2G to 5G – so devices would connect initially with 3G or 4G and then use 5G as network coverage becomes available. Multimode is also a great way for utilities to help future-proof their systems as operators migrate networks from one generation to the next one. When necessary, additional solutions such as small cells could be used to further extend coverage. As a result, connectivity can be provided to all smart meters and distribution network devices in the utility's service area.

The use of cellular networks also can provide utilities with benefits in reliability and security. Cellular networks are designed with reliability and high availability as basic requirements. Cellular networks operate in licensed spectrum that forms the foundation for offering good quality of service. Technologies operating in unlicensed spectrum are not able to the control number of users or type of protocols used. This makes it difficult to guarantee quality of service over long life cycles which is a key requirement for industrial applications including utilities. Modern network equipment incorporates redundancy features to help ensure continued operation even when there is component failure. Transport networks are designed with multiple redundant data paths and with fast rerouting when failure occurs, cell sites have overlapped coverage, etc. Cellular operators, like AT&T and Verizon, have deployed backup battery and power generators at cell sites and data centers to help ensure services will not be interrupted during power outages. On top of the above, transportable cell sites, such as cell sites on wheels with satellite backhaul, are on standby to minimize network downtime even in disaster situations.

For security, cellular networks support a full suite of features and protocols, including authentication, integrity protection, ciphering, network security, and user confidentiality – and 5G is designed with a more advanced security architecture.

Cost-effectiveness

Just like other major cellular technologies, 5G is backed by global standards, helping ensure interoperability among devices and networks enabled by in band and guard band operation. The global standards-based approach has resulted in a large ecosystem including chip developers, device makers, infrastructure vendors, and service providers – which leads to low device, deployment, and operation costs. Some of the biggest countries in the world are adopting cellular for smart metering as a result.

In addition, the competition among network operators to expand their businesses into IoT opportunities has resulted in a dramatic decrease in the price of cellular connectivity in the last few years. When taking performance into account, cellular solutions can deliver the highest performance and available data rate at the lowest cost – a trend that is expected to extend after the arrival of 5G.

With more connections worldwide than people on Earth, cellular is the most proliferated communication platform ever developed. Utilities can benefit from the strong ecosystem that has been put in place by the mobile industry – as well as with the new mobile broadband, ultra-reliable and scalable capabilities that 5G will bring in the next decade.

ABOUT THE AUTHOR:

Dr. Jeffery Torrance serves as the vice president of business development for Qualcomm Technologies, Inc. (QTI), where he is responsible for the Commercial and Industrial IoT business. He has more than 20 years of experience spanning across consulting, investor relations, and business management and development. He began his career at IBM, and later worked at PA Consulting, where he analyzed, developed and co-authored strategic recommendations for blue chip- clients. In 1999, he co-founded UbiNetics, a pioneering 3G technology company, where he became senior vice president and business unit manager of volume product technology. Before joining Qualcomm, Torrance served as vice president of investor relations and corporate development at CSR, where – based in the Bay Area – he led the company's strategic transformation to grow outside the mobile handset. He moved to Qualcomm following the Company's acquisition of CSR. Torrance holds a Ph.D. in digital modulation from the University of Southampton, UK.

AUTOMATED MONITORING

FOR INSPECTIONS AND CONDITION-BASED MAINTENANCE – PART III

RICHARD HARADA AND EDGAR SOTTER

Overview

There are a number of choices to consider when connecting sensors in the field to a network. Different networking technologies offer varying amounts of speed, throughput, range, resiliency, privacy and security. Additionally, the utility will need to consider how to pay for the data connection, whether it will be an upfront capital expense, a lower upfront cost with added maintenance, or a service. A utility needs to consider all of these factors when selecting the network technology for their sensor network. This article looks at these factors to consider the pros and cons of each choice of network type.

Given the relative novelty of Internet of Things (IoT) applications, there is not one solution that can fit all needs, instead, technologies for network communications have been borrowed from other applications, resulting in a multitude of options with their own pros and cons. Therefore, selecting the right communication network is a trade-off exercise between technical and economical considerations, for each specific case.

Technical Considerations

The latest advances in technology and reduction in price of sensing devices have catapulted their use for many applications. Miniaturization, and their low power consumption allow their deployment at high scale, creating a stream of aggregated information that, once processed, can provide a complete picture of a whole site, not just the condition of a few assets.

Communication Technology

Traditionally, sensors in a substation are connected to a Remote Terminal Unit (RTU), that consolidates all signals and sends the data back to a SCADA system. The IEC 61850 standard requires that communication between the devices be wired, so the preferred choice of media to communicate sensors with an RTU has been wired media (i.e., UTP, coaxial, fiber, etc.). For sensors used to gather critical information for substation automation, this is still the best approach given the maturity and robustness of wired technologies. While using wired media works well when only a few sensors are used, it is impractical and incredibly costly for applications that involve the connection of tens to hundreds of sensors in the site[1].

The previous arguments point to the fact that to fully unlock the potential of IoT; we must go beyond wired communication and consider the options available for wireless communication. Luckily, this is not a black-or-white decision, as a combination of both technologies can still be used. This way, the requirements of the IEC 61850 standard are met for those sensors that are highly critical, while deploying the sensors needed to monitor the whole site remains practical and within budget. The use of wireless communication adds more complexity to the design of an IoT system, as one must now decide which of the many available technologies is the proper one for a specific application. **Table 1** summarizes the technical characteristics of the most common technologies used for IoT wireless networks[2]. →

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TABLE 1
COMPARING COMMUNICATION TECHNOLOGIES FOR IoT APPLICATION[2]

	Satellite	Cellular	LoraWAN	Sigfox	Weightless-P	Wifi	Z-Wave	Zigbee	Bluetooth	Bluetooth Low Energy
Data Rate	200 kbps	14.4 kbps (GSM); 1 Gbps (LTE)	300 bps - 50 kbps	100 bps	200 bps - 100 kbps	54 - 1300 Mbps	40 - 200 Kbps	20/40/250 Kbps	1 - 3 Mbps	1 Mbps
Frequency Band	1-2 GHz	900/1800/ 1900/2100 MHz	868/915 MHz	868/915 MHz	169/433/470/ 780/868/915/ 923 MHz	2.4/5 MHz	868/915/ 2400 MHz	868/915/ 2400 MHz	2400 MHz	2400 MHz
ISM Band	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mode of operation	Full Duplex	Full Duplex	Half Duplex	Half Duplex	Half Duplex	Half Duplex	Half Duplex	Full Duplex	Full Duplex	Full Duplex
Max. Payload size	–	–	256 Bytes	12 Bytes	10 Bytes	–	64 Bytes	127 Bytes	358 Bytes	47 Bytes
Power profile	High (weeks)	Medium (months)	Low (+years)	Low (+years)	Low (+years)	High (weeks)	Low (+years)	Low (+years)	Medium (months)	Low (+years)
Typical Range	Global	35 Km	3-15 Km	5-25 Km	2 Km urban 5 Km outdoor	15-150 m	30-100 m	30-100 m	3-30 m	5-100 m
Standard	Proprietary	GSM; GPRS; EDGE; HSPA; LTE; LTE-A	LoraWan	Sigfox Proprietary	Weightless SIG	IEE 802.11 a/b/g/n/ac	Z-wave Proprietary	Zigbee (based on IEE 802.15.4)	IEEE 802.15.1	IEEE 802.15.1

As **Table 1** shows, each technology has different characteristics in terms of data rate, frequency, payload size, power consumption and range, so a good understanding of the application is fundamental to select the proper one. As an example, sensors reading physical measurements like voltage, current, temperature and humidity do not generate large amounts of data individually, (only a few bytes per measurement), and they are usually deployed in high quantities at a site, powered from batteries or solar panels.

Therefore, characteristics like data rate or payload size would not be as important as power consumption or range to determine the right communication technology for the application. If we were to deploy sensors like these in a distribution substation, wireless communication technologies like Z-wave, 802.15.4 (Zigbee) or even Bluetooth Low Energy (BLE) would fit the requirements. However, if we were to deploy these sensors on towers along transmission lines, technologies like LoRaWAN or Sigfox would be more appropriate.

Another example would be the use of video or thermal imaging sensors. This type of sensor generates much more data than the previously considered sensors (approx. 500Kbps for video with VGA resolution), and the packet size of this data is much higher (>1KB). At the same time, the number of this type of sensor deployed in a site rarely goes above a 10 and are usually located on the perimeter of the switchyard, making it easier to power them from conventional sources. Therefore, characteristics like data rate and payload are extremely important, while low power consumption and range might go to a second level. In this case, using WiFi would be the proper choice of wireless communication, if the sensors are deployed in a substation, while cellular would be better for installations that require long range.

There is no rule establishing a limit on the different technologies that can be used at a site. In fact, many applications would require a combination of technologies (e.g., PLC (wired), Zigbee and WiFi), as the requirements of the deployed sensors often diverge. However, it is important to keep in mind that the complexity of the system increases considerably when this is done because new devices are needed to consolidate the signals from sensors using different technologies. In this case, a trade-off between complexity and costs must be done.

Data Storage and Processing

The potential of IoT relies on the data it gathers, so the capacity to analyze that data and/or store it for future use is important. The storage and processing can be done at the edge, on a local server, or using cloud-based services. Again, the right choice depends on the goal the system must achieve.

The aggregation of all data captured by sensors, also known as Big Data, is used to find patterns that can predict behaviours. These predictions provide operation and substation managers with valuable insights that lead to cost reductions in maintenance and increase in asset performance. However, the computation required to find those patterns in the aggregated data, using machine learning algorithms, typically lean on powerful processing units that are costly for an electric utility to acquire and maintain.

The level and complexity of the computations, and hence, the processing power needed, increases if artificial intelligence tools are employed to optimize the use of resources and assets, based on the patterns obtained from the data. If the goal of a utility is to implement a system that uses machine learning and /or artificial intelligence tools, then using a cloud-based service that provides storage and processing power would be the best option. The use of such cloud-base systems creates a path for easier and faster scalability in a sustainable way, as it would allow a utility to increase storage capacity and processing power as needed, without having to add more hardware. It would also allow the upgrade of existing systems without replacing hardware, shutting down the system or disturbing operations. Another key benefit is that cloud platforms already provide access to powerful machine learning and artificial intelligence tools, making the development and implementation of the system much easier.

Some utilities believe that cloud computing is not as secure as hosting applications on their own servers. The concern seems legitimate when considering the data that controls the management of critical assets are hosted on platforms that are not totally being managed by the utility. Similar concern exists for the hosting of customer billing information being hosted on a cloud network. Utilities are beginning to accept that advancements in technology can make it more cost-effective to rely on security measures implemented in the cloud than to implement those measures on their own.

Not all applications for the data from sensors involve pattern recognition and behaviour modeling. Useful insights can also be obtained from basic trending analysis using local servers. Consider, for example, sensors measuring the temperature on the bushings of a transformer. They each should read a similar temperature, as the bushings are exposed to the same load. If the readings of one sensor start to diverge from the others, an operator can conclude that something might be wrong with that bushing, and a basic regression using the historical temperature values from the sensor, adjusting for differences in load and ambient temperature, could help forecast the time when the issue would become critical.

When local servers are used, it is important to consider that although the data generated by one sensor is not much, the aggregation of the data from many sensors can generate a high amount of traffic, impacting the performance of the network between sensors and server. Therefore, the network should be designed or upgraded to support the new traffic. For the same reason, the servers used for this type of implementation must have enough throughput capability to accept the incoming traffic without losing information, and enough processing power to manage that amount of information.

For cases where the network can't be adjusted to the new traffic, there is the option of moving the data storage and analysis process to a device located at the remote site (e.g., substation), which is considered the edge. The main advantages of this configuration are related to the network: there is no big stream of traffic going through the utility network that would degrade its performance, and the impact on the IoT system of network problems is minimized or even eliminated. The main disadvantage is that the cost of the system is higher due to the need for local processing devices.

An important consideration when implementing an IoT system with storage and processing on the edge is that the devices used at the site must be hardened enough to function reliably under the environmental and electrical conditions at the site. The risk of doing otherwise is that the output of the system turns out to be unreliable and therefore, useless. The costs of maintaining or replacing failing devices can also become a burden for the utility's budget in the long term. For application in substations, the recommendation is that any edge processing and storage device should meet the standards IEC61850-3 and IEEE1613, support a wide temperature range (-40ºC to +85ºC), and with no moving parts.

Power Source

New technology is making a compelling reason to power sensors by battery power. Sensors can be programmed to sleep most of the time and awaken only to take a reading and transmit the data upstream. Furthermore, since it is the wireless transmission that takes the most power, the data can be gathered periodically, stored in the sensor and transmitted upstream less frequently (i.e., a sensor may gather temperature data hourly and transmit upstream only once per day). The frequency of readings and transmissions and the size of the data all have an obvious effect on the life of the battery. The current battery technology makes them more compact and able to hold a charge for long periods of time. It is possible for a sensor to last up to 10 years on its own battery power if it is programmed optimally. A hybrid approach is also possible where the battery may be recharged by a small solar panel or harvested from an existing power line using a current transformer. When considering battery power vs. wired power, the utility will also have to decide between the initial cost of installing power supplies and cables vs. replacement of sensors/ batteries at the end of their life.

Economical Considerations

As with any business decision, the implementation of an IoT system is subjected to having an attractive return on the investment. So, the choice of components and technology for the system must take into account not only the financial cost but also the resources it will require from the company to operate in the long term. →

FIGURE 1
FORECAST GROWTH WORLDWIDE TELECOM SERVICES SPENDING FROM 2014 TO 2020

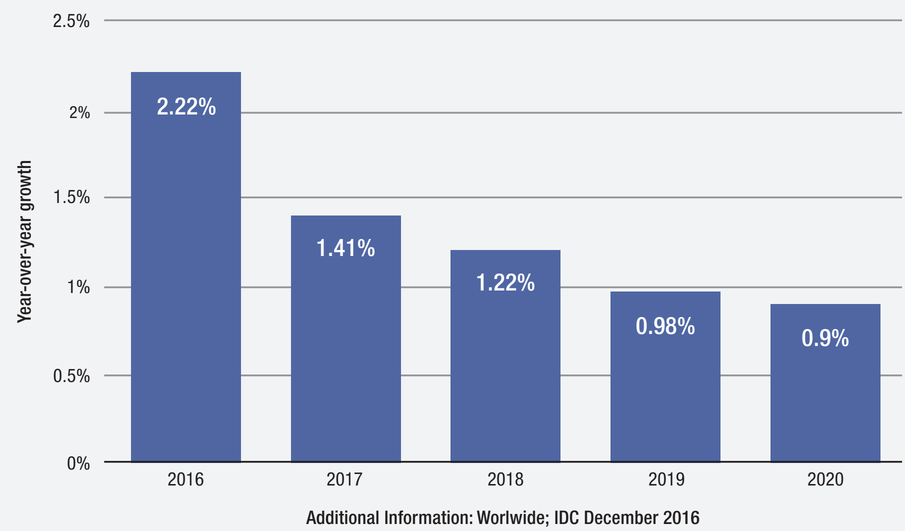

Figure 1. *Forecast growth of worldwide telecom services spending from 2014 to 2020 (IDC, 2016)*

Public vs. Private Networks

The network used to transmit data from the sensors or gateways, to a centralized server for storage or analysis, can be owned or outsourced. This situation applies mostly to the link to a remote site, as the local area network (LAN) at a site it is usually owned by the utility.

Until a few years ago, many industries, including utilities, relied on their own resources to ensure proper communication to their remote sites. Some of them created their own fiber optic networks and radio frequency networks, that later turned into new business opportunities.[3,4,5] However, from the forecasted growth on telecommunications services spending worldwide from 2014 to 2020 (shown in **Figure**[6]), we can deduce that the telecommunication industry is already mature, and its market is reaching a plateau.

Telecommunication companies (telecoms) had already gone through enormous capital expenses to create their infrastructure, and their core business specializes in operating and maintaining that infrastructure. Currently, almost every telecom has products specialized for customers that need highly reliable and secured services, like electrical utilities. Therefore, unless an electrical utility is already running a telecom business levering its existing network, or there is no telecommunication service in an area, there is not any strategic reason for a utility to deploy a new telecommunication network on its own. The capital investment and the operation expenses will be high, and the operations will not be as efficient as the ones of a telecom company.

Cloud Storage and Processing

The choice for utilities to use public or private networks can be driven by their choice to use cloud computing or private server-based computing. Utilities have lagged other industries in the adoption of cloud computing for at least a couple of reasons:

1. Privacy and security – utilities have had a view that cloud computing is not as secure as hosting applications on their own servers. The concern seems legitimate when considering the data that controls the management of critical assets are hosted on platforms that are not totally being managed by the utility. Similar concern exists for the hosting of customer billing information being hosted on a cloud network. Utilities are beginning to accept that advancements in technology can make it more cost effective to rely on security measures implemented in the cloud than to implement those measure on their own.

2. Capital expenditure – investor-owned utilities have preferred owning their IT assets for the fixed rate of return that they provide.[7] To help encourage utilities to adopt cloud-based computing, regulators are considering ways that would allow utilities to pay for the service as a capital expense.[8]

As with telecoms, cloud services companies are better positioned to invest in new technologies and securities because of the economies of scale that they possess. It makes it easier for utilities to seamlessly adopt the latest technologies and scale up on services when it is required. The change is already happening at a fast pace; the OpenFog Consortium estimates that, based on current data, the compounded growth on market size for cloud computing utilization by electrical utilities will be close to 120 percent annually between 2018 and 2022.[9]

Conclusion

Utilities can benefit enormously from new technologies like IoT and cloud-based platforms. Currently, there are several technologies available that provide the reliability and security required for critical infrastructure applications. However, the implementation of such technologies can be very difficult for many electrical utilities because it requires skills and resources that are out of their scope. To overcome this problem, utilities could use the service of companies that specialize in telecommunication and cloud platforms. This would limit the control a utility has over such assets, but it would guarantee the maximization of the benefits and the lower cost.

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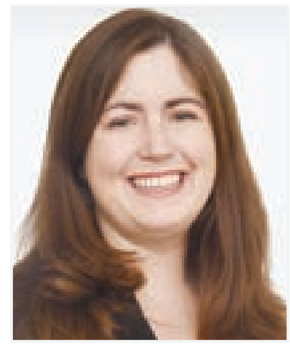
THE TRANSFORMATIVE POTENTIAL OF TABLETS AND SMARTPHONES FOR ENERGY WORKFORCE





AJAY JAWAHAR, JAMISON ROOF, AND ELIZABETH METZGER

Meet Alice, the Next Generation Energy Field Worker.

On a cold, rainy morning, Alice reaches for her waterproof tablet and sees that she has 15 stops for the day. After arriving at her first stop, she heads to the customer's door with her tablet and tool bag. While the customer is not home, she quickly finds their contact information and notifies them she is on site. She uses an asset map on her tablet to guide her to the exact location of the meter on the premise. Once the meter is replaced, the meter details are updated with a quick scan using her barcode scanner. The customer returns home, and using the built-in credit card reader on her tablet, Alice can collect payment. Within seconds, the customer's transaction is complete and a confirmation text message is sent. Alice even records a quick comment on the work order using the tablet's speech-to-text feature.

The beauty of this workflow is that Alice could deliver top-of-the-line customer service quickly and efficiently. She was connected and equipped with the right tools and information to complete her work at the field site – no paperwork, no typing.

Tablets and smartphones are fundamentally improving utility field operations, as these lightweight, powerful and intuitive devices are perfectly suited for seamless integration into on-the-go field operations. So, how can utilities unlock the full potential of tablets and smartphones and ensure a successful deployment with maximum benefits? The key for digital utilities is to rethink their current business workflows, enable the right ecosystem for the new devices, and effectively manage the change. →

For example, utilities can reimagine their business workflows in the following ways:

- Optimize work scheduling and routing by allowing a field worker to navigate to the site directly with a single click from their work management solution. When used with a work scheduling system, they can provide real-time location visibility to schedulers and foremen.
- Improve workforce safety with a "Lone Worker Alert" system. Where there are safety concerns, using the app, the lone field workers would notify a dispatcher, providing GPS location and timeframe. The app will alert the dispatcher if the worker fails to check-in within the alloted timeframe.
- Introduce intrinsically safe tablets and smartphones, especially in hazardous environments, to enable seamless technology-based workflows and optimize operations.
- Utilize complimentary device add-ons to optimize operations further and enable a better customer experience. Integrated barcode scanners can automate meter scanning at field sites and improve inventory management at asset depots. Mobile devices can be used with integrated credit card readers, thereby creating a full PoS (Point-of-Sale) solution for collecting payments.

Understand Field Workers' Needs and Establish the Right Device Ecosystem

Every field group is unique in its operations and has different mobility needs. For example, first responders handling emergency situations value weatherproof capabilities and a large screen to view asset maps on the go, while field collection agents making 25-30 stops a day value portability and integrated card readers to collect payments. And meter journeymen investigating meter issues need multiple device ports to connect and test field equipment. Understanding the real field worker mobility needs and deploying the right device ecosystem is critical to obtaining the most value out of these devices.

Throughout the mobility journey, utilities have to make several selections that define the capabilities delivered as well as end user experience. These decisions must be based on the mobility needs of the field workforce as well as the firm's existing enterprise infrastructure. For example, the application needs of the field worker as well as the firm's platform capabilities are strong drivers for the OS/platform selection. Similarly, the field worker's everyday work environment (number of stops per day, outdoors vs. indoors, emergencies vs. regular support) dictates the ruggedness of the device and the form factor (smartphone vs. tablet).

In addition, there are several mobility considerations that are foundational for tablets and smartphones but are often overlooked, especially when migrating from laptops. These include:

- Network connectivity: Cost of new data plans, handling network signal drops/reconnects, enabling offline mode of operations for remote areas
- Mobility lifecycle management: Mobile Device Management (MDM) software, initial provisioning and final decommissioning processes, helpdesk training for supporting new devices
- Cyber considerations: Steps to manage risks from additional mobility including new usage policies and remote device controls

Managing Change Is Critical

A one-size-fits-all change delivery approach never works when deploying mobile devices to multiple field workforce groups. Any change delivery approach should be firmly rooted in the operations they perform and the associated challenges that entail. In addition, the change journey and the associated training elements are very different when first deploying mobility to transition from paper-based workflows than when migrating from existing laptop-based electronic workflows.

To achieve success with change management, utilities need to consider the following tips:

- Always run a pilot deployment to gather field user feedback and catch issues early, before an enterprise wide deployment.
- If the tablet/smartphone deployment is part of the utility's broader field work modernization effort, decouple the device deployment from the workforce mobility solution deployment to reduce the amount of change inflicted upon the field worker.
- Get it right the first time by preempting the key operational challenges. For field workers who are constantly on the move and need instant access to accurate information, integration and connectivity challenges are the most important factors to ensure smooth operations.
- Ensure support staff preparedness for new platforms, workflows and capabilities. Since tablets and smartphones are mobile and provide fundamentally different interactions through touch-sensitive user interfaces, the support issues are often very different from that of laptops.

Engage Key Stakeholders

Deploying mobility solutions does not occur in a vacuum. Bring the business and IT stakeholders along in the decision-making process to keep them engaged and on board. This becomes even more critical with tablet and smartphone deployments because these devices are new to business operations, and takeholders may not be fully aware of their transformative power to drive efficiency and productivity increases in the field.

Looking Ahead

The case for mobile device adoption is powerful. It allows Alice to streamline her work, ultimately providing better service to her customers. However, these devices create new capabilities, usage models, and training requirements – all of which need careful consideration and planning. Digital utilities can position themselves for success by maximizing the value of these ultraportable, uber-connected devices by rethinking business workflows, establishing the right ecosystem (tools, infrastructure, and support), and effectively managing the change.

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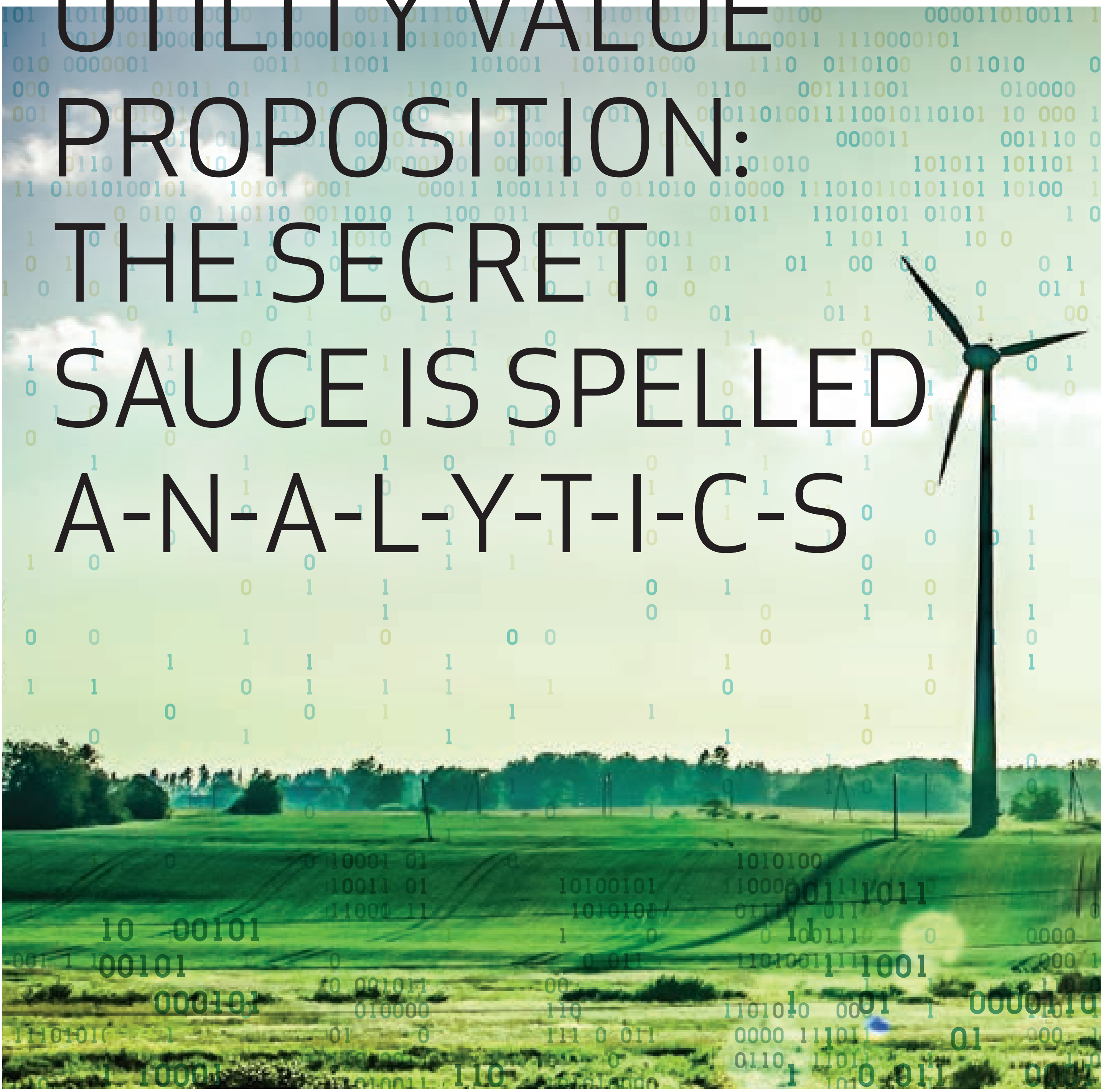
THE DIGITAL UTILITY VALUE PROPOSITION: THE SECRET SAUCE IS SPELLED A-N-A-L-Y-T-I-C-S



MIKE SMITH

At times it seems like the entire world is abuzz over IoT ("Internet of Things"), and there is no mistaking that this is a game changer for many industries and indeed in our day-to-day lives. At its core, IoT is a digital infrastructure comprised of physical objects with a (usually) robust communications layer enabling a wide variety services and applications that were not possible, or even thought of, prior to the IoT revolution that we are all living in today.

For utilities, this is most prominently known as the "smart grid" and is creating a new operating and business model that is based on the "digital utility", where the IoT infrastructure is basically overlaid across the utility enterprise. The changes facilitated by the digital utility range from modest improvements, to existing processes and services, to reinvention of business functions, to entirely new programs and offerings. This market is estimated to grow to $US30 billion globally by 2025, according to GTM Research, so this continues to be a significant and growing market. The key to success with this pricey proposition is how well a utility transitions from a focus on the infrastructure to one of delivering value, two very different skill sets.

Moving from Building Infrastructure to Building Value

The progress of the digital utility is evolving from an era of building an infrastructure to one that is building and delivering value for customer, employees, and other stakeholders.

Figure 1 will help us understand this evolution from infrastructure to value. Stages 1 and 2 are arguably all about the buildout of the architecture. Stages 3 and 4 are where the value is realized and are all about data and analytics. Most large utilities are in stages 3 and 4, so bring on the value! →

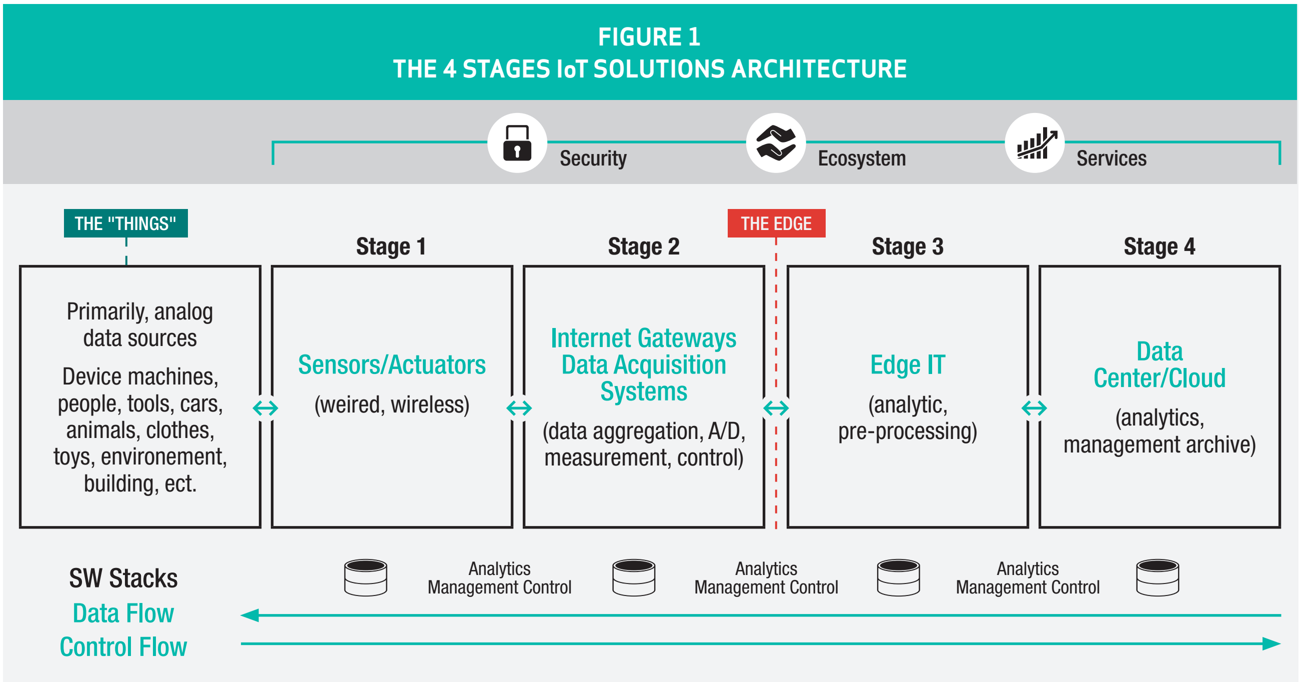


Figure 1. IoT Architecture. (Source: TechBeacon)

At the core of this movement to value is a utility's ability to leverage the data that is a result of this intelligent infrastructure into meaningful analytics, and this in itself is an evolution. Many in the industry remember the early days of the smart grid and its relatively short list of use cases that were used to build the business case for these massive investments, some of which approached $US1 billion. Comparing this to today's use cases that take advantage of advanced analytics, third-party data sources, and some very creative people one can see how far the industry has come in less than a decade.

So, what does delivering value via a digital utility look like? A glimpse into some leading use cases provides some ideas of how this is happening today and will accelerate in the future.

The Great Potential and the Ugly Truth of Customers

The utility industry tends to be pretty insular. We all tend to get excited about new technologies and how the latest regulatory ruling will impact the industry. But guess what? Nobody else cares; that is, nobody else cares until their lights go out or if they see a leap in their bill. One industry researcher estimates that the average utility customer spends about eight minutes per year thinking about his or her utility. So while the utility has millions of captive customers, the industry does not have a great track record of engaging these customers.

That's the bad news. The good news is that this is changing, and the digital utility is what is making this all possible. Examples include:

- Better Offers: With a deeper knowledge of each customer that can include payment history, energy usage patterns, and the inclusion of third-party data utilities can provide mass customization tailored to the needs of specific customers. This can include different pricing programs, energy efficiency offers, and more.
- Saving Money: The combination of increased and volatile fuel prices typically creates higher energy costs for consumers if they continue to practice business as usual with their energy usage practices. The utility is uniquely positioned to be the consumer's champion in making special programs available that can save their customers money. As utilities start moving towards time-of-use pricing, how well a utility educates its customers on their energy choices can be the difference between success for both the utility and its customers, and failure, which can (and predictably will) get ugly as utility bills increase continuously over time.
- Personal Responsibility: A growing portion of the population is concerned about the environment. Many utilities already have options for customers to opt in to a variety of green energy programs. Watch for these to grow in popularity as utilities become "part of the solution" in the face of competition (roof top solar being chief among these competitive forces). The EVs are coming!

Not really. They are already here, and the growth potential is staggering. Navigant Research estimates that annual demand from EVs for electricity could exceed 400 TWh by 2035 (that's 400,000 GWh!). Selling all of these electrons could very well be the best growth opportunity in decades for an industry that has flat to declining revenues. Austin Energy estimates that each new EV in their service territory represents a potential $400/year in new revenue. That doesn't sound like much until you learn that they are expecting up to 300,000 new EVs in their territory within the next 10 years. ***That's $120 million in new annual revenue…game changer!***

Figure 2 shows the different "business model lanes" for electric utilities as EVs proliferate the landscape. These use cases require a finely tuned data and analytics infrastructure with accompanying business processes to be successful. For instance, all of the various charging scenarios will require the tracking and billing of all of those electrons, many of which will also have special rates and time slots to accommodate grid management and different customer requirements. Similarly, mobility services like smart park-and-charge or shared autonomous vehicles will be facilitated by a strong underpinning of data and analytics to track users, manage billing, and even to schedule maintenance.

FIGURE 2

INFRASTRUCTURE	MOBILITY SERVICE
Residential charging	Smart park-and-charge apps
Workplace charging	Multimodal transport schemes
Public charging	Carsharing services
Shared charging	Neighborhood EV schemes
	Shared autonomous vehicles

GRID SERVICES	FLEET CONVERSION/MANAGEMENT
EV-specific TOU tarifs	Carshare fleet conversion
V2H/V2B	Commercial fleet conversion
VIG/V2G	Public transport fleet conversion
Transactive energy	

Figure 2. EV Business Model Lanes (Source: Navigant Research).

Distributed Resources is the Mother of Invention

The growth of Distributed Energy Resources (DERs) is where things are getting really interesting for the electric utility industry. The introduction and growth of rooftop solar, energy storage, microgrids, and other technologies are creating challenges across the entire utility enterprise, impacting financial, customer, and operational success in ways that were unanticipated just a few years ago.

This new operating paradigm is creating the need for radical changes to the traditional value chain for how a utility operates, particularly, at the distribution grid level. Managing peaks, addressing reliability, connecting DERs, and enabling the marketing and selling of energy across and to/from non-traditional entities all makeup what will be a very different role for every utility.

Examples of the scope if these changes include (according to GTM Research):

- The peak demand impact of DERs and connected devices will grow from 46.4 GW in 2017 to 104.2 GW in 2023.
- More than100 utilities have established some basic form of a marketplace for DERs, suggesting that the role of a Distribution System Operator ("DSO") is on the horizon.

The changes in the electric utility industry demonstrated here are really just the beginning. The role of the electric utility might be practically unrecognizable in as little as five years. We are all starting to hear that the utility industry is becoming one where the data is becoming as important as the electrons. We might even call this a digital utility.

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Mike Smith is the principal industry consultant with the utilities group at SAS Institute. He is a 28-year veteran of the utility industry, having started as an analyst covering SCADA systems in 1990, and since then, leading numerous industry initiatives including founding the "smart grid" market's first dedicated publication in 1995 and co-founding the Utility Analytics Institute in 2012. He is a graduate of San Jose State University (BA, economics) and is a veteran of the US Army (Captain, Infantry). He can be reached at mikef.smith@sas.com.

USING TRANSACTIONAL COMMUNICATIONS TO ENGAGE CONSUMERS

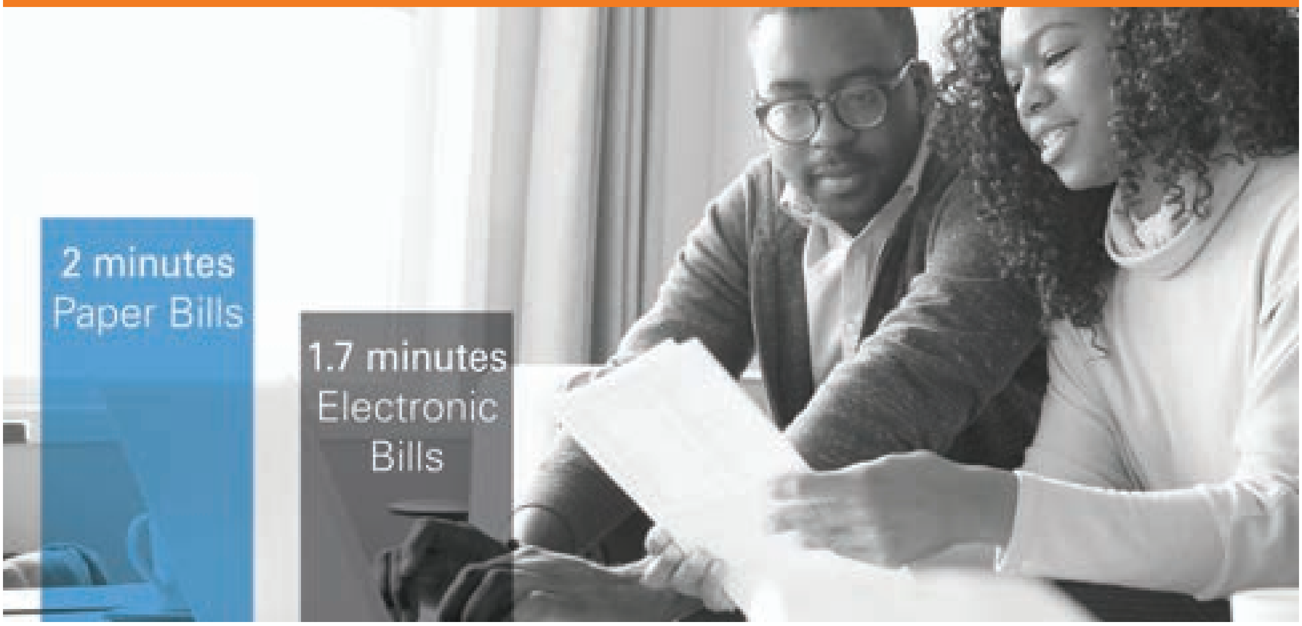
CHRIS CHRONIS

People are challenged with the day-to-day race to keep up with their lives. However, in a world so focused on immediacy, there remain moments where people pause and take note. These moments present a golden opportunity for organizations to interact most effectively with consumers to enhance their engagement and overall experience, whether in person, online or through other communications.

Transactional communications are a perfect example. It might seem counterintuitive to think people still spend significant time poring over statements and bills. However, transactional documents, such as monthly bills, are still important and widely read, both in digital and paper formats.

The estimated median amount of time consumers spend examining their paper utility bills is two minutes, according to recent research. The same survey showed an estimated average time of 1.7 additional minutes that consumers spend reading those same bills in electronic form (**Figure 1**). This adds up to more than 20 minutes a year that consumers take to read either paper or electronic bills. People are engaged with their utilities; they just want to engage on their terms. →

FIGURE 1
Estimated Median Time Consumers Spend Reading Their Utility Bills



Source: *Expectations & Experiences: Household Finances, Fiserv, 2017*

Listen to What Customers Want, and They'll Listen

Transactional communications can be far more than compliance necessities; they provide a crucial platform for utilities to actively interact with their customers. New competition brings with it pressure to find new ways to share information and advice in order to build engagement. Utilities can use the billing and statement experience as an opportunity to connect with customers and strengthen relationships.

The research also found that 37 percent of consumers remember seeing personalized messages in their statements or bills. The message has to resonate, and personalizing the content allows customers to know their utility is speaking directly to them. That could mean, for example, calling out a specific energy-efficient product or offering a relevant service. It might include capturing customer interest by using color and clear branding, or partitioning the content and drawing attention to specific promotional or educational information. Utilities can add QR codes to the documents linking to websites or special offers, creating a more seamless link between different channels.

Monthly correspondence can highlight new services such as notification and alert options to let people know about maintenance activity in their neighborhoods or account access changes. Those communications enhance relationships with consumers by empowering them and deepening their trust in the utility. And that, in turn, strengthens the relevance of the transactional document communications, no matter how they are delivered.

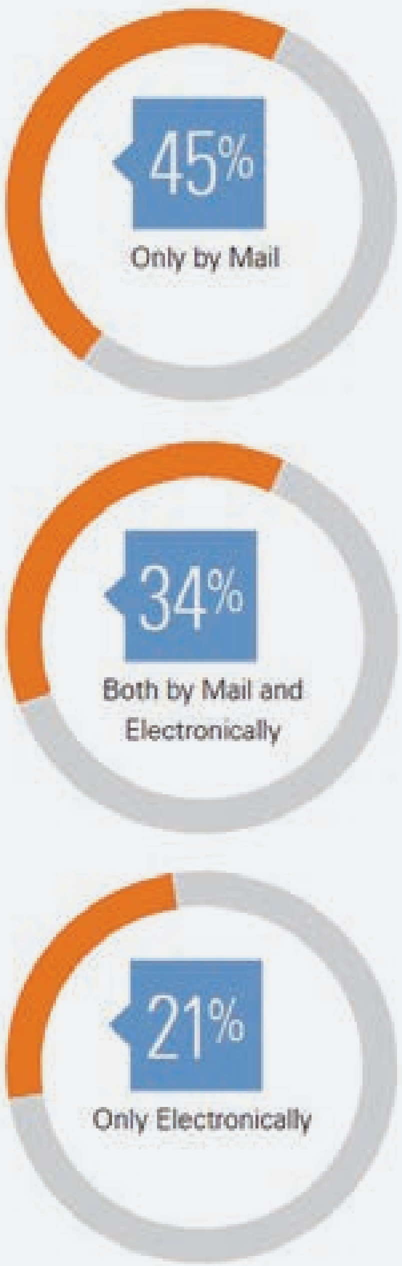
Consumers Use All Channels and Will Continue to Do So

Utilities looking through the lens of consumers know people gravitate towards all of the channels and are inclined to use the one that best meets their needs at any given point in time. Mobile platforms are obviously growing and increasingly important, but that immediacy does not necessarily come at the expense of other communication channels. Paper remains a relevant avenue through which consumers receive and pay bills, despite the growth in digital channel use and acceptance of digital transactional communications.

The recent research showed 45 percent of consumers receive their utility bills by mail, 34 percent receive both paper and electronic versions, and 21 percent receive electronic only (**Figure 2**). Furthermore, while people are comfortable with various ways of receiving bills, 52 percent still consider traditional postal mail as the most secure.

If current paper suppression rates continue, utilities can expect only half of all consumers to have discontinued paper transactional documents by 2022. Utilities will, therefore, need to support multiple modalities for the foreseeable future.

FIGURE 2
Consumer Preferences in Receiving Utility Bills



Source: *Expectations & Experiences: Household Finances, Fiserv, 2017*

The Key to Deeper Engagement

The more people engage in personalized interactions that anticipate their billing and payment needs, the higher the bar is set for consumers' engagement in other channels, such as IVR, or in person. No matter the channel through which bills are delivered, transactional document communications give utilities an opportunity to enhance the overall consumer experience through well-placed communications. When that monthly correspondence is on target, the benefits are abundant.

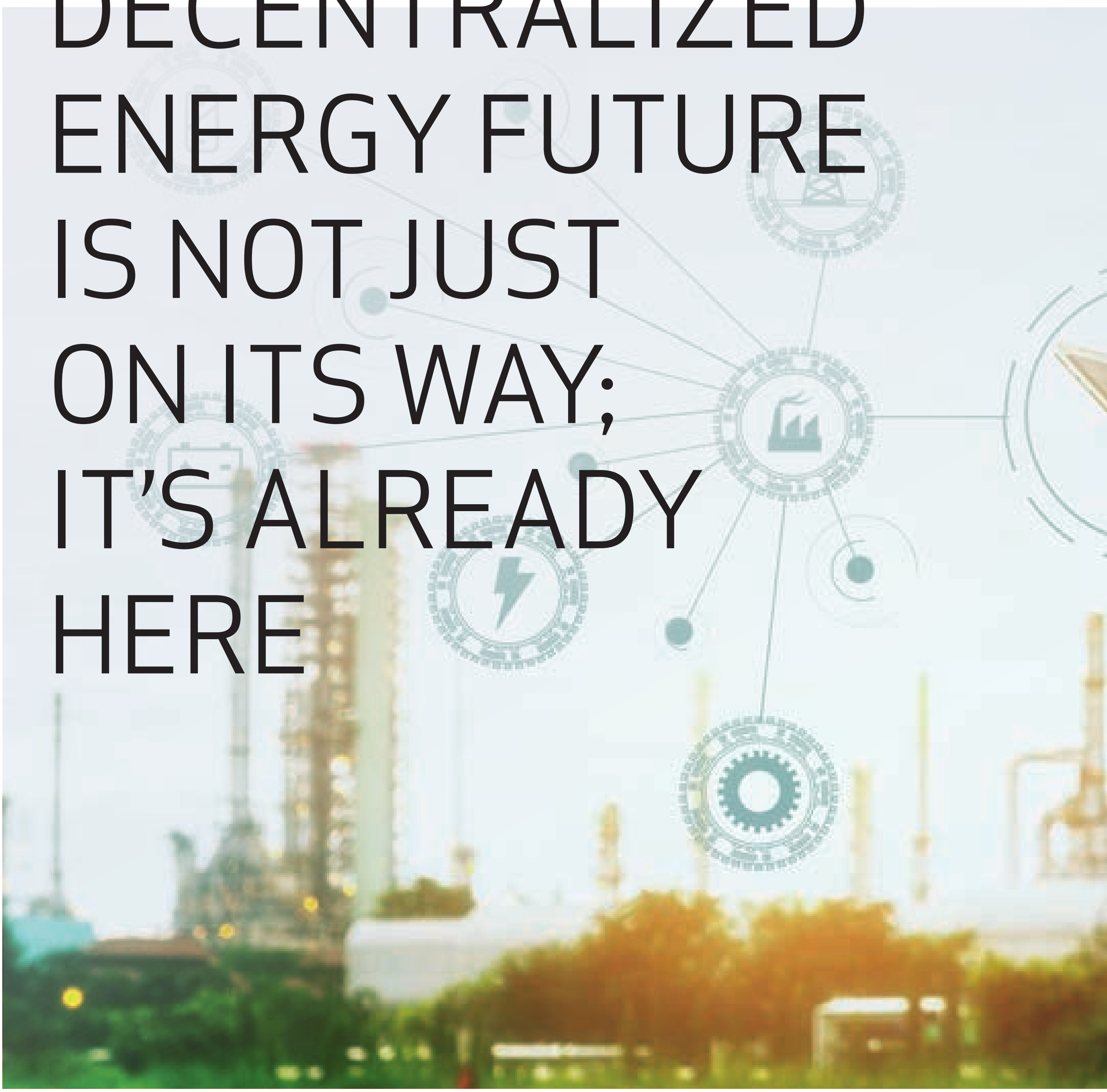
Utilities can amplify their brand voices with consistent communications, increase engagement and loyalty by directing specific information to consumers, reduce unnecessary call center calls, and enhance the customer experience with clear messages about when bills need to be paid.

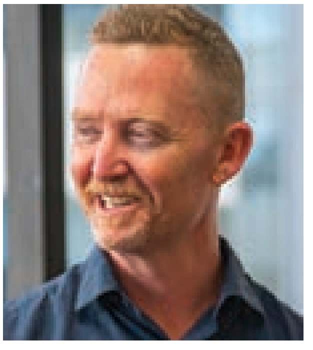
Ultimately, customers want providers to connect with them wherever and whenever they choose. Utilities have the opportunity to meet people at that point of convenience – when they are actively engaged and ready to listen – and position themselves strongly to drive meaningful engagement and loyalty.

ABOUT THE AUTHOR:

Chris Chronis is director of product marketing and research at Fiserv. Chronis joined Fiserv in 2009, and his focus is product marketing, market and competitive intelligence and strategic planning for Output Solutions. Prior to joining Fiserv, Chronis spent more than 20 years in the financial services industry and 18 years in the customer communications management segment, where he focused on competitive intelligence, strategic planning and market and product requirements development. He has been quoted in many industry publications including Bank Technology News, Insurance and Technology, Securities Industry News, Mutual Fund Market News and has provided many briefings to leading analyst firms including Gartner, Forrester, Mercator and IDC.

A NEW, DECENTRALIZED ENERGY FUTURE IS NOT JUST ON ITS WAY; IT'S ALREADY HERE





DAVID MARTIN

When I first entered the electricity industry, the then-general manager of transmission at Western Power (an Australian utility) patted me on the head and said, "Son, this industry is about scale. The bigger our power stations, the lower our unit cost. The higher the voltage, the more efficient the supply[1]…"

That epithet no longer rings true; with small, even micro-scale Distributed Energy Resources (DERs) presenting a fundamental shift in the way we produce and use energy.

Given their small scale, relatively low cost and predominantly renewable nature, DERs may also present the best solution available to address the dual challenge of meeting carbon reduction targets (such as they are in Australia) and alleviating electricity poverty, providing low-cost, low-carbon energy anywhere in the world.

But DERs are a challenge to most of the things we think we know about running the industry. From concepts of scale, system security and market operation, to tariff design and data management, the prevalence of DERs means we now need to re-imagine the electricity industry.

As a use case, this article addresses the issues that centralized energy production Australia has experienced, and that can be applied to most jurisdictions across the globe.

During the past 30 years, Australian states undertook a series of reforms that variously privatized and disaggregated traditional state-owned power utilities. In the early 1990s, vertically-integrated businesses began to devolve into separate businesses and authorities responsible for various elements of the electricity supply value chain. →

Competition was introduced, but so was a new era of regulation that was intended to maintain the secure, coordinated and efficient development of energy systems in a disaggregated industry; reflecting what still was a very linear energy supply model. Generators generated and consumers consumed. Energy flowed from transmission and distribution networks to hungry customers.

Fast-forward to today, and our energy system is no-longer simply linear.

Working with consumers is no longer a "one-way street." Today's consumers expect a satisfying relationship with their energy providers through a combination of supply and demand, using the technological advances that are already available.

Generators aren't just distant, heavy, spinning machines providing dispatchable gigawatts, inertia and emissions – they're increasingly the roofs of the homes and businesses that are the basis of demand.

Prosumers – so called because they produce and consume energy – represent a quarter of all households in Western Australia and a third of households in South Australia. Increasingly, new generation sources across the country are non-dispatchable, often community-scaled and connected at distribution voltages. Yet energy regulation, market rules, tariff designs and data management legislation still largely reflect the historical "command and control" centralized power generation models previously used by vertically-integrated utilities.

In an environment where it is increasingly possible and cost-effective for prosumers to efficiently generate and store the bulk of their energy needs themselves, and where service industries are springing up to make energy self-sufficiency an achievable reality, DERs are taking what began as disaggregation of energy utilities closer to the distribution of energy systems.

Worryingly though, if we can't present an attractive scenario to the owners of DERs to stay connected, we could reach the ultimate (and illogical) conclusion with the disintegration of power systems.

> "The best way to do this without heavy-handed compulsion is to facilitate the development of an economic model that values the contribution of DERs to creating a low-cost, low-carbon energy future."

New Competition – Hearts and Minds and Kilowatts

Competition between generators and retailers that has delivered lower prices and better services to consumers is now experiencing a new pressure, and networks that have, until now, existed in a regulatory bubble, are also experiencing a competitive threat – the possibility for consumers to go it alone.

The regulatory frameworks that have been designed to protect consumers who previously had no control over how their energy needs were met, increasingly need to present a compelling reason for consumers to stay connected to traditional energy systems. Otherwise, they face a future of falling demand, falling revenues and failing relevance. The best way to do this without heavy-handed compulsion is to facilitate the development of an economic model that values the contribution of DERs to creating a low-cost, low-carbon energy future.

The industry needs to reconsider the long-held view of itself as a centrally-controlled and operated market to reflect the emerging physical reality of the industry – it being a series of dynamic, integrated and distributed energy markets, with DERs playing an increasingly important and value-creating role at a distribution level.

Technological changes, particularly the emergence of digital, transactive technologies like blockchain, create the possibility to redesign the way we buy and sell energy. This changes the nature of the agreements between consumers and retailers through supporting secure commercial transactions; thus unlocking layers of value made available through the integration of DERs.

ABOUT THE AUTHOR:

David Martin is the managing director and co-founder of Power Ledger, a leading blockchain energy trading platform with a variety of projects spanning across three continents. He has more than 20 years' experience in the electricity industry and has held executive positions in two state-owned utilities. Martin's previous role was as a senior consultant to industry participants specializing in the regulation of distribution networks, Distributed Network Service Provider (DNSP) consumer engagement, renewables/new technology feasibility studies, and business development.

A New Energy Paradigm

In a distributed market, agreements won't be bilateral only; there will be multilateral agreements of varying temporal nature, sometimes occurring simultaneously, sometimes moving seamlessly from one set of counterparties to another. For example, a residence with both solar PV and a battery could be trading their excess solar to their neighbour through a trading platform one minute, while providing power quality management services to the network through an aggregator the next.

Blockchain, a distributed ledger technology, can help manage this complex multiplicity of agreements, whether it be trading renewable energy, or providing voltage support for the network.

Current settlement and payment systems used by energy markets are characterised by a latency that will likely act to discourage DER owners from participating in Virtual Power Plant (VPP) arrangements, or in one other emerging markets. To participate in the National Electricity Market (NEM) and the Wholesale Energy Market (WEM), and in these multiple, usually temporary trading relationships, DER owners will need clear financial incentives and a frictionless settlement process.

Blockchain is the only technology we have found that is capable of facilitating such a complex transactive environment, in close to real-time. Within a VPP scenario, blockchain software can act as the transactive layer between the various functions of the VPP, providing for settlement between generators, distribution network operators, retailers, the wholesale market - if required- and consumers.

These multi-party agreements may cease to persist after a service is provided or a trade is completed. Smart contracts allow for the trustless, instantaneous settlement of these agreements.

Participation in the wholesale and Frequency Control Ancillary Services (FCAS) markets, or agreements outside of Australia's NEM, can be facilitated using the same transactive platform for instantaneous, autonomous financial settlement, creating the most value for all participants and maximizing utilization of network assets.

The value case for blockchain, and for peer-to-peer platforms, is that they can be utilized to help manage the transition towards emerging distributed markets, in a relatively seamless way. They can function through the provision of data from advanced metering infrastructure (AMI) and other sources. If implemented correctly, the platform could contribute to the visibility of behind-the-meter DER installations. Using close-to-real-time data from smart meters and other sensing devices, each transaction that occurs between the layers of services in a distributed market can be immutably recorded on the blockchain, and the information relayed to the Australian Energy Market Operator (AEMO) or the Distribution System Operator for system planning purposes.

For emerging economies, DERs will deliver even bigger changes. Access to reliable, clean and affordable electricity is an inalienable human right. Since 2008, and for the first time in our history, more than half of the world's population now lives in metropolitan areas; with a constant, reliable and secure electricity supply of which 80 percent comes from burning fossil fuels.

For the remainder, and in terms of electrification rates, 2.7 billion people have no access to electricity for cooking or heating and are required to use emission intensive fuels such as wood or coal. Of those living in electricity poverty, almost half (approximately 1.2 billion, or 16 percent of the population) have no access to electricity at all. These people suffer the burden of reliance on traditional, time-consuming fuel supplies such as firewood, restricting time that could otherwise be spent generating an income or gaining an education.

The Real Challenge

The challenge for traditional energy systems now is not technology change; the electricity system has been developing and incorporating new technologies for more than a century. The challenge faced today is a cognitive one. Can the industry change the way it sees itself after decades of a relatively consistent operating model?

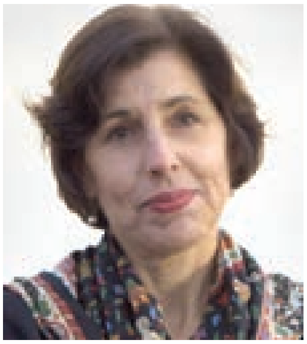
For DERs to flourish and for billions of dollars in system assets to remain viable, the energy sector needs to acknowledge it no longer operates as one homogenous system. Instead, the energy sector comprises a number of dynamic, integrated and distributed energy markets that, when operating in concert, will encourage small-scale, low-cost and zero carbon distributed energy technologies to take us towards the energy future we need.

References:

1. To paraphrase very badly – it was a long time ago….

THE BIGGER PICTURE

DOE'S BETTER BUILDINGS FINANCING NAVIGATOR 2.0 UNLOCKS FINANCING FOR ENERGY PROJECTS



MARIA T. VARGAS

Upfront costs are often cited as a major barrier to getting energy efficiency projects done. Many organizations cannot spare the capital required to pay for the equipment, installation and servicing of energy efficiency and renewable energy upgrades out of pocket. Even those with access to cash may prefer to spend it on their core operations as opposed to a project that they view as "optional." Despite demonstrated savings and the low-risk nature of investments in energy efficiency and renewable energy, these projects can face significant barriers to financing. These barriers are due in part to poor market information and education regarding financing solutions.

While the U.S. is experiencing an era of exciting growth in energy finance – including the rise of models like Efficiency-as-a-Service, Property-Assessed Clean Energy (PACE), and Power Purchase Agreements (PPAs) – many building owners still struggle to find the capital they need and financial products that work for their specific situation and location.

To provide better information for end users, the Department of Energy (DOE) recently released version 2.0 of the Better Buildings Financing Navigator. This online tool helps public and private sector organizations find financing solutions for energy efficiency and renewable energy projects. Since 2017, the tool has helped nearly 10,000 users understand the array of financing solutions available in the market as well as refine and explore which options may be best for them. The updated Better Buildings Financing Navigator expands and improves upon the previous iteration of the tool, adding renewable energy financing options such as power purchase agreements and solar leases, a database of financing providers that can be searched and filtered, sector-specific and location-specific financing resources, updated market data, and more. →

Common Barriers to Financing

In the broadest terms, "financing" means using someone else's capital to fund projects in your facilities and then paying them back over time. Despite a large investment opportunity and increasingly available capital, many potential energy projects do not receive the funding required for implementation.

There are a few common reasons for why businesses struggle to access financing for clean energy and energy efficiency projects:

- Many organizations have a limited understanding of the financing solutions that are available to them, and they do not know where to look for information.
- Oftentimes the resources that do exist are inaccessible, too technical, or are fragmented and require extensive research to confirm they meet an organization's investment criteria.
- Personnel in charge of energy projects have limited time or expertise to shop around for financing.
- It is difficult to locate providers of a specific financing solution due to a lack of centralized information on provider offerings.
- Often, the individuals responsible for project implementation do not have the authority to enter into financing arrangements without the consent of executive management. This creates issues such as extended timelines for project execution, additional evaluation of the proposed financing, or potentially a flat refusal to continue the process of securing financing.
- Split incentives. When the parties responsible for paying energy bills (tenants) are not the same as those making the capital investment decisions (the landlord or building owner), the landlord may not be inclined to initiate building upgrades or projects when the resulting energy cost savings accrue to the tenant. This is a situation that affects a significant portion of commercial buildings in the US.

Diverse Array of Financing Options Now Available

As demand for energy efficiency and renewable energy financing has grown, the diversity of financing options available in the marketplace – and the number of companies that provide them – has grown as well. In the last decade, there has been a tremendous increase in the number of lenders offering products for clean energy projects, and many existing banks and lenders have innovated their product offerings in response. The current financing landscape can be summarized by categorizing financing options into two main buckets: traditional and specialized.

Traditional financing options, such as leases and loans, are commonly used to finance a variety of projects - including those focused on energy. These options have existed for many years and are typically well understood by both lenders and consumers. Although exact figures are difficult to quantify, the current market size for leases and loans is very large and these options are among the most common mechanisms for financing clean energy.

While traditional financing options have historically financed a large majority of projects, these simple structures often do not account for some of the unique challenges that energy efficiency and renewable energy projects face such as split incentives, performance risk, or third-party ownership. An emerging trend in the market is the use of specialized financing options tailored specifically to help consumers overcome these barriers that traditional options typically do not address.

Property assessed clean energy (PACE) financing is a structure in which building owners borrow money for energy efficiency, renewable energy, or other projects and make repayments via an assessment on their property tax bill. The financing arrangement then remains with the property even if it is sold. The transferability of PACE loans allows building owners to facilitate long-term investments in building performance without concern for a debt burden if the property is sold before the PACE term is complete. PACE can also overcome the tenant/landlord split-incentive problem through aligning incentives for landlords and tenants, as both the tax assessment and cost-savings from the project can be shared with tenants under most lease structures.

Power Purchase Agreements and savings backed arrangements such as energy savings performance contracts (ESPCs), and efficiency-as-a-service involve a service provider (rather than the building owner) assuming the performance risk of an energy efficiency or renewable energy project by guaranteeing a certain amount of savings or level or operational performance. This immediately alleviates the need for upfront funding on the part of the building owner and allows them to make the payments as an operating cost instead of a capital outlay.

On-bill financing (OBF) and repayment (OBR) are financing options in which a utility or private lender supplies capital to a customer to fund energy efficiency, renewable energy, or other generation projects and is repaid through regular payments on an existing utility bill. The benefits of OBF/OBR include low-to-zero interest rates, streamlined repayment, availability for leased space, and structural flexibility that allows for repayment obligations to be passed along to future tenants. Utilities can also bundle financing with incentives such as rebates and tax credits to reduce the need for financing and lower payback periods. However, OBF and OBR are only available in regions where utilities support on-bill programs.

While the expansion of available financing options and providers mean that there is a greater potential for funding energy projects, it also adds complexity to the process of gathering information and many organizations don't have time to wade through scattered resources in an attempt to understand and compare all of the available options. This is where the Better Buildings Financing Navigator comes into play.

Making Sense of It All: The Better Buildings Financing Navigator

Developed as part of DOE's Better Buildings Initiative, the Better Buildings Financing Navigator offers unbiased assistance to users in a few key areas. This recently updated tool helps users seeking to learn more about the basics of the energy efficiency and renewable energy financing landscape. The tool's "Explore" section features "everything you need to know and nothing you don't" fact sheets on each financing option and a new compendium of sector-specific financing resources. The Navigator also includes a browse section where users can compare financing options across different attributes such as balance sheet treatment, contract complexity, typical close time, and more. These tools and resources help to simplify the diverse financing landscape and provide guidance to users on the options available to them in a straightforward manner.

Users with specific projects in mind can answer a few simple questions about the opportunity and their preferences to see which financing options might be a fit for them; users can easily see how each option matches to their preferences and compare pros and cons.

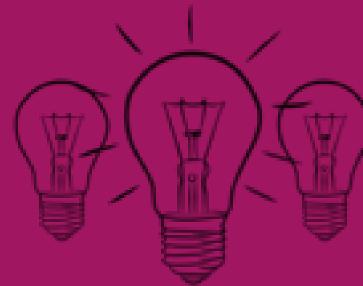
The Navigator also connects users to the larger Better Buildings Financial Ally community, which includes banks and lenders that are committed to investments in energy and are actively pursuing new opportunities to finance projects. Version 2.0 of the Better Buildings Financing Navigator features a filter that allows users to search for the right financing partner based on products offered, sectors served, technology types financed, and the region in which they work.

The Better Buildings Financing Navigator is located on the Better Buildings Solution Center. The Better Buildings Initiative encourages collaboration between public and private sector organizations across the country to share and replicate successful strategies with the overarching goal of making commercial, public, industrial, and residential buildings 20 percent more energy efficient over the next decade. This means saving billions of dollars on energy bills while accelerating America's investments in energy infrastructure and creating thousands of jobs.

More than 900 Better Buildings partners are sharing their innovative approaches and successful strategies to accelerate the adoption of energy efficient technologies; discover more than 1500 proven solutions in the Better Buildings Solution Center.

ABOUT THE AUTHOR:

Maria T. Vargas is the director of the Better Buildings Challenge at the Department of Energy. The goal of the Better Buildings Challenge is to make American buildings 20 percent more efficient in the next decade. Vargas also serves as the senior program advisor to the Office of Energy Efficiency and Renewable Energy. Prior to her work at DOE, Vargas was the brand manager for the ENERGY STAR program at the US Environmental Protection Agency for more than 17 years.



MICHELE NEGLEY

SENIOR VICE PRESIDENT OF CLEARESULT'S SOUTH REGION

Meet Michele Negley. With more than 20 years of experience in the energy sector, she has seen how dramatically the industry has grown. We are pleased to have this opportunity to introduce her to *EET&D* Magazine readers for this, our 20th anniversary issue.

When she was younger, Negley wanted to be a doctor. She was good at science and math and had the fortitude for the years of study a medical degree required. However, with putting herself through college, Negley recognized the logistics were an uphill battle she did not have the time or money to climb. Knowing she needed to settle on "what to be when she grew up," Negley decided on electrical engineering.

"My mother worked at an engineering school while she was pregnant with me, so she encouraged me in that direction."

After she graduated, Negley viewed the utility space as one with ample opportunities to grow as a professional in an industry poised for change. "Working for a utility was a great way for me to use my engineering degree while learning about the broader business, says Negley, "I knew it would allow me to take my career in a lot of directions." She purposely worked in the most technical areas early in her career to put her on a path towards management down the road.

About 15 years ago, the utility space was fairly stagnant, and Negley took a break from the industry. When a consulting firm, specializing in energy efficiency asked her to help grow their business, Negley ended her hiatus. From there, Negley went on to join the energy efficiency consulting firm, CLEAResult, starting out as a senior director in 2010. Today, CLEAResult has more than 2500 employees and 70 offices throughout the U.S. and Canada, and Negley serves as the company's senior vice president of its South Region.

Of the nearly 250 utility clients with which CLEAResult consults Negley focuses on 35, but she works with as many as 50 utilities throughout the southwest. In her role, Negley helps her clients design and implement energy efficiency programs, including several that serve low-income consumers.

"From a regulatory process, as well as utility desire, serving low-income populations has always been a priority for CLEAResult. Low-income residents spend a significant portion of their income on their utility bill, and so we work with them to help them save energy and money," says Negley.

One program Negley's team assisted with creating for consumers in need is a partnership between CLEAResult and NV Energy. For this project, CLEAResult has developed program designs for energy storage and solar. Additionally, Negley and her team streamlined and automated the solar application process for PNM.

For each client, Negley tailors energy efficiency strategies to meet their specific needs.

"The regulations and customer desires are very different from one utility to the next," explains Negley.

"For example, one client in Arizona has 30 percent of their distribution feeders connected to significant solar, as opposed to Oklahoma, which has 400 rooftop solar units across the entire service territory."

Negley and her CLEAResult team partner with established firms like Nest and ecobee, integrating their solutions into the energy efficiency programs her team implements. For example, CLEAResult worked with a San Antonio utility to transition to energy-efficient technology by integrating Nest thermostats into residences. "We've just installed our 10,000th Nest thermostat," states Negley. "The technology makes it easier for consumers to use it in such a way that's valuable to them."

Negley's enthusiasm for what she does is evidenced by the way she talks about her work with utilities and industry leaders, "It's fun; it really is," exclaims Negley.

"This industry is heading into a very unique time of unprecedented change. Utility customers have so many options available to them now. For me, as an executive, this kind of change and challenge is exhilarating. There's a lot of opportunity to add value as we help our clients transition their business models and the way they serve their customers."

Asked if she believes she approaches her work differently than a man in her position might, Negley responds, "Of course. I tend to expand my thoughts and talk through things a little bit more. Women are great multitaskers. We also are good at picking up nuances, which is valuable when it comes to shaping our clients' strategies and moving their businesses forward."

Looking towards the future, Negley says the industry must be more agile and become comfortable with ambiguity. "When I did system planning for utilities early in my career, we would look out 20 years and could pretty much anticipate what would happen. At the time, the main variable we were concerned with was the natural gas price. Today, we do not have such certainty. You look out five years; it's pretty foggy. I think we're going to see an ever-increasing pace of change throughout the industry. All of us must be ready to navigate with flexibility as this change occurs."

As Negley ponders what's in store for her personally during what she considers the final quarter of her career, she believes leaving a legacy of positive impact and change is very important – especially when it comes to those individuals she has mentored along the way.

"What makes my heart smile is the talent that I've been able to identify and grow throughout my career. Half of the leadership within CLEAResult came from my team. Two of the vice presidents at CLEAResult came up under my organization and now have their own territories. I also have a colleague I began mentoring when he was 15 yeaeeers old, who is now a vice president at a generation and transmission company in Austin, TX. Negley encourages younger professionals who are considering a career in the energy sector to "go for it."

As she explains, *"I like to tell them, 'you be you,' but you must also pay attention to the inherent biases that exist in every workplace. The world is changing rapidly, but I'm optimistic that if you stay true to yourself and remain open-minded and flexible, you will succeed."*

ABOUT MICHELE NEGLEY:

Michele Negley has more than 30 years of experience in the energy industry, beginning as an electrical engineer and later managing distribution and transmission system planning in Phoenix, AZ, before joining CLEAResult in 2010 to run 25 percent of the operations, helping the company grow to nearly 3,000 employees and $440M in service revenues with 245 utility clients. Throughout her decades of experience, Negley has provided engineering, acquisition, organizational transformation and operational excellence counseling to utilities across the U.S.

Negley's background as an electrical engineer gives her a unique advantage in her position as senior vice president for CLEAResult, enabling her to marry the technical necessities of the utility industry with the energy efficiency needs of the consumer. Her rare breadth of electric industry knowledge, leadership and experience allows her to guide utility clients through evolving market conditions with a strategic yet pragmatic approach to deliver results.

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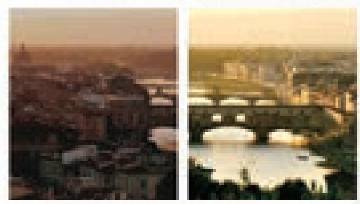

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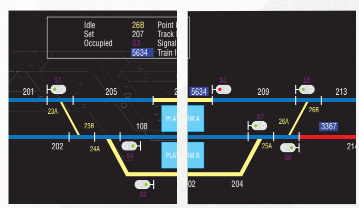

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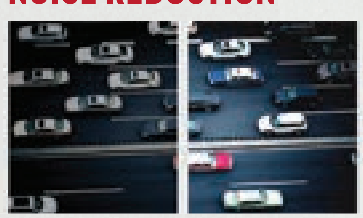

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