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FROM INNOVATION TO
GRID TRANSFORMATION**



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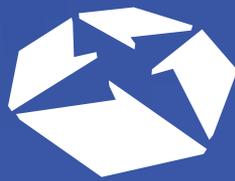
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Energy Partners Aim for Preparedness and Resiliency
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Vermont-based Green Mountain serves 265,000 customers and is partnering with them on a new energy future that is cleaner, more reliable and cost-effective. GMP CEO Mary Powell answers our questions about GMP's innovative approach to grid transformation.



PUBLISHER

Steven Desrochers
steven@electricenergyonline.com

EDITOR IN CHIEF

Elisabeth Monaghan
elisabeth@electricenergyonline.com

ACCOUNT EXECUTIVE

Todd Shipway
todd@electricenergyonline.com

ART DESIGNER

Z communications
r.poitras@zcommunications.ca

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Tel.: 888 332.3749 | info@electricenergyonline.com
electricenergyonline.com

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A PREVIEW OF EPRI'S ELECTRIFICATION 2018 CONFERENCE & EXPOSITION | Rob Chapman

The need for economic and environmental improvements has never been more critical. Enter EPRI's Efficient Electrification Initiative – a research, development, and demonstration effort that explores the benefits and costs of increasing the share of end-use served by electricity. The embodiment of this initiative is EPRI's upcoming international conference.

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According to Bloomberg New Energy Finance, the global energy storage market will double six times between now and 2030. This equates to a start point of 5 GWh in 2016, to 300 GWh by 2030, with a total of US\$103 billion invested in energy over that period. It is estimated that 70 percent of this capacity will be distributed across eight countries: the U.S., China, Japan, India, Germany, U.K., Australia and South Korea.

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With utility bills making up an average of 1.4 percent of a hospital’s operating revenue, hospitals in the U.S spend about \$8.3 billion total on energy costs each year. The impact of these energy costs on an individual hospital is huge.

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WEATHERING THE WEATHER: THE BENEFITS OF COMPOSITE UTILITY POLES IN STORM ZONES

| Dan Coughlin

An average of 2.5 million of the roughly 130 million poles made from wood need to be replaced each year due to loss from age, rot, decay and, in the most high-impact instances, weather events.

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THE BIGGER PICTURE

FERC REQUIRES GREATER TRANSPARENCY REGARDING RTO/ISO UPLIFT | Glenn S. Benson

To at least begin addressing market participant concerns about uplift, the Federal Energy Regulatory Commission (FERC) issued a new rulemaking (Order 844) on April 19, 2018.

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“Zero-day” attacks may get a lot of attention in the press, but for electric utilities, the reality is that more “mundane” threats pose a far greater risk to their operations.

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CALIFORNIA ISO GARNERS INTERNATIONAL AWARD FOR SOLAR PLANT FINDINGS: GROUNDBREAKING TEST WILL BE INSTRUMENTAL IN TRANSITION TO A LOW-CARBON GRID

July, 2018

The California Independent System Operator (ISO), in partnership with First Solar and the National Renewable Energy Laboratory (NREL), has received the inaugural Smarter E Award for an Outstanding Project for work on photovoltaic solar power and grid reliability.

The project tested and demonstrated the effectiveness of highly responsive and essential services for maintaining grid reliability on a 300-megawatt (MW) utility-scale photovoltaic (PV) power plant in California, proving that renewable resources can be used for ancillary services related to grid stability.

The findings could open the door to better management of a growing amount of green energy into the electric system.

In the most extensive testing of its kind, the analysis focused on performance in three critical areas: frequency control, voltage control, and ramping capability, all

identified as essential reliability services by the North American Electric Reliability Corp. (NERC) for expanded integration of renewable resources into the power grid.

The tests, conducted on a First Solar unit in August 2016, demonstrated that renewable energy plants with smart inverter technology can offer electric reliability services similar to, or in some cases, superior to conventional power plants. The findings highlighted the role of advanced power controls in leveraging solar PV's value from an intermittent energy resource to providing reliability services.

“The test results mean that renewable energy can be incorporated into power systems at a much higher level and faster pace than once believed, giving a glimpse at the clean green grid of the future.”

- Clyde Loutan, California ISO's principal for renewable energy integration.

In the award citation, the review jury called the project, ***“a game changer for large-scale solar plants,”*** saying, ***“solar plants can not only reduce the need for carbon-emitting resources but can also improve system performance and operate with significantly high levels of variable generation.”***

The award was presented on June 22 at the InterSolar Europe 2018 conference in Munich, Germany.

“The ISO is proud to be part of a project that could one day help achieve the vision of using primarily renewable sources to power our economy.”

Criteria to be nominated includes exemplary and groundbreaking work in transitioning toward a low-carbon future through global applications, energy innovation, and exploration of renewables.

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DEWA EXCELS IN UTILISING SOCIAL MEDIA COMPARED TO OTHER UTILITIES WORLDWIDE

July, 2018

According to the Arab Media Outlook 2016-2018 report, issued by Dubai Press Club, the future of media is characterised by rapid digitisation and content on the small screen. This is already evident in the share of views on mobile phones which jumped from 11% in 2011 to almost 70% in 2015. According to the same report, millennials interact much more with media content, making them creators as much as consumers. As per the Arab Social Media Report 2017, issued by the Mohammed Bin Rashid School of Government, 58% of social media users in the Arab region express their views or sentiments regarding their government's policies using social media. Government organisations in the UAE, are aware that 95% of the population use Facebook, and accordingly utilise social media to develop their services, collect ideas, suggestions, and feedback to develop their services and make their customers happier.

DEWA is a pioneer in using social media

Dubai Electricity and Water Authority (DEWA) was one of the first government organisations in the UAE to use social media tools to communicate with the public. DEWA actively interacts with the public through social media based on international best practices. It was the first government organisation to adopt a social media policy that is aligned with the Guidelines for Social Media Usage in United Arab Emirates Government Entities, which was issued by the Emirates E-Government in the Telecommunications Regulatory Authority (TRA). DEWA uses social media to receive enquiries, observations, and feedback from customers and the public to improve its services and make customers happier. DEWA also utilises social media to promote awareness about its programmes, initiatives, projects, smart services, and conservation campaigns, as well as spread awareness about sustainability and the environment.

“ At DEWA, we are guided by the long-term vision of our wise leadership who realised early on the positive role of social media in developing government services by listening to comments, suggestions, and ideas. Thanks to the directives of His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, we have successfully transformed these channels into tools for development, innovation, and knowledge, and windows for communications and constructive interaction. This is done by utilising these modern, rapidly-developing, widespread tools and making use of their capabilities. Our social media channels are key tools to positively communicate with our customers and listen to their suggestions and feedback. This helps us achieve their happiness and the happiness of society as a whole as well as achieve DEWA's vision to become a sustainable innovative world class utility”

- HE Saeed Mohammed Al Tayer, MD & CEO of DEWA

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Social media channels are tools to develop government services

“DEWA is the first organisation to develop a social media policy that includes performance indicators, communication methods and plans, as a way to select platforms and interact with different channels, types of content, number of posts, and other criteria. DEWA uses six social media platforms for interaction, and promote its services and campaigns, using a variety of content types for different stakeholders. This includes photos, videos, infographics, and live streaming. These efforts have contributed to DEWA’s corporate identity perception reaching 89% in 2017, which underlines the success of social media in establishing constructive interaction with stakeholders and receiving their positive feedback,” said Khawla Al Mehairi, Executive Vice President of Strategy and Government Communications at DEWA.

DEWA excels in using social media compared to its global counterparts

DEWA conducts an annual survey to study society’s happiness about the information it provides and the channels used to deliver these messages, including social media. A quarterly study is also conducted to analyse the results of key performance indicators related to the social media strategy. The results demonstrate DEWA’s excellence globally in various indicators compared to the best 10 utilities worldwide and the best 10 electricity and water companies in the USA. These include the number of social media followers, interaction with the public, and number of YouTube views among other indicators.

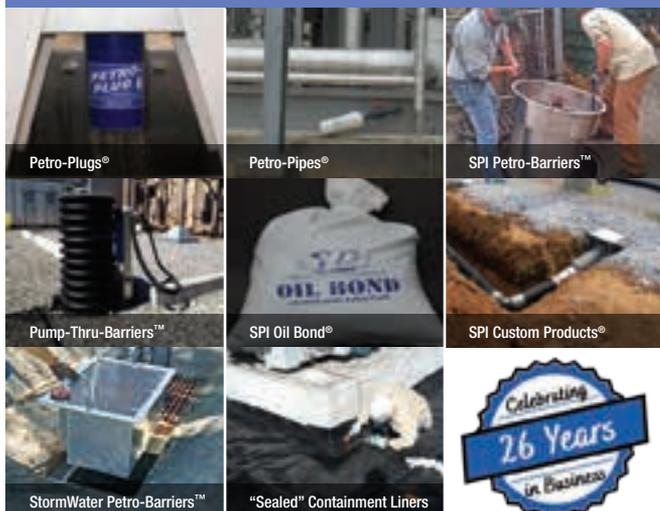
In 2017, DEWA’s social media accounts had over 4 million followers, while the average of the best utilities worldwide was 190,427 followers.



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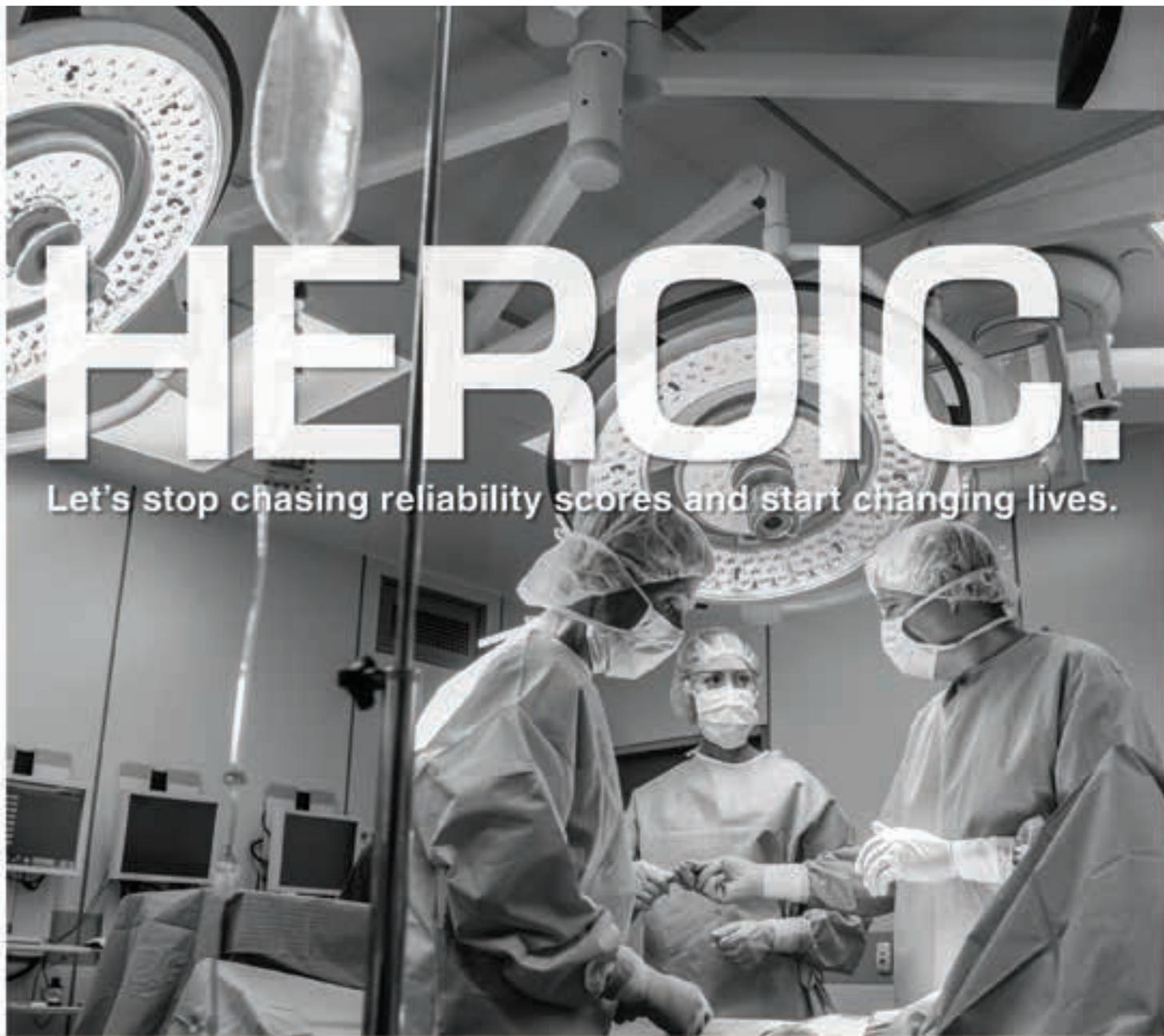
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At the UAE level, the percentage of society’s happiness with DEWA’s commitment to providing useful information to them continuously was 90.78% in 2017 (this includes accuracy, benefit, information accessibility, and reliability) compared to 86.82% in 2015. 18% of the participants said they received information through social media channels compared to 10.5% in 2015. A recent report published by Mintrics in cooperation with Forbes Middle East, showed that DEWA topped government organisation in the UAE in terms of videos posted across different social media channels during the Holy Month of Ramadan 2018.

Awards

In recognition of its successes in the digital media and in using social media channels, DEWA has received many awards including the Arab Social Media Influencer Summit Award for its work on the environment in 2016. It also received the Distinguished Entity in Government Communications at the 19th Dubai Government Excellence Program Award 2017. Between 2015 and 2017, DEWA has received 15 government organisations from the UAE to conduct benchmarking and learn about its distinguished experience in this field.



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PG&E DEMONSTRATION PROJECT TESTS SMART INVERTER BENEFITS, ELECTRIC GRID IMPACTS

July, 2018

Pacific Gas and Electric Company (PG&E) announced interim findings from an ongoing Electric Program Investment Charge (EPIC) project that aims to demonstrate the functionality of smart inverters.

As more Californians power their lives with solar energy, energy storage and electric vehicles, PG&E is looking to the smart inverters that will be installed on those technologies to manage their interaction with the grid in support of continued clean energy growth.

“ We have a long history of embracing innovation and new technologies for the benefit of our customers and the communities we serve. The smart inverters being installed on our customers’ solar and energy storage systems, paired with our investment in grid operations systems and technology, show promise to facilitate distribution system reliability and power quality in the increasingly complex grid.”

-Roy Kuga, vice president, Grid Integration and Innovation, PG&E.

A standard inverter converts power from solar panels and batteries from its native direct current (DC) into alternating current (AC) which can be used on site or fed into the power grid. A smart inverter is a more sophisticated version of an inverter that makes autonomous decisions that can help maintain grid stability, reliability and power quality. In the near future, smart inverters will be required to have the capability to receive remote operation instructions and communicate measurements and status. Some solar installations already have smart inverters with these advanced capabilities. California’s investor-owned utilities (IOUs) began requiring smart inverters on all new solar

interconnections starting September 8, 2017, through the California Public Utility Commission’s Rule 21 tariff. As smart inverter standards and requirements continue to evolve, PG&E can use demonstration projects like this one to explore how smart inverters on customers’ solar installations function and interact with the grid.

Completed Project Activities

PG&E recently published an interim report on project activities and findings to date, along with planned next steps.

PG&E’s Grid Integration and Innovation group, which is leading the project, has found that smart inverters can be beneficial. As solar has become more ubiquitous in California over the past decade, the grid has started to experience reliability and power quality issues. Smart inverters have the potential to prevent the solar systems from contributing to voltage fluctuations and adverse impacts on protection systems due to reverse power flow. The demonstration has also shown that more work and investments are needed to standardize the technology and improve communications reliability. The ongoing project will next test the capabilities of smart inverters on a different type of electrical distribution circuit with higher solar penetration.

PG&E believes that with additional investments that enable grid planning and operations to achieve better utility monitoring, visibility, and communication capabilities, smart inverters have the potential to become an important tool in the integration of clean energy into California’s electric grid.

Ongoing Project Activities

Working with Turlock-based JKB Energy, PG&E is testing smart inverter capabilities on commercial-scale solar installations for agricultural customers. These installations are all connected to the same distribution line in Merced County, and this particular circuit already has a high penetration of solar-generated electricity and has experienced problems as a result of the amount of solar currently installed. →

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The project includes installing smart inverters to prevent the inverter from contributing to voltage issues, ensure greater electric reliability, and facilitate the continued integration of additional solar. JKB Energy installed and maintains the customer-owned solar generating stations.

This project is funded by PG&E customers through EPIC - a program that enables California investor-owned utilities to demonstrate new and novel technologies and evaluate how they support safety, reliability, and affordability objectives for the benefit of their customers.

To learn more about EPIC, visit www.pge.com/epic.

“At JKB Energy, we place a heavy emphasis on paying close attention to the details that can make or break a project. In working with PG&E to install smart inverters for some of our shared customers, we have the opportunity to enhance our customers’ experience with a solution that integrates more clean energy onto the grid, ultimately resulting in greater safety, reliability, and affordability for our customers”

-Bob Hansen, vice president and chief operating officer, JKB Energy

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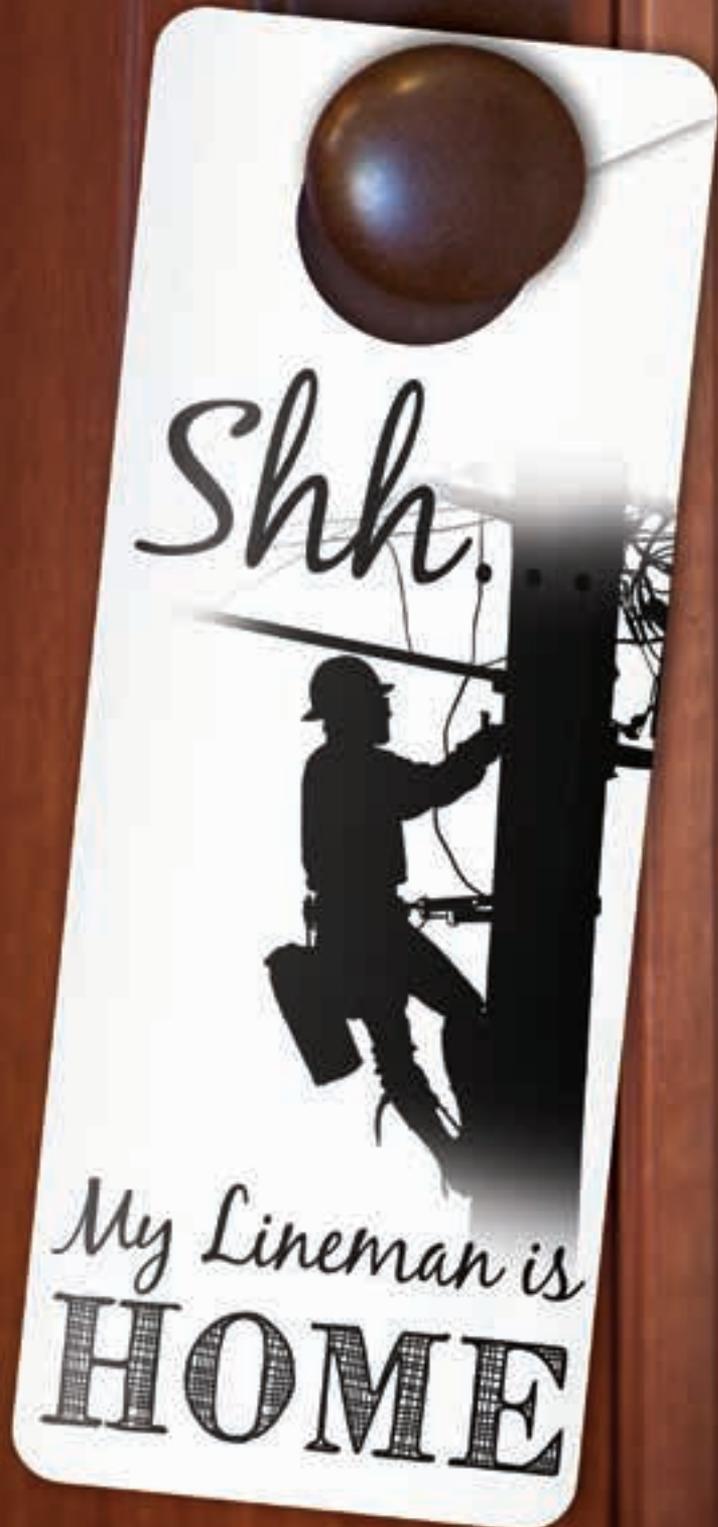
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AIM FOR PREPAREDNESS AND RESILIENCY



ELISABETH MONAGHAN
Editor in Chief

EET&D Magazine identified Hurricane Preparedness as one of the market/application focus areas for our Sept/Oct issue, but hurricane season will be well underway by then. That means thousands of homes and businesses already may be reeling from the destruction and heartache from one or more hurricanes.

Some areas hit by Hurricanes Harvey and Maria are still recovering. Puerto Rico still has thousands of residents without power, while the island braces for this year's raging storms. So how do utilities get ready for another hurricane season? It is a rhetorical question, but more utilities are partnering with their customers and industry partners to figure out lasting solutions.

A number of articles in this issue of *EET&D* demonstrate how industry thought leaders are seeking best practices to bolster the power grid. This issue also spotlights some of the ways the industry's efforts to improve energy use and reliability, which will allow for quicker resilience.

For example, S&C recently partnered with Frost & Sullivan on a Commercial & Industrial (C&I) power reliability study. In his article about this study, Jerry Yakel explains how everyone tolerates outages differently. Power outages are an inconvenience that can result in spoiled food or foil tasks like cooking or doing laundry, but most of us can resume our lives as soon as the power comes back on. When hospitals experience these same power outages, the impact can be deadly. While the S&C study did not

provide instant answers, the responses show to what extent C&I customers will go for more reliable power – even if it means deploying their own alternative energy sources, independent of the utilities.

In his article for this issue, Peter Fairbanks, with Fairbanks Energy Services, talks about how some facilities, such as hospitals, cannot afford to be without power for long. Pointing to some specific energy challenges hospitals-face, Fairbanks suggests steps hospitals can take to improve their overall energy efficiency without completely disrupting their daily operations. Fairbanks' suggestions, if followed, could result in safer and more energy-efficient environments for patients and hospital staff. In the long run, a facility that focuses on how energy is used is likely to have a better handle on its reliability before and after a catastrophic storm.

Dan Coughlin, with the American Composites Manufacturers Association, explains how replacing the old wooden utility poles with poles that are made of composite materials will help mitigate power outages. Replacement is a massive undertaking that is not inexpensive, but Coughlin makes a compelling case for why now is the time to invest in storm-resistant utility poles.

Looking to battery storage, Green Mountain Power (GMP), may have found an approach to ensure both C&I customers and homes alike have backup power during outages. As you will read in the Grid Transformation Forum, GMP is piloting a program to offer Tesla's Powerwalls as backup power for residences during peak periods or outages. Granted, GMP is a smaller utility, and the program is in its infancy stage, but if this program succeeds, it could be a matter of time until larger utilities can scale this or similar programs for their customers.

Regardless of time of year, there will always be some disaster to affect the power grid. By showcasing our partners' successes, we hope *EET&D* readers will learn from each other's missteps and successes in order to respond to and quickly recover from whatever natural or human-made disaster comes their way.



IEEE PES
2019
GTD
CONFERENCE
& EXPOSITION

In the May/June issue, I mentioned that *EET&D Magazine* was the media sponsor for the inaugural IEEE PES GTD Conference in Asia next year. I wanted to provide a little more information for our readers, which is why I am thrilled I had the opportunity to ask Saifur Rahman, Ph.D., who is the 2018-2019 president of the IEEE Power & Energy Society, about this new conference.

EET&D – Who will benefit from attending?

SR – Manufacturers, vendors, consultants, electric utility engineers and executives, regulators and academics will benefit from attending. This is because all parties will have a chance to see the huge displays of electrical hardware, discuss with industry engineers and designers the operations of complex and modern hardware being introduced.

EET&D – How will they benefit?

SR – Through networking, visiting display booths and sharing each other's experiences.

EET&D – How many attendees do you expect for the first year?

SR – We expect 3000 attendees and 1000 exhibitors.

EET&D – In discussions about the event, people have asked why IEEE would want to participate in a market that uses IEC standards. Can you speak to this?

SR – IEEE does not produce standards for a given country; it produces standards for technology under consideration. For example, IEEE 802.11 (for wireless data communication), IEEE 1547 (for renewables integration). What standards a country choose to use depends on that country's standards board. Some countries accept

IEEE standard for their own use; some accept IEC standards, and some accept both. IEEE just offers alternatives for the country's standard board to consider.

To learn more about the IEEE PES GTD Conference, visit <http://ieeegt-d.org/>

If you would like to contribute an article or if you have an idea about interesting technology, solutions, or suggestions, please email me at

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GREEN MOUNTAIN POWER: FROM INNOVATION TO GRID TRANSFORMATION

ELISABETH MONAGHAN



EET&D had the opportunity to speak to **Mary Powell**, president and CEO of Green Mountain Power (GMP) in Vermont. GMP serves 265,000 customers and is partnering with them on a new energy future that is cleaner, more reliable and cost-effective. The company is focused on transforming the grid to a home-, business-, and community-based system by leveraging the latest in innovations. GMP was #1 on Fast Company's 2018 list of Top 10 Innovative Companies in Energy, and #8 on SEPA's 2018 Top 10 for Energy Storage Installed. It is also the first utility to become a certified B Corp, committed to using business as a force for good. We are pleased to have this opportunity to share what we learned about GMP's approach to grid transformation.

EET&D – What does grid transformation mean at GMP?

MP – We are so excited at GMP to radically transform the existing energy system. We see it as necessary. I have spent 18 years in the energy business, and GMP is in a pivotal and important period of transition. Our passion around this transformation is two-fold: we want to help Vermonters dramatically reduce dependence on carbon, while at the same time, earn our way into new energy relationships with our customers to help transform the grid to drive down cost pressures.

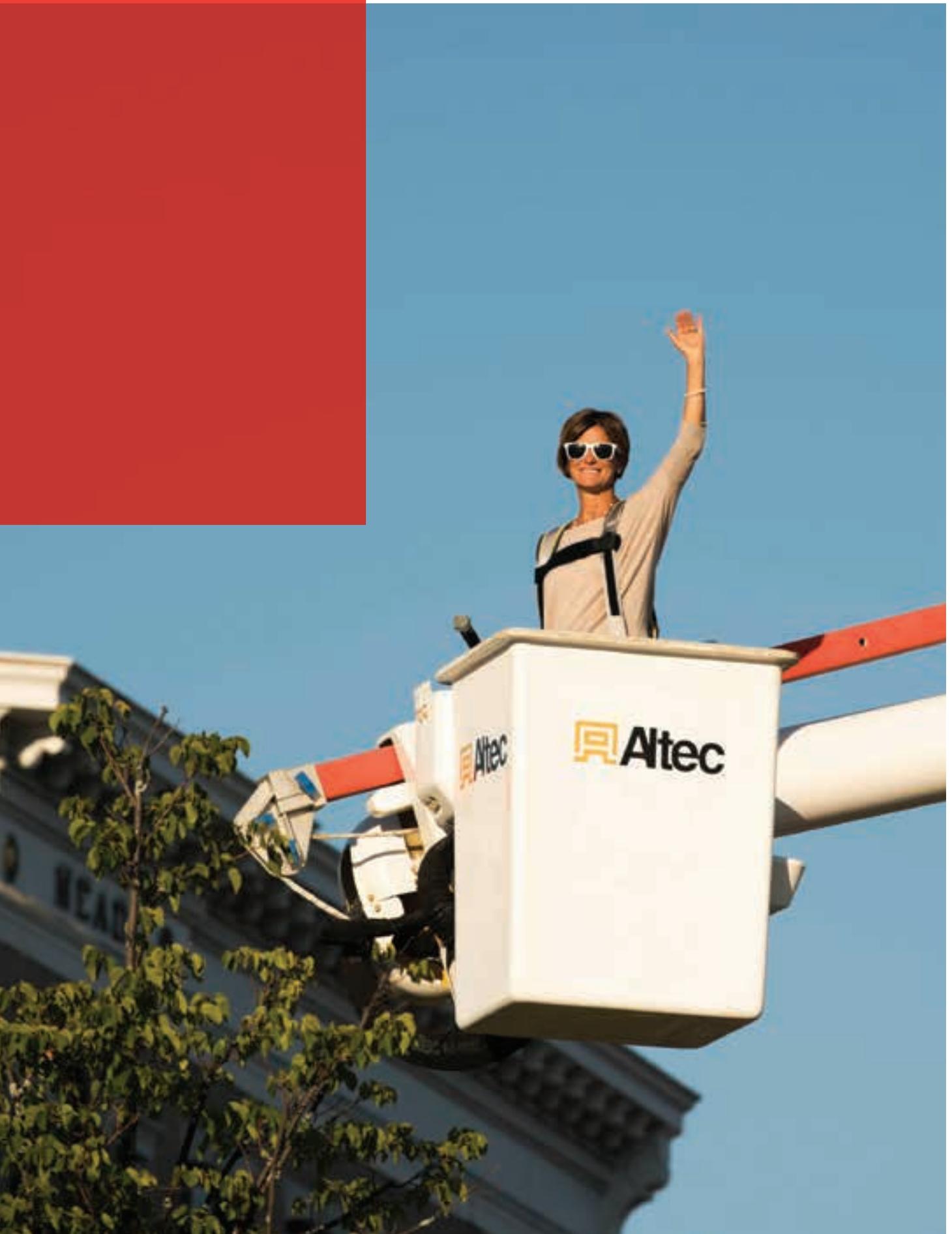
EET&D – There is a lot of discussion on grid transformation, when did you realize that change was needed?

MP – In 2006, we launched a new energy vision to reduce carbon in our power supply. That was the first step, and now we are 60 percent renewable and 90 percent carbon-free. Our energy vision has evolved, and today the focus

is on leading the transition from the traditional grid of the past, to one that is more resilient and reliable, using energy generation and innovative storage solutions paired together. This will empower customers and provide key ways to drive down costs of the antiquated bulk grid system.

EET&D – What do your customers think about this?

MP – Our customers tell us that they want energy that is low cost, low carbon, and highly reliable. At the same time, our customers are partnering with us to transition from the traditional bulk grid to an energy system that is home-, business-, and community-based. As new technologies continue to emerge in the energy market, our customers are showing us they are interested in generating their own clean power, and storing it too, while sharing access to their energy resources (including heating, cooling, and vehicle charging), in order to enable better grid outcomes that drive down costs for all. →



EET&D – That kind of change isn't easy. How do you go about that?

MP – It starts with culture. I always say culture eats strategy for breakfast. You can have all the best ideas, but if you don't have the right culture to implement them, not enough will happen. We talk about being customer-obsessed at GMP. What that means is ensuring that customers have a good experience and employees are empowered to make decisions. We eliminated layers of bureaucracy to run a flat organization that moves quickly to deliver these innovations to customers.

EET&D – Let's talk about solar and storage. That seems to be a key part of your approach.

MP – It is. Battery storage is a core part of our service now and of our strategy in the future. In the last decade, research and development in battery storage technology has grown exponentially. There have been breakthroughs in larger scale batteries that have the capacity to store large amounts of energy for several hours, and then release it onto the grid on command. This technology is already delivering early benefits in Vermont by driving down the cost of the bulk grid and creating the ability to deliver energy that is clean, cost-effective and reliable.

Storage is helping to integrate renewables and smooth their uneven output, providing "islanding" ability that can serve as backup power during outages, and reduce costs for customers through peak shaving, energy arbitrage, and other ancillary services. For example, by deploying the 3.4 MWh of battery storage at our 2MW Stafford Hill solar project in Rutland, GMP saved customers more than \$180,000 in a single hour – and also provided customers with over \$150,000 of value through participation in other ISO New England ancillary markets.

EET&D – It's not just grid-scale; you are also providing customers Tesla Powerwalls for backup power for homes. You have an innovative program - how are your customers reacting?

MP – The response has been amazing. We were the first utility to work with Tesla to offer Powerwalls. It's a pilot program and we are on track to reach our target of 2,000 powerwalls subscribed by the end of the year. It really is a win-win. Customers who have them tell us about riding through outages – unaware there was any outage because the Powerwall kicked on seamlessly. And, we have been tapping into all that stored power to help shave the peak, so it is saving all customers money and providing convenience at the same time. Customers are paying \$15 a month or a one-time cost of \$1,500. It's just one of the innovative programs we have. You have to be creative in this environment to find ways to drive down costs. At 2,000 Powerwall systems, GMP will have access to nearly 10 MWs of aggregated, stored energy to use during expensive peak times.

EET&D – How do you see utilities working together with other businesses in this new grid?

MP – We all have to come at this from an approach of how do we continue to provide reliable service for customers and make needed upgrades to the system, while accelerating this transformation in a cost-effective way. As part of that work, we are supporting a community of third-party developers to deliver transformation solutions to Vermonters cost-effectively. We recently launched our "Bring Your Own Device" ("BYOD") program. The BYOD pilot allows GMP customers to bring their own backup power solutions, procured independently from one of Vermont's energy solution providers, to participate in GMP's grid transformation capabilities and help manage peak costs to benefit customers.

ABOUT MARY POWELL:

Mary Powell is nationally recognized as an energy visionary, positioning Green Mountain Power as a leading energy transformation company. She has served as president and Chief Executive Officer for GMP since 2008. Powell has initiated and implemented a strategic and comprehensive restructuring of the company that dramatically transformed GMP, and she has been the backbone of a cultural transformation and service quality improvement. Under Powell's leadership, GMP became the first utility in the world to become a member of B Corp, showing a commitment to use energy as a force for good.

In 2014, Powell was recognized by PowerGen as the Woman of the Year, in 2015 The Burlington Free Press named her Vermonter of the Year, in 2016 Fast Company named Powell one of the 100 most creative people in business, and in 2017, Powell was named one of the top 25 Most Influential Women of the Mid-Market by CEO Connection. And Conscious Capitalism Media named Powell to its 2018 list of 30 World-Changing Women in Conscious Business.

EET&D – Some utilities might think leaning in quickly to these innovations is risky....

MP – We think holding on to the old way of doing business is the bigger risk. In New England, there is the ever-increasing cost of regional transmission and capacity. Transmission expense has increased by roughly 20 percent in the last three years, and capacity costs have more than doubled. These increases occurred despite the fact that the amount of electricity used throughout New England is flattening or even in some cases on the decline. These costs are out of the utility's control. But, we don't want to sit back and just accept these cost pressures, which is why we are finding that empowering our customers is working. We like to say that we are an un-utility. We are providing energy as a service, and in turn, our customers are providing us the opportunity to bring down costs for everyone because we can tap into stored energy in a network of devices – from Tesla Powerwalls and smart water heater monitors - to solar storage facilities.

EET&D – Are you hopeful this transition will happen? Is now the time?

MP – Yes! Change in our industry is happening rapidly, and some strategies for controlling costs have to be seized early to benefit customers. Our approach is to address uncontrollable external pressures head-on and to drive down costs through innovations in operations and service to our customers. We are working to reduce our share of transmission and capacity costs through aggressive peak management, including battery storage and demand response. We are also working on controlled shared access to end-use devices in a variety of ways like heat pumps, EV chargers, batteries, and water heaters, that can be turned down during peak times in a way that is imperceptible to customers. With a culture of innovation, paired with a lean and effective operating approach, GMP is ready to keep working with customers on this new energy future that is already here, now.

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FROM RESEARCH TO ACTION

A PREVIEW OF EPRI'S ELECTRIFICATION 2018 CONFERENCE AND EXPOSITION





ROB CHAPMAN

In today's complex and rapidly changing technological electric power landscape, the need for economic and environmental improvements has never been more critical. Enter the Electric Power Research Institute's (EPRI's) Efficient Electrification Initiative – a research, development, and demonstration effort that explores the benefits and costs of increasing the share of end-use served by electricity. The embodiment of this initiative is EPRI's upcoming Electrification 2018 International Conference & Exposition at the Long Beach Convention Center in August. This first-of-its-kind conference provides an opportunity for participants to hear from and interact with leaders in electrification, industry, academia, government, and the vendor community, from the United States and around the world.

The conference consists of workshops, exhibitions, tours, panels, networking events, and five diverse conference tracks covering an expansive breadth of topics associated with efficient electrification. →

Industrial Electrification

Industry and manufacturing remain the lifeblood of a nation's economy, even as other sectors (for instance, the service economy) grow in prominence. Industry is vital to trade balances, high-wage jobs, and national security. As manufacturing evolves to compete in the world economy, electric technologies play an important part in sustaining competitive capabilities.

In addition to higher energy efficiency (per-unit-of-good produced), electrification in the industrial sector can offer a range of non-energy benefits including:

- Increased productivity through greater processing speed;
- Improved process control, including responsiveness, reliability, and process intelligence; and
- Reduced emissions at the point of use, and potentially overall, as electricity produced with low-or no-carbon emissions becomes a larger portion of the generation mix.

Residential and Commercial Electric Technologies

Complementing the diverse industrial track is the residential and commercial technologies track. "This is fertile ground for efficient electrification," explains EPRI Senior Program Manager and track chair Ron Domitrovic. "It's where heat pumps, energy-efficient buildings, customer-connected electric devices, and smart communities rule." In just one example of these technologies, widespread adoption of next-generation heat pumps could save utility customers money, enhance demand response, and reduce the environmental impact of space conditioning.

A full-day, pre-conference workshop will focus on the opportunities and challenges with electrification of residential and commercial buildings. Six breakout sessions over three days will cover advanced heat pump technology, the future of water heating, the potential of customer-connected devices, understanding customers, and community and campus electrification.

Another session will cover advanced energy communities and zero net energy neighborhoods. What are utility opportunities and customer options in these integrated, connected, and electrified developments?

Electric Transportation

Consider the following trends: a significant rise in auto-maker electric vehicle (EV) spending, the ever-increasing range of EV models now available, and declarations from cities and nations around the world to phase out petroleum-fueled vehicles. At the same time, charging infrastructure is growing, and autonomous vehicles are proliferating. Do these recent trends indicate the approach of a tipping point for widespread, global adoption of electric transportation? If so, how can industry stakeholders prepare for and enable this growth?

The electric transportation track is designed to benefit experienced industry experts as well as those less familiar with electrification. Spirited dialogue and exchange are expected in expert panel discussions.

Innovative and Breakthrough Technologies

This conference track is unique because it showcases exciting, emerging technologies. "We're looking at breakthrough solutions for utilities, their customers, and society," explains EPRI Technical Leader and track chair Beth Hartman.

A key part of this track is the growing EPRI Incubator Energy Network. Originally launched with a U.S. Department of Energy grant, this national consortium of 20 energy-focused technology incubators and accelerators collectively supports more than 500 companies that have raised more than \$1.6 billion in funding. The network supports solutions such as advanced EV charging systems, data analytics and artificial intelligence applications, advanced indoor agriculture, smart buildings, smart cities, and more.

Grid Modernization

The potential benefits of electrification can only be realized if the underlying power delivery system can support them. For example, electrification has the potential to add new, significant load shapes to transmission and distribution (T&D) systems. This adds another challenge to T&D systems that already must evolve to incorporate higher levels of renewable generation and distributed resources. How will T&D system planners adapt as electricity's share of end-use energy consumption continues to increase?

This track highlights the T&D infrastructure components – beyond the poles and wires – that utilities need to address as electrification progresses.

Policy and Regulatory Landscape

Policy and regulatory developments can impact the acceleration and adoption of electricity at the point of end-use. This track will explore the policy and regulatory implications and potential developments in five sessions:

1. The Big Picture: Key Policy Considerations for Efficient Electrification

Features a dynamic panel that will focus on high-level policy and regulatory considerations when evaluating efficient electrification's potential contribution to a cleaner, more flexible, reliable, and affordable energy future.

2. Charging Ahead: Preparing for Transportation Electrification

Explores the policy issues surrounding transportation electrification; transportation electrification's role in achieving public policy goals; and how to optimize investments in a way that benefits all customers and the grid.

3. Policies to Achieve Flexibility in an Increasingly Electrified System

Examines policies, markets, and incentives that could help promote seamless integration of efficient electric end uses and cleaner electricity resources.

4. Evaluating Electric End Uses in the Context of an Evolving Energy System

Focuses on specific considerations for evaluating customer end uses and their energy sources.

5. Electrification: The Key to Unlocking Smart Communities?

Explores the connection between electrification and smart communities.

These sessions will feature energy government leaders from Illinois, Minnesota, Ohio, and California; representatives from a regional transmission organization and a transportation alliance; and electric utility executives.

Costs and Benefits of Electrification

"Understanding the potential for electrification first requires a comprehensive view of the power sector and the rest of the economy, including all of the associated options and their cost and performance," explains EPRI Director of Strategic Analysis, Safety, and Sustainability Bill Gould. "Different nations, regions, and localities have very different characteristics – whether its climate, policy or cost of different energy and technology options – and those specific characteristics need to be taken into consideration. What may be an effective strategy in one place may not work in another."

This session track will explore the many needed considerations for examining the potential benefits and costs of electrification.



ABOUT THE AUTHOR:

Rob Chapman is vice president, Energy and Environment, at EPRI. He leads the team responsible for research and analysis on environmental science and technology issues from the generation, transportation, and use of energy, and is the executive business lead for EPRI's Efficient Electrification Initiative. His group's research addresses environmental, health, and economic issues focusing on air, land, water, and energy challenges; informing public policy; enabling sustainable practices, and improving occupational health and safety.

FIVE ENERGY PREDICTIONS FOR 2018





PERRY STONEMAN

As the global energy industry wrestles with two seemingly contradictory requirements, the need to innovate and the need to economize, it is bound to see significant shakeups and innovations over time.

Against this backdrop, here are five trends that will shape the global energy and utility landscape in the remainder of 2018. They cover the growth of renewable energy technologies, Elon Musk's push for battery storage solutions, self-powering communities and the role of new technologies like AI and robotics in meeting consumer expectations. Additionally, I will discuss some areas where Canada is either behind or on par with its global companions.

PREDICTION 1

Energy markets will be challenged by the rise of RenTechs

You may not know what RenTechs are yet, but they are having a disruptive effect on the energy industry.

RenTechs are “renewable energy technologies” that have entered the market. Technology companies are building or buying their own solar and wind farms to become 100-percent green. Major players like Google, Amazon, Apple, Walmart and other corporate giants are entering the market for a number of reasons. For example, to satisfy their energy needs, reduce their dependence on traditional energy suppliers, and even sell the surplus back to the grid. This is likely in response to factors such as green energy and climate change initiatives, or general cost savings. For instance, Apple recently announced its entire global operation, including offices and retail stores, is completely powered by renewable resources. →

RenTech companies are poised to disrupt long-standing business models. Even though incumbent technologies have a stake in renewables, the impact of tech giants, corporate giants and startups will increasingly play a role in the energy-generation mix and ownership.

In Canada, RenTechs have been slower to emerge compared to other countries. This is because Canada already has a fair amount of green energy suppliers that major RenTechs can partner with. The motivation to move to a 100-percent green business model is therefore much less in Canada, though RenTechs will pop up in Canada over time.

PREDICTION 2

Consumers will consider self-powering communities over traditional utilities

Now that renewable energy is becoming more affordable, communities are starting to see the value of implementing community-owned and operated renewable generation facilities. These “prosumers,” or members of a self-powering community, are essentially RenTechs but on a residential level.

These self-powering communities can include physical communities such as cities, towns, or campuses, led by mayors, counselors or facility owners. Or they can include virtual communities, where members can trade energy and share their energy assets in a peer-to-peer network. One example is Sonnen Energy in Germany. In this peer-to-peer group, citizens with rooftop solar and battery storage can join a community and sell surplus energy to each other. Another example is Nottingham City Council, which set up a non-profit supplier using renewable energy to provide residents with the lowest cost power available. These self-powering communities demonstrate another reason traditional providers will see a decline in revenue and/or sales.

At the same time, traditional utilities can still participate in this market through certain channels. For example, they can partner with communities that do not want to own and manage the facilities but are still interested in renewable energy projects. Traditional energy suppliers can step in and be the Engineering, Procurement and Construction (EPC) company and operate it for the next 20 years.

Self-powering communities have also been slow to appear in Canada. Canada’s sparse demographics make it difficult and more expensive to power communities compared to places like coastal California, which has the critical mass needed to provide economies of scale. Startup companies that put solar panels in homes are indeed starting to emerge, but these companies are in the early stages and will have tough barriers to overcome, such as creating the necessary energy infrastructure, before they can scale up.

PREDICTION 3

Artificial Intelligence and robotics will start to restore consumer faith in utilities

A third prediction is that Artificial Intelligence and Robotic Process Automation (RPA) will play an important role in restoring consumers’ faith in utilities. This is an area that’s severely lacking, though research suggests AI and RPA are already having an impact. In the utility industry itself, there is a customer expectation gap of 71 percent, and the industry has the worst customer experience relative to the expectation of all industries. Three-quarters of utilities that have implemented AI, however, have seen a 10-percent improvement in sales, and 73 percent believe AI and RPA will change the customer experience. Further, 65 percent feel that it will both improve customer experience and reduce churn. I expect AI and RPA will continue to have a profound effect on utilities.

Canada is behind many parts of the world in enabling consumers with mobile applications and energy insights. This is because the country’s regulatory and policy frameworks have not nurtured a particularly innovative environment for utility companies. Since utilities have service territories with fixed customer bases, many aren’t in a rush to adapt to changing consumer preferences because they have not felt the risk of losing customers. But as competitors start to offer consumers an alternative to the traditional utility model, this will be an important investment for traditional utilities going forward.

PREDICTION 4

Elon Musk will prove battery technologies’ potential for energy storage

Elon Musk is a vocal advocate for battery technology. Recall the recent power outage in South Australia, when Musk publicly promised he would get the system installed and working within 100 days of contract signing or it would be free. The future of energy and utilities will continue to become tilted towards the use of batteries to store self-produced power, and I predict the costs will continue decreasing, on track to be below \$190/kWh by 2020.

Further, significant projects are underway worldwide in which battery technologies are being implemented at the utility scale. In South Australia, power outages are frequent, due to the variable nature of renewable energy there. The region has a high percentage of renewables, and that can impact the grid adversely. This led to the decision to install 100 MW of battery capacity to make the grid harder and take the excess energy when the renewables are strong. Then, turning to the battery when needed.

Another region to watch out for is the storm-ravaged Caribbean, where Puerto Rico and some other islands must rebuild their energy infrastructure. There will be a higher percentage of renewable energy in the rebuild using battery technology. These types of projects will offer an opportunity for batteries to prove themselves.

Canada's unpredictable climate and the variability of its renewable generation has led the country to be keenly focused on battery technology. Batteries will be an important feature for the future of Canada's energy mix.

PREDICTION 5

Utilities transformation programs will accelerate and start to pay off

My final prediction is that 2018 will be the year that utilities' transformation programs start to pay off. The job of the Chief Digital Officer (CDO) is to improve performance, reduce costs and transform operations. The CDO is a deciding factor in whether these programs accelerate. When a senior executive is perceived to take on the CDO role, the board of directors will be more aware of the need and put a plan into action. Importantly, there are also more resources forming for CDOs, such as peer-to-peer networks, and communities of like-minded CDOs to help with each other's programs. These resources will continue to support and accelerate digital transformation.

There are both challenges and opportunities ahead for energy and utility companies as they tackle changing consumer preferences, alternatives to traditional utility models and technological advancements. It is the companies that are nimble and able to adapt that will surmount these challenges and lead the way to a cleaner, more prosperous future.

ABOUT THE AUTHOR:

Perry Stoneman is executive vice president and global head of energy & utilities for Capgemini, a leader in consulting, technology services and digital transformation. He is responsible for the Group Energy and Utility strategy, partnerships and portfolio. Perry's was the second residence in Canada to have a Tesla Powerwall – it was installed by Toronto's MPOWER Energy Solutions.

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BATTERY STORAGE AND PUMPED STORAGE POWER: THE PERFECT SYNERGY

BY GABRIEL HURTADO AND SASAENIA PAUL OLUWABUNMI

Energy storage technologies are fundamental if the decarbonisation and the transition to a new energy mix are to succeed. Two different technologies offer a feasible solution for the required demand in energy storage capacity: Pumped hydropower (or heat) electrical storage (PHES) and battery storage. Whereas the former is a well-known and established technology, the latter is new but developing rapidly. These two technologies are very different and have their limitations.

According to Bloomberg New Energy Finance (BNEF), the global energy storage market will double six times between now and 2030. This equates to a start point of 5 GWh in 2016, to 300 GWh by 2030, with a total of US\$103 billion invested in energy over that period. It is estimated that 70 percent of this capacity will be distributed across eight countries: the U.S., China, Japan, India, Germany, U.K., Australia and South Korea.

This trend is similar to the market expansion that solar energy experienced between 2000 and 2015, when the market share of solar PV generation doubled seven times.

It is anticipated that this growth will be driven not only by the progressive decommissioning of fossil fuels but, most importantly, by a rising need to successfully manage the production risks associated with a renewable-powered grid. Hence, this article aims to provide a comprehensive overview of the new energy storage paradigm.

Techno-Economic Considerations

The costs of lithium ion batteries are reducing at a significant rate, from US\$1,200/kWh in 2012 to US\$700/kWh in 2017. BNEF predicts that the cost will further plummet from US\$700/kWh in 2016 to US\$300/kWh in 2030. This significant fall in prices will favour investments in battery store and the mass production of batteries for a wide range of applications.

On the other hand, PHES is a very inexpensive technology, as it costs circa US\$200/kWh to US\$250/kWh¹, making it a very cost competitive option compared to battery storage technologies².

In addition, the capital costs for grid-scale solutions for both technologies also differ; for PHES the capital costs range from US\$1.5 million to US\$2.5 million per MW of capacity installed; whereas grid-scale battery solutions are estimated to be approximately US\$3.5 million per MW installed³. The ability of PHES to level demand and excess power allows plants to operate at the maximum efficiency as required, thus creating a better return on investment. →



Regarding life-cycle costs, lithium ion batteries have to be replaced between every 10 to 15 years, depending on their usage patterns and number of usage cycles. Therefore, a battery storage facility will need to be replaced at least six times during the potential 100-year life of a pumped storage project⁴. According to the BNEF, lithium-ion batteries are expected to decrease in price to US\$120/kWh in 2025, which means that whole life cycle costs, including Operation & Maintenance, could fall in the range of US\$200/kWh to US\$300/kWh by 2025, which will put them in a very good economic position against PHES⁵.

Future Prospects

Energy storage can be deployed both on the grid and at an individual consumer's home or business. Although the principles of energy storage involve complex technology, its economics are shaped by customer type, location, grid needs, regulations, customer load shape, rate structure and nature of the application. It is also uniquely flexible in its ability to stack value streams and change its dispatch to serve different needs over the course of a year, or even an hour. These value streams are growing both in value and in market scale⁶.

The performance of the energy storage market was robust in 2016, with 500 MWh of new capacity installed during the first half of the year and 1 GW of new capacity installed at the end of the year. More than 90 percent of the new capacity was lithium-ion batteries, with the remaining accounting for lead-acid batteries and redox flow batteries.

According to the International Energy Agency's (IEA) 2017 Energy Outlook, energy storage technologies will account for nearly 70 percent of global investment and provide 40 percent of the world's electricity by 2040. The Report also highlights the fact that battery costs have reduced 40 percent since 2010.

In addition, the report also states that: while "positive market and policy trends" are pushing more capacity into the market, "an additional 21 GW of capacity is needed by

2025, which will require several changes in energy policy." Consequently, it is inevitable that the rise of renewables will lead to a wide diversity of storage and supply solutions, which will ultimately depend on the resources and geo-political needs of each region and location. For example, battery storage technologies might be more appropriate for developing economies, where there are large off-grid areas, and only small amounts of power are required.

Although batteries can provide fast response times, they are yet to show their potential to provide the full range of ancillary services required to support the grid. However, PHES is regarded as a landmark technology, both proven and reliable, which can meet the grid demand and supply sustained output for up to a century.

Furthermore, in comparison, battery storage technologies are more cost-effective at releasing small amounts of energy over a short time at high power levels, whereas PHES is more cost-effective at storing and releasing large amounts of energy in a short period. Therefore, the fact that both technologies will play crucial roles in the development and expansion of a future network powered by renewable technologies cannot be ruled out.

Conclusion

The rise of renewables will inevitably lead to a diversity of storage and supply solutions. The range of these solutions will depend on the resources of particular regions and locations⁷. Hence, the future for both batteries and pumped storage technologies will be "bullish." Energy storage is essential to balance supply and demand. Although peaks and troughs in demand can often be anticipated and satisfied by increasing or decreasing generation at fairly short notice. In a low-carbon system, intermittent Renewable Energy Systems (RES) make it more difficult to vary output, and demand increases do not necessarily correspond to increase in RES generation. Therefore, higher levels of energy storage are required for grid flexibility and grid stability and to cope with the increasing use of intermittent wind and solar electricity⁸.



ABOUT THE AUTHORS:

Gabriel Hurtado, energy solutions manager at Mitie, and **Sasaenia Paul Oluwabunmi**, operations officer at the OPEC Fund for International Development, are specialists in international energy solutions & strategies. Their portfolio includes publications in the United States, China and India. They have extensive experience in business development, project management and energy engineering.

In addition, smart cities, which are increasingly becoming a key energy policy goal, require smart grids and smart storage.

Hence, it is expedient for policy makers and governments to synergise with key players in the private sector to further develop battery storage and PHES solutions as these technologies will be important for achieving not just a global renewable energy future but also a sustainable energy future.

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SHORT-CIRCUITING THE HIGH COST OF TRANSFORMER UPGRADES

BY ALAN OBER

**AMEREN'S RUSH ISLAND GENERATING STATION'S USE OF
RETROFITTED TRANSFORMERS OFFERS INSIGHTS FOR ANY PLANT
SEEKING TO INCREASE CAPACITY ON A BUDGET**

Increase capacity! When the call comes from upper management to produce more energy, a plant manager faces the challenge of upgrading the infrastructure, and upgraded power transformers often represent the biggest ticket item.

Adding to the expense is the fact that such change-outs usually require completely reworking the connections to and from the transformer. When spatial constraints that require rebuilding a new enclosure or pad mount are factored in, the prospect of increasing capacity can explode into a budget-busting endeavor.

In response, many plant managers are discovering the advantages of new retrofit transformers. These fully customized power transformers provide the benefits of increased power capacity while duplicating the form and fit of the originals. The option of a perfectly matched, plug-and-play transformer holds the potential for capacity upgrades that meet regulations, timelines and budgets.

The experience of one major power utility demonstrates that plant managers can successfully balance the demand for upgrades against the cost constraints set by the controller by retrofitting.

Saving Money in the "Show Me" State

Since "first fire" more than 40 years ago, management at Ameren Missouri's Rush Island Energy Center in Festus, Missouri, has run a tight ship. The plant's two, coal-fired generating units have often scored one and two in the nation for the lowest NO_x produced by units without selective catalytic reduction, while producing 1,242 megawatts of electricity.

Here, the impetus for transformer upgrade stemmed from a larger project that required more power for added in-house load.

"We were upgrading our bottom ash system, changing from a wet sluicing system with bottom-ash clinker grinders to a submerged flight conveyor, and the existing auxiliary boiler stood in the way of the conveyor," explained Herb Fischer, consulting engineer, Rush Island technical support. "So, we demolished the old 'aux' boiler and put in a new one." →





The jump from 75 to 250 horsepower needed for the forced draft fan on that boiler drove the need for the larger transformers. The load study called for upgrading the supply transformers from 1000 kVA to 1300 kVA.

On the face of it, ordering bigger transformers with larger secondary windings would seem simple enough, except that Fischer and his team faced the difficulty of having to fit the new transformers into an existing cabinet with no leeway for extra girth. Rebuilding the enclosure and reworking the terminations would have pushed back the project deadline and led to a large cost overrun.

“There were several components involved in making a decision for the replacements, and cost and fit were high on the list,” continued Fischer. “For those reasons, we had to have a supplier that could handle this type of custom work with a quick turn.”

The project took place at a double-ended unit substation within the energy center and only four days were allotted for the complete removal of the old transformers and the installation of the two 6900V to 480V replacements.

“The enclosure was going to stay so the dimensions had to fit and the transformers had to match up with the high voltage connection and the low voltage bus bar,” said Fischer. “Not having to perform any field modifications was critical, so only a duplicate retrofit would do.”

Retrofit Explained

Retrofit transformers represent significant cost savings for plant managers seeking to reduce capital expenses primarily because of the plug-and-play advantage of a perfect fit. Yet, without proper manufacturing controls, performance and reliability could end up sacrificed.

When it comes to the material used in the windings of a well-manufactured retrofit, copper is a superior conductor to aluminum because copper offers less resistance, hence less heat. Even the geometry of the windings makes a difference, with round-wound holding the advantage.

Attention to detail also pays dividends in the retrofit manufacturing process. Hand wiring yields the highest quality. Additionally, the deburring of the copper conductor helps ensure that the insulation won't be punctured and create a short circuit.

Even insulation plays a major part in ensuring reliability. As temperatures can reach 200 degrees C in a dry transformer on a daily basis, skimping on insulation can lead to disastrous consequences. Glastic fiberglass insulation or Nomex® provide significantly greater protection from fires and short circuits than paper insulation.

Since Ameren specified a quality dry-type transformer that incorporated all the characteristics of a well-manufactured retrofit, the manufacturer was able to pass along a three-year warranty instead of the industry standard one year.



A Fast and Smooth Upgrade at Rush Island

According to the DOE, June 2012 study entitled Large Power Transformers and the U.S. Electric Grid, “In 2010, the average lead time between a customer’s large power transformer order and the date of delivery ranged from five to 12 months for domestic producers.”

Too long. Aside from having to meet the stage gates for any project, the window for an outage must compete with other projects. Miss it, and rescheduling can delay implementation for weeks and quickly inflate costs as contractors sit idle.

For the Rush Island transformer upgrade, the window was Columbus Day weekend of 2017. Retrofitting allowed them to complete the job within the approved timeframe.

“An electrical contractor did the work and had no installation issues whatsoever,” added Fischer. “The bus bars were where they needed to be and the cabling supplied was a sufficient length to reach the existing terminations. It fit like a glove.”

After implementation, Rush Island ordered two more units that also had to be delivered on a short timeline, this time with different voltages. To date, the utility reports it has had no issues with any of the transformers and that everything is functioning to specifications.

ABOUT THE AUTHOR:

Alan Ober is the chief engineer at Electric Service Company (ELSCO Transformers), with more than 40 years of experience in the design and manufacturing of transformers.



REAL-TIME REMOTE MONITORING

OF SITES AND ASSETS PART – PART II

BY RICHARD HARADA AND EDGAR SOTTER

Overview

Sensing technologies exist to monitor the most critical assets and processes in an electric power system, whose fault could cause extensive and expensive outages for the utility and strain the system as it is forced to reroute power delivery. In the past, only a few of these sensors or monitoring devices had the capability to report their readings to a SCADA system. Most of the data obtained from these sensors had to be obtained manually through a gauge, and many critical measurements, like oil quality of the transformers, could only be done offline using samples. In recent years, improvements in power consumption and communications in sensor technology not only has reduced the cost of asset monitoring but also allowed remote online data gathering, creating new horizons for condition monitoring systems for electrical substations.

Sensors in the Substation

Every major asset or process in a substation is being monitored using some sort of sensor. Transformers, breakers, arresters, capacitor banks, etc., all have a mechanism to monitor their operating condition and assess the risk of damage or need for maintenance. Although sudden failures of these critical assets do not happen often, they can have catastrophic consequences, and online monitoring can reduce the probability of these events to occur to almost zero.

Inside a substation, for example, the most expensive asset and the one that is the most monitored is the transformer. Failure of a transformer causes major outages, costly repairs and strain on the surrounding system as power must be routed from other sources while the repair is being done. Utilities do as much as they can to maintain the transformer to prevent these failures. A power transformer may have more than 100 sensors that are monitoring not only primary components such as the windings, tap changers and bushings but also the protective components such as the cooling system. The most catastrophic failure of the transformer is in the breakdown of the winding insulation. Accelerated insulation aging and failure are caused by overheating of the windings resulting from overcurrent incidents. Extensive protection and control systems are used to provide as much protection as possible for the transformer from overcurrent faults that will cause overheating. Even with protection and control schemes in place, faults will be felt by the transformer, and it needs to be monitored for signs of wear. This will provide the maintenance group with information on what parts of the transformer need attention. →



The following is a description of different monitoring processes that used to be manual and now can be automated and measured online:

Transformer Temperature

Keeping the winding temperature in the optimal range will maximize the service life of the transformer. Temperature, moisture content and oxygen are the contributors to the deterioration of insulation with temperature being the primary. The primary contributor to insulation temperature is the heat generated by load losses.¹

The overall average temperature of the windings could be an indication of the load on the transformer as well as the operation of the transformer cooling system. Fiber optic sensors can now detect subtle changes in temperature in the windings and report them to SCADA in real time. Winding hot spots could be an indication of insulation failure in a particular area and could be the result manufacturing defect, mechanical fault or partial discharge. Mechanical faults could be caused by seismic activity, transporting the unit and temporary overcurrent faults. Monitoring for and protecting from excessive winding temperature is vital to preserving the life of the transformer.

Monitoring the oil temperature in the transformer also provides an indication of winding hotspots and the performance of the oil cooling system. In turn, many parts of the cooling system can be monitored such as the oil level, oil flow, oil pumps, cooling fans, radiators, pressure and filters.

Online Dissolved Gas Analysis (DGA)

DGA analysis is a known and accepted method of evaluating transformer health. As insulation breaks down it generates gases inside the transformer and DGA is recognized as the most informative method for detecting those gases.³ Traditionally, DGA required the oil samples to be taken from the transformer and transported to a lab for analysis. The manual sampling was done on a periodic basis but was recommended to be done at least annually. Advances in sensors, analysis and communication technology now allow DGA to be done online, remotely and continuously. Online monitoring provides more accessible data that allows more accurate trending analysis and indication of sudden changes. Time-stamped data allows correlation of changes with electrical disturbances. Online DGA can detect not only the deterioration of insulation but also a probable cause and is an important input into a condition-based maintenance program.

Partial Discharge Monitoring

Partial discharge (PD) is an electrical discharge across an area of insulation. It can be caused by damage or manufacturing imperfections in the insulation and can cause the further, accelerated deterioration of the insulation over time once initiated. PD results in a localized release of energy that produces a number of effects: chemical and structural changes in the insulating material, electro-magnetic effects, heat and sound². Since PD releases energy in different forms, there are a number of different ways to detect its presence. Some of the methods are listed below:

1. If PD occurs in the insulation inside a transformer, the changes in the insulation will release chemicals into the insulating oil that can be detected using dissolved gas analysis.
2. The release of energy causes electromagnetic pulses in the UHF band to be released. The pulses can be filtered and detected with UHF sensors and with triangulation techniques can approximate the location of the source of the PD.
3. Sound is also produced in a specific frequency band as a result of PD. Similar to UHF detection, the sound can be filtered, and the source can be approximated using triangulation techniques.
4. Current flow through the insulation will cause resistive heating along the path that can be detected with infrared imaging cameras or other heat detection methods such as resistive temperature sensors.
5. Partial discharge can be detected in metal switchgear cabinets using Transient Earth Voltage, (TEV), measurements.

A combination of sensors that detects each of the previous physical indications of this phenomena, supported by algorithms of pattern recognition, can now provide early warning of the deterioration of a critical component in the substations, so a proper maintenance plan that optimizes resources can be set in place before a catastrophic event occurs.

Corona Discharge

Corona discharge is the electrical discharge usually through ionized air that is surrounding high voltage conductors. Corona can have several negative side effects such as power loss, audible noise, electromagnetic noise, generation of gases that can lead to insulation damage and conductor corrosion. It is advisable to detect and eliminate corona discharge to avoid losses and before damage to insulation or conductors is great enough to cause a flashover and further damage to the surrounding equipment and personnel. Corona discharge can be detected using ultrasound or ultraviolet light monitoring equipment.

1. Ultrasound - Corona discharge emits sound at a higher frequency than humans can hear. The monitoring equipment can detect the sound and modulate down to a frequency that humans can hear. Using a parabolic dish, the sound source can be pinpointed.
2. Ultraviolet radiation – emitted during corona discharge can be detected using UV cameras. The cameras detect the ultraviolet light and modulate into a band that can be seen by the human eye. This method can be used in daylight if filters are applied to block out the UV that is radiated from the sun that would interfere with the image. The UV cameras are very effective since they allow the operator to “see” exactly the points of corona discharge.



General Temperature Monitoring

Many processes in the substation generate heat as a by-product. This heat, or lack of heat, can be normal, but many times it is also an effective way to detect impending faults in the system. Most failures that involve partial discharge or the corona effects will show increasing temperatures as the fault becomes more severe due to the I²R factor. Increased temperature can also indicate different types of connection problems. Loose, dirty, corroded or over-tightened connections will have less surface contact area and will show increased temperature as a result. Joints and splices that are defective or that have degraded over time, will also heat up as a result. Switch contacts that do not engage fully or properly will have less surface area and will overheat and cause damage to the switch. Temperature can be measure in any of the following ways:

1. Resistive Temperature Detectors or RTDs are simple, inexpensive devices that measure temperature by changing resistance as applied temperature changes. The challenging part of implementing RTDs is the installation of the power and communication infrastructure that connects them to a real-time monitoring system.
2. Fibre Optic temperature measurement of transformer windings has some advantages over their electrical counterparts because of higher bandwidth, immunity to electromagnetic interference, multiplexing capability and ease of remote sensing.⁴ Fibre optic sensors are capable of finding a winding hotspot temperature more accurately than oil temperature measurement. Using fibre optic sensors enables the preventive measures to be deployed to reduce damage to winding insulation more reliably than other methods. The disadvantage is the fibre optic sensors must be installed during manufacturing or rebuild/repair of the transformer.
3. Infrared measurements are useful in that no direct attachment to a device or asset is required to read the temperature. Installation is, therefore, easier than installing RTDs on each point. An infrared camera can monitor many assets and points if set on an automated, preprogrammed scanning sequence. Care must be taken since many environmental conditions can affect the accuracy of the measurement including ambient temperature, humidity, wind and the emissivity of the object being measured. Generally, a comparative measurement between like components on different phases to locate problem areas is recommended to negate the environmental effects. →

New Applications

Applications for deploying sensing and monitoring technologies have typically been used in substations to monitor high-value assets such as transformers and breakers. Technology advances in sensors themselves, as well as in the network communications and processing of data, is making it more feasible to deploy sensors in other areas both inside and outside of the substation. Predictive analytics, health indices and scheduling tools make it more manageable to deal with the huge amounts of data that come from deployed sensors.

Underground system monitoring, for example, is an application that is gaining interest among utilities. Utilities have little or no visibility of the components in their underground system until an outage occurs. Most vaults are not monitored and have neither communications nor power sources available. In many areas, underground vaults are prone to flooding, which can lead to advanced aging of the system insulation, joints and splices. Providing the utility with online information on the health of the system will help them to find and fix faults before an unplanned outage occurs. With new, low-power sensors and communications technology, it is possible to harvest small amounts of power from the underground vault or to power the sensors from a long-life battery.

Summary

Sensors are continuously evolving; becoming more sophisticated, smaller, less expensive and with improved networking capabilities. These technological advances now allow remote and online gathering of data that used to be done manually. The flow of data coming from sensors in the field can now be used to predict problems with critical assets and processes and thus prevent unplanned outages. All these measurements that once required manual data gathering can now be obtained periodically and automatically by a monitoring system. The data can be analyzed to recognize patterns that can predict when a component must be replaced.

The decreasing cost and size of sensing and monitoring equipment mean the return on investment can be realized sooner with the advancing technology. Sensors can be used in a wider range of applications such as overhead lines and underground systems that previously were too expensive to monitor. As increasing numbers of sensors become deployed the electric power system will become more reliable, and utilities will be able to use maintenance resources more efficiently.

ABOUT THE AUTHORS:

Richard Harada has more than 20 years of experience in industrial networking communications and applications. Prior to joining Systems with Intelligence, Harada worked at RuggedCom and Siemens Canada, where he focused on product management and business development for industrial communications in the electric power market. Harada is an electronic engineering technologist and has a Bachelor of Science degree in computer science from York University in Toronto.



Edgar Sotter has a Bachelor of Science in electrical engineering from Universidad del Norte in Colombia and a doctorate degree in electronic engineering from Universidad Rovira I Virgili in Spain. Sotter's fields of expertise are in sensing and monitoring systems and computer networks. Sotter has past experience working at Siemens/RuggedCom, and he is currently managing the service and support team at Systems With Intelligence, where he has been for the past eight years.

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DISCOVERING THE TRUTH

ABOUT C&I POWER RELIABILITY

BY JERRY YAKEL

Reliability is sort of like an onion in that it has one overarching concept with many layers. Energy professionals are bombarded with thousands of “reliability” messages every day: industry indexes, customer-satisfaction reports, and even public-policy debates that also include resiliency in the discussion. It’s no wonder they often define reliability differently.

To cut through the noise, a global provider of equipment and services for electric power systems reached out directly to those that purchase power – utility customers. More specifically, these were Commercial & Industrial (C&I) customers who rely on electricity to provide their products or services and would be in the responsible position to act on their own to find reliable alternatives if there were service gaps.

For its research, the company partnered with Frost and Sullivan to publish the first “State of Commercial & Industrial Power Reliability” report. C&I facilities and energy managers were surveyed across the United States to gather their perspectives on power reliability and their future energy needs.

The respondents’ companies average \$4 billion in revenue and make up the majority of metered income for the utilities serving them. If the grid isn’t working for them, the company believed it’s important the industry understands their needs to help shape the grid of the future.

They sorted the respondents into five major sectors: Manufacturing, Data Centers, Healthcare, Small Franchise, and Education. With more than 250 respondents, they had a statistically significant sample that accurately portrayed the industry’s current conditions.

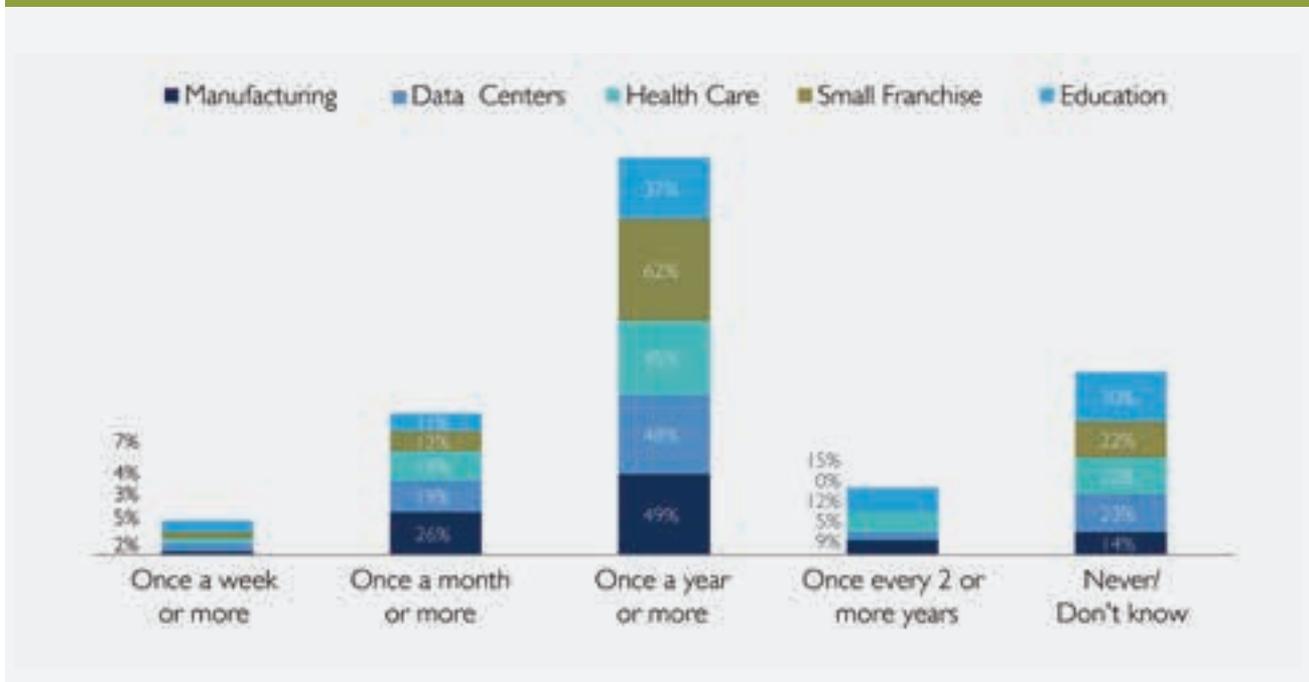
First, they looked to gauge the current experiences C&I customers have with power reliability. Nearly half of those surveyed experienced an outage at least once a year, with another 21 percent experiencing an outage at least once a month. When it came to duration, more than a quarter of participants said their outages lasted more than an hour. Another 41 percent experienced outages between five and 59 minutes. Further results can be seen in **Chart 1**.

An interesting takeaway was the frequency of outages. When average power users are at home, everyone tolerates outages differently. But most users would logically expect the industrial and medical complexes up the road from to have better service than their residential neighbors. For hospitals, for example, lives could depend on it.

Many of the C&I customers surveyed were typically in locations on the grid that result in better power service than the average residential area. Knowing this, experiencing an outage per month is interesting because one would expect these companies to be on a higher hierarchy of energy service. →



CHART 1
U.S. C&I OUTAGE FREQUENCY, BY INDUSTRY, 2017



As part of its research, the company also looked deeper into each participant's worst outage. Most of the worst outages these C&I customers experienced lasted an hour or more. Power outages affect business in many ways, and most involve unplanned expenses or other costs. Our survey found that 18 percent of C&I customers experienced a financial impact of \$100,000 or more from their worst power outage in 2017, and 19 percent sustained costs of \$50,000 or more.

While the survey report does not directly correlate costs to cause, typically, financial loss fell in line with other study results. Not every C&I customer surveyed reported a financial loss caused by an outage, but facilities can, and should, use this information to help justify action to limit future outages.

To this point, all the results could be verified and proven against utility records, but the company wanted to understand more of the frustration and satisfaction that the participants felt with their power provider's reliability.

When asked, 52 percent of respondents stated they were not fully satisfied with their power provider's reliability. This suggests respondents hold greater expectations for their providers. While Healthcare experienced significantly fewer and shorter outages than did other segments, the sector led the pack in dissatisfaction. This brings us back to those reliability anecdotes we have all heard. If a midsize manufacturer loses power, it will

likely result in a significant cost and potential delays in productivity.

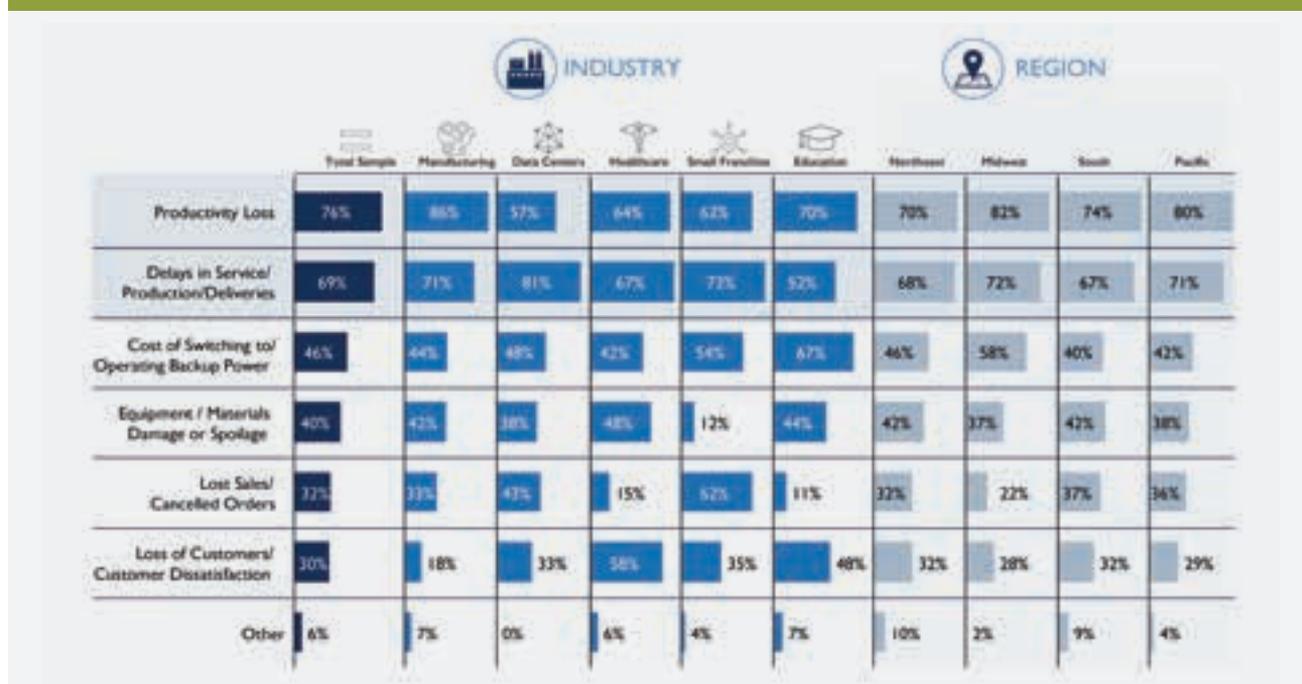
Further, the survey uncovered C&I customers' thoughts on key areas of improvement for their power providers in terms of reliability. Overwhelmingly, respondents said they would like their power providers to have a long-term view: greater reliability in poor weather, increased use of smart automation, lower prices, increased renewable generation, and an improved ability to address and fix problems quicker than the current standard dictates.

As C&I customers plan for future growth, they seek long-term partnerships with their power providers, and this requires their provider to grow with them and adapt to meet their power demands. Indeed, C&I customers have plans for long-term success, so they value power providers having clear, long-term strategies to update their infrastructure to address customer needs. As a result, when power providers invest in grid hardening and modernization, they are simultaneously solidifying customer retention and improving satisfaction.

On the flip side, the most common reason for C&I customer dissatisfaction with their energy provider was the financial impact to the business. Following that, the common rationale for dissatisfaction with reliability was too many outages with unpredictable timing. Storms aside, these customers require a high level of reliability to continue operations within their business.

CHART 2

U.S. C&I IMPACTS BECAUSE OF THE POWER OUTAGES, 2017



As noted earlier, C&I customers often face a financial impact stemming from each outage they experience, but that cost comes in many different forms. And it's not just loss of productivity or delays in shipping. If a C&I customer has back-up power, a cost is associated with moving from grid power to back-up power.

As every business can confirm, customer satisfaction is incredibly important. But when the lights go out, that satisfaction, especially in the Healthcare and Education sectors, is greatly affected. Additional impacts can be seen in **Chart 2**.

The results clearly show C&I customers are looking for improvements from their power providers, but some have taken increasing power reliability into their own hands. While most respondents believe power providers should be held responsible for providing reliable power, without interruption, more than half indicated a willingness to seek options to improve power reliability outside of what their current power provider offers, as shown in **Chart 3**.

Data Centers may be an obvious example, but they represent a good cross-check of the survey results. Data Center operators have long held that reliable power is a major requirement for their business model, and they often have held a belief that procuring their own power solutions is the best way to guarantee the reliability they require. Ironically, despite most respondents indicating

they don't want to pay premiums for their power, many have funds allocated for guaranteeing their power reliability on their own.

Nearly a quarter of respondents spend \$50,000 or more per year on improving their power reliability, independent from their power provider. While they don't want to pay a premium, that they are willing to allocate these funds suggests power reliability is a true priority concern for their businesses.

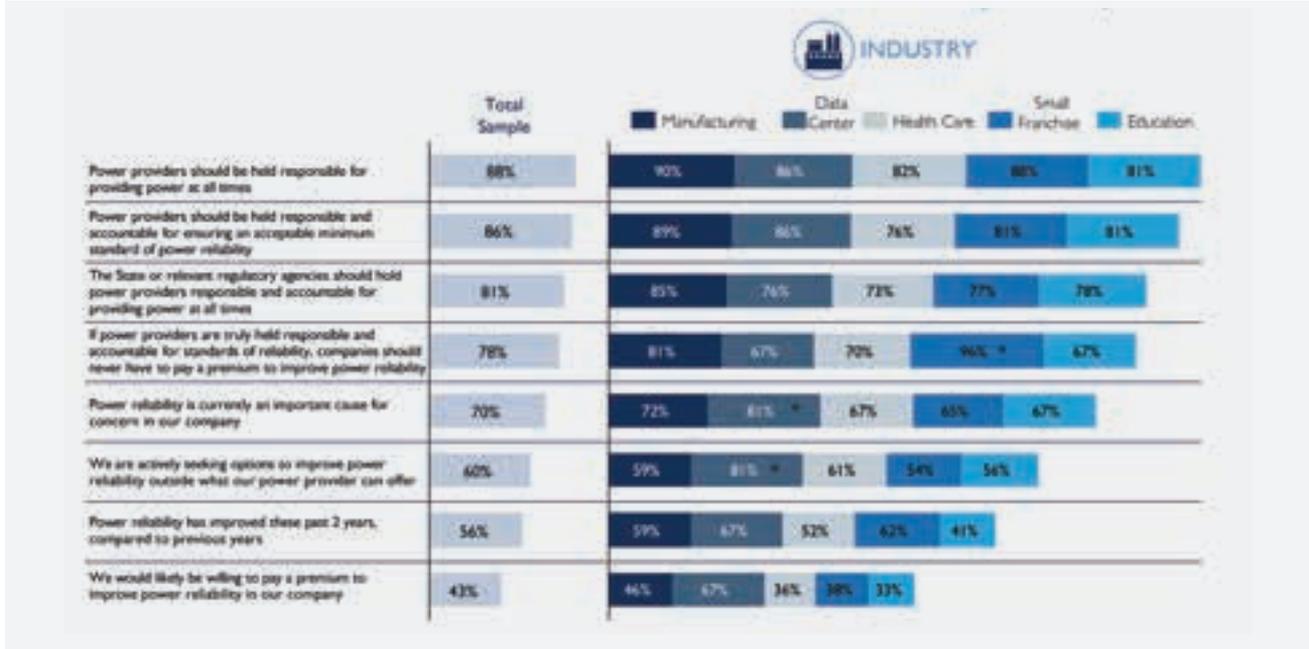
Knowing so many C&I customers value their reliability, it's not surprising 35 percent of respondents indicated they own their own alternative energy sources, such as on-site generation, or battery energy storage systems. Another 25 percent indicated they own these solutions and plan to expand on them to continue to meet their needs.

Not surprisingly, Data Center respondents on average, 57 percent said they own alternative energy sources, and 43 percent said they plan to expand on those solutions. But it is interesting to see majorities in other sectors trending towards the data center and health care sectors when it comes to proactive reliability strategies.

Should the local utility offer premium power? When asked, 62 percent of respondents said yes. But what is premium power? →

CHART 3

U.S. C&I CUSTOMER'S REVIEW ABOUT POWER PROVIDERS, BY INDUSTRY, 2017



- 72 percent of respondents agreed or somewhat agreed the bar for reliability should be raised to include loss of generation.
- 67 percent of respondents agreed or somewhat agreed the bar for reliability should be raised to include major weather events.
- 67 percent of respondents agreed or somewhat agreed the bar for reliability should be raised to include outages lasting less than five minutes, and 80 percent of those respondents agreed the bar should be raised further to include outages lasting less than one minute.

Why should the bar be raised? When asked, customers explained that outages are simply too disruptive and costly to their business, in line with earlier findings. The costs these customers incur from outages are large and growing.

Overall conclusions from the survey results point out that, although most C&I customers initially claimed to be content with their power reliability, their behaviors and concerns indicated otherwise—exposing that power reliability is a concern for their business. More importantly, 71 percent of the respondents own, or plan to develop, alternative energy sources to supplement their existing provider.

The study also uncovered that customer satisfaction is the acceptance of the status quo, when in reality, C&I customers need services with higher performance and future-proofing technologies.

Reliability demands aren't going away. In fact, they will likely increase as load complexity also rises. Today's grid can no longer meet our demand and reliability needs. With C&I customers voicing their concern, this may be the catalyst for change our grid so desperately needs.



ABOUT THE AUTHOR:

Jerry Yakel is the director of grid reliability at S&C Electric Company. A tenured commercial leader with broad experience in product management, strategy development, pricing, marketing communications and field sales, his passions are for people and power-system applications. Before joining S&C, Yakel held various leadership roles at Cooper Power Systems, including having global responsibility over various products that included both overvoltage and overcurrent equipment.

Full results from this report can be found at www.sand.com/CI.



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UTILITIES INCREASINGLY CONCERNED ABOUT SECURITY THREATS

NEED TO OUTTHINK THE ENEMY

BY RICHARD JONES

There is nary a day that passes that the risk of, or worse yet the perpetration of, a cyber-attack doesn't play out across the headlines. It is no surprise then that the recently released 2018 BRIDGE Index™ Survey on Grid Security revealed that utility operations professionals across IT and OT rated the changing cybersecurity threat landscape as having the biggest impact on operations. In fact, so great the concern, it ranked twice as high as all other major industry shakeups, including critical employee retirements, and nearly four times as high as the impact from the emergence of distributed energy resources.

The concern is well founded. Hackers are organized, well-funded and are not restricted in their thoughts or techniques; neither do they have to abide by laws. This gives them a significant advantage over the *good guys* who are trying to protect the real-time operations of our power grid while managing their 'day job'. In addition, new technologies, such as those driven by grid modernization, and the ever-changing regulations, make it even harder to stay ahead of the hackers.

With the odds seemingly stacked unfavorably against the utilities, inspiration may be found in the history books. Faced with defeating a superior enemy, many a leader has credited the ability to creatively out-think one's enemy as the turning point to their success. Leveraging this lesson, utilities must shift from a compliance first approach that places them in a reactive position. Instead, utilities must outthink their would-be enemies by developing a strategic approach that addresses both compliance and security on a holistic, ongoing basis.

History and Today

Recent developments show that bad actors, some with the support of foreign governments, continually seek new areas of access. While NERC-CIP standards are ever improving, unfortunately so too are the techniques of these would-be hackers whose goal is to undermine the grid. Considering this, it is not sufficient for utility organizations to continue as they have been. For example, compliance driven security measures such as providing employees training on how to secure laptops, thumb drives and physical facilities such as substations or control centers, will not alone ensure the safety of the national power grid. What's needed is an overarching flexible security strategy that encompasses a series of foundational steps evolving as needed to protect the real-time operations of the grid.

A foreshadowing of what's likely to happen if we remain on our current path, occurred in December 2015, in an overseas grid control center where operators watched helplessly as their cursors moved across their computer displays, clicking substations offline. They frantically struggled to retake control until being involuntarily logged out. By the time the cyber-attack ended, three stations were seized and over 225,000 electricity customers lost power. The hackers also shut down the three centers' uninterruptible power supplies (UPS), leaving even the operators themselves in the dark. →



threat

In March 15, 2018 headlines announced that Russia had infiltrated the U.S. Power Grid based on a joint report from FBI and Department of Homeland Security (DHS) report claiming Russian hackers had gained access to computers collecting sensitive data including passwords, logins, and information about energy generation.

The financial impact of similar kinds of attacks in the U.S., rose to \$5 billion in 2017 and the monthly attack rate in 2017 was 10 times the rate of attacks in 2016.

The U.S. power grid is one of the 16 critical infrastructure sectors monitored by the DHS as essential to our nation's well-being, and is naturally considered a high-value target to those that seek to harm the U.S. According to an IBM report (Year in Review: How Did the Cyber Threat Landscape Change in 2017), "dozens of U.S. power companies were compromised in 2017, with some attacks causing shutdowns and disruption of distribution. Attackers took over systems that controlled valves, pipes and conveyor belts in what may have been experimental activities or mere displays of what they could accomplish with a full-scale attack."

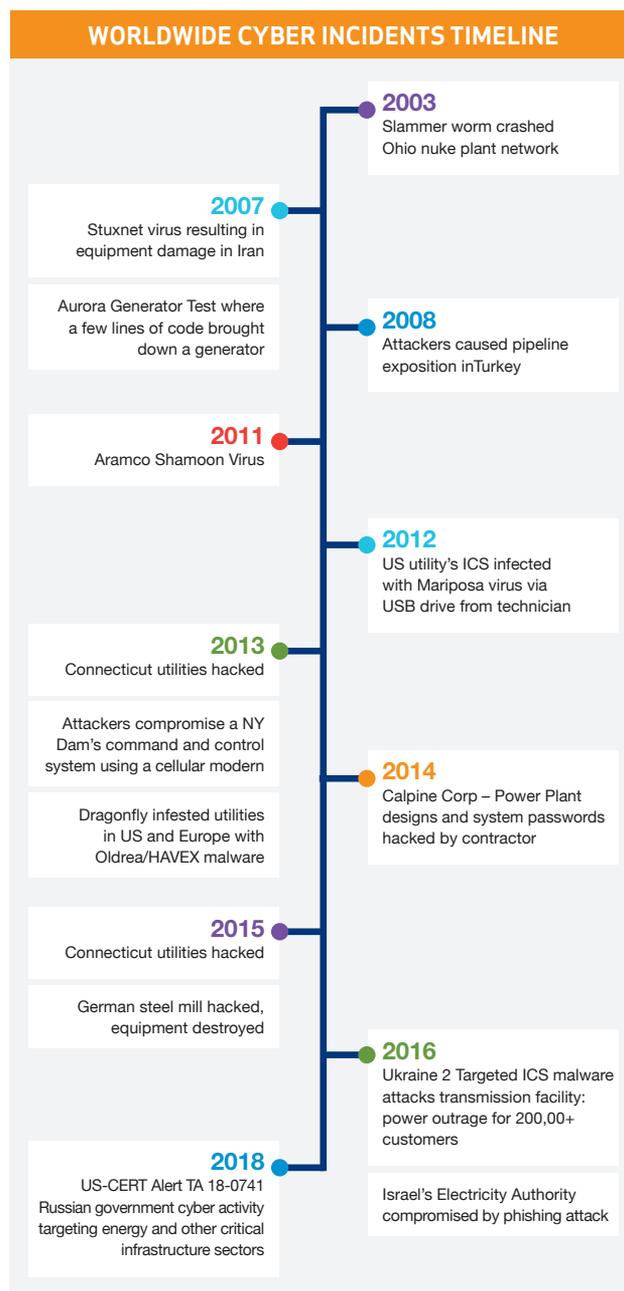
You Can't Afford to Wait. You Can't Afford to Act, Either

The nature of the utility business is continually evolving. Distributed Generation at the Grid Edge is becoming the norm as well as development of distributed energy resource management systems that connect consumers into a utility's grid management system. While there are many benefits to these changes, it also broadens the attack surface for threats to the power grid.

Almost five years ago, Louise Downing and James Polson warned in the article, "Hackers Find Open Back Door to Power Grid with Renewables," published by Bloomberg Business, that "the communication networks and software that link green energy sources to the grid (as well as the electronic meters) that send real time power usage to consumers and utilities, are providing new back-door entry paths for computer hackers to raise havoc with the grid."

There are many governing bodies and even more rules and regulations that are trying to help address these types of risks. And while this has helped, the bar is not being set high enough or measures deployed fast enough. This is complicated by the fact that for the majority of those who work in utility companies, their time available for strategic security and compliance thinking or actions is very limited. Even those whose primary responsibilities are security and compliance find themselves in tactical response mode more than 90% of their time.

Given the challenges and the limited resources to solve this problem, is it hopeless? Simply put, no! While there is no silver bullet to providing security, there are concrete strategies and actions that can be taken by utility organizations to reduce the risk. It is critical to note that this isn't a discreet, one-time task. In the same manner as utilities continue to address safety issues, security must be managed on a continuum basis. In fact, security should be a series of flexing strategies with adaptive focus and ongoing tasks that impact every employee, supplier, process and technology. This is the only true design to reduce the risk of compromise for the power grid.



Credit: BRIDGE Energy Group

Why Change Now?

In summary, there are four primary drivers of the need to act now:

- 1. Exponentially more risks** - Collectively as an industry, we have broadened the cyber-attack surface all the way to the home. The intelligent electronic devices (IEDs) inside the customer dwelling are, in many cases, not under the direct control of the utility. And as the grid's edge becomes increasingly populated with these IEDs such as inverters, grid controllers, battery control devices and more, the types, forms and numbers of vulnerabilities utilities are dealing with will continue to multiply.
- 2. Increasingly dynamic threats** - As an industry, we are increasingly aware of advances in the development of malware targeted at our SCADA / EMS (and other ICS) systems and perhaps even more frightening, is the vulnerability that the supply-chain of these systems represents. This was highlighted by the January 2018 DHS announcement describing Russian government cyber hackers' activities using the supply-chain vector to conduct network reconnaissance, move laterally and then collect information about Industrial Control Systems (ICS).
- 3. Compliance first focus gives hackers the advantage** - The utilities' response has been to solve the immediate problems. Point-solutions and reactive activities abound. Compliance requirements are addressed with heavy employee burdens driven by repetitive, yet knowledge-based tasks. Security threats and alerts are often met with stop-gap measures and solutions. When strategic capabilities are deployed, the number of stakeholders and the incredibly federated models for disbursement of accountability, resulting in a lack of effectiveness and efficiencies and increased employee burden.
- 4. Increasing security and compliance costs** - According to the recent 2018 Grid Security Survey, more than 47 percent of the respondents have a major compliance project planned in the next 24 Months. Clearly, CIP Compliance expenditures continue to increase. After more than 10 years of CIP Compliance, it is surprising that utilities have not yet fully assimilated compliance concepts into their cybersecurity programs to reduce costs and exposure to change. Utilities routinely declare that they cannot afford CIP+, but they can and should adopt strategic cybersecurity policies that drive sustainable compliance solutions.

To Win Long-Term, More Strategic Thinking is Needed

The 2018 Grid Security Survey also revealed that utilities are still concerned about the lack of IT/OT alignment, compliance burdens, cybersecurity and the learning curve for IT. These concerns take on increasing importance and must be addressed for utilities to take full advantage of the digital grid. A strategic security and compliance approach must be taken to address these concerns and proactively address risk and cost.

Utility leaders must take the following actions:

- 1. Integrate – Assimilate compliance concepts and requirements into your security program making security and thus – compliance – a strategic element of business.** You already have “Safety Moments.” It is time to introduce “Security Moments” as well. This will raise awareness, demonstrate importance and immediately drive the enterprise into a more proactive mode in all aspects of operations and planning, including budgets, resource allocation and accountability.
- 2. Prioritize – Manage both security and associated compliance activities using a risk perspective.** The Grid Security Survey results indicated that more than 30 percent of respondents did not report on real-time operations risk or do it on an ad-hoc basis. However, a risk register using a threat risk assessment is needed to give adequate insight into the true risk to drive prioritization. You should establish and leverage objective measures, on-the-ground personnel and security expertise, to gain insight into the effectiveness of your work. Your program should have the ability to flex, repurpose, reorganize and refocus, based on changing priorities.
- 3. Drive Continuity – As part of your overarching security strategy, effective and continuous action for compliance is critical.** It must also be informed through an approach that provides a holistic status and understanding of the multitude of interconnected activities required. With limited resources to tap and budget demands at an all-time high, this strategic approach requires a creative solution that considers the impact on your people, makes use of your established processes and in-place technologies, reduces audit preparation time and drives proactive, not reactive actions. In compliance language, this means not only understanding what compliance state you are in today but also having a certain level of assurance as to whether you will be compliant tomorrow or are ready for the audit next year. →

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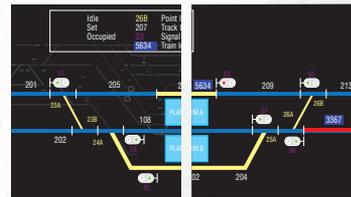


Before

After

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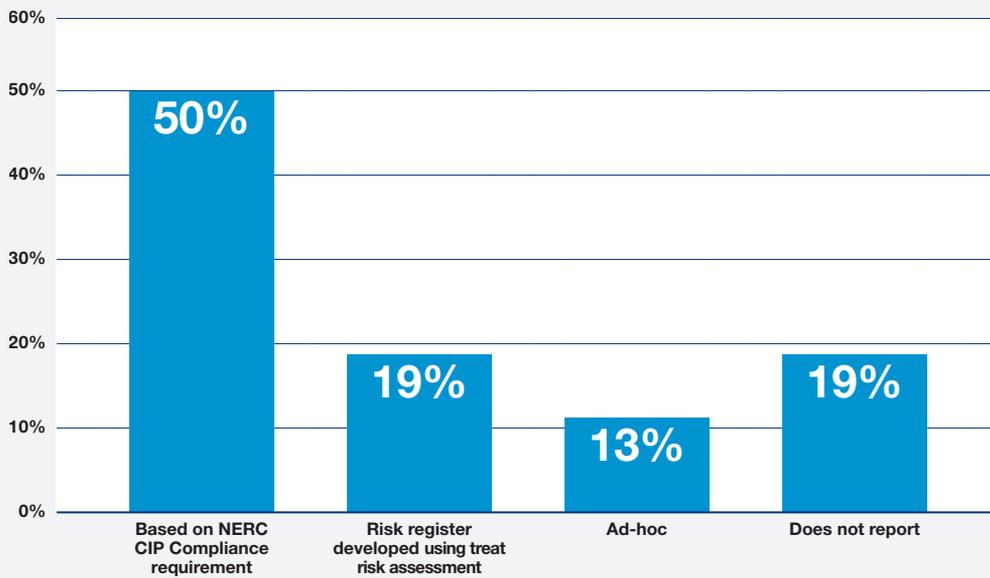
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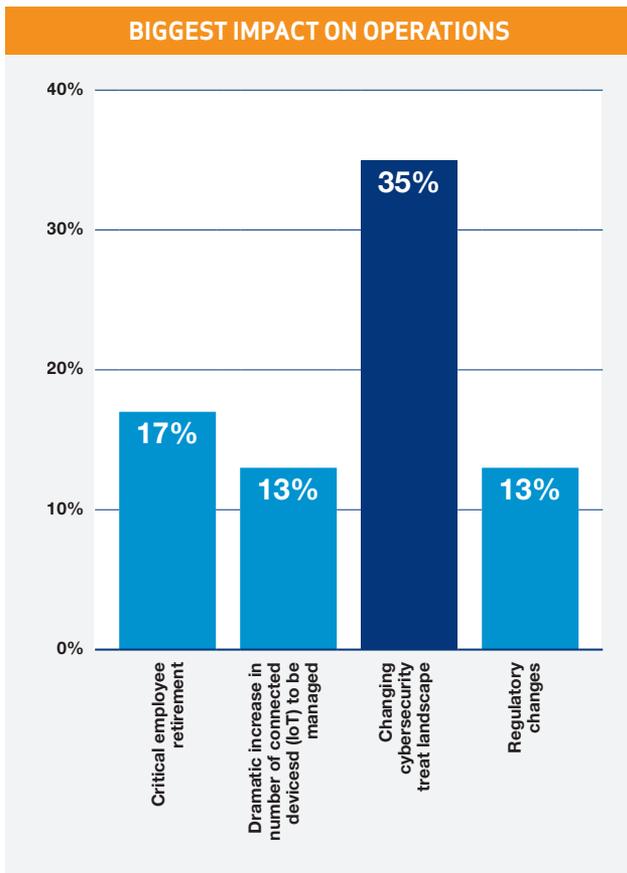
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Conclusion

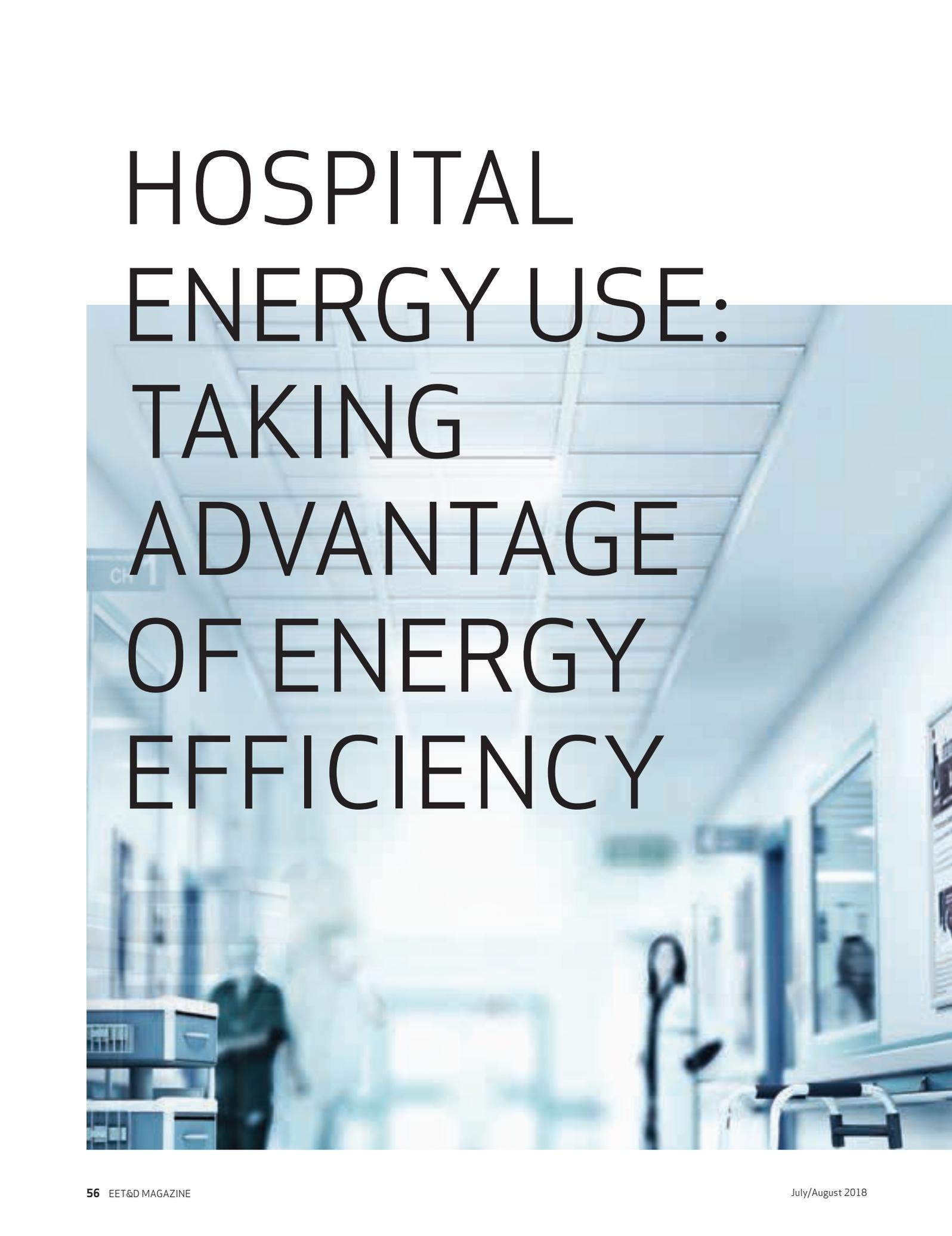
Last month’s announcement by NERC of their findings of cyber breach against a WECC utility and the subsequent assessment of a \$2.7 million fine again highlights what is on the line for utilities, customers, and shareholders. As consumer expectations evolve and advanced grid management schemes become a reality, operating the U.S. power grid in a secure and compliant manner means considering associated Internet-of-Things (IoT) connectivity and other open communication networks. It doesn’t take much imagination to understand that this is increasing the potential for a cyber-attack that might easily cripple a broad swath of the U.S. economy.

While regulations will continue to evolve, raising the preparedness of the industry as a whole should be the focus. As such, these regulations cannot match the pace of the increasing sophistication of the threats and the focus of the bad-guys. Utilities cannot rely on compliance with standards as their security strategy. Cybersecurity strategies and their associated compliance requirements are critical business elements, and not just an IT issue. There is no mystique to good security! Through simplifying programs, prioritizing actions based on risk and internalizing the need for continuous vigilance and actions, we can and will meet the security challenges of the future.

ABOUT THE AUTHOR:

Richard Jones, VP Grid Security at BRIDGE Energy Group, is a recognized thought leader in Cybersecurity, NERC CIP and general utility regulatory compliance and reporting with over 25 years of energy and utility industry experience providing business, technology and management consulting based services. Prior to joining BRIDGE, Richard held a number of security leadership positions with the big 5 and industry focused consulting firms.





HOSPITAL ENERGY USE: TAKING ADVANTAGE OF ENERGY EFFICIENCY



PETER FAIRBANKS

According to the U.S. Department of Energy, healthcare is one of the top five energy-consuming building categories and accounts for nine percent of energy use in commercial buildings. With utility bills making up an average of 1.4 percent of a hospital's operating revenue, hospitals in the U.S spend about \$8.3 billion total on energy costs each year. The impact of these energy costs on an individual hospital is huge. For example, a 200,000 square foot, 50-bed facility spends about \$13,600 per bed on energy costs, equaling about \$680,000 each year.

Electricity is the major energy cost for all commercial buildings and lighting is the largest single use of electricity. With this amount of money being spent on energy costs in general, and electricity specifically, it's no surprise that hospital owners and managers target lighting when looking to improve energy efficiency and reduce costs. Healthcare is a unique business model, as the amount providers can charge patients is controlled by government regulations and insurance company reimbursement rates. They cannot simply raise their rates as expenses increase, meaning that rising or unchecked energy costs can threaten the financial health of hospitals or even create a situation where patient care is compromised by budgetary constraints.

In addition to the direct financial savings, improving existing lighting benefits the overall hospital environment – such as improving the mood of patients and creating a more comfortable and safer environment for staff. The money that is directly saved from reduced energy costs is a resource that can be diverted back into the institution for investments in improving patient care or updating other areas of the campus or facilities. →

Understanding Hospital Energy Use

In addition to the cost of energy, many healthcare facilities simply do not operate as efficiently as possible because of the different systems in use. Because many hospitals and healthcare campuses are the result of buildings and additions made over the span of many years, quite often systems and resources are outdated and inefficient and not integrated with each other. As some areas are updated, with a new HVAC system or new and more energy-efficient lighting, for example, others remain outdated and use energy inefficiently. Facilities managers then must navigate multiple types of equipment and multiple building management systems to optimize operations.

To overcome this challenge and mitigate the financial risk, hospitals are looking to outside consultants to help them navigate all their options. The initial step for any project designed to increase energy efficiency is an energy audit. This gives the hospital a clear picture of existing systems, how they are used, how they do or don't work together, and how the always-on nature of the facilities impacts energy use. Once there is a baseline understanding of systems and a picture of energy use, hospitals can then look to solutions like replacing outdated equipment, integrating systems like HVAC, and upgrading the building management and control systems.

While the path forward may be clear after an energy audit and there are great benefits to upgrading energy systems and retrofitting lighting fixtures, making these updates is not a simple fix for hospitals and other healthcare facilities. They present unique challenges to anyone wanting to accomplish a campus- or system-wide update – the buildings are continuously occupied, security of facilities and patient confidentiality is a critical concern, and there are sterilization and cleanliness protocols that must be adhered to.

Challenges Working with Hospital Facilities

It can be difficult for owners and managers to get approval for this kind of project, due to the fear of disrupting operations. Hospitals are a unique environment for anyone, internal staff or outside consultants, to make large-scale system changes or energy efficiency upgrades. In addition, hospitals are bound by the Health Insurance Portability and Accountability Act of 1996 (HIPAA), which ensures the privacy and confidentiality of patient information. Any contractors working in a hospital environment, especially in patient areas, must comply with this law. So any energy efficiency updates must be done with the utmost attention to protecting patients and their privacy and without compromising care. There are three major challenges that hospitals face for projects like these:

- 24/7 environment: Because hospitals cannot shut down, any hospital-wide projects must minimize the impact on patients and staff and ensure constant uptime for electricity and all hospital systems.
- Health and contamination concerns: Anyone working on hospital-wide projects, especially those that require they work in patient rooms or sensitive areas like operating rooms, must be healthy and workers must take special precautions to protect sensitive spaces.
- Non-integrated facilities: Many hospitals are built over time and with multiple buildings and systems that are not integrated, creating a mishmash of fixtures, equipment, management systems, and documentation.

Best Practices for Hospital Energy Upgrades

With the proper attention to details, it is possible for energy efficiency projects, like a lighting retrofit, to be conducted without threatening the power supply or compromising patient care. When energy consultants follow best practices for the industry, they can achieve success.



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Scheduling and managing the site.

- To address the issue of around the clock operations, anyone working on an energy efficiency project in a hospital or healthcare facility must create a detailed schedule. This includes working on upgrades only in areas when it will not disrupt daily activities. For example, no one is allowed to do this type of infrastructure work in occupied patient rooms, and any work in unoccupied rooms must be coordinated with the nursing staff and the hospital's facilities team.
- Contractors must schedule time to do the work in operating rooms and other sensitive areas, like laboratories, which will need to be cleaned and sterilized after the work is complete.
- In addition to scheduling, managing the worksite is more critical due to cleanliness and infection control requirements in healthcare facilities. This requires being creative about finding staging areas and space to store materials and coordinating with staff to ensure that the materials and work do not compromise patient health and care.

Health and contamination practices.

- Working in hospitals and other healthcare facilities requires protections and practices outside the norm for most energy efficiency projects. To make sure that the project is as safe as possible, energy efficiency contractors must work closely with the facility's infection control department and follow their recommendations about how to ensure that the workers and materials do not contaminate sensitive areas or put patients at risk. This includes one simple step—ensuring that workers have received their flu shots, so they do not infect patients.

- These protections also include extra precautions such as using containment carts to collect dust while working. This can be time-consuming and costly, but it is the only way to ensure that dust from the project does not spread to patient rooms or contaminate other sensitive areas in the facility.

Integrating systems.

At almost every hospital, large-scale projects across the campus will encounter systems, equipment, and fixtures that are dissimilar and not integrated with each other. Any project that touches on these systems is an opportunity to install a more uniform and compatible set of equipment and fixtures, integrate the existing and new systems and develop common controls to increase energy efficiency and make it easier for the facilities team to operate more effectively.

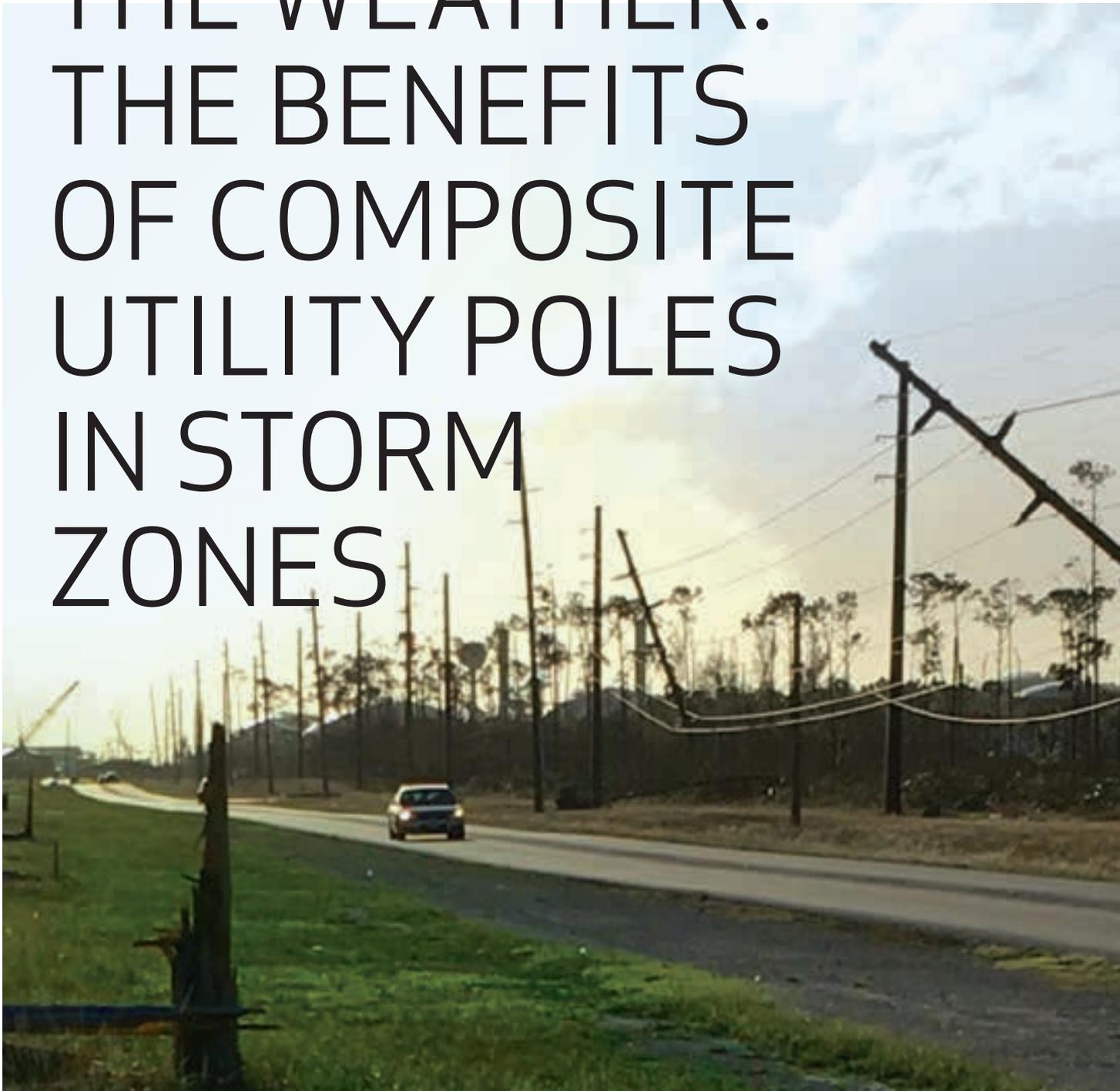
Expert energy efficiency consultants know how to address these unique challenges in healthcare environments. They also know how to choose the project equipment and lighting fixtures for a lighting upgrade job – such as ensuring proper lumen output, controls, and color temperature for each location and type of room – as well as knowing how to identify other opportunities to improve energy efficiency, such as upgrading HVAC systems and cooling and refrigeration equipment.

As non-profit institutions, most hospitals cannot take advantage of tax incentives for energy efficiency projects. However, they are often eligible for rebates or special incentives from their local utility provider or their state or local government. Energy efficiency consultants know how to find these incentives and will work to ensure that healthcare facilities optimize their energy use and costs in every way possible. The results of a well-implemented energy efficiency project are financial savings for institutions, improved and safer building environments, and more comfortable facilities for patients and staff.

ABOUT THE AUTHOR:

Peter Fairbanks has more than 30 years of engineering and management experience related to mechanical system design and energy conservation project development. Prior to forming Fairbanks Energy, he founded Bluestone Energy Services, which successfully grew to a company of 30 engineers and project managers by the time he sold it in 2011. Fairbanks has held positions with HEC Energy as regional technical director, provided combined heat and power plant analysis and design at Trimont Engineering, and for 14 years filled various engineering roles at United Engineers and Stone & Webster, large power plant and cogeneration plant design firms. Fairbanks has his Professional Engineer's Registration in MA and CT and is a member of the following professional societies: American Society of Mechanical Engineers, American Society of Heating, Refrigeration, and Air Conditioning Engineering and the Association of Energy Engineers. He also is featured in McGraw-Hill's "Standard Handbook of Plant Engineering" Energy Conservation Chapter. Fairbanks earned his B.S. in mechanical engineering at the University of Massachusetts, Amherst.

WEATHERING THE WEATHER: THE BENEFITS OF COMPOSITE UTILITY POLES IN STORM ZONES





DAN COUGHLIN

Nearly 175 years after America's first wooden utility poles were installed to carry telegraph wires from Washington, D.C. to Baltimore, they have become a classic element of the American landscape. Today, an estimated 185 million utility poles carry telephone and electrical lines along the nation's highways and byways, powering homes and businesses both urban and rural.

However, an average of 2.5 million of the roughly 130 million poles made from wood need to be replaced each year due to loss from age, rot, decay and, in the most high-impact instances, weather events.

And when it comes to storm zones, which endure an estimated \$18-33 billion in damage annually, the economic impact of downed poles is far greater than just the cost of infrastructure replacement. Wide-scale grid failures impede the movement of manufactured goods, leading to residual losses of critical food and pharmaceuticals.

These outages immediately halt economic activity through the loss of mass transit, traffic lights, electronic tolling stations, and retail cash registers. They also raise recovery costs related to mobilization, backup power provision, and temporary housing. To make matters worse, the frequency and costs of storms are on the rise.

According to a 2013 White House Report, *Economic Benefits of Increasing Electric Grid Resilience to Weather Outages*, storms in recent years have resulted in more widespread damage and a higher cost of recovery (averaging \$40-75 billion per year) than those of the 1900s. Looking at power outages specifically, a recent report from the Lawrence Berkeley National Laboratory, *Assessing Changes in Reliability of U.S. Electric Power System*, found that customers have experienced a 260 percent increase in outage duration from major weather events over the last 15 years. →

LIFE CYCLE COST ANALYSIS

	Wood Utility Pole	FRP Composite Utility Pole
Life Expectancy	30 years	60 years
Purchase Price	\$233	\$708
Installation Cost <i>*varies by project</i>	\$1,000	\$500
Maintenance Cost	\$210	\$0
Disposal Cost <i>*\$30/ton tipping fee</i>	\$15	\$5
Life Cycle Cost Simple <i>*60 years</i>	\$2,916	\$1,213
Life Cycle Cost Discounted <i>*60 years, 5% discount</i>	\$1,652	\$1,208

Source: "Cycle Assessment of Composite vs. Ceramic Transmission Insulator (Part 1) And of Composite vs. Wood Utility Pole (Part 2)", Daniel Mays, John Xu, Ryan Powanda, Sara Timtim, Stanford, 2009

Recent natural disasters have vindicated these trends. Hurricane Harvey, for example, destroyed 5,000 wooden utility poles and left 250,000+ people powerless for numerous days in August 2017, inflicting a record-setting \$125 billion in damage. One month later, Hurricane Maria brought down 80 percent of Puerto Rico's wooden poles and caused an island-wide power and communication blackout that lasted for weeks.

Given these facts and figures, it's no surprise that some regions that regularly experience storms or other weather events have begun to take proactive action to prevent future damage. The California Public Utilities Commission, for example, conducted a study of the failure rate of the state's entire pole population in response to recurring wind storms. After estimating that nearly 19 percent of its 1.4 million poles were prone to failure, the Commission announced that it would accelerate inspection to 250,000 poles per year and would replace 35,000 poles per year – an unprecedented action that suggests proactive pole replacement will accelerate in the future.

The all-important question is what type of poles federal, state, and local utilities should choose to replace the wooden poles whose eventual, or sudden, failure is inevitable.

And when it comes to choosing the most storm-resistant poles, an increasingly attractive – and, if performance is an indicator, well-founded – answer is composite poles: poles made from two or more materials that, when combined, produce a stronger and better material that offer lighter weight, corrosion resistance, versatility, and overall cost-effectiveness. A litany of recent evidence has exhibited the benefits of these qualities in storm zones across the continent. The Comisión Federal de Electricidad (CFE) – Mexico's national utility, for example, decided to replace every fifth pole with a composite pole in the Baja Peninsula in October 2012 to harden its distribution lines. When Hurricane Odile and its 125-mph winds struck in September 2014, these fortified lines were the only ones left standing on the entire peninsula. Similarly, the 450 composite poles installed in the Grand Bahama in 2009 have withstood major hurricanes including Irene and Matthew, which took down 2,700 wood poles in 2016. There are plenty of stateside statistics as well, as Hurricane Matthew and the 100-Year Ice Storm destroyed 2,700 and 1,600 wooden poles, respectively, in October 2016 and January 2009, while the composite poles in Florida and Texas were left unscathed.



But the reasons for installing composites, either proactively or post-storm, goes far beyond these specific anecdotal instances. For starters, the utility industry's acceptance of fiber reinforced polymer (FRP) composites is growing each year. The Institute of Electrical and Electronics Engineers (IEEE), which publishes the National Electrical Safety Code, now officially recognizes FRP poles and crossarms in its utility industry codes. The American Society of Civil Engineers (ASCE) 111 Design Guide, Reliability Based Design of Utility Structures, now includes considerations for composite pole structures; and an ASCE committee is working on a revised Manual of Practice for FRP Utility Structures. On the federal side, USDA's Rural Utilities Service has recently developed

an approval document for co-op borrowers wishing to purchase composite distribution poles, and FEMA has officially approved them for storm rebuild in the U.S. Virgin Islands, another area severely impacted by wooden pole failure.

This wide acceptance is due to composites' strength and durability when compared to wood poles. It's important to note wood poles were made from long-standing, dense, resilient hardwoods when first introduced in the 19th century but are now made from less robust, shorter-lived timbers harvested from rapid-growth tree farms. Empirical testing illustrates this stark difference: one recent study found that wood beams could withstand a 3,109 lb ultimate load versus a 4,436 lb load for composite beams, while observation of in-ground poles has demonstrated that composite poles last approximately twice as long (60-80 years vs. 20-40 years) due to their resistance to rot, fire, corrosion, woodpeckers, and bugs.

Environmentally speaking, composite poles are friendlier to mother nature than their wooden counterparts. Unlike wood poles, which require chemical coatings, composite poles are chemically neutral and environmentally inert. This means they pose no risk of leaching chemicals into drinking water or sensitive habitats such as coastal areas, wetlands, and bogs. Composites poles are much lighter and easier to install, particularly in remote areas. Also, FRP poles require little or no maintenance, further reducing the risk of accident or injury.

This reduced need for maintenance, of course, contributes to the benefit that federal, state, and local utilities care the most about when making long-term decisions: reduced costs. As the Life Cycle Cost Analysis shows, composite poles' life expectancy, installation, and maintenance costs more than make up for their higher purchase price when compared to wood poles. And when you add these numbers to costs of storm zone damage due to the failure of wood poles, both in the form of poles requiring replacement and the economic disruption due to power and communication loss, the case for composite poles has never been clearer.

ABOUT THE AUTHOR:

Dan Coughlin is the vice president of composites market development for the American Composites Manufacturers Association. With more than 30 years of manufacturing and R&D experience, Coughlin received a master's degree in chemical engineering from the University of Maine and started his career with GE working in thermoplastics and silicones. As a consultant, Coughlin has worked with Fortune 500 companies across several industries to develop new products and enter new markets. He began working for ACMA in 2012, taking on the market development role in 2014 to expand the use of composite products in the U.S. and around the world. The U.S. composites industry is made up of approximately 3,000 companies in all 50 states. ACMA advocates for the interests of the composites community, including energy and environmental, health, and safety, as well as expanded trade and workforce development.

FERC REQUIRES GREATER TRANSPARENCY REGARDING RTO/ISO UPLIFT CHARGES





GLENN S. BENSON

FERC REQUIRES GREATER TRANSPARENCY REGARDING RTO/ISO UPLIFT CHARGES TO ENHANCE EFFICIENCY OF ORGANIZED MARKETS

Participants in organized wholesale power markets across the United States have long complained about the level of “uplift costs” passed through to them and the processes by which such costs are incurred and allocated. Uplift costs are incurred when a regional transmission organization (RTO) or independent system operator (ISO) has to take out-of-market actions (i.e., operator-initiated commitments of resources priced too high to clear the market) to ensure system needs are met as a result of the market software’s inability to resolve operational challenges, such as unplanned transmission and generation outages, or to maintain adequate voltage throughout the system. Uplift costs are charged to market participants in various ways, including on the basis of load ratio share and deviations from day-ahead schedules.

To at least begin addressing market participant concerns about uplift, the Federal Energy Regulatory Commission (FERC) issued a new rulemaking (Order 844) on April 19, 2018. Order 844 will require RTOs and ISOs to begin publishing, on a monthly basis, (1) a Zonal Uplift Report showing total uplift payments for each transmission zone, broken out by day and uplift category; (2) a Resource-Specific Uplift Report showing total uplift payments for each resource; and (3) an Operator-Initiated Commitment Report showing, for each operator-initiated commitment, the size of the commitment, transmission zone, commitment reason and commitment start time. →

Additionally, each RTO and ISO will be required to file tariff sheets showing the transmission constraint penalty factors used in its market software, the circumstances under which those factors can set locational marginal prices and any process by which those penalty factors can be changed. FERC's stated rationale for these requirements is that increased transparency will help market participants tailor their investments in facilities and equipment with the needs of the system, as well as better understand and suggest changes to RTO/ISO uplift and commitment practices, and that such actions might ultimately help shift some of the costs of serving load out of uplift and into market prices, resulting in a more efficient market and lower prices for consumers. As a legal matter, FERC's rulemaking is based on a determination that current prices in RTO/ISO-administered markets are unjust and unreasonable because they do not reflect the efficiencies that can be achieved from the increased transparency FERC is requiring.

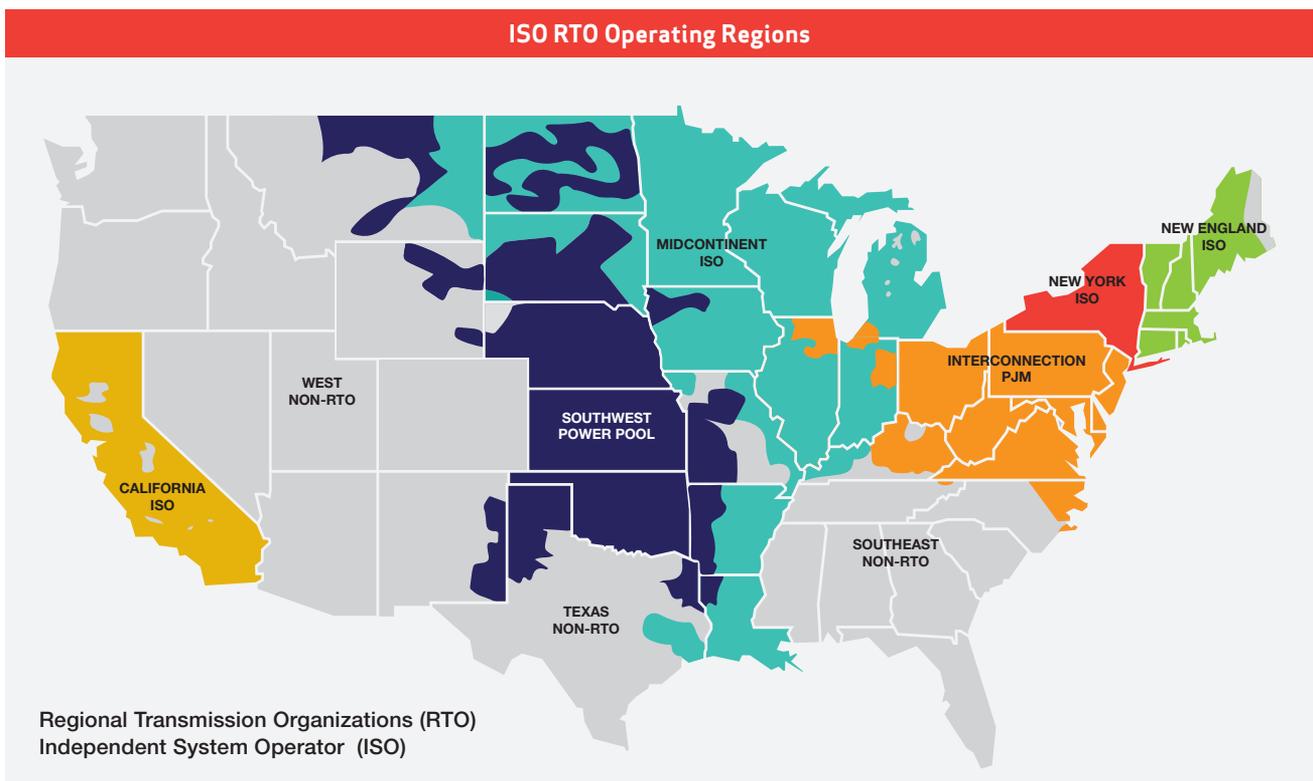
Zonal Uplift Report

The Zonal Uplift Report will provide more granular information about the location, timing and causes of uplift than is currently given to market participants in most of the organized markets. FERC has determined that such

information should facilitate more informed stakeholder discussions in RTO/ISO planning processes, improve the ability of market participants to raise concerns regarding RTO/ISO uplift payments, and promote cost-effective solutions to system needs by allowing market participants to make more informed investment decisions.

The transmission zones used in Zonal Uplift Reports will need to correspond with geographic areas that are used for the local allocation of charges, such as a load zone that is used to settle charges for energy. Understanding that a particular category of uplift is concentrated in a limited area may provide information to market participants about the nature of the reliability need or may inform discussions about uplift cost allocation, which could lead to more efficient market outcomes in the future.

To safeguard each resource's commercially sensitive energy offer or cost information, RTOs and ISOs will be permitted to aggregate transmission zones having fewer than four resources with one or more neighboring transmission zones until each aggregated zone has at least four resources. This report must be posted in machine-readable format on a publicly accessible portion of the RTO's/ISO's website within 20 calendar days of the end of each month.



Source: The Sustainable FERC Project

Resource-Specific Uplift Report

The Resource-Specific Uplift Report is intended to complement the Zonal Uplift Report by providing more granular technology-type and geographic information, allowing market participants to identify potential system needs at specific locations that may not otherwise be revealed through price signals. FERC found that the combination of the Zonal Uplift Report and the Resource-Specific Uplift Report can improve market efficiency by providing information signaling where market participants should site new resources, transmission facilities or demand response. FERC further determined that knowing, for example, that uplift is concentrated in combustion turbines rather than steam units could provide insights into the nature of the system need that is being addressed through actions that led to uplift.

The Resource-Specific Uplift Report will contain the resource name and total amount of uplift paid in dollars aggregated across the month to each resource that received uplift payments. To reduce the likelihood that the information could be used to harm competition or individual market participants, RTOs and ISOs are not required to post their Resource-Specific Uplift Reports until the 90th calendar day after the end of each month. FERC found that any inferred information regarding a resource's offers or costs becomes less likely to be used to harm competition or individual market participants with the passage of time because fuel prices and other market conditions change.

FERC noted that with the 90-day lag, the report will be released in a season different from that in which the uplift was incurred, increasing the likelihood that transient issues will be resolved, and thus decreasing the likelihood that any deduced resource-specific cost or offer data can be used to harm the competition or individual market participants.

Operator-Initiated Commitment Report

The Operator-Initiated Commitment Report will provide granular information about the location, timing, causes and size of operator-initiated commitments. Specifically, this report must list the commitment size, transmission zone, commitment reason and commitment start time of each operator-initiated commitment, whether manual or automated. FERC determined that such information would allow stakeholders to better understand the connections between system needs and operator actions and to make investments in facilities and equipment, where most needed by the system, thus potentially improving market efficiency.

An operator-initiated commitment is defined as a commitment made after the day-ahead market, for a reason other than minimizing the total production costs of serving load. Market software may make commitments to meet needs for additional supply due to changing market conditions or variations from forecast after the day-ahead market. These commitments reflect the next marginal supply to meet load and minimize total production costs and are thus exempt from this reporting requirement. On the other hand, some constraints cannot be included in market software, and as a result, RTOs/ISOs are often required to make commitments to address reliability considerations that have not been modeled. Because these considerations are not included in the software, they may not minimize total production costs and therefore must be reported in the Operator-Initiated Commitment Report.

Commitment reasons must include system-wide capacity, constraint management and voltage support. FERC dropped its proposed requirement that such report be posted within four hours after an operator-initiated commitment, finding that such a timeline might place an unnecessary burden on some RTOs/ISOs. Instead, the rulemaking requires that this report be posted in machine-readable format on a publicly accessible portion of the RTO's/ISO's website as soon as practicable and no later than 30 calendar days after the end of each month. However, FERC added the requirement that the report include the commitment start time in order to enable stakeholders to understand system conditions surrounding the commitment.

Each RTO/ISO is required to include in its tariff the type of zone that it proposes to use in its Operator-Initiated Commitment Report, explain how the chosen type of zone meets the definition of transmission zone adopted in the rulemaking, and provide justification for any differences between the sets of zones used for this report and the Zonal Uplift Report. The rulemaking does not require RTOs/ISOs to identify resource names or specific constraints in the Operator-Initiated Commitment Report. In addition, each RTO/ISO is permitted to propose, upon compliance, modifications to the report to avoid disclosing information that could be used to harm system security. →

Transmission Constraint Penalty Factor Requirements

Transmission constraint penalty factors are the values at which an RTO's/ISO's market software will relax the limit on a transmission constraint rather than continue to re-dispatch resources to relieve congestion associated with that constraint. FERC found that transmission constraint penalty factors have the potential to materially affect energy and ancillary services prices, so those factors should be included in each RTO/ISO tariff. FERC also noted that greater transparency into transmission constraint penalty factors will allow market participants to understand how an RTO's/ISO's actions and practices affect clearing prices.

The rulemaking requires that each RTO/ISO file tariff sheets showing its transmission constraint penalty factor values; the circumstances, if any, under which the transmission constraint penalty factors can set locational marginal prices; and the procedure, if any, for temporarily changing the transmission constraint penalty factor values. Thus, if an RTO/ISO currently has the flexibility to temporarily override transmission constraint penalty factor values, for example, to account for reliability concerns, the circumstances under which the factors may be changed, and any procedures for doing so must be included in the RTO's/ISO's tariff. The rulemaking also requires that any process for temporarily changing transmission constraint penalty factor values must provide for notice of the change to market participants as soon as practicable.

Uplift Cost Allocation

In its Notice of Proposed Rulemaking (NOPR) that preceded this order, FERC proposed to require that each RTO/ISO currently allocating the costs of real-time uplift to deviations must allocate such real-time uplift costs only to those market participants whose transactions are reasonably expected to have caused the real-time uplift costs. In its rulemaking, however, FERC states that it is withdrawing that proposal and declining to take generic action on that issue due to comments filed

that raised substantial concerns as to how the proposed allocation rule would be applied in certain RTOs and ISOs in light of the reasons for uplift in those markets, and whether certain RTOs and ISOs could reasonably implement the proposed uplift cost allocation reforms. FERC's rulemaking backtracked from a number of other proposals in its NOPR that would have made the reporting requirements more challenging for RTOs and ISOs on various grounds, some relating to feasibility and others to protection of sensitive information.

Conclusion

Because out-of-market actions and the resulting uplift costs are not reflected in market prices, there has been an unjust and unreasonable lack of transparency in certain of the organized markets concerning these costs and the reasons for their incurrence. Out-of-market actions can mask system conditions, which, as FERC recognized, "limits the ability of competitive electric markets to send appropriate price signals to compensate and financially encourage investment in resource attributes that respond to system needs." Furthermore, lack of transparency concerning both uplift costs and operator-initiated actions can impair the ability of stakeholders to provide valuable input during RTO/ISO transmission planning processes and in committees that review RTO/ISO resource adequacy. While FERC's decision to punt with respect to uplift cost allocation is disappointing, it is not surprising, given the difficulties of adopting a generic mandate to address an issue so fraught with controversy and region-specific differences. Nevertheless, ensuring system needs are transparent to market participants is a critical first step in finding cost-effective solutions to the operational challenges RTOs/ISOs face in ensuring reliable operations. The reporting of more granular information about uplift and operator-initiated commitments that the rulemaking does require will facilitate more efficient market entry and planning for the betterment of the markets.

The views expressed in this article are those of the authors and not necessarily those of BakerHostetler or its clients.

ABOUT THE AUTHOR:

Glenn S. Benson is a partner with national law firm BakerHostetler. Based in Washington, DC, Benson is one of the country's leading representatives of onshore and offshore oil and gas producers on regulatory matters. He has more than 24 years of experience and an uncommon familiarity with the Federal Energy Regulatory Commission (FERC). He counsels clients across the energy industry on tariff and contract disputes before FERC, regulatory compliance and enforcement, and the negotiation of commercial transactions, including power purchase agreements, interconnection agreements, pipeline precedent agreements, asset management agreements, and oil and gas purchase and sale agreements.

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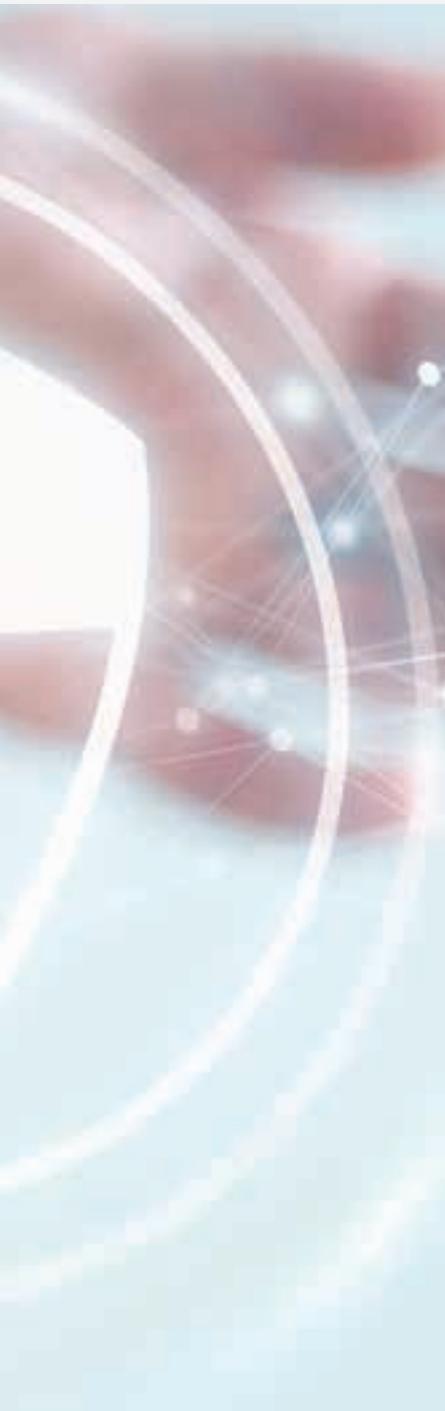
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MORE DANGEROUS THAN ZERO-DAYS: THE N-DAY THREAT

A hand is shown in the foreground, holding a glowing, interconnected network of fiber optic cables. The background is a soft-focus image of a shield icon, symbolizing protection and security. The overall color palette is light blue and white, with a subtle grid pattern.



ANG CUI

“Zero-day” attacks may get a lot of attention in the press, but for electric utilities, the reality is that more “mundane” threats pose a far greater risk to their operations.

Utilities depend upon industrial control system (ICS) devices, but what is largely unknown to this industry is that the majority of these products have significant security vulnerabilities embedded within them. To make matters worse, these flaws have been well documented by researchers, security companies and the U.S. government, so they are public knowledge. They are, what is referred to as, a “known vulnerability,” or “n-day.” This means attackers know about them too.

At the 2018 S4X18 cybersecurity conference, an in-depth examination was conducted of the ICS devices most commonly used in utility operations to see how widespread these known vulnerabilities actually are. This examination found that most of the ICS devices made by the world’s leading manufacturers contain a significant number of n-day vulnerabilities, which leaves them susceptible to exploitation. Additionally, many of these vulnerabilities are considered to be critical in nature, with a CVSS score of 7 or higher. This means that if an attacker is able to breach the utility’s network and gain access to the ICS, he or she would be able to take partial or total control over those devices and the facility’s operations.

Operators should be reminded of two recent attacks on Ukraine’s power grid, in which hackers were able to trigger regional power outages by disabling or subverting key ICS functions. By exploiting these latent n-day vulnerabilities in commonly used ICS equipment, an attacker could – in theory – pull off a similar attack on the U.S. mainland. →

Breaking It Down – What We Found

By analyzing the firmware of widely used ICS devices, it has been found that n-days are widespread throughout the ICS environment. In fact, most utility operators who read this article are likely to have at least some of these vulnerabilities inside their own systems.

In addition to the hundreds of n-day vulnerabilities discovered, it was also found that many of them are considered “low complexity.” Therefore, it would not be difficult for attackers to exploit them if they are able to gain access to the utility’s network. For example, in some cases, it could take just a few days to a few weeks to adapt a discovered n-day into a potential attack.

It is also important to realize that many of these n-day vulnerabilities were not at all recent – in some cases, the vulnerabilities date back two years and have remained unpatched.

Specific vulnerabilities against named devices cannot be disclosed, since there is a long lead time on ICS patching, and this would further aid attackers. However, there is one example which can be shared. There is a vulnerability in VxWorks which remains unpatched by many top manufacturers. In no case was this vulnerability listed for the individual ICS products, so vendors may not even know these vulnerabilities exist. The vulnerabilities can be exploited for such malicious purposes as manipulating settings and controls, physically damaging or destroying equipment, disrupting key operations and stealing sensitive information.

Evaluating the Risk

Utility operators are on the front lines of criminal cyber activity, as they make a tempting target for all of the key malicious actors – nation-states, espionage actors, organized crime and “hacktivists.”

For this reason, utilities must prioritize any potential threat to their networks, and in particular the ICS, since a successful attack there could lead to disruption of operations and even physical damage. When it comes to the mode of attack, hackers are more likely to utilize n-days as opposed to zero-days. Why? Because zero-

days are difficult, costly and time-consuming to find and exploit. N-days, on the other hand, are exactly the opposite – in many cases, ready-made exploits already exist which an attacker can look up or purchase. This makes the n-day a more likely method of attack for hackers.

The world has already seen a number of attacks on industrial targets that have exploited weaknesses in ICS devices and protocols.

Several recent cases illustrate this threat:

- CrashOverride, or Industroyer, is one of the more dangerous examples of ICS malware. As many will recall, this malware was used in a December 2016 attack to disrupt operations at a Ukrainian electrical transmission substation, resulting in a regional power outage. Based on the analysis by ESET and Dragos, this malware exploits the known CVE-2015-5374 Denial of Service condition to the Siemens SIPROTEC relays.
- TRITON, also known as HatMan, is a type of ICS malware discovered by FireEye’s Mandiant in 2017. The malware targets Schneider Electric’s Triconex Safety Instrumented System (SIS) controllers, which provide emergency shutdown capability for industrial processes.
- The BlackEnergy malware has also been implicated in the Ukrainian outage incident. It is designed for espionage as opposed to physical damage but can be useful for gathering intel on targeted networks and maintaining persistent access to the ICS. According to Dragos, this malware contained exploits for specific types of HMI applications including Siemens SIMATIC, GE CIMPLICITY and Advantech WebAccess.

In the past, it has been difficult for remote actors to pose a significant threat to utilities, but the situation has changed dramatically in recent years, due to the increased connectivity of utilities; a large body of publicly available exploitation and vulnerability research on industrial systems; the rise of the Dark Web, which makes sophisticated tools and “kits” readily available to actors all across the world; and the increased investments of nation-states in offensive cyber operations.

ABOUT THE AUTHOR:

Ang Cui, Ph.D., is founder and CEO of Red Balloon, a leading security provider for embedded devices across all industries. Prior to launching RBS, Cui was a prominent security researcher at Columbia University’s Intrusion Detection Systems Lab, where he discovered serious vulnerabilities in many widely used embedded devices. His research culminated in the development of Symbiote Defense, an advanced firmware defense system for embedded devices. Cui’s company has secured multiple U.S. government contracts to study Symbiote’s effectiveness in military, national security and industrial applications. Cui has received numerous industry awards and was named a DARPA Riser in 2015.



In security at the Heart of ICS:

Cyber attacks pose a threat to all major industries, but the utility market – and other industrial operations – face the greatest level of risk because of specific circumstances unique to the ICS environment:

1. Systems must always be available.
2. Complex patching procedures. In an ICS, as opposed to a standard computing environment, patching is often a manual proprietary process that requires unique software and knowledge for each vendor.
3. Patches rarely propagate between vendors that use shared code. This highlights an example we covered at S4. In that case, a vulnerability was reported to a vendor in a different sector (telecom) and was patched by the software vendor (Intel/Windriver), but patches were not applied by a number of large vendors in ICS.
4. Extended lifetime. Systems are typically deployed in the field for over a decade and well past their support period. Vendors who desire to sell new products are disincentivized to routinely patch and support older products with security updates, even if they are still commonly found in the field.

How to Address the Problem:

N-days are not an easy problem to address, and this is largely due to a slow to act supply chain and the technical complexities involved with patching/updating the ICS.

However, utilities can take a number of steps to reduce the risk:

- Engage with ICS equipment manufacturers about security concerns: Firmware security needs to become a key negotiating point with these vendors and operators should demand more robust built-in security features for the products they are buying.

- Security should be integral to ICS devices; not an afterthought: The current reactive approach of patching known vulnerabilities is no longer tenable. Every component of the ICS environment should have strong security baked into the software, firmware and hardware from the very start in order to lower the overall risk of n-days and other problems, and to mitigate or prevent damage from their exploitation. The best solutions will combine intrusion detection and mitigation techniques to protect against known and unknown attacks without relying on continuous updates. By and large, these features do not exist in current products, so it is incumbent upon manufacturers to develop or source this technology as quickly as possible.
- Be proactive: Utility operators need to be far more proactive with their own networks. They need to scan their networks regularly for known vulnerabilities. They also need to stay on top of the latest vulnerability reports and execute security patches whenever these become available from the vendors. When patches are not available, operators need to contain the threat as much as possible by taking such actions as air-gapping critical systems; prohibiting the use of external media devices (USBs, CD-ROMs); establishing strict controls on physical access to these systems, especially from third-party contractors; conducting open source intelligence audits to eliminate vulnerable/open ports from public information sources; active network security monitoring; and checking traffic related to logic updates for ICS equipment.

Conclusion

Malicious cyber actors are growing, both in quantity and sophistication, and they will increasingly target industrial operators for a variety of reasons, ranging from industrial espionage to extortion, terrorism and state-sponsored cyber warfare. Since the ICS environment is inherently vulnerable to attack, it is critical for all operators to prioritize cybersecurity and take a number of proactive measures to reduce their risk.

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Tel: 507-387-8069 | 1-888-980-1209
www.conduxtesmec.com

PULLERS - CONDUCTOR

Condux Tesmec, Inc.
Tel: 507-387-8069 | 1-888-980-1209
www.conduxtesmec.com

PULLERS - ROPE

Condux Tesmec, Inc.
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www.conduxtesmec.com

PUMPS - DEWATERING

Tallman Equipment Co.
Tel: 630-860-5666
www.tallmanequipment.com

R

RADIO COMMUNICATIONS

S&C Electric Company
Tel: 773-338-1000
www.sandc.com

RADIO TWO-WAY - FIXED

S&C Electric Company
Tel: 773-338-1000
www.sandc.com

RECLOSERS

S&C Electric Company
Tel: 773-338-1000
www.sandc.com

Thomas & Betts - Utility Group
Tel: 1-800-326-5282
www.tnb.com

Thomas & Betts Canada Utility Division
Tel: 1-800-466-1102 X 234
www.tnb.ca

RECLOSERS - CONTROLS

S&C Electric Company
Tel: 773-338-1000
www.sandc.com

RECLOSERS - SINGLE-PHASE

G&W Electric Co.
Tel: 708-388-5010
www.gwelec.com

S&C Electric Company
Tel: 773-338-1000
www.sandc.com

RECLOSERS - THREE-PHASE

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www.gwelec.com

S&C Electric Company
Tel: 773-338-1000
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REELS - HANDLING EQUIPMENT

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REELS - WIRE, GROUNDING

Hastings Fiber Glass Products, Inc.
Tel: 269-945-9541
www.hfgp.com

RELAYS - PROTECTION

Manta Test Systems Ltd.
Tel: 905-828-6469 | 1-800-233-8031
www.mantatest.com

RELAYS - SUBSTATION AUTOMATION

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Tel: 416-207-6000
www.kinectrics.com

S&C Electric Company
Tel: 773-338-1000
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REMOTE - SITE MONITORING

H&L Instruments
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www.hlinstruments.com

REMOTE CONTROL - EQUIPMENT

H&L Instruments
Tel: 603-964-1818
www.hlinstruments.com

REMOTE TERMINAL UNITS

Open Systems International, Inc.
Tel: 763-551-0559
www.osii.com

REMOTE VIDEO INSPECTION SYSTEMS

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Tel: 289-562-0126
www.systemswithintelligence.com

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ROPE - WIRE

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www.hfgp.com

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Tel: 630-860-5666
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www.techproducts.com

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Mackay Communications - Satellite Solutions
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<https://www.mackaycomm.com/satellite/>

SCADA - COMMUNICATIONS

H&L Instruments
Tel: 603-964-1818
www.hlinstruments.com

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Tel: 714-252-7826
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SCADA - ENERGY CONTROL SYSTEMS

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www.me-vis.com

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Tel: 763-551-0559
www.osii.com

SCADA - INSTALLATION SERVICES

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Tel: 773-338-1000
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Tel: 763-551-0559
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Systems With Intelligence Inc.
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www.lindsey-usa.com

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www.southernstatesllc.com

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www.gwelec.com

S&C Electric Company
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SIGNS

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Uticom Systems, Inc.
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www.uticom.net

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Dow Chemical
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www.dow.com/electrical

SPLICES & ACCESSORIES - TENSION

CTC Global Corporation
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Tallman Equipment Co.
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TransGard
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www.deltastar.com

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www.southernstatesllc.com

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www.sargentlundy.com

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www.emspec.com

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Southern States, LLC

Tel: 770-946-4562
www.southernstatesllc.com

SWITCHES - AIR, GROUP-OPERATED

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www.emspec.com

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Tel: 773-338-1000
www.sandc.com

Southern States, LLC

Tel: 770-946-4562
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SWITCHES - CAPACITORS

Southern States, LLC

Tel: 770-946-4562
www.southernstatesllc.com

SWITCHES - CAPACITORS BANK

Southern States, LLC

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www.southernstatesllc.com

SWITCHES - DISCONNECT

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Tel: 450-430-5522
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Tel: 770-946-4562
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Tel: 450-430-5522
www.emspec.com

MindCore Technologies

Tel: 450-477-5959
www.mindcoretech.com

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Southern States, LLC

Tel: 770-946-4562
www.southernstatesllc.com

SWITCHES - HOOKSTICK, DISCONNECTING

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Tel: 773-338-1000
www.sandc.com

Southern States, LLC

Tel: 770-946-4562
www.southernstatesllc.com

SWITCHES - ISOLATION

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Tel: 450-430-5522
www.emspec.com

Southern States, LLC

Tel: 770-946-4562
www.southernstatesllc.com

SWITCHES - LOAD BREAK

EMSPEC Inc.

Tel: 450-430-5522
www.emspec.com

G&W Electric Co.

Tel: 708-388-5010
www.gwelec.com

Southern States, LLC

Tel: 770-946-4562
www.southernstatesllc.com

SWITCHES - MOTOR-OPERATED

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Tel: 450-430-5522
www.emspec.com

MindCore Technologies

Tel: 450-477-5959
www.mindcoretech.com

Southern States, LLC

Tel: 770-946-4562
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SWITCHES - PADMOUNTED

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S&C Electric Company

Tel: 773-338-1000
www.sandc.com

SWITCHES - REGULATOR, BYPASS

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www.sandc.com

SWITCHES - SUBMERSIBLE

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www.gwelec.com

S&C Electric Company

Tel: 773-338-1000
www.sandc.com

SWITCHES - SUBSTATION, DISCONNECTING

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www.tnb.com

Thomas & Betts Canada Utility Division

Tel: 1-800-466-1102 X 234
www.tnb.ca

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Thomas & Betts - Utility Group

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Tel: 1-800-466-1102 X 234
www.tnb.ca

SWITCHES - TRANSMISSION DISCONNECT AND LOAD BREAK

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SWITCHES - VACUUM

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www.gwelec.com

SWITCHGEAR - ARC RESISTANT - MEDIUM VOLTAGE

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S&C Electric Company
Tel: 773-338-1000
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SWITCHGEAR - MEDIUM VOLTAGE RANGE UP TO 44 KV

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SWITCHGEAR - METAL ENCLOSED

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SWITCHGEAR - SF6

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TAPE - MARKING

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TELECOMMUNICATIONS

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RTDS Technologies, Inc.
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RTDS Technologies, Inc.
Tel: 204-989-9700
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www.mantatest.com

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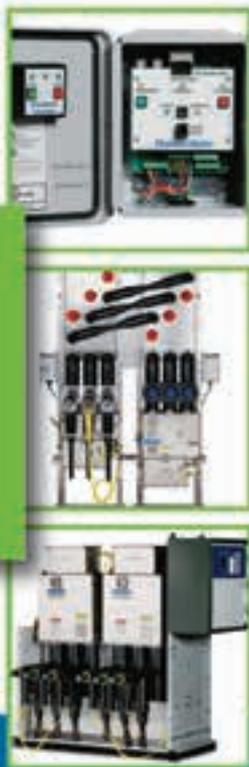
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