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AT THE FOREFRONT OF THE GRID TRANSFORMATION:

IEEE PES PRESIDENT TALKS ABOUT WHAT'S AHEAD FOR THE ELECTRIC ENERGY SECTOR

EET&D MAGAZINE

Quarterly Issue 1, 2024 — Volume 27

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INDUSTRY NEWS

Canada

GOVERNMENT LAUNCHES PUBLIC ENGAGEMENT ON THE 2035 GREENHOUSE GAS EMISSIONS REDUCTION TARGET

February, 2024

To create a future with a clean, healthy environment and a strong economy for people living in Canada, the Government of Canada is working with Canadians to significantly reduce greenhouse gas emissions and fight climate change. Everyone's contributions are essential to reach Canada's long-term target of net-zero emissions by 2050, a goal shared by more and more provinces, territories, businesses, and more.

On February 2, Environment and Climate Change Canada launched a public engagement process to hear the opinions of Canadians and Indigenous peoples across the country to inform setting Canada's 2035 national greenhouse gas emissions target. This important step is mandated under the *Canadian Net-Zero Emissions Accountability Act* and Canada's international obligations under the Paris Agreement. →

Canada is steadily making progress on cutting our emissions and building a stronger economy. In 2015, Canada was trending to exceed 2005 greenhouse gas emissions levels. Today, following successive climate plans, culminating in the 2030 Emissions Reduction Plan: Clean Air, Strong Economy, we are now projected to exceed Canada's interim objective of 20 percent below 2005 levels by 2026. We are also on the right trajectory to meet our 2030 goals, with many of the important building blocks needed for net zero already in place across all sectors of the economy.

The *2023 Progress Report on the 2030 Emissions Reduction Plan*, published in December 2023, demonstrates that Canada's climate plan is working, and that the emissions curve is bending. In addition to the federal government, other partners, stakeholders, provinces, territories, and municipalities across Canada are helping drive down emissions. Setting the 2035 target will help advance ongoing economic opportunities that are driving Canada to net zero by 2050, such as electrification, energy efficiency, and waste reduction.

To help inform the government's work in setting the 2035 target, the Honourable Steven Guilbeault, Minister of Environment and Climate Change, is inviting Canadians to share their views on the virtual public engagement platform, Talking Targets: Canada's Climate Future, which is open until March 28, 2024, 11:59 p.m. (PDT). The input collected through this engagement process is one of several components that need to be considered when setting the 2035 target.

Canada is leading the next decade of climate action toward a more sustainable future, but we can't do it alone. We need everyone to join us in taking climate action.

Quick facts

- Under the Paris Agreement to the United Nations Framework Convention on Climate Change (UNFCCC), countries agreed to collectively strengthen the global response to climate change by limiting global warming to well below 2 °C while also pursuing efforts to limit warming to 1.5 °C.
- All countries party to the Paris Agreement must submit greenhouse gas emissions reduction targets, referred to as nationally determined contributions, to the UNFCCC.
- Canada's 2030 nationally determined contribution under the Paris Agreement was updated in 2021, with the enhanced target of 40 to 45 percent below 2005 levels.
- Canada's next nationally determined contribution will be the 2035 emissions reduction target.
- The *Canadian Net-Zero Emissions Accountability Act* enshrines Canada's climate goals into law. It requires the government to establish targets and plans to achieve them at regular milestones on the pathway to net zero by 2050.
- Under the *Act*, the government must set an emissions reduction target for 2035 by December 1, 2024.
- The 2035 target is another milestone in the Government of Canada's transparent and accountable approach to charting the course to net-zero emissions by 2050. Under the *Act*, increasingly ambitious targets must be set every five years between 2030 and 2050 to ensure Canada stays on track to achieve the net-zero objective.

"Canadians want to ensure their kids and grandkids are left with a world that has clean air and good-paying jobs. Through the efforts of millions of Canadians from coast to coast to coast, we have been bending the curve on pollution, putting us on track to meet our climate targets. We have made substantial progress, but we know we need to do more. As we see from the intensifying wildfires, droughts, and heat waves, taking action today is what will protect our future. I look forward to working with everyone and receiving input to set Canada's 2035 emissions reduction target and build Canada's sustainable future together," said The Honourable Steven Guilbeault, Minister of Environment and Climate Change.

EnergyHub

ENERGYHUB HELPS ONTARIO'S IESO BUILD CANADA'S LARGEST RESIDENTIAL VIRTUAL POWER PLANT IN JUST SIX MONTHS

February, 2024

More than 100K homes enrolled in Ontario's Independent Electricity System Operator (IESO) Save on Energy Peak Perks program since June 2023 launch.

EnergyHub, a leading grid-edge flexibility provider, in partnership with Ontario's Independent Electricity System Operator (IESO), has enrolled more than 100,000 homes in the Save on Energy Peak Perks program in just six months to create the largest residential virtual power plant (VPP) in Canada. It's the fastest growing flexibility program in EnergyHub's decade-plus working with over 60 utility clients on Bring Your Own Thermostat programs.

With 100,000 homes enrolled, the VPP is capable of delivering peak demand reduction of up to 90 MW, the equivalent of taking a city the size of Kingston, ON off the grid during peak times. Flexible capacity is expected to climb as enrollment continues.

According to a recent report by the Rocky Mountain Institute, virtual power plants — groups of internet-connected devices like batteries, electric vehicles, and smart thermostats that can be actively controlled — are a valuable and largely overlooked resource for advancing key grid objectives. By 2030, VPPs could reduce peak demand in the United States by 60 gigawatts (GW) and could grow to more than 200 GW by 2050. In addition, VPPs could help reduce annual power sector expenditures by $35 billion in 2030.

"The scale and speed of enrollment proves that electricity providers and customers can partner on initiatives that provide mutual benefit," said Erika Diamond, Senior Vice President of Customer Solutions at EnergyHub. "The IESO has built a resource that will continue to grow and play a key role in keeping the grid reliable and accelerating decarbonization as demand for electricity in the province increases."

The Peak Perks program shows that well-designed and effectively-marketed programs scale quickly. Close coordination with device partners (OEMs) to secure maximum visibility for the program in OEM marketing channels, optimized customer-facing microsites and enrollment pages, and consultation on marketing best practices — paired with integrations with the industry's largest network of device partners — enabled tens of thousands of the IESO's participants to easily join Peak Perks with the smart thermostat of their choosing.

"We are so pleased that Ontario residents are taking an active role in energy efficiency through Peak Perks," said Tam Wagner, Director of Demand Side Management at the IESO. "Demand side management is a critical resource that can make a significant contribution to the reliability of the province's electricity grid — especially on hot summer days when air conditioning use is at its highest — and will play an important role in ensuring long-term electricity supply matches demand in the province."

MORE THAN 100 000 HOMES

FINGRID

MAIN GRID TRANSMISSION RELIABILITY RATE REACHED THE HIGHEST RECORDED LEVEL IN 2023

February, 2024

In 2023, the main grid managed by Fingrid recorded the best transmission reliability rate since measurements began. Several other key figures describing the main grid also reached record highs.

The main grid transmission reliability rate indicates the amount of energy transmitted for consumption in the main grid in relation to the total energy available for transmission. Last year, the transmission reliability rate was the highest since measurements began at 99.99995%. Several other key figures describing the main grid also reached record highs. The frequency quality in the Nordic synchronous area remained good.

Key figures for the main grid in 2023: (The averages for the preceding five years are given in parentheses.)

- The transmission reliability rate in the main grid reached a record-setting 99.99995% (99.99989%).
- The volume of electrical energy not transmitted for consumption because of disturbances in Fingrid's network was smaller than ever before at 33 MWh (75 MWh).
- The number of electricity supply interruptions (30 seconds) caused by disturbances was just 0.05 per connection point (0.14). Disturbances caused an average of 0.82 minutes (4.5 minutes) of interruptions at connection points.
- The volume of energy that was not received by the main grid from power plants was 11 MWh - the lowest ever level - and the imputed detriment to electricity producers was EUR 1,000.
- The system minute was 0.15 min (0.41 min), the lowest recorded level. One system minute corresponds to the interruption of all transmission for one minute compared to the annual peak demand of the system.

- The average interruption time was the lowest ever at 0.24 min (0.46 min). The Average Interruption Time (AIT) is calculated by dividing the energy not supplied by the average power of the system.
- The imputed economic detriment that disturbance interruptions caused to consumer customers was EUR 3.6 (4.5) million. This is the third-lowest value on record.

The quality of frequency in the Nordic synchronous area was good. In 2023, the frequency was outside the normal range (49.9-50.1 Hz) for approximately 9,600 minutes. The frequency quality metric was also below 10,000 minutes last year. The upper limit set in the European network code is 15,000 minutes, and the Nordic target is 10,000 minutes.

Further information is available on our website under Electricity transmission reliability rate. The website also provides annual fault statistics for the Nordic and Baltic AC network and fault and availability information for the cross-border connections.

RECORD-SETTING

99.9995%

EXPERTS DISCUSS INDUSTRY CHALLENGES AND SOLUTIONS

ELISABETH MONAGHAN
Editor in Chief

Four years ago, we featured a conversation with Shay Bahramirad, Ph.D. about the role IEEE PES plays in collaborating with utilities and energy consumers. At the time, Bahramirad was with ComEd and served as IEEE PES vice president of new initiatives and outreach. Today, Bahamarid is senior vice president of engineering, asset management and capital programs at LUMA Energy, the power company responsible for electric service in Puerto Rico. She also has just assumed the helm as president of IEEE PES.

While attending a conference this past fall, EET&D Publisher Steven Desrochers had a chance to speak with Dr. Bahramirad about LUMA Energy's progress since taking over as the utility in Puerto Rico, as well as her vision for her term as the leader of IEEE PES. In our Grid Transformation Forum section of this issue, we feature the conversation between Desrochers and Bahramirad.

According to Bahramirad, when LUMA stepped in as the grid operator for Puerto Rico in 2021, the reliability of the system was 300% worse than the worst utility in the U.S. Since then, LUMA has initiated 411 FEMA projects that represent 11.7 billion dollars of investment.

While Bahramirad remains focused on her work for LUMA, she is also excited about what she will be doing on behalf of IEEE PES and the electric energy sector in general. Because she has lived in the Middle East, Europe, the U.S., and now, Puerto Rico, Bahramirad has a broad view of the industry landscape, and she looks forward to using her experience and insight to continue moving the industry forward.

As she assumes her role for IEEE PES, Bahramirad talks about where the industry is headed, the challenges like climate change and grid modernization that the industry continues to face and the critical role industry partners must play to implement the best solutions to address those challenges.

Bahramirad is one of several contributors to this issue to address the numerous challenges that the electric energy industry will continue to face in 2024. Also writing about some of the ongoing challenges plaguing our industry are James Street with Epoch Solutions Group, Brian Rock with Bentley Systems, Richard Harada and John Nam with Systems With Intelligence and Brian Berry with Ampacimon.

Two additional contributors writing about obstacles within the power sector are Koustuv Ghoshal with Ericsson and Mishal Thadani with Rhizome. I wanted to spotlight their articles here because I appreciate the unique approach each has taken to identify those hurdles.

In his article, "Utilities need to decarbonize, decentralize and digitalize," Ghoshal notes that the grid is becoming more complex as more utilities charge towards meeting their Net Zero goals. Ghoshal suggests that there is potential for the communications and power grid sectors to collaborate in addressing these challenges head-on. According to Ghoshal, telecom networks is an untapped tool for creating intelligent networks to manage this increased complexity while also reducing carbon footprints.

As Ghoshal explains, "Mission-critical cellular networks providing grid connectivity can become that grid modernization mechanism that provides resiliency and flexibility for an evolving grid while reducing carbon emissions." Ghoshal believes that through their collaboration, the communications and power grid sectors can ensure that during an emergency, no one is left vulnerable without power or connectivity.

Rhizome CEO Mishal Thadani talks about the challenge of an aging electricity grid in "A health screen for the grid challenges of an aging grid," and compares the grid's infrastructure to that of the human musculoskeletal system.

As we get older, our bodies take longer to recover from illness or trauma. Over time, if we have not maintained a good diet, or taken proper care of our minds and bodies, we aren't likely to recover well, if at all. If we take care of ourselves and adjust our activity, diet and lifestyles throughout our lives, we stand a better chance of having stronger bones and maintaining better health as we age.

Thidani points out that for the electric grid, the more frequently natural or human-made disasters strike, the more damage they will cause to the electric grid. If the infrastructure of the grid is not maintained, the chances for it to recover quickly from any of these disasters decrease significantly. And just as it is wise to map out a treatment plan to address our health issues – especially as our bodies age and it takes longer for us to recover from from debilitating illnesses or accidents, it also is wise to create a treatment plan for an aging grid in preparation for existing and new climate threats. Thidani walks our readers through several steps – like projecting climate data, diagnosing the symptoms of climate change, measuring the damage, and designing a "treatment plan" that will lead to a healthier future for the energy grid.

It is impossible to know every challenge or hurdle nature or climate change has in store for the electric grid, but as our industry partners writing for this issue remind us, we have a better chance of overcoming these challenges if we acknowledge those challenges exist and remain proactive and prepared to tackle them when they strike.

As always, if you would like to contribute an article on an interesting project, please email me:

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Elisabeth

AT THE FOREFRONT OF THE GRID TRANSFORMATION:

IEEE PES PRESIDENT TALKS ABOUT WHAT'S AHEAD FOR THE ELECTRIC ENERGY SECTOR

In 2020, EET&D magazine wrote about Shay Bahramirad, Ph. D., who, at the time, was the vice president of new initiatives and outreach for IEEE PES. In that article, Dr. Bahramirad talked about the role IEEE PES plays in working with utilities and energy consumers.

Recently, our publisher Steven Desrochers had a chance to catch up with Dr. Bahramirad, who now serves as the senior vice president of T&D strategy and sustainability for LUMA Energy in Puerto Rico. She also has just assumed the mantle of president for IEEE PES. The following is a recap of their conversation about LUMA's efforts since they assumed the role of operator for transmission and distribution in Puerto Rico, along with Bahamirad's vision for IEEE PES.

EET&D: Let me start with a LUMA-related question: What is information about the power grid in Puerto Rico that you wish people outside the island would understand?

Bahramirad: When LUMA assumed the role of grid operator for transmission and distribution in Puerto Rico in June 2021, we inherited a fragile and broken system that had not been maintained for decades, and it hadn't been invested in for years, in addition to flaws in the system design under the prior operator, resulting in bottom of the fourth quarter reliability.

Basically, the reliability of the system was 300% worse than the worst utility in the United States. And since then, we have made tremendous progress. The largest settlement in the electric industry is the one between the Federal Government (FEMA) and Puerto Rico. There was no project under construction when we started.

As part of that transformation and reconstruction, we have initiated over 411 projects with FEMA, and 104 of them are under construction right now. As a result of that, we have improved the reliability of the system and reduced the frequency of outages by 35% in the first two years of operations. It takes time. There is a sense of urgency because of where the system is, what the software is and what the people of Puerto Rico are going through day to day, but it is also important to do this right because this investment is going to serve the next three generations of Puerto Ricans — it's important to get it right in having this sense of urgency. →

Image credit: LUMA Energy

EET&D: Thank you. How have things changed with LUMA in shoring up the power grid since you joined the organization?

Bahramirad: As I stated, we have initiated 411 FEMA projects that represent 11.7 billion dollars of investment. We are bringing the system design to industry standards such as NERC, SIP and Compliant. We have connected 102,000 solar panels to the system, which puts Puerto Rico fifth in the nation for residential solar per capita.

It's quite impressive. The people of Puerto Rico have decided that we want 100% renewable electricity by 2050, and we are committed to that. We've been upgrading the system to be able to accommodate that. We have replaced over 65,000 streetlights in 78 municipalities, and we are going to replace another 200,000 in the next year and a half or so to improve public safety.

Thousands of poles have been replaced. We have installed over 2,000 automation devices to reduce the frequency of outages and reduce the duration of outages for the first time in Puerto Rico because of the optical sensors that we have implemented, we have visibility and situational awareness of the transmission system.

So, there is a lot going on. We have cleared 3,700 miles of vegetation, and we have an agreement from the federal government and with the support of Puerto Rico to do a one-time vegetation clearing for 16,000 miles of lines across Puerto Rico, which is going to improve the reliability of the system by 45% in three years.

It's the mitigated hazard associated with [that] vegetation. It's understated, so we are quite excited about that, and we are on target to start the work by early 2024.

These are a few highlights of what we have done so far, and the last thing I will tell you about is the people-side of this business. We have focus. It was my personal commitment to develop the next generation of local talent. We have a Memorandum of Understanding with six universities across the island. We have hired over 200 recent graduates from six universities, and we've led them through extensive training. The enthusiasm you see from the young talent — it's quite impressive. We have over 70 interns from the local universities, and we have sent over a dozen engineers to extensive 61850-3 substation training in North Carolina to get award-class training by Quanta Technologies.

They are going to be the brains. They are going to operate, troubleshoot and commission complicated substation equipment and are well on their way.

EET&D: Wow. Well, I appreciate that human power in that answer you just gave me. It's not part of the questions, but I was going to ask what's been done because it's a challenge. You're on the island, and you have only so many people that you can tap into, and I know that you've grown the workforce by I don't know how many over the last three years, but kudos on that.

Bahramirad: On the island, we call it brain drain. There are several very good universities, and other utilities and companies from the mainland come to hire these recent graduates. [The graduates] have a very solid and technical foundation, and we want to keep them here.

EET&D: Are you able to tap into universities outside the island?

Bahramirad: We have been working with a number of universities. We've just kicked off Center of Excellence, and the thought is to attract researchers and graduate students from the mainland to have a dialog with engineers from LUMA and the recent graduates that we continue to hire, and this dialogue is going to help create the foundation and benchmark for cross-country learning for our talent in Puerto Rico.

EET&D: How can LUMA be a better community partner?

Bahramirad: So, as part of our grid transformation, we have been working very closely with municipal officials to inform them that the work is coming. As part of the work to perform system upgrades, we often need to implement planned outages to ensure work can be completed safely, so we inform our customers through the municipalities and social media. They also support us during construction [because construction work] creates lots of traffic and some logistics they are part of, in addition to the permit process.

We have held several STEM events working with several community stakeholders, and the thought has been to expose the next generation of high schoolers and middle schoolers to the path of STEM. What does it look like? Fourteen female engineers from my team mentored 40 female students from across the island, partnering with community stakeholders. Together, they worked on building an electric car from scratch and raced the cars in one of our facilities.

We also had the first workshop around climate science for a number of high schools. In addition to that, we are kicking off a program to go around the island to different elementary schools and read books to the students about energy and how to save the planet.

So, that's just the work that we are doing by our people and the team at LUMA to closer to the communities that we serve. →

Image credit: LUMA Energy

EET&D: How are Luma and consumers in Puerto Rico working together more effectively?

Bahramirad: We are committed to working with customers to develop solutions for a brighter energy future in Puerto Rico. As the Puerto Rico system operator, we are responsible for implementing the public policies that the people of Puerto Rico have decided, like having 100% renewable electricity by 2050.

We've done several initiatives. You've heard about connecting over 100,000 solar panels to the system propelling Puerto Rico to rank fifth among US states and territories for residential solar per capita. We have increased the number of monthly solar connections from approximately 450 under the previous operator to approximately 4,100 interconnections per month under LUMA.

We just announced our customer battery energy sharing (CBES) initiative. It's a future power plant if you will, and we've put a contract in place with a number of aggregators, and they are working very closely with customers and community leaders to get subscriptions so they can participate as part of operation during peak demand to provide that service to the grid, helping with the reliability for 1.5 million customers in Puerto Rico.

The program is going to provide participating solar customers who have battery storage the opportunity to contribute to the stability of the system during the time of lowest generation supply. Across multiple programs, we have made historic and measurable progress to strengthen the network and improve its reliability. We also have been working on providing more information to customers and doing a lot more communication through the press, social media, and other mechanisms to inform them of the work we are doing.

EET&D: Thank you. Switching to IEEE. When were you elected president of IEEE PES?

Bahramirad: Almost two years ago. But for the first two years, I was president-elect, so my role was to [work on] the long-term strategic plan, and in 2024 and 2025, I will be president to execute on those promises.

EET&D: What unique insights and experience do you bring to IEEE PES?

Bahramirad: IEEE PES is the leading provider of scientific and engineering information about electric power systems in the energy sector. I have had unique positions in the industry around the country. I have lived on three different continents, so, I am familiar with the challenges from the Middle East, to Europe, and then to the United States, and now in Region 9 of Puerto Rico, which is similar to the Caribbean. Interestingly, even though there are a lot of similarities, it gives me quite a unique view of the landscape of the energy sector. Coming from the industry at the same time, teaching for decades and working very closely with national labs, I can bring together — and I plan to bring together practitioners, as well as scientists and professors from academia, and researchers, to work together to solve a lot of problems and challenges associated with the climate crisis.

EET&D: What excites you about the role you will be playing as president of IEEE PES?

Bahramirad: It's an exciting time to be part of this business. It's an exciting time to be an engineer, and it's an exciting time to be part of this energy transition, and I cannot think of a better organization than PES to create a dialogue to make proper decisions and provide unbiased facts to decision-makers globally. That excites me the most.

In addition to that, the talent that this industry needs, the younger generation, they are mission-driven, and I cannot think of a bigger humankind challenge than tackling the climate crisis that will excite the next generation. I've seen it in our IEEE young professionals, and I look forward to working with them over the next couple of years.

EET&D: What are some of the greatest challenges IEEE must meet over the next couple of years?

Bahramirad: We are at the forefront of the rapidly changing technological advancements that impact everyone, from grid operators to manufacturers, to communities, and the greatest challenge we face is time. Climate change is dramatically increasing the frequency and the extent of events everywhere around the world, and more resilient solutions are needed to address them. That's why it's important to learn from experience in places like Puerto Rico.

As experts in engineering in climate change, we are in a position at PES to discuss the latest thinking to ensure people in different parts of the world don't have to live the same experiences. The other part that I should highlight is that gathering at conferences like the Smart Grid Conference in Puerto Rico for our global network of leading power engineers is quite important…climate change is a global phenomenon, but the impacts are seen locally, and there are a lot of parallels across the globe. IEEE is the right foundation and the right platform to bring people together and have this transparent, unbiased dialogue. It translates into the foundation of decision-making.

EET&D: I'd like to add that IEEE, like any other association… we need to go and get those students young, and we want to get them involved as early as possible, as our future generation. You said that you are part of Region 9. What do you see in the future to attract those students to embark on the IEEE association?

Bahramirad: We have a workforce development strategy that we've been working on for the past two years. There are elements to that from virtual job fairs for the ones that are already in college to introduce them to what IEEE PES is about and connecting the companies to students on a larger scale, where there's no physical attendance required in one location.

We also have been looking into gaps. We have scholarship cross-programs and we've been looking into expanding them outside of power systems, the power sector, or electrical engineering to relevant engineering disciplines.

If you want to build a system, you are required to have civil engineers, mechanical engineers, chemical engineers and so forth, and we've been looking to expand that scholarship to different disciplines in engineering. In addition to that, we have STEM programs that IEEE provides and at PES we work very closely with them.

There's Learned Engineering. It's a program that IEEE uses, working with high school and middle school kids to expose them to all the opportunities in the world by working on a hands-on project, and during the process, they learn what opportunities are out there in the future, so there is a long spectrum of initiatives globally that is getting led by young professionals to expose the next generation and make sure that they have a proper pipeline of talent that come through IEEE and that they participate in developing standards, guidelines and the educational material that is needed to bring the talent to the next level to tackle all of the problems that we talked about.

EET&D: Is there anything you'd like to talk about that we didn't cover?

Bahramirad: Maybe one thing I would say is that I think IEEE PES is on the right track to facilitate change globally. It's very important to PES leadership, and to me, that we foster global connection — connecting people and experts and providing that unbiased view to decision-makers — and we are going to facilitate change. Without immediate efforts, engineers will be left with a rapidly growing crisis with no solutions.

ABOUT SHAY BAHRAMIRAD:

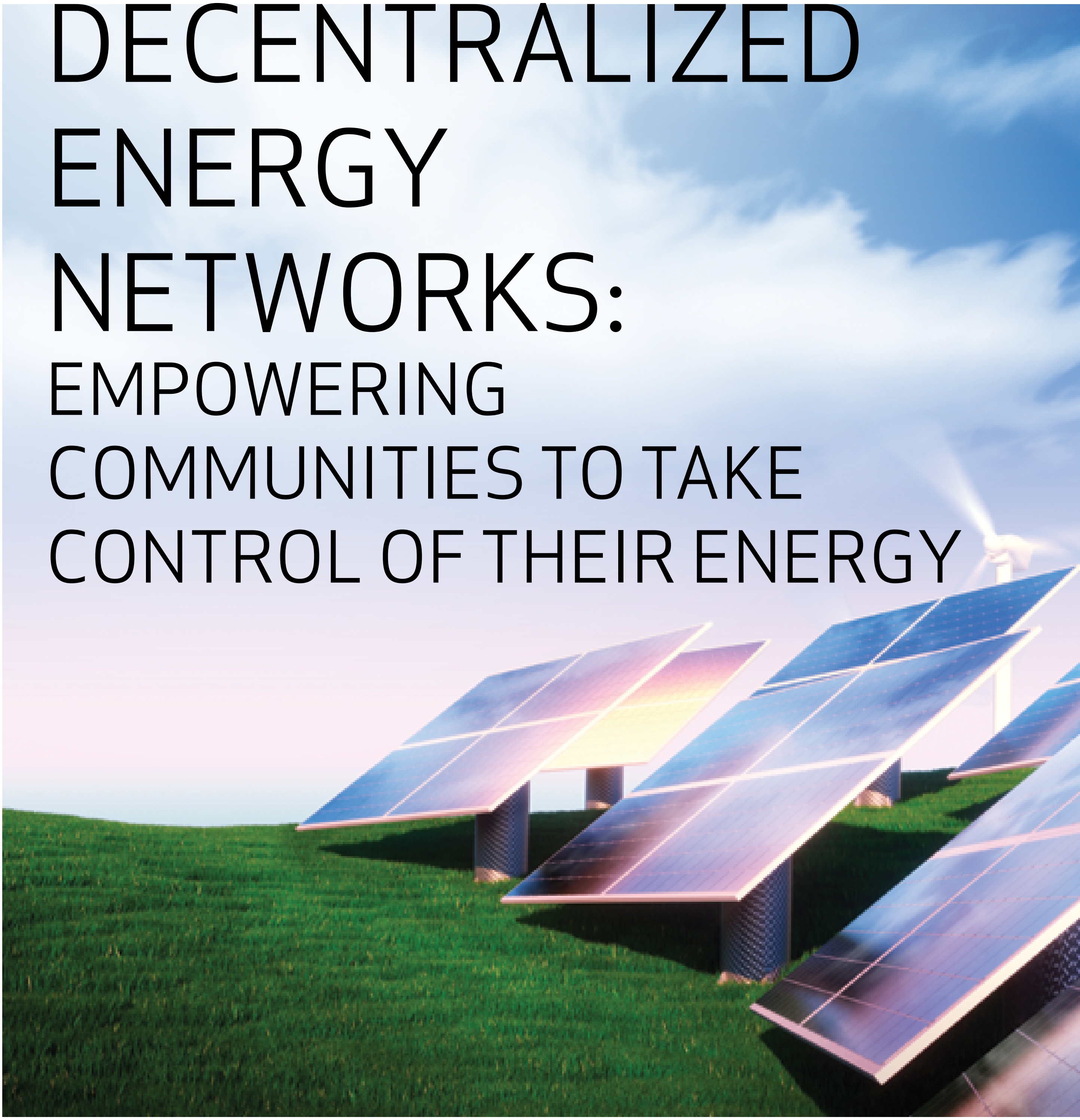
Shay Bahramirad, Ph. D., is globally recognized as an industry leader in defining the next horizon of the electric utility industry, Bahramirad serves as the senior vice president of engineering Asset Management and Capital Programs for LUMA Energy as well as the president-elect of IEEE PES. She is passionate about mitigating climate change and driving social equity.

ABOUT IEEE POWER & ENERGY SOCIETY (PES) :

The **IEEE Power & Energy Society (PES)** is the leading provider of scientific and engineering information on electric power & energy for the betterment of society and a trusted resource dedicated to the technical, informational, networking, and professional development needs of its members. With over 40,000 members around the globe representing every facet of the electric power and energy industry, PES is at the forefront of the rapidly changing technological advancements that impact everyone's future. Additional information on IEEE PES can be found at ieee-pes.org.

WEB3 AND DECENTRALIZED ENERGY NETWORKS:

EMPOWERING COMMUNITIES TO TAKE CONTROL OF THEIR ENERGY



ALAN VEY

The need for a sustainable and reliable energy system has never been more urgent. The world's energy demands are growing, climate change is worsening, fossil fuels are becoming scarce and the current energy system, which is centralized and controlled by large utility companies, cannot meet the world's evolving demands.

A new concept is emerging that can better distribute power generation, storage and management to local communities – a decentralized energy network.

Decentralized energy networks do not rely on a centralized power generation infrastructure. Unlike traditional centralized energy grids, which rely on a single source of power generation, decentralized energy networks involve multiple energy sources, like solar panels, wind turbines and microgrids. These distributed energy resources (DERs) are interconnected to form a network, allowing the optimization of grid operations. A decentralized energy network aims to put energy production closer to the site of energy consumption. →

The role of Web3 in decentralized energy networks

The foundation of decentralized energy systems is Web3 – also known as the decentralized web. By leveraging the principles of transparency, decentralization and peer-to-peer transactions that underpin Web3 technologies, decentralization energy networks can lead to a more resilient and sustainable global energy ecosystem.

Decentralized energy networks can not only play a significant role in helping achieve global energy targets but can also create new opportunities for countries that are less economically developed and more reliant on fossil fuels.

Let's further explore some of the benefits of decentralized energy networks.

Building resilience

One of the key advantages of a DER is its inherent resilience and reliability. Unlike centralized grids vulnerable to single points of failure, a decentralized network comprises numerous DERs such as solar panels, wind turbines and microgrids. These DERs operate independently, reducing the risk of widespread outages.

What is more, decentralized networks empower communities to become more self-sufficient, enabling them to generate and store energy. By embracing this localized approach, regions can become less dependent on long-distance transmission lines, mitigating the risks associated with transmission losses.

Environmental advantages

Decentralized energy networks offer significant environmental benefits. Because Web3 technology facilitates the tracking and verification of renewable energy generation and consumption, through the use of distributed ledger technology, renewable energy systems can securely record and verify energy production and usage data. This transparency ensures the integrity of renewable energy certificates, incentivizes renewable energy production and enables accurate carbon accounting.

By generating clean energy at the local level, communities can lower their carbon footprints and contribute to global efforts to combat climate change. Moreover, decentralized networks enable integrating energy storage systems, such as advanced batteries, which help balance supply and demand. This flexibility optimizes energy usage, reduces wastage and further enhances sustainability.

Economic empowerment

Decentralized energy networks have the potential to stimulate economic growth and create job opportunities. This shift towards local energy production retains energy spending within the community, bolstering the local economy. Furthermore, decentralized energy infrastructure deployment, installation and maintenance require a skilled workforce, leading to job creation in various sectors. From technicians and engineers to project managers and researchers, decentralized networks can generate employment across the energy value chain.

Efficiency and optimization

In a decentralized energy network, localized power generation and storage enable greater energy efficiency and grid optimization. Energy efficiency improves by minimizing the need for long-distance transmission and reducing losses associated with centralized energy systems.

Moreover, decentralized systems can leverage smart grid technologies, allowing for real-time monitoring and control of energy consumption. These systems enable demand response mechanisms, empowering consumers to adjust their energy usage based on price signals and grid conditions. The result is a more efficient and dynamic energy ecosystem that effectively manages peak demand, reduces strain on the grid and minimizes the need for costly infrastructure upgrades.

Web3-Driven energy transition enablement in practice

To bring these benefits to life, let's consider a real-life use case: Energy Web, a global non-profit organization that builds open-source technology solutions for energy systems implemented a decentralized technology designed to optimize energy services and accelerate the decarbonization of the grid.

By taking advantage of the benefits of Web3 technology, including decentralization, interoperability and scalability, Energy Web can now enable its clients to connect to the ecosystem easily, enhancing transparency and enabling democratic decision-making by ecosystem members via decentralized governance votes regarding significant development decisions.

This example signifies an important milestone in advancing the potential of decentralized energy networks. With Web3, Energy Web can extend the reach of its technology and drive global change in the transition to clean energy.

As Web3 continues to evolve, its integration into decentralized energy networks holds tremendous promise for unlocking greater efficiency, grid optimization and seamless integration of renewable energy resources.

This example signifies a significant milestone in advancing the potential of decentralized energy networks and underscores the transformative benefits they offer. By combining the power of Web3 technology with the inherent advantages of decentralized energy networks, we can create a sustainable and resilient energy future.

From enhanced resilience and environmental advantages to economic empowerment and efficient grid optimization, decentralized energy networks hold immense promise in revolutionizing our energy production and consumption approach. By leveraging the power of Web3 technologies like blockchain and smart contracts, we can accelerate the transition to a resilient and sustainable energy system that will benefit individuals, communities and the planet as a whole.

ABOUT THE AUTHOR:

Alan Vey is the founder & chairman of Aventus, a technology company that onboards enterprises to Web3. He completed his undergraduate degree in computer science and Master's in artificial intelligence at Imperial College London.

SEVEN STEPS TO BRING GENERATIVE AI

INTO UTILITIES' CUSTOMER SERVICE

STEFAN ENGELHARDT

The utilities aren't alone in seeing the potential of generative AI in customer service. A recent cross-industry survey of more than 1,000 businesses found that nearly half of organizations are planning to use generative AI for sales and customer service such as optimizing support chatbots and boosting self-service capabilities. Among utilities and energy companies, that figure was higher yet – 52%. What's more, 39% of energy and utility companies surveyed had established a dedicated team and budget to integrate generative AI into product and service development plans.

There are grounds for such enthusiasm. Unlike existing utilities-focused AI-assisted functions such as predictive maintenance, generative AI will complement and augment existing customer service approaches without the need to reconsider fundamental business processes. AI-driven solutions can speed response times and cut customer service workloads. They can also help steer customers – and, when necessary, customer service representatives (CSRs) – to the right answers, quickly.

Those AI-assisted answers contain the seeds of lower operational costs and higher revenue through tailored cross-selling and upselling products and services such as heat pumps and energy audits. Generative AI will be able to reconcile the minutiae of utilities' and partners' vast product and service offerings with real-time insights into the specific consumption patterns and demographics of inquiring customers. That will open doors to improved service and better and more profitable customer relationships. That, at least, is the vision. →

> **AI-driven solutions can speed response times and cut customer service workloads.**

But how might utilities best go about bringing generative AI into the customer-service fold? Here are a few considerations for those starting down that road.

1. Choose your target. Generative AI will ultimately handle a wide variety of customer service tasks. But you have to start somewhere. Perhaps that somewhere is the management of billing complaints. Or maybe you go with appliance rebates or tariff recommendations. Pick a target and pilot it.

2. Think data. Choosing a target means narrowing the focus. On the data front, do the opposite. The more data a generative AI system has available, the better it can be. Lay the data groundwork early. Among the data sources potentially in play include meter-to-cash-related data, operational data, network-related mapping data, demand-response data, SCADA data and smart-meter data.

3. Get the data tools. Utilities live in many places. Generative AI wants it all together. That takes an analytical strategy to aggregate diverse data for the 360-degree view AI needs. Combining diverse data sources for generative AI then requires data-management solutions to handle the data retrieval and aggregation. Such solutions must include safeguards for data privacy and compliance.

4. Go real-time. Customer acceptance of generative AI chatbots will vary based on demographics, technological predilections and other factors. But even digital natives most likely to embrace them will have high expectations. The limitations of today's chatbots will likely fuel initial skepticism of generative AI versions, so the data they work from must be timely and accurate – whether the topic is order status, usage forecasting, or billing-related. In-memory computing is a good way to ensure that queries tap real-time data.

5. Keep your LLM options open. Different large-language models have different strengths. Your platform should be able to work with a variety of LLMs to ensure the best fit.

6. Test responses and establish guardrails. Building generative AI for utilities' customer service involves a collaborative effort combining the strengths of solution providers with those of the utilities who know their customers and business goals best. The process involves guiding AI toward the proper responses to the real-world questions, as they're likely to be asked and ensuring that the answers are accurate based on the underlying data sources. It can be a painstaking process, but it's one that's critical: A utility can ill afford to have its customer-service AI hallucinate the answers to billing-related or outage-related inquiries, among others.

7. Consider the human role. People will remain vital to utilities' customer service for the foreseeable future, but the human role will evolve. One envisions AI handling increasingly complex inquiries independent of human oversight, but also enabling higher-level decision-making among lower-level customer-service staff. Operationally, the interactions and handoffs between AI and human users must be delineated, and there are obvious human-resource implications in terms of onboarding and training.

Utilities and their solution providers have a long way to climb on the generative AI learning curve. Given the technology's tantalizing potential, it would be unwise to bet against a rapid ascent. Utilities – and their customers – simply have too much to gain.

ABOUT THE AUTHOR:

Stefan Engelhardt joined SAP in 1997, where he supported the specification and launch of SAP's first industry solution for utilities. Since then, he has held various management positions within SAP's Industry Business Unit Utilities and became vice president Utilities in 2007.

Engelhardt studied geo-sciences at the University of Heidelberg and holds diplomas in geology, geography and ethnology. He holds as well a Ph.D. in natural sciences from the University of Heidelberg.

BC HYDRO SUCCESSFULLY LEVERAGES THE POWER OF GIS TECHNOLOGY

FROM MULTIPLE PROVIDERS

JAMES STREET

Electric utilities face unprecedented challenges in today's dynamic and quickly evolving energy landscape. Navigating the complexities of adapting to changing regulations and standards, exceeding higher consumer expectations, upgrading legacy IT systems and aging infrastructure, addressing technology constraints, meeting the ever-increasing demand for energy, confronting extreme weather patterns and moving away from fossil fuel sources, all while delivering reliable and affordable electric service, present utilities with an array of hurdles.

In response to these daunting obstacles, utilities are investing in grid modernization, transitioning to renewable energy sources, focusing on effectively navigating regulatory pressures, and engaging with customers in new ways.

Transforming key business processes through GIS technology

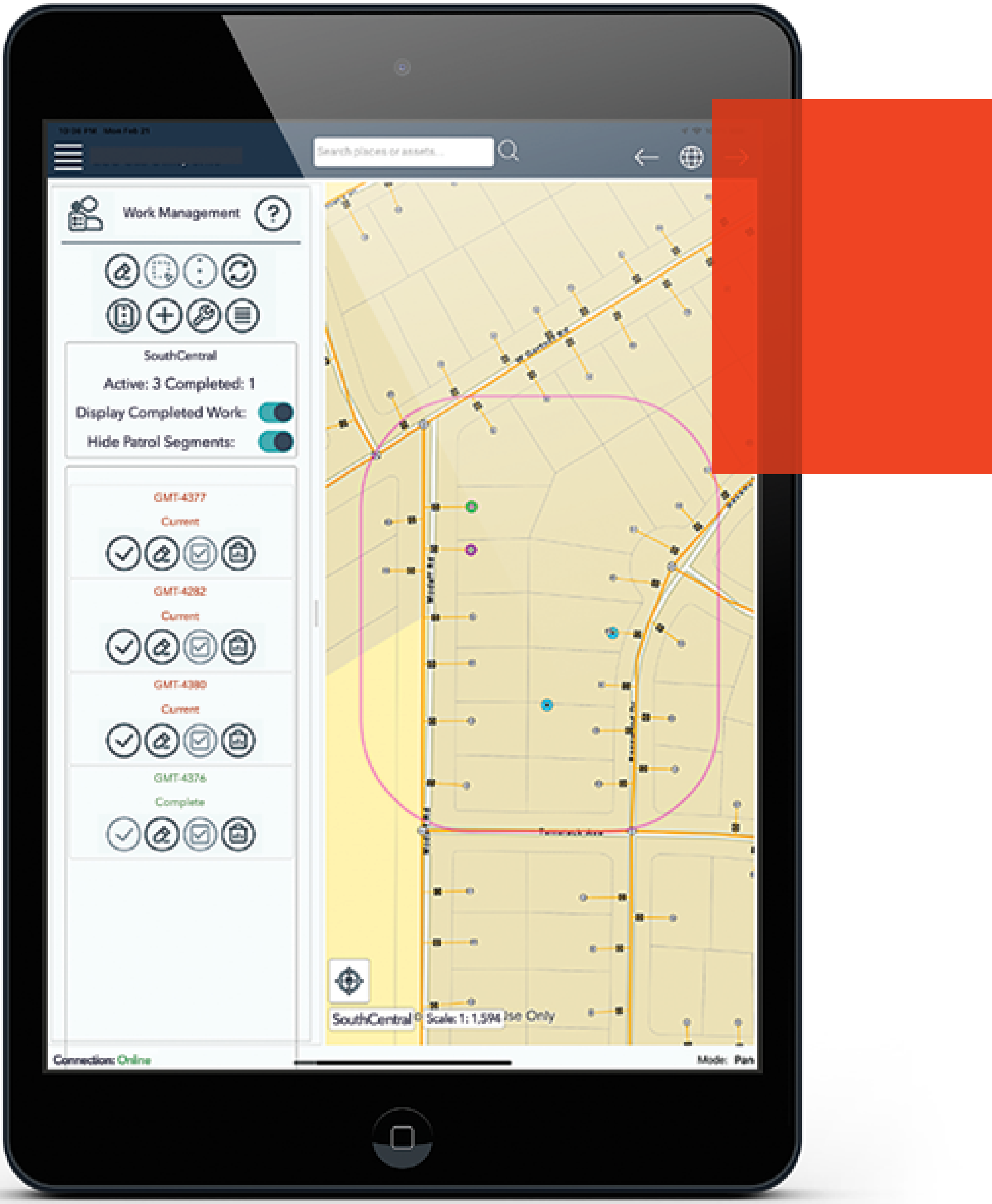
Most utilities are also adopting innovative technologies such as geographic information system (GIS) technology. They recognize that GIS extends far beyond maps and can help them effectively manage their infrastructure while transforming key business processes.

GIS technology enables utilities to visualize, analyze and interpret spatial data, such as the locations of infrastructure assets, land use patterns and environmental factors. It helps them identify locations and events that are static and don't change over time, such as where an existing building is on a property or the site of a previous power outage. GIS can also track dynamic locations and events, like the spread of wildfires or rising flood waters.

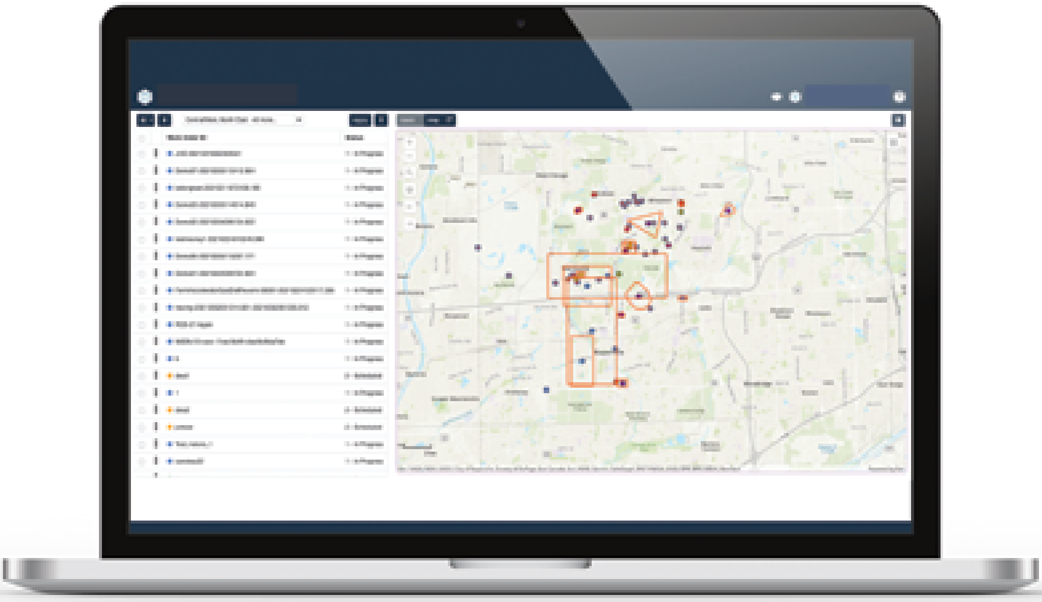
GIS technology eliminates the need to plot routes on traditional paper maps, locate specific assets through manual searches, or rely on an individual's memory. Furthermore, GIS technology greatly assists field workers by digitizing the process of recording asset inspections and infrastructure data. This shift from paper-based recording not only saves time but also reduces the likelihood of data entry errors.

By ensuring that both field workers and office staff have access to the same authoritative, up-to-date data, GIS technology fosters a more cohesive and efficient working environment.

The most sophisticated solutions on the market today display utility company geospatial data digitally via interactive maps. Utilities receive real-time information to make informed decisions, such as whether to monitor an asset's condition, manage vegetation more often, or respond to an outage. →



GIS technology can eliminate reliance on paper processes. Image credit: Epoch Solutions Group



Utilities can schedule and dispatch resources easily with GIS-enabled workforce automation. Image credit: Epoch Solutions Group

Ensuring effective asset management

In many cases, GIS technology allows users to drill down on pertinent details about assets, including the manufacturer, age, current condition, inspection history, projected remaining useful life and more. This data lets utilities know whether an asset needs to be inspected, serviced, or repaired, thus reducing asset breakdowns, preventing network disruptions and enhancing asset lifespan.

Driving field services efficiency

Managing utility field services is a highly complex endeavor. Coordinating field crew workers and equipment across vast utility service areas requires teams of administrators, timely access to field data, volumes of paperwork, and the industry's most advanced high-performance computing systems. While routine inspections and maintenance work can be planned in advance, outages occur unpredictably, disrupting field crew operations and impacting the lives and businesses of customers throughout the community.

When outages occur due to storms or unforeseen incidents, such as a worker accidentally cutting a line, GIS technology with integrated GPS tracking proves more efficient than manual data collection. Utilities can employ GIS-enabled dashboards for quick and visual identification of outages, crews and work sites. Rapid location of these elements streamlines damage assessment and repair prioritization, significantly improving field crew response efficiency.

If the GIS technology is integrated with an advanced workforce automation tool, the utility can assemble and deploy large groups of field crews to repair and restore outages using real-time data displayed on maps and graphs. Many solutions enable field crews to use their mobile devices to access work orders either online or offline, send and receive information from the back office and electronically sync data with the back-office enterprise systems.

Because GIS technology provides situational awareness, utilities can also optimize crew deployment for such non-urgent tasks as managing vegetation and inspecting power lines, gas lines, cell towers and other assets—ensuring safety, complying with rapidly evolving regulations and gaining full asset traceability.

Leveraging multiple GIS technology solutions

In today's dynamic utility landscape, if a utility is already leveraging GIS technology, seamless GIS data integration is vital. It's crucial to be able to visualize geospatial data across systems within the organization. If multiple GIS systems are in use, integration requires flexible mappings that support sync between different data models, a plugin architecture for easily deploying custom data format connectors and transforms and incremental data synchronization that ensures only data changes are synchronized.

In numerous cases, utilities that implemented a foundational, robust GIS technology solution years ago — such as GE Smallworld — now also seek the advanced tools and technologies available in the Esri environment.

- GE Digital Smallworld - GE Digital Smallworld highlights that it streamlines design and data capture workflows to ensure the accuracy and completeness of utility network representation, from planning through operations and maintenance for the end-to-end asset lifecycle. It also enables multiple users to make concurrent changes through singular versions and allows for a coordinated convergence of the changes back into the master in any order demanded by the business process.
- Esri ArcGIS Utility Network - The Esri ArcGIS Utility Network (UN) is designed to be a spatial information system that provides greater functionality "over massive datasets at every resolution scale." ArcGIS Utility Network states it is configurable for any utility, municipality, or organization with linear assets.

Utilities leveraging a GIS system of record often desire to migrate data to Esri UN as their system of engagement. They seek a solution that allows their end users to log in through a single portal and access several different geographic datasets, regardless of the data's origin, and desire minimal requirements for manual intervention and limited ongoing management.

BC Hydro challenge: limited ability to work with GIS data

For BC Hydro, generating and delivering electricity to 95% of the population of British Columbia, Canada, involves 30 hydroelectric plants and a network of more than 80,000 kilometers of power lines that transport power across a varied terrain. Ensuring reliable service to more than five million customers in this demanding environment requires ready access to robust GIS data.

Since the utility's GIS information for transmission and distribution resided in GE Smallworld, the organization sought more tools to work with that data effectively.

"Other business groups in the company, like our power generation group, were using Esri for GIS data," noted IT Advisor Evan Schwab. "While we currently have two GIS systems, we're looking to develop new capabilities on the Esri platform going forward."

Two factors provided a strong impetus for getting BC Hydro's GIS data accessible on Esri:

- In the short term, the utility wanted to move to a web-based, map-based application for managing its many environmental documents, with reference layers for the transmission and distribution functions. "Because we were going with a web-based application for our new environmental solution, we had to have the data in an Esri format," Schwab said.
- In the long term, BC Hydro saw more and more applications eventually moving to Esri. As the organization rolled out other Esri-based solutions, including an emergency operations dashboard and a street light management system, the utility envisioned benefits from an enterprise view of its transmission and distribution data in an Esri format.

The solution: migrate GE Smallworld data to Esri

BC Hydro sought a third-party GIS data migration software solution to sync its GIS data between GE Smallworld and Esri. It found a dedicated solution purpose-built for data synchronization between Smallworld Version Managed Data Stores and Esri ArcGIS Enterprise Geodatabases.

In 2020, it implemented the software, which involved an initial full synchronization of the data between Smallworld and Esri. Once implemented, the solution only needed to perform periodic data synchronizations, ensuring just the incremental data changes were synced. In early 2023, BC Hydro implemented the latest version of the third-party solution that supported Esri's latest ArcGIS Pro SDK and support for the Esri UN.

"We needed to be sure we could continue to use this product long term, staying ahead of any software compatibility issues," Schwab explained.

The results: simple synchronization, better access

Schwab describes the third-party solution as "a simple tool that works great," specifically citing its ease of use. "The phrase we use is 'set it and forget it.' We set up an interface and now it just runs every night and does what it's supposed to do."

BC Hydro's in-house research team can easily make any data model changes. And, with the seamless migration of GE Smallworld data to the Esri environment, the utility has gained powerful advantages.

"We're leveraging 'no-code tools' like ArcGIS Story Maps to develop planning for maps for distribution," Schwab said, eliminating the need for planners to rely on PDFs and essentially start from scratch anytime they needed to create a map. BC Hydro's planning maps communicate key details to senior leaders and the Distribution Engineering and Design group, such as low capacity issues and upcoming system improvement work.

The utility can now embed maps into off-the-shelf tools like Collector, Field Maps and SAP Service and Asset Manager, providing its field personnel with the up-to-date information they need to complete their work effectively.

→

"We're leveraging a number of software developer kits for Esri to embed maps in web applications for street light management, customer connection requests and environmental study tracking," Schwab said.

BC Hydro can also share GIS data with external groups—like Emergency Operations BC—to ensure everyone has much-needed situational awareness when major events occur.

Opportunities abound: GIS technology moving forward

For decades, utilities have relied on manual processes to collect data in the field, transfer it to central databases, and issue work orders, as well as dispatch instructions and master schedules for their field operations.

Today, these labor-intensive processes are no longer sustainable. As populations increase, infrastructure assets age and regulatory standards become more stringent, utilities must leverage GIS technology to keep pace with advancing field asset management demands. By integrating GIS technology with automated workflows, they can meet their operational demands as well.

Simultaneously, the benefits of an enterprise-wide solution that provides seamless GIS data integration between multiple platforms are vital. The ability to share real-time data throughout the utility's geographic area enables more detailed and accurate tracking of asset conditions, which leads to timely inspections, servicing and repairs. And visualizing spatial information in a digital format also allows for better, more precise predictive models. It empowers utilities to effectively manage thousands of field workers responsible for maintaining power grids and orchestrating efficient and effective disaster responses.

With access to detailed, dynamically updated infrastructure maps and data, utilities can project the time and costs involved with field operations more accurately, restore services faster and reduce environmental impacts along the way.

With the ability to aggregate and share data in real-time, utilities can respond more strategically when emergencies strike, getting workers to critical areas faster so they can repair assets, mitigate damages and quickly restore services for impacted communities.

GIS technology provides a powerful tool for spatial analysis, asset management, emergency response, resource allocation and efficient and informed decision-making. By employing a singular GIS technology or synchronized solutions that are integrated with advanced workflow management tools, utilities will be able to meet the current challenges head-on and thrive for years to come.

ABOUT THE AUTHOR:

James Street is the founder and Chief Executive Officer of Epoch Solutions Group, a map-first leading provider of mobile workforce management software for utilities and data synchronization capabilities.

THE KEY TO UTILIZING DRONES FOR ENERGY INFRASTRUCTURE:

HOW BEYOND VISUAL LINE OF SIGHT AND COMPUTER VISION CHANGES THE ECONOMICS OF DRONES

KEITH MIAO

The energy industry has steadily adopted drone technology over the past decade, with many regulatory hurdles either overcome or actively being addressed. Drones are used to monitor and inspect critical power generation sites and sprawling transmission networks. They are being deployed in the face of threats to infrastructure – human or natural – to reduce the need to put personnel in harm's way.

Most investor-owned utilities now have a drone program, and many smaller or publicly owned utilities are on their way. However, in the current state of the drone industry, there is sometimes an uphill battle to justify the Return on Investment (ROI) of scaling up drone technology. This is largely because, at present, personnel must be on location to operate drones – ironic seeing as they are supposed to be autonomous or uncrewed systems. Although drones can help personnel see elevated or dangerous places, their value is hampered by the selfie-stick nature of how they are used today.

Beyond Visual Line of Sight (BVLOS) is the first step in enabling drones to be operated remotely and detect energy infrastructure issues without a person being on location. A remote operator with the right software and processes can tap into any location on demand. With BVLOS, operators can inspect critical infrastructure from wherever they choose – even at home on the couch. The transition to BVLOS can unleash never-before-seen volumes of data that enable energy infrastructure companies to anticipate and prevent security and safety issues. →

BVLOS drone intel with real-time computer vision. Image Credit: Birdstop

The holdup

Since commercial drone regulation emerged in 2016, speculative doubt about BVLOS has persisted. Two myths largely carry these doubts:

1. Myth: BVLOS is binary – either you have it or you don't.

In reality, there is a world of nuance behind that simple acronym. BVLOS can be segmented into several levels similar to the levels of self-driving car technology. For much of the time since 2016, the flavors of BVLOS still revolved around someone on location - Visual Observer (VO) - making sure safety is met and the airspace is clear. The operator of the drone could be remote but the area of drone operation needed to have a person. Today, the cutting-edge companies in BVLOS are beginning to operate at a small scale without anyone on location. Electronic systems are used to ensure safety and airspace deconfliction remotely. Once this is mastered, the industry can move toward one command center operating many drones at once with the assistance of software and AI.

> **In reality, there is a world of nuance behind that simple acronym.**

2. Myth: The regulators are too slow.

In the United States, doing any level of BVLOS requires bespoke approval from the Federal Aviation Administration (FAA). As such, regulation is often blamed for the lack of widespread BVLOS. While the process for obtaining BVLOS approvals can be long and the process opaque, the actual approvals granted are likely not far off what can be safely performed in practice. The discrepancy is more about what the FAA considers safe, which may be more stringent than what the private sector considers safe. As much as the private sector does bemoan the stringent approval process of BVLOS, it is worth noting that less than a decade ago there was no BVLOS of any sort and today BVLOS is at a point of commercial usage.

With increasing BVLOS, existing data processes do need to change to handle the immense volume of data returned by BVLOS operations. A second piece is needed to unlock the full value of drones while eliminating data processing bottlenecks: Computer Vision Artificial Intelligence (CVAI). CVAI will help existing personnel process and analyze the drastically increased volume of data on energy infrastructure.

Together, BVLOS and CVAI unlock the full potential of contemporary drone fleets, saving money, expanding capabilities and ensuring safety.

> BVLOS is the solution needed to maintain energy infrastructure while keeping workers safe.

Safety first

In addition to increasing speed and efficiency, BVLOS drone operations can reduce the need for personnel in precarious situations. According to OSHA statistics, repairing infrastructure is among the most dangerous jobs in America. And, although personnel regularly climb elevated high-voltage structures, most accidents actually occur in transit while personnel are traveling to areas where hurricanes, wildfires, or other natural disasters have affected energy infrastructure. Not only can BVLOS prevent certain trips into the field, but it can also provide situational awareness to personnel when a trip is unavoidable. If onsite personnel are needed, drone technology is ineffective at protecting workers from travel-related dangers. With renewables projected to grow rapidly through the next decades, towering wind turbines, remote solar fields and radioactive nuclear sites pose maintenance challenges and safety questions that require urgent answers. BVLOS is the solution needed to maintain energy infrastructure while keeping workers safe.

Looking forward

Since the US commercial drone industry began in earnest in 2016, regulators and companies have fought the good fight to enable commercially valuable BVLOS operations. For years it seemed like a pipe dream, but now there are meaningful BVLOS operations providing value to the energy industry. Barring any catastrophic reversal, over the next few years the expansion of BVLOS and AI will allow drone systems to be operated by largely remote personnel, massively shifting how these flying sensors are used and the volume of intel they can produce. This wealth of real-time intel has the potential to create a step shift change in ROI and a transformation in how energy infrastructure is managed at scale.

ABOUT THE AUTHOR:

Keith Miao is the CEO of Birdstop, a remote sensing platform used by enterprise to automate inspection and monitoring workflows. Miao's background in remote sensing and data science started over a decade ago at the Columbia University Earth Institute. He has a regulatory background from his early career working in Washington DC and a technology background from his later career at Google in California.

WESTERN KENTUCKY UTILITY DRIVES RESTORATION EFFORTS AFTER LETHAL TORNADO

EMERGENCY PREPAREDNESS AND COMMUNITY SUPPORT ENABLE A KENTUCKY UTILITY TO COMBAT WIDESPREAD OUTAGE

DAN BENNETT

Families in Mayfield, Kentucky went about their night just like any other. Watching television, doing dishes and putting their little ones to bed. They had no idea disaster would soon strike. On the evening of December 10, 2021, a catastrophic tornado hit their city. It struck with winds of up to 190 miles per hour, causing widespread outages and devastation throughout the community. Precious lives were lost, families were displaced and resources like electricity and water were scarce.

The tornado left a mark on the city that remains an impact to this day. Two years later, Mayfield continues to work towards a full recovery and rebuild what was lost.

No stranger to weather emergencies

This was not the first major weather emergency Mayfield had experienced. An ice storm in 2009 left 10,000 residents without power. The service provider lost all communication capabilities and the slick roads stalled restoration efforts. Add to the challenge no precedent for such a large outage.

Marty Ivy, the general superintendent of Mayfield Electric & Water Systems, became adamant that he and his team be better prepared for future emergencies. He created a list of challenges they faced from the ice storm, mistakes they made in their response efforts and ideas for improvement next time. Little did he know how helpful this would be 12 years later.

Facing disaster once again

The tornado touched down at night, and its vast destruction only took 3 minutes. The severe weather tragically took 22 lives and leveled 481 homes, businesses and structures. Uncertainty and grief filled the community when they found the path of destruction to be more than a mile wide. Yet, the team at Mayfield Electric & Water Systems turned their grief into action.

"My first thought was, 'Are my employees okay?'" said Ivy. "I connected with each of my managers, and they began making calls to the rest of our team members." →

Image credit: Xylem

Once he found his crews were safe, Ivy secured 100 hotel rooms in neighboring communities for employees, so they would have electricity, running water and temporary housing for their families. Giving them a warm place to stay allowed his employees to put their best foot forward and go to work for their community.

Recovery efforts began with evaluating their equipment and checking the power grid, transformers and substations. They discovered most everything was destroyed including the main office, the computers and servers and some of the fleet of bucket and digger trucks. They immediately purchased new trucks to begin work.

Help poured in

With $45 million in damages, it was clear the City of Mayfield needed all the help it could get. Vendors, friends and strangers alike poured in from neighboring towns and states to lend a hand.

“It all happened so quickly,” said Ivy. “On Friday, we had a company of 42 employees. On Monday, we had 250 people helping us. From linemen to water operators and pipe fitters, people from all over the Tennessee Valley and Kentucky were there to pitch in.”

Of course, the utility industry is known for its mutual aid.

“Everyone helps each other out,” said Ivy. “One of the first groups to call and offer support was [a Washington, DC-based] provider of smart technologies and services for utilities. We’ve been a customer of theirs for 12 years now, and I consider them my friends.”

Within 48 hours, the engineers visited Mayfield to check the equipment. They ensured both electric and water meters continued to provide reliable operations alongside the service provider’s communication network in the storm’s aftermath. The services provider also partnered with Americares to set up a charitable campaign that yielded $28,000 in relief funds for Mayfield.

The neighboring utility, West Kentucky Rural Electric Cooperative, pitched in, as well. The assistance enabled Mayfield to bring three circuits back online and to restore power at the local hospital just five days after the tornado. The diligent persistence and teamwork of crews and volunteers sped up the outage restoration timeline and resulted in:

- Bringing the substation back online within one week;
- Reenergizing more than 80 percent of the city within two weeks;
- Restoring power to all customers who could be reconnected to the grid within one month.

Times like these emphasize how important relationships are. As Ivy looks back on the 2021 tornado, he says close-knit partnerships were key to his team’s resilience.

“You can’t do it yourself,” said Ivy. “So many people poured their hearts out to help us and I will never be able to repay them.”

Image credit: Xylem

Image credit: Xylem

Using technology to persevere

Mayfield lost a lot, but the community support they gained, coupled with the existing technology is what helped them prevail. They used their advanced metering infrastructure (AMI) and meter data management (MDM) system to remotely track each time someone's power was restored.

The AMI system also helped the team identify the biggest water issues and leaks in the tornado's path and repair them before they became major breaks. In just 30 hours, Mayfield's water system was fully operational and pressurized, providing more time for them to prioritize power restoration.

"It's invaluable to have an AMI system," said Ivy. "We used ours to export visual graphs of our electric restoration progress. Knowledge is power, and we used this information to understand our remaining workload and to share status reports with the community."

Ivy credits the success so far to slowing down, planning and committing to not push his team too hard. They worked tirelessly for several weeks, but he capped their hours to prioritize safety and productivity.

The recovery wouldn't be what it is today without the team's discipline and precision to ensure an efficient recovery and safe environment. Mayfield now has a more concrete process for responding to crises like the ones they experienced in 2009 and 2021. If a weather emergency happens again, they are prepared. Meanwhile, they hope their story helps others.

ABOUT THE AUTHOR:

Dan Bennett is the vice president of product management, energy and water solutions with Xylem. He has 10 years of service with the smart technology company. He earned a Bachelor of Science degree in both electrical engineering and computer engineering from North Carolina State University in Raleigh.

UTILITIES NEED TO DECARBONIZE, DECENTRALIZE AND DIGITALIZE

NEXT-GENERATION COMMUNICATION TECHNOLOGY IS THE KEY ENABLER

KOUSTUV GHOSHAL

The utility industry is facing a number of challenges. There is an urgent need to modernize to digitize the grid for reasons of operational efficiency, asset ownership and control. The grid is becoming more complex with increasing operational expenses. At the same time, many utilities have set ambitious Net Zero goals amid pressure from consumers and governments to decarbonize. Add to that, the demand for more reliable and higher quality power and a diversifying mix of intermittent resources — and the grid is ripe for a wholesale transformation.

There is potential here for telecom and power industries to come together and address all these challenges head-on. Mission-critical cellular networks providing grid connectivity can become that grid modernization mechanism that provides resiliency and flexibility for an evolving grid while reducing carbon emissions.

The future of the power grid is ever more a two-way street, where power is generated, stored and shared between multiple locations, creating energy savings as well as reducing the carbon footprint. Cellular connectivity at individual cell sites fortified with on-site Distributed Energy Resources (DER), linked together, can enable that future. →


5G
5G

No intelligence without connectivity

The best possible path to meeting the aggressive goals set by utilities is through making the energy grid "smarter" — such as directing resources where and when they're needed, and ramping down production when it's not required. But there are degrees of intelligence, from simply demand response (DR) management to "self-healing" networks that take advantage of automation, to advance AI functionality that not only responds to peaks and valleys in demand but predicts them.

The key to that intelligence? Ubiquitous connectivity. And in the race to build a smarter grid, utilities have started down this path by building hundreds of mission-critical private cellular (4G or 5G) sites. It's faster and more cost-effective than laying fiber, it's secure and most importantly flexible enough to accommodate the deployment of future use cases or other "smart" solutions. The fast, high-bandwidth and low-latency connectivity these networks provide will enable the intelligence necessary to manage an increasingly complex grid. For example, sensors at substations connected to the network of cell sites via the 4G/5G networks across a region can help utilities shape their load profiles and energy-use profiles by collecting real-time data about the ebbs and flow of usage — as well as predicting when future peaks and valleys will occur. That intelligence is also critical for managing power consumption at the site itself, reducing energy usage and lowering costs as well as carbon emissions. This connectivity will be critical as utilities move to a decentralized model.

Nanogrids: The catalysts for an evolving power grid

The most important evolution of the utility industry is that soon, the majority of consumers will no longer simply consume energy but have the ability to create and share it too — as prosumers. This is happening today on a small scale, when for example residential solar owners sell excess production back to the grid, or with other microgrids.

As distributed generation gets even more granular, segments can be divided further from a microgrid into nanogrids. If a cluster of distributed energy resources (DER) systems comprises a microgrid, a nanogrid is one level below that — such as the power management infrastructure at a single cellular site, that can act as an on-demand resource to serve around 5-10 kilowatts for 12 hours or more.

Each of these cell sites can be an opportunity for the utility. Such a nanogrid site becomes one of the available energy resources in an overall network of hundreds of sites. They can draw power from on-site solar panels, battery storage systems, or other clean sources of power, replacing lead batteries and diesel generators. In addition, such a mechanism becomes key toward leveraging Ultra High-Voltage (UHV) transmission towers as potential cell sites, where secondary voltage may not be typically available to energize the 4G/5G electronics.

For example, one company's headquarters in Plano, Texas has a new proof-of-concept 4G/5G site situated on its roof. The site has the ability to be fully powered by solar energy, complemented by integrated long-duration dual redundant battery storage units, for up to 18 hours. It brings together hybrid energy management, renewable energy sources and energy savings strategies while enhancing grid resiliency — and can be a model for broader partnerships between telecom and power interests.

Communications technologies and utilities must come together

Data from the U.S. Energy Information Administration shows that extreme weather driven by climate change is increasing power outages. We have witnessed catastrophic environmental disasters brought about by brushfires caused by downed conductors on the West Coast of the US.

Deeper collaboration between the communications and power grid infrastructure can help ensure no one is left vulnerable without power or connectivity in emergencies. But we need a system that welcomes flexibility in the power generation and distribution chain.

By decentralizing the power grid and connecting it with a global standards-based ubiquitous intelligent communications network, we can transform the existing power grid ecosystem to support digital transformation. And such nanogrids that leverage renewable sources and intelligent energy management systems will be an important building block for that transformation.

ABOUT THE AUTHOR:

Koustuv Ghoshal is vice president and the head of Ericsson North America's Utilities and Energy verticals. Prior to this role, Koustuv was the VP and head of Ericsson's management consulting division (inCode) for North America He brings over 30 years of experience in the utilities, telecom and mission-critical industry verticals. Before joining Ericsson, Ghoshal had P&L leadership roles at leading companies in the ICT domain. He has a bachelor's degree in electrical engineering and a master's degree in power systems automation from the University of Texas.

A QUESTION OF QUALITY

HOW ACCURATE FORCE MEASUREMENT IS HELPING TO ENSURE SAFE AND EFFICIENT BATTERIES

DANIEL JONSSON

Long applied in metals and paper production processes, technologies for measuring flatness, tension and thickness are increasingly finding a new field of application in helping to meet the rapid growth in demand for lithium batteries.

The global shift to renewable energy sources is leading to a boom in electrification and energy storage worldwide. Lithium-ion batteries in particular — rechargeable, lightweight, energy-efficient and boasting a high energy density — will be part of a cleaner energy future.

The applications are important too. Demand for consumer electronics, like laptops, tablets and smartwatches, will continue to grow, making demands for battery power that lithium-ion is well placed to meet. The nascent electric vehicle (EV) market is possibly the most significant factor. The Economist suggests that, in the coming years, the proportion of vehicles powered by batteries will grow quickly, with China leading the way.

Thus, lithium-ion-based battery solutions will most likely dominate in the near future. With yearly battery demand growth forecasted to be more than 25%, one estimate suggests that more than 100 giga-size factories need to be built to keep up with demand until 2030.

Another important factor is cost. The combination of lower raw material prices for lithium and cobalt and economies of scale in battery production is driving down costs. This in turn fuels further growth, as more and more applications become economically feasible.

However, the challenge for manufacturers is to keep up with demand and, despite lower raw material prices, to manage costs; this is a highly competitive market.

Currently, battery supply is very tight, and in turn is driving interest in equipment for measuring and controlling flatness, tension and thickness, which play a crucial role in ensuring the final quality of the finished battery. →

A force for quality

In a highly competitive and demanding manufacturing environment such as battery production, even small improvements in equipment performance can make a big difference. In terms of the battery manufacturing process, the primary applications demanding accurate measurement of flatness, tension and thickness are found on the downstream side, which compromises various stages including slurry mixing, electrode manufacturing and cell assembly, including winding and stacking.

The process starts with copper and aluminum foil of thicknesses of up to 0.2mm down to 10 μm or even thinner being coated with slurry used to create the anode (copper) and cathode (aluminum) electrodes.

The coated foils are then dried at temperatures from 20 to 150°C, before being passed to the calendering process, where they are compressed and compacted to achieve a consistent thickness and improved energy density of the battery.

Following these stages, the electrode coils are slitted into strips to be rolled up and stacked into packages and placed in a sleeve filled with electrolytes to allow electricity to flow.

Cell assembly is where the separated anode and cathode sheets are either wound or stacked, always alternating with a separator sheet between them. The assembled cell is packed into a pouch foil and filled with the electrolyte. The resulting pouch cells can be rolled or stacked in different configurations before they are finally placed into a housing, which is filled with electrolyte again.

Cell finishing involves processes such as pressing, high-quality formation, degassing, aging and testing. Throughout these processes, it is essential to control both the tension and flatness of the foils. With machines in the processes moving at typical speeds of 250ft per minute (76m) or more, there is risk of issues that could lead to foil strips breaking or that could cause potential imperfections or damage that could affect the final quality of the finished battery.

One problem is wrinkling of the foils that can occur if they are not correctly tensioned and flattened. If the foils are wrinkled, it can result in uneven distribution of the electrode slurries. As well as reducing battery performance, this could also present a safety risk, with the potential for batteries to explode. For this reason, and to avoid potentially costly product recalls, it is vital to ensure accurate application of tension and flatness throughout the production stages to minimize the risk of the foil becoming distorted.

Accurate web tensioning is also important during the cell assembly stage. Two alternative methods are used at this stage, specifically winding, or stacking. During the winding process, the anode foil is overlaid onto the cathode foil and a separator is inserted to prevent short circuits and enable the flow of ions during operation. Accurate tensioning is needed to ensure the foils and the separator are properly aligned. Failure to align them properly, or to apply the correct tensioning can both result in impaired performance and increase the risk of a short circuit that could affect the safety of the finished battery.

The other method, stacking, involves cutting the anode and cathode sheets and stacking them into alternate layers. As with the winding process, accurate tension control is key to ensuring that the sheets are positioned correctly to ensure optimum performance of the final assembled battery.

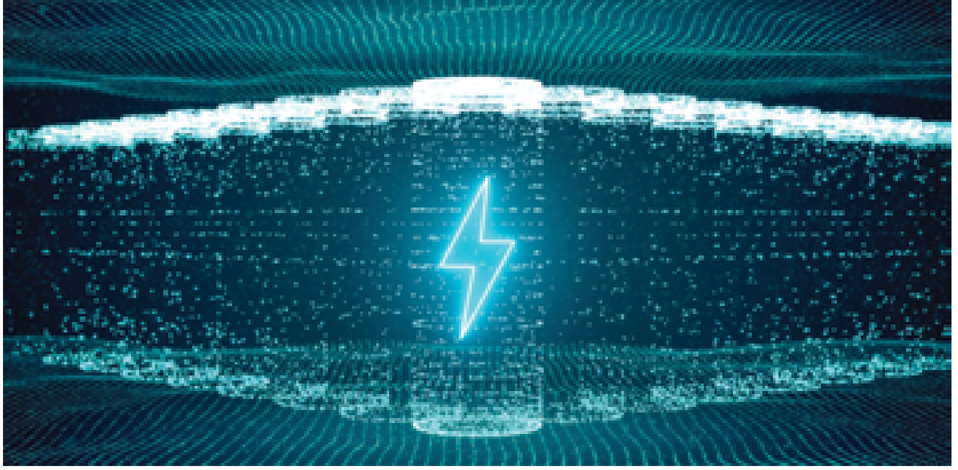
Avoiding production disruption

Satisfying the rapidly escalating demand for batteries calls for production lines that can be maintained at full operation with minimal downtime. As well as inspection checks and repairs and replacements for maintenance purposes, this downtime can also be incurred by the need to check and, if necessary, adjust the calibration of measurement equipment to ensure their continued accuracy.

In tension measurement applications, for example, typical load cells based on strain gauge and LVDT (Linear Variable Differential Transformer) technologies can be impacted by a variety of factors, including vibration, unexpected shock loads, electrical interference and incorrect specification and installation. This can increase the frequency of calibration checks, and/or recalibration, requiring the affected production line to be put out of service for several hours for the necessary work to be carried out.

This issue can be overcome by opting for devices using technologies that can function for long periods without drift or loss of calibration. Based on magnetoelastic transducer technology, load cells do not require a physical movement in the transducer, enabling it to withstand vibrations, shocks and overloads that can affect other sensor types. They are also impervious to the ingress of dirt and fluids that could impede performance. By eliminating the need for recalibration and enabling measurement accuracy to be maintained, the load cells can help to maximize yields by reducing disruption to production.

These same benefits apply to the flatness and thickness gauges, which both utilize highly stable measurement techniques that avoid the need for recalibration and are unaffected by external disturbances such as vibration and ambient temperatures.



Minimizing the risk of recalls

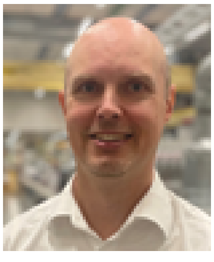
The importance of eliminating problems that could affect the quality of the assembled battery is highlighted by the potential implications of safety recalls in the event of a fault. In 2016, a major electronics producer recalled 2.5 million of its smartphones from across 10 countries after a flaw was discovered in the batteries used to power the devices that could cause overheating. To placate customers, the company issued replacements for each of the phones, resulting in its manufacturing lines being tied up for two weeks to produce the new units.

There have also been instances involving overheating and fire risks presented by faulty batteries used in everything from laptops to cars and even aircraft, highlighting the need for the highest levels of accuracy, reliability and consistency during the battery production process. Furthermore, with battery manufacturers held liable for the consequences of a failed battery even if the fault was due to improper handling or mistreatment by customers, there is the added impetus to ensure that every step is taken during production to achieve the required standards of quality.

Rolling out a new future for energy

The growing role of lithium-ion batteries in providing a renewable source of power to support everything from electronics to transportation and microgrids will see global demand continuing to increase, with projections from Statista estimating an elevenfold rise between 2020 and 2030[1].

As lithium-ion batteries are used to power an expanding range of products, manufacturers will need to ensure they are making the right choice when it comes to selecting the best measurement instruments for their processes. When it comes to selecting measurement and control technologies for flatness, tension and thickness applications, making the right choice will ensure both the quality and safety of one of the critical components in EVs and consumer electronics, potentially saving billions of dollars and minimizing the risk of injuries from defective products.



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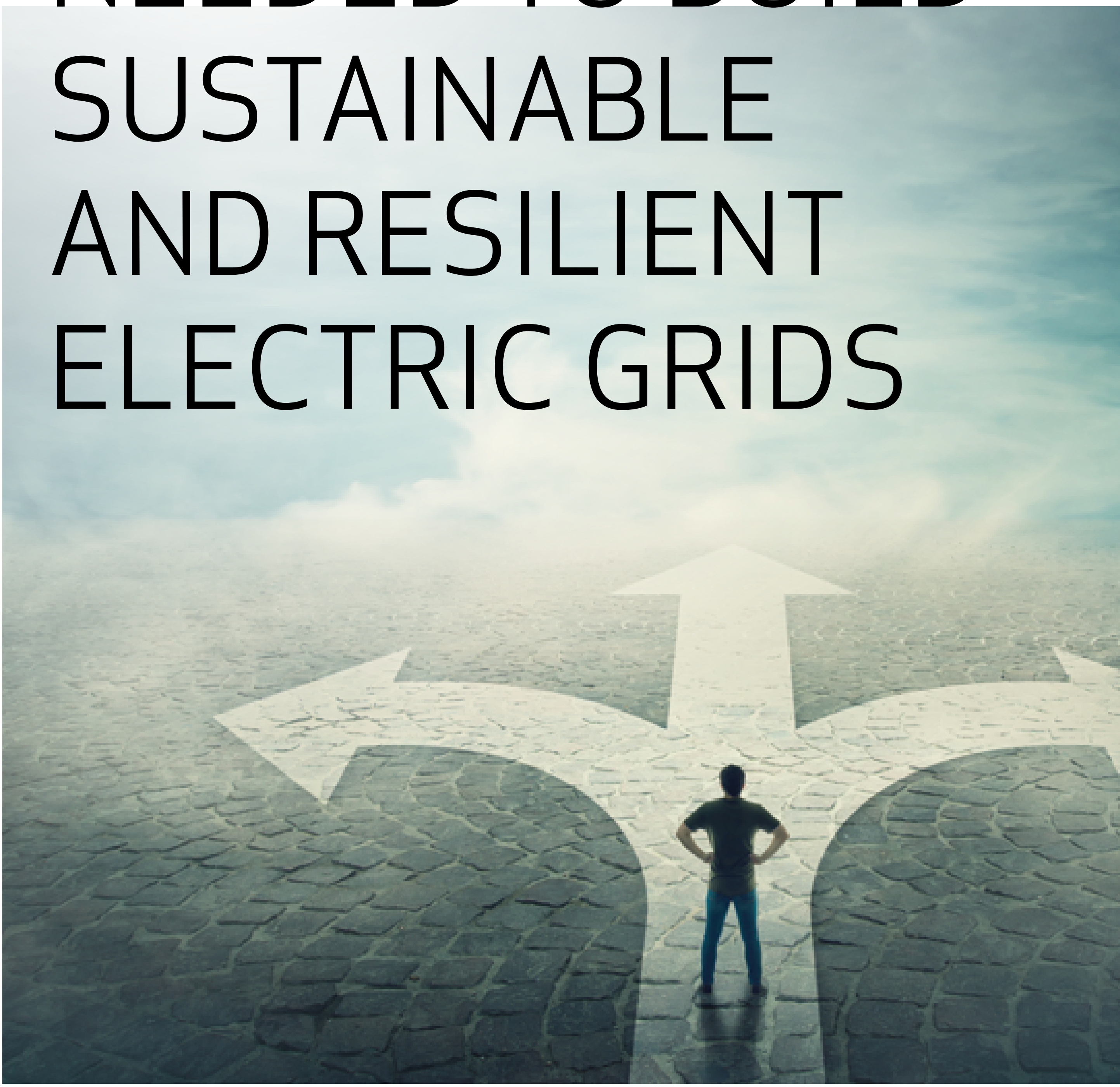
[1] Statista - Lithium-ion batteries - statistics & facts - https://www.statista.com/topics/2049/lithium-ion-battery-industry/

THE CHANGE NEEDED TO BUILD SUSTAINABLE AND RESILIENT ELECTRIC GRIDS



BRIAN ROCK

Flash flooding in high deserts, roads melting in the summer heat, rare Mediterranean hurricanes, wildfires in tropical paradises — the recent headlines are chilling for anyone. But knowing the impact of these calamities as they relate to electric utilities makes the headlines particularly alarming for those in the utility industry.

Climate change events — combined with demand growth, shifting requirements and antiquated electric infrastructure – are wreaking havoc. The challenges are too big to be ignored, and utilities are at a crossroads. Changes must occur to ensure the future sustainability and resiliency of our electrical grids — changes, in part, informed by data coming from digital technology and transformation.

The perfect (electrical) storm

Much of the infrastructure that makes up electrical grids is old and/or outdated. For instance, in the United States, experts estimate that over 70% of the components of the U.S. grid are more than 25 years old. This weakness makes grids even more vulnerable to the intense weather conditions brought on by climate change. Moreover, electric grids were, by in large, built to bring energy from where electricity is generated (typically by fossil fuels) to where electricity is consumed. With the increase of renewable energy sources, coupled with the new types of demands for electricity, such as electric vehicles- (EVs), the grid's underlying purpose is quickly becoming outdated. Massive change in investments for infrastructure, people, processes and technologies are needed to make it cleaner and greener. →

Utilities themselves are struggling to adapt to change. From new electrification and load demands to equipment upgrades and regulatory obligations, changes that traditionally happened in 20 years might now be happening in a handful of months. Today's utilities need to address these quickly changing external requirements, as well as their own internal operations. Expectations of customers have been revolutionized based on today's business-to-consumer online business experiences. Since much of the deep knowledge in the workforce has or is about to retire, a utility's technology platforms must also be cutting-edge to attract and retain newer employees.

But funding for vital changes continues to be challenging. Given the convoluted web of local, state and regional utility regulators that control their purse strings, public utilities need hard numbers to justify the rate recovery increases that fund grid upgrades. Capital expenditures are needed, for example, to replace transformers that were never intended to serve all the new EVs tapping into the electrical grid or cannot cope with the sharp rise in home electrification.

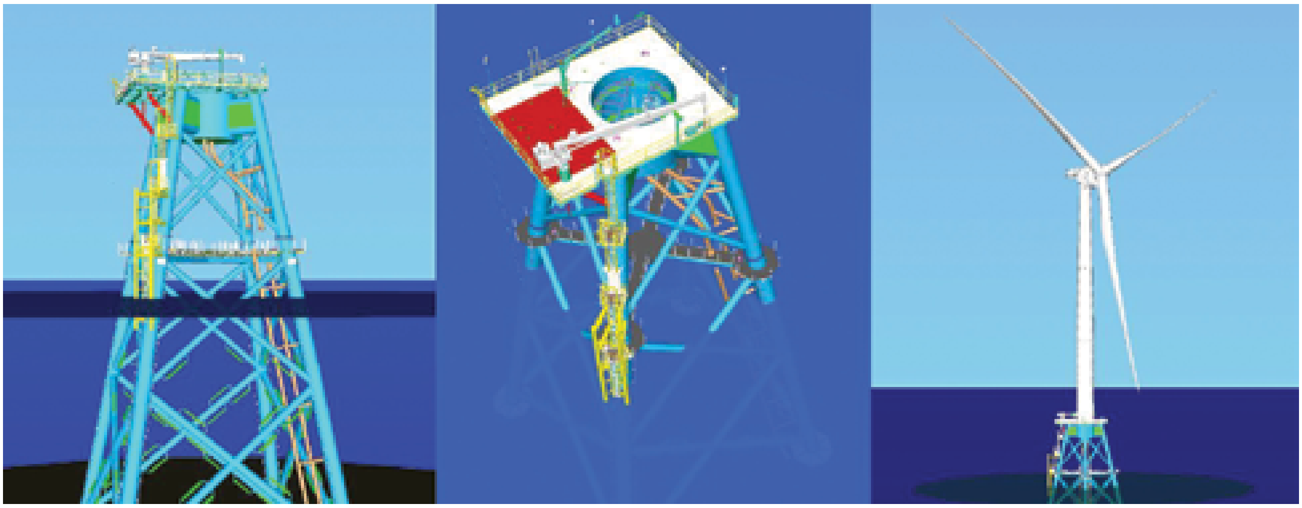
Now or never

These challenges have created a perfect storm — but one with a silver lining. We have a now-or-never moment to modernize the grid, making it more sustainable and resilient for the decades to come. And data is the basis for that change. Buried within every infrastructure asset and every project is data — data waiting to be unlocked, understood and used, and data delivering the insights that empower infrastructure intelligence. From connecting critical information and workflows to leveraging digital-twin-powered and AI-driven advancements, infrastructure intelligence is how we will build a more sustainable and resilient electrical grid. With data as the foundation and digital capabilities as the building blocks, accelerating infrastructure intelligence can address some of the biggest challenges facing our electrical grids.

Connecting digital workflows within an organization and across disciplines gives stakeholders the information that they need to make the necessary changes. This information empowers data-driven, real-time decision-making and provides irrefutable data needed for change.

Getting this information requires technology solutions that facilitate real-time data exchange, creating a connected data environment for an evolved electrical grid. By leveraging the data stemming from these solutions, utilities can share data to improve their transparency — both internally and externally — while enhancing their customers' experiences. In addition, cutting-edge technology can attract and retain a younger, eager workforce. More importantly, the information from these solutions can help utilities quantify and communicate needs with regulators to make the bold grid upgrades that are needed to build sustainability and resiliency into today's electrical grids.

The Block Island Wind Farm will reduce the cost of future offshore wind projects by providing a viable design and fabrication process.
Image courtesy of Keystone Engineering.



Keystone Engineering designed jacket-type substructures for five wind turbine generators. Image courtesy of Keystone Engineering.

Digital technology and workflows for electricity production and delivery are enabling organizations to improve project delivery, optimize operations, increase grid resilience and safeguard "last-mile" energy networks.

Improve project delivery

Digital solutions are essential for the expedient delivery of renewable energy projects that support our transition to cleaner energy production. Digital technology enables organizations to analyze, design, simulate and collaborate more intelligently and effectively. Project workflows are enhanced using integrated, cloud-ready, scalable and adaptable multidiscipline design and analysis.

Connected, digital project delivery solutions also provide end-to-end workflows and data. By unifying multidiscipline teams and connecting the project delivery supply chain, data integrity is enhanced, leading to improved project performance and increased productivity.

An example is Keystone Engineering, who used digital solutions to effectively design the first offshore wind farm in the U.S. The firm was tasked with designing the substructures of five wind turbine generators for the USD 290 million Block Island Wind Farm off the coast of Rhode Island.

Keystone used engineering infrastructure software solutions to optimize design, mitigate risk, minimize steel weight and reduce fabrication and installation costs. By performing multiple simulations and design iterations simultaneously, they were able to shorten the design cycle by 50% while lightening the weight of the substructure. Optimizing the amount of steel needed for the foundations saved the client 20% in installation costs.

Optimize operations

Organizations are increasingly turning to digital twins to improve asset health, system performance, reliability, safety and sustainability. Using sophisticated cloud-based technology to connect the physical and virtual worlds, digital twins combine disparate data created by diverse design, construction, inspection and maintenance applications into a federated environment. It gives utilities the insights needed for more accurate, data-driven decisions and business processes that make their infrastructure more sustainable and resilient.

For example, digital twins can provide increased visibility into a utility's operational data — enabling them to determine how assets are performing and what changes are needed. Maintenance teams can work smarter to ensure accurate reporting and compliance, improve safety and reduce maintenance costs. Moreover, this digital record of current conditions and changes can be used to inform future inspections, reporting and operations.

For instance, hydroelectric power from Washington's 160-foot-high Diablo Dam feeds the greater Seattle area power grid. To improve safety and efficiency while minimizing risks, Seattle's electric utility, Seattle City Electric (SCL), tasked engineering firm HDR to create a digital twin as part of the utility's physical inspections. HDR used aerial and drone surveying and reality modeling solutions, as well as AI and machine learning algorithms, to create a digital twin of the dam that is accurate to within two centimeters.

This digital twin of the dam serves as the baseline of the structure, helping SCL improve and visualize the surveillance and monitoring of the dam. Real-time monitoring provides the right information at the right time for proactive risk management, safety and predictive maintenance applications. →

Aerial view of the Diablo Dam. Image courtesy of HDR.

Increase grid resilience

Digital technology also helps ensure the integrity and resiliency of transmission and distribution systems, big or small. Utilities are relying on digital solutions — from the digitization of previous manual surveys and design work to the use of reality capture models, model-based clash detection and automated workflows — to replace traditional error-prone, time-consuming manual methods.

By using digital means to manage the delivery of capital investments related to the refurbishment, replacement and construction of assets, utilities are lowering network operating costs. These solutions enable timely and safe design decisions, resulting in reduced outage times and a more resilient network.

For example, Australia's Essential Energy provides electricity services to 95% of homes and businesses in New South Wales, including many rural and remote communities. To lower network operating costs and unlock value across small capital energy projects, the utility is using reality modeling-based solutions to digitize previous manual survey, design and construction workflows for some of its rural substation sites.

By automating previously manual processes, Essential Energy has reduced its substation design hours as well as its environmental impact. The utility's new workflows have improved quality and efficiencies, reduced rework associated with design and construction errors, enhanced safety and minimized travel to remote substation locations. As a result, project costs have been lowered by 50% and design-related travel by 80%.

Safeguard last-mile energy networks

Digital solutions are also helping utilities ensure the integrity of the overhead infrastructure that is at the end of their energy distribution and communications systems. The challenges associated with safeguarding this last mile of networks are intensifying as electrical grids are modified to accommodate new requirements.

Essential Energy is using reality modeling to lower network operating costs and unlock value across small capital energy projects. Image courtesy of Essential Energy.

Software applications are helping asset owners, telecommunication companies and contractors digitally assess and manage the assets and activities related to their overhead systems to meet these new challenges. These challenges include accommodating renewable energy sources, providing power for EV charging stations, supporting the expansion of broadband networks expansion to 5G,and taking on the vital task of modernizing the grid and hardening it to withstand severe climate events.

Mastering a new normal

Meeting the new demands that tax today's electrical grids and adapting to the new normal occurrences of what were once-in-a-lifetime climate change events are the challenges that we all face. Considering this new normal, those of us in the utility industry must act now to preserve and improve the sustainability and resiliency of the electrical grid and its underlying infrastructure.

Data stemming from digital technology and transformation — and the infrastructure intelligence created — will help build optimizations and efficiencies into every aspect of designing, building and operating our energy infrastructure.

ABOUT THE AUTHOR:

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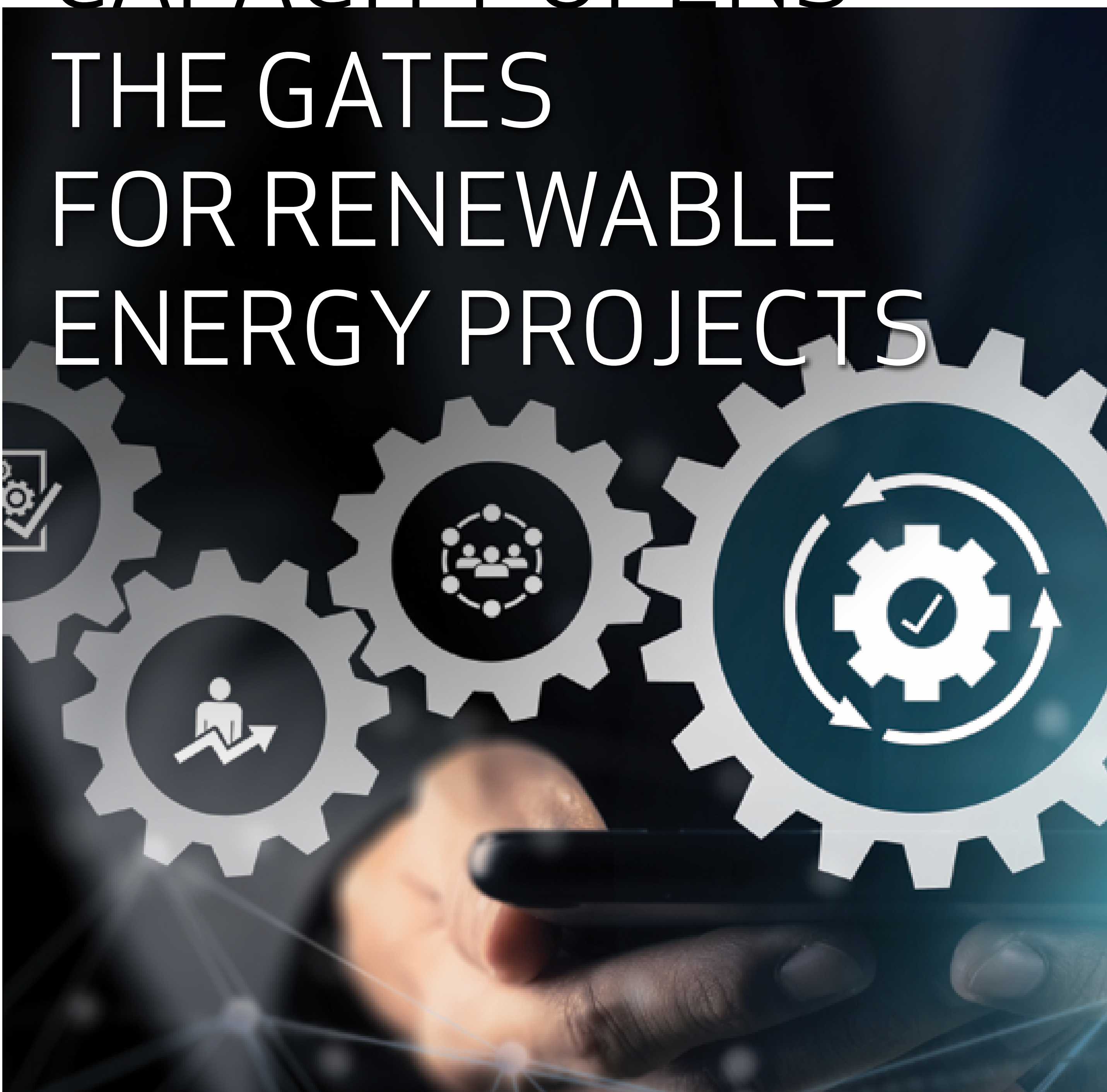
UNLOCKING GRID CAPACITY OPENS THE GATES FOR RENEWABLE ENERGY PROJECTS



BRIAN BERRY

It's well understood that the world's aging power grids are rife with problems. However, replacing major portions of the grid assets to fix those problems is not realistic, so the challenge facing utility leaders becomes how to do more with existing assets. Moreover, the challenge is how to wring more out of existing assets with solutions that won't take ages to implement or are cost-prohibitive. With a focus firmly on improving existing assets, challenges and opportunities can be placed into three main categories: capacity optimization, asset health and grid reliability.

For this article, I'll focus on the first opportunity: capacity optimization. Capacity optimization unblocks the renewable energy interconnection queue by finding and leveraging untapped grid capacity, making power transmission more efficient and cost-effective.

Two innovative technologies, Dynamic Line Rating (DLR) and Ambient Adjusted Rating (AAR), are igniting the transformation to capacity optimization by unlocking the latent capacity of power lines. DLR and AAR technologies, which leverage real-time and forecast weather data and conductor condition monitoring, are at the forefront of increasing grid capacity. →

Dynamic Line Rating (DLR): DLR uses sensors installed on critical sections of power lines, or attached to the transmission towers, to constantly collect data on parameters such as current, sag, conductor temperature and wind speed. Algorithms use this real-time information, combined with weather data, to accurately estimate the capacity of a line. By dynamically adjusting line ratings based on environmental conditions, DLR enhances grid efficiency.

One notable example of DLR in action is PPL's award-winning capacity optimization project. PPL, one of the leading electric utilities known for its cutting-edge power grid and customer focus, was faced with grid congestion and high nodal prices. Rather than undertake expensive network upgrades, the bellwether opted to implement DLR, which proved to be 90% more cost-effective. This choice allowed PPL to increase line capacity by 20% for 90% of the time, leading to more reliable power supply.

Ambient Adjusted Ratings (AAR): AAR does not use sensors. Instead, it leverages atmospheric data from third parties to optimize capacity. While simpler and more cost-effective than DLR, AAR lacks sensor-driven data about wind's cooling effect, which means it typically yields lower capacity gains than DLR. Yet those gains are critical. The Federal Energy Regulatory Commission's Order 881, mandates that by 2024 all transmission line owners leverage AAR. The primary goal of FERC Order 881 is to enhance transparency in calculating transmission line ratings. By mandating documented and publicly available transmission line rating methodologies and using AARs, FERC aims to increase the capacity and utilization of the transmission infrastructure. AAR is a crucial element to that end. It's worth mentioning that in addition to the focus on AAR, the FERC is also exploring the merits of DLR following order 881, so DLR could potentially be mandated as well.

Unlocking the future with DLR and AAR

DLR and AAR solutions are already well-proven and utilized in both Europe and the US, and now it's time for more utilities to start this journey to smarter, adaptable power networks.

DLR and AAR technologies significantly improve capacity on existing overhead transmission and distribution lines – particularly during cooler or windier weather conditions. DLR produces up to 40% additional capacity 50% of the time and AAR yields a humbler and more conservative 5% to 10%. The combined benefits are significant, largely reducing locational electricity prices, deferring line upgrades and enabling improved outage windows. These are big benefits that cost about 2% of the price of alternative solutions such as reconductoring or building new lines.

FERC has done amazing work with 881 to unblock the systematic challenges and in the US, DLR could be mandated, too. This would "open the floodgates" on getting the most out of grids and benefit all. While the majority of technical and systematic challenges have been solved, significant financial hurdles still exist, and adding DLR could help solve those. DLR and AAR examples exist worldwide and they are high TRL and delivering real value. This shows it is possible. With the right financial and regulatory framework in place, all utilities could benefit from DLR and deliver value to consumers by reducing electricity prices whilst increasing the uptake of renewable energy.

Leveraging both DLR and AAR solutions is a crucial step in leveraging untapped grid capacity helping grid operators meet the surging demand for electricity. Moreover, the solutions help preserve asset health and bolster grid reliability, all of which support efficiency and cost reduction. Utilities and their customers both gain significant advantages delivered by these transformative tools.

ABOUT THE AUTHOR:

Brian Berry brings over 14 years of experience to the energy sector. He leads with a senior and strategic perspective at Ampacimon, where he spearheads innovative solutions to address the intricate challenges faced by power systems. His previous roles at Reactive Technologies, GE and Eskom involved technical leadership, strategy and delivery of solutions focusing on improving power system operations with stability monitoring and control.

A HEALTH SCREEN FOR THE GRID: USING CLIMATE DATA TO UNCOVER FUTURE RISKS

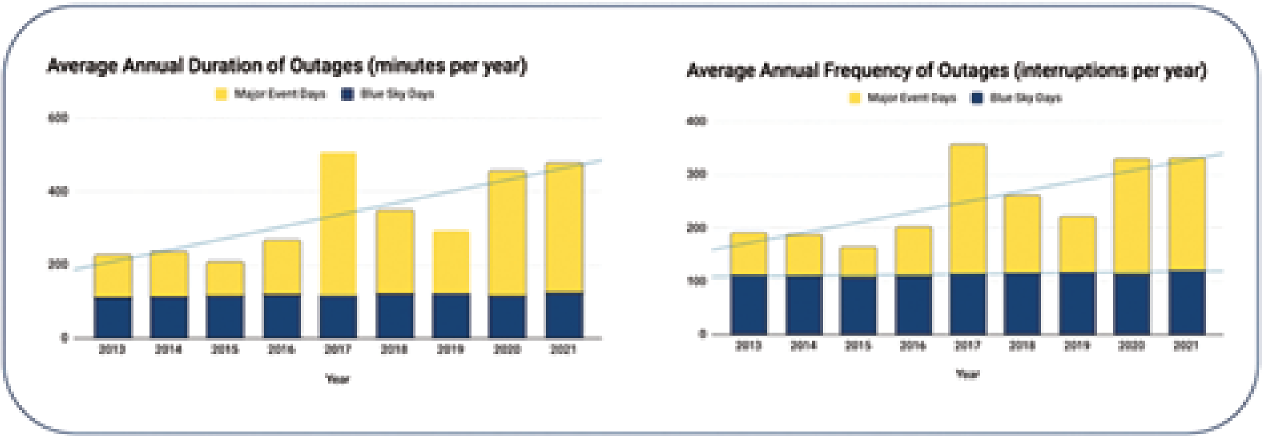
MISHAL THADANI

Our musculoskeletal system is a magnificent, but sensitive apparatus. We navigate life through stages of our bodies being capable of a variety of different feats. We have an incredible ability to recover from injury when we're kids, and athletic prowess when we're young adults, but then something happens at a certain age — the condition of our body very slowly starts to deteriorate. When we fall, it's harder to get back up. When we exercise, it takes a bit longer to recover. Eventually, if we're not taking proper care of our bodies, any sudden impact could have devastating consequences.

It's only because we can forecast these changes that we can prevent their onset through some form of intervention: changing our diet, exercising, practicing yoga, or getting blood tests are all common actions for increasing physical longevity.

If we treated our adult bodies like we did when we were kids, we'd be putting ourselves at high risk in the future.

This is the current state of the electric grid. →



Energy Information Administration Reliability Metrics of U.S. Distribution System

If you've been paying attention to climate trends, you've probably seen the chart from NOAA demonstrating the growth in billion-dollar disasters over time. There were 25 separate billion-dollar disasters in 2023. To fully contextualize this phenomenon about the electric grid, the U.S. Energy Information Administration offers data on power grid interruptions for blue sky days and major event days.

The trend demonstrates a roughly 50% increase per year in severe weather outages while blue sky outages stay flat, making one thing clear: the way we've been investing in the grid works well for reliability during normal conditions, but not for resilience during extreme weather conditions.

A study by McKinsey estimates that utilities can unlock 40-60% of value from capital assets by using advanced analytical approaches.

An aging grid compounded with more severe weather events means that we need to invest more in the grid and do it in a smarter way.

As utilities invest more capital on infrastructure hardening than ever and the federal government puts an historical amount of dollars to work, utilities must also adapt their investment prioritization models, which often look at limited, historic data sets. A study by McKinsey estimates that utilities can unlock 40-60% of value from capital assets by using advanced analytical approaches.

Current multivariate attribute value functions used by utilities are typically limited — incorporating asset health scores, outage data and certain other variables — and tend to rely on historical information and traditional statistical methods. These methodologies are ineffective in planning for future scenarios and understanding the impact of extreme weather on utility assets such as poles, conductors, cross-arms and transformers. A causal inference approach — the ability to attribute some asset failure as a *result* of a threat or combination of threats — is critical to understanding the relationships and quantifying the impact of various weather conditions on a variety of utility assets.

In order for decision optimization models to adequately reflect future environmental conditions, utility data sets need to be enriched with information that represents physical threats to their infrastructure, such as weather, vegetation, topographical information and aerial imagery. This geospatial contextualization can then be coupled with global and regional climate models to understand not only how extreme weather trends will increase in the future, but how they will result in vulnerability on the power system.

Diving into the world of climate data

Coupling climate projection data with historic data sets is no small task. For almost 20 years, scientists have been conducting experiments and running climate models to better understand natural changes in response to radiative forcing from an increase in greenhouse gas emissions. This work has evolved into the Coupled Model Intercomparison Project, or CMIP, which coordinates experiments, simulations and models to publish standardized data sets globally for various climate variables, and forecasts those variables over the long term according to various carbon emission scenarios. These data sets offer the best understanding of future climate conditions.

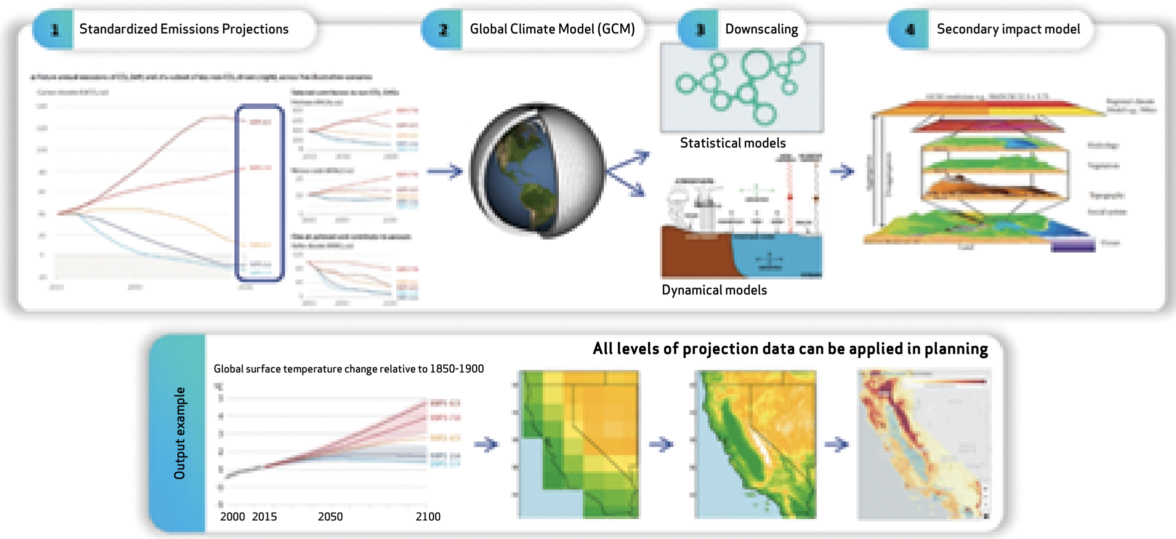


Figure 3. Sequential modeling process for climate projections (Sources: IPCC AR6, NOAA, Al-Ghadi et al. (2020), USGS)

However, the data sets in their current state are usually not conducive to performing quantitative analyses on utility assets — they're coarse, temporally disparate, and require immense amounts of bias correction and validating with ground-truth weather and climate observations.

Understanding scenarios

When climate models are run, they're done according to various emissions scenarios known as the Shared Socioeconomic Pathways (SSP). It takes different scenarios of inputs such as global population, GDP and policy activity to project emissions profiles and subsequent global mean temperature increases.

For utilities, it's important to understand which scenarios to model against when quantifying extreme weather risk. For instance, if one were to assume SSP5, the highest emission scenario, then the climate risk profile would be extremely high — in anticipation of much greater severity and frequency of extreme weather events — and would result in more favorable cost-benefit metrics for resilience-enhancing investments.

Utilities must be able to determine which scenarios to choose and how to compare them against each other when assessing future risks, creating resilience plans, and making the corresponding investments.

Diagnosing the symptoms

All along the chain, from generation to behind the meter, a changing climate is anticipated to have enormous consequences.

Generation: In the Pacific Northwest, higher temperatures are likely to lead to increased drought conditions, putting many of the hydroelectric generators at risk of future production challenges. For a state like Washington, where 65% of its electricity comes from hydropower, planning for this threat to resource adequacy is essential. Similarly, as long-term patterns related to wind and solar irradiance change across the country, wind and solar developers will need to adjust generation projections over the typical 25-year lifetime of their projects.

Transmission: In the Northeast, longer winter cold snaps are starting to result in greater ice buildup on transmission lines, causing excessive sagging and degradation, and in some cases immediately causing the line to break. In the Southeast and Puerto Rico, more frequent and intense tropical storms and hurricanes have the potential to bring down large swaths of transmission lines, which will cause long-duration regional economic disruptions and negatively impact communities' health and safety.

Distribution: Distribution infrastructure, because it is so geographically vast and tends to be more vulnerable than other grid assets, is especially at risk of failures and disruptions from natural threats. High winds have the ability to snap old, degraded poles. Intense precipitation can flood underground networks and substations. Extreme temperatures can cause transformers and other expensive components to overload and degrade more rapidly. Vegetation is also a serious threat, as distribution infrastructure commonly exists along tree canopies that are taller than the conductors, paving the way for significant potential contact between vegetation and poles and conductors. →

Behind-the-Meter: In many states that have implemented specific energy transition policies, such as incentivizing electrification, heat pumps and other electric appliances are supplanting fossil fuel-based appliances such as furnaces and gas stoves. In colder regions, it's likely that new winter peaks will emerge as consumers increasingly rely on the power grid to heat their homes. During polar vortex and other cold snap periods that are likely to become more common, the duration of those low temperatures could last up to a few days, potentially leading to winter load-shedding events that simply can't be solved by demand response or other temporary load-shifting strategies.

Measuring the damage

Once we have an understanding of the hazards that may present themselves on the grid, we need to understand the impact of that hazard. The best way to think about impact is to unpack what happens during an extreme weather event. For simplicity, let's focus on hurricanes and their impacts on a distribution system.

When a hurricane hits, power lines are susceptible to toppling over and flooding can cause underground equipment to go offline. The result is that hundreds of thousands of homes and businesses lose power for a long duration. Commercial businesses are unable to operate, industrial activity comes to a halt, food spoils and vulnerable populations experience health and safety risks. Simultaneously, electric distribution operators activate massive emergency workforces and call on mutual aid to restore the system and replace damaged equipment. The restoration effort for Hurricane Ian, for instance, cost $1.1B.

A study published in October 2023 by Rowan University demonstrated that hurricanes in the Atlantic Ocean are now twice as likely to grow from a weak storm into a major Category 3 or higher hurricane within just 24 hours.

Tracking the anticipated future changes in losses from disruptions helps understand the type of investments that should be made and their magnitude. If the grid is like our bodies, then new patterns of hurricanes and other climate hazards are like new viruses. Every new virus requires a new immunization tailored to the characteristics of the threat itself.

Designing the treatment plan

Just like when you go to the doctor for health concerns, the grid is in need of a treatment plan for these new and changing climate threats. If the first step is diagnosing the challenges, the next step is identifying all the possible mitigation options and having a clear understanding of the potential outcomes.

Distribution operators and engineers have an enormous toolbox to choose from to reduce the vulnerability of specific climate threats. Vegetation management, replacing or upgrading wooden poles to steel or composite, reinforcing cross-arms and replacing cold-end hardware are all forms of system hardening that help reduce the *probability* of wind- and storm-related outages. To reduce the *impact* of these events, distribution automation devices such as reclosers and fuses can help automatically restore power for a subset of customers, even if certain parts of the grid experience disruptions. Lastly, distributed energy resources such as batteries and microgrids not only help mitigate peak load during extreme temperature days but can provide life-saving backup power for communities that need essential resources during catastrophic events.

In thinking about the enormity of the distribution system, there are trillions of scenarios in which a multitude of investments could be made in a specific section of a feeder. To combat the short-term and existential resilience challenge, prioritization is more valuable than ever. Having the understanding of which assets are likely to fail, based on component design standards, age, condition, proximity to vegetation and fragility to a climate event, and which specific investment provides the greatest benefit stack per cost, is the key to closing the current $500B resilience gap.

Equity considerations are becoming increasingly important within the context of resilience planning as well. Some communities are more prone to hardship and difficulty attaining life-saving resources than others. Poor neighborhoods, areas with significant elderly populations, rural communities and even communities that specifically lack transportation resources that inhibit the ability to reach places with power, should all be taken into consideration when weighing resilience investments.

Climate isn't the only thing that's changing

The picture of risk across a utility's distribution system is constantly changing, but that's not only due to external threats like climate and weather. Utility customers and the system itself are going through transformations. We are increasingly relying on electricity for transportation and heating. New infrastructure such as data centers, telecommunications equipment and manufacturing facilities are being connected. Backup generators and microgrids are allowing customers to operate even if the grid goes down. And, spurred in part by the Infrastructure Investment and Jobs Act, distribution assets are being replaced and reinforced daily.

It isn't easy to keep track of the fluidity of all these pieces, which is why the industry needs a Fitbit for resilience. Much like developing a health plan, the energy transition is about envisioning a better future, and information is key to meeting our goals. Leveraging the vast amount of climate data available — and performing *in-situ* system resilience tracking — is the only way to a happy, healthy grid for the long term.

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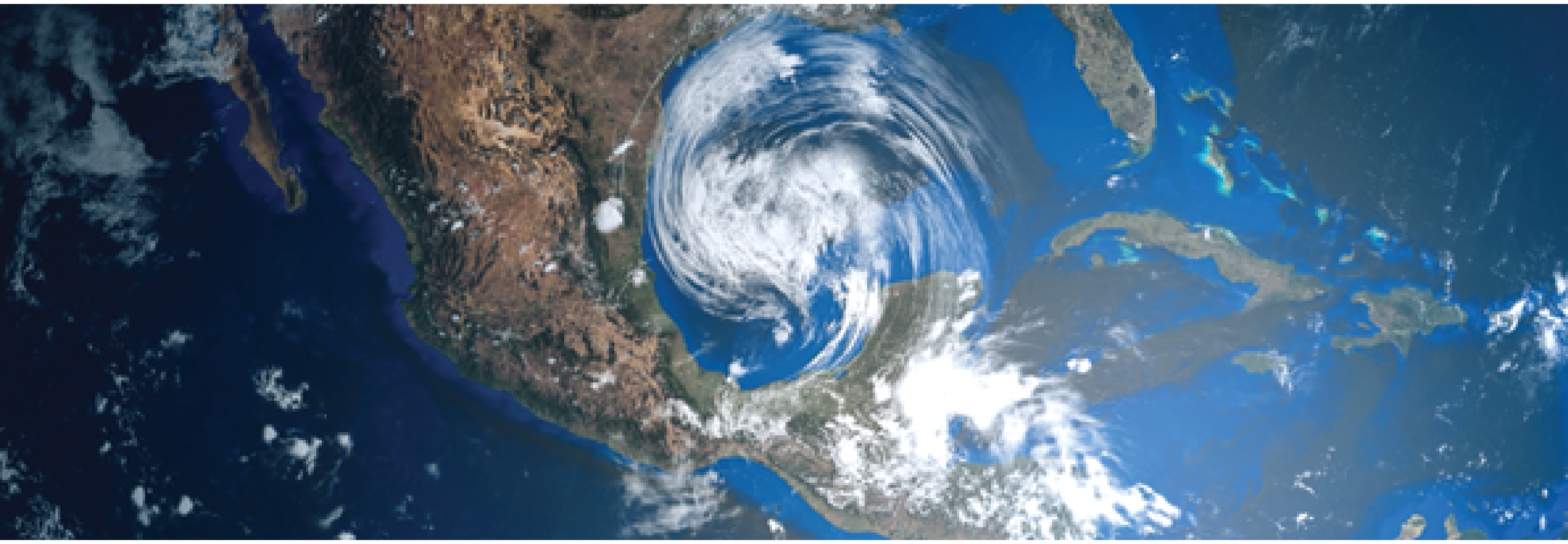

DON'T FEAR THE CLOUD - DEVELOPING CLOUD SECURITY POLICIES FOR REMOTE MONITORING APPLICATIONS

RICHARD HARADA AND JOHN NAM

The electric power utility industry is in the midst of a transformation. Energy 4.0 technologies, such as the Industrial Internet of Things (IIoT), cloud computing, data and analytics and artificial intelligence and machine learning (AI/ML) are increasingly being implemented to provide utilities with greater visibility and control over the grid.

Collectively, these technologies have the potential to transform how generation, transmission and distribution infrastructure is managed, maintained and modernized.

However, utilities remain hesitant to transition to cloud-based applications that harness the full capabilities of Energy 4.0 technologies. Concerns over cloud security and the risk of regulatory penalties have restricted utilities and limited the full adoption of these new and innovative solutions.

Fortunately, utilities can overcome these challenges by taking a strategic approach to cloud-based applications. By developing cloud security policies and implementing secure IIoT architecture, utilities can enhance performance, optimize operations and maintenance and improve safety all while protecting data and ensuring the reliable flow of power to customers. →

On-premises vs. cloud-based IT infrastructure

As technology advances, utilities are faced with an important strategic decision — should they invest in on-premises IT infrastructure or leverage the capabilities of a cloud provider?

While both on-premises and cloud-based IT infrastructure offer advantages and disadvantages, choosing the best approach will depend on the utility, the strategic objectives of the business and the specific application requirements.

On-premises IT infrastructure

On-premises IT infrastructure is built, owned, managed and controlled privately by the utilities. Data centers, servers and other hardware are located on-site while software and applications are installed locally.[1]

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Because it is privately owned, on-premises infrastructure generally allows for greater control. The IT department can tailor the system to meet specific requirements and make upgrades or expand capacity as required. Localized data storage may also be needed to meet regulatory requirements.

However, the utility must also bear the full costs of procuring, deploying, maintaining and upgrading the system over its entire lifecycle, while also managing auxiliary components, real estate and security.

Cloud-based infrastructure

Cloud computing is the delivery of services through the Internet, including data storage, servers, databases, networking, and software.[2] Hardware and software reside offsite and are hosted, managed and maintained by the cloud service provider. Multiple organizations may securely share these resources on a pay-per-use basis, scaling access as needed in response to changing business requirements.

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[1] https://www.hpe.com/us/en/what-is/on-premises-vs-cloud.html

[2] https://www.investopedia.com/terms/c/cloud-computing.asp

Because the utility is not required to build or maintain equipment, cloud computing generally offers a lower upfront cost than on-premises infrastructure. Reputable cloud providers also tend to offer better security, greater resilience and higher performance than most in-house systems due to the size and scale of their business.[3]

Cloud-based applications

While a utility may use the cloud for their day-to-day operations, in many cases they will be leveraging cloud-based applications from vendors or other strategic partners.

Cloud-based applications provide utilities with access to the vendor's cloud for specific purposes, such as accessing data from remote monitoring sensors or storing thermal and visual images for future analysis.

Because the vendor has a relationship with the cloud service provider, the utility simply pays to use the service and does not need to build or maintain any internal infrastructure.

The benefits of the cloud

While there may be times when a utility needs to build traditional, on-premises infrastructure, the cloud offers numerous benefits in most situations.

LOWER UPFRONT COSTS

Building an on-premises data center is expensive and requires specialized expertise and experience that may be difficult to attract or develop. Utilities must find suitable real estate, procure equipment and components, design and build the system, run power and cooling infrastructure, implement networking and communications, install and maintain software and ensure everything is fully optimized.

With the cloud, utilities simply pay to access resources on-demand without the burden or costs associated with on-premises infrastructure.

GREATER SCALABILITY

Because demand for IT resources can change, utility-owned data centers must operate at far lower than full capacity most of the time to ensure they can meet peak demand if required. Not only does this increase IT costs, but it also limits flexibility and responsiveness to changes in the business.

The cloud, on the other hand, allows utilities to easily scale resources up or down as needed. This on-demand, pay-as-you-go model makes it easy to add new applications, sensors, facilities or workloads without building capacity or expanding the system. →

[3] https://www.infosysbpm.com/newsroom/analyst/documents/next-gen-it-services.pdf

FEWER MAINTENANCE REQUIREMENTS

Utilities tend to favor upfront capital investments over ongoing operating costs, which may make the idea of an on-premises solution more attractive. However, managing, maintaining and upgrading IT infrastructure still incurs significant operational costs and requires skilled personnel to oversee and maintain.

> **Managing, maintaining and upgrading on-premises IT infrastructure incurs significant ongoing costs and requires skilled personnel to oversee and operate.**

In contrast, reputable cloud service providers handle these ongoing requirements on the utility's behalf, reducing overall costs as well as the burden on internal IT departments.

BETTER DISASTER RECOVERY

Storms, fires, floods, power outages and other disasters can destroy IT infrastructure or wipe data from servers, with catastrophic consequences if data is not properly backed up.

Instead, utilities can make use of pre-built backup and disaster recovery tools from cloud service providers that operate numerous data centers and multiple servers.

ROBUST SECURITY

While security is often one of the primary concerns utilities have when considering the cloud, the truth is that most reputable cloud providers can achieve greater security and respond to emerging threats more quickly and effectively than an internal IT team.

Most cloud service providers offer more robust security and pre-built management and policy tools such as multi-factor identification, user and role-based permissions and encryption as standard features.

ACCESSIBILITY

Finally, software or files stored locally can only be accessed by a specific device, limiting collaboration, flexibility and responsiveness. Cloud-based data storage allows utilities to access data and synchronize files between multiple devices, improving decision-making and ensuring data is available when and where it is needed.

ADDRESSING THE BARRIERS TO THE CLOUD

Despite the advantages of the cloud, utilities may find that there are barriers to successfully implementing and using cloud-based applications. Many of these barriers are rooted in regulatory and compliance requirements or internal policies and workflows. While some may ultimately restrict utilities from using the cloud in all scenarios, many can be addressed for common applications.

DATA RESIDENCY AND COMPLIANCE

Data residency refers to the localization of regulated data, especially Personally Identifiable Information (PII), within a particular region or country. Many regulators do not allow companies to collect, store or use data outside their home country due to privacy and security concerns.

Similarly, data transit requirements may further state that data cannot transfer through another country or region, which can be especially difficult given the inter-connected nature of the Internet.

These regulations can pose challenges for cloud-based applications since cloud providers may have data centers spread across multiple countries.

However, many cloud-based applications do not collect, transmit or store PII or any data that is critical to the flow of electricity. In these cases, the data may be less regulated.

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SECURITY CONCERNS

As critical infrastructure, utilities are rightly concerned about cybersecurity threats. Regulated standards enforce cybersecurity defenses, but internal security policies may go even further in limiting the use of network access or services due to perceived security risks.

Cyberattacks have increasingly targeted utilities and other industrial control systems, seeking entry through the least protected links. In fact, the utility sector saw a 46% year-over-year increase in cyberattacks in 2021, averaging 736 attacks per week.[4]

[4] https://www2.deloitte.com/content/dam/Deloitte/us/Documents/energy-resources/us-eri-renewable-energy-outlook-2023.pdf

> **The utility sector saw a 46% year-over-year increase in cyberattacks in 2021, averaging 736 attacks per week.**

However, as highlighted above, reputable cloud providers place security as one of the most important areas of their business. And depending on the application, not all data can be useful to malicious actors, mitigating the risk of harm even if it does fall into the wrong hands.

North American Electric Reliability Corporation regulations for remote monitoring systems

The North American Electric Reliability Corporation (NERC) is a not-for-profit international regulatory authority responsible for the reliability and security of the grid.[5]

NERC regulations define what is considered to be a Critical Asset subject to the Critical Infrastructure Protection (NERC CIP) standards.

According to the NERC document Identifying Critical Cyber Assets Version 1.0, a Transmission Substation is identified as a Critical Asset. 'Equipment Monitoring' systems, such as thermal and visual sensors, are identified as a Cyber Asset associated with the Transmission Substation that is "important, but not critical to the Bulk Electric System (BES) operation".

Given this definition, remote monitoring solutions are not subject to the regulations of NERC CIP 5, allowing the utility to leverage cloud-based applications.[6]

Note that other countries and jurisdictions may have different regulations. Utilities should always ensure they are compliant before implementing cloud-based applications.

Managing cloud-based applications

As cloud-based applications become more prevalent in the industry, utilities must develop a strategy for selecting, implementing and managing these solutions.

Identify strategic objectives and develop a business case

When choosing a cloud-based application, the first step is to identify the strategic objectives of the project. Define and articulate how the solution aligns with the larger goals of the business, and state the expected outcomes that will determine if the project is successful. Identify project milestones, key performance indicators and other strategic requirements that will shape the rest of the project.

From there, utilities should conduct a more comprehensive business case to determine the viability of the project. Take into account the various costs and benefits of any potential solutions that are being evaluated. For example, for a remote monitoring system, compare the costs of procuring and installing the solution against expected improvements in operations, maintenance, safety, and reliability.

Ensure interoperability

One of the potential challenges when using multiple vendor-driven cloud-based applications is that each vendor may rely on a different cloud provider. It is therefore vital to ensure interoperability and the ability to share and access data from multiple sources within a centralized software or dashboard.

When evaluating potential solutions, ensure they offer APIs, DNP hooks for SCADA or other standard protocols that make it easy to transfer and analyze data between systems. Without these links, utilities can end up with data silos that add complexity and limit the ability of users to view information when needed.

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Cloud vendor selection

Finally, utilities should be aware of the potential for vendor lock-in. Fully implementing cloud-based applications can sometimes require time and resources that tie the utility to a specific vendor. Once up and running, switching costs can make it prohibitively expensive or difficult to change to a new solution down the road. →

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[5] https://www.nerc.com/AboutNERC/Pages/default.aspx

[6] https://www.nerc.com/pa/Stand/CIP0024RD/Critcal%20Cyber%20Asset_approved%20by%20CIPCI%20and%20SC%20for%20Posting%20with%20CIP-002-1,%20CIP-002-2,%20CIP-002-3.pdf

Before making a selection, take the time to ensure the solution is flexible and can meet requirements both now and in the future.

Cloud security policies and architecture for remote monitoring

The cloud is a highly secure alternative to traditional, on-premises infrastructure. However, utilities still need to design effective security policies and architectures when deploying IIoT solutions such as remote monitoring sensors.

Encryption

Despite not being subject to NERC CIP 5 standards, utilities should ensure the IIoT architecture of a remote monitoring solution has comprehensive Transport Layer Security (TLS) encryption and authentication built along every step in the communication. This ensures that data cannot be intercepted and viewed by hackers and that only authorized users have access through two-factor identification. Once stored in the cloud, data should be encrypted using the Advanced Encryption Standard.

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Segregation from critical assets

When deploying remote monitoring solutions, utilities should ensure that the IIoT sensors have no electrical or physical connections that may disrupt the operation of the equipment that is being monitored. Infrared technology is an example of a non-invasive, contactless means of measuring temperature on electrical equipment. The sensors should be physically outside the security perimeter as defined by NERC CIP 5, and the sensors and cloud dashboard should have no connection to the Critical Asset communication network.

By segregating the systems, the utility eliminates the risk of infiltration through the IIoT network connection. Further, because the sensors are collecting temperature data and thermal and visual images of equipment, the data itself is not sensitive and cannot be used in any harmful way to disrupt the flow of power.

Cloud vendor security policies and vendor audits

Before deploying any application, the utility should evaluate the vendor's cloud security policies. Ask how they manage and store data, how much, if any, access employees have to the data and whether they can directly access the sensors. Ask to see their security policies, and ensure they are willing and able to answer questions about their cloud provider and the measures they take for security.

Many utilities will take this a step further by conducting a detailed vendor audit before working with a vendor. This provides a complete understanding of the vendor and makes it possible to identify potential vulnerabilities before selecting a technology.

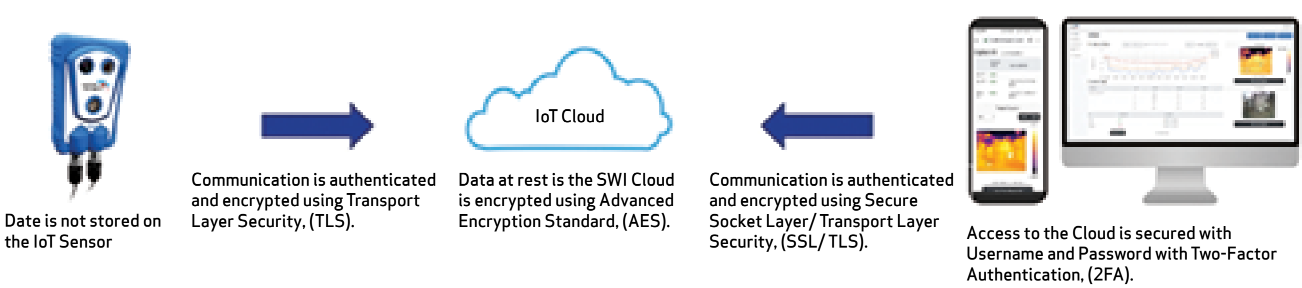

Figure 1. IIoT Architecture shows the communication paths and security measures that are used on each step. Note that the IIoT network is outside of the utility security perimeter.

Ongoing user training

While it may seem low-tech, many attacks on utilities actually come in the form of phishing emails, malware-laden attachments or infected links.[7] These behavioral attacks have become more sophisticated and can be extremely effective if employees are unaware or unsure of what to look out for.

Frequent user training helps employees recognize potential security threats and identify suspicious emails or links. By continuously improving the security knowledge of team members, utilities can mitigate the risk of infiltration.

A strategic approach to cloud-based applications

Energy 4.0 technologies will play an increasingly large role in the electrical utility industry. As more organizations embrace the Industrial Internet of Things, cloud computing, data and analytics and artificial intelligence and machine learning, the electric grid will become more flexible, responsive and reliable.

Thermal and visual monitoring systems are one example of a cloud-based application that can significantly improve utility operations. By providing greater visibility and control over high-value critical assets and components, remote monitoring solutions make it possible to transition away from physical inspections toward a Condition-Based Maintenance strategy without the need for costly IT and networking infrastructure.

Faced with rising complexity and pressure to deliver affordable and reliable power to customers, utilities cannot let the fear of the cloud limit their capabilities. Through effective cloud-security policies and architectures and relationships with vendors that understand the unique security requirements of the industry, utilities can effectively implement cloud-based applications that lower costs, improve scalability and performance and deliver a better experience to both customers and internal teams.

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[7] https://www2.deloitte.com/content/dam/Deloitte/us/Documents/energy-resources/us-eri-renewable-energy-outlook-2023.pdf