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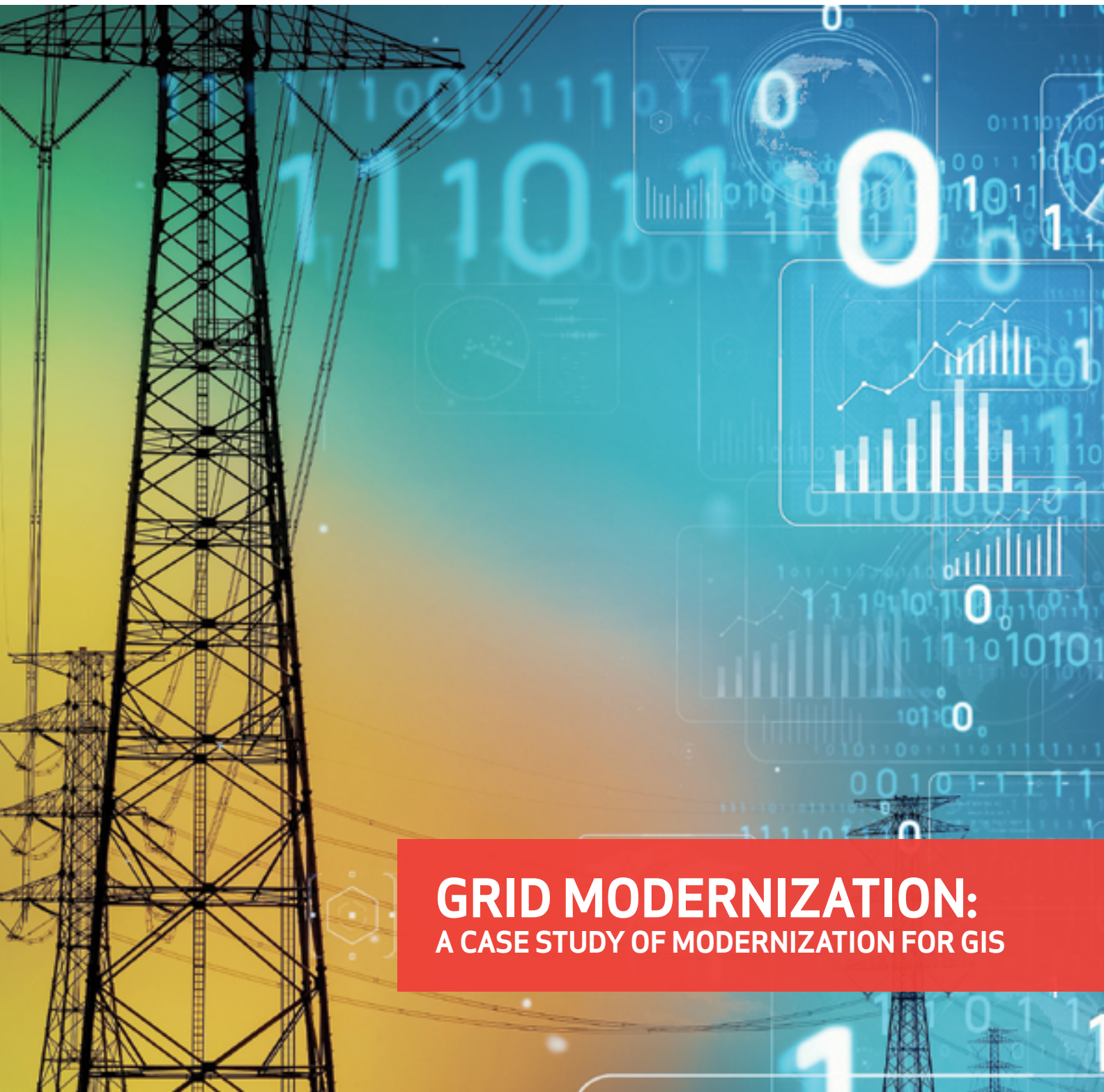
Quarterly Issue 4, 2023 — Volume 26



GRID MODERNIZATION:
A CASE STUDY OF MODERNIZATION FOR GIS

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Quarterly Issue 4, 2023 — Volume 26

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HYDRO ONE COMPLETES $46.9 MILLION INVESTMENT TO STRENGTHEN TRANSMISSION SYSTEM AND IMPROVE RESILIENCY AND RELIABILITY IN OTTAWA

November, 2023

Today (Nov 23), Hydro One Inc. (Hydro One) was joined by Hydro Ottawa and representatives from the City of Ottawa and government of Ontario, at Merivale Transmission Station to announce the completion of $46.9 million in transmission line upgrades. These critical upgrades will increase the electrical capacity of the power lines by 66 per cent, from 650MW to 1,080MW, providing a reliable supply of energy to support the growing demand in the Ottawa area. The project also allows for generation facilities in eastern Ontario to transfer more power to the rest of the province and import more clean energy from Quebec. The upgrades also improve resiliency of the electricity network and improve reliability for residents, business, commercial and industrial customers.

The investment included reinforcing the transmission towers and replacing power lines and insulators on 12 kms of 230kV double circuit transmission line between Merivale Transmission Station and Hawthorne Transmission Station. The project began in July 2020 and was completed in time for Ottawa's cold winter season to ensure power was available when needed in the community.

In addition to the completed improvements made to these transmission lines, Hydro One is making progress on modernizing the Merivale Transmission Station to ensure this key station serving Ottawa can supply clean, reliable energy as the region continues to grow. This project includes expanding the current footprint of the station to house two new 230 kilovolt transformers and a new operations building. As part of this project, Hydro One has signed a new Community Support Agreement with the City of Ottawa that will directly support recreational projects for local residents.

"Demand for energy in Ottawa is growing rapidly. It is important for Hydro One to make a substantial investment in building a grid for the future to support the increasing and changing needs of local businesses, residents, and the economy," said Andrew Spencer, Executive Vice President, Capital Portfolio Delivery, Hydro One. "As a proud member of the Ottawa community, the upgrades Hydro One continues to make will energize life for customers and improve power reliability and resiliency for years to come."

$46.9
MILLION
INVESTMENT

"As we further our commitment toward climate adaptation and ensuring our grid can support the energy transition and shift toward electrification, we are proud to be collaborating with our colleagues at Hydro One for this announcement, knowing we are making life better for our customers and our community," said Guillaume Paradis, Chief Electricity Distribution Officer, Hydro Ottawa. "Increasing the capacity, reliability and resiliency of our transmission network is a vital step to ensuring the distribution system in Ottawa can provide the power needed now and in the future." →

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"In a growing city like Ottawa, ensuring reliable electricity is crucial for our communities and our businesses," said Mayor Mark Sutcliffe. "We know how critical these electricity transmission projects are for our city's future growth plans and prosperity. We look forward to seeing the Community Support Agreement come to life."

"Electrifying the homes and businesses in our community relies on making sure we have a reliable and resilient electricity system," said Knoxdale-Merivale Councillor, Sean Devine. "I'm very pleased at the close collaboration between Hydro One, my office and community members to ensure these upgrades are developed with sensitivity to local interests in mind, and that the Community Support Agreement announced today will provide local benefits for years to come."

> *"Today's announcement is good news for Nepean residents and all of Ottawa, preparing the electricity network for the future," said Lisa MacLeod, Member of Provincial Parliament for Nepean. "I am pleased to see Hydro One invest in the transmission network as our community continues to grow."*

More information about the investments Hydro One is making in communities across Ontario can be found at: www.hydroone.com/majorprojects

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Energy for generations

ESB NETWORKS INSTALLS 1.5 MILLION SMART METERS NATIONWIDE AS PART OF THE NATIONAL SMART METERING PROGRAMME

November, 2023

Highlights

- The upgrade programme represents a step change in how individual customers and businesses can manage their electricity more efficiently
- This includes 100,000 new homes also connected to the electricity network with smart meters by ESB Networks
- Smart meters empower customers to take more control of their consumption through the ESB Networks Online Account

ESB Networks has today (Nov 21) announced that it has successfully installed 1.5 million smart meters in homes, farms and businesses in every county across Ireland. This milestone also includes the safe connection of over 100,000 new builds with a smart meter to the electricity network.

The National Smart Metering Programme (NSMP), which commenced in late 2019, is on track to complete the installation of over 2 million meters in early 2025. The rollout recently expanded to include the upgrade of Day/Night meters thereby ensuring these customers will also have access to the benefits of smart meters.

A new smart meter reduces the need for estimated bills and allows customers to see how and when they use electricity, directly through the ESB Networks Online Account. This can help customers use electricity more efficiently, reduce consumption or choose a suitable smart meter tariff from their supplier, which allows customers to have more control over their electricity costs.

Other benefits include access to the microgeneration scheme, in which currently over 55,000 customers who generate their own electricity (via solar panels etc.) receive payments for any excess electricity they sell onto the network. In addition, smart meters will improve network services to customers in areas through fault monitoring and the prioritisation of system improvements nationally.

Eamon Ryan TD, Minister for the Environment, Climate and Communications, said: "It is extremely positive that we have reached the 1.5 million milestone in the National Smart Metering Programme. This is an initiative that is delivering real benefits for homes in every part of the country. Smart meters provide individuals with more information, giving them more control over their usage and electricity costs, which is so important at a time of continued high international energy prices. As the rollout continues at pace, I look forward to it nearing completion and commend ESB Networks for their delivery of this programme. A smart meter in every home and business in the country will not only help us to meet our climate goals and allow us to become more energy independent, but it will also unlock an array of smart energy solutions that will connect and empower our citizens as part of Ireland's energy transition."

Commenting, Nicholas Tarrant, Managing Director, ESB Networks,, said: "We are delighted with the progress to date on the National Smart Metering Programme and achieving the milestone of 1.5 million smart meters installed. This programme is a key element of our Networks for Net Zero Strategy and provides customers with new technology that enables them to take more control of their electricity usage. This is a vital component in enabling a smarter, low carbon electricity network and in supporting the delivery of the Government's Climate Action Plan."

The NSMP forms an important part of the National Climate Action Plan. It will enable delivery of the Energy Demand Strategy which is currently under development by the Commission for Regulation of Utilities and supports the transition to a low-carbon electricity network. The roll out programme is being delivered nationally by ESB Networks in cooperation with the Commission for Regulation of Utilities (CRU), the Department of the Environment, Climate and Communications (DECC), the Sustainable Energy Authority of Ireland (SEAI) and with all electricity supply companies.

OVER 100,000 NEW BUILDS WITH A SMART METER TO THE ELECTRICITY NETWORK

Commissioner Aoife MacEvilly, Commission for Regulation of Utilities, said: "We are very pleased with the success of the roll out to date. Regardless of supplier, smart meters give customers access to more information about their consumption. The ESB Networks online account provides time of use information that can help customers to understand and reduce their electricity use, or choose a suitable smart meter tariff from their supplier, which ultimately allows customers to have more control over their electricity costs."

CENTERPOINT ENERGY HOSTS GRAND OPENING OF STATE-OF-THE-ART TRAINING CENTER IN SOUTHWEST HOUSTON

November, 2023

On Nov. 16, CenterPoint Energy celebrated the grand opening of its new Hiram O. Clarke Training Center by welcoming members of the community to take a behind-the-scenes tour.

This 150,000-square-foot training center employs more than 25 expert instructors who are currently leading approximately 400 electric apprentices and 320 natural gas new hires through CenterPoint Energy's comprehensive training programs. It will also host tenured employees for continuing education and support the company's partnerships with Career and Technical Education school programs.

During the tour, visitors were able to experience the cutting-edge training offered by CenterPoint at this center. The group visited classrooms with equipment and tools and hands-on simulation areas with electric circuits and natural gas line connections, including wood utility poles to practice climbing and making repairs. The visitors were also able to see how the facility could be used for emergency operations during severe weather or natural disasters.

> *"This new training facility is a testament to our dedication to safety, which extends to our customers and the communities we have the privilege to serve," said Al Payton, Vice President of Safety and Technical Training at CenterPoint. "By providing our employees with the latest safety and technical training incorporating best practices, we will continue to strive to provide the safe, reliable electricity and natural gas that enable everyday life and the pursuit of possibilities for our millions of customers."*

With safety as our top core value, the company is dedicated to sustaining a culture of excellence with industry-leading training and safety at the forefront. The opening of the facility is also part of the company's ongoing efforts to nurture and develop local talent, supporting workforce development and career opportunities for the next generation.

> *Payton said, "This facility really showcases CenterPoint Energy's industry-leading practices and our commitment to the development of our workforce."*

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Hydro Québec

UNDERGROUNDING OF POWER LINES SERVING DOWNTOWN GATINEAU

November, 2023

To meet the increased demand for electricity in downtown Gatineau, Hydro-Québec will underground four overhead distribution lines between Val-Tétreau substation and Rue Eddy. A new underground concrete duct bank approximately 2 km long will be installed to accommodate the 25-kilovolt (kV) lines.

> *"The growth of downtown Gatineau, specifically the Hull sector, has increased the demand for electricity," said project manager Pascale Bolduc. "Building the concrete duct bank and undergrounding the existing lines will strengthen the grid and ensure its long-term operability."*

Preliminary work will begin in fall 2023, with construction of the concrete duct bank expected to take place from May 2024 until December 2025.

Associated local enhancements

Undergrounding the existing lines will allow Hydro-Québec to dismantle the overhead structures between Val-Tétreau substation and Hull-2 generating station. The company will also take the opportunity to dismantle an overhead line which is no longer in use.

"In total, we'll be removing 9 transmission towers and 14 distribution towers along the Ottawa River in the downtown and Val-Tétreau areas. This will greatly enhance the visual appeal of these areas for residents and for the many users of the Voyageurs Pathway," said Bolduc.

To find out more, visit the project Web page at hydroquebec.com/val-tetreau-downtown

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THE CHALLENGES AND SOLUTIONS DRIVING WIDESPREAD EV ADOPTION

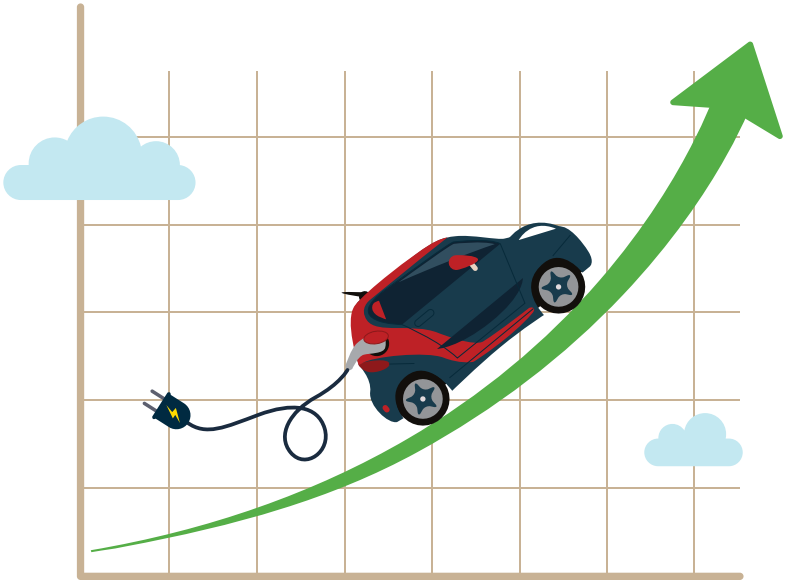
ELISABETH MONAGHAN
Editor in Chief

With this issue, we say farewell to 2023. A few of the articles published in this issue touch on the electric vehicle market. We already have published numerous articles about the need for more charging stations and reliable solutions to ensure EV drivers have the battery power they need to get to their destinations. What I appreciate about the articles by the authors who talk about EVs in this issue is the way each presents a broader view of some of the challenges the industry is facing, as well as solutions industry experts are exploring.

Electric vehicles have remained among the top trends that industry experts have watched for several years. But EVs are more than just an industry trend. Because car emissions are responsible for about 30% of greenhouse gas emissions, EVs give environmentally-conscious drivers, who can access and afford EVs, a way to lower their carbon footprint.

Based on the increasing number of EVs now on the road in the U.S., more consumers are switching to electric vehicles. According to a 2023 report from the Bureau of Labor Statistics, in 2011, there were about 22,000 EVs on the road, and by 2021, that number jumped to a little more than 2 million. Cox Automotive reports that EV sales accounted for 7.9% of total industry sales in Q3 of 2023, which is up from 7.2% in Q2 of this year, and up from 6.1% in 2022.

Although there are significantly more EVs on the road now than a decade ago, some barriers, like high purchase prices and the availability of EVs, make it difficult for the masses to embrace electric vehicles. Even if EVs were readily available in every market, and people could afford the cost of purchasing or leasing an EV, the lack of access to charging infrastructure remains challenging to the widespread adoption of EVs. →



In his article, "Battery Swapping: Friend or Foe of the EV Charging Industry?" Aatish Patel with XCharge points to charge anxiety as another hurdle that gets in the way of widespread EV adoption. As Patel explains, the EV market has seen an increase in charging networks, but battery swapping stations have also shown up as a possible solution.

Patel also writes about how the EV industry is looking at battery swapping to match the convenience and speed of visiting a gas station, but as he explains, until there is uniformity in the way EV batteries are manufactured, people with charge anxiety will be among those sticking with gas-fueled cars. Patel lays out steps the industry must take for battery swapping to be a viable alternative or complement to charging stations. Battery swapping and charging station companies each offer advantages. Additionally, they present different challenges, but ultimately, both are working toward the same goal. So, as Patel suggests, the best approach is for these companies to work together to achieve that goal.

Ronald Hermans, who works for Honeywell, adds EVs to his list of emerging trends in utilities. According to Hermans, more EVs on the road could result in a heavier strain on electricity infrastructure. Consequently, not only will there be a greater need for more charging solutions, but the impact of EVs extends beyond charging stations. Hermans points out how the evolution of EVs is reshaping the urban landscape, which includes dedicated EV lanes on roads, broad acceptance of public charging infrastructure and ensuring new building codes are EV-ready.

As renewable energy becomes more mainstream, we will see more consumers begin to rely on alternative energy sources. Wider deployment of alternative energy means companies that make up the electric power sector will need to grow their work force. However, with so many current workers retiring, the need to fill the positions vacated by those experienced workers has.been an issue about which human resource experts have been concerned since the first Baby Boomers began to age out.

According to the U.S. Census Bureau, by 2030, all Baby Boomers will be age 65 and over. Granted, not all Boomers will retire at age 65, but as more workers age, the need to replace them will increase. In The Bigger Picture section of this issue, Michael J. Reidy, who is a senior consultant at Interaction Associates, writes about the future of talent in renewable energy.

Recognizing the increasing gap left as aging workers retire, and the next generations develop the skills and experience necessary to fill those positions, Reidy provides suggestions for hiring managers and HR professionals to follow. Reidy emphasizes that not only is it important to attract new workers, but also to remember that like all industries, the renewable energy sector is made up of different generations of workers.

So, as the renewable energy space expands, companies that want to attract and retain workers must recognize that each generation has valuable experience to contribute. Therefore, to ensure a sustainable workforce now and in the future, employers need to foster mutual trust among the different generations by encouraging the transfer of knowledge and working to establish a culture of respect.

As we venture into 2024, we look forward to sharing the latest updates from our experts in the electric energy sector and passing along their insights affecting the industry. Here's to wrapping up another year and to a new year of great prosperity, good health and innovative solutions!

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

Elisabeth@ElectricEnergyOnline.com

Elisabeth

GRID MODERNIZATION:

A CASE STUDY OF MODERNIZATION FOR GIS

Based in the City of Brookings, South Dakota, Brookings Municipal Utilities (BMU) supplies power to approximately 12,000 customers. It also manages water and wastewater utility services, internet and telecommunications for Brookings. While the company had a successful track record using AutoCAD to manage electric utility operations, its leadership recognized the need to modernize operations. BMU worked with a Denver, Colo-based location and mapping technology company to replace its legacy mapping with an enterprise GIS that integrates disparate data sets, delivers powerful analysis capabilities, and provides a foundation for the utility's future.

In this Q&A, Alex Shimmel, who represents the mapping technology company, and Russ Halgerson, who is the is the electric department manager at BMU, discuss their collaboration on modernization and share insights for other utilities.

Shimmel: BMU's GIS modernization initiative is a great case study for other utilities that are looking to migrate from legacy systems to a modern GIS system. Can you give readers some background about where things stood before this project?

Halgerson: This is a timely topic for our industry because so many utilities are running up against the significant limitations of legacy systems that have served them well for a long time. This topic comes up nearly every time I talk to my peers at other utilities.

Shimmel: How long was your legacy system in place?

Halgerson: Decades, which is a great thing. We used AutoCAD as the foundation of our mapping systems, and it met our needs for a very long time. As you know, IT technologies come and go, and it's very rare for one to have staying power like that. For decades, AutoCAD was a reliable backbone for the mapping processes and location information that is so critical to our operations. But during the last few years of its service to us, its limitations became more and more of an issue for our daily operations. One of the biggest issues we wanted to address was how siloed our information databases had gotten. After decades of use at the departmental level, those databases had become more and more isolated from one another. And as a result, critical data was often stranded on disconnected islands of information. →

Image credit: Locana

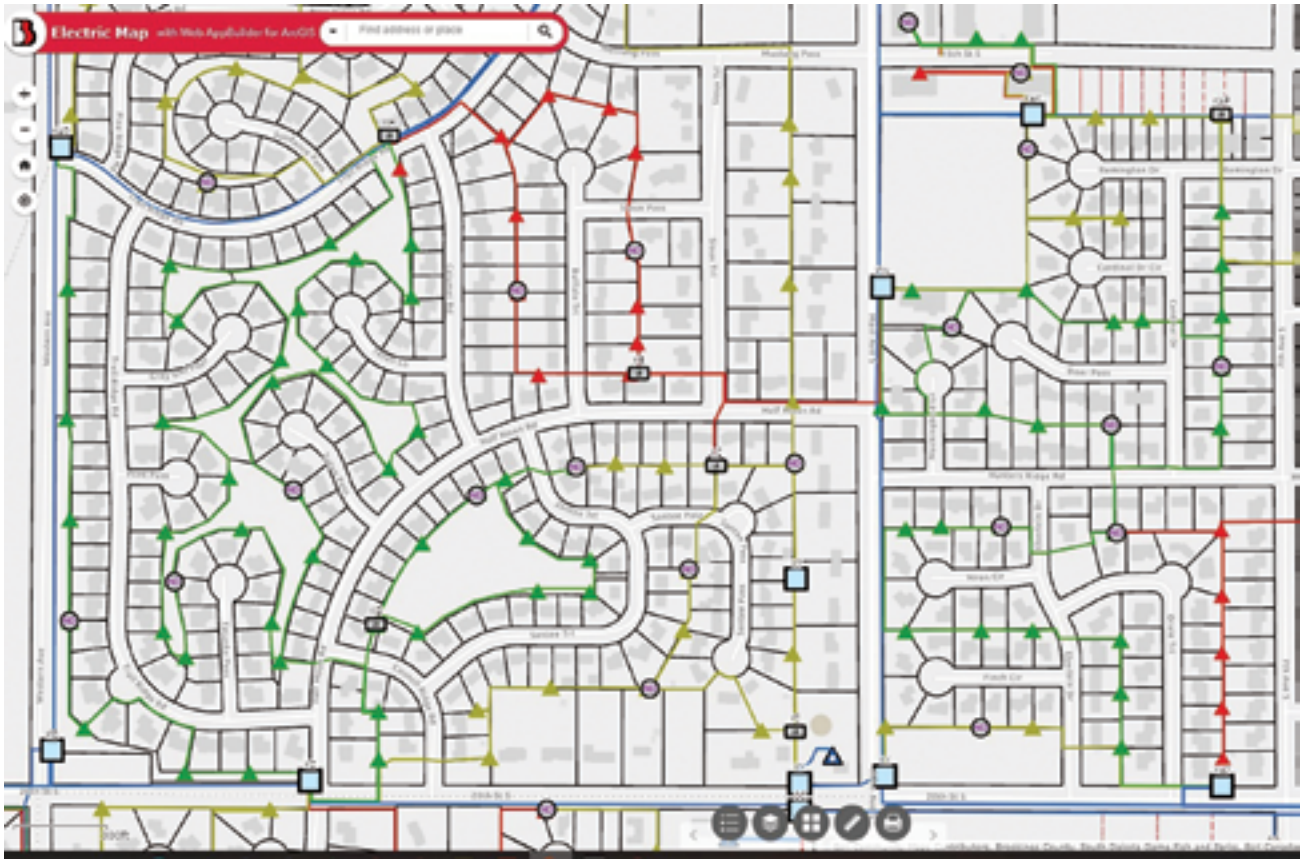


Image credit: Locana

Shimmel: That is one of the biggest pain points I hear when I start talking to utilities about their legacy systems. Having siloed data causes so many operational headaches.

Halgerson: Exactly. It was causing inefficiencies that became harder and harder to overlook. Plus there was a growing opportunity cost as well. There were a lot of things we wanted to do that we couldn't because of those data problems and because of that disconnectedness. We knew that huge efficiencies and benefits would come from breaking down those silos. It simply wasn't possible to do that while staying with those legacy systems. It's a difficult decision when an organization has used a legacy system for so long, but we knew we had to make a change.

Shimmel: Can you talk more about the decision to modernize? Back during that decision process, what was your team most excited about accomplishing by breaking down those silos?

Halgerson: We knew there would be a long list of benefits, but the thing that came up again and again in our meetings was decision-making. We wanted to make faster, better decisions at every level of the organization, and a more modern GIS system would be a huge catalyst for that. By unifying our data on a more modern GIS platform, decisionmakers would be able to make faster decisions with the help of data-driven insights at their fingertips. Better, faster decision making would mean more efficient processes, better collaboration across the organization, and better service for our customers.

Shimmel: I'm so glad you talked about that because it's the biggest thing I hear from people I talk to after they modernize their GIS. It removes roadblocks and inefficiencies that they accepted as an unchangeable part of their workflow every day. Plus it removes impediments that they didn't even realize were holding back their processes.

Halgerson: That was definitely our experience. We knew it would be a gamechanger for key departments like our GIS team, but it didn't stop there. We saw similar benefits across the organization, and at every level — from our leadership team all the way to our mobile workers that are doing work in the community.

Shimmel: Let's talk about the platform you chose.

Halgerson: Sure. After looking closely at all the major platforms, we decided that a next generation utility network platform was the right fit for us. Your team was very helpful as we evaluated the different options and made that decision. It was great to have a partner that was neutral like Switzerland during the process, since you have experience working with all the vendors. One of our key buying criteria was analytics. We wanted to be able to empower our teams with data-driven insights that they can put to use every day. That was big for us. So was ease of implementation and ease of use. Many utilities are much larger than us and have more resources for complex implementations and steep learning curves. But that's not us. It was critical for us that we could get it up and running successfully and have our team feel very comfortable using it right away.

Shimmel: What advice do you have for other utilities going through a similar selection process?

Halgerson: I get asked that quite frequently, and I always emphasize how important it is to have the right implementation strategy. For something like a GIS system that impacts every part of a utility's operations, it's important to have a streamlined implementation strategy that puts people first. Yes, this is a technology migration, but it's the people who will be using it every day that need to be kept front and center. Your team was a big help with that, given how many other Esri UN implementations you have done. →

Image credit: Locana

Image credit: Locana

Shimmel: Change management is so important. The BMU team made that a guiding principle for this GIS modernization initiative, and it really paid off.

Halgerson: Another thing that I always mention to peers at other utilities is the importance of how you prepare your data. You have to get your data right in order for the platform rollout to truly live up to expectations. We worked hard on that early in the process by assessing each of those islands of data, cleaning it, preparing it for use in a next generation platform for utility management, and then having a great strategy for the data migration process.

Shimmel: That is critical to focus on early in the process when going from legacy systems to a moderm utility network platform. Organizations are often stunned at how many batches of disconnected data they have across those legacy systems once they start doing a full inventory ahead of migration. And after years or decades in disparate GIS systems, the data sets often need a lot of TLC before they can be migrated.

Halgerson: Doing that up-front work to get our data right was a key factor in the success of our implementation. You and I started talking about the importance of that very early on, and I strongly suggest that approach to other utilities considering this kind of upgrade.

Image credit: Locana

Shimmel: Let's talk about the platform implementation. BMU deployed a utility network as the centerpiece of this initiative. Why was that the right choice for BMU?

Halgerson: Yes, we deployed the utility network platform and went with a package that allows for editing, visualizing and analyzing spatial data. This enabled us to get so much more out of our data.

Shimmel: Your models were previously only 2D, right?

Halgerson: Yes, only 2D. This was a huge upgrade for us, giving our team network-centric, 3D models that have far greater detail and accuracy. The richness of the data is a huge asset. A great example of this involves our switchgear. Before this implementation, mapping that part of our infrastructure was time-consuming and complex, but ArcGIS makes it far simpler and gave us far better information. By using templates for the inventory of switchgear that BMU uses in our network, we can rapidly add that information to our GIS system with a level of accuracy and detail that was impossible before. That is one of many ways that this initiative has made our digital GIS models a far better representation of the real-world network.

Shimmel: The last time we talked, you gave me an update about how this is helping with customer service, too. That's not necessarily what immediately comes to mind when someone thinks about GIS and utilities, but there's a very positive impact there, right?

Halgerson: We pride ourselves on the level of service we give to our customers, and communication is so important for that, particularly during outages. No one likes outages, but they happen. The key is identifying and responding to them quickly and keeping customers updated so they aren't in the dark, both literally and figuratively. With this GIS platform, our team is able to not only identify outages faster but also quickly determine exactly how many customers will be affected downline from the faulty equipment. Our team can then take rapid action to notify customers and keep them apprised of how quickly service will be restored. That kind of notification process was very complex to coordinate in the past. Now, our team has far more information and can take action quickly to support our customers.

Shimmel: That stood out to me when you shared it because it shows how wide-reaching the impact is on a utility's operations.

Halgerson: Totally agree. It has had a positive impact on so many aspects of our operations. That is what makes this intimidating for so many organizations, though. Those decades-old legacy systems have been serving so long and have deep, deep roots across so many departments and so many day-to-day processes. It's natural to worry about making a change and feel a sense of inertia. But this initiative has unlocked so much for our organization, and I think we've only started scratching the surface of what we can do for our customers with this foundation in place.

Russell Halgerson is the electric department manager at Brookings Municipal Utilities. Halgerson received his Bachelor's degree in electrical engineering from South Dakota State University in 2007 and is a licensed professional engineer in South Dakota and Minnesota. He has more than 15 years of electric utility experience in both distribution and transmission, including engineering planning, design, project management and operations.

Alex Shimmel is a GIS consultant at Locana. In this role, he works with gas and electric utilities to conduct successful implementations of advanced geospatial solutions. He earned his degree from Tufts University.

EMERGING TRENDS IN UTILITIES: WHERE TECHNOLOGY MEETS HUMANITY

RONALD HERMANS

If it's around long enough, every industry experiences change and disruption. The utility industry is no exception. When compared to other sectors of the economy, it may actually be experiencing a disproportionate amount of change driven by a wide range of factors — environmental, societal and technological. The primary paradigm shifts that are the source of disruption tend to fall into four different categories:

- Grid modernization
- Environmental, Social and Governance reporting (ESG)
- Preparation for electric vehicle growth
- Battery storage to empower grid flexibility

But there are two additional areas that don't get a lot of attention, the growth of smart cities and the role of edge computing. There is certainly overlap amongst all of these areas in terms of the challenges and opportunities they represent. You could also argue that the promise and phenomenon of smart cities and edge computing have a direct impact on each of these other areas as enabling solutions to help overcome some of the headwinds the industry is facing. To understand the roles of smart cities and edge computing, it may be helpful to take a quick look at the other foundational challenges that they can help solve. →

Figure 1 The modern grid's objective pivots towards the consumer empowering consumers to adjust their energy consumption, with dynamic pricing models that reflect real-time energy costs.

Grid modernization

The power grid stands as the backbone of our modern society. Yet, with time, signs of wear and tear are becoming evident. Aging infrastructure, stretched resources and rising cyber threats highlight vulnerabilities. Additionally, there's an urgent need to assimilate renewable energy sources and update the early-2000s first-generation "smart" meters that are nearing the end of their operational lives.

Addressing these challenges begins with the adoption of advanced metering infrastructure (AMI). The next generation of smart meters, integral to AMI, function as edge computing devices. These advanced meters offer real-time, actionable intelligence, enabling utilities to enhance efficiency, sustainability and profitability.

Historically, grids in the early 20th century were tailored for a one-way power flow — centralized energy plants channeled power to the consumers. However, the narrative is changing. The move towards decentralized systems, coupled with renewable energy sources and microgrids, showcases a pivotal transformation. We're transitioning from a simple one-way power delivery mechanism to intricate two-way power flow systems.

Digital transformation is revolutionizing the utility sector. As AI-driven solutions streamline operations, IoT devices enable precise monitoring, while blockchain promises transparent, tamper-proof energy transactions. The modern grid's objective pivots towards the consumer. Now, dynamic pricing models reflect real-time energy costs, empowering consumers to adjust their energy consumption. The grid's bolstered reliability means blackouts are increasingly rare. Moreover, the rise of "prosumers" — consumers who can sell their surplus solar energy back to the grid — demonstrates a vibrant, evolving energy ecosystem.

Environmental, social and governance (ESG)

In the contemporary world, a company's commitment to environmental and societal values is not just a moral obligation but also a crucial aspect of its public persona. The lens of scrutiny, particularly on publicly traded companies, has been sharpening. Stakeholders and regulators are now more alert than ever, especially concerning decarbonization efforts. However, the narrative of sustainability and global warming's implications has been so deeply woven into our societal fabric that the focus has expanded. It's not just the major corporations under the limelight; government entities and private sectors are also being observed and evaluated.

Solutions lie in technological and operational advancements. Grid modernization, advanced metering intelligence, the integration of renewable energy sources and battery storage are instrumental. They don't merely serve as technological upgrades but as tools to help both public and private sectors navigate ESG complexities. These innovations usher in operational efficiency and a shift towards more environmentally friendly solutions.

The evolution in utilities is also visible in their approach to societal responsibilities. There's a surge in initiatives like community solar programs, employment opportunities in the renewable sectors and efforts to tackle energy poverty. The aim is clear: to ensure universal access to consistent and reliable power.

Yet, these efforts must be underpinned by robust governance structures. It's not just about regulatory adherence but fostering a culture where the broader ESG vision cascades from leadership, permeating every organizational level and ensuring holistic alignment.

Electric vehicle growth

The trajectory of electric vehicles (EVs) is soaring, presenting both opportunities and challenges for utilities. As EV adoption accelerates, utilities confront the dual task of assimilating them into the power infrastructure while also catering to their rising electricity demand. The potential of EVs goes beyond just an environmental footprint reduction. Indeed, they spearhead the march towards a net-zero emissions world. However, this rise is not without its implications; it exponentially strains our electricity infrastructure. The strain is evident in two primary areas: the need for domestic charging solutions and the expansive development of public charging networks.

To navigate these challenges, the technological prowess of edge computing becomes invaluable. Especially when paired with tools like smart meters and Advanced Metering Infrastructure (AMI), they become pivotal in effectively managing the grid's demand and load balance.

The impact of EVs isn't just limited to roads or charging stations. It's reshaping urban landscapes. Urban planners, in tandem with architects, are now drafting the future blueprints of cities with a clear EV focus. This includes dedicated EV lanes on roads, widespread public charging infrastructure and ensuring new building codes are EV-ready.

As EVs continue to dominate, we witness a parallel decline in the conventional petroleum-driven transport model. This changing dynamic signals a clarion call for the oil and gas sectors. Adaptation is the key, whether that's through diversifying their portfolios, ramping up investments in renewable energy, or pivoting to produce components vital for the EV industry.

Battery storage

When delving into the intricacies of the energy landscape, the pivotal role of battery storage becomes unmistakably clear. This is accentuated as renewable energy sources, particularly wind and solar, claim a larger stake in the power grid. Their adoption not only underscores the pursuit of sustainability but also amplifies the importance of battery storage. The reasons are twofold: the unpredictable nature of renewables and the increased frequency of extreme climatic events. In such a scenario, battery storage acts as the bulwark, ensuring a resilient energy infrastructure and safeguarding against potential power disruptions. →

Figure 2 The impact of EVs is reshaping urban landscapes, changing how urban planners and architects draft future blueprints of cities with a clear EV focus.

Figure 3 Smart cities are urban hubs with intricate webs of connectivity, providing residents with a higher quality of life.

Legislative strides, especially in regions like the U.S. and Europe, further bolster the case for battery storage. Recent legislations, aimed at fueling energy innovations, have earmarked substantial incentives. These are designed to boost the integration and utilization of battery storage within the broader energy ecosystem.

The spectrum of battery technology is both wide and evolving. While lithium-ion batteries currently lead the pack in efficiency, the horizon shows promise with contenders like solid-state batteries, known for their extended lifespan and heightened safety parameters. Additionally, ongoing research in areas like graphene and flow batteries heralds a new era in storage potential.

On a more granular level, residential energy solutions like Tesla's Powerwall are redefining the domestic energy narrative. These systems enable homes to harness and store solar energy for nocturnal usage, inching closer to the reality of off-grid living. For the corporate sector, the appeal of battery storage lies in the promise of unwavering power — an essential for operations that can't afford interruptions.

Smart cities

One of the most transformative yet understated shifts in the energy domain is the emergence of smart cities. These aren't just urban areas focused on better energy management but are intricate webs of connectivity. At the heart of a smart city is the Internet of Things (IoT), interlinking devices, machinery and objects in a vast digital network that seamlessly communicates and exchanges data. This network serves as a lynchpin for municipalities, offering a bird's-eye view of traffic, waste management, public transportation and a plethora of other services.

The real magic, however, lies in the data analytics. By processing real-time data, smart cities optimize decision-making processes, enhancing both their speed and accuracy. The ripple effect of this is profound: residents enjoy a higher quality of life, sustainability goals are accelerated and resources are judiciously allocated.

Powering this intricate urban tapestry are foundational devices like smart meters and innovations in edge computing. These elements synergize, forming the robust neural network of the smart city, enabling both its digital and physical entities to function with unparalleled intelligence.

Trailblazing this movement are cities like Barcelona, renowned for its holistic IoT integrations across public services, and Singapore, celebrated for its pioneering smart traffic solutions. These cities not only manifest the potential of smart urban spaces but also spotlight their tangible societal and economic dividends.

However, the dazzling allure of hyper-connectivity does cast a shadow: privacy. The continuous data churn, while invaluable, underscores the paramount importance of robust data protection mechanisms. Ensuring that this data remains inviolable and isn't misused is a challenge that smart cities must earnestly address.

Figure 4 The future of edge computing will redefine paradigms by using AI algorithms to proactively schedule repairs and manage energy distribution.

Edge computing

Imagine a vast enterprise ecosystem, pulsating and thriving. At its core lies edge computing, akin to a central nervous system, responsive and agile.

In the realm of Advanced Metering Infrastructure (AMI), a prime example of edge computing is the smart meter. This device isn't merely a gauge of energy consumption. It's a dynamic tool, gathering, managing and analyzing energy data in real time. Instead of relying on remote servers or vast data centers, edge computing places the computational process right at the source of data generation. This can be any device — from equipment, machinery, sensors and even the aforementioned smart meters.

The moment an anomaly is detected, edge computing allows for immediate action, like shutting down the turbine and averting potential damages.

The beauty of edge computing lies in its immediacy and relevance. Rather than shuttling heaps of data across vast distances to centralized repositories or cloud storage, data is processed on the spot. This proximity enables devices to respond with lightning speed. For instance, machinery equipped with edge computing can identify wear and tear, prompting autonomous preventive shutdowns or notifying personnel with actionable insights. The benefits are multifold: reduced downtime, minimized maintenance costs and enhanced security since data is not aggregated in one vulnerable spot.

Now, imagine the applicability in utilities. Envision a wind turbine, bristling with sensors. The moment an anomaly is detected, edge computing allows for immediate action, like shutting down the turbine and averting potential damages.

The future of edge computing is, undeniably, expansive. It's set to redefine paradigms, from the way maintenance is predicted — with AI algorithms scheduling proactive repairs — to revolutionizing energy distribution, adjusting it dynamically based on demand and supply fluctuations. →

What's next?

At the intersection of curiosity, ingenuity and experience, there's a potent drive to address challenges across various industries. The commitment transcends beyond immediate needs, reaching out to our shared global future. Thus, R&D efforts are steered towards holistic solutions — ones that resonate with economic growth and enhance human well-being.

The pursuit of innovation is not merely about introducing new tools or technologies; it's about crafting solutions that elevate efficiency, resilience, sustainability and profitability. More so, it's about enhancing the quality of life on a global scale. Whether it's the intricate networks of smart cities or the rapid advancements in edge computing, the true power lies in connectivity. Every connection paves the way for new opportunities, each more promising than the last.

Navigating the future does come with its set of challenges. The increasing concerns of climate change and resource constraints underline the need for collaborative efforts. It is this spirit of global cooperation, manifested in combined research, technology sharing and cohesive policymaking, that will drive the shift towards sustainable energy frameworks.

Moreover, the energy grid of the future will be more interactive and inclusive. Empowered by innovative platforms, consumers will transition from mere users to informed participants. They'll possess the capability to monitor energy use, make data-driven decisions and even engage actively in energy trading ecosystems. Such a future, carved by technological innovations and a focus on human-centric approaches, is on the horizon.

ABOUT THE AUTHOR:

Ronald Hermans joined Honeywell through the Elster acquisition and has more than 20 years of experience in the utility and software industries. Hermans has worked in a variety of roles spanning solution and product management, technical sales, marketing and project delivery in EMEA, with customers across all segments of the utility industry, focused on leveraging technology to protect and improve business processes and customer service.

ENERGY 4.0 AND REMOTE ASSET MONITORING -

HOW UTILITIES BENEFIT FROM SMART, CONNECTED DEVICES

RICHARD HARADA

Industry 4.0 has long been a buzzword in the manufacturing and industrial sectors. Representing the fourth industrial revolution, Industry 4.0 highlights the transition from steam and electric power to modern advances in automation, data and analytics, networking and cloud computing.

Energy 4.0 applies the same concept to the electrical power utility industry. New technologies designed and built specifically for utilities have the potential to transform how generation, transmission and distribution infrastructure is managed, maintained and modernized. With access to real-time data, utilities can improve flexibility, resiliency and safety while lowering the cost of operations and maintenance compared to using traditional in-house resources and infrastructure.

Unfortunately, concerns over cybersecurity, IT infrastructure and reliability have caused utilities to hesitate when it comes to making investments that would modernize and enhance the electric power grid.

But with rising challenges and the transition toward renewable energy and distributed grids, the time to invest is now. Those who take a strategic approach and implement the right solutions that provide real-time situational awareness and automated monitoring for high-value and critical assets will be the ones who emerge best positioned for long-term success and profitability.

Energy 4.0 technologies

Energy 4.0 is a general term for the collection of hardware, software and technologies that leverage connectivity, data and computing power to modernize the grid.

The Industrial Internet of Things

The Industrial Internet of Things (IIoT) is a network of physical devices or sensors that collect, exchange and transmit contextual data. Soaring adoption and improving technology mean the global utility IIoT market is expected to grow to more than US$129 billion by 2032.[1]

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Cloud computing

Cloud computing is the on-demand delivery of computing services over the Internet, including servers, storage, databases, networking, software, analytics, or other IT services.[2] A recent survey showed that nearly all utility leaders have implemented cloud solutions, compared to less than 50% of lower-performing utilities.[3] →

[1] https://www.futuremarketinsights.com/reports/iot-in-utilities-market

[2] https://azure.microsoft.com/en-ca/resources/cloud-computing-dictionary/what-is-cloud-computing

[3] https://www.accenture.com/ca-en/insights/utilities/cloud-imperative-utilities-industry


NEW BUSINESS MODEL
1 2 3 4 5 6
AUTOMATION
SCANNING
4.0
BIG DATA
CLOUD COMPUTING
SMART TECHNOLOGY
AUTONOMOUS ROBOTS
CYBER SECURITY
IOT

Data and analytics

Data and analytics allow utilities to collect, store and use data from multiple sensors to improve decision-making, business processes and performance.[4] A recent study found that 52% of electric utilities had already or were currently implementing big data analytics.[5]

Artificial intelligence and machine learning

Artificial Intelligence (AI) allows computers to analyze and contextualize data to provide information or automatically trigger actions without human intervention.[6] Machine learning (ML), on the other hand, is a subset of AI that uses algorithms to automatically learn and recognize patterns to make increasingly better decisions.[7]

The barriers to energy 4.0

Despite a wide range of potential benefits and the adoption of similar technologies in other industries, the utility sector has tended to lag behind for two primary reasons.

Security considerations

As critical infrastructure, utilities are highly concerned about cybersecurity. Regulated standards enforce the cybersecurity defences that utilities must implement to keep their networks protected, but internal security policies may go even further in limiting the use of network access or services due to perceived security risks.

This fear is not totally unfounded. The combined energy sector experienced 10.7% of all cyberattacks, ranking it fourth among industries.[8] However, when evaluating cybersecurity risks, utilities should consider the type of data being transmitted and whether it can be used to disrupt the flow of electricity.

Internal policies and strategies

Utilities have traditionally focused on capital expenses (CAPEX), spending on equipment and assets needed to upgrade and build infrastructure. However, the move toward Energy 4.0 requires that utilities shift how they measure financial performance and allocate some budget toward ongoing operational expenses (OPEX) to pay for services such as network access, storage and computing.

The trends driving the need for new technology

The utility industry is changing, with emerging trends combining to place significant pressure on infrastructure that was not designed to meet current requirements.

Aging infrastructure

A recent report found that more than 70% of U.S. transmission lines were more than halfway through their 50-year life, while the average age of large transformers exceeded 40 years.[9] The situation is similar in Canada, where the majority of the electric system was built more than 50 years ago.[10]

Labour and skills shortages

In addition to the technology itself, utilities must also invest in the skills, capabilities and expertise needed to achieve the full benefits of a new solution.

But utilities are increasingly competing for these scarce resources against other industries, especially high-tech firms. At the same time, a recent report found that more than 50% of experienced utility workers are expected to retire within the next decade.[11] Technology can reduce the burden on scarce technical resources and free up personnel to focus on other, more strategic initiatives.

> **More than 50% of experienced utility workers are expected to retire within the next decade**

Extreme weather

Climate resiliency is now a key requirement as more frequent and severe weather impacts grid reliability and performance. A recent survey found that more than 50% of utilities said extreme weather impacted the delivery of electricity more than usual in the past year.[12] →

> **More than 50% of utilities said extreme weather impacted the delivery of electricity more than usual in the past year**

[4] https://www.gartner.com/en/topics/data-and-analytics

[5] https://www.osti.gov/servlets/purl/1639296

[6] https://ai.engineering.columbia.edu/ai-vs-machine-learning/

[7] https://ai.engineering.columbia.edu/ai-vs-machine-learning/

[8] https://www.ibm.com/downloads/cas/DB4GL8YM

[9] https://www.reuters.com/investigates/special-report/usa-renewables-electric-grid/

[10] https://natural-resources.canada.ca/sites/www.nrcan.gc.ca/files/canmetenergy/pdf/G7_Power_Systems_Report-2020-06-17-EN.pdf

[11] https://www.smart-energy.com/industry-sectors/energy-grid-management/the-ageing-workforces-brain-drain/

[12] https://www2.deloitte.com/content/dam/Deloitte/us/Documents/energy-resources/us-eri-power-utilities-outlook-2022.pdf

Renewable energy
Utilities are heavily investing in decarbonization in response to regulatory, social and investor pressure. Investments in sustainable energy sources are projected to total more than US$3.4 trillion over the next decade.[13]

Decentralization
Power has traditionally flowed in one direction from a generating station to users often located vast distances away. But that is likely to change. A 2022 study, for example, found that 86% of consumers were interested in generating their own electricity.[14] With locally generated power flowing in two directions, transmission and distribution systems need to be upgraded.

Putting Energy 4.0 technologies to use - Remote asset monitoring

Remote Asset Monitoring uses smart, contactless, infrared temperature sensors to provide utilities with automated remote thermal inspections on a near real-time basis.

Remote Asset Monitoring uses smart, contactless, infrared temperature sensors to provide utilities with automated remote thermal inspections on a near real-time basis

The smart sensors take advantage of Energy 4.0 technologies to continuously monitor the health and performance of high-value utility assets while providing greater visibility and control of critical infrastructure. Infrared sensors automatically detect faults and alert technicians, allowing them to diagnose the issue and prioritize a repair based on the severity and estimated time to failure.

With increased access to data, utilities can monitor trends over time, improve reliability and transition toward a condition-based maintenance strategy that significantly reduces operations & maintenance costs.

How thermal and visual sensors work

Utilities are already familiar with handheld thermal sensors that have long been used to detect overheating assets such as transformers and their subsystems.

Remote Asset Monitoring uses similar technology to provide continuous, 24/7 coverage to detect faults at any time and during any load or temperature condition. Infrared sensors detect if there are I^2R problems with any type of current-carrying asset. In a default configuration, thermal readings are taken every fifteen minutes while visual snapshots are provided twice a day, resulting in very low bandwidth consumption typically around 1MB per day.

AI/ML-powered software automatically alerts operators to a temperature anomaly that falls outside a set range. Since temperature can vary significantly due to changing load and weather conditions, alarms are based on temperature differential and are only generated if the component temperatures differ from each other by more than a few degrees. A consistent variance in absolute temperature will not sound the alarm.

Generally, the greater the temperature differential, the more severe the problem is and the sooner it needs to be repaired. Corrective maintenance can therefore be prioritized.

The IIoT dashboard displays the thermal image with the areas of interest identified by the green polygons. It shows the current and historical temperature readings graphed over time. The dashboard is also used to configure the sensors and view/set the alarms.

By leveraging third-party cloud services and network providers, utilities can minimize the cost of building, maintaining and upgrading IT infrastructure. Utilities can then scale these resources up or down based on actual usage, increasing flexibility and responsiveness as requirements change. Fewer in-house technologies also help to reduce the burden on internal IT departments.

[13] https://www.infosysbpm.com/newsroom/analyst/documents/next-gen-it-services.pdf
[14] https://www.ey.com/en_us/power-utilities/five-utility-trends-to-watch-in-2022

Main components of the contactless sensor

- Infrared Module
- Visual Sensor
- Wi-Fi or Cellular Communications
- GPS
- Bluetooth
- Digital Inputs and Outputs
- Information and Configuration Dashboard

Implementing sensors for remote asset monitoring

Before installing the sensors, utilities should develop a comprehensive project plan that ensures everyone is working toward the same objectives. Start by identifying the initial scope, the business reasons for the project and the key metrics before determining the equipment and technologies required. This will also make it easier to set realistic budgets and installation timelines. →

Utilities can then determine where the sensors will be deployed. For example, if the goal is to reduce the frequency of faults, a utility could select an older substation that requires more frequent maintenance. If, on the other hand, the goal is to reduce total travel time, sensors could be deployed at a distant facility that is difficult to access. With the site selected, utilities can identify the specific types of faults and the points on the equipment to be monitored.

Finally, installation and deployment can take place. Depending on the specific deployment, this can often be completed without an outage, drastically reducing installation costs compared to wired alternatives. Technicians can then complete the configuration and conduct testing, adjusting the parameters as needed to ensure complete and accurate data.

With the sensors installed, utilities can begin to transition toward a condition-based maintenance strategy, using AI/ML for predictive maintenance in place of periodic, scheduled inspections.

Using a carrier network can isolate the IoT network from the corporate network, mitigating cybersecurity risks and providing greater capacity, reliability and more frequent upgrades than an in-house network.

Optimizing operations and maintenance with Energy 4.0 technologies

By leveraging Energy 4.0 technologies and implementing a contactless system, utilities can optimize operations and maintenance and free up scarce technical resources for more strategic initiatives.

Communications

Carrier-grade networks provide utilities with the latest high-speed technology without the need for expensive hardware, cabling infrastructure, installation and maintenance. Using a carrier network can isolate the IoT network from the corporate network, mitigating cybersecurity risks and providing greater capacity, reliability and more frequent upgrades than an in-house network.

Storage and processing

Similarly, reputable cloud service providers provide greater levels of performance, security and scalability than on-premises infrastructure. After accounting for the hardware, software and maintenance costs, sharing computing resources over the cloud can lower costs to as little as 10% of owning and maintaining an on-premises data center over three years.[15]

Economies of scale

Because IIoT sensors are built with small, highly integrated parts and use standard carrier communications, the solution can easily scale up to more sites or assets over time. Utilities can start with smaller-scale pilot projects to sustainably invest while becoming familiar with both the technology and the process of procuring, installing and using the sensors.

Installation and deployment

The compact and easy-to-install sensors can be deployed faster and more cost-effectively than alternative monitoring solutions. No trenching is required for power or communications, and most sites will have a suitable mounting location without the need for further construction.

While the exact cost and schedule will vary, an IIoT sensor installation can be done in under an hour. Multiple sites can be managed simultaneously to reduce the total timeline. Utilities should plan to allocate 60% of the total cost to the purchase of the equipment and 40% to installation, with an additional 10% allocated to any contingencies.

Five examples of remote asset monitoring

Thermal and visual sensors can be deployed across a wide range of applications. Below are some examples of how utilities can implement IIoT devices for Remote Asset Monitoring.

Transformer monitoring

Transformers are high-value assets critical to the reliable flow of power. Physical inspections can detect faults, but these single-point-in-time inspections require crews to be in the right place at the right time.

Contactless thermal sensors can be aimed at transformers and their subsystems to detect temperature anomalies and automatically alert crews as soon as a fault appears. Instead of waiting for the next inspection, crews can be dispatched to address the issue before the component fails.

Wind turbine and substation inspections

Similarly, physical inspections on wind farms are time-consuming and expensive, requiring specialized expertise and certifications. Utility-grade thermal sensors reduce the need for manual inspections by providing 24/7 coverage of both the turbines and the supporting substations.

[15] https://cloudpost.us/capex-vs-opex-on-premises-versus-the-cloud-which-saves-more-money/

Underground vault monitoring
Underground transmission and distribution lines negatively impact the cost of maintenance and the overall life expectancy of the system. Underground vaults can also pose a threat to workers in cases of fires, explosions, or flooding.

Thermal and visual monitoring offers a way to detect potential problems and alert crews to hazards before they arrive at and enter the vault. Similarly, monitoring around joints and splices can detect cable faults or identify damage, wear and corrosion before failure.

Overhead switch verification
Verifying the position of motor-operated switches is often a highly manual and time-consuming process. Visual sensors allow technicians to remotely verify that switches are open or closed without traveling to the site, dramatically reducing the time and cost of switching operations and providing more flexibility and responsiveness to changing grid conditions.

Substation battery monitoring
Substation batteries are a vital part of the protection and control system. Failure could result in damage to equipment and put workers at risk. Substation batteries can be continuously monitored with thermal and visual sensors to ensure the health and performance of the battery before a failure occurs.

Embracing technology for long-term success

The utility industry has reached an inflection point. Accelerating trends toward renewable energy, distributed grids, labor shortages, and more frequent and severe weather events are taking a toll on aging infrastructure that was not designed to meet the challenges of the future.

Remote Asset Monitoring using contactless thermal and visual sensors provides utilities with a continuous view of high-value, critical assets while minimizing the need for physical inspections. With greater access to historical and real-time data, utilities can mitigate the risk of catastrophic failures, prioritize strategic investment decisions and reduce the burden on scarce technical resources.

And by implementing effective security policies and IIoT architecture, discussed in more detail in other papers, utilities can achieve the benefits of Energy 4.0 technologies without compromising sensitive data or critical equipment.

Energy 4.0 technologies including IIoT, cloud computing, data and analytics and AI/ML are changing the way that electric power and its critical assets are managed and maintained. By making the right investments today, electrical power utilities will be better positioned for long-term success and profitability.

ABOUT THE AUTHOR:

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

POLES APART:

THE SURPRISING TRUTH ABOUT POWER POLE EVALUATION METHODS AND THEIR RESULTS

NELSON BINGEL AND ROBERT BATCHELOR

What's the best way to assess and maintain your utility's pole assets? For many electric utilities, the decision has been guided without strong empirical data to back the choice of inspection process.

To provide the industry with more current insights, an Atlanta-based structural resiliency and utility asset management company just completed a robust, comparative study of multiple combinations of pole inspection methods to recalibrate which approaches provide the most reliable results for the circumstances and budget available. The findings of the study suggest that it is time for utilities to reassess their approach to pole plant asset management programs.

Healthy utility poles are essential for delivering electricity and communication services to customers. While utility poles may look resilient above the surface, they are subjected to climatic and soil conditions that most often cause unseen decay below the groundline.

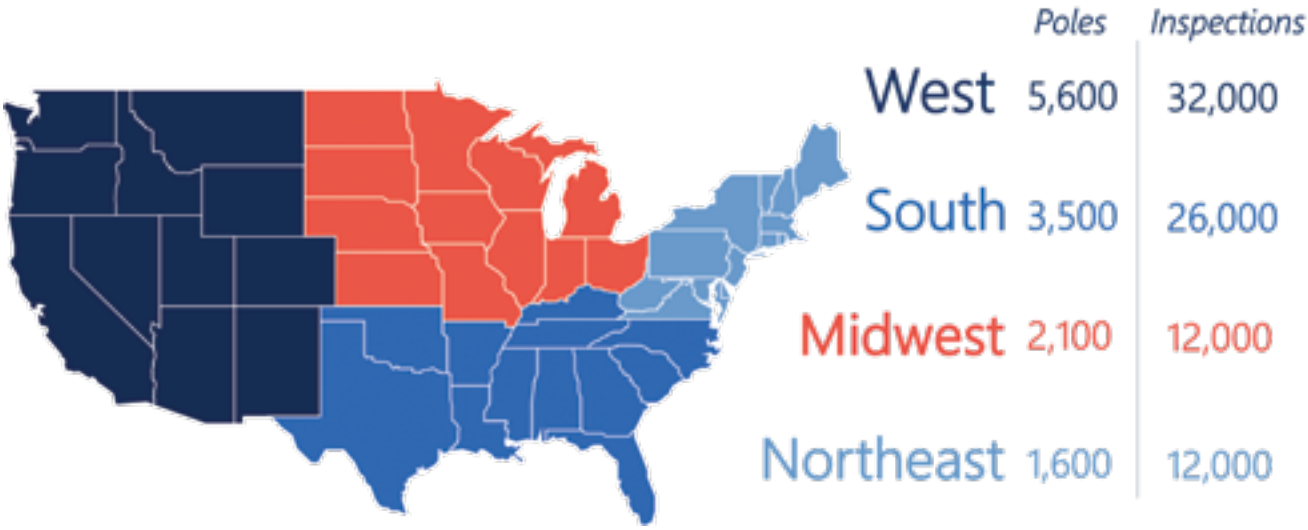
There is growing concern about the condition of these assets, and rightfully so, as the U.S. grid infrastructure continues to age. The average wooden utility pole without any groundline inspection, paired with the application of preservative treatment, deteriorates to a "reject" status between 45 to 50 years of service. This means that by the time a population of poles is between 45 and 50 years old, half of the poles will have a remaining strength that is below code requirements due to groundline decay. The average age of wood-based grid infrastructure in the U.S. is about 40 years old.

The key to efficiently managing the utility wood pole plant is the ability to correctly differentiate poles without decay from decayed poles that can stay in service (decayed but serviceable) and decayed poles that must be reinforced or replaced (reject poles) per the National Electrical Safety Code (NESC). Correct identification of a pole's condition into these categories reduces risk and allows the application of preservative treatments to mitigate decay and extend the asset's life.

The understood effectiveness for different types of inspection processes has evolved over the years as technology, inspection methods and industry knowledge continue to develop. Interestingly, there has never been such an extensive scientific field study with data to validate published expectations until now. Endeavoring to build and expand on previous studies and experience in the field, the asset management company sought to bring specific data to wood pole inspection programs that had not been researched to this degree before.

For decades, the utility asset management company that conducted the study has been the nationwide authority for evaluating wood utility poles, visiting five million poles in the United States each year across all climates and conditions. The company's widespread presence has led to the use of a variety of combinations of inspection methods that result in a variety of processes used across various environmental conditions. As industry leaders, the company's researchers understood that they were in a unique position to scientifically quantify the effectiveness of traditional wood pole evaluation methods.

In this study, the condition of each pole was evaluated after each additional method was added to the process including multiple types of partial excavation. →



Graphic shows the number of poles and inspections that were performed in each region.
Credit: Osmose Utilities Services

Rigorous study leads to reliable industry benchmarks

Beginning in February 2021, the utility asset management company began ambitious research to quantitatively measure the effectiveness of combinations of utility pole evaluation methods over the course of a two-year labor-intensive study across the United States. Over 13,000 poles were visited, with more than 80,000 different inspections performed, leading to the largest collection of effectiveness data for traditional asset inspection methods ever assembled.

The overall goal was to provide the industry with reliable benchmarks for the effectiveness of different inspection processes to correctly identify groundline condition as:

- No decay
- Decayed but serviceable (DBS)
- A reject

The study was executed across four regions in the United States and included the two species types used for utility poles today, thick and thin sapwood. These species types have very different primary decay patterns:

- Thick sapwood species, primarily southern yellow pine, typically decay from the outside-in below ground.
- Thin sapwood species, Douglas fir, western red cedar and lodge pole pine, typically decay from the inside-out below ground.

The performance of the inspection methods was separated by thin and thick sapwood since the primary decay patterns drastically impact the effectiveness of the different methods.

A single blind process was employed in the study:

- The first pass crew performed a bevy of combinations of inspection methods: visual assessment, sounding, boring and one-sided pull backs and partial excavations. In addition, two-sided pull backs and partial excavations were performed for thick sapwood. Thin sapwood species also had a one-sided deep partial excavation performed.
- The second crew performed the full excavation and treatment inspection process.

Each crew had no knowledge of the other's results, preventing bias. The first pass trained inspector determined the no-decay, DBS or reject condition for each pole at each additional step of the inspection processes (over 80,000 inspections). Using only the decay that could be detected and measured with each step, the crew estimated the remaining strength.

Performing a sounding inspection on a wood utility pole.
Credit: Osmose Utilities Services

The study considers condition-based, non-condition-based programs

Some pole owners specify an inspection process to start with a combination of fewer inspection methods than the comprehensive full excavation process. However, if decay is detected or expected at any point of the original inspection methods, a condition-based program calls for the crew to continue inspecting to the full excavate process. If the specification does not require additional inspection after detecting or expecting decay, the trained inspector makes the pole condition call based only on the specified combination of methods, which is known as a non-condition-based program.

For example, if a customer requested a one-sided partial program, the trained inspector would perform the visual assessment, sound-and-bore process and excavate an 8-inch by 8-inch area on one side of the pole. If the trained inspector identified some surface decay in the excavated area, a condition-based program would require the trained inspector to proceed to full excavation of down to 18 inches around the pole to accurately determine the extent of the decay and the serviceability of the pole. For a non-condition-based program, the inspection would end with whatever identification of decay was determined by the partial process. →

Performing a groundline inspection on a wood utility pole to detect decay.
Credit: Osmose Utilities Services

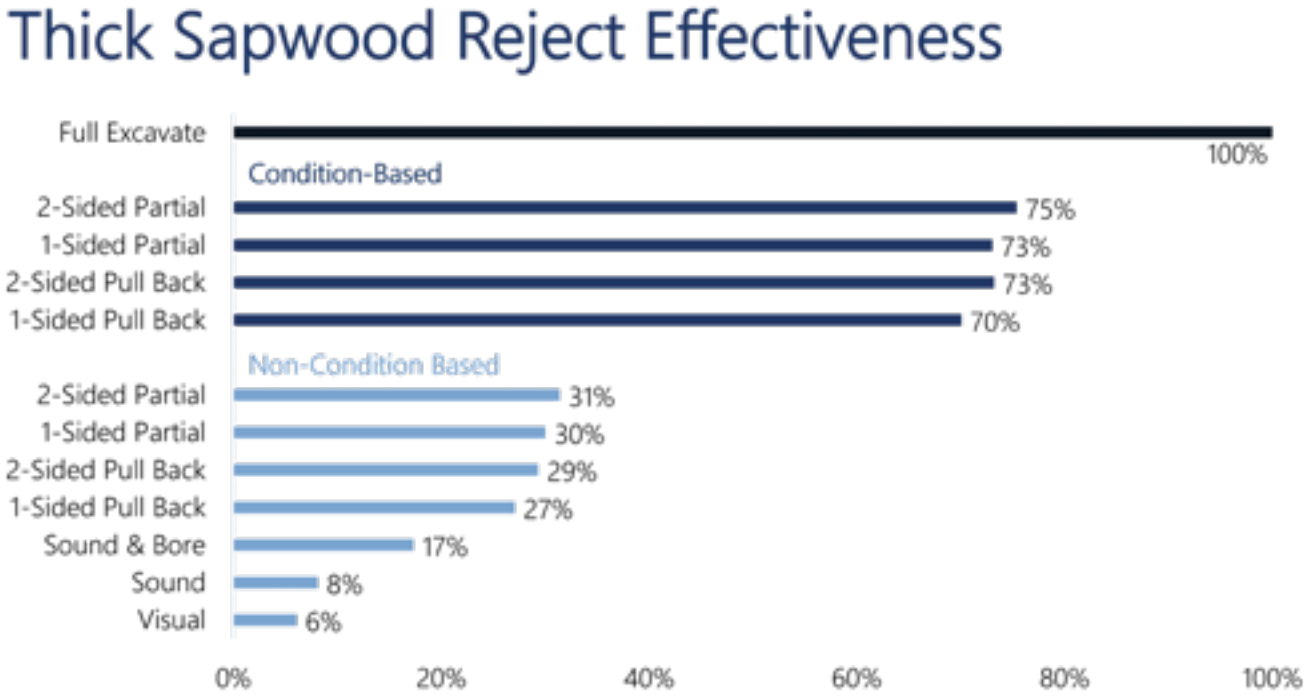


Chart shows the effectiveness of finding decay in thick sapwood poles by the type of inspection that was performed.
Credit: Osmose Utilities Services

The asset management company researchers included both condition-based and non-condition-based results for partial programs in the study to understand the value of each program type.

Inspection effectiveness in thick sapwood results

The thick sapwood reject effectiveness chart shows the percent of full excavate groundline rejects found by each inspection process, all of which identified over 500 reject poles. The thick sapwood pole species in these results include southern yellow pine and northern pine.

Since shell rot is the primary mode of decay and strength loss in thick sapwood species, the most important measure of determining decay presence is the physical assessment of the below ground outside surface of the pole. This can be seen most pronounced in the difference between the condition-based and non-condition-based partial excavate programs. The condition-based partial excavate programs identified approximately 40% more groundline rejects than the non-condition-based partial excavate programs.

Regardless of conditionality, there is very little difference between the average reject effectiveness of all four partial processes. Additionally, all average reject effectiveness results for the visual, sound and sound and bore processes are less than 20%.

While the graph displays full excavate inspection effectiveness at 100%, that number was used as the baseline number of rejects for this study. It is unlikely that field performance will find 100% of groundline rejects due to various field conditions.

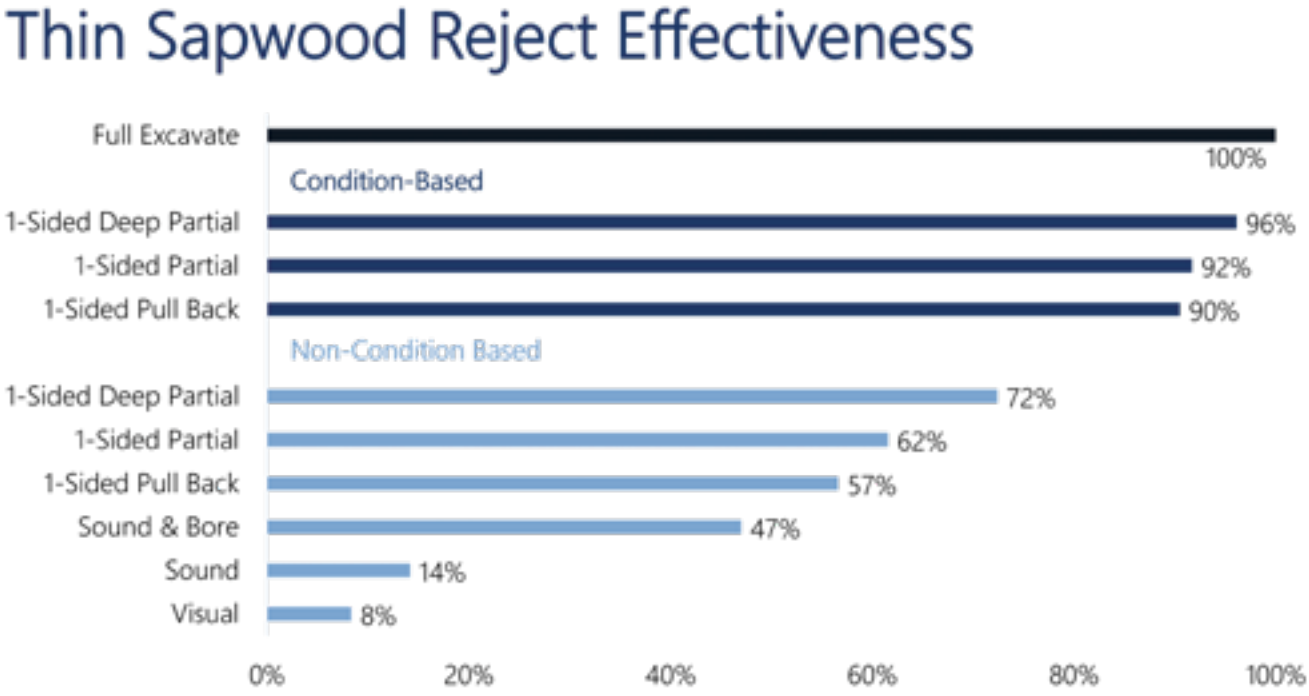


Chart shows the effectiveness of finding decay in thin sapwood poles by the type of inspection that was performed.
Credit: Osmose Utilities Services

Inspection effectiveness in thin sapwood results

The thin sapwood reject effectiveness chart shows the percent of groundline rejects found by full excavation for each of the other inspection processes all of which identified over 250 reject poles. The thin sapwood pole species in these results include Douglas fir, western red cedar and lodge pole pine.

Similar to the thick sapwood results, the condition-based partial excavate processes for thin sapwood species had an average reject effectiveness that was superior to the non-condition-based inspections by a margin of 20% to 30%. However, in thin sapwood species, there is more differentiation between the non-condition-based partials, with the one-sided deep partial being markedly superior to the one-sided pullback.

This difference does not equally translate to the condition-based partial programs, which are all very similar in reject effectiveness. Additionally, the sound and bore process in thin sapwood species has a higher average reject effectiveness than in thick sapwood species, with the visual and sound processes still showing an average reject effectiveness of less than 20%.

Like with thick sapwood, 100% effectiveness for thin sapwood is a baseline for the study, and it is unlikely that field performance will find 100% of groundline rejects due to various field conditions. →

Conclusion

As utilities strive to bring the best value to their customers and their shareholders, finding the proper balance between the additional cost of increased rigor in the inspection process and the costs of missing rejects in a utility's wood pole plant can feel like a guessing game.

With this study, the asset management company has provided an updated, quantified view of the differences in the effectiveness of various combinations of standard industry methods of utility pole inspection. This study recontextualizes the average groundline reject effectiveness for all inspection processes in thick and thin sapwood species using a research program never before conducted in the wood pole inspection industry. Utilities can now understand the realistic average reject effectiveness values for each process anywhere in the United States.

While the most effective inspection process available in any species is still a full excavate inspection, these results provide data-based comparisons to better understand the average reject effectiveness of any combination of other inspection methods. Additionally, by comparing these processes against the full excavate inspection, the gold standard of inspection in the utility industry, the asset management company, which conducted the study, has created a benchmark that any future inspection method can be measured against.

Shows the decay pattern of a thick sapwood pole because these poles decay from the outside-in
Credit: Osmose Utilities Services

Shows the decay pattern of a thin sapwood pole because these poles decay from the inside-out
Credit: Osmose Utilities Services

For thick sapwood species, there is so little difference between the most common partials, pole owners should prioritize the most operationally efficient partial program moving forward. Additionally, non-condition-based partials and sound and bore processes performed so poorly that their very existence as viable inspection programs are in question.

Conversely, for thin sapwood poles, condition-based partials performed almost as well as the full excavate inspection in finding groundline rejects, with the non-condition-based partials and sound and bore processes providing a lower level of performance.

ABOUT THE AUTHORS:

Robert Batchelor is the product manager, Pole Inspection and Treatment at Osmose. He holds a BS in chemistry from Armstrong University. Batchelor is an active member of AWPA and ASC 05, which provides standards and dimensions for wood poles. In his current role, he oversees the design, development and implementation of Osmose's wood pole inspection and treatment products and services.

Nelson Bingel has more than 30 years of industry experience focused on structural aspects of overhead lines. He received a BSME degree from Purdue University and has worked on research and development of improved structure inspection processes and restoration systems along with software for field strength and loading evaluation. Bingel was chairman of the Strength and Loading Subcommittee of the NESC for the last two code cycles and has been chairman of the full NESC Committee since 2016. He is also vice chairman of the Accredited Standards Committee 05, which develops standards for new wood poles and crossarms. While active on the NESC, Bingel also worked at Osmose for over 30 years.

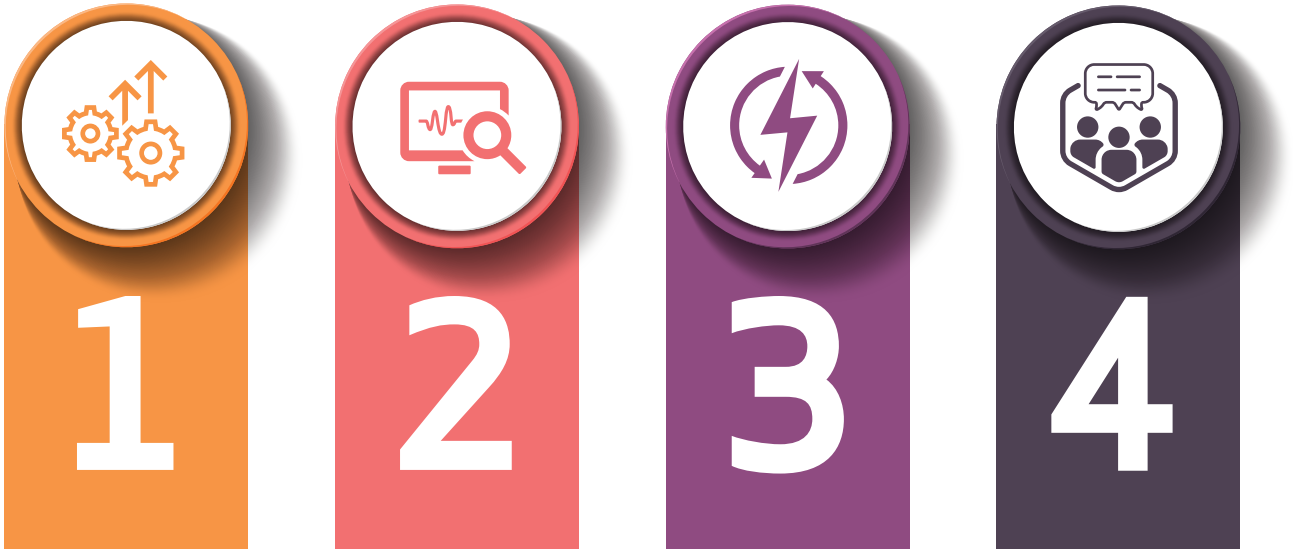
FOUR KEY FACTORS IN 2024:

SUSTAINABILITY BEST PRACTICES FOR ELECTRICAL MANUFACTURERS

CHERYL HASTY

As the world becomes more sustainable and electrified, electrical manufacturers will face increasing demand. Alongside that demand, manufacturers are facing increased pressure from a wide variety of stakeholders to operate more sustainably. Employees, customers, shareholders and governments are all pushing for companies to operate more sustainably, and companies are responding by setting sustainability goals to guide their efforts.

Managing their impact on the planet's natural resources while scaling production with increasing demand for electrical products is likely to be a defining challenge for manufacturers over the coming decades. But how should companies approach this challenge? A combination of strategic investments, operational efficiencies and employee engagement is required to drive lasting and meaningful progress. →



Factor 1. Focus on high-impact efficiency upgrades

Manufacturing facility managers know that it is impossible to address every potential sustainability improvement at once. Developing criteria to identify particularly impactful upgrades at various levels of investment can be a useful starting point. For instance, plant managers can identify which equipment uses the most energy or is used most frequently, or single out aging equipment that would probably need to be replaced soon for production reasons anyway. Building environmental considerations like energy use into the process when selecting new equipment is a good way to drive improvement while keeping costs down. At nVent, we were able to save 827,000 kilowatt hours and more than 238 metric tons of CO_2e in 2022 by completing air compressor upgrade projects.

Water use is a growing concern for manufacturing operations, particularly in water-stressed areas of the world. Many of the ways in which water is used in manufacturing lend themselves well to closed-loop systems where water can be recycled or repurposed to be used in multiple operations. Water recycling and recirculation systems can save millions of gallons per year for manufacturers, reducing costs and helping manufacturers reduce the pressure they put on their local water systems.

Facility lighting can also be a high-impact area. Switching to LED lighting where possible can save hundreds of thousands of kWh in a large global operation, helping companies manage energy costs as well. Heat reuse can also be explored as an option — repurposing heat generated by manufacturing operations in facility heating reduces the need for additional energy spent on heating. When pitching environmental improvement projects internally, remember that sustainability projects can often help pay for themselves over time through a reduction in energy and water costs and more efficient operations.

Factor 2. Monitoring and control technology

When replacing equipment with more efficient alternatives is not feasible, or even if it is, monitoring and control technology can be a critical step for reducing energy and water use. This technology can be applied to both manufacturing equipment and facilities. For instance, implementing automation systems in building heating, cooling and lighting can help reduce energy use overall by ensuring that energy is not being spent cooling, heating or lighting spaces where people are not present.

In a busy manufacturing environment, it is unfortunately common for machinery to be left running when not in use. Implementing auto-shutoff or timed switches and valves into equipment like washer systems, paint lines and more can help manage water and energy use. Monitoring and control technology helps bring all these systems together into facility management systems so building operators can get real-time insights into equipment that is using more power than it should and take action to mitigate any errors.

Factor 3. Renewable energy

On a larger scale, renewable energy projects can dramatically reduce manufacturers' environmental footprints. In many areas of the world, the large roofs of manufacturing facilities are ideal for solar installations. Solar energy can help drive employee engagement and pride as well. Displaying the amount of solar energy generated shows employees that they are working for a company that cares about the environment.

Renewable energy installations can certainly require investment — these projects often have high initial costs. However, the long-term energy savings as energy prices continue to rise will likely offset these costs over time. Consider how to prioritize projects based on important factors like available exposure to natural daylight, rising local energy costs and grants or tax incentives. Additionally, facilities that generate more energy than they use may have opportunities to sell energy back into the grid, introducing a new source of revenue for manufacturers and greening the local grid. As the world transitions away from fossil fuels, switching to renewable energy is an inevitability. Companies that begin making the transition now may have the advantage of staying ahead of regulatory pressure and new expectations from stakeholders.

Factor 4. Employee engagement

Developing a strong process for sourcing environmental improvement projects from within organizations is a key piece of any sustainability program. Employees who work every day with manufacturing equipment, within facilities and with customers are excellent sources of ideas that can become impactful projects. Establishing a good process to take advantage of employee ideas is critical. This can be achieved through collaboration with particularly motivated employees like employee engagement group (ERG) leaders, but it requires buy-in from leadership. Demonstrating a formalized process for implementing employee ideas will help develop momentum for these projects, with employees seeing their peers' ideas taken seriously and implemented, encouraging them to contribute their own.

For example, in 2022, the Employee Resource Group of a London-based design and manufacturing company has local sustainability teams around the world that help complete site assessments aimed at identifying potential environmental improvement projects. Grass Roots employees also held training events where employees learned about Scope 1, 2 and 3 emissions and the use of a new facilities assessment tool for identifying, measuring and reducing energy, water and waste emissions at local sites. Employees then put this knowledge to use, identifying potential improvement projects to help reduce our impact on the environment.

ABOUT THE AUTHOR:

Cheryl Hasty is nVent's environmental sustainability manager. She graduated from the University of Nebraska with a degree in environmental studies. From there, she found her way to environmental compliance consulting after internships with the USDA and the Nebraska DEQ. Hasty gained extensive subject matter expertise in U.S. environmental regulations supporting EPA's hazardous waste program and consulting on compliance programs for the U.S. Postal Service. She transitioned to the private sector for nine years and then led the Environmental Compliance team at Target Corporation. Hasty is pursuing her passion for environmental sustainability by joining nVent on its journey to become a leader in sustainable manufacturing for the electrical products industry.

DETERMINING THE ROI

OF YOUR INTELLIGENT LINE SENSOR PROJECTS

RANDY COUGH

In my previous article, "Intelligent Line Sensor Projects: How to get your grid modernization efforts off the ground," I provided several steps to help utilities get their line sensing pilot projects rolling.

Here, I'll provide guidance on how to take the next step: proving ROI from your line sensing pilot project. I'll include recommendations on how to reprioritize investment areas to achieve more value so you can confidently implement line sensing on a wider scale.

Where to begin: Determining ROI value streams

Traditionally, utilities have looked to line sensors to help improve overall reliability and prove the value with SAIDI reductions. However, today, advanced analytics leveraging high-fidelity data from intelligent line sensing offers utilities the opportunity to address multiple power delivery challenges, resulting in simultaneous returns on investment (ROI) and a variety of grid reliability use cases.

Value Stream #1 — Predict and preempt outages with advanced analytics

One of the most innovative uses of line sensor data is to predict and preempt outages. By adding analytics and machine learning to high-fidelity sensor data, utilities position themselves not only to execute proactive maintenance; but also, can identify potential risks for wildfire ignition.

To detect possible system problems before faults and thus outages occur, analytics modules must be deployed. It is recommended to leverage the power of the cloud due to the large amount of data collected and the computing resources required for machine learning. To maximize the ROI of this value stream, line sensor data integration software must also be flexible enough to integrate with cloud components.

Anomaly data is typically collected for several months to establish a baseline and predict outages. Line sensors detect waveform anomalies and machine learning algorithms identify precursors to faults caused by vegetation contact with power lines, as well as equipment failure. Daily reports alert utility companies to feeder segments experiencing high levels of precursor anomalies so they can take preemptive action.

While vegetation management is not new to utilities, using a data-driven workflow based on analytics and line sensor anomalies to predict faults associated with vegetation and line contact is an innovative approach. By proactively addressing these faults before they cause larger issues, utilities can significantly reduce wildfire risk and the costs associated with vegetation management. →


THIS YEAR
ROI
+10.3
+12.0
+22.6
+41.9
+83.0
COMPLETED
RECURRING
-6.230
First quarter
Jan-Mar
-1.5%
Third quarter

Image credit: Sentient Energy

Machine learning is also effective in characterizing anomalies that are precursors to equipment failures of insulators, cutouts, lightning arrestors, transformers and other components. Line sensing, data integration and analytics provide clear indicators of impending equipment failure, allowing utilities to prevent unplanned outages by taking preemptive action.

Preempting outages due to vegetation contact and equipment failure provides significant improvements in the system average interruption frequency index (SAIFI), leading to considerable O&M savings. By preventing future outages, utilities can also improve long-term system average interruption duration index (SAIDI) metrics.

Value Stream #2 — Reduce outage durations with fault detection and location

To achieve enhanced fault detection and reduced outage durations, overhead and underground line sensors provide utilities with enhanced system visibility along feeders and laterals. With remote communications, these intelligent sensors are often deployed on overhead lines, underground cables, pad-mounted or vault switches and underground residential (URD) transformers.

Regardless of where you installed sensors for your pilot project, having a more detailed view of the system gives you the ability to narrow down patrol areas and equip crews with better information to address faults swiftly. By integrating data from line sensors, you can improve reliability metrics such as outage durations, system average interruption duration index (SAIDI) and operations and maintenance (O&M) costs.

Line sensors assist utilities in detecting and locating faults, resulting in reduced outage durations on affected feeders and laterals. The integrated use of sensor data with supervisory control and data acquisition (SCADA) or ADMS applications increases the value of sensor data, creating a fast time-to-value.

Though you'll need to assess your own specific ROI, you can anticipate that you'll likely see improvements of 20% or more in Customer Minutes Interrupted (CMI) on feeders with line sensing deployments. This improvement is primarily due to significant reductions in patrol time, with some utilities reporting savings of up to 65% in patrol time. Reducing patrol time also leads to operations and maintenance (O&M) cost savings, with one large utility in the southeastern region reporting an 11% reduction in O&M costs due to line sensing initiatives.

Value Stream #3 — Plan for new distributed energy sources with load monitoring for enhanced system planning

When it comes to system planning, having accurate load data is crucial for making effective decisions. However, system planning teams often lack load data for the specific locations of interest, which can hinder their planning efforts. Intelligent line sensors offer a solution by providing visibility of system load at additional points on the grid, filling in these data gaps.

This is particularly important as power networks incorporate distributed energy resources (DERs) and electric vehicles (EVs), which introduce significant changes to historic load curves and make load forecasting more complex. Relying solely on load data from the substation is no longer sufficient.

In addition to load monitoring, line sensors installed on underground residential distribution transformers can also detect faults on the primary side and monitor transformer loading. This information aids utility engineers in improving asset management by using real system data to identify overloaded assets before they fail. With the increasing prevalence of electric vehicle charging, monitoring transformer loading becomes even more crucial, as a transformer that was previously appropriately loaded may become overloaded when multiple customers charge their EVs simultaneously.

Line sensor load data is available within minutes of sensor installation. You should be able to immediately integrate the data-driven insights into your decision-making processes and workflows for tracking ROI. You should anticipate that identifying and replacing overloaded transformers as part of planned equipment upgrades can result in savings in CMI and O&M costs, improve customer satisfaction and reduce the risk associated with wildfire ignition.

Image credit: Sentient Energy

How to crunch your numbers

When considering ROI, it's rather straightforward to simply add up the costs of the pilot in terms of sensor hardware, software and any other costs for deployment and ongoing management. It's a little more difficult to calculate ROI in terms of the payback or value to the utility derived from the pilot.

The approach to calculating value derived is different for each of the three value streams. The most straightforward way to determine value to the utility is calculated in Value Stream #2 — Reduce outage durations with fault detection and location.

In Value Stream #2, we can estimate value with either reduced customer minutes interrupted (CMI) or reduced O&M costs. To do this, we focus on faults that occur during the pilot and compare the resulting outage duration to that of the historic outage duration times for the same feeders. Utilities typically see a 20% reduction in outage duration by adding line sensing technology. Here's a sample calculation:

Outage Duration: 140 min

Historic Duration: 175 min

Number of Customers Impacted: 400

Utility's CMI Value: $1.20

CMI savings calculation:

With this scenario, we take the CMI savings of 35 minutes (historic outage duration minus pilot outage duration) and multiply it by 400 (the number of impacted customers). This gives us a total CMI of 14,000.

Then, we multiply 14,000 (the total CMI) by $1.20 (the amount the utility values CMI). This defines total savings for this one outage at $16,800.

O&M reduction savings

If O&M costs are preferred to CMI, we again start with the 35 minutes saved but this time multiply it by the cost of the crew. Let's say the crew cost with a vehicle is $1,000/hour, then the O&M savings will be $583.

When calculating ROI for Value Stream #1 — Predict and preempt outages with advanced analytics, we are estimating CMI and O&M savings based on an outage that didn't occur. We use the same formula to determine derived value as above. For example, if by predicting and preempting an outage on a feeder with 650 customers and a typical outage duration of 120 minutes, the "avoided CMI" would be 78,000, or at $1.2/CMI, $93,600. The "avoided O&M costs" would be for 120 minutes, or at $1K per hour, $2,000. →

In addition, predicting and preempting outages also creates "unrealized" ROI for utilities. This happens when there is an opportunity of potential savings by acting on predictions more quickly. Let's say a prediction is made that there is a potential fault indicative of equipment failure. However, a repair could not be made before the fault and thus, an outage occurred. By tracking unrealized value, the utility has an idea of the potential savings if predictions are acted on more quickly. In this case, the CMI and O&M cost associated with the outage predicted but not preempted would be considered "unrealized value".

For Value Stream #3 – Plan for new distributed energy sources with load monitoring for enhanced system planning, ROI is determined by quantifying the value of improving network load flow models by leveraging intelligent line sensors. Theoretically, accurate load flow models enable switching decisions which makes restoration more efficient. By comparing SAIDI numbers before and after adding line sensors, it would be possible to quantify more effective switching. For example, a fault was isolated, and part of the circuit was powered from a different feeder through switching. This switching operation restored 300 customers and a 120-minute outage was avoided. The CMI saved due to the switching operation was 36,000 at a value of $43,200.

Final thoughts

Like any experiment, it's best to start with a specific problem to solve, so begin with the primary use case or value stream for the line sensing pilot. From there, you can calculate CMI and O&M reductions based on reduced outage durations, faults avoided, or restorations enabled by effective switching decisions. Line sensing solutions are quickly deployed on the feeders and laterals and provide actionable data minutes after installation. No matter how the utility calculates ROI payback, either CMI or O&M savings (or both), crunch the numbers and you'll see the line sensing provides fast time to value compared to other reliability projects.

ABOUT THE AUTHOR:

Randy Cough has more than 30 years of electric distribution operations & planning and program management experience relating to grid modernization programs for electric utility customers. His primary expertise is in utility control center operations, distribution automation and control center applications such as advanced distribution management systems (ADMS) Outage Management Systems (OMS).

Prior to joining Sentient Energy, Cough worked at GE Energy for 20 years. His experience also includes more than 15 years at Niagara Mohawk Power (now National Grid) as a system electric operations director.

UTILITIES WANT TO REACH NET ZERO BY 2050. THEY NEED BETTER SOFTWARE TO GET THERE.

ANDRE TURENNE

From his first days in office, President Joe Biden has targeted climate change as a top priority. The administration's key achievement on this front has been pushing through the Inflation Reduction Act, the largest climate action ever taken in history.

Among a raft of innovations, programs and incentives in the act, the administration also set ambitious climate goals, including a pollution-free power sector by 2035 and a net-zero economy by 2050. While much of the focus has been on infrastructure deployment, look for much of the work to be implemented by an unlikely suspect: A new generation of AI-enabled software.

Utilities, as large power producers, are a prime target for decarbonization. Following pressure from regulators, customers, investors and other stakeholders, all major American electric utilities have set net-zero goals, although this has already proven to be a challenge for most. Utilities are massively complex organizations with conservative histories. Their incentives have always been to keep the lights on affordably and safely and deliver modest but steady shareholder returns—not to slash emissions. So, innovation has often taken a backseat to reliability.

Yet meeting these decarbonization deadlines will require widespread changes, and utilities must act quickly or risk falling behind. That will require unprecedented investments and support: The International Energy Agency estimates governments and the private sector will need to invest $4 trillion annually by the end of this decade to reach net-zero emissions by 2050. That's a fourfold spending increase from 2022 levels. →

As part of the industry's most active venture capital investor, I have a first-hand view of the work utilities are undertaking to reach net zero. Achieving these ambitious goals will take more than building infrastructure like solar, wind, storage and transmission. While those investments are critical, software must also be an essential part of the decarbonization mix to optimize assets, boost efficiency and operationalize sustainability, all with an eye toward achieving the lowest possible overall operating costs.

We call this type of investing operational efficiency. We're keenly aware that reaching net zero has to be done in a way that is affordable for our customers. The goal is to be able to reach decarbonization objectives while keeping our customer rate increases to the minimum amount possible. Improving the efficiency of our infrastructure and operations via new and advanced software is therefore key to our cost objectives. Operational efficiency is an under-hyped but vital component of net-zero efforts: If nobody can afford clean energy, net zero could face a backlash as we've seen for many ESG initiatives.

Software will be a critical part of our net-zero journey. Here's how we can give it the attention it deserves.

Prioritize business efficiency

This one's fundamental: We'll only reach net-zero goals if energy companies adopt business efficiency software.

Although it will never generate as many headlines as big infrastructure projects, using software to keep utilities running faster, more efficiently and with less bloat is immensely valuable — and deeply needed for many legacy operators. Utilities would do well to reassess their project management tools, budgeting platforms, customer service desks, billing solutions, HR management — every aspect of their back-office stack. Existing cloud software offerings can offer massive efficiencies many other businesses take for granted and can make a material impact on getting things done faster.

Embrace artificial intelligence and machine learning

In addition to existing cloud applications, operational efficiencies are suddenly being driven faster than ever by the rise of artificial intelligence. AI technology promises tremendous efficiencies as well as new products and services that can help solve some of our biggest problems — including climate change. Complex datasets like electric grids are perfectly suited to benefit from an AI layer.

AI is already helping utilities and their customers manage solar, wind, batteries and EVs across the grid while optimizing transmission lines to carry more renewable power. AI can match power generation to demand, putting the "smart" into smart grid. Utilities are also using AI to boost worker safety, enable predictive maintenance, monitor critical infrastructure and ensure quality data from sensors and other assets. And AI is reducing carbon emissions by facilitating demand-response programs that encourage customers to use less energy during peak demand.

That's helped improve grid reliability by 10% — a vital metric for utilities.

Here's one small example that can illuminate the massive opportunity. AI can pinpoint problematic areas within the grid where vegetation management crews should prioritize the battle against overgrowth. One company in the vegetation management space, for instance, uses satellite data and artificial intelligence to help utilities spot trees that could fall and damage power lines. That's helped improve grid reliability by 10% — a vital metric for utilities. It has also materially reduced our operating expense budget for vegetation management by changing the maintenance model from time-based to condition-based. This targets maintenance activities to the areas that need work versus those that don't.

Adopt visualization tools

Better visualization is another way software will have an outsized impact on net-zero goals. New software tools can help utilities create "digital twins" — virtual copies of the real-world environments where they're planning, building or maintaining clean-energy assets. By working with a comprehensive digital visualization, utilities can plan faster while identifying potential construction problems before they happen — and reduce the need to deploy costly worker teams.

One of the fast-growing players is a visualization software company based in the UK, whose platform improves coordination and communication by helping teams understand extremely complex, large-scale projects. This UK-based visualization software company is already working with several utilities and energy companies, including United Utilities and Lightrock Power. In 2021, the visualization software company also helped United Utilities reach its 2025 goal of reducing water leakage by 15% The start-up is meshing thermal data captured by drones with high-resolution photogrammetry that creates a predictive algorithm identifying locations where leaks are most likely to spring.

As better visualization software arrives tailored to the needs of the energy sector, legacy utilities will spot countless areas where the software can boost efficiency, reduce costs, improve safety and speed the deployment of clean energy.

Improve cybersecurity

As utilities update the grid to make it smarter, it will become increasingly connected. That provides tremendous opportunity for efficiencies and more clean energy assets, but it also provides more opportunities for attacks that can take networks offline, impede operations and interrupt service to customers.

> **Physical attacks on power grids rose by 77% last year in the U.S. alone, according to the Department of Energy.**

Physical attacks on power grids rose by 77% last year in the U.S. alone, according to the Department of Energy. And the potential scope of cyber attacks is even greater. America's power system connects 145 million customers and nearly every person and business; should an attack hit multiple targets across the country, the effect could be catastrophic.

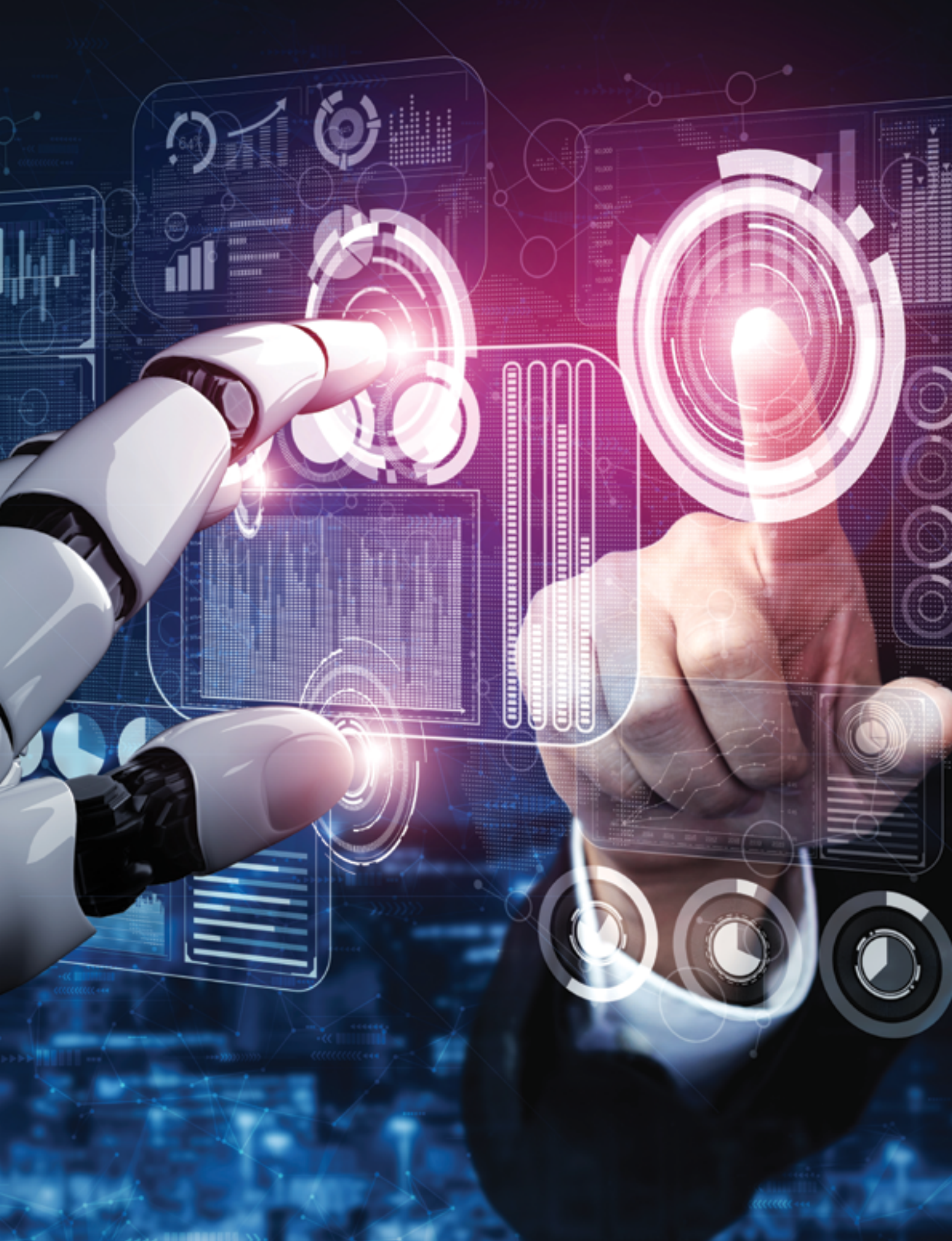
Utilities must adopt real-time asset identification, constant threat detection and immediate response software to keep the power on. Making cybersecurity a priority will not only require an innovation effort but also a cultural shift. Security leaders will need to make sure they're providing proper onboarding and consistent training to employees.

A leader in the real-time asset identification space is a Virginia-based company that was founded by a team from the National Security Agency and provides comprehensive management and response capabilities for industrial control systems; it already has hundreds of industrial customers, including 10 of the largest U.S. electric utilities, water utilities and energy providers. The company tracks dozens of different industrial hacker groups, including numerous national state bad actors, that specifically target the electric utility industry.

Cyber attacks will only become more sophisticated as hackers themselves increasingly turn to tools like AI. Utilities will need to continue rapidly evolving and adopting the latest software to stay ahead and protect our nation's energy grid.

Overcoming the red tape and placing customers first

But none of these software innovations will reach their full potential to transform energy infrastructure and combat climate change if utilities aren't better incentivized to pursue them. →



Most other companies reach for software before hardware or infrastructure when possible for a simple reason: Software is usually far less expensive. But in the utility world, there's a regulatory twist: The government guarantees utilities can bank a predictable rate of return on all capital expenditures. In other words, if a utility builds an expensive, capital-intensive power plant, a portion of those costs usually can be passed along to customers under current regulations. But operating expenditures — under which software investments typically fall — can't be passed along so easily because they're categorized as a cost of doing business.

As a result, utilities are incentivized to think construction-first, not software first. The downside is that capital expenditures almost always cost more than software implementations — especially software-as-a-service, which can be paid over time. Capital projects also take much longer to implement, which translates to slower progress on net-zero goals, more environmental damage and, in many cases, more costs passed on to end customers.

Utilities and regulators must work together to change the incentives and accelerate software adoption. It's an obvious win-win for the public, as well as for utilities and their stakeholders.

Software will show us the way

Utilities face incredible challenges ahead. They must scale clean energy production, transmission and distribution to support the electrification of everything, all while maintaining reliability, minimizing price hikes and adopting intermittent clean energy resources like wind and solar.

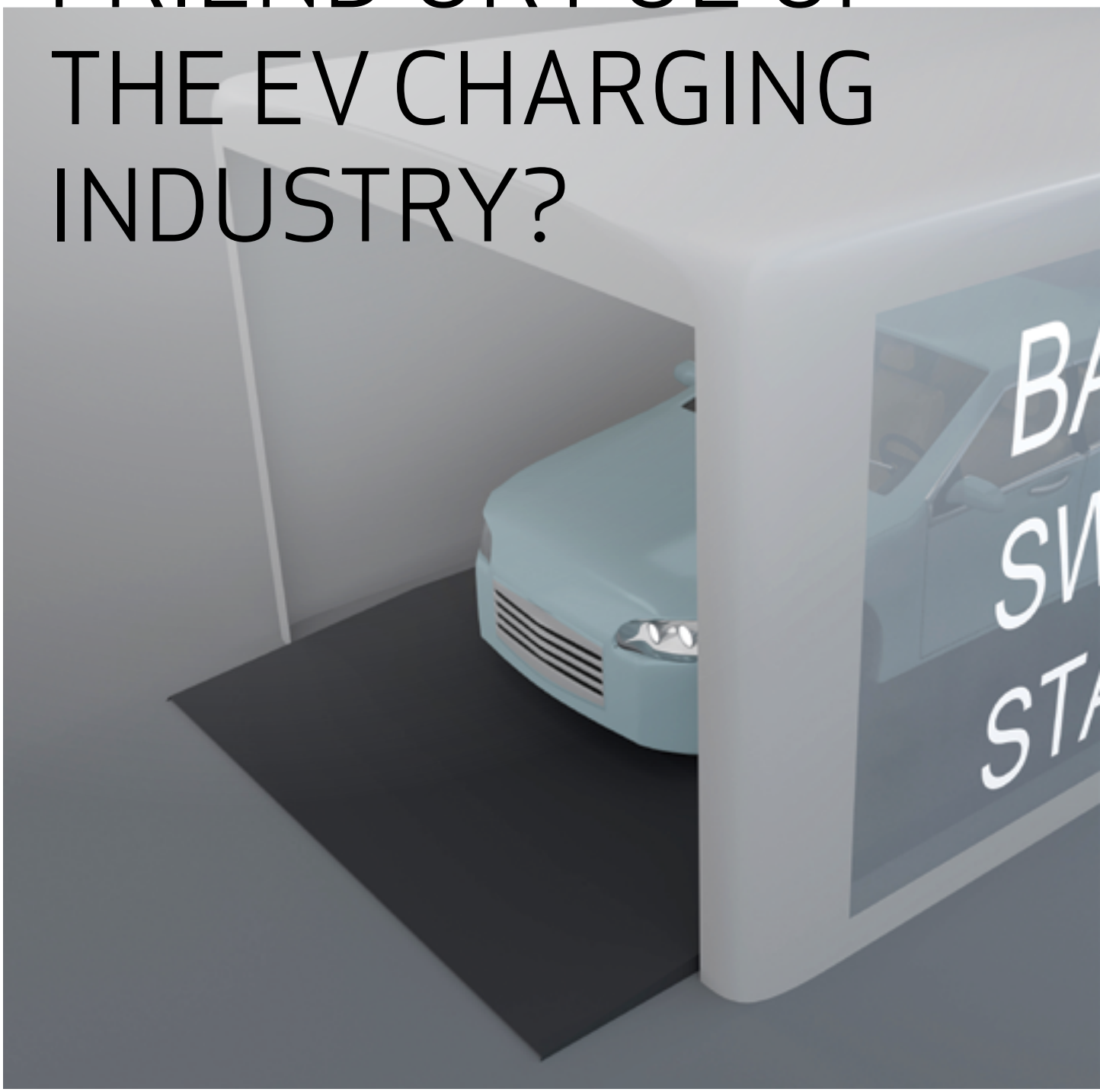
That's why building a net-zero utility must be focused every bit as much on software as large-scale infrastructure. It's simply the best way to reduce emissions at the lowest cost — and software continues to improve at breakneck speed.

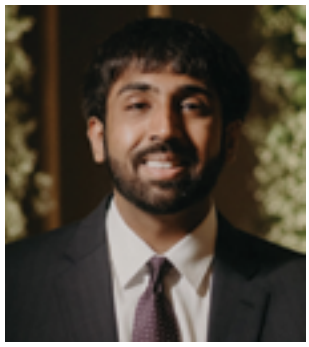
From AI, visualization and cybersecurity to business management, utility software deployments are just getting started. They can help make the most of existing and new infrastructure and are poised to kick off a golden era for utility innovation. Best of all, the software keeps getting smart — and I for one can't wait to see what comes next.

ABOUT THE AUTHOR:

Andre Turenne is vice president of Pathfinding and Incubation Investments at National Grid Partners, where he is instrumental in delivering both strategic and financial returns. He has more than 30 years of venture capital, business development, operating and technical experience spanning a wide range of areas, including enterprise software & services, SaaS/cloud, Data Analytics/AI, IT & network infrastructure, IoT/connected, digital utility/smart grid wireless and security.

BATTERY SWAPPING: FRIEND OR FOE OF THE EV CHARGING INDUSTRY?





AATISH PATEL

Charge anxiety — the fear or uncertainty of whether you will be able to find a charging station — remains a consistent hurdle to widespread electric vehicle (EV) adoption. To combat the anxiety EV drivers feel during long journeys, the EV industry has seen more charging networks emerge over the past decade. At the same time, battery swapping has surfaced as a proposed solution to the industry's woes, with companies such as Ample pursuing battery-swapping solutions.

Ample is not the first company to pursue battery swapping, however. In fact, Tesla Motors explored the concept in 2013, demonstrating the technology in the Model S, though they abandoned the idea to pursue their Supercharger network.

What is battery swapping?

Battery-swapping stations allow EV owners to replace their discharged batteries with fully charged ones that were previously stored and charged at the station in a matter of minutes. This sounds great in theory, as there is an abundance of EVs currently on the market. There are several advantages to this charging method, including taking up less time and expanding the range of an EV.

Battery swapping aims to match the convenience and speed of visiting a gas station. Still, some are skeptical, viewing it as just another expensive EV "charging" solution. But battery swapping could change the game for EVs by making long journeys more accessible. →

Battery swapping also has considerable appeal from a sustainability lens. With battery swapping, the batteries can be charged more slowly and efficiently, and in a way, that reduces demand on the grid, as opposed to fast charging, which can degrade the battery much faster. However, the EV industry must factor in the efficient reuse and recycling of batteries in order to be sustainable.

As the electrification of our transportation infrastructure evolves, so does the need to modernize and build a climate-resilient grid. And as demand for electricity continues to grow nationally, we must build EV charging solutions specifically for the North American grid to offset some of the need for grid resources.

The issue of uniformity

Currently, every characteristic of an EV's battery, from its shape to its location in the vehicle to its design, differs among automakers. Standardization is necessary for the commercial viability of battery swapping.

In previous years, China has implemented a battery-swapping system for EVs by mandating battery size and shape. This year, Chinese EV maker Nio Inc. began trial operations of faster, more efficient battery-swapping stations in China, further demonstrating battery swapping's effectiveness in this region. Nio has performed 20 million battery swaps. With 60% of Nio's users opting into the service, there is an opportunity in China to produce and lease the battery separately from the vehicle to solve the lack of current battery standardization.

However, not all battery-swapping efforts have been successful. Automotive manufacturer Geely's Cao Cao 60 (an EV built for Cao Cao Auto's ride-hailing service) dropped its entire battery pack while driving down the road. The company designed the Cao Cao 60 to have a swappable battery pack to limit charging time and optimize the time the vehicles could actively participate in the ride-hailing service, but it has its limits.

Though we are seeing a push toward charging uniformity in the U.S. — such as Ample building its own modular battery to combat the lack of EV standardization, with a $15 million grant from the California Energy Commission to expand its battery production facility outside of San Francisco — it is still a long way out from reality, and some pitfalls need to be kept in mind as production moves forward.

Why swap when you can charge?

Many automakers, including GM, Ford and Rivian, are adopting Tesla's North American Charging Standard (NACS). At the same time, another group of seven automakers (such as BMW, GM, Honda, Kia and more) announced a new charging network that will allegedly rival and overtake Tesla's Supercharger network. Though the methods differ, the goal is the same: uniformity across the EV industry — to the point that Honda has now also adopted NACS.

While large automakers battle over the correct route to take, other companies are looking to battery-swapping solutions as their saving grace. For instance, Mitsubishi Fuso and Ample announced a collaboration in July to begin a pilot project on battery-swapping technology for electric trucks in Japan, which will be tested on public roads this winter. With a "five-minute battery swap target," the trucks could return to the road as quickly as a traditional gas-powered vehicle.

> **With more EVs on the road, the total amount of electricity will decrease.**

Ample's "big sell" is that they will not have to set up a charging infrastructure at their vehicle storage facility. Setting up a charging infrastructure can be difficult and expensive, especially if a company has dozens of EVs in its fleet. However, at the same time, battery-swap companies would need to build costly swap stations — which could run roughly double the cost of an equivalent fast-charging station — as well as maintain the complicated machinery involved. Battery swapping still requires the batteries to be charged, so this isn't fundamentally solving the problem. While they could be slowly charged, that would still require energy and charging systems.

For battery swapping to work effectively, companies need the space, chargers and power to charge and manage the batteries that have been swapped. Vehicle batteries are heavy and expensive, and the machinery required to handle these swaps must have robust access to power to function. This system requires machines to carry them to and from vehicles that are being swapped, as well as sites to store and charge them safely, and that's a lot of added infrastructure to develop and continuously maintain

As we continue to search for alternative EV charging solutions, the industry must find more creative ways to create a capacity buffer for the modern electric grid. There is a common misconception that EV charging will only strain the electrical grid further. In reality, EV charging infrastructure can serve as a backup power bank for EV drivers, the community and local business operators. EV batteries can be easily attached to existing solar arrays, managing energy assets more effectively and providing more grid capacity. With more EVs on the road, the total amount of electricity will decrease. The key is finding a cost-effective way with batteries that allows us to have lighter cells, faster output and larger capacity.

What's next for battery swapping?

Battery-swapping and charging station companies must work in tandem because, at the end of the day, both charging solutions are the means to an end. They both share the same goal: replacing gas-powered vehicles with something cleaner, quieter and more efficient. And a future where the two coexist could easily become a reality.

The cost associated with fleet electrification is an increasing challenge for organizations to begin the complete transition and maintenance of electrified operations, so pursuing battery-swapping solutions could help reduce the cost of EV fleet maintenance.

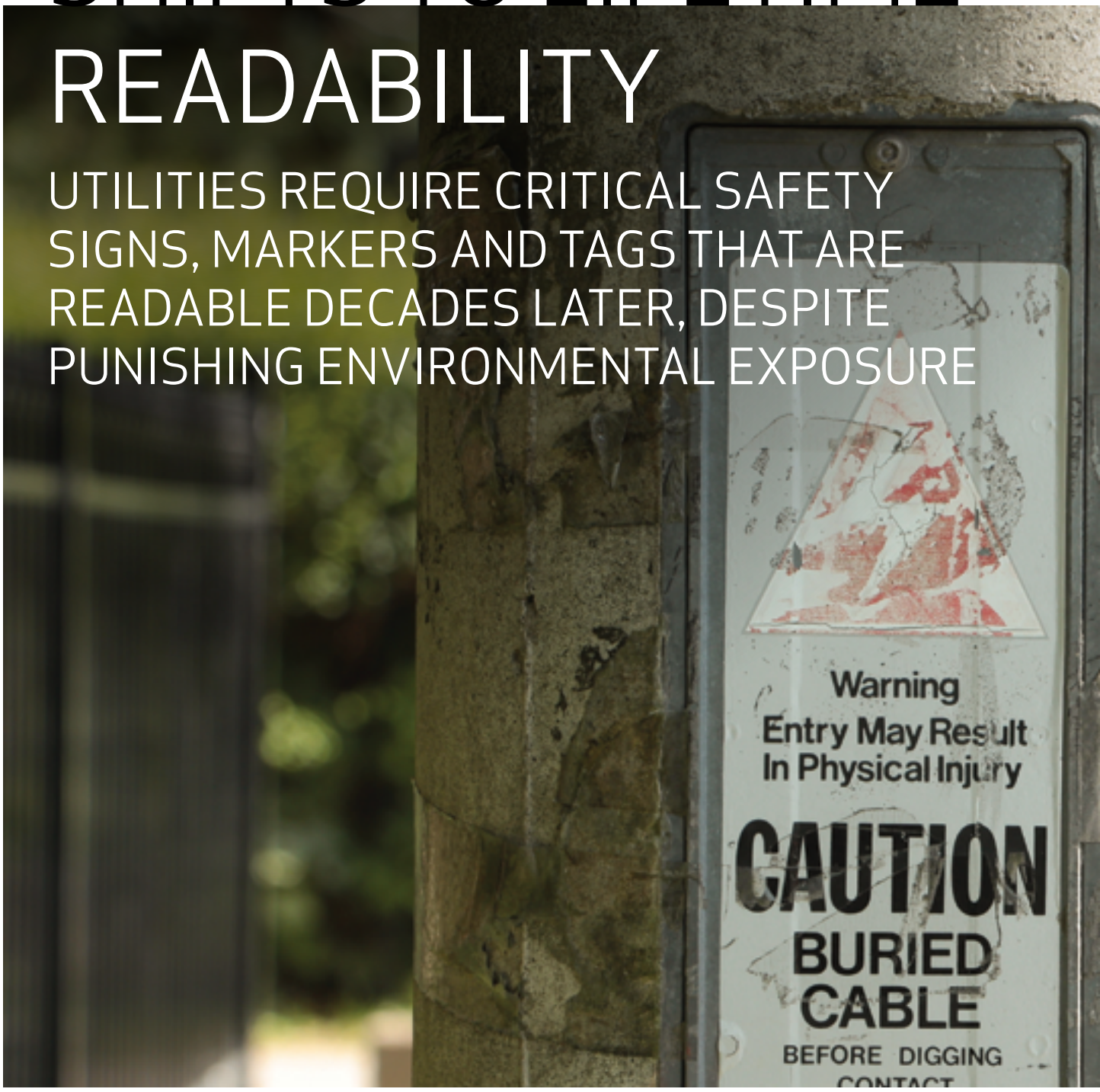
So, if you're looking to power fleets of delivery trucks or taxis, battery swapping could be the route to take, especially in instances where stopping at a fast charger is a major inconvenience. But for the time being, plugging in is the way to go for the everyday EV driver.

ABOUT THE AUTHOR:

Aatish Patel is the president and co-founder of XCharge North America. Before Patel became a founding member of XCharge North America, he was an XCharge customer. He previously worked in hospitality, where he installed an EV charging station at one of the hotels he oversaw. Before leading XCharge North America, Patel received a B.S. in mechanical engineering from New York University and an M.A. in management from Harvard.

EXPECTATION SHIFTS TO LIFETIME READABILITY

UTILITIES REQUIRE CRITICAL SAFETY SIGNS, MARKERS AND TAGS THAT ARE READABLE DECADES LATER, DESPITE PUNISHING ENVIRONMENTAL EXPOSURE



DAN O'CONNOR

For electric utilities and electric cooperatives, whether at substations or in the field, transmission and distribution identification products such as safety signs, tags and markers are critical to safe, efficient operation, maintenance and repair. These brief warnings or instructions, comprised of letters, numbers and symbols, must effectively convey key information to personnel. This is crucial not only to identify the location and type of equipment but also to protect utilities from the risk of personnel injury and litigation.

Unfortunately, traditional painted and laminated identification products frequently fade or delaminate when continually exposed to outdoor weather or punishing conditions. Solar UV, rain, snow, ice and windblown debris as well as humidity and seasonal temperature fluctuations inevitably degrade these identification products in a matter of years.

Over time, outdoor exposure can cause painted and laminated numbers and symbols to peel or fade. Even supposedly durable products designed for this purpose can become unreadable over ten years or more. Consequently, when safety warnings, asset location, or identifiers are needed most, technicians may make mistakes or waste time.

Given what is at stake, utilities are now increasingly shifting away from identification products that are marketed as long-lasting and durable but that have the potential to fade or peel, to those designed to withstand decades of abuse without becoming unreadable. →

The importance of safety signage

In the electrical utility industry, identification products are utilized just about everywhere.

In substations, signs often warn of arc flash and shock hazards, which OSHA states can result in "serious injury and even death." Markers and tags typically specify when Lock Out Tag Out (LOTO) is necessary before the set-up, maintenance, service, or repair of energized equipment. Substation structure numbers are also necessary for rapid identification and servicing.

On large, high-voltage transmission towers crossing and direction signs signal trouble areas. Phase tags are also commonly used to indicate phase polarity on the towers, which is important because connecting the wrong phases can lead to dangerous explosions, serious injury and extended downtime. Transmission towers also utilize aerial observation pole tags for rapid identification and better visibility to aircraft.

Smaller, lower-voltage distribution lines deliver power to homes and businesses on smaller poles. Pole identification products, such as tags and markers, are used to track and identify assets, data and other vital information. Pole tags can also be used to identify the pole's owner, maintenance history and other valuable data.

Transformers, whether in the substation or on poles also indicate phase with tags. Similarly, markers and signage are used to indicate LOTO situations.

Not good enough

Too many in the industry believe that their current identification products are "good enough" even as legibility becomes compromised over the years. However, the paint will fade and the laminate will peel on these products usually within five to ten years, requiring replacement.

Yet inspecting and replacing illegible products seldom – if ever – occurs on a comprehensive and timely basis because it can be a time-consuming, laborious process that is shortchanged in deference to higher priorities. Neglecting to do so, however, can lead to dangerous safety lapses as well as inefficient operation.

Designed for lasting safety

So, how can safety signage be designed and constructed to ensure readability after decades? The answer requires a shift in thinking. For applications with the longest-lasting requirements, impermanent paints and laminates should be avoided in favor of much more durable solutions. The signage should also be constructed using robust substrate or embossed characters that can take a beating from Mother Nature.

As an example, one type of sturdy signage system developed for the industry is made of thick, high-impact Polyolefin plastic with copy and pictograms that are permanently embedded through the entire thickness of the substrate.

The Polyolefin plastic is impervious to sun, wind, rain, humidity, salt water and temperature variations as well as fumes and acid or alkali solutions. The characters can be seen from a distance and have sharp contrast. The signage can be cut, scratched or even shot through, with little or no effect on the embedded characters, which helps to ensure readability decades later.

The signage can be cut, scratched or even shot through, with little or no effect on the embedded characters, which helps to ensure readability decades later.

Third-party certification validates the durability of this approach. UL performed numerous durability tests on the signs in compliance with UL and ASTM standards. When the signs were subjected to the equivalent of 43 years of UV exposure, salt spray, vibration, abrasion and temperature variation, the test results showed no change in color or legibility.

Another effective method of creating permanent signage is to utilize embossing. Embossing creates raised characters in metal materials to improve legibility even when covered in dust, dirt, or even paint.

When lasting transmission and distribution markers are required, for example, deep embossed pole badges, pole inspection and pole markers can be constructed of unpainted, embossed aluminum, brass, or stainless steel. The highly defined characters remain legible for the life of the pole.

Alternatively, on metal reflective pole tags, black characters can be screen printed on construction-grade yellow or silver reflective sheeting so that it is durable and UV stabilized. These tags can be used anywhere in areas that need to be seen with a flashlight.

For tight, confined spaces where close-up reading is required, miniature markers with raised, 3D characters can also be designed to remain legible even in low light, oily, or dusty environments. The raised, 3D characters are hot stamped with high-quality UV stable foil and are nonconductive and non-corroding, which is ideal for environments exposed to water such as utilities, offshore rigs and sewer systems.

No replacing physical signage

Another reason these identification products need to last decades is they are sure to remain valuable tools for utilities even as new technologies for asset management and maintenance are employed throughout the industry. Even with state-of-the-art technology like geographic information systems (GIS) and global positioning systems (GPS), electrical utilities will continue to require traditional physical identification products such as pole markers, for example.

Although pole tags are not mandated by regulations, many utilities choose to use them to assist with recovery efforts after a regional outage by still posting serialized GIS or GPS pole marking and numbering, corresponding to a pole's geographic location using GIS/GPS coordinates. During emergencies like hurricanes, mutual aid situations often arise where utility trucks from different regions are called on for assistance. These trucks may not have access to GIS or GPS location information, making pole tags essential for proper identification and location guidance.

Although electric utilities have long utilized identification products in the field or in substations, the potential that critical information could become obscured or unreadable in a matter of years is no longer acceptable as a standard. Even when not strictly mandated, utilities that opt to use innovative products designed to last for many decades can significantly improve safety and uptime, while reducing potential liability and litigation risk.

ABOUT THE AUTHOR:

Dan O'Connor is the general manager for Tech Products, Inc., a manufacturer of industrial identification products. In his 25+ years with the company, he has helped electric utilities, telecommunications, pipeline and OEM companies identify their critical assets with quality ID products.

BRIDGING THE GENERATIONAL GAP: THE FUTURE OF TALENT IN RENEWABLE ENERGY

MICHAEL J. REIDY

We are in the midst of a green revolution. At least, we might be if we can identify, attract and integrate enough workers to satisfy the surging demand for renewable energy products.

The Washington Post reported in April 2023 that "many construction and manufacturing companies worry they won't be able to hire enough clean-energy workers to make batteries and build wind or solar farms."

Fortunately, it's not all bad news on the talent front. Young workers are excited about and interested in renewable energy jobs.

One report found that 18-29-year-olds comprised one-third of the solar workforce last year, and companies are ramping up their recruitment efforts, anticipating continued growth in the months and years ahead, including increasing their outreach to students by 86% in the past year.

However, candidate volume isn't the only potential impediment to progress. Integrating different generations threatens to undermine continuity and create new conflicts that erode progress and productivity.

In many ways, GenZ (along with millennials) is the generation most concerned with climate change, and integrating this younger, activated workforce with an older, less-concerned cohort can be incredibly challenging.

In other words, as green energy companies work to recruit a younger workforce, they will need to understand the generational challenges that inevitably accompany these efforts, readying the companies to implement thoughtful strategies for making their workforce more responsive and resilient. →

The challenges of recruiting and maintaining a multi-generational workforce

Most companies understand that a multi-generational workforce is critical to long-term success and sustainability, combining institutional knowledge and established loyalty with young talent and novel skill sets. Eighty percent of global c-suite leaders say that a multi-generational workforce is "key to growth."

Notably, to recruit, integrate and retain top talent from the burgeoning GenZ talent pool, green energy companies will need to address the following:

- **Retention and capability:** Companies must address concerns about maintaining safety, meeting demand and making the industry attractive to increasingly selective workers.
- **Cultural workplace environment:** Companies must provide a culture that offers autonomy, taps into creativity and moves away from a lifelong commitment model to something more flexible and adaptive to the new generation's needs.
- **Collaboration across generations:** Companies must recognize the importance of intelligent collaboration between younger millennials, Gen X, Gen Z and older generations, aiming for mutual gain, trust and relationship building.

Anticipating these challenges positions leaders to take proactive steps to foster resilient and adaptive teams that can propel their green energy efforts forward.

Leaders can provide the solutions

Of course, understanding that impact is possible and enacting change don't necessarily go hand-in-hand. For leaders looking to maximize their influence in the year ahead, here are four steps to get you started today.

#1 Make the industry attractive

To appeal to this new generation of workers who are often reluctant to commit to one industry or a lifetime career, the renewable energy sector must link its mission to something greater. By connecting the work of the power industry with the larger goal of contributing to saving the planet and having work that challenges and stretches both intellect and relational capability, the industry can position itself as an attractive option.

"Purpose" is increasingly connected to employee satisfaction and retention, and GenZ employees are especially vigilant about identifying and enacting their purpose at work. As one Deloitte report helpfully concludes, GenZ employees "want agency to create a future that they find meaningful."

#2 Build human relationships
The workplace culture needs a significant shift to entice the next generation. This shift includes providing a certain amount of autonomy, tapping into creativity and allowing for short- and long-term commitments.

The traditional apprenticeship model, which has dominated the recruitment process in the power industry, may no longer be appealing. Instead, a culture that promotes innovation, personal growth and flexibility will resonate more with the new generation.

#3 Create clear processes and co-creation
A significant win-win possibility exists in fostering intelligent and effective collaboration across generations. The blend of technical knowledge and adaptability creates a synergy that enhances efficiency and innovation. Trust and rapport can be built, enriching perspectives and recognizing both generational differences and similarities.

#4 Share the responsibility for success
Ensuring all team members feel accountable for delivering on the processes starts with ensuring that every team member is on the same proverbial page.

To overcome misunderstandings, there must be a willingness to check for understanding and to acknowledge the value of experience and wisdom.

This is especially crucial in areas like safety, where the hard-earned wisdom of seasoned workers is invaluable. A culture that encourages humility and respects the lessons of the past, while embracing the adaptability and creativity of the new generation is key.

A strategic vision for a multi-generational future

In the midst of our evolving green revolution, the renewable energy sector's success hinges on effectively merging the wisdom of the past with the innovation of the present.

Bridging the generational divide is not just a task for human resources; it's a cornerstone for sustainable growth. By emphasizing safety, nurturing collaboration, fostering innovation and crafting an environment attuned to everyone's values and needs, the industry can ensure a sustainable talent pool and play a pivotal role in the future of global energy.

Simply put, bridging generational gaps while harnessing the unique strengths of both older and younger generations is more than a human resources task. Like a caterpillar sheds its skin and becomes something entirely new and better, we have the ability to put off our old ways while fostering a new, better vision for the future.

ABOUT THE AUTHOR:

Michael J. Reidy, a senior consultant at Interaction Associates, has more than 25 years of experience in consulting and responding to the learning needs of adults in the financial services, biotech, power and service industries. Reidy's interest is in adult education, and his belief is that the workplace has become the "third place" of learning and development for the 21st century. Reidy holds a master's degree in public administration from the HKS, Harvard University.

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