

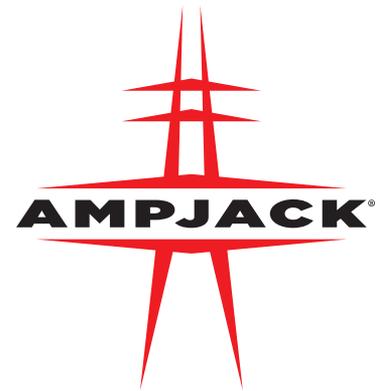
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MAGAZINE

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PREPARING T&D ASSETS FOR THE ENERGY TRANSITION





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4

INDUSTRY NEWS

18

POWER POINTS

TWO YEARS LATER | Elisabeth Monaghan, Editor in Chief

With the passage of the 2021 Infrastructure and Jobs Act, more than \$65 billion will go towards enhancing grid reliability and resilience, building and upgrading transmission lines, improving grid flexibility with demand response, distributed energy resources and boosting cybersecurity. It also will fund new programs to support the development and deployment of clean energy technologies to accelerate our transition from greenhouse gas emissions to a zero-emission economy.

20

THE GRID TRANSFORMATION FORUM

PREPARING T&D ASSETS FOR THE ENERGY TRANSITION
Andrew Phillips, Ph.D., EPRI

Last year, the Biden Administration announced new targets for the United States' greenhouse gas emissions goals by 2030. The announcement acknowledged that meeting these goals would require investment and innovation in America's aging utility infrastructure.

24

GREEN OVATIONS

HOW ADVANCED CONDUCTORS ARE SUPPORTING GRID DECARBONIZATION AND SAVING MONEY
Dave Bryant, CTC

While a number of utilities have begun using various Grid Enhancing Technologies (GET) to marginally increase transmission line capacity, such as dynamic line rating systems and load flow controllers, the use of advanced conductors is helping many utilities substantially increase the capacity of their existing corridors without the need to replace or rebuild existing structures.

28

IEEE T&D IS BACK AND IN-PERSON
Wayne Bishop, Jr., IEEE PES, Quanta Technologies

From April 25-28 this year's IEEE T&D will be held in New Orleans and hosted by local utility Entergy. With approximately 10,000 people expected to attend, more than 650 exhibiting companies and several new activities and additions to the program, this promises to be an outstanding event.

32

WHY INTELLIGENCE BASED DETECTIONS IN ICS FAIL
Ron Fabela, Synsaber

Threat intelligence plays an integral role in cybersecurity, but industrial control system (ICS) environments offer unique challenges. Let's dig into the basics of intelligence-based detections for ICS – noting the benefits, but also where intel misses the mark.

40

EASE OF USE KEY TO REPLACING AGING SUBSTATION RTUS | Conrad Oakey, NovaTech

The increasingly critical role of the substation RTU, notably in bulk and transmission substations, underscores the importance of ease of use, high performance, interoperability and scalability. The experience of a major U.S. utility in upgrading their legacy RTUs is described in this article.

44

UNDER THE WEATHER: RESILIENCE EFFORTS AMPLIFY VALUE OF DATA MODELING | Arron Lewis, Black & Veatch

Weather disruptions to the grid are nothing new – anything from a windblown tree branch to a raging wildfire can disrupt operation of overhead lines, causing power loss – but the recent barrage of events has highlighted the urgent need to make large-scale updates to the power grid.

50

GUEST EDITORIAL

REAL-TIME AND RENEWABLE: THE FUTURE OF THE ENERGY MARKET AND HOW TO PREPARE
Uday Baral, Hitachi Energy

In the U.S., the recently passed Infrastructure Bill provides some of the largest funding the transportation and energy sectors have ever received – primarily toward the goal of increasing electrification and renewables. On the wave of this national investment, we're seeing some of the biggest and most radical changes to the U.S. energy market.

56

GUEST EDITORIAL

AMERICA'S POWER GRID IS AT RISK. WE HAVE THE TOOLS TO FIX IT – BUT WE NEED THE WILL
Desmond Wheatley, Beam Global

Despite mounting blackouts and brownouts across the country as aging infrastructure fails to keep pace with growing demand, there has been little innovation to shore up our energy supply. Revolutionary technology and tools can help diversify and protect American power. We must marshal the resources, bolstered by the will of the public and private sectors to boost our energy resiliency and transform how this country runs.

60

GUEST EDITORIAL

INFRASTRUCTURE MANAGEMENT: MANAGING PROJECTS, STREAMLINING INSTALLATIONS AND RAISING CUSTOMER SATISFACTION WITH VIRTUAL INSPECTIONS | Anthony Perera, Inspected

A global energy crisis is happening. And the United States is no exception to the strained power lines and grids that severely affect the safety and comfort of your current customers and potential prospects. The U.S. Energy Information Administration reported in November 2021 that U.S. electricity customers experienced more than eight hours of power interruption, on average, in 2020.

66

THE BIGGER PICTURE

THE ROLE OF CODES AND STANDARDS IN ELECTRIFYING THE TRANSPORTATION SECTOR

Umer Khan and Brent Hartman, CSA Group

A significant portion of global greenhouse gas (GHG) emissions is attributed to the transportation sector. As the impact of climate change becomes apparent, governments are racing to reduce their carbon footprint by enacting policies and regulations to decarbonize the transportation sector through electrification.

72

SECURITY SESSIONS

DEFENDING CANADA'S ELECTRICITY SECTOR AGAINST CYBER SECURITY THREATS | David Masson, Darktrace

According to a recent bulletin on cyber security guidance for the electricity sector from the Canadian Centre for Cyber Security (CCCS), most of the attacks on Canadian electricity have been ransomware or fraud. And while an overt state-sponsored attack on Canada's electricity seems unlikely, Canada has already seen activity from nation-state actors.

78

POWERFUL FORCES

Didem Cataloglu, DIREXYON and Elisabeth Monaghan, Editor in Chief

Didem Cataloglu's journey in the technology sector began as she studied computer science in college. Her aptitude for writing efficient code ignited a passion for solving real world problems through modeling and technology.



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C2

AMPJACK

03 & 05

S&C ELECTRIC COMPANY

06

EASI-SET WORLDWIDE

07

HASTINGS FIBERGLASS PRODUCTS

08

TECH PRODUCTS, INC.

09

HASTINGS FIBERGLASS PRODUCTS

11

AMERICAN WIRE GROUP

12

EASI-SET WORLDWIDE

13

2022 IEEE PES T&D CONFERENCE & EXPO

17

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LOCAL ELECTRICITY MARKET PILOT COMING TO ESSEX COUNTY: IESO, OEB AND ESSEX POWERLINES SUPPORT COMMUNITY PARTICIPATION IN ONTARIO'S ELECTRICITY GRID

Local businesses to play a role in meeting southwest Ontario's growing electricity needs

April 2022

To meet growing energy needs in southwest Ontario, the Independent Electricity System Operator (IESO) and the Ontario Energy Board (OEB) are working with Essex Powerlines, NODES, Essex Energy and Utilismart on a market pilot to tap into local energy supplies in Leamington.

This project will implement a near real-time, local electricity market for Essex Powerlines customers who can supply electricity or reduce electricity use on demand to support system reliability. This will help address constraints on the local distribution network and potentially also reduce provincial needs.

"This project is just one example of how we can change the way we think about producing, managing and consuming electricity," says Lesley Gallinger, President and CEO of the IESO. "It builds on our experience in York Region where local businesses and consumers participate in a local electricity market to reduce peak demand in the area. This type of approach can also be part of the solution to meet needs in Essex County."

The OEB Innovation Sandbox is providing customized guidance describing how Essex Powerlines can proceed with this project and test an innovative business model.

"We are pleased that the OEB Innovation Sandbox has enabled this project to advance," says Susanna Zagar, CEO of the OEB. "By working together, we can really move the needle on the energy transition. This kind of work provides insight into emerging challenges in a rapidly changing sector - and supports regional solutions that can tackle those challenges."

"I am very proud that Essex Powerlines and our partners, are collaborating with the Ministry of Energy, IESO and OEB, leading the way to define the future of utilities not only in Ontario, but across North America," says John Avdoulos, President and CEO of Essex Power Corporation. "This initiative will enable power system flexibility, adaptive infrastructure and most importantly customer choice, which addresses the many challenges we face."

The Essex County Local Electricity Market Pilot will build on learnings from a similar initiative in York Region, taking it one step further. Through this local electricity market, Essex Powerlines will engage with commercial businesses, manufacturers and local organizations to help reduce local peak demands by directing them to either provide electricity on site or reduce their electricity use. It will also look at ways to coordinate the use of these resources at both local and provincial grid levels and the potential to help defer or reduce future transmission needs.

Southwest Ontario is experiencing tremendous economic growth which is expected to increase electricity demand from 500 MW to 2,300 MW by 2035. A multi-pronged approach to address needs is underway in this area, including upgrades to existing transmission infrastructure, new transmission lines, as well as funding energy efficiency and innovative projects. →

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"With our government's significant focus on reducing the cost of business, Southwestern Ontario has seen significant new investments and job growth. Pilots like this one will ensure families and businesses continue to benefit from Ontario's clean, affordable, reliable and sustainable electricity grid by enabling customers and businesses in the Leamington area to have flexibility and control over their local energy needs," said Todd Smith, Ontario Minister of Energy.

Since its inception in 2005, the IESO's Grid Innovation Fund has supported more than 260 projects, taking innovative ideas from the sector that can enhance reliability, sustainability and resiliency of the provincial electricity system. A third-party analysis of 27 past innovation projects showed that if those technologies were adopted more widely across the province, they could provide customer savings of half a billion dollars on an annual basis.

The OEB Innovation Sandbox enables innovators to better understand regulatory requirements. Where necessary, it clears a pathway for projects to proceed on a trial basis where there is potential to provide value to consumers.

MORE THAN 260 PROJECTS

Transgrid has entered into an underwriting agreement with the Commonwealth Government to develop the Victoria to New South Wales Interconnector West (VNI West), a major transmission infrastructure project proposed to secure the electricity supply and boost sharing between the two states.

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Chief Executive Officer Brett Redman said "The new 500kV interconnector would improve supply reliability and increase customer access to cheaper, cleaner electricity from generators like Snowy 2.0, as energy storage becomes critical to support growing renewables."

"We welcome the agreement, which will enable us to plan with confidence for a project identified by the Australian Energy Market Operator as critical to the delivery of a clean energy future."

The Australian Energy Market Operator (AEMO) identifies VNI West as an actionable project in the Integrated System Plan (ISP) for the National Electricity Market (NEM).

"VNI West is currently being assessed for viability and Transgrid is undertaking early works. This agreement will maximise the opportunity to deliver the project aligned with the regulatory investment test for transmission (RIT-T) process," said Mr Redman.





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VNI West is in the early regulatory assessment stage, however the project is not yet validated, committed or approved.

The Commonwealth's key objective in entering into the agreement is to facilitate development of the project, which when combined with Transgrid's other major infrastructure projects like EnergyConnect and HumeLink will transform the grid.

"Transgrid will link South Australia with New South Wales and Victoria with the new interconnector EnergyConnect and delivering the ISP vision to reinforce the backbone of the east coast's transmission network with another major transmission project HumeLink. Together, our major projects will transform the grid by enabling a significant increase in the amount of renewable energy that can be delivered to consumers across the National Electricity Market.

"We welcome the agreement, which will enable us to plan with confidence for a project identified by the Australian Energy Market Operator as critical to the delivery of a clean energy future."

Mr Redman said the Commonwealth and Transgrid have agreed to work collaboratively to achieve VNI West's early works.

The project's regulatory assessment stage is expected to be complete by early 2023 and if a positive outcome is realised, the VNI West project will have a solid platform to progress with full development and delivery of the new interconnector.

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MAKING IT SAFE AND MAKING IT RIGHT FOR OUR HOMETOWNS: PG&E REACHES AGREEMENTS WITH SIX COUNTIES TO FURTHER INVEST IN WILDFIRE SAFETY FOR CUSTOMERS

April 2022

Today (April 11), Pacific Gas and Electric Company (PG&E) and district attorneys representing six Northern California counties announced settlements resolving the 2019 Kincade Fire and 2021 Dixie Fire.

As a result of these agreements, no criminal charges will be filed in the Dixie Fire, and the criminal complaint regarding the Kincade Fire will be dismissed.

PG&E has also entered into long-term agreements with Butte, Lassen, Plumas, Shasta, Sonoma and Tehama counties to strengthen wildfire safety and response programs and to work with local organizations affected by the fires to help rebuild impacted communities.

These commitments include assistance for local non-profits, support for community colleges to expand their wildfire safety training and a direct claims program for victims of the Dixie Fire who lost their homes.

“We are committed to doing our part, and we look forward to a long partnership with these communities to make it right and make it safe,” said Patti Poppe, Chief Executive Officer of PG&E Corporation. “We respect the leadership of the local DAs, welcome the new level of transparency and accountability afforded by these agreements, and look forward to working together for the benefit of the communities we collectively serve.”

PG&E also committed to a five-year monitorship of its vegetation management and system inspection work in the six counties. The monitor will be independent of PG&E and will regularly report to the district attorneys on the company's progress. This role will be filled by Filsinger Energy Partners, which also serves as the Independent

Safety Monitor for the California Public Utilities Commission. PG&E will continue to provide the resources needed to enable the monitor to meet its commitments to the CPUC, as well as additional resources needed to focus on PG&E's critical wildfire safety work in these six counties.

“Making this agreement required a level of trust and partnership in meeting Plumas County's needs. PG&E's new leadership team has demonstrated they are committed to change and will continue to work towards earning our trust. I appreciate this commitment and, to paraphrase the 40th President of the United States, look forward to verifying these efforts as provided by today's agreement,” said Plumas County District Attorney David Hollister.

Below are highlights of the safety commitments PG&E is making:

Wildfire Safety

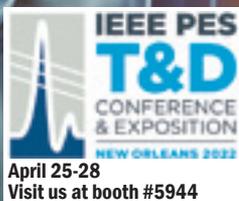
- **Local Safety Workforce:** Adding 80-100 new PG&E jobs based in Sonoma County, as well as 80-100 more positions collectively across Butte, Lassen, Plumas, Shasta and Tehama counties. These new positions will increase PG&E's local expertise and presence focused on completing critical safety work in these communities.
- **Local Inspection and Work Commitments:** Executing specific safety work and inspections in the six counties as detailed in PG&E's Wildfire Mitigation Plan including commitments to carry out vegetation management and equipment inspections, which will be reviewed and verified by the independent monitor.

Local Community College Partnerships

- **Fire Technology Training Program:** Committing to work collaboratively with Santa Rosa Junior College (SRJC) on efforts to expand and enhance the College's Fire Technology Program of the Public Safety Training Center, including providing funding and sharing PG&E wildfire safety know-how and learnings. The company also will provide funding to campuses in the six counties which, at the discretion of the colleges, can be used for site acquisition and development, equipment purchases, and developing and implementing fire technology program curriculum.
- **Vegetation Management Training Program:** Providing funding and assisting in the creation of new utility vegetation management training programs at SRJC and several campuses across the North Valley. These programs will be modeled after coursework that debuted at Butte College in 2020. →

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Direct Payment Program to Accelerate Community Recovery

- PG&E will launch a new Direct Payments for Community Recovery program with an online tool where individuals whose homes were destroyed by the Dixie Fire can submit claims for expedited review, approval and payment. PG&E will verify the claims and make offers based on an objective, pre-determined calculation. Claimants who accept the offers will receive payment, typically within 30 days of accepting an offer and within 75 days of first submitting a complete claim. PG&E has also agreed to provide in-person and telephone customer support centers to navigate this new program.

Payments to Local Non-Profit Organizations

- As part of PG&E's commitment to work with local organizations and communities, most of the money that PG&E will pay as part of these settlements - over \$35 million - will go to local non-profit organizations, including Fire Safe Councils, volunteer fire departments, local schools and community groups such as Rotary Clubs, Chambers of Commerce and organizations serving veterans and the homeless.

In addition to the above commitments, PG&E will pay a \$7.5 million civil penalty to Sonoma County related to the Kincadee Fire and a \$1 million civil penalty to each of the five North Valley counties related to the Dixie Fire. The financial commitments within the two stipulated agreements total \$55 million over five years, and PG&E will not seek recovery of these costs from customers.

PG&E's wildfire safety commitments across its service area are outlined in its 2022 Wildfire Mitigation Plan, which PG&E submitted to the California Public Utilities Commission on February 25, 2022. More information about this plan, and PG&E's work to reduce the risk of catastrophic wildfire, is available here.



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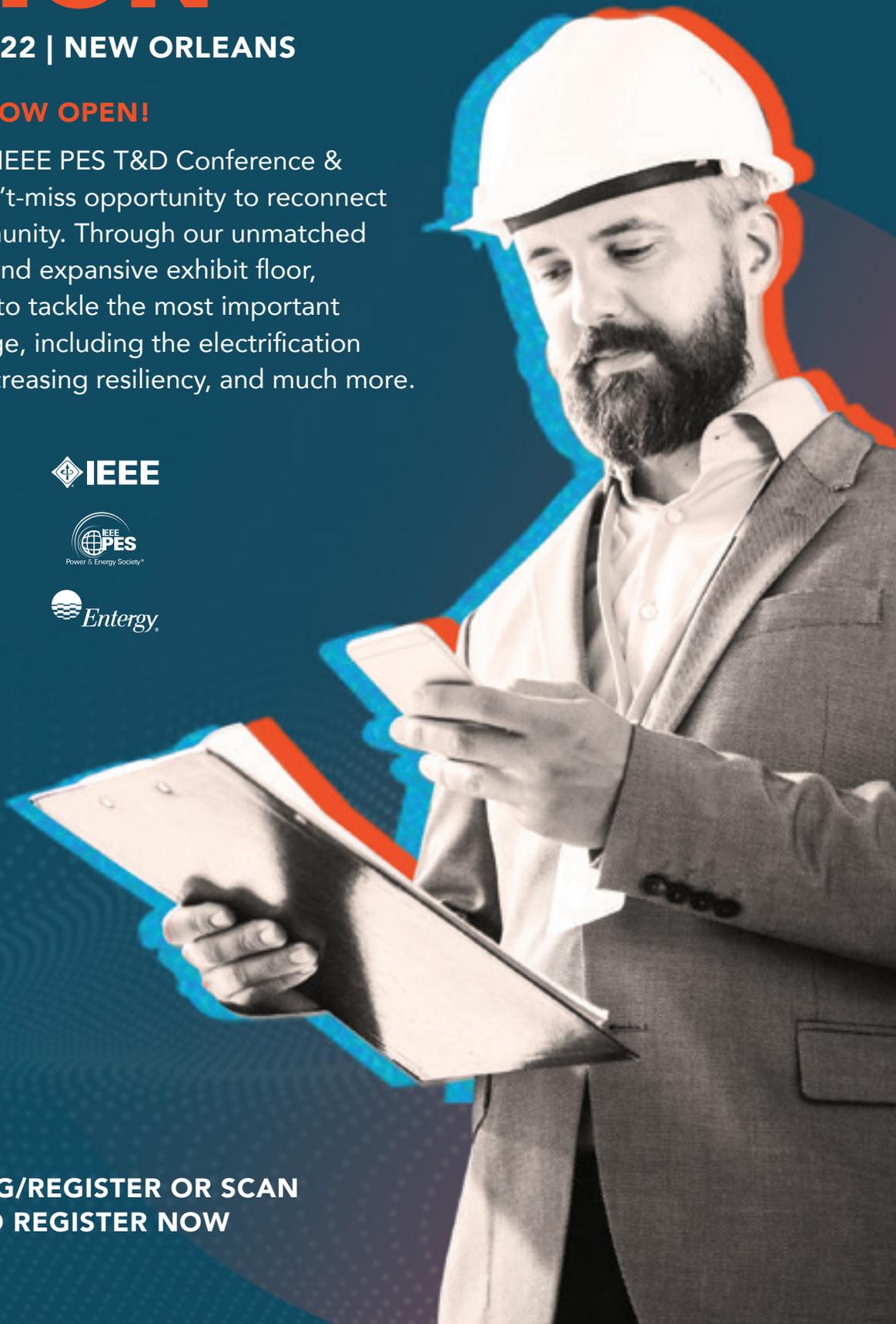
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HEI RELEASES 2022 CONSOLIDATED ENVIRONMENTAL, SOCIAL AND GOVERNANCE (ESG) REPORT

Includes HEI's first enterprise-wide greenhouse gas emissions inventory

April 2022

Hawaiian Electric Industries, Inc. (HEI) (NYSE: HE) today (April 12) released its 2022 consolidated report describing its updated policies, actions and performance for full year 2021 with respect to a range of environmental, social and governance (ESG) matters, including climate-related risks and opportunities. This is HEI's third and most comprehensive ESG report.

The report includes HEI's first enterprise-wide greenhouse gas (GHG) emissions inventory, which will further guide the company's ESG strategies and provide greater transparency around its progress on climate issues. Net enterprise-wide GHG emissions in measured categories decreased 15% from 2015 to 2021, driven largely by reductions in the utility's generation-related emissions.

HEI identifies 19 ESG priorities in the report and places special focus on seven topics: decarbonization; economic health & affordability; reliability & resilience; secure digitalization; diversity, equity & inclusion; employee engagement and climate-related risks & opportunities.

The 2022 ESG report extends HEI's Task Force on Climate-related Financial Disclosures (TCFD)-aligned reporting from 2021. It also presents data aligned with Sustainability Accounting Standards Board (SASB) guidelines for HEI's utility and bank subsidiaries.

To review the HEI 2022 ESG report, visit www.hei.com/esg.

“Our ESG progress demonstrates our commitment not only to operating a sustainable business, but also to building a sustainable Hawaii in which our children and grandchildren, our communities, our customers and our fellow employees will thrive together now and for generations to come,” said Scott Seu, HEI president and CEO. “Our company has been serving Hawaii for over 130 years, and this deep-felt mindset comes naturally to us as a longstanding business in our island state. The alignment between ESG principles, state policy in Hawaii, community expectations, and our goals as a company has never been stronger.”

DECREASED
15%
FROM
2015
TO
2021

AMONG THE HIGHLIGHTS:

Hawaiian Electric

- Reached a renewable portfolio standard (RPS) of 38.4% in 2021, which is ahead of schedule for achieving Hawaii's statutory goal of 40% RPS by 2030
- Released a Climate Change Action Plan committing to reducing 2005 baseline carbon emissions from power generation 70% by 2030 and to achieving net-zero or net-negative carbon emissions from power generation by 2045; as of the end of 2021, GHG emissions were reduced by 22% based on preliminary data
- Supported a 30% increase in electric vehicles in Hawai'i from January to December 2021
- Added 4,956 new residential rooftop solar systems in 2021, bringing the total number of solar installations on its system to 92,500, representing 21% of residential customers
- Issued its 2021-22 Sustainability Report summarizing key milestones and utility programs to achieve its Climate Change Action Plan and Hawaii's climate goals

American Savings Bank

- Originated about \$550 million in Paycheck Protection Program loans (from 2020 through 2021) to businesses representing 40,000+ jobs
- Financed over \$65 million in clean energy projects from 2010 to 2021, supporting a total of 21.3 MW in renewable energy capacity
- Originated more than \$8.6 million in residential clean energy loans, which allow homeowners to purchase and install their own photovoltaic systems, solar water heaters, solar air conditioning and battery backup and storage
- Was named one of *Hawaii Business Magazine's* Best Places to Work for the 13th consecutive year
- Released a Corporate Social Responsibility Report detailing its efforts pertaining to decarbonization, economic health and affordability, secure digitalization and diversity and inclusion

Pacific Current

- Partnered with Wastewater Alternatives and Innovation (WAI) and Cambrian Innovation to evaluate opportunities to deploy distributed wastewater treatment solutions that enable water reuse and production of renewable natural gas
- Continued to expand electric vehicle charging in the state through its joint venture with EverCharge, providing smart, power-optimized electric vehicle charging solutions for property owners and managers

ITRON AND EMERSON COLLABORATE TO OFFER SMART THERMOSTATS FOR DEMAND RESPONSE PROGRAMS

April 2022

Itron, Inc. (NASDAQ: ITRI), which is innovating the way utilities and cities manage energy and water, is collaborating with Emerson, a global technology and engineering leader, to offer reliable thermostats as part of Itron's Bring Your Own Device (BYOD), direct install demand response (DR) and distributed energy resource (DER) programs. With thermostats controlling about 50% of a home's energy usage*, offering Emerson's Sensi smart thermostat and Sensi Touch smart thermostats as part of any utility's energy management portfolio gives consumers more control and visibility into their energy usage and allows utilities to improve grid reliability and sustainability. They also provide a means for cost-effective, customer-focused incentive programs that manages air conditioning or heating load throughout a service territory.

Itron's newly developed DER Optimizer solution, which is powered by its industry-leading demand response platform, IntelliSOURCE®, will be fully integrated to provide direct control and management of Emerson's Sensi thermostats for BYOD and direct install programs. BYOD solutions give utilities the ability to easily include retail Wi-Fi thermostats and other third-party devices in new or existing DR, DER and energy efficiency programs. As part of a BYOD program, consumers who purchase an Emerson Sensi smart thermostat or Sensi Touch smart thermostat through retail outlets can seamlessly connect the device to their Wi-Fi. With the direct install model, utility companies have the option to install Emerson smart thermostats for participating customers, while the utility retains ownership of the thermostat in the consumer home.

Emerson's smart thermostats, when used in conjunction with Itron's DER Optimizer solution, give consumers control over their energy usage through the Sensi app or through the utility's mobile app and provides utilities with a flexible resource to achieve their program goals.

“We are excited to have Emerson's Sensi thermostats join our ecosystem of third-party devices for Itron's BYOD and direct install DR programs. The programs not only give utilities the opportunity to better engage with their customers, but also allow utilities to maintain supply and demand, and ensure grid reliability,” said Don Reeves, senior vice president of Outcomes at Itron. “Sensi smart thermostats are a great addition to our DR programs, featuring easy installation and intuitive controls compatible with other home automation systems.”

* Source: “Use of energy explained: Energy use in homes” U.S. Energy information Administration 2015

“Our advanced technologies make it possible for consumers to create their ideal home environment and lower their energy footprint,” said Craig Rossman, president of comfort control at Emerson. “In collaboration with Itron, which is dedicated to creating a more resourceful world, we are able to enhance demand response programs with the latest smart thermostat technology to help improve grid reliability and sustainability.”

Itron's Distributed Energy Management (DEM) group is a leading provider of utility technologies and services, with 25 active DR/DER programs controlling over 2 million behind-the-meter devices.

To learn more about Itron's programs, visit <https://www.itron.com/solutions/what-we-enable/dem>.

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TWO YEARS LATER



ELISABETH MONAGHAN
Editor in Chief

It's a little over a quarter of the way through 2022, and we've hit another COVID-19 milestone. After all, it was two years ago that most of us experienced some sort of mandated shutdown. For the magazine, it was also when our contributing writers first mentioned COVID-19. Since then, no one profession or industry has escaped at least some disruption due to the pandemic. And our magazine is no exception. To get back on track with our publishing schedule, we decided to combine our 2022 Q1 and Q2 issues, making it possible to print a more robust issue in time for a bonus distribution at both IEEE PES T&D and DistribuTECH events.

Over the past two years, contributors to EET&D have shared their experiences, concerns and suggestions to get us through what I hope is the worst of the pandemic. As the topics covered in this issue seem to indicate, we are now at the stage of the pandemic where we are assessing the physical, financial and psychological damages, while figuring out how best to prepare for what comes next.

In his article "America's Power Grid is at Risk. We Have the Tools to Fix It — But We Need the Will" Desmond Wheatley with clean technology company Beam Global talks about how the February 2021 power outage in Texas, and the hackers who shut down the Colonial Pipeline U.S. last May exposed the U.S. power grid's vulnerability. He also points to the aging infrastructure's inability to keep pace with the growing demand for energy as a key reason for this vulnerability. Wheatley believes we have innovative solutions like microgrids that can lessen the burden on aging infrastructure and help wean energy consumers of their dependency on fossil fuels, but it is the "will of the public and private sectors to boost our energy resiliency and transform how this country runs."

Fortunately, with the passage of the 2021 Infrastructure and Jobs Act, more than \$65 billion will go towards enhancing grid reliability and resilience, building and upgrading transmission lines, improving grid flexibility with demand response and distributed energy resources and boosting cybersecurity. It also will fund new programs to support the development and deployment of clean energy technologies to accelerate our transition from greenhouse gas emissions to a zero-emission economy.

And while the funding from the infrastructure bill will have a positive impact on the electric energy sector, CEO of DIREXYON Technology Didem Cataloglu cautions us that there are many steps involved to make the shift to truly clean energy, starting with recognizing that electric energy is not always synonymous with clean energy.



As she discusses in our *Powerful Forces* profile on Cataloglu, when talking about the transition to clean energy, people often use the words 'clean' and 'electric' interchangeably. "But when you purchase an electric vehicle, it may not be entirely 'clean,' because the electricity may have been produced from fossil fuels – in which case, it may not be decreasing your overall carbon footprint to its fullest potential," says Cataloglu. She also offers steps to consider that will help pave the way for clean energy. You can read more of Cataloglu's insights on page 78.

In this issue's *Grid Transformation Forum*, we asked Dr. Andrew Phillips, vice president of Transmission and Distribution Infrastructure for EPRI, to talk about the future of T&D infrastructure in the global transition from greenhouse gas emissions.

According to Phillips, utilities are figuring out how they can leverage existing assets to meet the Biden Administration's greenhouse gas emissions goals by 2030. He elaborates, saying, "Research from the Electric Power Research Institute (EPRI) shows that leveraging the existing energy infrastructure – including hydropower, nuclear and transmission assets – is a realistic option to provide low-cost carbon reductions.

Referencing findings based on research conducted by EPRI, Phillips identifies the challenges utilities looking to leverage their existing infrastructure may face, and steps they can take to address them.

The pandemic may stick around for a while yet, and the infrastructure bill will not magically remove any potential disasters that aging utility infrastructure could cause, but the past two years have shown us that by optimizing existing and investing in new infrastructure, while having emergency response protocols already in place, utility providers and consumers stand a significantly better chance of surviving a global energy crisis than we did two years ago.

On a lighter note, we are pleased that Wayne Bishop Jr., who is the IEEE PES vice president of meetings and conferences, graciously agreed to provide a preview of is year's event in New Orleans. Some may be reading this issue after the IEEE PES 2022 conference has ended, but Bishop's detail gives anyone who missed the event a sense of the topics and issues the conference covered. If you are among those who weren't able to experience the opportunity to reconnect with industry colleagues in real life or catch up on the latest technology during IEEE PES, Bishop has agreed to share a recap of the event in our Q3 issue.

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

Elisabeth@ElectricEnergyOnline.com

Elisabeth

PREPARING T&D ASSETS FOR THE ENERGY TRANSITION

ANDREW PHILLIPS, PH.D.



For this combined issue of the magazine, Vice President of Transmission and Distribution Infrastructure for EPRI Andrew Phillips shares his thoughts on the future of T&D infrastructure in the global energy transition.

Last year, the Biden Administration announced new targets for the United States' greenhouse gas emissions goals by 2030. The announcement acknowledged that meeting these goals would require investment and innovation in America's aging utility infrastructure.

As a result, utilities are exploring how to meet and support these energy goals by using and optimizing existing assets. Research from the Electric Power Research Institute (EPRI) shows that leveraging the existing energy infrastructure — including hydropower, nuclear and transmission assets — is a realistic option to provide low-cost carbon reductions.

For transmission and distribution (T&D) assets, this work focuses on optimizing two key resources: transmission lines and rights-of-way (ROWs). Upgrading assets may allow for expanded capacity and operational capabilities but should always be done on a case-by-case basis. This ensures site-specific understanding and assessment of costs and engineering challenges.

Increasing demand on assets

The global energy transition continues to move away from fossil-fuel-based energy generation to more sustainable, clean energy resources such as wind and solar photovoltaic (PV). In many cases, the location of these variable resources

is different from the location of the existing fossil fleet. In addition, reducing the greenhouse gas emissions of residential, transportation and industrial sectors may be realized by increased electrification, which may increase the demand for electricity.

To meet the demands of integrating more renewables and the potential increase in the electricity demand, the transmission system must evolve, which will require an increase in the transmission system capacity in many regions. As a result, many new miles of new transmission lines — and the associated grid assets — are predicted to be required.

Utilities should expect new assets to be subject to stricter resilience and reliability requirements due to society's increasing dependence on electricity. In addition to more stringent requirements, identifying and financing new siting locations may also present a challenge, particularly in urbanized, highly populated areas.

For these — and many more — reasons, utilities may be considering if there is potential to optimize and leverage their existing assets and resources to meet these needs. EPRI research shows that (despite technical challenges) increasing the power transfer capacity of existing transmission systems and utilizing existing ROW may offer another feasible option for utilities. →



EPRI's research finds this work shouldn't be approached in a silo but as part of a more holistic evaluation that accounts for all aspects of the transmission process. This includes grid operations and planning and addressing new and existing asset designs. With decades-long industry experience, EPRI's transmission team works closely with utility members nationwide to execute increased power flow projects through detailed modeling, analysis, lab testing and field implementations which evaluate cost, reliability, compatibility and future maintenance needs.

One of the first areas to explore to identify the site-specific challenges is determining the source of the transmission capacity — or power flow — limitation. In alternating current (ac) lines, the power flow limitation can be one of the following:

- **Thermally limited:** This applies to the rated current of the conductor system, which is primarily determined by the characteristics of the conductor (e.g., the area of aluminum strands).
- **Voltage drop limited:** This occurs when the voltage at the end of the line drops below the established operational limits due to the current flowing through the line impedance.
- **Stability limited:** On long lines, small changes in load can result in unstable receiving-end voltages due to the relatively large series impedance of the line.

In general, the dominant limitation depends on the line length. Depending on the type of limitation, the power flow capacity of a line can be increased by line uprating, voltage upgrading, or reducing impedance.



For short lines, the current-carry capacity can be increased by 5 to 50% through various methods aimed at addressing conductor temperature.



Providing increased capacity with existing ROWs

All three options for increasing power flow capacity can be explored on existing ROWs. Utility ROWs are strips of land used to construct, operate, maintain and repair transmission lines. These lands are acquired through a lengthy process subject to regulatory requirements and public opinion. The process can often be challenging and costly, which makes optimizing existing ROWs a viable option that should be explored whenever possible as a potential solution to meeting increased transmission capacity.

Line uprating

For short lines, the current-carry capacity can be increased by 5 to 50% through various methods aimed at addressing conductor temperature. This, in turn, impacts sag and the probability of exceeding the conductor system temperature rating.

The methods are all situation-dependent and vary in the power flow increase provided, as well as the engineering challenges and experience of the industry applying these methods. Some methods include reconductoring by increasing the temperature type, rating, size, or the number of conductors per phase; implementing ambient adjusted line ratings, or using real-time or forecasted ambient temperatures to predict the conductor temperature (assuming all other factors in the rating equations are consistent); or adjusting static ratings using a risk-informed approach based on probabilistic assessment of the simultaneous occurrence of variables such as minimum wind speed, maximum temperature and load.



Voltage upgrading can increase line capacity by more than 100% by raising the operating voltage.



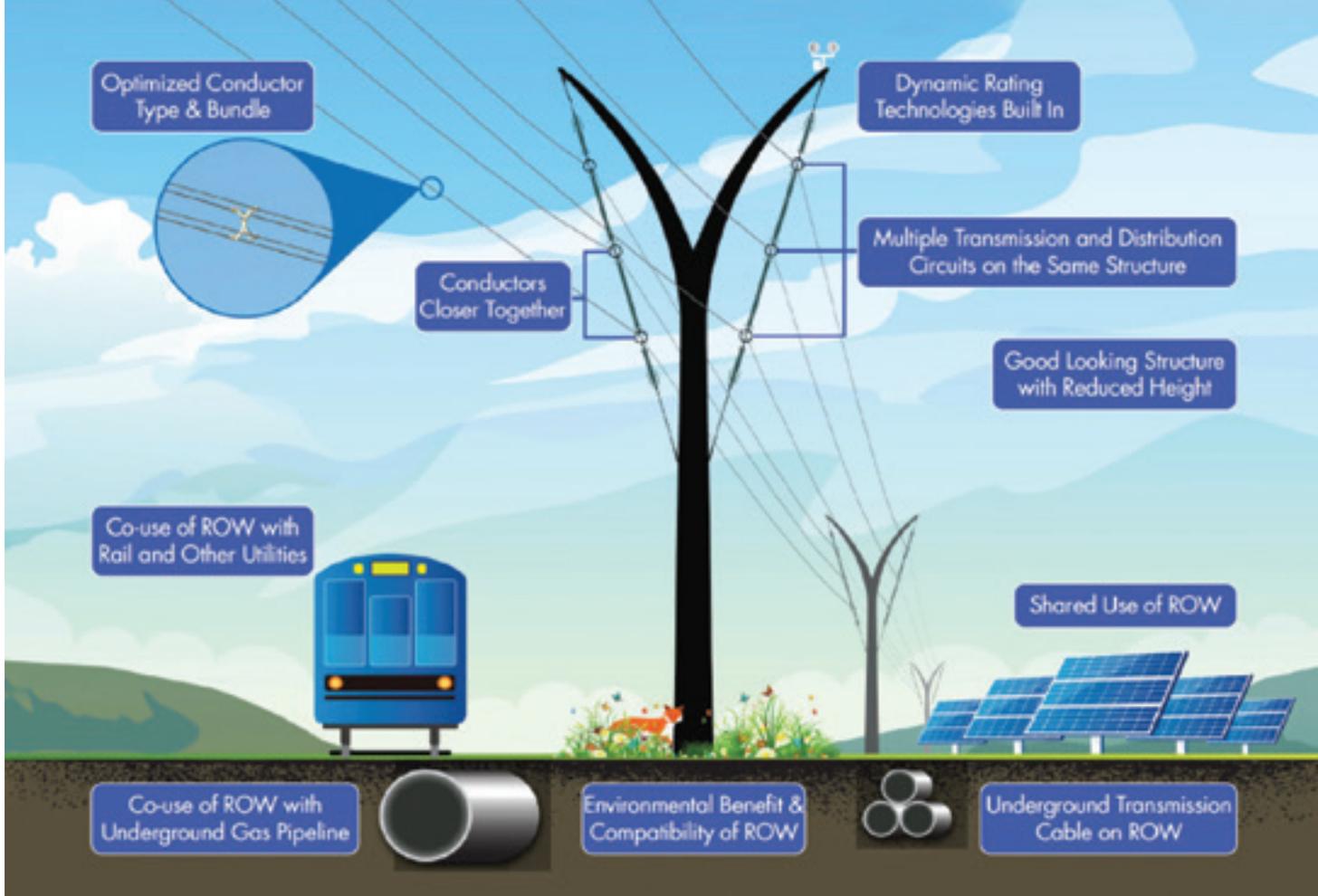
Voltage upgrading

Voltage upgrading can increase line capacity by more than 100% by raising the operating voltage. In some cases, moderate increase can be achieved with limited physical changes and no impact on reliability.

AC to DC conversion

Converting an existing ac line to HVDC operation can also significantly increase the capacity of longer lines for the same insulator lengths and phase spacing. In some cases, the capacity increases up to 250%.

While this process creates engineering challenges (such as electric field issues, contamination flashover and audible noise), all can be successfully mitigated and managed through existing engineering practices. In most cases, the biggest challenge facing conversions is cost, since converter stations connecting HVDC lines to the ac grid are expensive. However, they offer additional capabilities such as increased controllability and islanding, which can aid the larger network operation.



Credit: Electric Power Research Institute

Adding cables to ROW

Another option for increasing capacity comes in the form of adding cables. Cables can be placed below ground or on the surface. Generally, underground cables are the most expensive option due to the civil engineering and cable material required. Still, communities often prefer underground cables because they are less visible and the ROW is already acquired.

As with the other methods, site-specific assessment is needed to determine the challenges and mitigation steps. These assessments include access for maintenance, corrosion and other factors.

Implications

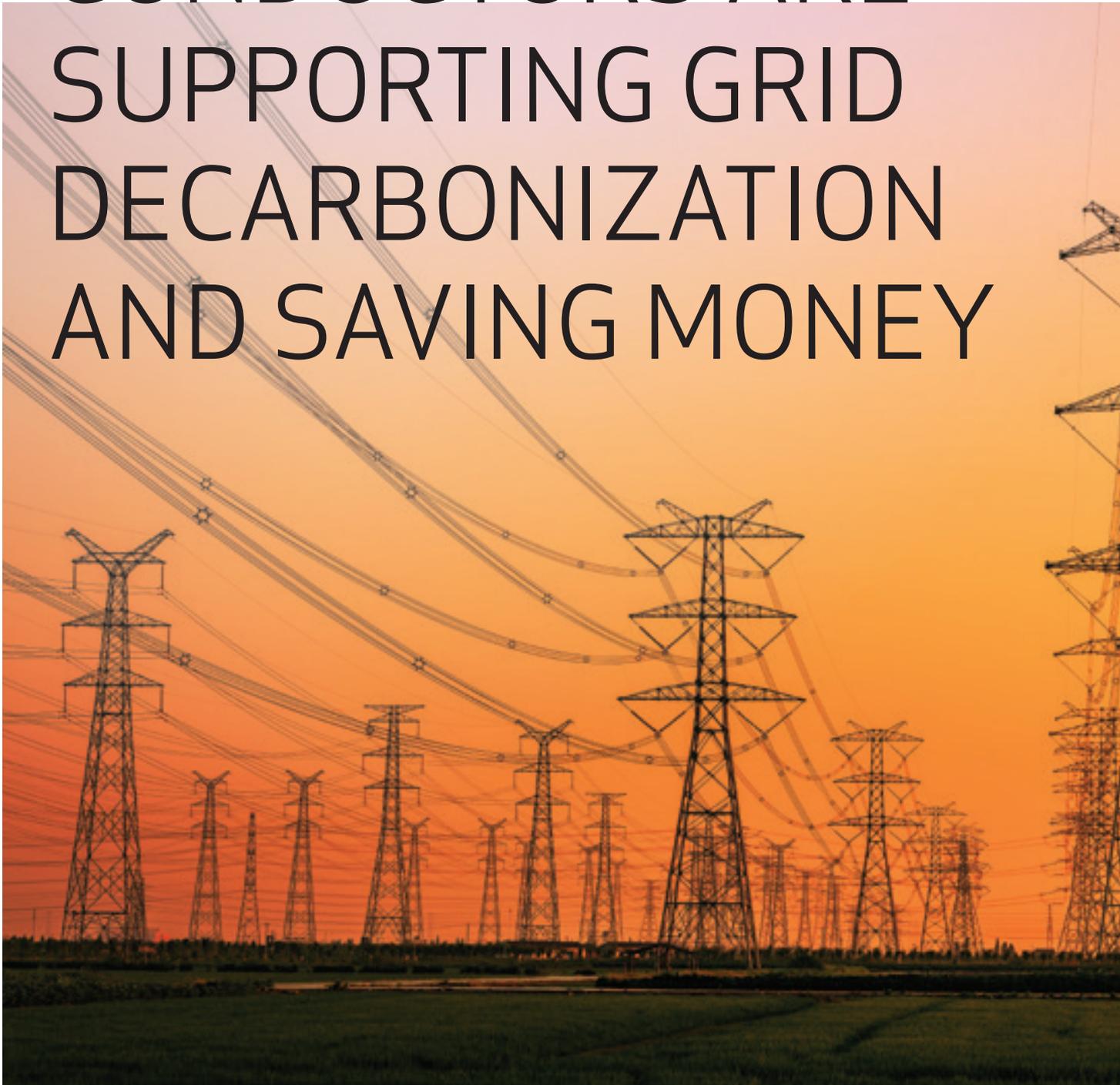
These methods provide broad ranges in impact to power-flow increase, costs and other key factors such as reliability, compatibility and maintainability. When increasing the power flow of an existing ROW, utilities should evaluate potential benefits compared to the cost, reliability and engineering challenges. These challenges should always be addressed through specialized knowledge, analysis and testing combined with field implementation and monitoring.

ABOUT ANDREW PHILLIPS:

Andrew Phillips is vice president of Transmission and Distribution Infrastructure for EPRI. He provides executive oversight and direction for research, development and demonstration programs addressing asset management, operations, planning and integration, including issues and opportunities in diverse areas such as data analytics, reliability, robotics and sensors. Since joining EPRI in 1998, he has led various research programs and initiatives covering transmission and distribution infrastructure and systems.

Dr. Phillips earned a Bachelor of Science, Master of Science and Doctor of Philosophy in electrical and electronics engineering from the University of the Witwatersrand, in Johannesburg, South Africa.

HOW ADVANCED CONDUCTORS ARE SUPPORTING GRID DECARBONIZATION AND SAVING MONEY





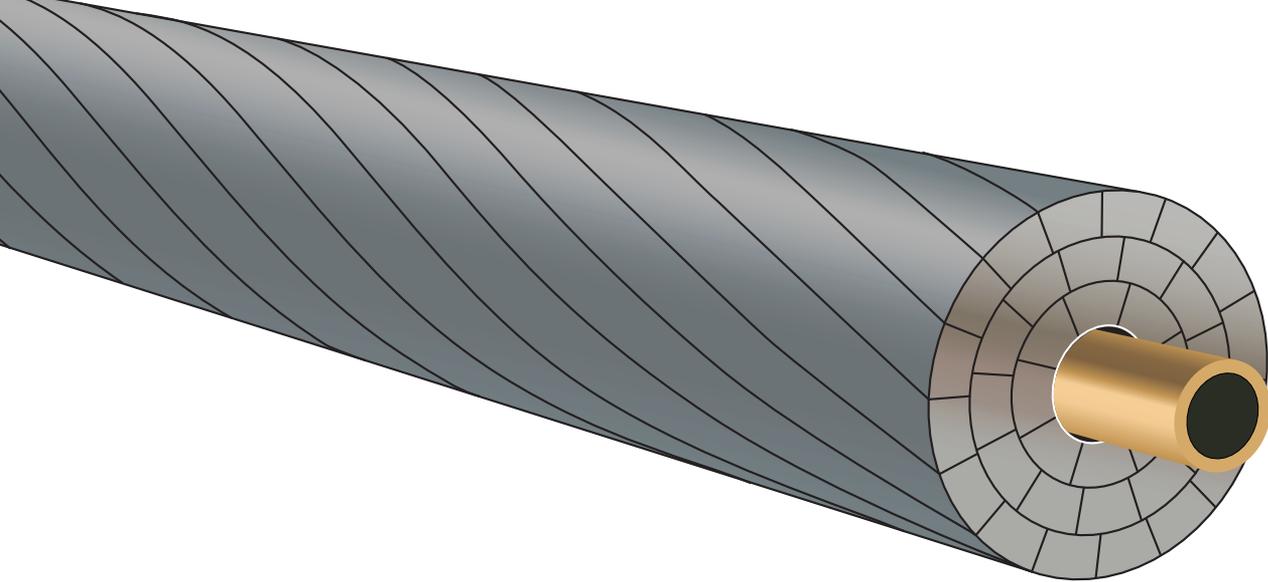
DAVE BRYANT

As utilities struggle to reduce GHG emissions and respond to net-zero-emission mandates while planning for a 50%+/- increase in consumer demand for (clean) electric energy, the need to build new transmission lines to connect cleaner sources of generation has never been more urgent. Unfortunately, regulatory and planning obstacles often delay these projects for years. For near-term solutions, many utilities are leveraging modern technologies to upgrade their existing transmission systems.

While a number of utilities have begun using various Grid Enhancing Technologies (GET) to marginally increase transmission line capacity, such as dynamic line rating systems and load flow controllers, the use of advanced conductors is helping many utilities *substantially* increase the capacity of their existing corridors without the need to replace or rebuild existing structures. The use of advanced conductors offers capacity gains ranging from 50% to 150%, and efficiency improvements ranging from 25% to 40%.

Advanced conductors use carbon fiber or metal matrix composite cores in place of legacy steel cores to increase overall conductor strength, mitigate thermal sag and enable the incorporation of ~30% more aluminum content with no weight or diameter penalty. The added aluminum content not only helps deliver more power but also reduces the conductor's electrical resistance and associated line losses.

In the past, increasing the capacity of an existing right of way (ROW) generally required replacing existing structures and conductors with larger, heavier components. In some cases, voltage increases also required taller structures and ROW expansion. Today, advanced conductors can be used to 'swap out old wire with new wire' with minimal environmental impact, much lower costs, and substantially reduced permitting challenges. →



While many U.S. utilities consider ‘rebuilding’ over ‘reconductoring’ because total returns are greater for larger investments, the reality today is that we just don’t have the time to do everything ‘the old way’ using old technology. The task at hand is just too large and the benefits of reconductoring are too substantial to ignore. We must leverage modern technologies if we hope to solve modern problems.

Here is one example of how this can work: In 2019, Southern California Edison (SCE) sought to increase the capacity of their double-circuit 230-kV Rector to Vestal transmission lines and their adjacent 230-kV Vestal to Magunden transmission lines in the Big Creek Transmission Corridor. Their goal was to increase line capacity from 936 amps to 1,520 amps to improve grid reliability, among other things. SCE selected a California-based power grid solutions provider’s advance conductor, which saved consumers an estimated \$85 million. The use of this technology also mitigated sag infractions. In this case, reconductoring with an advanced conductor also reduced construction time from an estimated 48 months, down to 18 months, which freed-up crews and equipment for other reconductor projects that SCE continues to work on.

While new transmission lines will ultimately help deliver more clean energy from remote locations to load centers, the existing grid was not designed to handle the additional load we now anticipate.

A March 2022 Grid Strategies Report, titled *Advanced Conductors on Existing Transmission Corridors to Accelerate Low-Cost Grid Decarbonization*, acknowledges that advanced conductors are not widely deployed in the U.S. “due to outdated transmission planning practices and outmoded economic incentives, among other barriers.” However, the report provided a number of specific recommendations that address institutional and regulatory barriers preventing faster adoption of

reconductoring as a decarbonization strategy. To remove some of these barriers, the report suggests specific actions that should expeditiously be taken by FERC, DOE, Utility Planners and State Regulators.

These recommendations include expansion of planning scenarios to consider the possibility of additional new renewable generation assets; the establishment of transmission conductor efficiency standards; consideration of advanced conductors as a priority for select Power Marketing Administration projects and for other projects which DOE supports via grants, loans or other financing mechanisms; and, shifting project evaluations by utilities and regulatory authorities from “least cost” to “maximum net benefits” when reviewing project options.

According to the report, over 200,000 miles of transmission lines will need to be replaced over the next 10 years. The report also suggests that if only 25% of these lines were reconducted with high-efficiency, advanced conductors, then at least 270 Gigawatts (GW) of zero-carbon generating capacity could be interconnected during that period just from the increased grid capacity enabled by the reconductoring. The report estimates that this increase in renewable capacity over that decade would reduce power sector CO₂ emissions by approximately 2.4 billion metric tons - equivalent to immediately retiring 22 large base-loaded coal-fired power plants. The energy savings from the added transmission capacity would also save consumers at least \$140 billion.

While advanced conductors are slightly more expensive on a per-foot basis compared to legacy AAAC, ACSR and ACSS conductors, their benefits greatly outweigh their cost delta in most cases. And for reconductoring on existing transmission structure, advanced conductors enable the lowest cost solution to gain substantial capacity since the existing structures can be used (no expensive rebuild).

As mentioned previously, advanced conductors cannot only carry more current, their added aluminum content also makes them more efficient. Improved efficiency and reduced line losses not only help deliver more power over existing ROWs, but they also free up generation assets otherwise wasted. Their added efficiency has substantial benefits for helping decarbonize the grid and helping utilities reach their sustainability goals.

In 2016, American Electric Power selected an advanced conductor to help double the capacity of two parallel 120 circuit mile 345 kV transmission lines in the Lower Rio Grande Valley in Texas. In this case, the use of doubled bundled Drake size ACCC Conductor not only allowed them to use existing structures — *and secure project approval on the day their project was submitted* — the use of this advanced conductor technology also reduced line losses by ~300,000 MWh per year (at a very low load factor of 34%).

Based on the average CO₂ emissions from all combined sources of generation in Texas at that time that equated to a reduction of CO₂ emissions by ~200,000 metric tons. From another perspective, the advanced conductor's improved efficiency also freed up 34 MW of generation capacity. While the Utility may not have directly benefited from this particular aspect, society and the environment surely did.

The idea of reconductoring using advanced conductors is not new, but it seemingly has been “hiding in plain sight” in the U.S. In countries like Bangladesh and Nepal, where international development banks are funneling money to support economic development by funding electric power transmission projects, the use of advanced conductors is being specified. This is not only to help them double the capacity of existing transmission lines and build highly efficient new lines, specifying and installing advanced conductors is also helping these entities reach their sustainability goals - as they recognize the substantial and measurable environmental benefits of these technologies.

Though the Energy Policy Act of 2005 offered a 200-basis-point adder for utilities that used advanced conductors (ACCR and ACCC specifically), not a single U.S. utility took advantage of the incentive. In January 2022, the U.S. DOE posted the “Building a Better Grid” initiative in the Federal Register, which is designed to support a huge expansion and grid modernization. The initiative anticipates the need to increase transmission capacity by 60% by 2030 and as much as 300% by 2050. As such, we cannot afford to overlook advanced conductors any longer.

LINK: The report can be found at: <https://gridprogress.files.wordpress.com/2022/03/advanced-conductors-on-existing-transmission-corridors-to-accelerate-low-cost-decarbonization.pdf>

ABOUT THE AUTHOR:

Dave Bryant is director of technology at CTC Global Corporation in Irvine, California. Bryant was a co-inventor of the patented ACCC[®] Conductor and ancillary hardware components. His 35-year background as a design engineer focused on the use of advanced composite materials in numerous industrial applications which helped expedite the development, testing, and commercialization of the ACCC[®] Conductor, which has been deployed to more than 1,000 projects in 60 countries since 2005.



IEEE T&D IS BACK AND IN-PERSON

WAYNE BISHOP JR.

The last IEEE PES T&D Conference and Exposition was held in Denver back in 2018. (The 2020 T&D slated for Chicago was canceled because of COVID).

From April 25-28, this year's IEEE T&D will be held in New Orleans and hosted by local utility Entergy.

With approximately 10,000 people expected to attend, more than 650 exhibiting companies and several new activities and additions to the program, this promises to be an outstanding event. We are all so excited to see each other again in person and what better place to celebrate the return of an iconic in-person event than New Orleans! The Big Easy is 100% open for business with world-class restaurants, attractions, and entertainment.

One of the biggest changes for this year's T&D is that the IEEE PES ISGT Conference will be co-located with T&D in the New Orleans Convention Center. This means that everyone who attends T&D can also have access to the Innovative Smart Grid Technologies (ISGT) conference at no extra charge.

ISGT is an annual event typically held every February in Washington DC. Because of COVID, the organizing committee decided to postpone ISGT and hold it the same week as T&D. It will give everyone a chance to attend both conferences. We tried our best not to have any of the Super Sessions or Keynotes compete with one another.

When so many things in this world are being taken away, we are pleased to give something more to our valued ISGT NA and T&D attendees.

ISGT NA 2022 website <https://ieee-isgt.org/>
Technical Program <https://ieee-isgt.org/isgt-2022-program-schedule/>

Registration: <https://ieee-isgt.org/registration/>

The ISGT Conference is broken down into three tracks:

1. Decarbonization of the grid, including renewable and DER technologies.
2. Grid democratization including technologies and tools for broad active participation
3. Decentralized and distributed decision and control while maintaining grid reliability and resilience.

We hope T&D attendees will take advantage of attending some of the ISGT technical sessions.

T&D kicks off Monday evening with an extravagant Welcome Reception at Mardi Gras World, which is adjacent to the Convention Center. There will be plenty of food and beverages along with entertainment and lots of great fun. The T&D Local Organizing Committee under the leadership of Michelle Bourg at Entergy has been planning this Welcome Reception for nearly a year. It's a great way to reconnect with industry colleagues and have a lot of fun too. This is something you won't want to miss! →



Opening Session

This year's Opening Session on Tuesday morning will be a "Keynote Panel" with the theme: *How the Past is Powering the Future*.

T&D Technical Chair Chan Wong of Entergy helped plan the keynote panel, and it includes some of our industry's most iconic pioneers:

- **Dr. Edmund O. Schweitzer, III** president, chairman of the board and chief technology officer of SEL. Schweitzer is recognized as a pioneer in digital protection and holds the grade of Fellow in the IEEE, a title bestowed on less than one percent of IEEE members. In 2002, he was elected as a member of the National Academy of Engineering.
- **Dr. Damir Novosel** president and founder, Quanta Technology. Novosel is an IEEE Fellow and was elected to the U.S. National Academy of Engineers in 2014. He served as president of the IEEE Power and Energy Society, VP of Technical Activities, and chair of the Industry Technical Support Leadership Committee.
- **Alison Silverstein** is an independent consultant, strategist and researcher on electric system reliability, resilience, market design, transmission, energy efficiency and technology adoption issues. Her work on major federal electricity efforts includes the U.S. DOE's Staff Report on Electric Markets and Reliability, three national transmission congestion studies, the Hawaii Clean Energy Initiative framework, and the industry-wide advancement of synchrophasor technology.
- **Paul D. Hinnenkamp** executive vice president and chief operating officer of Entergy. Hinnenkamp has more than 38 years of power industry experience including 17 years with the Philadelphia Electric Company and 21 years with Entergy. He is responsible for executive oversight of safety, incident response, power generation, transmission, system planning and capital project management.
- **Dr. Jessica Bian** president of IEEE Power and Energy Society (PES) will be the moderator. Bian is a visionary leader and architect who has spearheaded the electric industry's reliability metrics and grid risk assessment. Currently, she is the vice president of Grid Services at Grid-X Partners. Before that, she was with the Federal Energy Regulatory Commission (FERC), Washington, DC. Previously, she was the director of performance analysis at North American Electric Reliability Corporation (NERC) in Atlanta, Georgia.

Entergy and the T&D local organizing committee has assembled an outstanding technical program consisting of more than 400 speakers, three super sessions, 110 poster sessions, tutorials, technical tours and much more. The T&D Super Sessions planned for this year cover three topics: Data Analytics, Resiliency, and the Future Grid. The Super Sessions are set up as panels with plenty of time for Q&A. All of the panelists are subject matter experts and industry thought leaders.

Technical Tours will include: the Entergy Grid Modernization Labs, Naval Air Station Joint Reserve Base in New Orleans, Entergy Grid Storm Hardening, and Laser Interferometer Gravitational Wave Observatory (LIGO).

Innovation Stages

The NEW Innovation Stages will be located in two places on the Expo Floor. These Innovation Stages will feature 12 different companies giving "Ted Talk" style presentations lasting 30 minutes. Most presentations will be about a current industry trend or a new technology for the market. There are so many changes happening in our industry, and this is a good way to bring yourself up to date on some of these changes and new technologies.

IEEE Smart Cities Pavilion

Also new in 2022, the IEEE PES T&D Conference and Exposition is excited to announce the addition of the Smart Cities Pavilion. Developed in partnership with IEEE Smart Cities, this dedicated pavilion on the exhibit floor will feature a variety of presentations and case study exhibits showcasing the effective collaboration necessary to make smarter cities a reality. Access the latest in new technologies and real-world applications meant to promote business and connect thousands of attendees from around the globe with best practices for urban planning and innovation. The Smart Cities Pavilion will provide a platform where public business managers, directors, urban administrators, and international authorities responsible for developing urban policies can offer their services to develop smart cities.

Utility Super Saver Program for Registration

We have added a Utility Bundle registration package to encourage more utility attendees. Utilities can register 10 employees for \$1000, which is an incredible savings. Utilities can buy as many bundles of 10 as they wish. We sold over 110 bundles for the 2020 Conference and we are starting to see more and more utilities register for 2022.



Collegiate Program

At this year's IEEE T&D we are offering an exciting and comprehensive schedule of students and young professional sessions and activities. The "Collegiate Program" at T&D is designed to help students launch successful careers in the power and energy industry. We will also feature a Poster Session and Reception providing a relaxing environment for registered conference attendees to enjoy hors d'oeuvres and beverages while viewing hundreds of accepted papers in poster format. This will be held on Wednesday evening, April 27.

I'd like to take this opportunity to thank Carl Segneri, IEEE PES North America T&D director and Barbara Powell,

T&D operations manager. They are the glue that holds T&D together. Carl has been involved with T&D for more than a decade, and Barbara for more than 30 years. I'd also like to recognize Entergy and the Local Organizing Committee. They have done an outstanding job of putting together a world-class technical program along with all of the fun networking activities. It's an honor to serve as the volunteer IEEE PES vice president of Meetings and Conferences. The most rewarding part of my job is the incredible team of volunteers that help plan an event like T&D. I look forward to seeing all of you at this year's IEEE PES T&D Conference and Exposition!



ABOUT THE AUTHOR:

Wayne Bishop Jr. has worked in the electric power industry for more than 30 years.

He is currently the senior director of industry outreach at Quanta Technology. Bishop is also IEEE PES vice president of meetings and conferences and a member of the IEEE PES Governing Board. Additionally, he is a Senior Member of IEEE.

Previously, Bishop worked at OMICRON electronics where he was the head of marketing for North America for 13 years. Before that, he was employed at Doble Engineering for more than 16 years in several senior management positions. Bishop is a graduate of Merrimack College, Harvard University, and the Executive MBA Program at Suffolk University in Boston, graduating with honors.

He is a proud Eagle Scout and also a recipient of the Suffolk Executive MBA Great Leaders Executive Excellence Award and has been inducted into Beta Gamma Sigma—the National Honor Society of Business Schools.

WHY INTELLIGENCE-BASED DETECTIONS IN ICS FAIL

RON FABELA

Threat intelligence plays an integral role in cybersecurity, but industrial control system (ICS) environments offer unique challenges. Let's dig into the basics of intelligence-based detections for ICS – noting the benefits, but also where intel misses the mark.

Part 1: Understanding intelligence-based detections

We'll start with some quick sound bites:

Intelligence is the analysis of current and past activities that may inform future prevention or detection efforts.

There are very few current and past activities in ICS.

Threat detections attempt to make those intelligence efforts a reality with your current data.

Limited known activities overly specific to single targets make for weak detections.

Intelligence relies on first-party collection, analysis from experts, context from industry (impact) and knowledge of your environment to make actionable decisions.

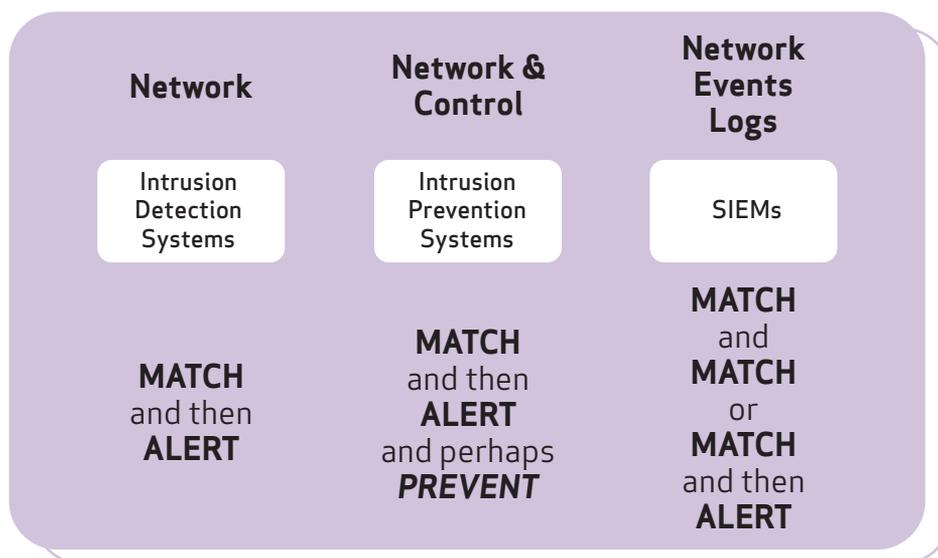
Little first-party collection in ICS, experts are limited but growing, context from industry is at least nuanced, knowledge to make it actionable is low.

Tactics, techniques and procedures (TTP) derived from threat actors via intelligence pave the way for capturing malicious actions.

Besides initial attack vectors via the enterprise networks, the few ICS attack vector TTP are still overly specific to the target, live off the land, or are so IT generic that they're useless for ICS.

History and basics of detections

Detections and their technologies have evolved from rules-based matching to correlation and automation. See the (oversimplified) diagram below:





And all was well in the world. But there was one problem. Much like detection's out-of-state cousin *antivirus (AV)*, you were only as good as your signatures. This resulted in organizations being beholden to their vendor's rules for detection.

Luckily, as technology evolved, so did our options. Open source tooling like Snort and Suricata started to standardize the format for rules-based detections. Groups like Proofpoint and Talos began publishing regular rules updates, and the indicator of compromise (IOC) arms race began.

Indicators of compromise

Think of IOCs as AV signatures, but for everything else. An IOC can be as simple as an IP address or a file hash that someone says is malicious or indicative of malicious activity. IOCs represent past behaviors now identified with some context. IOC information is then converted into a detection rule, such as snort/yara/sigma.

Pros: IOC-based rules will 100% either fire or not fire. These are great if you're looking for something specific, either in the past, present, or future.

Cons: You won't catch what you aren't looking for. IOCs can be too specific, so much so that they miss any variation. Or they may be too broad and cause false positives and lower confidence.

Analytics, behaviors, ML/AI

Some organizations may use the term analytics to differentiate how their detection rules work. This takes some correlated or math-based view at one or many data streams to find 'badness.' Imagine taking one element of an IOC (like a file hash), one element of math (standard deviations from a norm) and some context about the user or entity (device type). The idea here is to cast a wide enough net to catch badness while not restricting yourself to a single thread. To overly summarize ML/AI, so far in security, it comes down to advanced stats (ML) or very complicated IF/THEN statements (AI).

Pros: Good systems elevate actual threat activities from the noise floor of millions of snort rules firing.

Cons: Systems need a complex correlation of many data events and types. Correlation rules engines haven't worked as advertised (see <https://medium.com/anton-on-security/security-correlation-then-and-now-a-sad-truth-about-siem-fc5a1afb1001>)

Part 2: Understanding ICS security

To understand industrial threats is to understand the environments in which they wish to act on their objectives. Current enterprise intelligence works well due to the volume of telemetry/monitoring data, common threat actor objectives and general uniformity of the attack surface. But in industrial environments, not all of those factors are present.

Not All ICS is the Same

Misconceptions often occur when bundling all of the world's infrastructure into the bucket of ICS. These misconceptions take place even more so when it comes to security. The amount of vendor diversity alone adds enough complexity without even considering the specific processes, configurations, operational procedures, safety and human elements of industrial control.

Although it may sound simple:

The power grid in Ukraine has very little actual overlap with a power grid in Texas.

PLCs/RTUs, relays, instrumentation, HMIs, EWS/OWS, historians, protocols... could all match precisely, and the operational posture of that system could still vary wildly. Once designed and built, the operations of the asset cause a shift in how it can and should be secured.

No two ICS attacks are the same

Due to the purpose-built nature of ICS and even considering diversity in technology, no two attack vectors are the same (so far). The areas of overlap exist only in the IT technologies that reside in the enterprise and provide initial access to the OT environments. →

THE CYBER KILL CHAIN

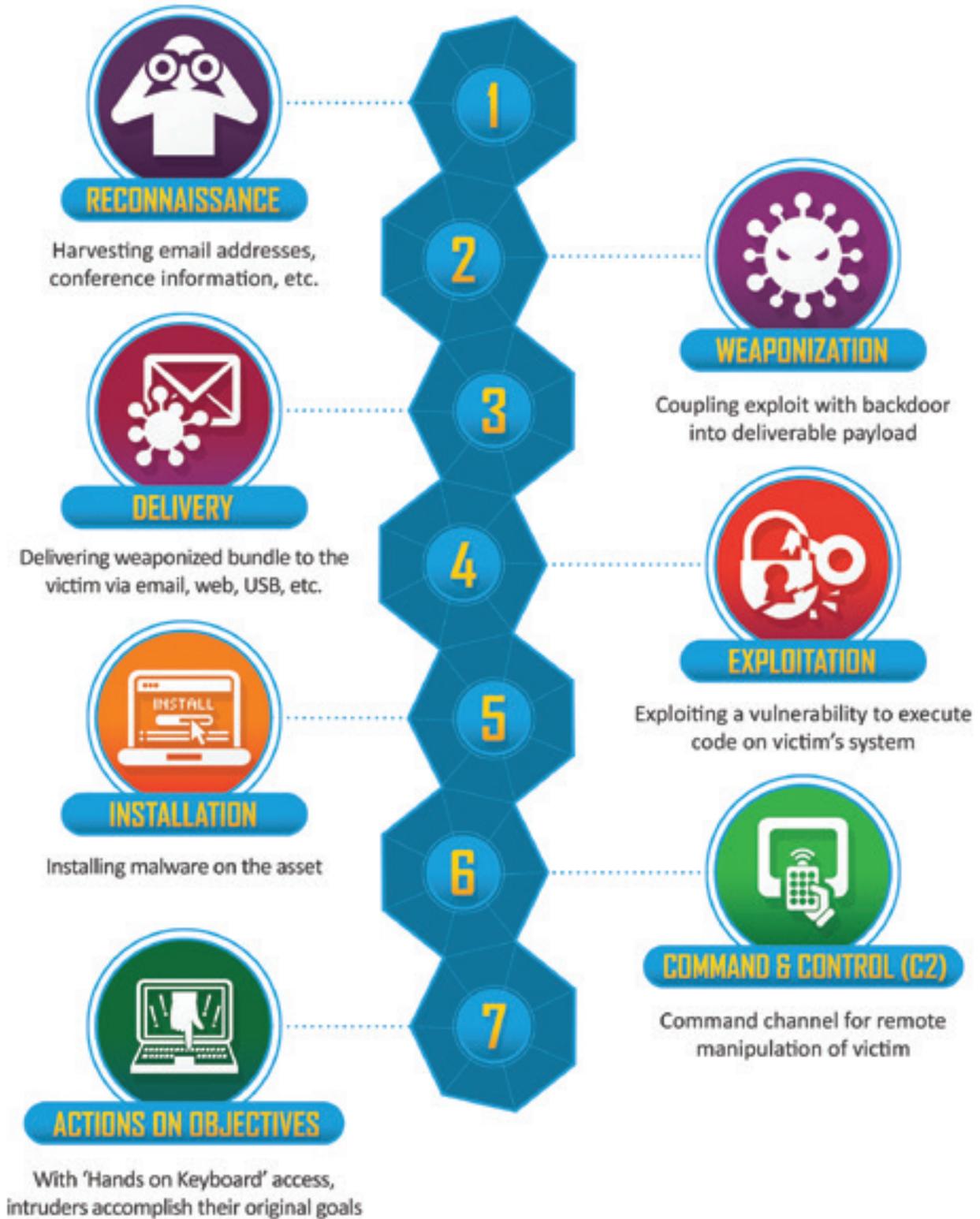


Image from Lockheed Martin; <https://www.lockheedmartin.com/en-us/capabilities/cyber/cyber-kill-chain.html>

The concept of cyber threat intelligence is great. Attackers must generally follow the kill chain steps to act on objectives successfully. These actions can be mapped and detected, allowing defenders multiple opportunities to catch the 'badness.' For an enterprise with tons of users exposed to the internet and other organizations, factoring in the latest TTP gives blue teams an edge in detecting the latest threats.

History has shown us that for ICS attacks to be effective, the TTP has to be so customized for the target as to not have much reuse. While individual attacks on assets by threat groups prove interest and academically provide use cases, not much of the intelligence proves effective in day-to-day operations.

It's about acting on objectives

What we are really trying to prevent is for the threat actor to "act" on objectives. This changes, depending on the environment. Enterprise operations may be targeted with ransomware while ICS is caught in the splash damage. For the most part, current ICS attacks, intelligence and TTP fall into **two categories**:

1. Phishing a utility does not an ICS threat actor make

While most agree that spearphishing as an initial inject may lead to process disruption 20 steps down the kill chain, it doesn't necessarily make the case that the TTP is specific to ICS.

2. Reversing ICS malware

Brilliant reversers are out there with actual ICS-specific malware to investigate. When coupled with industrial experts, these reversers can dig into how the threat actor intended to act on objectives. When this capability is applied to real ICS malware, the wealth of knowledge provided is staggering. The deep-dive reports that come out are typically well constructed, even if the media overhypes the impacts. However:

The intelligence data derived from existing ICS attacks/malware do not scale or apply outside their target. Stuxnet/Triton/Industroyer researched and documented at that moment in time will never resurface exactly elsewhere (and have not to date).

Understanding that current ICS threat intelligence is overly focused on **targets** and not **objectives** isn't necessarily a nail in the coffin. Threat intelligence has its place in the world. In industrial, that world consists of wildly diverse architectures, systems and processes where current intelligence has a minimal impact at the operational level.

Part 3: INDUSTROYER

We've covered some intelligence basics and the diversity and variation of ICS environments. Now let's combine the two concepts using an example from the industry.

INDUSTROYER background

A well-known cyberattack against Ukrenergo's "North" substation caused power outages in and around Ukraine's capital of Kyiv on December 17th, 2016. Like Stuxnet, the Ukrenergo use case became well documented and often misrepresented among cybersecurity professionals.

Finally, the industry had a specific and targeted attack against a substation where the actor achieved its objectives. While this was still an attack in a far-off land for some, industrial cyber consultants, advisers and vendors had the evidence they needed to back the messaging.

However, for those in the IOC and analytics shops, it was still a difficult task to convert this deep intelligence history and information into actionable results.

Thankfully, MITRE has broken out and mapped each of the INDUSTROYER components for us to digest.

MITRE ATT&CK for ICS

What is MITRE ATT&CK for ICS?:

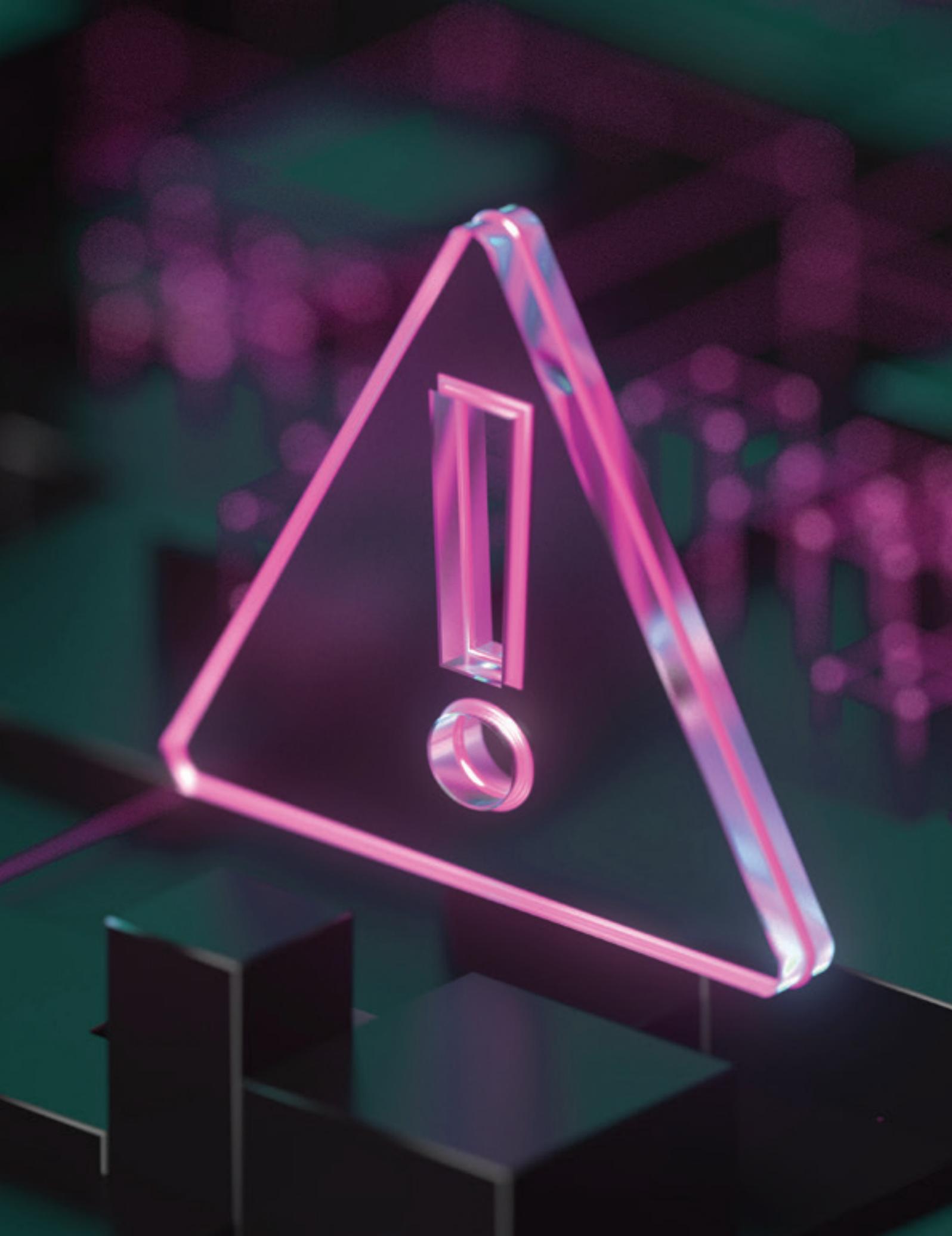
"ATT&CK for ICS is a valuable knowledge base for describing the actions an adversary may take while operating within an ICS network. The knowledge base can be used to better characterize and describe post-compromise adversary behavior."

from <https://collaborate.mitre.org/attackics/index.php/Software/S0001>

You can review the in-depth matrices MITRE put together describing every action an adversary can take in an ICS network. These categories help bucketize all known, unknown and future attacks into standard nomenclature to improve the community's ability to defend and respond.

Actions and outcomes

For INDUSTROYER, MITRE attaches nearly 30 actions and outcomes from the attack, ranging from denial of service to loss and manipulation of view/protection/view and everything in between. The concept here is that a defender could break the attack chain at any given point, potentially disrupting the adversary's end objectives of causing a power outage. →



From a monitoring, visibility and detection stance, it's difficult to translate these components into analytics that matter across the board. By reading the first in the list, the challenge is apparent:

*The **Industroyer** SIPROTEC DoS module places the victim device into "firmware update" mode. This is a legitimate use case under normal circumstances, but in this case, is used by the adversary to prevent the SIPROTEC from performing its designed protective functions.*

Many other techniques utilized or abused current functionality within the substation SCADA systems. This further complicated the idea that these TTP could be codified into detection rules. One part of the attack did stand out, however:

Question: How do you make a SIPROTEC relay go to sleep?

Answer: Send specific data over UDP 50000

In the case of INDUSTROYER, causing a line of power relays to become unresponsive just needed packets on UDP/50000 with a certain 18-byte payload. **That was it.**

While there is more to the INDUSTROYER event than this particular packet, it was one of the few actionable detections directly related to the event.

What happened next?

- CISA released a specific advisory for a known (and patched) vulnerability exploited by the adversary in this instance.
- Cisco Talos released a snort rule looking for the specific 18 bytes in UDP/50000.
- Some YARA rules for INDUSTROYER were created.
- IOCs were released, a collection of IP addresses that were TOR node exits, files hashes, etc.

But for an attack that will *most likely never be seen in this form again*, how useful are these for proactive monitoring and detection?

The history lesson here is good, but there are no magic analytics for the INDUSTROYER attack. The attack was a series of stitched together nonindustrial-specific tactics and techniques to gain initial access, followed by highly specialized malicious applications that ended up abusing *completely normal industrial protocols*.

Detections are the safety net — everyone will want or require your organization to be able to detect known "bads." **The disconnect with our ICS-specific examples is the expectation (and maybe the marketing) that ICS threat intelligence directly translates to analytics and detections.**

Part 4: Where intelligence succeeds in non-detection use cases

Where intel-based detections in industrial are ineffective compared to enterprise, intelligence for ICS still has some significant benefits.

BENEFIT #1: HISTORICAL AND REAL ATTACK USE CASES

Industrial intelligence used to be focused solely on vulnerability research, adjacent malware reversing and hypothetical use cases. But when an incident occurs, an expert and detailed analysis of what transpired is valuable. Current industrial threat intelligence does a superb job closing this historical documentation gap.

Take this detailed account of the INUDSTROYER event presented by Joe Slowik at VirusBulletin 2018 (see <https://www.virusbulletin.com/uploads/pdf/magazine/2018/VB2018-Slowik.pdf>.)

"While the original script was not recovered, in log data a series of rapid RPC authentication attempts to multiple hosts were observed for user 'Administrator' with the same password across over 100 endpoints, specified by host name."

This is helpful context for how actual adversaries footprint and pivot around an industrial environment. Interestingly, regarding the SIPROTEC vulnerability, this module by the adversary was a complete failure but still provides context as to how/what adversaries may target in the future.

BENEFIT #2: INFORMED AND DEFECTIVE THREAT HUNTING

Before industrial attacks' historical and real use cases, scenarios were stuck in the fantasy realm. My peers and I would conjecture how to attack an industrial control system effectively. These attack scenarios, while well-informed, were theoretical. Therefore the recommendations and best practices for defense were also *technically* hypothetical.

With actual events and retrospectives from intelligence groups, the community finally had some breadcrumbs to follow. While we may never see the same exact attack as INDUSTROYER, we have a blueprint for informed and effective threat hunting.

SANS white paper from Gunter/Seitz

A white paper from Dan Gunter and Marc Seitz on threat hunting, using INDUSTROYER as a reference, is a perfect example of this idea (see <https://www.sans.org/white-papers/38710/>).

Especially important is what Gunter/Seitz call out as "Phase 2: Hypothesis Development." In summary, hypotheses can be derived from many different sources and perspectives, but having historical intelligence from previous events is a significant step in the right direction. That first step is difficult without reference material to spark the imagination, and cases like INDUSTROYER lay out the roadmap.

BENEFIT #3: MOVING MOUNTAINS (CISOS AND BUDGET)

Early on in ICS cybersecurity, most of the effort was around convincing decision-makers and budget approvers that industrial cyber threats were, in fact, real. We piled on proof points like vulnerability research, attack path analysis, penetration testing and the little bits of intelligence we had about enterprise attacks against industrial companies (remember Shamoon, BlackEnergy and Havex?).

But it was difficult to gain traction. Pentesters could pivot down to the control system, get administrator on an HMI, show they could impact the process and often, the question back was, "So what? Who would actually figure out how to do this?" <sigh>

The intelligence deep dives and supporting content described above have effectively moved industrial companies' budgets and projects to improve security. For better or worse, these events moved ICS attacks from purely hypothetical to current reality.

Visibility is key

While industrial threat intelligence may *inspire*, operations-based intelligence *empowers*. Visibility crafted, maintained and controlled by operators (security or industrial) defending their environments is the critical gap in the intelligence conversation.

The goal of this article isn't to downplay the importance of threat intelligence, but to broaden the aperture a bit on where intel can be derived. For ICS, it's vitally important to have a solid understanding and control of the single most effective intelligence generating environment you have: *your own control system*. To put it another way:

No one knows your environment better than you and your operators.



ABOUT THE AUTHOR:

With more than 20 years of cybersecurity experience and a deep understanding of industrial control systems (ICS), operations technology (OT) security and the industry as a whole, Ron Fabela is leading the charge at SynSaber as co-founder and Chief Technology Officer to develop solutions that actually help the analyst and operators defend their environments.

EASE OF USE KEY TO REPLACING AGING SUBSTATION RTUS

SW ELECTRIC UTILITY SUCCESSFULLY NAVIGATES CHALLENGES OF REPLACING LEGACY RTUS

CONRAD OAKY

Support challenges associated with aging and obsolete Remote Terminal Units (RTUs), combined with built-in cybersecurity and expanded functionality in modern RTU designs, are accelerating utility efforts to replace legacy hardware. The increasingly critical role of the substation RTU, notably in bulk and transmission substations, underscores the importance of ease of use, high performance, interoperability and scalability. The experience of a major U.S. utility in upgrading their legacy RTUs is described in this article.

“When we began to look at replacing our RTUs, our oldest terminals had been in use for more than 20 years,” said one engineer at a major SW US utility.

“Because of all that is involved in replacing our RTUs, we had been hesitant to initiate a search for a replacement system but when our vendor discontinued the type of platform that we utilize, we had to make a change and it became an opportunity to really consider our long-term needs.”

Key implementation considerations

The utility initiated its RTU replacement search by issuing a Request for Information (RFI), followed by a Request for Proposal (RFP) to the top five vendors that most closely matched their requirements. ‘Ease of use’ was heavily weighted.

For this utility, ease of use meant five things:

1. How easily the new RTUs could be configured to meet specific utility needs
2. The ease of installation and integration with existing hardware and systems
3. How easily field engineering and support staff could be trained
4. Quality of supporting documentation
5. How easily the system could be maintained

“In an RTU replacement project, you are not just replacing terminals but impacting everything around it,” said the engineer. “It’s the RTU, the chassis components, the power supply, the I/O and the cabling. You have to know all of it, and so, there’s a lot of training that is required with a project of this scope.”

As a result, ease of use and training were key factors in overall vendor selection. Because of the complexity of the legacy platform (due to the number of connections, amount of hardware, as well as software and logic-building nuances), the utility was concerned it would require extensive training for any new engineer or designer. They did not want to risk having team members unprepared because they were overwhelmed by a new system. →



Credit: NovaTech

“Historically, it can take a new technician or engineer two to three years to truly learn a platform well enough to go out on-site on their own,” the engineer explained. “Since we have a six-month rotational engineering program, we really needed the ability to effectively and quickly train our team in RTU set up and configuration with all the necessary documentation and customer support to be successful going forward.”

Because this utility has a large RTU fleet, ease of maintenance, particularly for its software and firmware, was also rated highly. “Live firmware updates, security patches for new vulnerabilities and feature upgrades to a live system are extremely important, but these can be cumbersome to execute,” the engineer said. This resulted in the utility’s review of each vendor’s firmware history as part of their RTU evaluation process to gauge what they could expect in the future.

Form factor also played a role in assessing overall ease of use. Older substations may not have been built with the capacity to expand in the future. Older legacy RTUs are also heavily hardwired, sometimes requiring half to a full day in cutover time.

“Everybody is trying to look for a form factor that is similar to what they already have,” said the engineer, “The reality is that what you are switching over to will likely not need as much wiring as your legacy RTUs. What is desirable is to be as plug-and-play as possible so you can reduce the amount of cutover time to the new RTUs. Our goal was to get operations back up and running as soon as possible.”

Selection of a replacement RTU system

From the five vendors participating in the RFP and evaluation process, the utility chose an automation platform for the RTU and HMI replacement portion of the RFP.

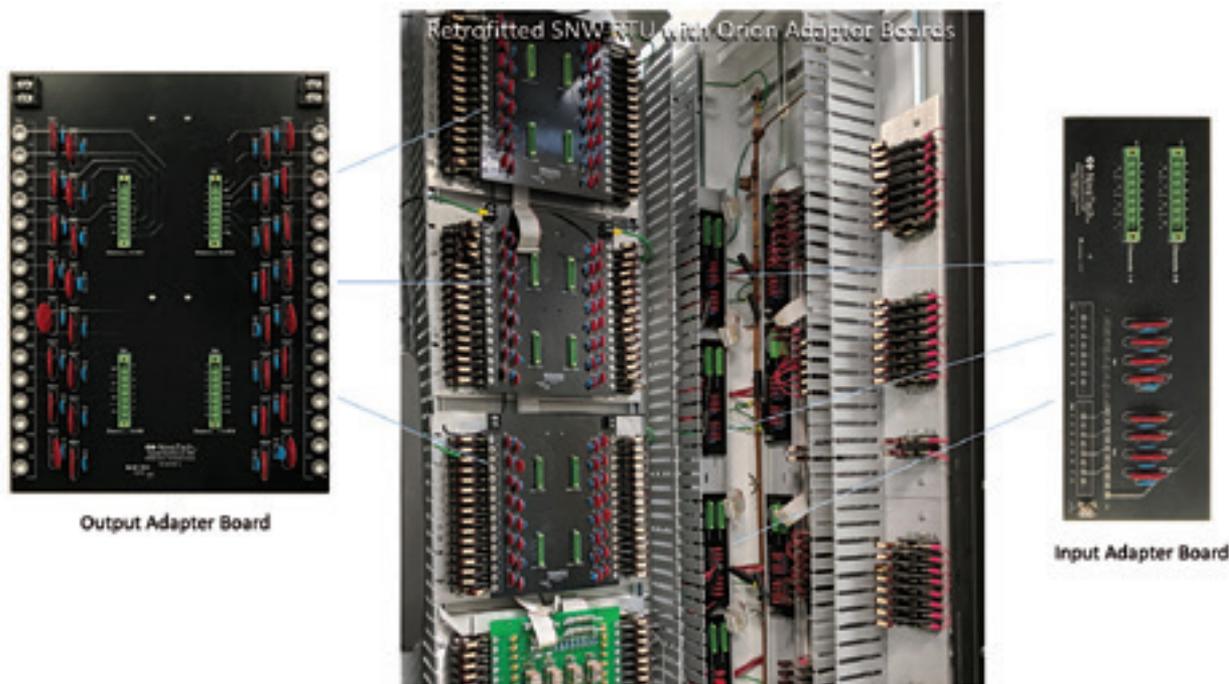
Before the upgrade, the utility legacy configuration included a customized HMI in every transmission and distribution substation. While the Alarm pages made it easy for technicians to identify events in real-time, the annunciator graphics program was cumbersome to edit and build new pages. Further, the legacy HMI used a database separate from the RTU database, increasing overall configuration efforts. A better design was needed.



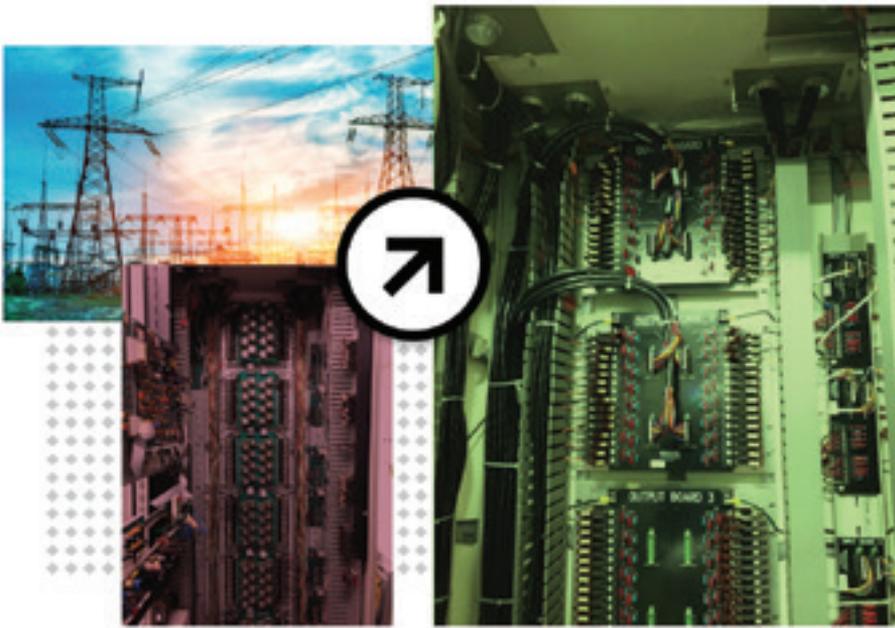
Even our most experienced engineers
were pretty impressed.



“One of the features that we like about the RTU [selected] is the ability to build a page in minutes and then test and get the page working extremely quickly – usually within an hour,” explained the engineer. “Even our most experienced engineers were pretty impressed.”



NovaTech: Automation Adapter Board for Legacy Systems Northwest Input and Output Cards



Credit: NovaTech

Configuration of the RTU, including the I/O system, the Alarm Tile Annunciator, Math & Logic routines and IED data access, is accomplished through a license-free tool. This eliminates most configuration efforts by providing pre-configured pick lists for over 250 commonly applied intelligent electronic devices (IEDs).

The utility's need for future operability and scalability are also addressed by the platform, which is offered in a range of models for pole top applications, distribution substation applications and transmission substation applications. All models are provided with identical firmware and configured with the same tool. Moving to a larger or smaller platform is a matter of transferring the configuration and editing a few hardware-specific parameters. In addition, new protocols (e.g. IEC 61850, IEC 61851, etc.) and software options (Email, IEC 61131, etc.) are modular and can be added easily, in many instances, without requiring a firmware upgrade.

Getting it right

The challenging tasks of keeping the data flowing reliably between the RTU system and the utility enterprise is now complicated with aging and obsolete infrastructure. The engineer concluded, "Planning for our future power needs through the replacement of legacy RTU systems in our utilities enables us to continue to play our part."



ABOUT THE AUTHOR:

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UNDER THE WEATHER: RESILIENCE EFFORTS AMPLIFY VALUE OF DATA MODELING

USING DATA-DRIVEN MODELING FOR GRID-HARDENING EFFORTS

ARRON LEWIS

How 'bout that weather last year? The Pacific Northwest sweltered under a “heat dome” that melted power cables and shut down Portland’s streetcar service. Texans shivered through a deep freeze that took power from five million people and disrupted water service as well. Hurricane Ida shut down the grid for millions in Louisiana, Mississippi and throughout the Northeast.

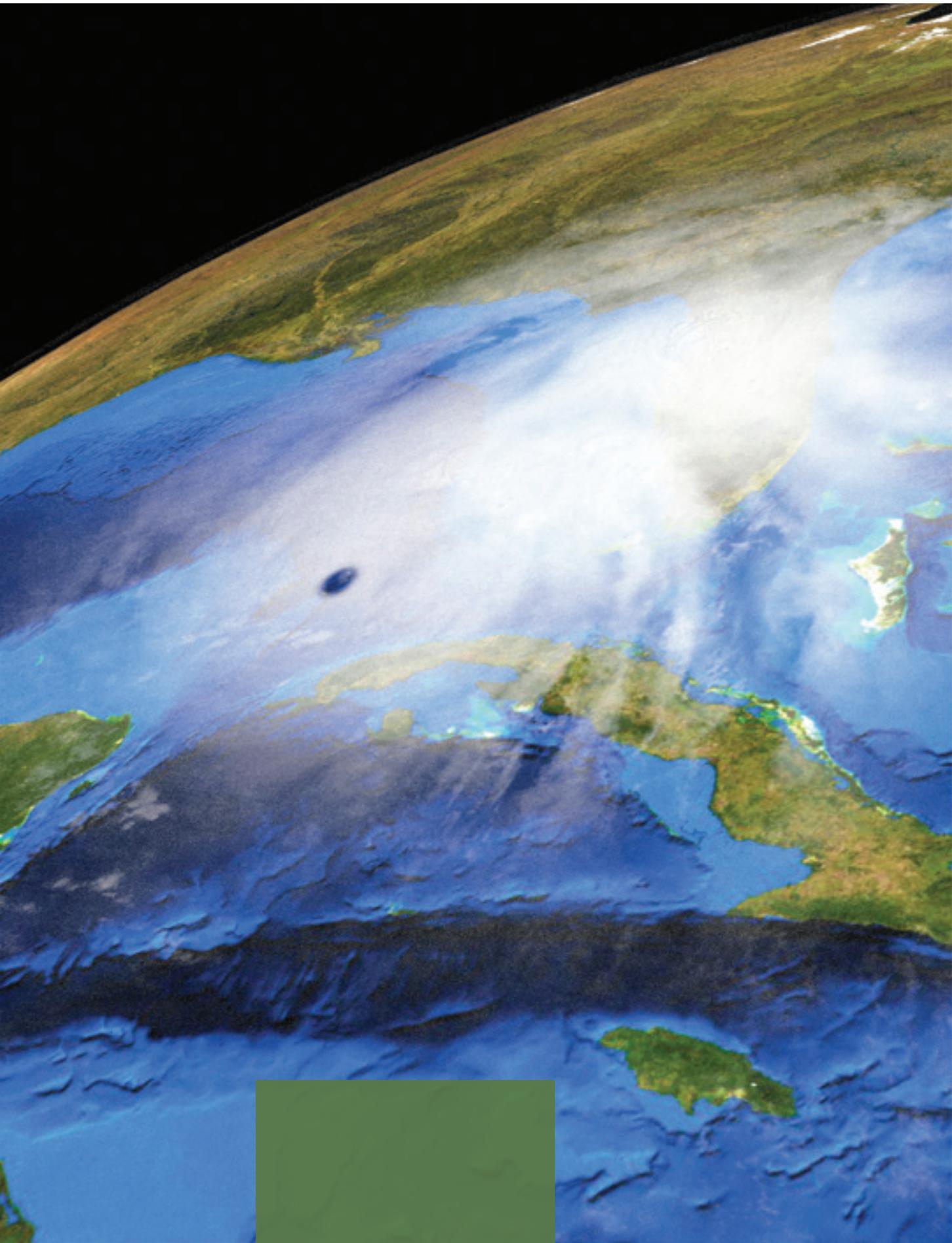
It was a banner year for climate change, as the increasing frequency and impact of severe weather events left millions of people battered, and their communities and infrastructure systems stressed. According to a *Washington Post* examination of federal disaster declarations, more than one-third of all Americans live in a county that experienced a climate disaster during the summer of 2021.

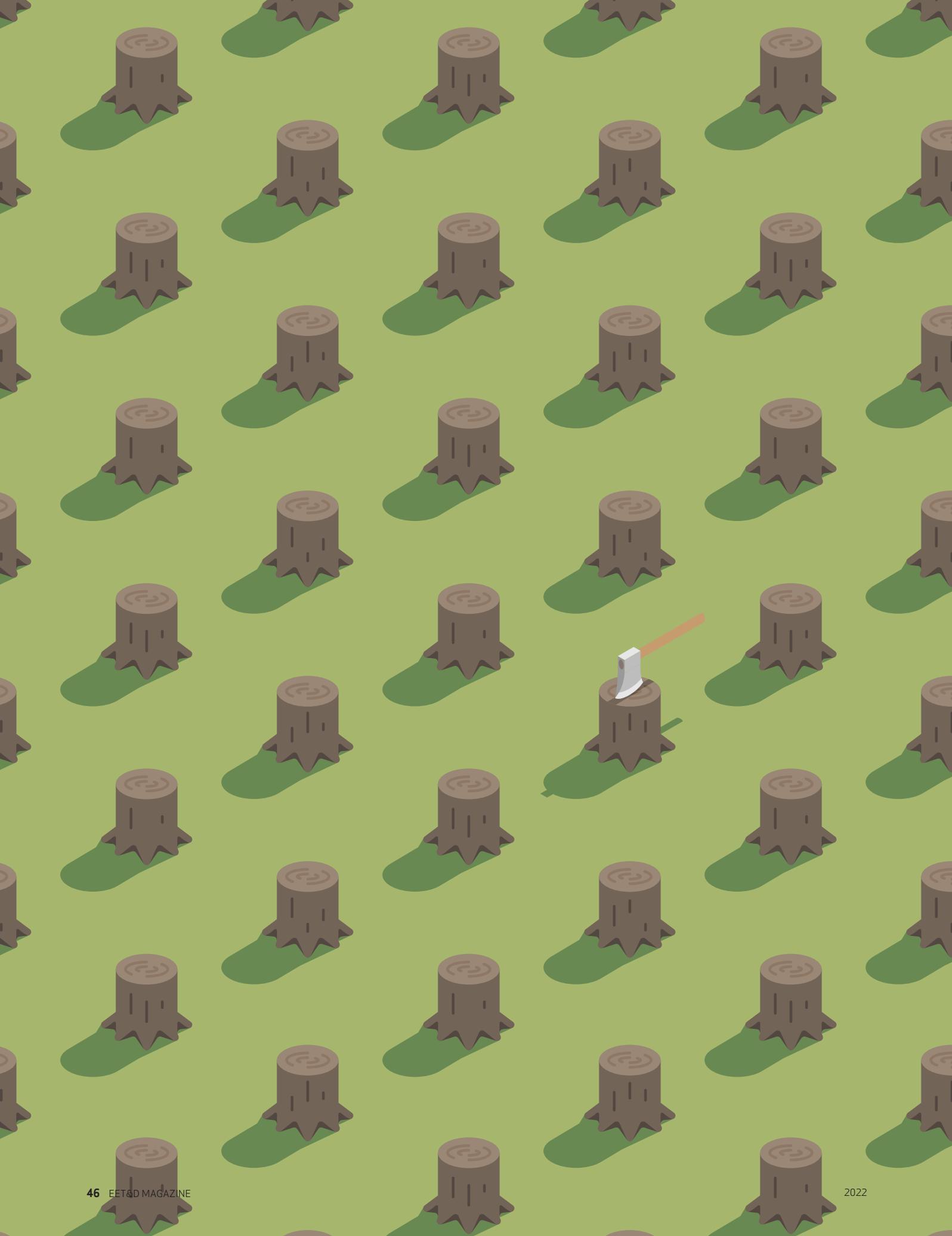
Weather disruptions to the grid are nothing new – anything from a windblown tree branch to a raging wildfire can disrupt operation of overhead lines, causing power loss – but the recent barrage of events has highlighted the urgent need to make large-scale updates to the power grid.

Today, the problem is being felt more deeply because customers are increasingly sensitive to system failures – and service providers haven’t done the best job of managing expectations. But these events, though they deliver devastation and frustration, are also serving as catalysts for change.

Hardening against climate change

The rising impacts of climate change are driving utilities to reconsider and reprioritize how they approach system hardening. According to a 2021 Electric Report, which is a compilation of quantitative data and qualitative analysis based on a survey of industry participants, more than 80% of power utilities now say system hardening is more important than it was even a year ago. This may be due to the immediacy of 2021’s weather issues, but it could also reflect respondents’ awareness of the significant financial and reputational risk they face when systems fail. →







This is reiterated by the CDP's Global Supply Chain Report 2020, which estimates that by 2026, suppliers stand to lose a total of \$1.26 trillion in revenue due to climate change, deforestation and water insecurity. The CDP, a nonprofit organization that runs a global disclosure system for managing environmental impacts, also projects that corporate buyers may face up to \$120 billion in increased environmental costs by 2026.

So how can utilities get ahead of the climate change curve? There's a long list of hardening techniques utilities can employ to protect their critical infrastructure.

For example, after the destruction of Superstorm Sandy in 2012, the State of New Jersey Board of Public Utilities laid out 103 activities to improve their preparedness and responses to major storms, including requiring utilities to "submit ... an analysis of the current 100-year flood plan data for their respective areas of operation," and "develop and submit ... a Storm Damage and Outage Prediction Model."

And the disruption is only expected to continue. The U.S. Department of Energy reports that between 2003 and 2012, an estimated 679 widespread power outages occurred in the U.S. due to severe weather, disrupting the lives of millions of Americans and costing the economy between \$18 billion and \$33 billion.

When asked which hardening techniques utilities are most likely to deploy within the next five years, respondents to the 2021 Electric Report survey pointed to continued vegetation management (57%), smart grid improvements (55%) and structural upgrades to transmission and distribution systems (48%) as the top three methods to help protect systems against extreme weather events.

Overgrown and unhealthy trees, branches and weeds are a threat to power lines, as they can dry out and create wildfires, long-term outages and devastating fatalities. Vegetation management allows utilities to control, clear and remove any possible hazards before an issue occurs.

For example, a fallen tree is to blame for the second-largest wildfire in California's recorded history. In 2021, a tree fell onto one of Pacific Gas & Electric's (PG&E) powerlines, sparking the Dixie Fire, which ended up burning nearly one million acres and destroying at least 1,329 structures, including more than 700 homes.

PG&E includes vegetation management as a core tenet in its 2022 *Wildfire Mitigation Plan* and plans to spend approximately \$5.96 billion on wildfire mitigation this year, roughly \$1 billion more than last year.

Smart grid improvements will also be prioritized. According to the Council of European Energy Regulators (CEER), smart grids can help meet climate change targets by helping to reduce power losses and lower energy consumption, thereby reducing GHG emissions and improving energy efficiency. Deploying smart systems that can provide awareness of the current state of infrastructure assets and automate quick restorative actions can be invaluable when it comes to protecting against climate change.

Structural upgrades to transmission and distribution poles and towers will be critical moving forward. Trillions of dollars have gone into building out the nearly 150 million utility poles in service in North America, according to the *Washington Post*, putting serious capital at risk during weather-related events.

Infrastructure is designed and built according to design criteria that relies on historic weather data, but the design basis is only as good as the information it is based upon. Today, ambient temperatures are changing, hurricane-force winds are becoming more prevalent, flood plains are shifting, and probabilities are increasing which can make design criteria obsolete. This is testing infrastructure, requiring utilities to reconsider new design standards and to invest in upgrades that will ensure their poles and towers can stand up against the climate risks associated with their regional location. →

Utilities are also working to improve incident response time to severe weather events. The survey found that nearly one-third of respondents (32%) have either deployed or piloted projects — or are actively doing so — to help improve incident response time. Their efforts span from installing microgrids to smart meters, to “inundation protection for substations” and building new transmissions that can stand up to higher wind speeds.

The solution? Modeling and tracking

But all these efforts aside, utilities have one key tool in their pocket when it comes to making their systems more resilient. Nearly two-thirds (63%) of survey respondents are using risk analysis, modeling or similar inputs to prioritize resilience projects. The remaining 26% who don't use these methods have most likely been stymied by cost or a lack of knowledge, while 11% said these approaches are not necessary to prioritize projects.

Data-driven modeling and risk analysis can help mitigate the risk of failure and unplanned outages by allowing for effective data collection and management, enabling utilities to monitor a broad range of operational metrics. Data collection and management systems include devices that can detect environmental, physical and electrical data such as flood sensors, cameras equipped with artificial intelligence (AI), drones equipped with high-resolution photography or live feeds that can identify damaged or at-risk equipment, temperature monitoring for both hot and cold weather threats and much more.

These assets are paired with technologies that improve outage management, reduce energy consumption, offer greater reliability and efficiency, and provide greater focus on the development of the smart grid. The use of remote monitoring paired with data analytics can help ensure continued operation.

Early anomaly detection can be used to detect issues before they become critical. For example, one Kansas-based global engineering, procurement and construction company worked on a project where, during a cold snap, the asset monitoring system detected a small change in lubricant oil temperature on a critical fan. This led to the discovery of a broken hinge on a skid enclosure that ended up freezing a water line. The system detected the issue early enough for the operator to thaw the frozen line and prevent downtime.

And data modeling and risk analysis rank as the No. 1 strategy for justifying expenses for climate change adaptation and resilience projects, according to 40% of respondents to the survey. Utilities can create data-driven models to simulate climate events and predict system responses to events — and then use this information as evidence when working to persuade regulators and investors of the case for hardening.

This is followed very closely by cost tracking to show cost recovery (39%). Respondents attach lesser weight to the review of case studies (9%), project demonstration (4%) and changes in insurability (3%).





Planning for the future

But no matter how many benefits are promised by data-driven modeling and risk analysis, there is a drawback when it comes to data collection and digitization — all too often, utilities end up with more information than they can manage. But asset management services integrated with data analytics capabilities exist to help utilities sort through the mounds of digital data, helping to prioritize the most important actions.

As asset monitoring becomes more available, utilities will find even deeper value in data modeling and risk analysis. These tools can help utilities guard against an increasingly temperamental climate, offering protection for valuable assets. Plus, utilities can leverage these tools to not only organize and prioritize extreme weather responses but also can deploy these capabilities to gather the necessary information for when it comes time to make a case for investment.

When it comes to preparing grids for extreme weather events, there is no one-size-fits-all approach. Success will require broad-based strategies and each utility will need a different strategy that accounts for system constraints, location, asset vulnerabilities, budgetary considerations, workforce availability and more. For example, electric utilities in the Northeast may focus more on vegetation management than their counterparts in the desert Southwest, where high temperatures and drought force new demands.

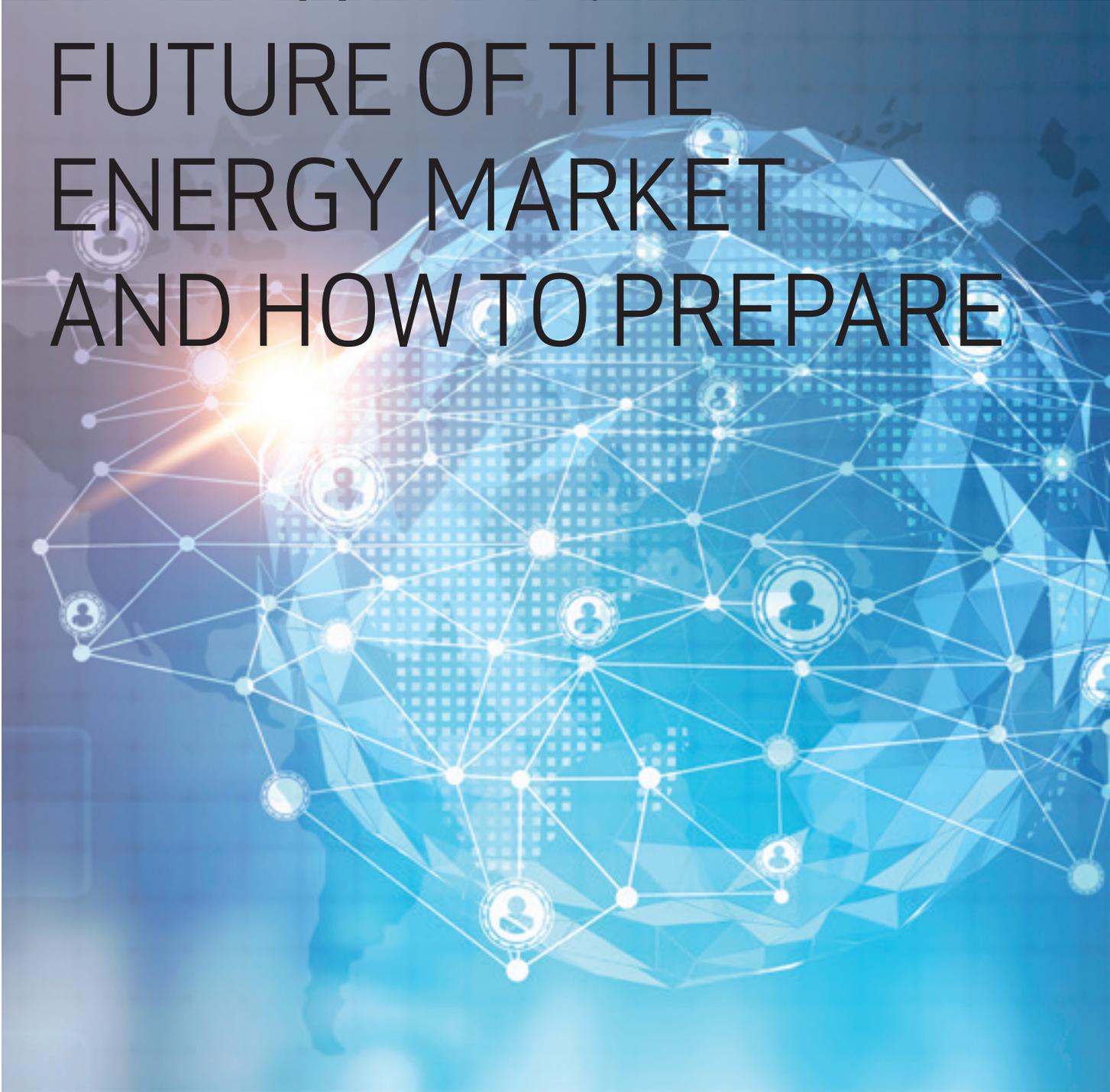
Data modeling and risk analysis will be key going forward as they drive intelligence regarding the real-time “health” of infrastructure. The era of Big Data provides the opportunity to collect and analyze vast amounts of data, creating a 360-degree view of power infrastructure, letting us manage extreme events more effectively. The prediction and monitoring capabilities provided by digitization and data management will allow utilities to confidently define effective resiliency plans, guarding against a temperamental climate and the extreme weather events that can occur.



ABOUT THE AUTHOR:

Arron Lewis is vice president, energy utilities, for Black & Veatch's Energy & Process Industries business. Lewis previously served as managing director of the Global Power Distribution business for Black & Veatch. He has served with the company for more than 28 years. Lewis oversees the planning and execution of energy infrastructure projects that support the delivery of clean, reliable and resilient energy.

REAL-TIME AND RENEWABLE: THE FUTURE OF THE ENERGY MARKET AND HOW TO PREPARE





UDAY BARAL

Electrification plays a dominant role in our global pursuit of net-zero emissions. The International Energy Agency outlines a narrow path to that goal globally by 2050, naming electrification and renewables as critical components.

In the U.S., the recently passed Infrastructure Bill provides some of the largest funding the transportation and energy sectors have ever received — primarily toward the goal of increasing electrification and renewables. On the wave of this national investment, we're seeing some of the biggest and most radical changes to the U.S. energy market. By that 2050 goal, the energy market will be vastly different.

Renewables will become an ever-increasing portion of the mix. The ramping up of renewables and the integration of new infrastructure bring extreme challenges to the grid. The real-time supply and demand grid balancing act will become more complex thanks to the influxes of electric vehicles, prosumers and energy storage. It will also significantly influence the economics of our electricity markets. Energy trading is poised to see massive shifts. →

Increasing renewables

Last year, for the first time, renewables generated more electricity than fossil fuels in the European Union. By 2050, the U.S. Energy Information Association projects renewables will comprise 42% of electricity generation. Similarly, Japan has set an ambitious target for renewable energy in the nation's electricity mix as it aims to tackle climate change and achieve its 2050 carbon-neutral goal.

The global market demand for renewable energy grows due to governmental programs, corporate sustainability initiatives and “prosumers” choosing green energy. Over 1,000 companies, holding more than \$23 trillion in market capitalization, have set 1.5°C-aligned science-based targets for decarbonization.

We are not only witnessing changes in how electricity is produced and consumed, but we're also seeing the way energy is traded. Outputs from wind and solar are less predictable than thermal generators. These renewable sources can lead to either an abundance of generated power at low prices (even negative when the grid can't absorb the excess) or exactly the opposite when there is less wind or sunshine than forecasted. Then thermal generators are challenged to fill the gap.

Add to this the impact of localized generation on transmission networks, and it's clear how market positions become more uncertain as renewable energy supply increases. The volatile and intermittent nature of renewable resources introduces rapidly changing market positions, which will move the market to more short-term trading.

However, as renewable energy continues to be promoted as the path to meeting our energy transition goals, any short supply in the market will greatly impact market prices. Energy storage projects alongside an electricity network are necessary to achieve the decarbonization goals that countries have set for themselves.

With outputs from wind and solar being less predictable than thermal generators, batteries are set to become increasingly critical in the power market as backups to supply (discharge) or absorb (charge) electricity. With such a pivotal function, battery storage owners are in a position to take advantage of potential revenue opportunities in an increasingly volatile power market as the share of renewable generation grows.

In addition, decarbonization efforts have created a growing market in green certificates — receiving a boost by the European Union Fit for 55 program as well as the recent report from the Intergovernmental Panel on Climate Change — driving demand for tradable certificates to offset CO₂ emissions to prove electricity was generated by a renewable source. These Energy Attribute Certificates —

known as Reliable Energy Certificates (REC) in North America and Guarantee of Origin (GOO) in Europe — also include Energy Saving Certificates, or white certificates, and can cover both power and biogas. Managing this increased volume requires new solutions to manage risk, financial and compliance reporting. Moreover, new consumer and business demands are calling for support of business scenarios to serve their needs for trade-to-trade matching, peer-to-peer matching of electricity deals (B2B and B2C) with a desired set of certificates. As a result, wholesale market participants are facing increased complexity — necessitating automation and market integration.

Unpredictable, extreme events

In addition to increased renewables, extreme and unpredictable events (such as the bankruptcy of Enron and the California energy crisis in 2001) have rocked the electricity landscape throughout history and seem to be occurring with increased frequency. More recent events include the COVID-19 induced national lockdowns, failing retail energy suppliers in the United Kingdom, Texas' February 2021 freeze leaving millions without power and the E.U.'s plan to cut emissions by 55%. These have all presented energy players with some of the most extreme supply and demand shocks ever seen. This doesn't even incorporate extreme weather events, from hurricanes to fires, that have stressed the system.

With this shift from legacy energy commodities to next-generation renewables, it is time for energy companies to consider doing the same with their systems and develop core competencies that support their activities around cleaner energies. Market participants are increasingly tasked with developing a sound energy portfolio management strategy but are challenged by legacy technology and processes not equipped to support the operations in a renewable energy market.

To be successful, companies need to constantly evaluate markets to understand the effects of tightening regulations, resource constraints, market volatility and environmental pressures. Considering the complex nature of today's energy markets, the process of gathering, modeling and analyzing data to produce good intelligence, is a resource-intensive but crucial task needed to operate in a competitive market.

Evolving electricity markets

As the electricity landscape continues to transition and evolve, a new market landscape is emerging. It addresses the primary question: how can a reliable and resilient grid be maintained while simultaneously onboarding and adequately compensating flexible resources?



In the U.S., the Federal Energy Regulatory Commission (FERC) has focused a great deal on this topic. It aims to address the challenges and opportunities of optimizing energy and ancillary services markets. Recent meetings highlighted the importance of how new modern electricity market design is needed to accommodate the rapid changes occurring across the power industry. The combination of diverse energy resources – capacity, and fast-responding flexible resources such as quick-responding natural gas turbines, energy storage and new technologies to improve power quality – are paramount to keeping the lights on. This also includes ways to relieve the power distribution grid. As smaller renewable generators, as well as residential generation, seek access to the market to sell production or surplus production, smaller companies need affordable and easy access to green power. Individual prosumers can relieve constraints on the power grids through peer-to-peer electricity trading without the need for an intermediary.

Similar discussions with varying levels of implementation are being held around the world.

This is indeed a challenge. However, although the volatility and shorter-term and intraday trading create more risk and complexity for traders, they also bring increased opportunities. The key lies in how to best leverage those opportunities.

Preparing for change

As the energy transition continues, utilities will have to adapt their grids and ready their infrastructure to take on more renewables, diversified/distributed generators, electric vehicles and storage. In addition, they'll need

to prepare for new market entrants, such as renewable energy investors who need to equip themselves to own and operate their generation assets. Participating in the wholesale market means they subject themselves to wholesale electricity prices. This, by definition, increases their risk exposure. However, the ability to manage this risk is key to maintaining a competitive position.

These market participants will also need to look at how they can successfully navigate an evolving and dynamic market landscape. A key element to how they will do this starts with the adoption of a sound, forward-looking energy portfolio management strategy that is supported by innovative digital tools.

Broadly speaking, portfolio management is an interplay between electric market simulation, actionable energy market intelligence, optimization of generation resources and portfolios into solution models. It also includes forecasting of prices, load, and generation, as well as energy trading and risk management and communication interfaces with market operators. When all of these components are integrated into a comprehensive portfolio management strategy, planners, portfolio managers, traders and investors can make better economic and strategic decisions that support effective operations.

Companies continue to rely on manual processes and spreadsheets to track their market access activities. Yet, manual and unintegrated system processes can no longer handle the complex and varied nature of all of the components. Unintegrated systems lack the visibility and risk controls necessary for effective portfolio management and optimization. Market participants need and crave digital technology to handle today's dynamic and complex market environment. →



“

The electrification and renewable energy revolution has already begun – it’s important to stay ahead of the changes it will bring.

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A real-time integrated Commodity/Energy Trading and Risk Management (C/ETRM) system automates bid-to-bill business processes that support the forecasting and optimization of trade cycles from deal capture and contract management to market integration. Market participants can use these digital solutions to tackle everything from pricing and complex fees, trade confirmations, portfolio management and valuations, environmental product optimization, risk controls, collateral and credit management, to settlement and regulatory compliance reporting.

With the advancement of renewable energy, I’m seeing portfolio management now involves capturing, tracking and redeeming certificates either related to emission allowances, such as Verified Emission Reduction (VER) certificates, or related to Energy Attribute Certificates, such as GOO certificates. These are tradable products, and while the capture of purchase or sale of these certificates is straightforward, the inventory management, expiration and cancellation are more complex.



The volume of these certificates is increasing due to more organizations and individuals looking to reduce their environmental footprint. This in turn increases the demand for renewable energy, which will impact price development and risk exposures and add complexity in environmental product optimization and compliances in multiple jurisdictions. Specialized C/ETRM systems to address these new certificates and market shifts are becoming a necessary part of an overall energy portfolio management solution.

Volatility and shorter-term and intraday trading will certainly provide traders increased opportunities but, at the same time, it gives rise to greater risk exposure. Market participants need to be able to track positions and risk exposures in real time – not only to monitor risk but also to trade opportunistically. The technology behind C/ETRM systems is catching up to the energy transition. The market participants engaging in sophisticated energy contracting and trading transactions to serve their load efficiently, profitably and in a balanced fashion on a real-time basis are using a robust and integrated real-time solution.

Today, every organization needs to disrupt or be disrupted. Market participants have little choice but to shake up their operations, reinvent and reposition themselves to find new growth categories by embracing disruption and innovation.

To prevent this wave from dragging you under and to defend your business, your revenue generation operations must run optimally. Productivity-enabling technology is the key tactic to modernize the operating model. Accelerating the energy transition will require changes in electricity markets. We'll see a higher share of variable renewables such as wind and solar, as well as more distributed power generation. Beyond adapting to these changes, utilities will also need to be prepared for an increasing number of unanticipated, extreme events. An agile approach can help utilities and energy companies to meet and respond to these rapidly changing conditions from both grid operations and a wholesale power market perspective.

The key to successful, nimble navigation of this changing market landscape, now and into the future, lies in successfully anticipating and sorting through market changes, like smaller renewable generators and leveraging batteries in EVs. It also requires the expansion of C/ETRM technology, purpose built for this new market to take advantage of new certificates and trading opportunities. The electrification and renewable energy revolution has already begun – it's important to stay ahead of the changes it will bring.

ABOUT THE AUTHOR:

Uday Baral is the head of Global Energy Portfolio Management at Hitachi Energy and brings almost two decades of energy and commodities trading experience to his position. He previously founded Pioneer Solutions, a provider of industry-leading front-to-back-office Commodities/Energy Trading and Risk Management (C/ETRM) solutions, which Hitachi Energy acquired in 2020.

AMERICA'S POWER
GRID IS AT RISK. WE
HAVE THE TOOLS TO
FIX IT – BUT WE NEED
THE WILL





DESMOND WHEATLEY

Whether it's an unusually but predictably cold Texas winter freezing natural gas supplies, or a band of hackers shutting down a major oil pipeline and demanding millions in ransom, recent energy crises have confirmed again the vulnerability of the United States power grid. Federal officials have long known of the threats facing the nation's outmoded hub-and-spoke system. Yet, despite mounting blackouts and brownouts across the country as aging infrastructure fails to keep pace with growing demand, there has been little innovation to shore up our energy supply. Revolutionary technology and tools can help diversify and protect American power. We must marshal the resources, bolstered by the will of the public and private sectors to boost our energy resiliency and transform how this country runs. →



Thinking small

Emerging energy resiliency resources such as microgrids have the potential to reshape how energy is generated, stored and distributed across the United States. Microgrids are small, local self-sufficient power networks, found in a broad variety of locations, such as on military installations and college campuses, that can continue operating in the event of a large-scale power failure. There are about 160 across the U.S. that generate just 0.2% of American power.

Microgrid power is derived from diverse, distributed generation, rather than a single, centralized source. This diversification can better withstand the catastrophic weather events, voltage fluctuations, and equipment failures that can take down a massive power grid anywhere along thousands of miles of transmission lines or hundreds of thousands of miles of distribution lines. The demand for off-grid power sources is steadily increasing, with the number of microgrids expected to grow by more than 27% to \$33 billion by 2027, according to industry projections.

A sustainable security solution

Microgrids have long been an important element of the nation's energy security. The U.S. military has roughly 50 microgrids in place or in development to maintain mission-critical power, in addition to creative public-private partnerships designed to increase energy resilience by tapping the sizable stored energy reserves at military

installations. The more microgrids that can keep power flowing in the event of a terrorist attack or other threat to the main power grid, the better equipped the military will be to continue operations and defend national security.

Microgrids also offer a sustainable energy solution in the midst of the grave dangers posed by climate change. Smaller, localized grids operate more efficiently and less vulnerably than long-distance, high voltage power lines and can drive down power costs. Traditional lines that stretch thousands of miles shed voltage during the transmission journey, losing as much as 5% of power over distance. In addition, a small, distributed grid can utilize renewable energy sources such as wind and solar coupled with energy storage, reducing carbon emissions.

Powering pandemic preparedness

Over the past year and a half, the COVID-19 pandemic has demonstrated how absolutely essential hospital facilities are to public health, particularly on the front lines of a deadly pandemic. As part of a newly urgent push for pandemic preparedness, hospitals are recognizing energy resiliency as a critical component of patient safety. More and more health systems are deploying microgrids at health facilities as they are more cost-effective, quieter, and pollute less than traditional backup diesel generators. Powering hospitals through microgrids ensures continuity of care even in emergency conditions. With independent energy sources, hospitals can remain a safe haven in storms of every kind.

Supercharging the EV revolution

Microgrids also offer enormous potential to help accelerate the widespread adoption of electric vehicles by motorists, already underway in many parts of the world. Millions of new electrically powered cars and trucks will exponentially increase the burden on the main power grid: experts say U.S. power generation will need to double by 2050. The Biden Administration is committed to promoting clean technology, including electric vehicles, to reduce the harmful greenhouse gas emissions that contribute to disastrous climate consequences. There are plans to build 500,000 new electric vehicle charging stations—microgrids will be key to boosting U.S. energy resiliency by handling the accompanying demand for power.

Incentivizing microgrids

This growing demand has catalyzed promising new partnerships between utilities and universities to research and develop microgrids. Federal and state governments are starting to recognize the power of these small, flexible, reliable energy solutions. U.S. Representative Jimmy Panetta has introduced legislation to provide tax credits for microgrids, especially urgent to his California constituents, who experience regular power outages due to wildfires and other natural disasters. In addition, The U.S. Department of Energy is funding federal microgrid projects.

Many long-standing state utility regulations intended for a traditional, centralized power grid can complicate or derail microgrid development efforts. California, Hawaii, Texas, and Washington state are at the forefront of forward-thinking microgrid regulations, reviewing standards, revising regulations, creating new metrics, and establishing tariffs that allow microgrids to be used in emergencies. Progressive microgrid policy there can be used as a model for other states. But there is still much to be done.

Modeling microgrid success

Isolated communities have established effective microgrids to lessen their reliance on importing expensive fossil fuels. Cordova, Alaska established a microgrid system that includes two renewable hydroelectric projects that provide 78% of local power. And the U.S. Army recently showcased a mobile, vehicle-based microgrid prototype that can be used on the battlefield, provide humanitarian aid, or respond to natural disasters.

Visionary energy solutions such as these offer a path for America to lessen its dependency on fossil fuels and its precarious reliance on an aging, fragile power network. Microgrids are a nimble, local, sustainable way forward into a brighter, more energy resilient future.

ABOUT THE AUTHOR:

Desmond Wheatley is the president and Chief Executive Officer of Beam Global, a clean technology company providing renewable charging infrastructure solutions for electric vehicles, energy security and disaster preparedness.



INFRASTRUCTURE MANAGEMENT:

MANAGING PROJECTS,
STREAMLINING INSTALLATIONS,
AND RAISING CUSTOMER
SATISFACTION WITH VIRTUAL
INSPECTIONS





ANTHONY PERERA

A global energy crisis is happening. And the United States is no exception to the strained power lines and grids that severely affect the safety and comfort of your current customers and potential prospects. The U.S. Energy Information Administration reported in November 2021 that U.S. electricity customers experienced more than eight hours of power interruption, on average, in 2020.

Whether your generator installation company is doing business in the Southwest, where temperatures soar to more than 100 degrees during the summer, or in the East, where temperatures drop below freezing and residents face harsh storms during the winter, individuals everywhere feel the burden of strained power systems and are urgently seeking solutions. Generator businesses across the country have reported skyrocketing numbers of sales and calls for the installation of home backup generators. →



The pandemic ushered in the use of modern technology to accomplish jobs without the need to be physically present. Conducting virtual inspections has helped a variety of industries reduce the need to halt projects altogether and allocate resources toward completing projects.

In fact, the global generator sales market is expected to grow from an estimated \$21.6 billion this year to \$28.6 billion in 2027, according to ResearchandMarkets.com. That's an annual growth rate of 5.8%, driven by industrial, commercial and residential end users' demand for reliable, uninterrupted power supplies. An expanding manufacturing sector and growing information technology infrastructure also are expected to contribute to demand.

Given the increased demand for generator installations and customers' rising interest in how well your business manages its operations, generator businesses and installers should turn to virtual services during the necessary inspections and permitting process. Using on-demand virtual services instead of relying on unpredictable, traditional in-person inspections will give you the technology to better manage projects, streamline the installation process and improve your customers' experience with your company's service as you install their new generators.

Customers fear being left in the dark

The United States' aging power grid system and volatile weather leave concerned homeowners desperate to avoid being left in the dark. As a result, demand for residential backup generators is surging, and the average homeowner is coming to regard such generators as a new necessity.

The benefits of adding a backup power generator are becoming increasingly clear to homeowners. During lengthy power outages, generators provide them with the comfort of heat in the winter, cooling in the summer and light at night, as well as the ability to use the appliances and electronics they depend on for daily life. Homeowners also view generators as protecting them from the expenses — ranging from hotel costs to home repairs to replacing spoiled food — that can come with storm damage and power outages. Furthermore, they see that backup generators can keep their home security systems operating and increase the resale value of a home, especially in areas prone to power outages. When enlisting the services of a generator installation company, customers view backup generators as a serious investment in their homes.

Even as homeowners recognize the benefits, however, they most likely have a long wait before they can obtain generators they can rely on. One Florida-based generator installer, estimates that customers in its area may wait anywhere from 20 to 40 weeks to get generators installed. And because many people don't feel the urgency to buy generators until just before major storms hit or in the weeks after major storms, waiting only adds to homeowners' anxiety over power outages.

Workforce shortage, surging demand

Generator installation companies across the country face a daunting task: meeting this growing demand while lacking enough time and labor to speed up the process.

They must navigate the ongoing supply disruptions and workforce shortages that have affected the global economy. On top of that, the current process for inspecting and permitting generator installations in the United States is another problem that generator businesses must face.

The generator installation process can be lengthy, and as many as six code inspections are required from start to finish. City and county inspection departments, chronically short-staffed due to the lack of experienced tradespeople able to become inspectors, also must deal with inspectors' lengthy drive times between job sites and high demand for inspection services during the current building boom. Installers report crews wasting entire days waiting to get inspections completed instead of being able to move on to projects for other customers. All those factors create an inefficient operation that costs generator installers time and money.

Being unable to manage projects and keep up with the increased demand creates a snowball effect that is detrimental to your business operations and customer satisfaction. As labor shortages spread workforces thin, many businesses find themselves unable to send managers out to every project. A virtual inspection service can eliminate the need for managers to travel, spare you from adding more tasks to your employees' already busy workdays and act as your manager for generator installations.

The general manager of the Florida installation company estimates that virtual inspections save his company more than 100 hours of labor a month because they eliminate the time crews spend waiting for in-person inspectors and because they allow his company to schedule inspections on short notice, if crews finish a job ahead of schedule. That's an extra two-and-a-half weeks a month that his workforce can spend on starting new installations, serving more customers and serving them quickly.

Generating new value in your company's services with customer satisfaction

Most businesses, regardless of industry, will agree that customers are their top priority. Customers serve as a lifeline to your generator installation business. A single outstanding customer experience leads to additional prospects through referrals and high praises in reviews, all of which add value to your company's services. →

Customers are paying attention not only to your employee's soft skills, such as a friendly greeting, but also to your company's commitment to their project and how your company accomplishes its goal. If the assignment is to install a generator, your customers are paying attention down to the final detail — including the tools and operations your business uses to ensure their generator installation runs as smoothly as possible.

For example, before using the Florida-based generator installer often had to reschedule or make multiple calls to customers due to the complicated scheduling and tight availability of in-person inspections. Although an inspector's availability was beyond the company's control, the rescheduling and multiple calls annoyed or upset customers. Now, instead of giving homeowners a last-minute notice of when an in-person inspector might arrive, this installation company asks what time works best for the homeowners. The installer then schedules the remote inspector according to the homeowners' availability, giving customers control over their schedule and improving the customer experience and satisfaction.



**Virtual inspections have an advantage
for your bottom line, too.**



By using a virtual inspection service to streamline the inspection and permitting process, you give your company a competitive edge and the ability to stand out against local competitors that are stuck in the current permitting and inspection process. A company that can offer shorter, quicker installations to customers desperate to avoid the problems of power outages is a company that will have a competitive edge in selling and servicing backup generators.

Virtual inspections have an advantage for your bottom line, too. For companies that finance their inventory of generators, being able to shorten installations means they can invoice customers more quickly and save money on their borrowing costs.

Bringing innovation to inspections

Video conferencing technology has gained wider adoption in recent years, especially during the pandemic. Managers and co-workers in a range of industries conducted meetings from distant offices and home. The health care industry embraced telemedicine, with doctors using secure video platforms to meet with patients or consult



Businesses connect with inspectors and other on-site personnel virtually to achieve a safer work environment, save time, money, labor and ultimately, higher customer satisfaction.
Credit: Adobe Stock Photos

with specialists. Higher education offered online learning, giving students across the country and around the world the chance to study with experts in their field.

Smartphones and tablets make this technology available at the personal level, too. Nearly all of us use our phones and tablets to make video calls, take photos and videos, share them with others and save them for future reference. Given that we have the technology and already use it in our daily lives, it's a natural next step to bring this innovation to the process of installing backup generators.

States across the country have recognized the advantages of using video technology and third-party inspectors to conduct inspections of projects such as generator installations. In July 2021, Florida lawmakers approved third-party inspections to use these emerging technologies, in part as a way to protect the health and safety of municipal code officials, contractors, employees and property owners. More states, including Louisiana and Texas, are passing laws to embrace virtual inspections as a permanent solution to help businesses work more efficiently.

A new best practice

Virtual inspections can reduce costs, save time, maximize resources, increase productivity and benefit customers by eliminating the time spent waiting for a government code inspector. Virtual inspection platforms developed with contractors in mind allow those working on a generator installation, such as project managers or installers, to create a profile for each project online, geotag it to verify the address and open a permit request with the local government. A worker on-site will be able to take high-quality video and images of the installation in progress.

A roster of remote, third-party inspectors, all certified to the same standards as government inspectors, is available on your schedule, not theirs. Your employees can contact a remote inspector as needed, and the inspector can join a call, review the installer's work and verify that it meets the code requirements. In less than a day, an inspection can be scheduled, completed and passed. Your business can schedule an inspection whenever the crew is ready instead of the traditional way of waiting — and waiting and waiting — on an in-person inspector.

Conclusion: Sparking a new solution

By turning to a new technology with virtual inspections, your generator installation business is setting itself up with a new best practice and as an industry professional.

Since the Florida-based generator installer began using the virtual inspection service in September 2021, its installation time has been slashed in half. Before using the virtual inspection process, the company's installations would take up to a month. Its installers now complete customers' generator installations in an average of 14 days. Customers and their neighbors, friends and family have all noticed. The generator installer connects the use of virtual inspections to an increase in customer referrals and positive reviews.

Chances are that your business's office already uses technology such as paperless timekeeping systems, or it adjusted to remote solutions during the pandemic. Having done that, it's time to take the next step and use virtual, remote services in the field. Multiple benefits come from using a virtual inspection service, all of which led to improving customer satisfaction.

When your business can get a generator installed and operating quickly and efficiently, it makes all the difference to the person most important to your business — the customer.

ABOUT THE AUTHOR:

Anthony Perera is the founder of Inspected.com, a provider of virtual inspection software based in Plantation, Florida. A serial entrepreneur, he previously founded Extreme Media Group and the Cowboys Saloon chain. He also is the founder and president of Air Pros USA, an HVAC service company based in Florida.

THE ROLE OF CODES AND STANDARDS IN ELECTRIFYING THE TRANSPORTATION SECTOR





UMER KHAN AND BRENT HARTMAN

A significant portion of global greenhouse gas (GHG) emissions is attributed to the transportation sector. As the impact of climate change becomes apparent, governments are racing to reduce their carbon footprint by enacting policies and regulations to decarbonize the transportation sector through electrification. The proliferation of battery electric vehicles (BEVs) will require the convergence and collaboration of the transportation sector with electrical utilities and manufacturers, creating both challenges and opportunities. Electrical utilities will be required to maintain a resilient grid with increased demand from BEVs and integration of renewables. Manufacturers of charging equipment will be required to comply with the safety rules and regulations in different jurisdictions to sell their products and help ensure safe installation and reliable operations. There must be sufficient charging infrastructure available to increase consumer confidence and overcome the barriers to mass-market adoption. →



The challenges faced by the transportation sector, electrical utilities and manufacturers can be partly addressed through codes and standards, which can help ensure quality and safety of services, products or systems for consumers. Codes and standards can help facilitate the safe and sustainable deployment of infrastructure that is required to electrify and consequently decarbonize the transportation sector. Moreover, standards encourage compatibility and interoperability, promote environmental protection and enhance trade. When harmonized at the regional or international level codes and standards can help reduce the regulatory burden by aligning common requirements and ultimately reducing time-to-market and costs for manufacturers. Binational standards are applicable for Canada and the United States, and trinational standards include Mexico.



Codes and standards can help facilitate the safe and sustainable deployment of infrastructure that is required to electrify and consequently decarbonize the transportation sector.



CSA Group is accredited by the Standards Council of Canada (SCC) and the American National Standards Institute (ANSI) to develop standards in both Canada and the United States. The mission of CSA Group is to enhance the lives

of Canadians through the advancement of standards in the public and private sectors and the organization is a leader in standards development, research, education, and advocacy. Standards development promotes safety, environmental stewardship and economic efficiency in an open, transparent and consensus-based development process with technical rigor from volunteer members organized in committees with balanced representation. The deliverables of standards development can include fully accredited solutions, guidance documents or workshop agreements – all designed to meet the changing needs of the market. Other CSA Group activities include research that aims to explore standards gaps in existing and emerging technologies or provide evidence-based content to inform requirements in standard; promotion of stakeholder education and usability of standards; and advocacy and public awareness for standards across various sectors. Codes and standards can help facilitate the safe and sustainable deployment of infrastructure that is required to electrify and consequently decarbonize the transportation sector.

Since 2010, CSA Group has laid the foundation for future standards development activities with electrical product safety certification and installation standards for charging technologies that are aligned across North America. Safety standards for the installation and maintenance of electrical equipment, including BEV charging infrastructure, are covered in the Canadian Electrical Code (CE Code). Sections 8 and 86 of the CE Code apply to BEV charging infrastructure and provide requirements for equipment

installation to prevent fire and shock hazards. In addition to the installation requirements, the CE Code indicates the use of approved equipment that must comply with specific product safety certification standards. Product safety certification standards, used for conformity assessment, have been developed or are under development for infrastructure such as Electric Vehicle Supply Equipment (EVSE), Direct Current Fast Chargers (DCFC), wireless chargers, plugs, receptacles and couplers. As discussed below, CSA Group has leveraged the CE Code and discrete product standards to advance a systems approach to seamlessly integrate BEVs to the electrical grid with techniques such as energy management, bidirectional power transfer and energy storage. These techniques will help overcome the challenges of increased energy demand and ultimately support the widescale proliferation of BEVs and a net reduction in GHG emissions.

Canadian electrical code

Playing a key role in helping to specify the safe installation of BEV charging infrastructure, the Canadian Electrical Code (CE Code) outlines the installation and maintenance of electrical equipment and can be adopted into legislation with or without modifications. Electrical installation requirements related to BEVs are specified in Sections 8 and 86 of the CE Code, *Part I*. The installed equipment must be certified by a certification organization, accredited by the SCC, to the relevant certification standard listed in Appendix A (*Part II*) of the CEC or other applicable standards. This is referred to as *approved* equipment. *Part II* of the CEC has individual standards that provide definitions and specify construction, marking and test requirements for a single class or closely allied group of electrical equipment.

Section 8 of the CE Code defines an Electric Vehicle Energy Management System (EVEMS) as a means to control EVSE loads through a variety of techniques from disconnecting the load to using communications-based control. Section 8 permits disregarding the EVSE loads, particularly when these loads are added to the load of an existing building if an EVEMS monitors the service and feeder. An EVEMS limits the electrical service and feeder sizes, therefore, eliminating any costly infrastructure upgrades and becoming a more affordable option for deploying EVSE in new and existing multi-unit residential buildings (MURBs). Section 86 of the CE Code covers the installation of EVSE and DCFCs by specifying the ampacity, protection, and signage requirements as well as specifying appropriate indoor and outdoor installation locations.

Electric vehicle supply equipment

Level I (1.1 kW) and Level II (3.3 kW to 19.2 kW) EVSE are affordable options for applications facilitating longer charging durations. The product safety certification

standard for an EVSE providing AC power to an onboard charger of a BEV is CSA-C22.2 NO. 280-16 (trinational). EVSE is used with plugs, receptacles, vehicle inlets and connectors for which the product safety certification standard is CSA-C22.2 No. 282-17 (trinational). EVSE installations have accessible parts that can pose shock hazards. CSA-C22.2 NO. 281.1 (trinational) specifies general requirements in a product safety certification standard to reduce the risk of electrical shock from the accessible parts of an EVSE. CSA-C22.2 NO. 281.2 (trinational) states the particular requirements for electrical protection devices in a product safety certification standard.

Direct current fast chargers

For public locations such as highway corridors requiring shorter charging times, high-powered DCFCs are the best option. CSA-C22.2 No. 346 (binational) is a product safety certification standard currently under development for DCFCs.

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BEVs can also be charged wirelessly
without the need for a physical connection.
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Wireless power transfer

BEVs can also be charged wirelessly without the need for a physical connection. CSA Group has adopted the first part of the IEC Wireless Power Transfer (WPT) standard, CSA C22.2 No. 61980-1, with the appropriate Canadian deviations to maintain consistency with the requirements specified in the CE Code. This IEC standard, the first of four parts, contains the general requirements for WPT with background and definitions for efficiency electrical safety, electromagnetic compatibility, and electromagnetic fields. →



BEV cables

Complex high-powered charging technologies will require complex cable design. CSA-C22.2 No. 332 (trinational) is a product safety certification standard to address the design, construction, and performance requirements for power, signal and control cables used between an EVSE or DCFC and BEV.

Electric vehicle energy management systems

To seamlessly integrate BEVs into the electrical grid, a systems approach is used to take the discrete product safety certification standards and develop demand management strategies using energy management systems, bidirectional power transfer, and energy storage. As discussed earlier, the definition and installation requirements of the EVEMS are specified in Section 8 of the CE Code. EVEMS can monitor the service or feeder loads and control the EVSE loads accordingly, thus reducing costs associated with expensive capacity upgrades. CSA Group first published a research report on this topic in 2019, leading to the publication of a guidance document, SPE-343, applicable in both Canada and the United States. The product safety certification standard for an EVEMS, C22.2 No. 343, is currently under development and will address requirements for the controller, software, sensor and communications that are necessary to prevent overloading of the circuit.

Vehicle-to-grid

The second approach is to seamlessly integrate BEVs to the grid with bidirectional power transfer, or vehicle-to-grid (V2G). BEVs can be used as distributed energy resources, supplying or extracting power from the grid in a flexible

manner to maximize efficiency and increase renewable integration. CSA-C22.2 No. 348 (binational), currently in development, is a product safety certification standard that will address the safety requirements for equipment that will facilitate the bi-direction power transfer from the BEV.

Battery management systems

Another approach for efficient grid integration of BEVs is the use of lithium-ion batteries (LIBs) for energy storage. The generation of electricity from various sources, including renewables, and demand from unpredictable events, such as high-power charging with DCFCs, can be managed with LIBs. LIBs operating in unsafe conditions present a high risk of fire and explosion hazards. A Battery Management System (BMS) can maintain the battery in a functional state and respond accordingly upon detection of unsafe operating conditions. To address the requirements for the design, performance and safety of the BMS, CSA Group has initiated the development of a binational product safety certification standard, C22.2 No. 340. This standard will be applicable to batteries in stationary and mobile applications in residential, commercial and industrial settings.

To play a role in advancing the systems approach to BEV standards development, CSA Group invites experts to consider participating in technical committees or provide comments during the public review period. As technologies advance to facilitate the proliferation of BEVs, input from experts will be required for the development of robust and harmonized codes and standards. To learn more about CSA Group's standards works related to BEVs, visit <https://community.csagroup.org/community/electrical/electric-vehicles>.



Canada	USA	Title
CSA-C22.2 NO. 280-16	UL 2594	Electric vehicle supply equipment
CSA-C22.2 No. 282-17	UL 2251	Plugs, receptacles, and couplers for electric vehicles
CSA-C22.2 NO. 281.1	UL 2231-1	Safety for personnel protection systems for electric vehicle (EV) supply circuits: General requirements
CSA-C22.2 NO. 281.2	UL 2231-2	Safety for personnel protection systems for electric vehicle (EV) supply circuits: Particular requirements for protection devices for use in charging systems
CSA-C22.2 No. 346	UL 2202	Electric Vehicle (EV) Charging System Equipment
CSA-C22.2 No. 332	UL 2263	Electric Vehicle Cable
CSA-C22.2 No. 348	UL 9741	Electric Vehicle Power Export Equipment (EVPE)

Table 1: Equivalent standards in Canada and the United States.

ABOUT THE AUTHORS:

Umer Khan is a project manager at CSA Group and is responsible for facilitating the development of standards related to electric vehicle (EV) infrastructure. Khan also collaborates with stakeholders in the EV ecosystem to identify standardization gaps and priorities for new and emerging technologies.

Brent Hartman is the director of Fuels & Transportation Standards for CSA Group. Hartman leads the development and implementation of the standards strategy for the fuels and transportation sectors in the United States and Canada. Technology areas in the sector include hydrogen, fuel cells, electric vehicles, connected and automated vehicles, biogas and gas-fired appliances and equipment.



DEFENDING CANADA'S ELECTRICITY SECTOR AGAINST CYBER SECURITY THREATS



DAVID MASSON

In 2015, power was cut to 225,000 households, when cyber-attackers penetrated the systems of a western Ukrainian power company with a spear-phishing email. In 2016, citizens in certain parts of Kyiv lost power for an hour, again, due to a cyber-attack, reducing Kyiv's total power consumption by a fifth for that night.

Though this happened in Ukraine, Canada is also susceptible to these threats. In fact, Canada's electricity sector has already experienced cyber-attacks, albeit of a different variety. According to a recent bulletin on cyber security guidance for the electricity sector from the Canadian Centre for Cyber Security (CCCS), most of the attacks on Canadian electricity have been ransomware or fraud. And while an overt state-sponsored attack that aims to debilitate Canada's electricity sector seems unlikely, Canada has already seen activity from nation-state actors that can position them for a future attack. →



Why Canada's electricity sector is a target

We see two types of threat actors who have targeted and will continue to target Canada's electricity sector, cybercriminals and state-sponsored attackers. Their motives, however, are very different.

Cybercriminals tend to be financially motivated. These motivations include ransom payments and profiting from the exfiltration of personally identifiable information (PII) and intellectual property (IP) to sell on the Dark Web. An example of this occurred in April 2020, when ransomware encrypted the corporate systems and website of the Northwest Territories Power Corporation.

On the other hand, nation-states have more complex geopolitical motivations. Many of these threats are classified; however, several instances of state-sponsored threats against the North American electricity sector have been made public. In 2019, for example, threat actors sponsored by Iran conducted a vast espionage campaign against industrial control systems (ICS) suppliers.

The consequences of cyber-attacks against Canada's electricity sector

A cyber-attack on the electricity sector goes farther than business disruption. Because Canadians depend on power for their daily lives, any interruption or shutdown

could directly impact public safety. The consequences also could affect the nation at large, including national security and the economy.

Case in point: A 2003 power outage lasted a week throughout the Northeast, causing a CAD 2.3 billion loss to Ontario's economy, contributing to a 0.7% decrease in Canada's overall GDP. While a cyber-attack did not cause this outage, cyber-attacks against the bulk power system or local distribution networks could undoubtedly lead to similar results.

The 2003 outage also highlights another important fact about the Canadian electricity sector: Canadian grids and U.S. grids are deeply interconnected. Canada's most extensive power grids are connected within the country and externally to grids in the U.S. Over 35 Canada-US transmission line connections, called "interties," cross the provinces that border the U.S. As a result of these interties, the U.S. and Canada will likely have to share the impact burden of any cyber disruption.

According to the CCCS bulletin, this interconnectedness makes Canadian grids a target of cyber warfare, as attackers might attempt to disrupt the U.S. electricity sector via Canada's electrical grids. Indeed, the electricity sector is a prime target for nation-states and state-sponsored actors seeking geopolitical advantage due to the importance of electricity in all aspects of life.



How Canada's electricity sector is vulnerable

It is worth discussing how exactly Canada's electricity sector is vulnerable to cyber-attacks. These issues stem from both internal and external factors: the technology architecture of the electricity sector itself and the cyber threat landscape that surrounds it.

First, ICS and operational technology (OT), used in the electricity sector to monitor and manage the grid centrally, were often engineered before the internet and thus were designed with reliability and safety in mind rather than cyber security.

Due to their often-outdated design, common vulnerabilities and exposures (CVEs) are abundant in ICS and OT environments. On top of this, tracking and patching these vulnerabilities remains a vexed process. Many vulnerability advisories for ICS devices have no practical mitigation advice, and over a fifth of reported CVEs don't even include a patch. For these reasons, most vulnerability management workflows are a process of diminishing returns, making ICS and OT devices particularly difficult to secure.

Considering the challenges involved in securing ICS and OT – along with the high stakes of compromise, which can lead to massive financial loss and threaten human safety—organizations with ICS and OT, many of which are critical infrastructure, have historically implemented what's known as an 'air gap,' with ICS and OT systems entirely disconnected from the internet.

IT-OT convergence

However, internet-connected IT systems have increasingly become connected to ICS and OT systems, poking holes in this 'air gap.' This much-discussed trend is called IT-OT convergence. This convergence can be unintentional, such as when OT protocols are unwittingly used on the IT network. A British IT company specializing in cyber security AI detected over 6,500 suspected instances of ICS protocol use across 1,000 enterprise environments in one anonymized study.

IT-OT convergence can also be intentional. Connecting ICS to the cloud (what's known as "ICSaaS"), remote management of OT, and the adoption of the industrial internet of things (IIoT) and cyber-physical systems are all valid reasons to connect your IT and OT systems. According to one of the British cybersecurity company's customers in the electric industry, "IT-OT convergence brings opportunities for new services, efficiencies and productivity gains. But just as it expands the benefits, it also introduces additional vulnerabilities and avenues for exploit." This convergence can increase efficiency and reliability.

Though laudable, these technologies will only increase IT-OT convergence and thus the vulnerability of the electricity sector. Ultimately, IT-OT convergence widens the attack surface, allowing threats to spread laterally more easily from IT into OT systems. →



Therefore, many of the attacks we see today that disrupt OT start in IT. For example, the cyber-attack against Colonial Pipeline led to the shutdown of OT but only actually affected IT systems. Due to the threat of the attack spreading from IT to OT, the organization decided to shut down OT manually out of caution. According to the cybersecurity company's customers, "Attacks like that on Colonial Pipeline served as a reminder of why security investments are necessary, and we need to do more regarding cyber security technology, training, and education."

The threat landscape surrounding Canada's electricity sector

Attacks on Canada's critical infrastructure are constantly increasing in volume and variety. In conversations with one customer in the electric industry, their security team noted, "Our biggest challenges are the threats that we don't know about, and that strive to remain unknown, along with bad actors exploiting the best intentions of good people." The entire industry widely shares this sentiment. The electricity sector must closely understand three significant attack methods: ransomware, supply chain attacks and insider threats.

As mentioned above, the increasing interconnectedness of IT and OT means that even ransomware that only compromises IT can indirectly affect OT systems. At the same time, we are also seeing more and more ransomware strains that can directly affect OT. At least seven known

ransomware variants directly target ICS processes, including the infamous EKANS ransomware that shut down operations globally for a major automobile manufacturer.

Supply chain attacks are also a significant concern for the electricity sector, especially in the wake of the Log4j vulnerability, which has affected IT and OT/ICS systems. Supply chain attacks help threat actors access ICS IP, and thus, state-sponsored attackers often leverage these methods. According to the cybersecurity company's customer, "Every partner and supplier has the potential to introduce code or processes that on the surface appear to be valid. We vet vendors rigorously to establish that they are secure and that the integrity of their products is solid."

The company continued, "But despite everyone's best efforts, any vendor is a potential backdoor into their partner and is a target for exploitation. Constantly monitoring traffic from trusted components and receiving alerts should a bad actor be able to subvert everyone else's good efforts is mission-critical. Correlating events and identifying patterns or behaviours that pose a risk to our organization is a great asset as a countermeasure and a key component of a zero-trust cyber posture."

Lastly, whether intentional or unintentional, insider threats are still a persistent threat to Canada's electricity sector. Whether a threat actor bribes an employee to install malware or an ex-employee is disgruntled and vengeful, insider threats allow cyber-attacks to slip past perimeter defences.

How can Canada defend its electricity sector from cyber-attacks?

To protect Canada's electricity sector from these attacks, we need to take a fundamentally different cyber defence approach. The air gap is increasingly becoming a thing of the past. On top of this, traditional defence methods, such as mapping and patching CVEs, prove ineffective because many CVEs in OT and ICS are not patchable.

Self-learning artificial intelligence (AI) can uniquely detect and respond to threats without relying on these legacy security methods. By learning the 'digital DNA' of an electricity organization's technology infrastructure, self-learning AI empowers machines to defend themselves against in-progress attacks. Self-learning AI achieves this by understanding the typical pattern of life for all devices, machines, and operators in an environment and the organization, which allows it to spot even the most subtle forms of unusual behaviour wherever and whenever it occurs.

According to another customer of the cybersecurity company, "Without this understanding of what 'normal' behaviour on our network and in our environment should look like during work hours and normalized traffic by our employees – you can't always highlight and zero-in on activity that could be harmful. Big things stand out, but security teams and tools could miss a series of little things. Self-Learning AI helps establish a baseline of activities so that we can much more easily identify atypical behaviours. This allows us to concentrate efforts on the riskier behaviours much faster than we could with traditional tools and methods."

We also need to move away from a mindset of protecting either OT or IT in isolation. These environments are increasingly converged, as discussed above. Fortunately, self-learning AI technology spans both environments, from laptops and servers within enterprise environments to human-machine interfaces (HMIs) and programmable logic controllers (PLCs) in industrial environments. This unified view enables the AI to thwart attacks in IT before they can spread to OT and vice versa.

Defending against threats to the electricity sector in the real world with self-learning AI

There are many examples of self-learning AI fighting back against threats to the energy sector in the wild. For example, an energy supplier in North America thwarted a signatureless, double-threat ransomware attack with self-learning AI, preventing operations from shutting down.

In another example, an attacker gained entry to the digital estate of a European energy provider in mid-2020. Before installing the cybersecurity company's self-learning AI within the digital estate, the attacker managed to install a backdoor onto a computer. This backdoor was likely Meterpreter, a piece of the Metasploit software.

Within hours of being installed, self-learning AI observed the infected device displaying beaconing behaviour and downloading several executable files from endpoints associated with command and control. This visibility allowed quick remediation of the threat, preventing further damages to the customer network.

Towards the end of 2020, another attacker penetrated the systems of a European energy provider. Before the organization deployed self-learning AI, the attacker had already successfully installed the Emotet malware onto multiple devices. The attacker then installed malware associated with both the Qakbot banking trojan and the ransomware strain Egregor onto previously infected devices.

Within one week of being installed, self-learning AI identified the infected devices beaconing to endpoints associated with Emotet, Egregor and Qakbot. In the second week of the deployment, this AI identified a device spreading malicious executable files to other internal devices using SMB and Service Control.

Ultimately, Canada's electricity sector must adopt sophisticated technologies that can defend against today's influx of increasingly sophisticated threats to maintain service for Canadian consumers. When the next attack will strike an organization in the electricity sector and what it will look like remain unknown. However, technologies like self-learning AI can identify the 'unknown unknowns' in any environment and stand ready to fight back.

ABOUT THE AUTHOR:

David Masson is the director of Enterprise Security for Darktrace. He brings over two decades of experience working in fast-moving security and intelligence environments in the UK and Canada across civilian, military and diplomatic circles. Before Darktrace, Masson held senior management positions with Public Safety Canada, the UK Ministry of Defence and Royal Auxiliary Air Force (RAuxAF).

MEET DIDEM CATALOGLU, CEO OF MONTREAL-BASED DIREXYON TECHNOLOGIES.



BY DIDEM CATALOGLU AND ELISABETH MONAGHAN

Didem Cataloglu's journey into the technology sector began as she studied computer science in college. Her aptitude for writing efficient code ignited a passion for solving real-world problems through modeling and technology. Equipped with her skills and a desire to do something meaningful with them, she went on to pursue a Master of Business Administration in IT & management, enhancing her focus on leveraging technology to drive business value.

Before joining DIREXYON in 2020 as their Chief Revenue Officer, Cataloglu spent more than 20 years in global enterprises, such as Nakisa and Fresche Solutions. After establishing a highly successful customer-centric approach, that resulted in significant revenue gains for the company, Cataloglu was promoted to CEO a year later.

Now that the Infrastructure and Jobs Act has been passed, *EET&D* asked Cataloglu, to talk about what the transition to clean energy really means. We also asked her to share her thoughts on other topics, like what she considers the most significant industry advancement over the past five years, what projects she's working on currently and how her approach as a woman in the electric energy sector might be different than her male counterparts. These are the highlights of our conversation:

According to Cataloglu, when talking with other industry experts about the transition to clean energy, they frequently discuss the way people use the words 'clean' and 'electric' interchangeably. "Electric energy is not synonymous with clean energy," says Cataloglu. "But when you purchase an electric vehicle, it may not be entirely 'clean,' because the electricity may have been produced from fossil fuels — in which case, it may not be decreasing your overall carbon footprint to its fullest potential. Electric vehicles are certainly one step closer to achieving clean energy, but there is still plenty of work to be done. As leaders, we are responsible for educating consumers about the current situation and its impacts on future generations."



Asked if her comments about differentiating between clean and electric energy have been met with resistance, Cataloglu says, “Most environmental, social and governance {ESG} experts agree there is a lot of work to be done toward clean energy. This is especially true in the United States, where sustainability and clean energy are urgently being prioritized.” However, as she explains, utilities are realizing there are too many complexities at play to effectively maintain the current aging infrastructure. “If we examine 2017 clean energy production data by state and analyze the trajectory adopted, we may be led to conclude that more robust technologies in asset investment planning are required to better support decision-making for capital investments and organizational objectives.”

Elaborating on what, specifically, can be done to pave the way for clean energy, Cataloglu listed what she believes are the five key considerations:

- 1. A high-level view:** Identify how you will achieve the complete transition to clean energy — not just the small incremental steps. Be prepared to endeavor beyond compliance by taking giant, proactive steps toward ESG goals.
- 2. Digital transformation:** To ensure a smooth transition to clean, start by digitalizing your organization’s guarded subject matter expertise, decision policies and data granularity. Advanced analytics will assist in precise and timely management of your clean-energy asset components and variables over the short-, medium- and long-term.
- 3. Decarbonization and decentralization:** Decide how to decarbonize over the next few decades. Focus highly on integrated processes and automation of decentralized operations. Upkeep business savviness to predict disruptions before they occur.
- 4. Prepare today:** Act now in making long-term asset investments because this shift is happening as we speak. Focus on securing the right talent and using the right technologies to make decisions that will help with more efficient handling of any potential risk that could arise — such as evolving markets and regulations.
- 5. Investment strategy optimization:** Determine milestones toward the full clean energy transition in the next five, 10 and 40 years. →

Describing what she considers the most significant industry advancements over the past five years, Cataloglu points to sustainability and ESG, which she says should be top priorities for forward-looking cities and utility infrastructures. “Pledges during the recent COP26 conference, in addition to the historic U.S. infrastructure bill, are both massive steps in the right direction,” says Cataloglu. “Our job is to assist them in achieving those commitments by strategically allocating the funding, and decision-makers will need to be held accountable. The commitment to achieving net-zero emissions is about attaining results, not more capital spending. Leaders will need to generate plans for the short-, medium- and long-term to facilitate the switch.”

When it comes to her job, Cataloglu speaks with enthusiasm. She takes tremendous pride in how, by focusing on product-led growth and R&D innovations, her team delivers exceptional customer experiences, while ensuring they are prepared for a smooth and sustainable transition towards clean energy. Explaining her specific role in collaborating with her colleagues and customers, Cataloglu says, “I am passionate about my work and its diverse challenges, which require bridging the gap between technology and business. I work with a team of extremely dedicated professionals who are committed to DIREXYON’s mission of co-creating a better tomorrow. I firmly believe in inspiring the next generation of leaders, and I feel very fortunate to have them on board.”

Regarding how her approach as a female in the clean energy space may be different than her male counterparts, she says she believes in collaboration and bringing different perspectives to innovate. “The way I see it, since women comprise only 18% of the infrastructure industry workforce a greater representation of females would only benefit this industry. After all, diversity contributes to innovation. I hope to inspire more women to join typically male-dominated industries. We would ultimately be one step closer to an optimal working environment that encourages innovative ideas and more diverse perspectives.”

Cataloglu recognizes the role collaboration continues to play in the fulfillment she gets from her work. “Every day, I leverage the wisdom of leaders worldwide to guide them in rethinking their asset investment journeys,” she says. “Whether we are addressing the shift to clean energy, or maintaining their grids to meet important ESG goals, I am grateful for the opportunity to assist them in making a difference through smarter solutions.”

With an eye on the future, Cataloglu says, “My goal is to continue exploring innovative and efficient new technologies that will accelerate resilience and sustainability for tomorrow’s generation and facilitate the shift to net-zero emission objectives.”

ABOUT DIDEM CATALOGLU:

Didem Cataloglu joined DIREXYON team as the company looks to rapidly expand. She joined DIREXYON Technologies in 2020 as Chief Revenue Officer prior to her appointment as CEO in December 2020. As CEO, Cataloglu oversees building a new sales and marketing team, delivers exceptional customer experiences and manages the company’s global expansion. Before DIREXYON Technologies, she was vice president of global services for Nakisa, a provider of enterprise solutions for organizational design and lease management. She also served in various customer-facing executive roles such as vice president of professional services for Fresche Solutions and director of customer service for Fleetmind Solutions. Cataloglu holds a BSc in computer science from University of Ottawa and an MBA in management and information technology from Bayes Business School.



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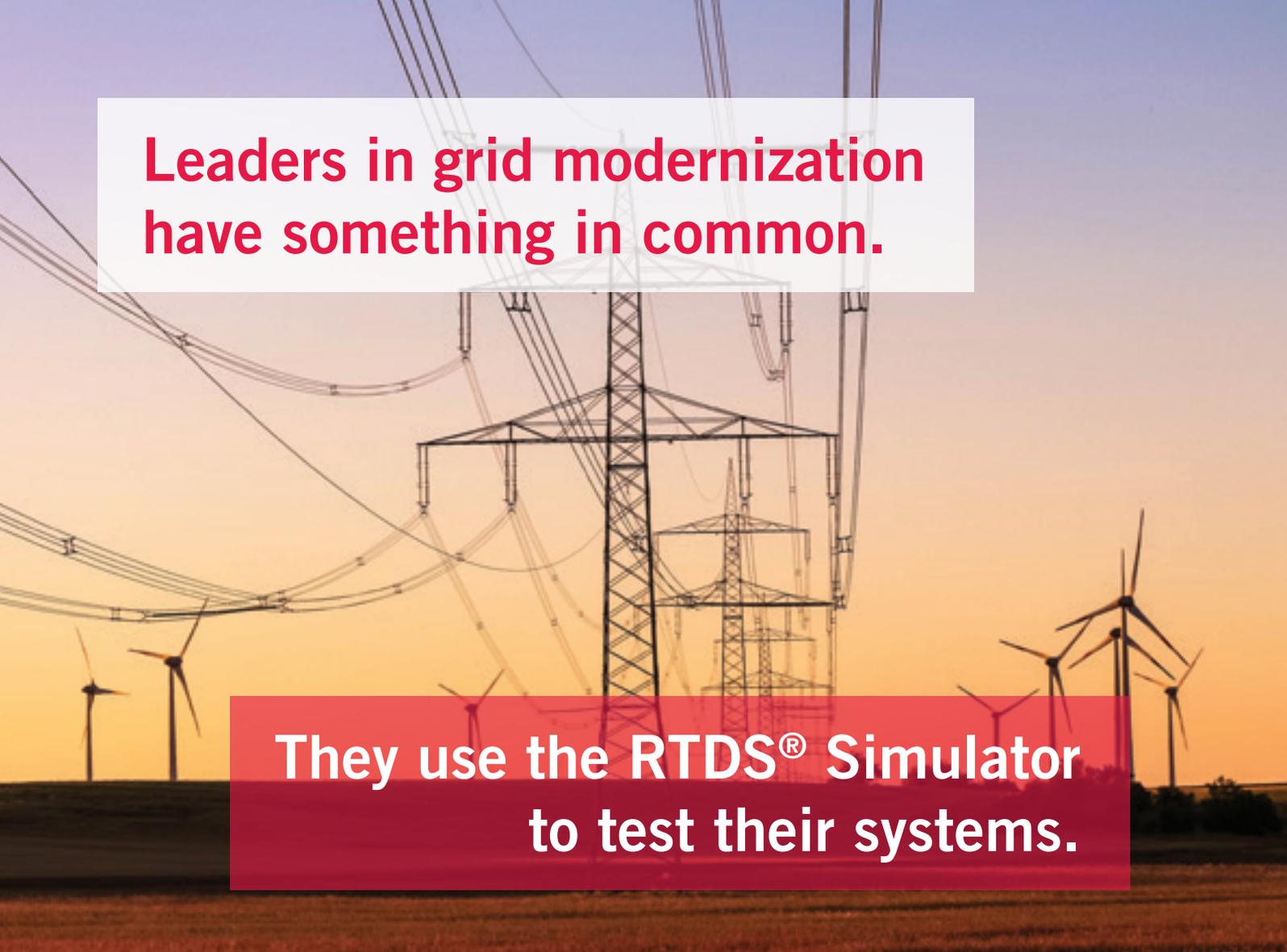
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