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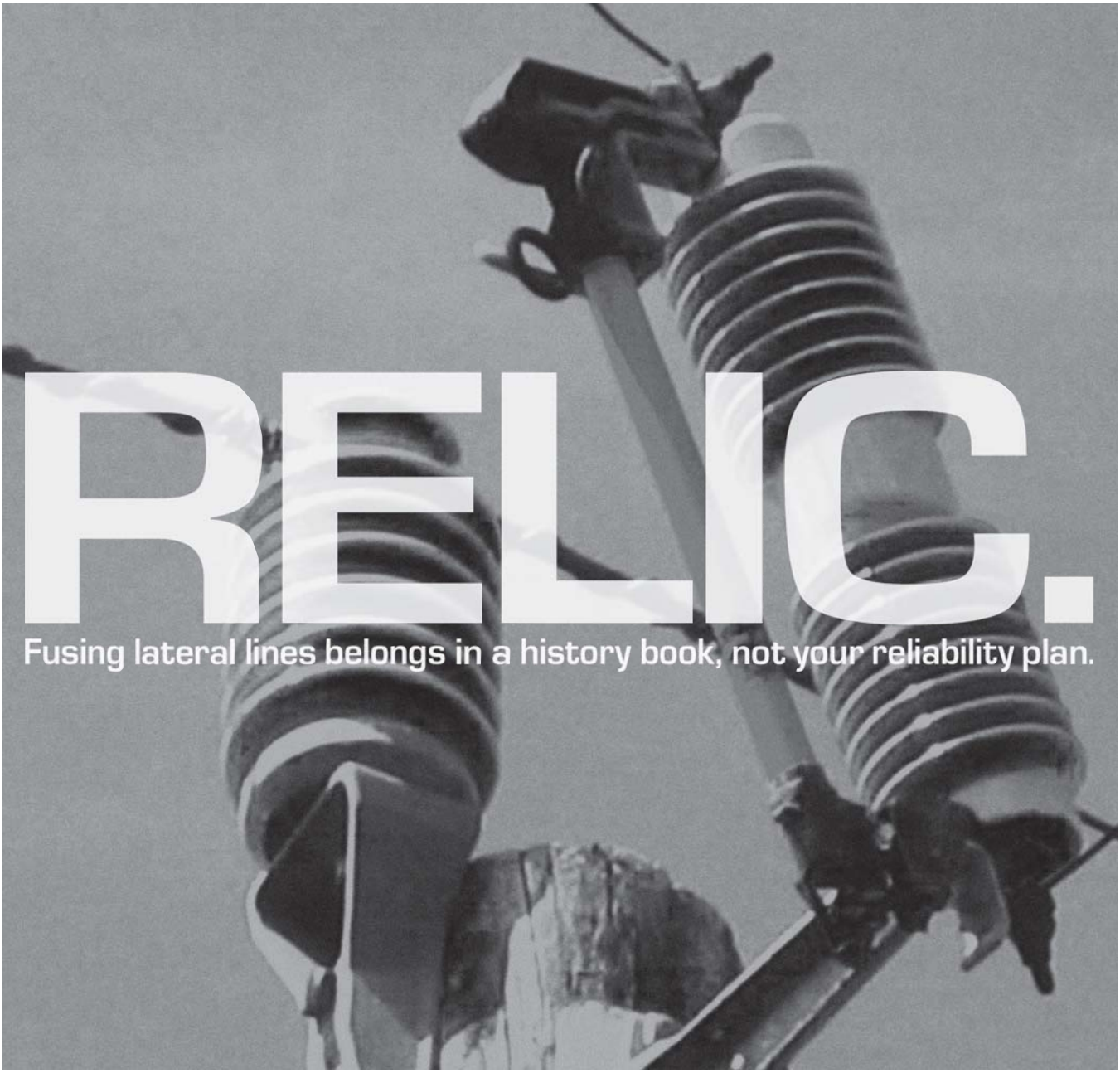

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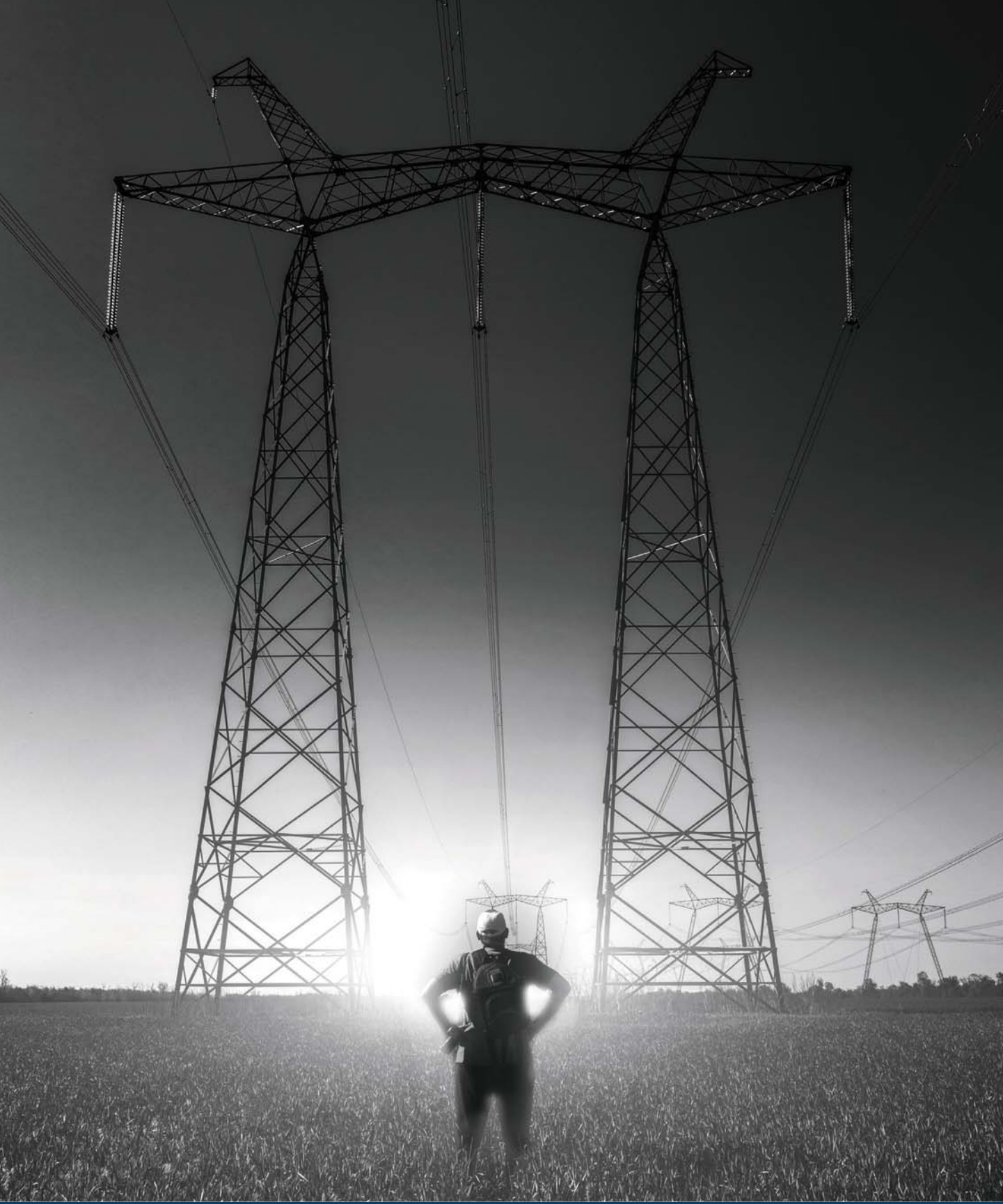

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Nordic's Transformer/Meter Pedestals

CBP-37-43-15A-MP-22x24

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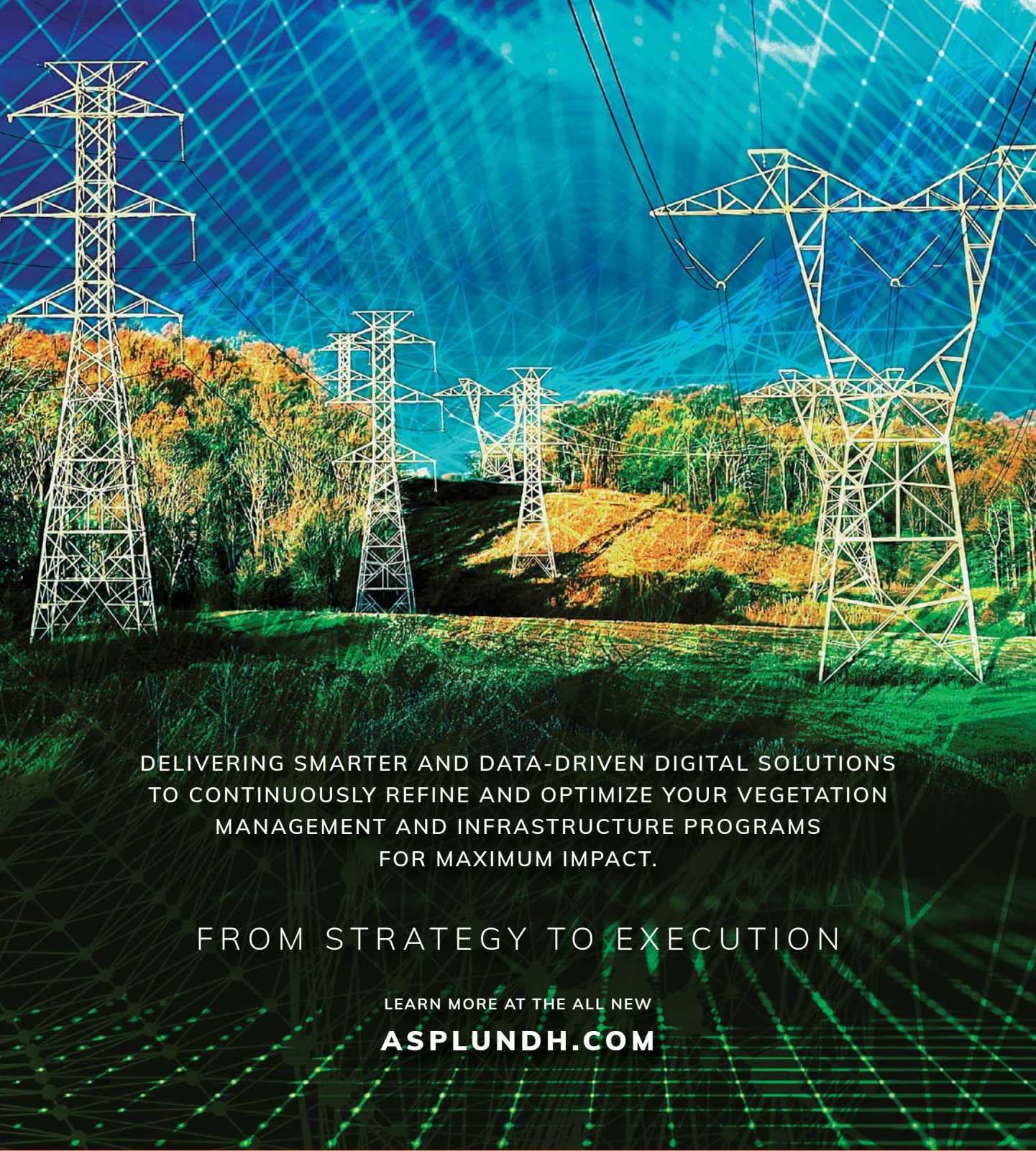

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Failure is Not an Option for Stressed Grids

Summer 2023 is proving to be another record-setting summer in the United States and the world. In mid-July, 90 million Americans across the southern U.S. were under extreme heat warnings from California to South Florida. That same week, thousands of people in western Massachusetts, southwestern New Hampshire and Vermont were dealing with some of the worst flooding ever seen in those areas. And, just to the north, Canada continued to deal with ongoing, record-setting wildfires across the entire country. In fact, the Canadian Interagency Forest Fire Centre reported on July 8 that there were 639 active wildfires, half of which were out of control. On that same day, temperatures hit 100°F in Canada's Northwest Territories, the highest temperature ever recorded that far north, according to numerous news sources.

People living in countries across the globe, including Europe, China, South America, and South Asia, have dealt with record heat, drought and flooding, too. I'm sure most of you have heard by now that according to NASA, Earth had the hottest June on record, going back to 1850. According to NOAA, July 3, 4 and 5 all consecutively broke records as the Earth's hottest day since scientists began recording in 1979.

I could go on about extreme weather events, but I won't, except to say that electric grids worldwide are stressed to the max and failure is not an option. The companies that generate and deliver electricity have, since the industry began, understood the importance of reliable, affordable and safe electricity. For the past two decades most have understood that clean electricity is just as important.

Few industries, if any, are impacted more than electric utilities by both extreme weather events and the transition to zero-carbon electricity. Recovering and rebuilding from weather-related destruction is expensive. Creating, operating and maintaining an electricity delivery system that is more resilient and at the same time able to add clean, more intermittent and grid-edge (distributed) electricity is expensive, and transitioning generation fleets, whether utility-owned or independently-owned, to no carbon also is expensive. In addition, it's almost impossible to prioritize these initiatives or to say that one is more important than the other.

It's imperative for the electricity industry to decarbonize and at the same time increase the amount of clean electricity available to other industries so those industries can also decarbonize. The goal is to not only slow down climate change, but lower the earth's temperature and hopefully in turn, mitigate extreme weather events. The industry has talked about this for years, but it's past time to act.

For 75 years, *T&D World* has been at the forefront of bringing its audience stories about the latest technologies and solutions needed to keep electricity reliable, affordable, safe and, more recently, clean. Creating a magazine and various types of digital content to help utilities solve big challenges has been the brand's contribution to the industry for years. During the COVID 19 years, we expanded our offerings to include online events, and last year we launched our live event: T&D World Conference & Exhibition, or what we call T&D World Live. We're proud of all our content offerings and believe all are needed. We know, however, that there's no substitute for face-to-face events when it comes to discussing and solving big challenges...the type the industry faces now.

I, therefore, want to use the rest of this space to tell you about some of the content and opportunities that will be available at T&D World Live in September 2023. It's no coincidence that our cover story features Frankie McDermott, Chief Operating Officer at Sacramento Municipal Utility District (SMUD), T&D World Live's host utility. As you will see when you read the story, SMUD has faced some major weather-related challenges recently and, thanks to some of its latest initiatives, the utility restored 90% of the nearly 600,000 customers with power interruptions within 24 hours. In addition, you'll learn a lot about how SMUD is attacking what McDermott believes is SMUD's and the industry's biggest challenge: climate change and its impacts on utilities and their customers. McDermott shares about SMUDs best practices in the article, but as I mentioned, there is no substitute for hearing about SMUD's initiatives live — not only from McDermott, but from many other SMUD employees. McDermott is a keynote speaker, and several other SMUD experts are scheduled to speak in various conference sessions.

In many ways, California utilities are leading the way when it comes to tackling climate change and extreme weather events. They are dealing not only with extreme climate-related issues, but California legislators have also enacted some of the most aggressive zero carbon laws in the world. In addition to SMUD, other California utilities, including Pacific Gas and Electric and Southern California Edison, have several speakers on the program who will cover wildfire mitigation, modeling climate impacts, grid modernization and a lot more.

T&D World Live will feature more than just what's happening in California, though. Utilities from all over the country, and some from outside the U.S., are scheduled to speak at this year's event. If you want to know what other utilities are doing to solve challenges and create a low or no carbon grid, T&D World Live is the place to learn about that. Check out our great program and speaker lineup at *events.tdworld.com* and be sure to also look at our one-day co-located event: Commercial Electric Vehicles and Infrastructure Conference (CEVIC). We're also offering three Learning Labs (pre-conference classes) and some awesome technical tours.

And, finally, I want to remind you that our smaller, more intimate event was created by utilities for utilities. If you want to do more than just sit through the sessions, like talk one-on-one to the speakers and panelists, as well as solution providers, we've built in a lot of time for that, too. I hope to see you in Sacramento. TDW

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SCAN ME

How Will the U.S. Military Achieve Bold DER Goals?

The U.S. Army's recruiting slogan once again is "Be All that You Can Be" after several decades of publicizing other slogans.

The nation's oldest fighting force might also try to "Be All of the Above" when it comes to its future energy plans for decarbonizing non-combat military operations. In fact, the Army's Climate Strategy announced last year included a pledge to add a microgrid at every one of its hundreds of installations by 2035.

Military objectives can change as surely as political parties do, but the military clearly is attacking climate change through long-term, lower carbon energy strategies.

The U.S. Army's Climate Strategy announced last year included a pledge to add a microgrid at every one of its hundreds of installations by 2035.

What that might look like will vary with the post. A group of military and energy industry experts united in mid-May at the Microgrid Knowledge Conference in Anaheim to highlight the promises and changes of the U.S. Army's climate pledges.

"Every military installation is different. At Fort Bliss (in Texas) we're not worried about people freezing, but there might be an issue about heat stroke," said David Irwin, director of project development at the U.S. Army Office of Energy Initiatives. "At other bases it might be freezing."

The challenges are formidable and footprints of each individual Army installation present unique problems and opportunities.

"I don't think there is a least resistant path; there's just different hurdles," Irwin said. "We have to determine what those hurdles are going to be."

Last year, the U.S. Army contracted a privately funded, owned and operated energy resiliency projects with developer Bright Canyon Energy. Construction is under way at Joint Forces Training Base — Los Alamitos to provide a hybrid power project which can sustain the base for at least 14 days in the event of a grid emergency and also provide benefits to the local community around the California base.

The microgrid at Los Alamitos will comprise 26 MW of solar, a 20-MW-40-MWh battery energy storage system of 3 MW of backup generation supplied by Tier 4 diesel gen-sets. The equipment contracts focused on a domestic supply chain, including solar panels by First Solar and Tesla Megapacks for battery storage.

Photo courtesy of U.S. Army.

Jason Smith, vice president at Bright Canyon Energy, was part of the Microgrid Knowledge panel and was forthright after the benefits and realities of the developing project. The Los Alamitos base microgrid will be connected to the local grid to create a revenue opportunity, but fully devoted to the critical mission of supplying the base when the energy around it is down.

"This is really an at-the-meter project," Smith pointed out. "When the grid is up and running, the power goes to San Diego Gas & Electric. . . When the grid goes down, we turn it inward."

Bright Canyon Energy was fortunate to have a 100-acre footprint at Los Alamitos to do what it needed to build a microgrid at scale, Smith admitted. Not every base situation will offer such ample space.

But the clock is ticking: the U.S. Army has more than 1,000 installations and, if there's going to be distributed energy resources at every one and fully funded, the work is complex and unrelenting.

The U.S. military is expert at being unrelenting when it comes to defending the nation. Moving through regulatory and complicated energy needs and limitations is another matter.

"We're good at making things slow," quipped Irwin, drawing easily the biggest laugh at the Microgrid Knowledge session.

Seriously, though, he noted that the military objectives in energy terms are fairly clear: No. 1 is resiliency; No. 2 is the climate change objective; and No. 3 is cost.

These often conflict and present hurdles, as Irwin admitted. "There's lot of tensions between those three," he said.

Many developers and energy partners are thrilled to have that kind of clarity going forward.

"At least with the military you know resiliency is No. 1," said Michael Geocaris, consulting engineer with S&C Electric. "Sometimes you never know with other customers" what the top objective is.

Microgrid Knowledge included three days of content an exhibition displays from companies such as S&C, Caterpillar, Enchanted Rock, Block Energy, Siemens, PowerSecure, Scale Microgrid Solutions and numerous others. Next year's event will be in April at the Harbor in Baltimore. TDW

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Technology's Edge

Well, the 107th running of the Indy 500 is in the history books. Watching car racing is like following technology. It's never boring and sometimes it's downright adrenaline pumping like the tire flying off the race car this year. The tire flew over the crowd and landed in a parking lot damaging a parked car, but no one was hurt. It was an exciting race, which is what makes the event so electrifying. Speaking of electrifying, what about those Formula E races.

This year marks Formula E's 9th season! Officially it's called the ABB FIA Formula E World Championship, and you can download smartphone apps for tracking the action. Years ago, I was at a T&D conference and saw a Formula E race car sitting on the floor. It caught my attention because e-racing gives electric vehicle (EV) technologies the racer's edge.

The racetrack has demonstrated that it's the toughest test site available when it comes to new applications, but those that prove themselves improve the overall product. The simple rear view mirror was introduced on the racetrack as were disc-brakes. Racing teams look for an edge to beat their opponents and advanced technologies do that.

EPerformance

Formula E racing is doing that in many ways with its ePerformance applications. Their ninth season has started, and the GEN3 formula E car was introduced with its 350 kW (469-hp) motor, but it doesn't stop there. These machines are lighter, faster, and designed specifically for street racing, Grand Prix style, not drag racing.

When electric motors were added to each wheel, it redefined all-wheel drive. Innovations in regenerative braking systems provided power back to the battery and extended miles-per-watt capabilities. The future of ultra-fast chargers, recyclable batteries, and new composite body materials are in the racetrack's testing laboratories right now.

Researching these future applications led me to a branch of the digital family tree that has been on pit row for many years, but hasn't grabbed headlines. If you look closely, you'll see digital twin technology, predictive analytics, and sophisticated software. A closer view reveals that machine learning, algorithms, and other trappings of artificial intelligence (AI) are also evident. Racing teams are tapping into technology's edge big time.

More Awareness

Have you heard of the Indy Autonomous Challenge (IAC)? Keeping it simple, the IAC website said it's a high-speed self-driving car racing event to challenge advanced technologies. These are not EVs, they use internal combustion engines

PoliMOVE passes TUM in the final pass of the competition at the Las Vegas Motor Speedway. Indy Autonomous Challenge.

with all of the standard accoutrements found in the typical Indy race cars. The student-teams add optical GPS-units, optical sensors, LiDAR, radars, supercomputer, cutting-edge AI algorithms, etc. to make these race cars fully autonomous.

These races have been taking place for several years and some experts are saying the competition is pushing the boundaries of fully autonomous driving platforms. These vehicles are the most advanced in the world and are capable of operating at high speeds on the demanding racecourse with other autonomous race cars, but imagine this technology applied to drones. It would be a game changer for vegetation and wildfire surveys along rights-of-ways not to mention storm-recovery efforts.

Autonomous Drones

When will autonomous drones be available for power line surveys? With the advancements being made in autonomous vehicle platforms, that's a question that keeps popping up. Presently, the Federal Aviation Administration (FAA) only allows Uncrewed Aircraft Systems (UAS) to be operated within the pilot's line of sight and must remain under 400 ft (122 m).

The FAA has been investigating the possibility of operating autonomous drones to operate beyond visual line-of-sight (BVLOS). Some waivers have been issued and several utilities have taken part. Currently UAS BVLOS is still in the realm of no-can-do, but that may be changing. Last year the FAA's Aviation Rulemaking Committee (ARC) finalized its report titled "UAS BVLOS ARC."

The report recommends expanding UAS BVLOS with lots of caveats and training requirements. The ARC recognizes the knowledge gained in the waivered programs and improvements in the technologies involved. It also acknowledges the economic and societal benefits UAS BVLOS offers many businesses such as the power delivery industry. There is still a long way to go, but the report lays out a logical progression to achieving UAS BVLOS!

Drones need to be able to fly BVLOS to make a difference in our world of new normals due to climate change. Vegetation management needs this ability in its toolbox to keep up with wildfires and extreme weather events. We have the technology, now we need regulatory support to make it happen. TDW

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Remote wind farm. Photo by Gene Wolf.

Transmission Lines With A Different Twist

How many times have we heard the power grid is in transition or grid-wise technology is transforming the industry? These terms and others like them come up regularly as we struggle with all the technologies being deployed to modernize the power delivery system. One of the most complex of these transitioning points is the move from fossil-fuel powered generation to clean renewables, and it's happening at a faster pace every year.

According to the U.S. Energy Information Administration renewable generation surpassed coal-fired generation in the U.S. last year. Globally CNBC reported that 12% of the world's electricity came from wind and solar generation in 2022. This record growth has focused a lot of attention on the bulk transmission system's ability to connect this flood of renewables. Of particular interest is the massive backlog within the interconnection queue process that seems endless.

It's estimated that there are currently about 2,000 gigawatts of wind, solar, and storage in the queue. Late last year the Federal Energy Regulatory Commission announced it was working with PJM, an RTO (regional transmission organization), on a systematic approach to streamline the interconnection process. They are exploring fast-lane methods along with several other schemes. This promises to be a step in the right direction, but it's going to take time and time is one thing the transition is short on.

Digging Deeper

The queueing issues are going to be solved, but we still need a flexible and resilient bulk transmission system. That brings us back to digital technology in the form of power electronics. Power electronics is very much like standard electronics with the exception that it operates more robustly (i.e., kilovolts, kilo-amperes, and megawatts), and that is just what is needed!

It is everything that high-voltage alternating current (HVAC) is not when it comes to pushing power. The power grid's transmission technology of choice has been HVAC, but HVDC (high-voltage direct current) is gaining ground. When HVAC moves massive blocks of power extremely long distances some of the laws of physics get in the way. And as *Star Trek* taught us, "ye cannae change the laws of physics." Of course it is possible to bend those laws somewhat with VAr (volt-ampere reactive) compensation, but that too has its limitations.

The simplest solution would be to keep the distances short and the power transfer at lower levels, but that isn't always possible. Contemporary windfarm projects are pushing multiple gigawatt ranges and potential project locations are more remote than ever. Those wind-rich sites that were close to existing transmission lines for the most part have been taken by the older windfarms. You might say, the "low hanging fruit" has been harvested and that is why we need a transmission technology with a different twist!

The Technology Option

The modular voltage source converter (VSC) is the latest generation of HVDC transmission technology and it's exactly what the non-utility transmission developers require for an economic power delivery system. VSC-based HVDC point-to-point interregional transmission projects can be customized for maximum flexibility. The technology has evolved to the point that supplying enormous amounts of power over immense distances isn't a problem. They can utilize overhead, underground,

submarine, or a combination when constructing VSC-based HVDC links.

Recently Pattern Energy announced it had selected Hitachi Energy to supply the VSC-based HVDC and other advanced technologies needed for the SunZia Transmission Project. The SunZia transmission project is a 550 mile (885 kilometer), ±525 kilovolt (kV) HVDC transmission line connecting the 3,500 megawatt (MW) SunZia Wind Project in central New Mexico (NM) to the 500 kV AC bulk power transmission grid in south-central Arizona.

The HVDC transmission line will have the capacity to transport 3,000 MW of clean, renewable energy. The SunZia Transmission project will be among the largest VSC-based HVDC transmission links in the world delivering power when completed. This project presents some amazing engineering solutions unique to this HVDC link. *Charging Ahead* contacted Andreas Berthou, global head of HVDC at Hitachi Energy to discuss Hitachi Energy's customized engineering solutions for the SunZia Transmission project.

Berthou began the discussion saying, "Worldwide there is a strong trend between renewable energy and HVDC transmission. NM boasts some of the most abundant, constant wind energy resource in the United States. This resource is currently trapped due to the lack of transmission infrastructure and the SunZia Transmission project will carry this vast resource to areas with high long-term demand for power, delivering fuel-free, affordable energy to Arizona and the Southwestern United States."

Berthou explained, "Hitachi Energy is supplying the VSC-based HVDC converter stations for the transmission link and will also supply AC chopper (*editor's note*, AC-AC voltage control converter) technology to the project. Chopper technology is necessary to help restore power if the power flow on the HVDC line or in the AC grid in Arizona is temporarily interrupted by weather and other contingency events. The choppers will be installed at the sending end of the SunZia Transmission Project in NM and connected to the new 345 kV AC switchyard for the wind power collection system, which is islanded from the existing power grid in NM."

Berthou continued, "These choppers are installed for the purpose of absorbing the power generated by the SunZia wind farms when the power transfer on the transmission line is disrupted by temporary faults. They will be utilized for fault clearing on either the SunZia HVDC transmission line or in the receiving end's AC network in Arizona. In addition, the choppers aid during permanent faults on one pole during bipolar operation by giving the wind farm's controls time to rebalance the power output from the wind-turbine generators with the remaining transmission capacity on the HVDC transmission link."

Berthou said, "Clearing faults on the HVDC transmission line or at the receiving AC network in Arizona can be a serious problem. Faults are capable of temporarily disrupting the delivery of the windfarm's power to the Arizona AC network, which can cause overvoltage conditions. The temporary imbalance between the power output from the windfarm and the power transmitted to Arizona causes a rapid rise of the DC voltage. It must be mitigated immediately by the braking resistor banks in the choppers. They absorb the power output from the windfarm and prevent severe DC overvoltage conditions. This allows the VSC-based HVDC converter stations to ride through the clearing of temporary faults. The activation of the chopper's braking resistor banks is performed by the HVDC scheme's control system."

Berthou clarified, "The design of the thyristor controlled braking resistors ("TCBR") is based on Hitachi Energy's proven SVC (static VAr compensator) technology. The TCBR capacity will be divided into two identical and independent chopper units. Each chopper unit is connected to the 345 kV AC switchyard via dedicated AC feeder lines (one AC feeder line for each chopper) and have a dynamic capability of up to 1,500 MW for two seconds. The VSC-based HVDC converter stations and associated technologies are expected to be in service by the end of 2025 to support final testing and commissioning of the SunZia Wind facilities in 2026."

HVDC's Expanding Technology

In addition to the SunZia Transmission project Hitachi Energy is working on the Champlain Hudson Power Express VSC-HVDC project. It represents a totally different challenge for moving 1,250 MW more than 370 miles (600 km). Rather than repeat the details, see January 2023, "Charging Ahead" (*https://tdworld.com/21255605*) for the entire story.

Another challenging non-utility transmission developer project is the TransWest Express Transmission project. A few months ago, the Bureau of Land Management issued a notice to proceed with the transmission project. TransWest Express LLC has selected Siemens Energy to supply the HVDC transmission technology for the 732 mile (1,178 km) 3,000 MW transmission system running from south-central Wyoming to the Marketplace Hub about 25 miles (40 km) south of Las Vegas, Nevada.

Earlier this year SkyQuest Technology published its HVDC Converter Market report. It estimates the HVDC converter market will attain a value of US$ 20.60 billion by 2030. This is happening because the demand for HVDC converter technology is growing. It's being driven by the demand for efficient and reliable power transmission systems pushed by renewable energy developers needing to move "enormous amounts of electrical power over vast distances." This should be good news for VSC-based HVDC suppliers like GE, Hitachi Energy, Toshiba, Mitsubishi, and Siemens Energy to name a few.

Berkeley Labs says, "the grid of the future looks sunny and windy," which means there are going to be a lot more opportunities for interregional transmission interconnections. Since a VSC-based HVDC transmission line can transmit about three times more power than an AC line of equivalent voltage, there is a strong argument to utilize VSC-HVDC technology for these point-to-point links. It's possible to build these links along road and rail rights-of-way. They can go overhead, underground, or submarine as required. VSC-HVDC is flexible, reliable, and ready to move clean-energy to market! TDW

MORE THAN 100 UTILITY INDUSTRY LEADERS JOIN THE PUSH FOR PRIVATE BROADBAND

The Utility Broadband Alliance (UBBA), a collaboration of utilities and solution providers dedicated to championing private broadband networks for critical infrastructure industries, recently announced that it has reached a major milestone by surpassing more than 100 members.

Photo 193289464 © Phuttaphat Tipsana | Dreamstime.com

CenterPoint Energy, Duke Energy, and Lower Colorado River Authority (LCRA) are the newest utility members to join the utility-led Alliance, which incorporated in 2021 and seeks to help accelerate utilities' journey toward a more secure, resilient and future-proof grid.

Utilities across the U.S. and globally are realizing the critical role of private broadband in grid modernization as they seek to achieve aggressive sustainability goals and deliver new, connected services to customers. While many utilities currently manage a multitude of siloed, narrowband wireless networks, private broadband can provide the scale and efficiency required to meet customers' needs for an evolving, distributed digital grid.

"A modernized grid requires high levels of security and efficiency that can only be achieved through the advancement of digital networks," said Carmine Reppucci, Southern Linc CEO. "Only private broadband can meet the demands for connectivity and efficiency that utility customers require. As a founding member, we share in the UBBA's goal of championing the advancement and development of these networks," he said. ■

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ATLANTIC CITY ELECTRIC RECEIVES APPROVAL FOR $93.1 MILLION POWERING THE FUTURE PROGRAM

Atlantic City Electric has been approved for a $93.1 million project called Powering the Future. The project will modernize and enhance the local energy grid in South Jersey over the next four years.

The project includes 22 specific projects that are important for expanding the local energy grid's capacity to support the connection of more solar and clean energy technologies. This will improve system reliability and utilize smarter technologies to strengthen the grid against severe storms.

Powering the Future is a continuation of Atlantic City Electric's efforts to modernize the local energy grid, improve service reliability for numerous customers, and support the growth of distributed energy resources like solar power. The company has already assisted nearly 50,000 customers in connecting their solar PV systems, and this program aims to expand that effort. It will create new opportunities for residential solar interconnection, enabling around 16,000 additional residential solar arrays in most areas. Additionally, Atlantic City Electric is implementing other upgrades that will extend solar interconnection access to over 50,000 customers.

The project encompasses four main categories:

- Solar/Distributed Energy Resource (DER) Enablement: This category focuses on expanding the local energy grid's capacity to integrate clean energy technologies, including solar power and other distributed energy resources, in line with the state's clean energy and climate objectives.
- Targeted Reliability Improvements: These projects are aimed at enhancing grid reliability by addressing areas with frequent power outages or implementing redundancy measures to minimize the impact of outages.
- Smart Technology Upgrades: This category involves enhancing the communication network and associated devices to reduce the frequency and duration of power outages.
- Substation Improvements: Various substations in Atlantic City Electric's service area will undergo upgrades to modernize infrastructure and critical equipment, ensuring improved r eliability and resilience against extreme weather events.

Through Powering the Future and previous investments, Atlantic City Electric has made significant strides in making the local energy grid smarter, stronger, and cleaner. These efforts have led to the lowest frequency of electric outages in the company's history, resulting in improved service reliability for customers. Despite the rising occurrence and severity of storms, the frequency of electric outages for Atlantic City Electric customers has decreased by over 75% since 2012.

The project will begin in July 2023 and will be funded by gradual rate adjustments over a four-year period. ■

AUSTIN ENERGY ADDRESSING NATIONWIDE SHORTAGE OF RAW MATERIALS, SUPPLY CHAIN ISSUES

Austin Energy is proactively addressing the complex issues arising from a nationwide shortage of raw materials and supply chain disruptions.

In 2022, the company experienced a significant impact when transformer deliveries dropped by 90% in the third quarter compared to the first quarter. Transformers are crucial components that convert voltage levels to power homes and businesses.

Photo 4714161 © Richard Santillan | Dreamstime.com

Austin Energy is focusing on four key areas to address thesupply chain issues:

1. Pinpointing Critical Supplies: Creating a Material Resource Plan to forecast demand, identify incoming supplies, and find alternative sources to fill future gaps.

2. Adjusting Equipment Standards: Increasing flexibility in materials standards to improve the likelihood of finding supplies and meeting customer needs.

3. Expanding Sourcing: Exploring international equipment options and adjusting supplier contracts to increase supply channels.

4. Improving Processes: Enhancing customer communication about lead times and allowing customers to source their own equipment, if it meets safety requirements.

During the first quarter of 2023, transformer deliveries increased to the highest level in five years. Scheduled deliveries for the next two quarters are even higher, with over 2,500 transformers ordered and additional manufacturing allocations in Austin Energy's name. The public utility is asking existing suppliers to seek refurbished equipment and additional transformer sources. They are also extending the lifespan of pad-mounted equipment through repair-in-place activities.

Nationwide supply chain challenges, including labor shortages and high demand for electrical components, have led to significant delays. Distribution transformer procurement times for public power utilities like Austin Energy have increased from two to three months to over a year, according to the American Public Power Association. ■

SMUD crews perform work with a large crane on a power line at Arno Road. Photo courtesy of SMUD.

SMUD Navigates the Energy Transition

COO Frankie McDermott discusses SMUD's efforts to address the industry's 'greatest challenges.' SMUD is the host utility for the T&D World Conference & Exhibition, and McDermott is one of the featured keynote speakers.

By **JEFF POSTELWAIT**, Senior Editor

When Sacramento Municipal Utility District took over responsibility for the city's power grid from Pacific Gas & Electric Co. in 1946, it was the culmination of decades of wrangling in the courts and the political battles that followed the 1923 vote to establish a municipal utility. One hundred years after that vote, SMUD is the sixth largest utility of its kind, with detailed plans ready for the future of electricity delivery.

Chief Operating Officer Frankie McDermott said SMUD has made big moves to cut carbon from its electric supply by 2030 and the utility plans to share its knowledge at T&D World Conference and Exhibition, Sept. 12-14 in Sacramento.

"SMUD is partnering with T&D World because of the value it brings to the industry. As we work to decarbonize, we rely on new and emerging technologies. T&D World is at the

McDermott at a groundbreaking ceremony at SMUD's Rancho Seco Solar Project. Photo courtesy of SMUD.

forefront of those technologies as we work to find affordable and scalable solutions to a zero-carbon economy," McDermott said. "We want to share our best practices and what we've learned along the way, so other utilities can move toward a carbon-free electric supply."

The utility's effort to address the challenges of climate change and mitigate its impacts on the Sacramento region is among the most serious tasks SMUD has before it, McDermott said.

"The greatest challenge to the industry is climate change and the impacts of severe weather events. For example, this past summer's heat wave saw us hitting near record electricity usage. Then starting in January, we saw a series of extreme storms that again set more records in terms of damage that we experienced from the heavy rains and winds," he said.

SMUD crews worked through the night to restore power during the most damaging storms. Photo courtesy of SMUD.

The string of January storms was unlike anything SMUD or the Sacramento area experienced in recent memory, with the region seeing hurricane-force winds. Those heavy winds and rains caused "unprecedented" storm damage to the local power grid, with 599,000 customers seeing power outages. However, more than 90% of those customers were restored in less than 24 hours.

"To put it in perspective, the first 10 days of 2023 saw 1,200 downed wires — four times the number in 2008, which was previously our most damaging storm. There were more than 2,300 outages — double the number in the 2008 storm," he said.

He added that SMUD needed to replace more than 425 poles, compared to 140 in 2008, as well as respond to more than 1,000 tree and vegetation issues – most of which required a tree crew to clear a hazard before line crews could begin repairing power grid equipment.

Throughout this outage restoration mobilization, SMUD had over 100 crews working in the field around the clock including 39 external crews, contract and mutual aid crews. This is a larger mobilization than the utility has ever had to carry out, he said.

"Our Emergency Operations Center was activated to help coordinate our response," he said. "Our employees managed switching operations, made sure our crews had the equipment they needed, took more than 35,000 customer calls, reached out to support our customers, gathered new equipment, dispatched crews, planned vegetation work, re-routed electrical loads and responded to media and social media inquiries and more."

The growing severity of storms and other weather conditions across the West and the country are a challenge to many utilities, and underscore the need to build resilient, reliable and renewable electric grids, he said.

"We must still prioritize safe and reliable electricity, while at the same shifting to renewable energy. We must make a paradigm shift to zero carbon for the long-term health of our communities and economies," he said.

Zero-Carbon Plan

McDermott calls SMUD's 2030 Zero Carbon Plan the most aggressive carbon reduction plan by any large utility in the country, adding that it will completely eliminate carbon from its electricity supply by 2030.

"Over the next seven years, we are investing billions of dollars to advance clean energy technologies in our region while creating a pipeline of green jobs," he said.

SMUD's plan consists of:

- tripling its renewable energy resources and supporting customer owned resources like solar and batteries.
- electrifying the building and transportation sectors.
- repurposing natural gas plants and bringing to scale new technologies like virtual power plants and vehicle to grid technology.

"This plan is really comprehensive. We are taking a community benefits approach and ensuring that we do so in an affordable way so we can all benefit in a new carbon free economy," he said.

The utility's leadership believes it can get about 90% of the way to its zero-carbon goal with current technologies while simultaneously maximizing community benefits.

"This is key for us. We want to do all this while keeping rates below inflation, providing clean technology jobs, improving overall regional health and doing so in an equitable manner. We can't leave any community behind while we make this transition to a carbon free economy," he said.

SMUD installed its first utility-scale battery storage system at the Sacramento Power Academy (shown) and will add Phase 1 of its partnership with ESS at the same location. Photo courtesy of SMUD.

Low Carbon Investments

The remaining 10% of carbon reductions, however, will be the most challenging. Those gains will require partnerships with local, state and federal leaders on a variety of projects that SMUD may be able to scale, he said.

This could include applications such as virtual power plants and vehicle to grid technology. The utility also recognizes it will

need to investigate technologies not currently in its portfolio to reach the final 10% of emission reductions.

"We are investigating carbon capture and storage as a short-term bridge to meet our goals. Though green hydrogen holds promise, it won't be available at scale by 2030, so it's more about fuel blending in our natural gas plants. Long-duration energy storage, carbon capture, hydrogen and demand response programs are all tools that are needed to help us reach our goal," he said.

SMUD's plan includes adoption of customer-owned distributed energy resources, such as rooftop solar, energy storage batteries and electric vehicles.

"Optimizing these resources will be critical to ensure customers, the utility, the grid and the community all benefit. That's where ADMS and DERMS come in," he said.

In September of last year, SMUD launched its ADMS and Phase 1 of DERMS. These technologies will allow SMUD to transform its grid from a one-way street to a multi-directional grid, he said.

Phase 1 of DERMS gives SMUD visibility into customer-owned distributed resources such as smart thermostats, batteries and electric vehicles. Phases 2 and 3 will help dispatch these resources to help address grid conditions.

"It will also allow us to leverage customer resources for economic performance – providing benefits to customers and to SMUD," he said.

Using Solar Precisely

A common problem for utilities that manage service territories where customers like to use rooftop solar arrays is some customers wish to generate more solar than the grid is equipped to handle. In February 2022, SMUD went live with PRECISE (PREconfiguring and Controlling Inverter SEt-points), a tool that helps SMUD's planning engineers analyze local grid impacts from PV resources.

"PRECISE is a cutting-edge PV interconnection evaluation tool that enables utilities to cost effectively host more solar," he said. "This project was the first automation of the technical interconnection evaluation process of its kind, and one that could serve as a template for many utilities that wish to automate the increasing challenge of evaluating new interconnection requests."

The early results have shown a more streamlined interconnection application process, enabling smoother and better use of solar in SMUD's territory, he said. PRECISE can automate an assessment of what size system the grid can accommodate and how advanced inverter functions can support approval.

"In these scenarios, planning engineers can work with customers on a solution that enables the PV system to interconnect successfully," he said. "Now that PRECISE has linked the diverse utility datasets (e.g., meter data, GIS, interconnection applications) needed for automated evaluation of new distributed energy resources, PRECISE could now be applied to large commercial solar sites, battery energy storage, or to evaluate the impact of electric vehicles as they come on to the network."

EV Impacts

California is an early adopter state for electric vehicles, and this is another area where a careful balance between decarbonization and reliability has to be struck. For its part, SMUD plans

for 288,000 light duty EVs and 27,000 medium and heavy duty EVs to be used in its service territory by 2030.

"As for load growth, we are forecasting that EVs will represent over 30% of new load growth over the next 20 years, where 1 in 3 kWh that SMUD sells by 2040 is forecasted to be coming from an EV," he said.

SMUD is taking steps now to prepare to support the expected rapid growth of EVs, both from residential customers as well as commercial, industrial and institutional customers who may be planning electric fleets. This includes concentrating on charging and the grid infrastructure to support it as well as partnering with customers and other entities, which will be key to preparing for mass EV adoption.

The power generated at the Solano Wind Project counts toward California's Renewable Portfolio Standard, helping SMUD reach zero carbon in its electric supply by 2030. Photo courtesy of SMUD.

"We've done analysis over the years to understand how we need to plan our distribution grid infrastructure to support the evolution of EV charging needs. As we look towards the increasing number of EVs, the higher charging capacity options for customers, and the growth of medium- and heavy-duty vehicle electrification, we are completing comprehensive grid impact analyses," he said.

SMUD is also looking at customer charging patterns and how it can partner with customers to influence charging behavior in a way that benefits them financially while supporting the grid during times of peak demand.

"We have customers enrolled in a managed charging pilot now, which provides important insights and data," he said.

A SMUD fuel break along its transmission corridor. SMUD's is one of only seven utilities in the nation to be recognized by the Right of Way Stewardship Council for its vegetation management practices. Photo courtesy of SMUD.

By working closely with customers early while they are first considering buying or leasing an EV, SMUD believes it can guide them toward solutions that work with their lifestyle or business operations while optimizing for grid infrastructure investments. This includes things like the size of their chargers they put in, leveraging program opportunities such as managed charging to avoid charging on-peak, using technologies such as circuit splitters and power sharing to avoid electrical panel upgrades, coupling their EV charging with adoption of other DERs like battery storage in virtual power plants, and managing whole home/building/site energy use to minimize the need for grid upgrades.

"We are making significant investments in our grid. And we know that if we can partner with our customers to manage their charging in ways that benefit the grid and reduce grid impacts, we can share in that value with our customers. Managed properly, EVs can help with grid reliability, and integrating more renewables," he said.

Virtual Solutions

Developing technologies such as virtual power plants can be game changers during those times when the power grid is under the most stress. VPP applications could help SMUD and other utilities take full advantage of customer-owned resources by grouping them as a dispatchable, remotely controlled resource to help forestall outages.

SMUD recently launched a residential virtual power plant program called My Energy Optimizer Partner+ program. The project is intended to enable customers to share their solar and storage benefits with their entire community.

""Virtual Power Plants allow us to tap into customer resources for capacity instead of relying upon traditional natural gas-generation and/or less clean options. We recognize that partnering in our customer-owned investments provides a significant benefit to the community and we provide generous incentives for those customers who choose to partner with us," he said.

By becoming a partner in this program, a customer can receive up to a $2,500 one-time incentive for a battery storage systems and receive ongoing performance payments.

A Wildfire-Safe Grid

The Golden State has unfortunately become synonymous with a practically year-round wildfire season that local, state and federal authorities, as well as utilities, have to prepare for year-round. Although SMUD's service territory is largely urban and not deemed to be high risk for wildfires, the utility still operates a system of transmission lines through El Dorado County to its Upper American River Project (UARP), which integrates hydroelectricity into its power grid.

"Safety is our top priority," he said. "We patrol and maintain 1,000 acres in the UARP and more than 3,800 miles of overhead distribution lines in our service territory."

For decades, SMUD has had a robust vegetation management program in place that trims trees and other vegetation around power lines – both within its service territory as well as in the UARP.

SMUD also builds in firebreaks around transmission lines and prunes more than 70,000 trees annually to help maintain safety and reliability around lines, poles and transformers.

"We have many methods that help us to monitor our lines including LiDAR technology, aerial inspections, ground patrols, infrared inspections, x-ray splicing and more. We use digital technology to monitor trees around our transmission lines so we can identify potential safety concerns before they happen and negotiate with property owners to manage potentially problematic vegetation outside of our rights-of-way. We can also de-energize our lines in an emergency if needed," he said.

SMUD works continually to mitigate fire risk with tools such as real time monitoring weather stations. The utility also runs distribution wires underground, replaces fusing and arresters with non-spark emitting equipment, and installs covered conductors and utilize ductile-iron and steel poles.

"We have had a robust wildfire mitigation plan in place for many years that we regularly review with our stakeholders to ensure we are in compliance with changing regulations," he said.

SMUD also uses less common methods for keeping power line pathways clear of potentially damaging vegetation.

"We also utilize newer methods when managing our lands. For instance, we began using goats and sheep as an alternative to motorized mastication to help with weed and vegetation control around our power lines," he said. TDW

For more information and to register for the T&D World Live Conference and Exposition, coming Sept. 12-14, 2023, to Sacramento with host utility SMUD, visit events.tdworld.com/2023.

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(Left) Enclosure for FCCP device. BGE started piloting this solution in August 2022 at a substation with only one dc supply. (Right) A newly installed Multitel box. The FCCP device has a clamp-on current transformer (CT) that can be installed on one wire of the battery dc supply charger cable. Photos courtesy of Baltimore Gas & Electric.

Open-Circuit Detection Protects Substations

BGE reviews several alternatives for a battery open-circuit monitoring device to protect from a dc supply single point of failure.

By **JOSE ABI KARAM DURAN**, **ABBAS ZAIDI** and **BENJAMIN CARSTENS**, Baltimore Gas and Electric Co.

The Federal Energy Regulatory Commission issued Order 867 on Jan. 23, 2020, approving Reliability Standard TPL-001-5 Transmission System Planning Performance Requirements. Reliability Standard TPL-001 was originally created to establish requirements for reliable operation of the bulk electric system (BES) during various system conditions and addresses a wide range of contingencies during abnormal operations.

TPL-001 contains several scenarios, from P0 to P7. Among these, P5 considers a multi-contingency scenario as "fault plus nonredundant component of a protection system failure to operate." TPL-001-5 updated the analysis for redundancy of protection system relays to include all protection system components, including communication systems, dc supply and control circuitry. Even though it starts from a normal condition, the event considers a "delayed fault clearing due to the failure of a nonredundant component of a protection system." In accordance with footnote 13 of TPL-001-5, a single-station dc supply associated with protective functions is considered a nonredundant component of a protection system.

Utility substation design varies widely across the U.S. While some utilities consider redundancy of dc supplies, others do not. Even within the same utility, redundancy of dc supplies is usually only considered for those stations deemed critical based on the utility's standards. Since many substations have been in operation for decades, any new requirement requires careful consideration and proper planning before implementation. Application of methods to comply with these requirements is disruptive to normal operation and utilities must also ensure engineering feasibility. Retrofits, in particular, are difficult to perform, depending on the complexity of the dc system in question.

Addressing TPL-001-5

Utilities can address the TPL-001-5 requirement in several ways for a single dc supply as part of a nonredundant component of the protection system. One method is to include a

second dc supply for the protection system. However, this is significantly easier in concept than in application. Installing a second dc supply requires thoughtful planning, additional space requirements and rewiring of components to allow the primary and backup protection systems to be fed from different dc supplies. If the TPL-001-5 requirement is considered from the beginning of a substation's design, these challenges can be overcome and provisions for proper primary and backup dc systems provided.

When considering retrofit or brownfield situations in existing substations, installation of a second dc system is difficult and oftentimes impossible to fully implement. This difficulty is usually because of space constraints in the existing substation control house and the significant effort required to rewire primary and backup protection systems to use the second dc system. Extensive planning and outage considerations are required, many of which are likely to be either cost prohibitive or ill-advised because of the compromised state the associated protection systems will be placed in during installation and rewiring of the second dc system.

Considering these obstacles, the standard also provides an exception to the requirement for a redundant dc supply that provides an alternate path for utilities to comply with the standard. A substation with a single dc supply can be compliant with the standard, provided the voltage and continuity of the dc supply is both monitored and reported in real time. Specifically, both low-voltage and open-circuit conditions on the dc supply must be monitored and reported to the utility's control center through a supervisory control and data acquisition (SCADA) system.

A close view of the Multitel device. Another reason BGE chose this device was because other utilities were planning on initiating similar pilot programs. Photo courtesy of Baltimore Gas & Electric.

Low voltage can be sensed at different points, as electronic relays with this function are added across the substation. When the battery charger fails and the system is powered by a single dc source, voltage is constantly monitored by several relays and alarms are sent to the control center. However, the exception in the standard also calls for open-circuit monitoring.

During normal operation, when components are powered by the charger, a fault on the dc supply might go unnoticed. Under normal operation, the charger alone has enough capacity to supply all necessary station loads. During a fault condition, more current than normal is necessary to open multiple breakers — which is when the batteries supply the additional current. If the charger were to fail before the dc supply from the batteries

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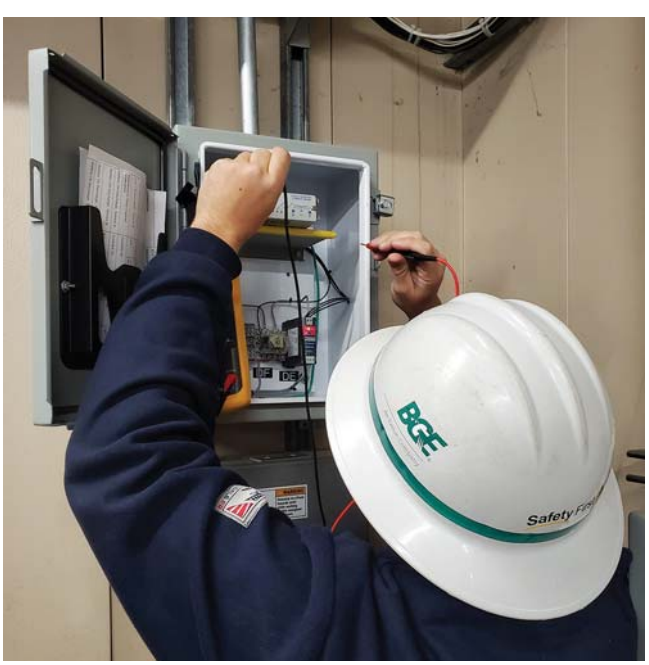
A clamp-on CT is shaped like a donut that clamps around an existing wire and measures the current flowing through the wire, this is preferred because wiring does not have to be disconnected. The device continuously monitors for charging current using the clamp-on CT. If the device does not see current for 30 minutes, an alarm is sent indicating a potential open-circuit condition. Photos courtesy of Baltimore Gas & Electric.

is necessary, it could go unnoticed until it is needed, and the protection system might not be able to properly operate.

Supply Monitoring

Baltimore Gas and Electric Co. (BGE) recently reviewed several alternatives for a dc supply open-circuit monitoring device. The most expensive solution was adding battery monitoring equipment attached to each individual cell. This solution would accomplish open-circuit monitoring and much more, but cost was a concern.



The FCCP device is tested once it is installed. Photo courtesy of Baltimore Gas & Electric.

BGE then explored devices providing open-circuit monitoring only. A few devices are manufactured specifically to address open-circuit monitoring while other devices can be repurposed for it, such as meters. Many of these solutions would be intrusive to the system, requiring outages that would be costly and labor intensive.

Ultimately, BGE chose to test Multitel's Float Charging Current Probe (FCCP) device. The FCCP provides consistent measurement of float charging currents and programmable alarms that alert the control center of any possible loss of dc supply. Another reason BGE chose this device was because other utilities were planning on initiating similar pilot programs.

The FCCP device has a clamp-on current transformer (CT) that can be installed on one wire of the battery dc supply charger cable. A clamp-on CT is shaped like a donut that clamps around an existing wire and measures the current flowing through the wire, this is preferred because wiring does not have to be disconnected. The device continuously monitors for charging current using the clamp-on CT. If the device does not see current for 30 minutes, an alarm is sent indicating a potential open-circuit condition. The principle behind this method is a vented lead-acid (VLA) battery naturally loses charge over time. The BGE battery charger will top off the batteries every few minutes to their nominal voltage. If this charging is not taking place, then an open-circuit condition may be present.

BGE Pilot

BGE started piloting this solution in August 2022 at a substation with only one dc supply. The FCCP device was installed, calibrated and tested within one day of fieldwork. It was installed on the wall of the substation close to the battery terminals, as BGE selected clamp-on CT cables about 10 ft (3 m) in length — although a 50-ft (15-m) option is also available. The CT was oriented to align with the current flow, and the FCCP device was programmed to trigger an alarm if no current flow was sensed for 30 minutes.

BGE engineering developed a standard design for a FCCP box that could be deployed at any facility requiring this open-circuit monitoring functionality. The box consisted of the following:

- Wall-mount-type enclosure that hols all the components
- Multitel FCCP sensor
- Power supply to step down from 125 Vdc supplied by the battery down to 24 Vdc for the device
- Struthers-Dunn relay with contacts rated at the same voltage level as the remote terminal unit
- Various terminal strips for easy connections
- Fuses to protect the device.

The FCCP operating voltage is between 18 Vdc to 60 Vdc. Therefore, the 125-Vdc to 24-Vdc power supply was added to the box to reduce the voltage level to be within the device input range. In addition, the FCCP output contacts are not rated for 125 Vdc, BGE's common battery operating voltage. Therefore, the

Struthers-Dunn relay was wired to the alarm output to convert the 24-Vdc signal to 125 Vdc, so it could be used for SCADA input.

The FCCP box provides all the components necessary for the design to work in a small space on the wall near the battery terminals using dc power from the existing 125-Vdc batteries at the substation. After the initial installation, an improvement to the design was engineered to add a light to the FCCP box indicating the power supply was in working order. As a result, technicians can now easily verify power is available to the unit without having to open the enclosure.

An additional pilot installation was done at another substation using alternating-current power supply to the FCCP device, to test a simpler installation method where dc supply may not be feasible. This solution provides BGE with the means to pilot both power supply solutions, offering the flexibility to use the best design for each substation as necessary.

Moving Forward

Although the TPL-001-5 standard does not require a redundant dc supply or monitoring to be installed at all locations (it just requires the use of this potential failure in analysis), BGE has decided to move forward with installation of open-circuit detection devices as a best practice at all its existing BES substations as well as new substations regardless of whether they are BES or not. For existing BES substations, the installation will occur in conjunction with preplanned relay and remote terminal unit upgrade projects over the next few years. TDW

JOSE ABI KARAM DURAN has worked at Baltimore Gas and Electric Co. for over five years and is currently in the transmission and substation engineering projects area as a senior engineer. Prior to that, Duran worked as a senior engineer in the distribution automation group, where he performed coordination studies for distribution automation reclosers and implemented sensor technology. He focuses on grid automation and intelligent devices. He studied electrical engineering at the Universidad de Carabobo in Venezuela and obtained his master's degree in power and energy systems from New Jersey Institute of Technology in Newark, New Jersey.

ABBAS ZAIDI has worked at Baltimore Gas and Electric Co. for over four years and is currently in the transmission and susbstation cybersecurity area as a section engineer. Previously, Zaidi worked as a senior engineer in the system analysis and support group, where he was the subject matter expert of North American Electric Reliability Corporation PRC-005, PRC-025 and PRC-026 standards and maintained the day-to-day compliance program of relays in scope for these standards. He has previous experience at Exelon Nuclear, where he focused on the cable aging management program of the Exelon Nuclear fleet. He graduated with a BSEE degree with a minor in mathematics from the University of Connecticut and obtained his professional engineering license in electrical power engineering in 2016.

BENJAMIN CARSTENS has worked at Baltimore Gas and Electric (BGE) for the last eight years. He currently works as a section engineer in the transmission and substation regional projects engineering group. His previous experience in BGE's transmission and substation engineering department includes work in the areas of system protection and control, North American Electric Reliability Corporation Critical Infrastructure Protection compliance and large substation projects. He holds a BSEE degree from the University of Maryland College Park and a master's degree in power systems from Worcester Polytechnic Institute.

Aerial photograph of Eolian, L.P.'s Madero & Ignacio battery energy storage facility, a 200 MW/2.5+ hour duration storage system in Texas. Eolian is the developer of PGE's Seaside battery energy storage system, one of the large-scale storage projects recently procured by PGE. Photo courtesy of Eolian, L.P.

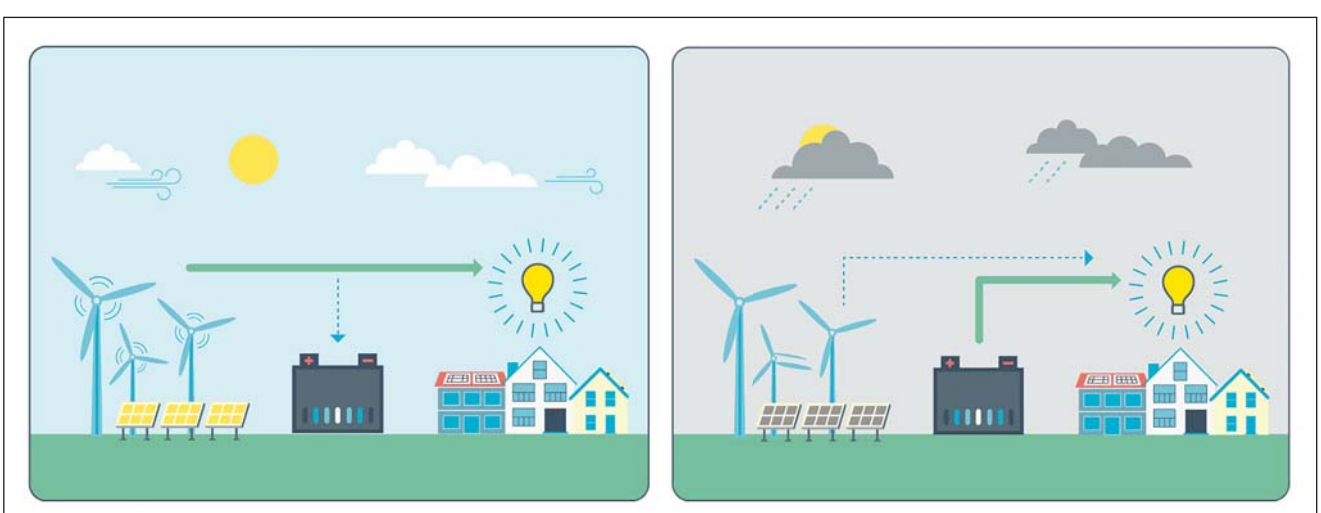
Bolster Reliability with BESS

Portland General Electric uses battery energy storage systems in its portfolio to balance clean energy with reliability and affordability for customers.

By **BRETT GREENE**, Portland General Electric

During the 2021 legislative session, Oregon state lawmakers passed an ambitious decarbonization framework requiring investor-owned utilities to reduce greenhouse gas emissions associated with electricity sold to Oregon retail customers. House Bill 2021 (HB 2021) mandates an 80% reduction in emissions from baseline amounts by 2030, 90% by 2035 and 100% by 2040. Additionally, the law prohibits the construction of new generating facilities producing electric power from fossil fuels.

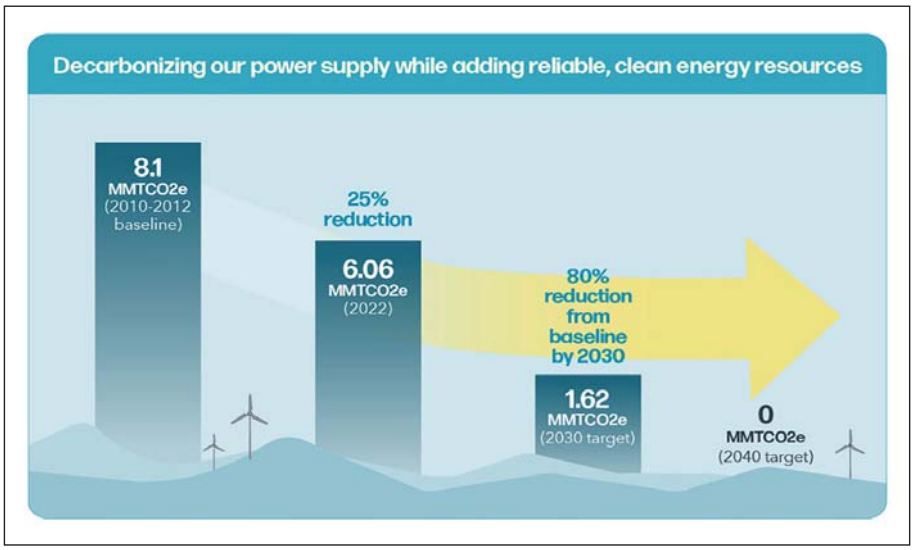
As the state's largest electric utility serving more than 900,000 customers — and a key supporter of Oregon's clean energy legislation — Portland General Electric (PGE) has a steep road ahead



(Left) When the wind is blowing and the sun is shining, most of the electricity generated by renewable resources goes to powering homes and businesses, while excess energy from these resources and other generation sources charges up battery storage projects for later use. Battery power acts as energy reserves, ready to quickly deliver electricity to customers as soon as it's needed. (Right) When less power is available from renewable energy resources, due to weather conditions or unexpected interruptions, batteries step in. Rather than purchasing power from energy markets or relying on other forms of generation, PGE can dispatch stored energy directly to customers. This bolsters reliability, reduces emissions and helps manage costs. Graphic courtesy of Portland General Electric.

to execute on these clean energy targets. Estimates from the utility's 2023 Integrated Resource Plan suggest it will need to add 3500 to 4500 MW of non-emitting resources to achieve the 2030 emissions reduction obligation.

At the same time, PGE remains steadfast in its commitment to deliver clean power in a manner that maintains reliability and affordability for all customers. While adding significant quantities of intermittent renewable resources, such as wind and solar, contributes to its decarbonization journey, additional actions are required to fulfill its duty to serve customers and keep the lights on reliably. That is why PGE recently announced the procurement of 475 MW of battery energy storage systems (BESS) — the second largest procurement of stand-alone battery storage in the U.S. and a critical tool in the clean energy transition.



PGE's 2023 combined Integrated Resource and Clean Energy Plans outline the utility's path to an 80% reduction in greenhouse gas emissions from power served to Oregon customers by 2030. Achieving this target requires PGE to add non-emitting energy resources and capacity at an accelerated pace in order to maintain system reliability while systematically reducing fossil fuel purchases and generation. Graphic courtesy of Portland General Electric.

Adding these battery storage projects to an increasingly clean portfolio of generation resources helps to harness wind and solar energy when it is available and deploy the stored power during times when customers demand and use electricity.

PGE's Resource Portfolio

The planned battery storage projects include Seaside (200 MW), Evergreen (75 MW) and Troutdale (200 MW) — four-hour Lithium-ion battery systems strategically located within PGE's service territory at substations close to electrical demand. Together, these facilities are designed to increase system flexibility for PGE's grid operators to meet changing conditions and help manage costs. These services become increasingly valuable as the region navigates an accelerated clean energy transition, anticipated industrial demand growth, a changing landscape of traditional baseload generation.

While wind and solar will continue to play a key role in generating emissions-free power, the intermittency of these resources presents a challenge. Compared to traditional baseload generation, renewables offer less dependable capacity and have a low correlation with summer and winter peak demands. Expected to begin operation by the end of 2023, PGE's 311-MW Clearwater wind facility in Montana will offer a higher capacity contribution and improved correlation to winter peaks, but it will not fully address the capacity needs required to maintain reliability while integrating intermittent renewables.

In addition to wind, solar and hydropower, PGE's resource portfolio includes five highly efficient natural gas plants representing approximately 1800 MW of nameplate capacity. These facilities will be used to maintain resource adequacy through 2040, operated with a commitment to reduced emissions resulting from fewer operational hours, a cleaner fuel mix and investments in new technology.

These actions support a decarbonized future and reflect a changing reality for Oregon's resource mix — a transition being mirrored across the West as energy providers retire baseload resources and shift their gas plant operations.

In addition to this evolving generation landscape, Western energy markets have experienced increasing volatility driven by regional carbon policies and macroeconomic pressures on gas prices. What was traditionally viewed as one of the lowest cost markets in the U.S., driven by abundant hydropower in the

Battery storage allows PGE to harness and store energy generated from its wind fleet, including the Biglow Canyon Wind Farm, pictured here.

30 MW of battery storage, owned by NextEra Energy Resources, are sited at the Wheatridge Renewable Energy Facility, a first-of-its-scale project to combine wind, solar and battery storage at one location. PGE purchases the output and storage capacity from Wheatridge to serve customers. Photo courtesy of Portland General Electric.

region, is no longer reliably inexpensive, as market participants experience daily, weekly and monthly price fluctuations not seen since the California energy crisis of the early 2000s.

Reliable Battery Storage

Battery energy storage facilities promise to reduce some of this volatility, enabling PGE to optimize the renewable power in its portfolio and deliver electricity even on days when the wind is calm and during the nights and evenings when the sun has set, particularly in the winter. Stored energy can be reliably deployed within seconds to customers during extreme weather events or times of high demand, reducing dependence on energy markets and fossil fuel generation.

Utility-scale BESS projects provide a variety of services that improve reliability, reduce costs and bring flexibility to the grid. Additionally, the location of the BESS projects and timing of commercial operations temporarily defers the need for certain distribution upgrades.

Procurement Challenges

Procurement of these BESS projects resulted from a robust all-source request for proposal (RFP) process, designed to ensure reliable service while meeting existing and growing demand obligations. This process enabled PGE to navigate many obstacles, namely the passage of HB 2021 and its implications for procurement timing and magnitude, as well as broader macroeconomic pressures. For the first time in years, if not decades, prices for non-emitting resources — including BESS — were increasing. Passage of the federal Inflation Reduction Act helped by making BESS projects eligible for the Investment Tax Credit (ITC). All the while, global supply chain disruptions introduced uncertainty as to when major project components manufactured outside of the U.S. (for wind, solar and BESS) could be delivered.

In spring 2023, PGE executed agreements for 475 MW of four-hour Lithium-ion BESS projects at competitive prices and on timelines to satisfy growing customer needs. Working with experienced industry counterparties and BESS manufacturers proved essential in navigating the challenging procurement environment.

Project Details

- Seaside is a 200-MW resource that will be owned and operated by PGE, located in North Portland, Oregon, and interconnected to the Rivergate substation. The project has been in development by Eolian, LP, since 2017, and PGE customers are receiving the benefits from the federal ITC. It is scheduled to begin service by mid-2025.
- Evergreen is a 75-MW resource that will be owned and

In addition to procuring wind, solar, and battery storage, PGE is also investing in the performance of its hydropower projects, including the recently modernized Faraday Powerhouse – a 116-year-old hydropower facility on the Clackamas River. This multiyear restoration effort improved the efficiency and seismic safety of the historic plant. Photo courtesy of Portland General Electric.

operated by PGE, located in Hillsboro, Oregon, and interconnected to the soon-to-be-constructed Evergreen substation. The project has been in development by PGE since 2019, and PGE customers are receiving the benefits from the federal ITC. It is scheduled to begin service by the end of 2024.

- Troutdale is a 200-MW resource that will be owned and operated by a subsidiary of NextEra Energy Resources, located in Troutdale, Oregon, and interconnected to the Troutdale substation. PGE will acquire the output from the resource under a 20-year contract. The project has been in development by Eolian since 2018, and service is scheduled for the end of 2024.

Building For The Future

The addition of three utility-scale BESS projects accelerates PGE's position as a clean energy leader, balancing clean energy, reliability and affordability for all customers. The BESS projects increase diversity within the utility's generation portfolio while delivering additional operational flexibility.

PGE will continue adding non-emitting resources through its current all-source RFP, a draft of which was filed with the Oregon Public Utilities Commission in May 2023. The utility anticipates robust participation from wind, solar and BESS developers, and it looks forward to achieving further progress on the path toward meeting Oregon's clean energy targets. TDW

BRETT GREENE is senior director of Clean Energy Strategy and Commercial Initiatives at Portland General Electric, Oregon's largest electric utility. In this capacity, Brett and his team are responsible for negotiating agreements to add new and existing regional resources through complex structured transactions. Brett's leadership is focused on delivering a clean energy future for all PGE customers.

IVM: A Blueprint for Continuous Improvement

OG&E has enhanced service reliability, cost efficiency and sustainability through IVM — and there's still room to grow.

By **GRANT EHLEN**, OG&E and **LUCAS MADISON**, Corteva Agriscience

In the early 1990s, Oklahoma Gas & Electric (OG&E) used a variety of vegetation control methods to prevent incompatible plant species from interfering with right-of-way (ROW) accessibility and the reliability of electrical service. At the time, about one-third of the utility's vegetation management budget was dedicated to herbicide applications. These chemical control methods assisted mechanical mowing and tree-trimming practices to help OG&E reduce the density of incompatible trees, such as hackberries, elms, mulberries and oak species, throughout the utility's ROW corridors.

Chemical control strategies helped OG&E enhance the control of undesirable woody plants. However, the formulations and treatment methods used to support herbicide applications 30 years ago were far less selective than they are today, which periodically contributed to off-target control issues for the investor-owned utility. Similarly, mechanical control methods damaged desirable plants, including plum, sumac, honeysuckle and other compatible tree species.

The mowing and tree-trimming practices employed by OG&E also stimulated regrowth and seed spreading for targeted plants. These adverse effects gradually increased maintenance requirements and associated costs, which reduced the amount of budget available for herbicide treatments. Eventually, all resources were reallocated to help the utility keep up with trimming and mowing maintenance demands.

Reverting to trimming and mowing as primary vegetation control strategies proved costly for OG&E. Without the help of selective herbicide applications, the utility saw incompatible plants return in full force, reducing visibility for aerial transmission line inspections and limiting site accessibility for distribution and transmission maintenance crews. These recurring issues ultimately led the utility to reintegrate selective herbicides as its chief strategy for vegetation control.

"We learned that working exclusively with tree and mowing crews is likely to lead to higher stem counts," said Shawn Huff, supervisor of vegetation management for OG&E. "They can only

do so much, and they only deal with immediate problems — not future problems. We can't even come close to achieving our goals without herbicides."

A New Beginning with IVM

Since 2019, OG&E has used a variety of chemical control strategies as part of the utility's integrated vegetation management (IVM) program. This approach is structured to enhance mechanical mowing results and mitigate some of the most prevalent threats to electrical service reliability throughout the utility's 30,000 square-mile transmission and distribution service territory. After initially using high-volume foliar applications to reclaim areas filled with dense and incompatible brush species, OG&E and contract partners integrated the following herbicide applications to further refine the utility's IVM-based approach:

- Ultra-low volume wire zone spray trimming and chemical side-trim applications to selectively control limbs or sections of trees posing a threat to service reliability
- Tree growth regulator applications to control regrowth in trimmed trees
- Bareground applications to control all vegetation on substations, including persistent thistle species

A few months after application, Quality Assurance (QA) teams audit each treatment site to confirm the targeted area received 100% coverage. QA then audits treatment sites the following year to determine if applications achieved the utility's goal of 90% control.

Low-volume spray trim applications in the wire zone allow OG&E to control only portions of trees that pose a threat to impact overhead power lines. Photo courtesy of OG&E.

Applying herbicides to the lower 12 to 15 in. of a targeted plant stem's base after mechanical control allows vegetation managers to eliminate resprouting and the risk of vegetation regrowth. Photo courtesy of Corteva.

Field results have shown that foliar season applications used by OG&E have helped Oklahoma's largest investor-owned utility reduce the need for tree-trimming practices. While tree crews still work in urban and rural areas to control overhanging limbs or heavy growth impacting minimum approach distance to energized wires, licensed personnel now follow those treatments with a variety of selective herbicide applications to enhance easement reclamation.

While OG&E plans to continue transitioning from mechanical control methods to higher-reaching drone applications for wire zone spray trimming and chemical side-trim treatments over the next five years, the utility is already reaping the economic benefits of using selective vegetation control strategies throughout the foliar season. But of all the herbicide treatments OG&E currently uses to control undesirable plants, Huff has found significant value in treatments applied from late fall to early spring.

"We are seeing a phenomenal return on investment with our dormant-season work," he says. "Since we can do those treatments at any time of the year, we're not as restricted to tight treatment windows."

Applying low-volume basal bark, cut-stump and cut-stubble treatments throughout the dormant season helps OG&E control incompatible brush species. As a result, the utility's contract partners can keep working throughout the winter months and enhance the future control of brush-sized tree species without sacrificing cost efficiency. "We're able to cover thousands of miles during the dormant season," Huff said. "We're talking tens of thousands of stems that are now controlled and no longer a problem for us. We've had zero complaints with our dormant-season work, and we're able to treat at a very low cost per mile. We just can't get that with the tree crews."

Perhaps most notably, dormant-season applications help OG&E impede the reestablishment of incompatible vegetation in the spring by supporting the development of desirable plants that facilitate biological control: beneficial grasses and forbs.

Strengthening a Grass-Friendly Approach

Unlike nonselective control methods, selective herbicide applications and grass-friendly brush mixes can help utility vegetation managers create barriers against woody plants

OG&E only relies on tree-trimming crews to control the tops of trees that herbicide application equipment is unable to reach. Photo courtesy of OG&E

and reduce off-target control risks. This supports the development of grasses and small forbs that prevent woody plant seed germination and provide habitat for small mammals that consume the seeds of incompatible brush species.

Results from long-standing environmental research studies also indicate the potential benefits IVM programs can provide throughout utility ROW. Findings from the State Game Lands 33 (SGL 33) research project, which has studied the ecological impact of various vegetation management strategies on utility ROW for nearly 70 years, show how using selective herbicide applications as part of an IVM-based approach can successfully lower viable woody plant seed germination by as much as 88%. These results yield landscapes in which low-growing native plant communities can thrive.

"IVM is a system of land management processes for establishing compatible plant communities," says Darrell Russell, market development specialist, Corteva Agriscience. "While mowing exclusively can impede native plant development, targeted applications of selective herbicides support this desirable vegetation by selectively controlling incompatible trees and brush species. This 'grass-friendly' approach creates landscapes in which beneficial grasses and forbs can thrive."

As a long-time funding partner of SGL 33, Corteva uses results from the extensive environmental study to help OG&E and other utilities develop treatment plans and communications tactics that keep all entities strategically aligned.

"The most value I get from Corteva is in the training, knowledge and resources they provide to help us understand what is taking place out in the field," Huff said. "From applicators and planners to foresters, myself and those above me, they're embedded in our program across the board."

In recent years, Corteva's vegetation management specialists have helped Huff identify different chemistries and selective tank mixes to enhance results and cost-efficiency for the OG&E program. This support has included the introduction of a foundational mix for grass-friendly brush control as well as product and tank-mix recommendations to enhance results for chemical side-trim, basal bark and cut-stump treatments used by the utility.

While Corteva helps OG&E get planners up to speed on recommended products and treatment methods from one season to the next, the utility pays for contractors to go to training and learn more about the chemistries and application strategies they're using. For Huff, these educational opportunities are essential.

"We're able to get ahead of public concerns by simply educating our partners on the products and strategies we want them to use," Huff said. "Our applicators are also well-educated on tank mixes, which allows them to talk through landowner concerns."

As Huff indicates, educational opportunities provided to program partners help OG&E improve not only results in the field, but also public perception.

Improving Landowner Relations

Utility companies commonly encounter varying degrees of public scrutiny. From infrastructure disputes to environmental concerns, today's utilities are often judged on misperception or misunderstanding — especially when herbicide applications are the topic of discussion. However, Huff has learned that simply explaining how selective herbicide applications enhance service reliability and environmental sustainability can pay dividends for practitioners when addressing customer concerns.

"People just want more information," Huff said. "Once we've provided it to them, they're usually more comfortable with what we're doing."

This notion increases the value of the grass-friendly approach OG&E has strengthened over the past few years. Chemical side-trim applications and dormant-season treatments used by the utility have reduced brownout effects and minimized off-target control issues. As these strategies also support the development of beneficial grasses and forbs, OG&E

has been able to limit the potential for landowner complaints.

"I've spoken with property owners who may not agree with the fact that we've controlled their tree, but when they understand our thought process and see that the grass is still there the following year, it makes a huge difference," Huff said. "It's hard to stand there when everything's browned-out and we can't say that we didn't hurt the grass. Thanks to the herbicide treatments we're using now, we've gotten a lot better at handling those types of complaints."

Supporting the development of low-growing native plant communities also enhances long-standing biodiversity initiatives OG&E has worked on to preserve and expand habitat for native wildlife. In fact, when representatives with the State of Oklahoma found the frosted elfin butterfly (*Callophrys irus*) along with wild indigo on one of the utility's solar farms last year, OG&E applied herbicides to remove incompatible vegetation before planting more wild indigo to develop additional habitat for the endangered pollinator species. "After finding a new colony that nobody knew existed, we disturbed the environment the least amount possible," Huff said. "The frosted elfin butterfly benefited from that greatly, and it solidified with our environmental group that we're approaching vegetation management the right way."

Resetting Industry Standards

From budget restrictions and landowner concerns to skilled labor shortages and program efficacy issues, a variety of formidable challenges can impact the success of UVM programs from one year to the next. But as far as Huff is concerned, IVM strategies featuring selective herbicide applications represent best management practices for industry leaders looking for ways to improve results and program flexibility in the near and distant future.

"It's a minor increase in costs upfront, but the long-term benefits are huge," Huff says. "When we have retractions in our budget, I cut zero dollars from our herbicide business. The benefit of getting that work done is so great that I'd rather have fewer tree crews than fewer herbicide crews. It's more important for me that I get that work done." TDW

Editor's Note: To learn more about successful herbicide programs and management techniques that help utility vegetation managers enhance service reliability and beneficial wildlife habitat, visit *HabitatWithHerbicides.com*.

GRANT EHLEN (*ehlengs@oge.com*) is a vegetation management supervisor with Oklahoma Gas & Electric (OG&E). Equipped with a master's degree in forest resource management from Oklahoma State University, and more than 35 years of experience in forestry and vegetation management, Ehlen oversees the vegetation management Quality Assurance program for OG&E, which currently has nearly 860,000 customers.

LUCAS MADISON (*lucas.madison@corteva.com*) is a vegetation management specialist with Corteva Agriscience. Madison uses more than 13 years of experience with forestry and agricultural solutions to provide technical support, product recommendations and industry best practices to vegetation management customers throughout Arkansas, Missouri and Oklahoma. He is based in northern Arkansas.

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AUGUST 2023

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Southern California Edison: Storm Strategies

OUR AUGUST FEATURED LINEWORKER

MD Rana Kabir

IBEW Local 3

- Born in a small village in Bangladesh.
- Has two brothers and two sisters and was raised by his uncle and his family after losing his parents early in life.
- Married to his wife, Nadira, and they have a son and daughter.
- Enjoys playing Cricket and riding his bike.
- Came to the United States in 2006 after finishing college in Bangladesh.
- Has no relatives who work in the utility industry.
- Nominated by Apprentice Daniel Walsh, who describes him as a humble, hardworking and experienced lineworker who taught him many great lessons in both the trade and in life.

MD Rana Kabir works in the heart of New York City as a lineworker for E-J Electric and IBEW Local 3.

Day in the Life

As a journeyman lineman for E-J Electric and Local 3 in New York City, my responsibilities are to teach apprentices, help my working foreman produce quality work, make sure the job site is properly set up and ensure everyone involved in the job is wearing proper personal protective equipment. On a daily basis, our main job is maintaining the distribution line, which includes setting new poles, replacing old poles, installing and replacing transformers, pulling wire, reconductoring, installing line safety equipment and risers and splicing overhead primary cable.

Challenges and Rewards

I think the main challenges are keeping the customers happy, working safely as a group and returning home without any harm. I count smiling faces as rewards when people get their power back after long, cold nights.

Safety Lesson

One day, I witnessed one of our journeymen linemen moving a big material box over a parked car. Suddenly, the sling broke and damaged two cars. Fortunately, no one was hurt. Since then, I never try to carry loads over anything that can cost lives or money. I always check load limits of slings or equipment.

Memorable Storm

In 2017, we traveled to Puerto Rico to restore power after Hurricane Maria caused significant damage to the island. People lost not only electricity, but everything they had in the devastating storm. All the roads and bridges were damaged by excessive floodwater, and plants and crops were destroyed. When we arrived, we saw their smiles, which they had never lost. We were welcomed by them, and they worked with us side by side to restore power. That was the best storm experience of my career. The people of Puerto Rico know how to smile after losing everything. I think that's the power of survival.

Tools and Technology

I think every tool is important in its own way. Nowadays, people are getting more reliant on electric tools, which is good for productivity, but nothing is wrong from using all the tools lineworkers have been using for decades.

Plans for the Future

I like to work with people, and I enjoy being outside. I also love exploring new places, which I get to do as a storm chaser. I'm currently working on energized distribution lines but would like to work on the transmission system in the future. TDW

Editor's Note: If you are interested in being profiled in our monthly Lifeline department or know of a journeyman lineman who would be a good candidate, email *T&D World* Field Editor Amy Fischbach at *amyfischbach@gmail.com*. To thank linemen for their dedication to the line trade, Milwaukee Tool sends each profiled lineman a tool package.

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Storm Strategies: Part 1

Southern California Edison shares its story on how it restored power swiftly and safely following back-to-back storms.

By **AMY FISCHBACH** , Field Editor

Across America, lineworkers respond to severe weather emergencies year-round. In our two-part Storm Strategies series, we are highlighting two recent storm responses — winter storms in California and a tornado in Oklahoma.

Not long ago in California, fallen trees toppled power poles during back-to-back winter storms. The storms inflicted 1,364 outages impacting 525,316 of the 5 million Southern California Edison (SCE) customers.

Before the first snowflake dropped, however, the utility was prepared for anything that Mother Nature could throw in the way of the line crews.

"We knew that this storm was going to be significant, and that's why we took several steps to ensure we could safely and reliably supply electricity to the communities we serve," says Gabriela Ornelas, spokesperson for SCE.

Mobilizing Crews and Materials

Southern California Edison began mobilizing its incident management team on Feb. 21 before the storm's forecasted arrival in the service area. To prepare, the company pre-deployed crews in areas expected to be hit the hardest, including the mountain communities of San Bernadino, California, and the Sierra.

"About 1,000 field crew members were on standby to respond to issues as they emerged," she says.

Case in point: Grapevine, which has a mountain pass on I-5 connecting north and southern California was shut down during the storm. Because SCE serves two communities north of Grapevine — Tulare and Kernville — the utility transported additional equipment and supplies ahead of the storms.

SCE also prepared its distribution operation centers, substations, customer contact centers and other facilities so that its teams were ready to aid customers. Liaison officers also coordinated with county emergency management agencies in advance of the storm conditions and throughout the event. The utility coordinated in advance with Santa Barbara, Kern and Los Angeles Counties, CalTrans, the California Highway Patrol and other local officials and regional utilities.

"We worked very closely with local agencies to safely restore service and support affected customers," she says. "We continued working together through the duration of the winter storms."

An SCE crew responds to a transformer repair in Lomita, California, during the storm.

Prioritizing Safety

The extreme weather conditions created hazards ranging from flooding to mudslides to avalanches.

"We were always in contact with our front-line crews and knew their location and any safety concerns as well as checked in with employees who live in evacuation and high-hazard areas," Ornelas says.

SCE also checked available resources to ensure it had sufficient coverage to respond to storm impacts to its system and customers, both during the day and overnight. This helped the utility to continue its response to outages when weather persisted through the night and minimized impacts to SCE's customers.

Pre-planning resources was critical to SCE's storm response. This included

staging crews and additional equipment in parts of its service area that had experienced access issues due to road closures during previous storms, which would have prevented field crews from reaching those areas to repair and restore service. The lineworkers relied on snowshoes, ATVs equipped with snow tracks and snowcats to reach repair sites in areas that received several feet of snow.

In addition to the crew members in the field, SCE's Air Operations provided support to assess the extent of snow damage caused to electrical equipment when conditions were safe for flying. The team also assisted with restoration efforts in Lake Arrowhead and the Mono Basin area.

A flatbed truckload of transformers is en route to SCE's Antelope Valley Service Center to be used for storm repairs.

The accumulation of snow restricted the crews' ability to safely access repair sites, leading to extended restoration times for some customers. In some areas, crews also encountered unsafe conditions due to heavy snowfall and low visibility.

"Our crews continuously assessed these conditions and moved forward with repairs as soon as it was safe to do so," he says. "Our first priority in these dangerous conditions was to make sure our team members remained safe — and that was paramount."

Avalanche warnings in Mono County also affected restoration efforts because SCE requires avalanche conditions to stabilize and access roads to be cleared before crews can safely reach the work area. To restore service to its Bridgeport customers quickly and safely, SCE fed power from its Lundy Hydroelectric Powerhouse and eventually with the use of temporary diesel generators.

Evaluating the Storm's Impact

While storms roll into SCE's service territory often, the February 2023 storms were more severe, widespread and affected many of the utility's customers and communities, from Catalina Island to Lake Arrowhead and from the Grapevine to Mammoth, California. In addition, these storms produced low-elevation snow — as low as 1,000 ft — in areas that don't normally get this kind of precipitation and

This view shows SCE's Lake Arrowhead Service Center during the storms.

The Lundy Substation in Mono County is covered in snow from the storm.

blizzard warnings for the Los Angeles and Ventura County mountains.

At the same time, however, the wet and snowy weather led to high moisture content on the ground, which helped with wildfire mitigation.

"These storms brought with them significant hazards and impacts to our customers, but an additional effect was that they brought precipitation to California's parched vegetation," Ornelas says. "Some areas experienced more than 300% of their average precipitation this winter and preliminary measurements show the Sierra snowpack is at about double the usual levels."

The fuel moisture content indicated the wildland grasses would remain green for several more months past the winter storms, even without additional precipitation. The SCE fire scientists forecasted no significant wildfire conditions from February through April. The utility is now continuing to monitor vegetative fuels as they dry out through the rest of the year.

SCE had about 1,000 crew members throughout its service area dedicated to restoring power during the storms.

Given the extreme nature of the weather and storms SCE has seen so far this year across its service area, its system held up well, Ornelas says.

"Our teams work hard during clear weather to harden our grid, and those infrastructure repair and replacement programs helped us minimize the impact to our customers," she says. "That work is never done, and we'll continue working to ensure we can deliver safe and reliable electricity to our customers and communities, while keeping our team members safe." TDW

AMY FISCHBACH (*amyfischbach@gmail.com*) is the Field Editor for T&D World magazine.

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Parting Shot

Photo by **KENDRA RANDOLPH**, SLTC

A student in Class 71 of Southeast Lineman Training Center's 15-week Electrical Lineworker Program works on crossarm construction. The class builds on the foundations of line work.

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High voltage cables have to be prepared for future power flows and changing demands. Photo courtesy of ewz.

Switzerland's Largest City Plans 2050 Target Grid

Switzerland's ewz uses data, calculations and simulations to define cable requirements and to develop its 150-kV grid of the future.

By **KLAUDIA MADEIRA BEIN**, **BRITTA HEIMBACH**, **JUERG DIETER BADER**, **ANDRI J. CASURA** and **RAFFAEL LA FAUCI**, ewz

As the distribution system operator for Zurich, Switzerland, ewz is developing its 150-kV grid to meet estimated demand in 2050. This grid of the future must also meet ambitious goals the city of Zurich has set for energy efficiency, sustainability and reduction of carbon emissions. To reach these goals, renewable energy (mainly photovoltaic systems), electric vehicles (EVs) and electric heat pumps have been identified as important focus areas. As the distribution system operator, ewz must provide the necessary infrastructure.

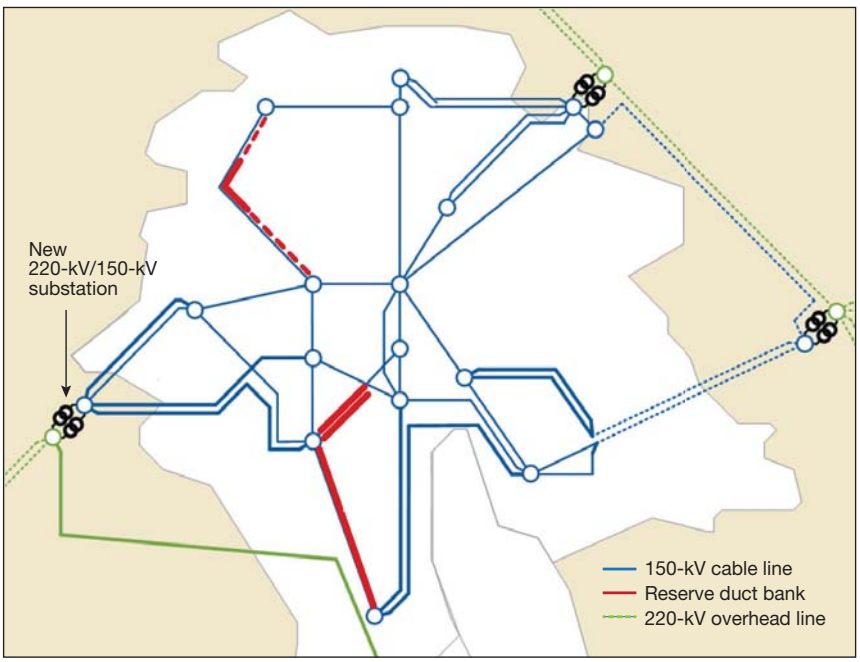
Additionally, a major change is planned for the network topology of Zurich's 150-kV distribution grid. Today, four coupling substations connect the 150-kV grid to the national 220-kV grid. Two of the stations are in the south, far outside the city of Zurich. From these, energy is transmitted through the 150-kV lines to the city. A new 220-kV/150-kV coupling substation right at the border of Zurich will replace them. The type and number of cables connecting this new coupling substation to the city must be planned.

Regulations regarding magnetic field emissions are strict in Switzerland. Therefore, ewz decided the cable type for its future high-voltage grid must be changed. Instead of single-core cables, three-core cables will be used because they do not require additional shielding. To make this change, ewz had to define completely new cable requirements that would be suitable for several decades, handling power flows today and well into the future.

Maximum Cable Current

One aim was to achieve a rated cable current as high as possible with a given conductor diameter. Thus, cable load and loss factors — both derived from load profiles — were used. The load factor is the ratio of the average current per day to the maximum current. The loss factor includes thermal inertia.

For permanent operation mode at full capacity, the factors are equal to one. For partial load operation mode and limited times of high demand, their values are below one. If these operation modes are applied to the same cable, the partial load allows a higher ampacity of the cable. To increase the rated current for a given cable size, not only the rated current but also the load factor is needed. Therefore, the future load and future load profile needed to be estimated.



A new coupling substation at the city border.

2050 Expected Demand

As electrical supply must be available in all conditions, the maximum load or production case was used for planning purposes. In Zurich, the maximum demand occurs during a cold and cloudy winter period, including high demand from electric heat pumps and electric vehicles but nearly no production from photovoltaics.

To estimate the city load in 2050, ewz used various scenarios with expected consumption and production for the future. The scenarios included a substantial load rise from increases in population, building density in the city and electric vehicles becoming 90% of vehicles on the road by 2050.

Thanks to Zurich's municipal structure plan, ewz was able to evaluate the effects of an increased population. The city is divided into building zones, and the municipal structure plan determines the maximum building floor space for each zone. With the planned increase in building density, the maximum floor space of buildings also is expected to rise. The potential for city load growth is in the zones where the maximum allowed floor space has not been realised yet.

Furthermore, the municipal structure plan assigns domestic and commercial building utilization to the zones. For both purposes, load densities (volts-ampere/sq m) were defined and assigned to the building floor spaces of the zones (sq m). As a result, ewz was able to aggregate the load for domestic and commercial purposes for each zone. The expected EV loadings, with load management, were added to these zone loads. The final zone loads were assigned to the city substations.

To establish substation load profiles, the domestic, commercial and EV loads were aggregated proportionately with corresponding profiles. Considering EV load management, ewz estimated a proportion of EV charging would be shifted into the night.

All zones with their accumulated loads and profiles were assigned to city substations. The sum of the substation loads provided the maximum possible city load. In the next step, this maximum possible city load was adjusted to the expected city load from the reference scenario in 2050. The substation loads were weighted accordingly. The results for each substation were

150-kV three-core cables before installation. Photo courtesy of ewz.

a maximum load and an aggregated load profile. After defining the substation loads and 24-hr profiles for 2050, the model was ready for use in the planning process.

Planning Requirements

To determine the critical cable loadings, planning requirements were established. Emphasis was put on outage conditions, during which the security of supply should still be guaranteed. These conditions strongly depend on the topology of the grid.

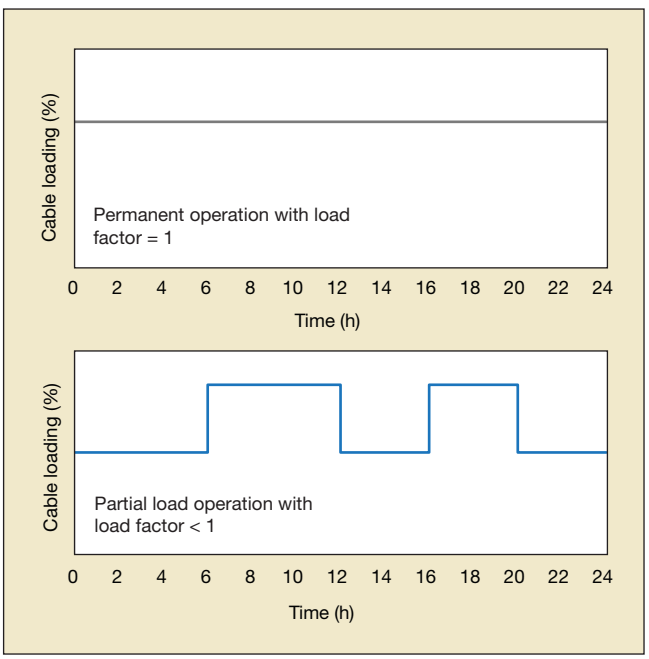
For the city of Zürich, high-voltage cables were separated into two groups and different planning requirements were applied:

- 150-kV cables connecting a coupling substation to the substations in the city — As these cables supply the city, they needed a high-rated current. Even if one of the connecting cables were to go out of service, the coupling substation should still feed its assigned load.
- 150-kV cables within the city, linking the substations — As this part of the grid is meshed, these cables transport less energy and require a lower-rated current. If any cable were to fail, the grid should remain in operation and stay within the cable capacity limits. In Zurich, because of frequent urban construction, several cables at a time often must be put out of service to ensure safety. Depending on the location of construction sites and taking into consideration the possible outage of a cable, the worst-case condition is one cable supplies a substation.

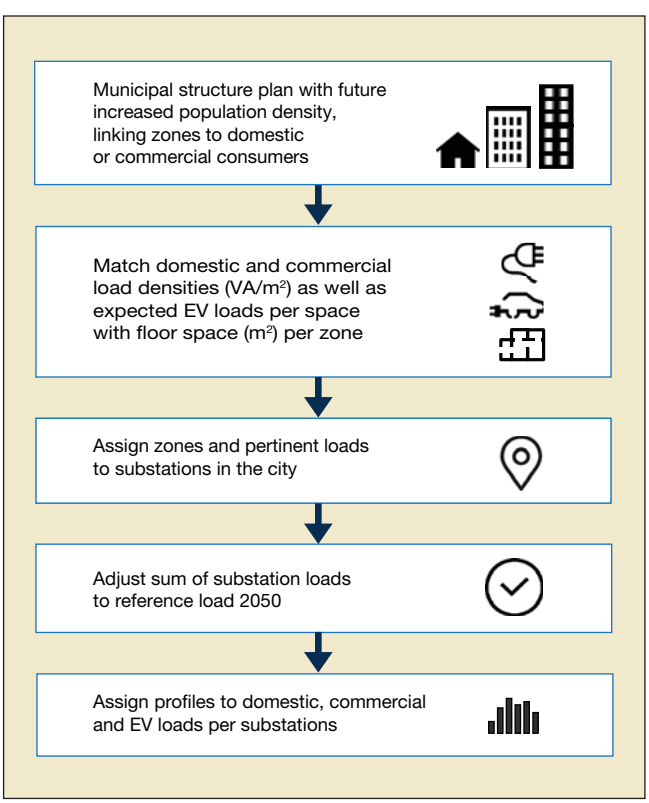
According to the planning requirements, the number of cables connected to a substation was assumed:

- For the new 220-kV/150-kV coupling substation, the number of cables in operation and the maximum coupling transformer power provided an estimated cable current. The number of cables was adjusted to make sure this cable current would be available.
- For the substations in the city, it was determined in the planning requirements that one cable in operation should be capable of feeding the maximum expected substation load — thus resulting in an estimated cable current (which was lower than that of the coupling substation).

These estimated currents were verified with load flow simulations.



Load profile for permanent operation and an example for partial load operation.



Deduction of expected load and profile per substation based on the municipal structure plan.

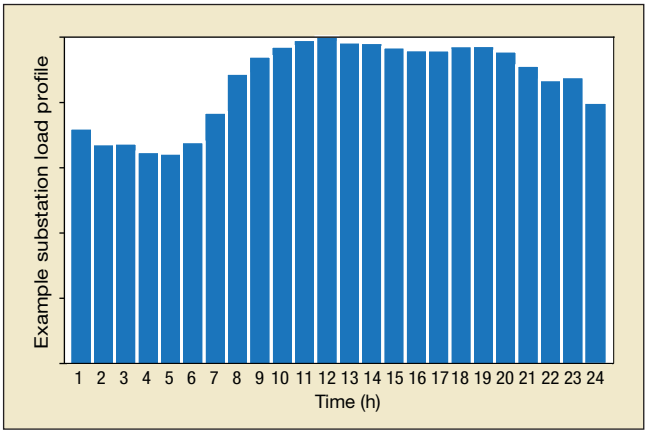
Load Flow Simulations

Load flow simulations for 24-hr profiles were performed according to the planning requirements. To switch the cables off and on for calculations, the load flow software was controlled by a script. The simulations for each cable in 24 hourly currents per day resulted in about several thousands of values in total.

To evaluate this large amount of load flow data, the calculated maximum current for cables was visualized in one distribution graph, from lowest to highest current. The same approach was taken for the cable load factor and cable loss factor of the cables. They were calculated from the 24 current values per day for each cable and case, and then shown as distribution.

These graphs were put together for cables connected to coupling substations on the one hand and for meshed cables in the city on the other hand. Then the distributions were compared to the respective estimated cable current. Results were especially interesting for the parallel cables, which lead from the coupling substations into the first city substations. About 50 % of load flow currents exceeded the estimated current. As these cables have different lengths and types — and, therefore, varying impedances — their maximum currents were highly unevenly distributed. It showed the estimated current did not account for any nonideal behaviour of the cables.

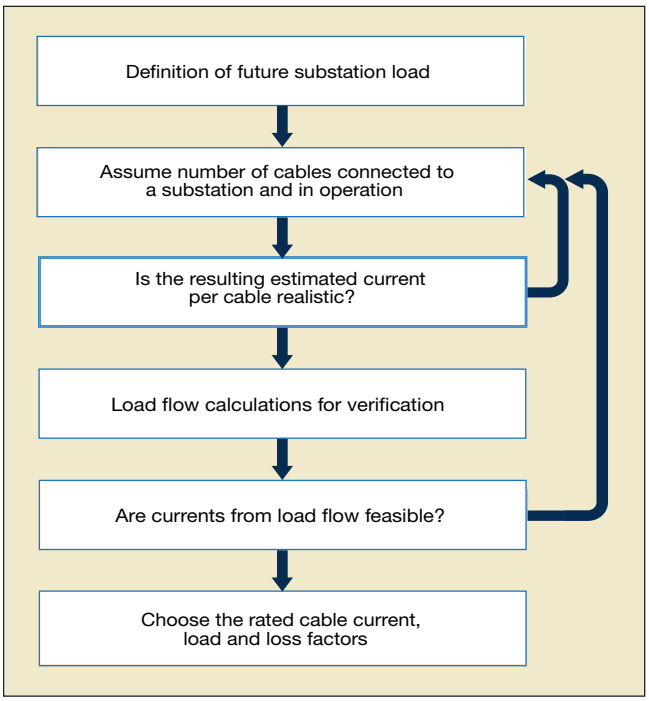
Again, it was the aim that rated current would be available and realistic. The final cable rating was chosen in a way that 90% of the currents from load flow calculations were smaller or equal. For the last 10% of load flow calculation currents above the chosen rated currents, it was decided additional measures would be investigated.



Example for an expected substation load profile in 2050.

For the meshed cables within the city, the load flow simulation resulted in a current distribution below or equal to the estimated current. Therefore, it was defined as the rated current for these cables.

With the chosen rated currents, cable load factors and loss factors from the 24-hr time load flow simulation currents were calculated. The rated load and loss factors were determined in a similar way to the rated current, so again, 90% of the calculated factors were below the chosen rated value. To have consistent factor requirements, the same load and loss factors were defined for all cables.



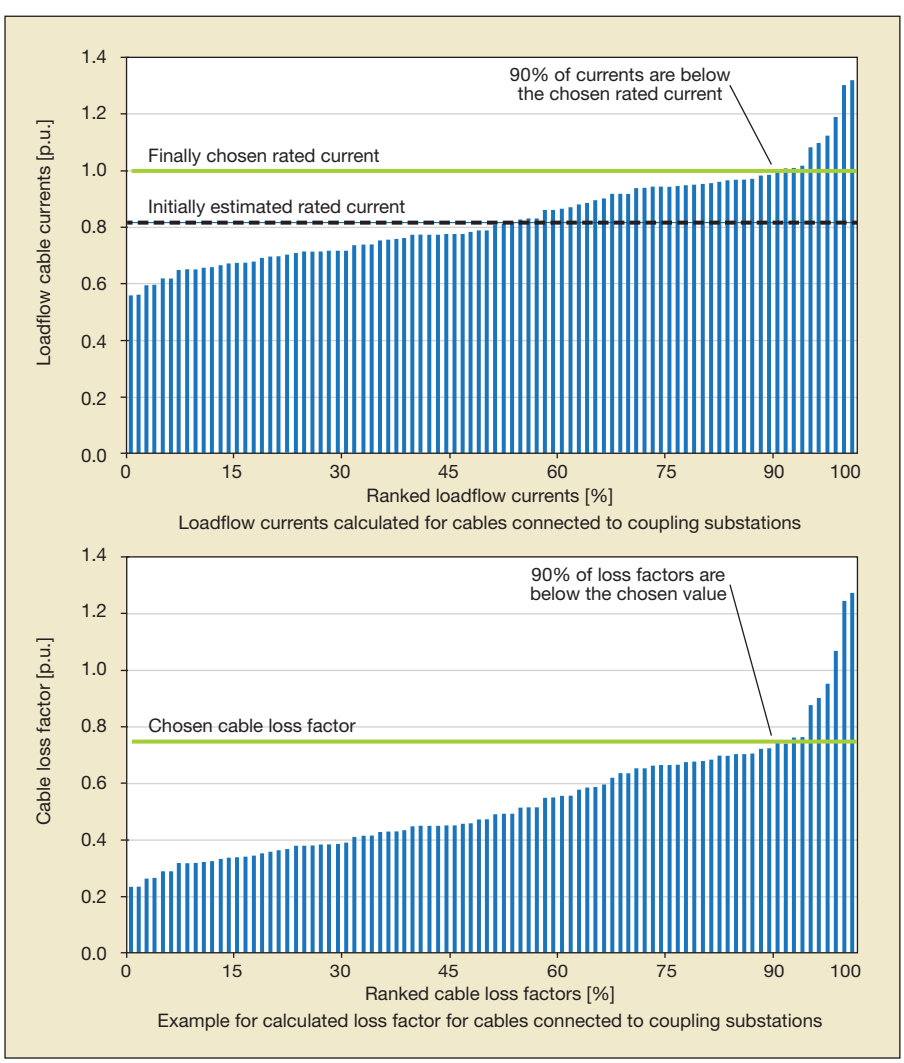
Process to determine cable requirements based on the municipal structure plan.

When analyzing the hourly currents for the cables within the city, no violations of the chosen rating were found.

The Target Grid

For 150-kV cables connected to the new coupling substation, which have different cable types and lengths, it became clear to ewz that load flow simulations were essential to perform because of the highly uneven current distributions. Thanks to the cable load and loss factors, determined from the hourly time simulations, a higher cable ampacity was achieved.

Based on the cable requirements, ewz developed a 150-kV target grid. It will serve as the backbone of the electric infrastructure to provide energy for a growing population and enable an increase in renewable energies and a reduction of carbon emissions in the city of Zurich. TDW



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BY **STEVEN WATT**, SENTIENT ENERGY

It is hard to ignore extreme weather events and natural disasters — and their effect on power delivery to customers in many regions.

Intelligent Line Sensing for Underground Reliability

Savings associated with reductions in customer minutes interrupted and O&M costs more than offset the price of intelligent line sensors.

With the start of the 2023 hurricane season and record-breaking heat already setting up another concerning wildfire season in the Western U.S., it is hard to ignore extreme weather events and natural disasters — and their effect on power delivery to customers in many regions.

A ScienceDirect peer-reviewed paper published in May 2023, "Shedding Light on the Economic Costs of Long-Duration Power Outages: A Review of Resilience Assessment Methods and Strategies" highlights the effects these events have on the country's power system. Unsurprisingly, the paper states, "Within the United States, many natural disasters cause long-duration outages such as hurricanes in the Southeast, freezing temperatures throughout the country, and wildfires, heat waves and earthquakes in the West. The impacts of these outages are numerous, including financial impacts, infrastructural impacts and societal impacts."

Undergrounding is costly at an average of US$1.1 million per mile in urban areas and upwards of $6 million per mile in particularly challenging areas, according to a recent Guidehouse Insights article. Leading utilities like Florida Power & Light Co. (FPL), Dominion Energy Inc. and many others have determined the reliability improvement benefits are well worth the cost, with FPL citing 50% better day-to-day performance and 85% better performance during hurricanes.

While utilities see measurable reliability improvements on their strategically undergrounded distribution lines, they may not be aware system visibility through intelligent line sensing can maximize those improvements. When it comes to undergrounding initiatives, utilities should consider the following:

- Bathtub-curve system failure rates
- Challenge of finding and fixing underground faults
- Identification of overhead vs. underground faults at key transition points
- Load monitoring for more effective system planning and asset management.

Reliability Considerations

Although overall fault frequency on underground distribution systems is significantly lower than with overhead lines, two reliability issues specific to undergrounding should be kept in mind:

1. As with other mechanical and electronic systems, underground circuits are susceptible to reliability issues like those represented by a bathtub curve. The bathtub-curve system failure rates for underground systems are higher in early and later

life, while lowest in midlife. For new undergrounding projects, the concern is the relatively higher system fault rate in the early-failure period.

2. While underground outages are significantly less frequent, outages that do occur are typically longer. These faults are more difficult to locate and often take more time to repair. It is not uncommon for utilities to see outages on underground distribution systems last an average of 2.2 times longer than on overhead systems. With fault frequency being approximately one-ninth that of overhead lines, reliability expectations are understandably high for new undergrounding projects. However, a doubling in outage durations can be an unwelcome surprise to customers when a fault does occur.

The good news is reliability impacts associated with the bathtub curve and resulting underground fault location as well as the outage duration challenges can be effectively addressed with intelligent line sensing that provides near-real-time visibility and valuable system data.

Augment With Technology

Overhead and underground intelligent line sensors provide visibility of key points along distribution feeders. When deployed at transition points, overhead line sensors help utilities quickly to know whether faults are overhead or underground.

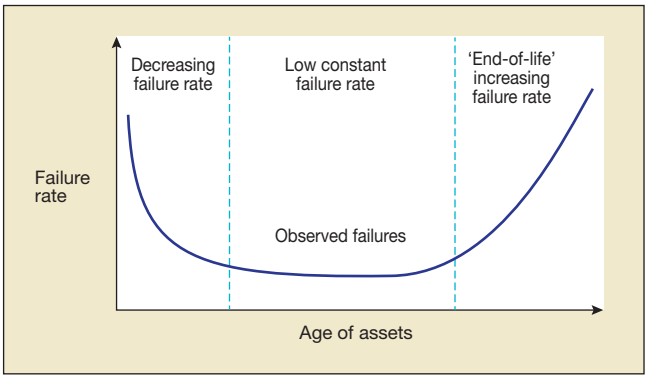
For example, visibility of underground distribution feeders can be improved with intelligent line sensors installed in switch cabinets or vaults. Downstream of the feeder switches, into single-phase underground residential distribution (URD), line sensors can be installed in transformer cabinets for enhanced residential system visibility. Both sensors wirelessly report faults, provide precise location data and load data to a central sensor management software application.

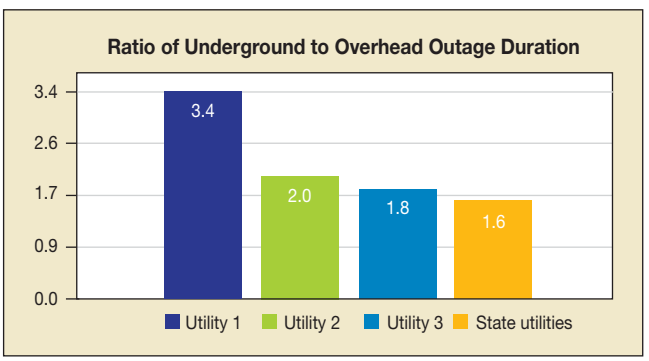
Fault Detection And Location

Fault detection and location information enables quicker responses and less patrol time, reducing outage durations. When utilities have a more granular view of their system, patrol areas are narrowed and crews are better equipped to address a fault. Line sensors are a proven method to improve utility reliability metrics, such as outage durations, system average interruption duration index (SAIDI), and operations and maintenance (O&M) costs.

Although line sensor data can be integrated with existing utility fault-finding processes in several ways, the simplest approach is to use line-sensing software to visualize the locations of fault indications and manually overlay them with supervisory control and data acquisition (SCADA), outage management system (OMS) and distribution management system (DMS) data. Direct integration of sensor data with the SCADA, OMS and DMS applications is a more streamlined method, providing a holistic view of system status. Line-sensing software must be flexible and have application programming interfaces (APIs) to enable this integration.

Integrating sensor data with advanced distribution management system (ADMS) applications, like fault location isolation and service restoration (FLISR) and distance-to-fault calculations, further increases the effectiveness of reliability improvements. In the FLISR scenario, sensors are paired with noncommunicating reclosers or feeder relays, allowing these devices to participate in FLISR schemes — delivering a dramatic reduction in SAIDI.





Utilities typically see improvements of 20% or more in customer minutes interrupted (CMI) on feeders with line-sensing deployments. The improvement is largely the result of a significant reduction in patrol time, with some utilities reporting upwards of 65% savings in patrol time. Reducing patrol time also saves on O&M costs. In fact, a large utility in the Southeast reports line sensing has yielded an 11% reduction in their O&M costs.

Load Monitoring

System planning teams do not always have load data for the locations they need to make the most effective planning decisions. Visibility of system load at additional points on the system provided by intelligent line sensors can fill in these data gaps.

Current supply chain constraints and lengthy wait times for critical equipment now make what was once a commonly accepted practice of run-to-failure a risky approach to asset management.

This data is especially important as distributed energy resources (DERs) and electric vehicles (EVs) are increasingly being added to power networks — creating significant changes in historic load curves and making load forecasting much more complex. Relying on load data from the substation alone is no longer sufficient.

Accurate load data from more system locations is essential for longer-term capacity planning. In the shorter term, load data is also critical for switching decisions during an outage to ensure circuits taking on new load do not become overloaded.

Yet another valuable benefit of visibility into system load data relates to system tuning. While the three phases of a feeder may look balanced at the substation, they can become significantly unbalanced at locations down the feeder. Leveraging line sensor data, planners can identify a location with phase imbalance and initiate action to rebalance the phases of the feeder to gain efficiency and reliability.

Current supply chain constraints and lengthy wait times for critical equipment now make what was once a commonly accepted practice of run-to-failure a risky approach to asset management. This, coupled with increased pressure for better grid reliability, necessitates a more proactive approach to asset management.

When added to URD transformers, line sensors not only detect faults on the primary side but also monitor transformer loading. This loading information enables utility engineers to use real system data to improve asset management and replace overloaded assets before they fail.

EV charging is increasing the importance of transformer monitoring, as a transformer that was appropriately loaded in the past may become overloaded if multiple customers charge EVs simultaneously.

A Southwestern utility used line sensor data to determine one of its transformers was overloaded 150 times in eight months, with an average loading of 126% of its nameplate rating and a peak loading of 212% during this period. When a transformer is overloaded like that, there is not only risk of an outage but also more severe risk of a transformer catching fire.

If an overloaded transformer is identified and replaced as part of planned equipment upgrades, there are potential savings in CMI and O&M costs, plus reduced legal risk related to fires.

Savings Offset Cost

Remote system monitoring adds only an incremental 1% to 2% to the total undergrounding project cost. Increased savings associated with the resulting reductions in CMI and O&M costs more than offset the cost of the intelligent line sensors.

There is no doubt utilities can achieve meaningful reliability and resilience improvements through strategic underground initiatives. However, without proactively monitoring using intelligent line sensors for fault location and load data, utilities may be challenged to gain the full reliability benefits of underground distribution systems. TDW

STEVEN WATT is senior product manager for Sentient Energy. He has worked in electric power distribution since 2012 in various roles in product management and marketing. Prior to that, Watt worked for HP in the IT market. He has an engineering degree from Virginia Tech.

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Android Tablets

Zebra Technologies Corp. has launched the ET6x series of rugged Android tablets. The ET6x series has a heated touchscreen and vehicle dock for forklifts and other material handling vehicles. The ET60 and ET65 are Zebra's first 2-in-1 Android tablets with a friction-hinge keyboard that transforms the tablets into a laptop to make heavy data entry easy in the office and in the field. The products feature consumer styling that can handle harsh indoor and outdoor environments from sub-zero cold to extreme heat.

The tablets are dustproof, corrosion-proof and tested for vibration, thermal shock, and solar radiation. Two of the most vulnerable tablet elements – the display and optional scanner exit window – are protected with shatter-and scratch-resistant Corning Gorilla Glass. The ET6x series is built to run enterprise applications in the most demanding environments. This includes warehouses where – according to Zebra's Global Warehouse Vision Study – the implementation of rugged tablets is expected to increase by 92% over the next three years.

The ET6x series runs on the Qualcomm QCS6490 processor with artificial intelligence (AI) and machine learning, more memory, advanced range barcode scanning and replaceable batteries. The 10-inch ET60/ET65 offers the fastest wireless connectivity available, supporting Wi-Fi 6E, Citizen's Broadband Radio Service (CBRS) and advancing 5G technology for industrial environments that are replacing Wi-Fi for private WWAN networks. Enhanced with Zebra's Mobility DNA software suite, the tablets are easy to implement, configure, manage, and tailor for use across a wide range of demanding applications and industries. The ET6x series leverages advanced security capabilities to safeguard business-critical systems and data, and are backed by best-in-class technical support from Zebra Services and the ecosystem of integrators and ISVs within the PartnerConnect program.

Zebra Technologies | *www.zebra.com*

Ambient Adjusted Rating Solution

Ampacimon has released GridBoost Lite and GridBoost Advanced to support utilities in deploying Ambient Adjusted Ratings (AAR) throughout their transmission systems for compliance with the recent FERC Order No. 881, "Managing Transmission Line Ratings." The order was issued by FERC in December of 2021 to improve the accuracy and transparency of electric transmission ratings in the United States. With full compliance mandated by July 2025, AAR is a Grid Enhancing Technology (GET) that will increase the capacity of power lines and minimize the curtailment of wind and solar generation. GridBoost is a grid-enhancing technology that was developed by the market leaders in line rating systems and presents a turnkey solution to utilities and an alternative to self-developed or EMS applications that can be expensive and complex to maintain. GridBoost is a family of solutions that include GridBoost Lite, GridBoost Advanced, and GridBoost DLR that monitor real-time line conditions to increase electric transmission capacity above traditional static and seasonal ratings. These systems integrate into a utility's EMS to provide hourly line ratings forecasted out to a 10-day time horizon and are compliant with all of the line rating requirements of the FERC order.

Ampacimon | *www.ampacimon.com*. TDW

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NV Energy

Today is Lineworker Appreciation Day, commemorating the contributions of the men and women who bring electricity to customers across the country and honoring the legacy of Henry Miller, one of the founders of the IBEW. We salute all our Journeyman Lineworkers, who are the best in the business. IBEW local 1245 #IBEWLocal396 #LineworkerAppreciationDay

Florida Power & Light

Our lineworkers are heroes to the community! Working around the clock, they help keep the lights on and deliver safe, reliable energy for our customers in good weather and bad.

Lisa Grow
President & CEO of Idaho Power and IDACORP

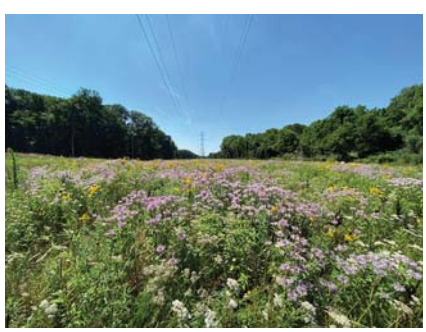
When we joined Micron Technology for the Black Mesa Solar project groundbreaking in December, it was a little hard to imagine the site becoming a field of solar panels delivering energy to the electrical grid. But envisioning possibilities is the key to achieving big goals, and we are proud to help Micron take this big step toward their goal of sourcing 100% renewable energy for their U.S. operations by the end of 2025.

Mississippi Power @MS_Power

Crews from Hattiesburg, Laurel, Meridian and Gulfport are replacing twelve 45' poles on Main Street in Moss Point after yesterday's tornado devasted the area. Our storm teams will continue working as conditions allow to restore service to our customers.

NiSource @NiSourceInc

Did you know? Pollinators are critical for local ecosystems and are responsible for one out of every three bites of food. To protect them, NiSource creates pollinator-friendly habitats on electric and natural gas rights-of-way in the six states we serve. #PollinatorWeek



Central Maine Power @cmpco

A car accident is the cause of a large power outage in the vicinity of Boothbay Harbor this afternoon. Our crews are working to restore power as quickly as possible.

AD INDEX

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Interregional Transmission in the Balance

Power from the Prairie (PftP) is a proposed, 4,000 MW high-voltage direct current interregional transmission line. It would span from the wind energy fields of Wyoming, crossing South Dakota or Nebraska, to the wind fields of Iowa. Unlike traditional DC lines that have only two HVDC converters(one at each end), PftP would have five, to enable interconnection of large quantities of new renewables in some of the best wind energy resources in the country, but currently landlocked due to lack of transmission and access to markets.

When combined with existing and proposed HVDC lines to its West and East, PftP would represent a renewable energy superhighway from the Pacific Coast to Chicago and Eastward. And unlike traditional HVDC lines that are usually unidirectional (wind to load), PftP would be bi-directional, enabling swaps of time-diversified renewable energy from one end to the other.

PftP LLC is an Iowa-based company created to facilitate change in how interregional transmission is done — to be productively disruptive to traditional industry approaches, which are largely ineffective. We are frustrated by the lack of progress. Not a transmission or renewables developer, we are an objective, neutral, and qualified coordinator of interregional transmission projects involving multiple participants. We designed PftP to be a publicly visible pathfinder project of what it takes to accomplish interregional transmission.

PftP LLC organized and led a PftP Concept Development Study (CDS) that was completed this April. The one-year, $800k study involved nine industry participants representing 14 utilities and developers. The project report is posted on our website (*www.powerfromtheprairie.com/the-cds*).

The CDS found the project can be cost-effective for public and private utilities. The 30% investment tax credit on transmission now being considered in Congress (Heinrich) would have a significant benefit to the cost-effectiveness of the project. For an investor-owned utility, it could represent $330 million to $500 million in annual pre-tax equity earnings (this range represents with and without the ITC, respectively). It would enable 3,000 MW of additional renewables at its HVDC converters.

Technology is not the issue. We already know how to do HVDC. No R&D would be required. While the various federal and state efforts now underway are needed and helpful, the still-missing puzzle piece is pretty clear. A senior executive at a large Midwest utility said it best: "There are only three things blocking our participation in projects like PftP: 1) cost recovery, 2) cost recovery, and 3) cost recovery."

Interregional projects are capital-intensive. For example, the HVDC parts of the 750-mile PftP line would cost about $7 billion. HVAC interconnections might be another $2 billion. And the uncertainty about how those costs would be recovered from ratepayers, regardless of the project's cost-effectiveness, is the true barrier to making progress. The potential line owners will not invest the money unless they are reasonably assured they will get it back.

The Challenge: There Are No Rules

1. There is currently no interregional transmission planning process. While the Regional Transmission Organizations and planning regions have done some "interregional" planning, they have resulted in only relatively small projects along their immediate seams. In the CDS, PftP LLC had to create a coordinated planning model across their systems because the RTOs did not have one — particularly for crossing the seam between the Western and Eastern Interconnections as PftP would do.

FERC needs to put some teeth into the wishful thinking of Order 1000 that only suggested interregional planning would be a good idea.

2. There is currently no interregional cost recovery process. The PftP CDS found that the benefits of interregional transmission appear across multiple regions and are not centered on only the line owners themselves. This suggests that a Multi-Value Project approach like is done in MISO, where costs are spread across the entire region that is benefitting, would be appropriate. But such approaches are not available consistently everywhere. And there is no process to coordinate such approaches and thereby allocate costs across multiple regions.

Again, we view that FERC has a role here too.

3. There is currently no regional cost recovery process in the West. Except for the California Independent System Operator, the Western Electricity Coordinating Council is a planning region; not an RTO. It is made up of 36 individual Balancing Authorities (BA). Much of the value of PftP occurs in WECC. How to go house-to-house to each BA to secure cost recovery for their individual share of the benefits? This appears to argue in favor of a Western-wide RTO that is currently under discussion.

4. The need for federal leadership. Finally, much of the current hesitation in doing interregional transmission relates to a need for someone to provide a Big Picture, non-Balkanized, responsible image of leadership for the states and individual utilities. This is necessary to resolve the above challenges, including the needs of states and sovereign tribes along the way. We believe U.S. Department of Energy is in a good place to do this. And they can use PftP and similar projects as examples.

In the meantime, interregional transmission development will remain in the balance. TDW

Editor's Note: Robert Schulte will be presenting "Experiences with HVDC" at the T&D World Live Conference & Exhibition on Sept. 13, 2023. Visit *https://events.tdworld.com*.

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