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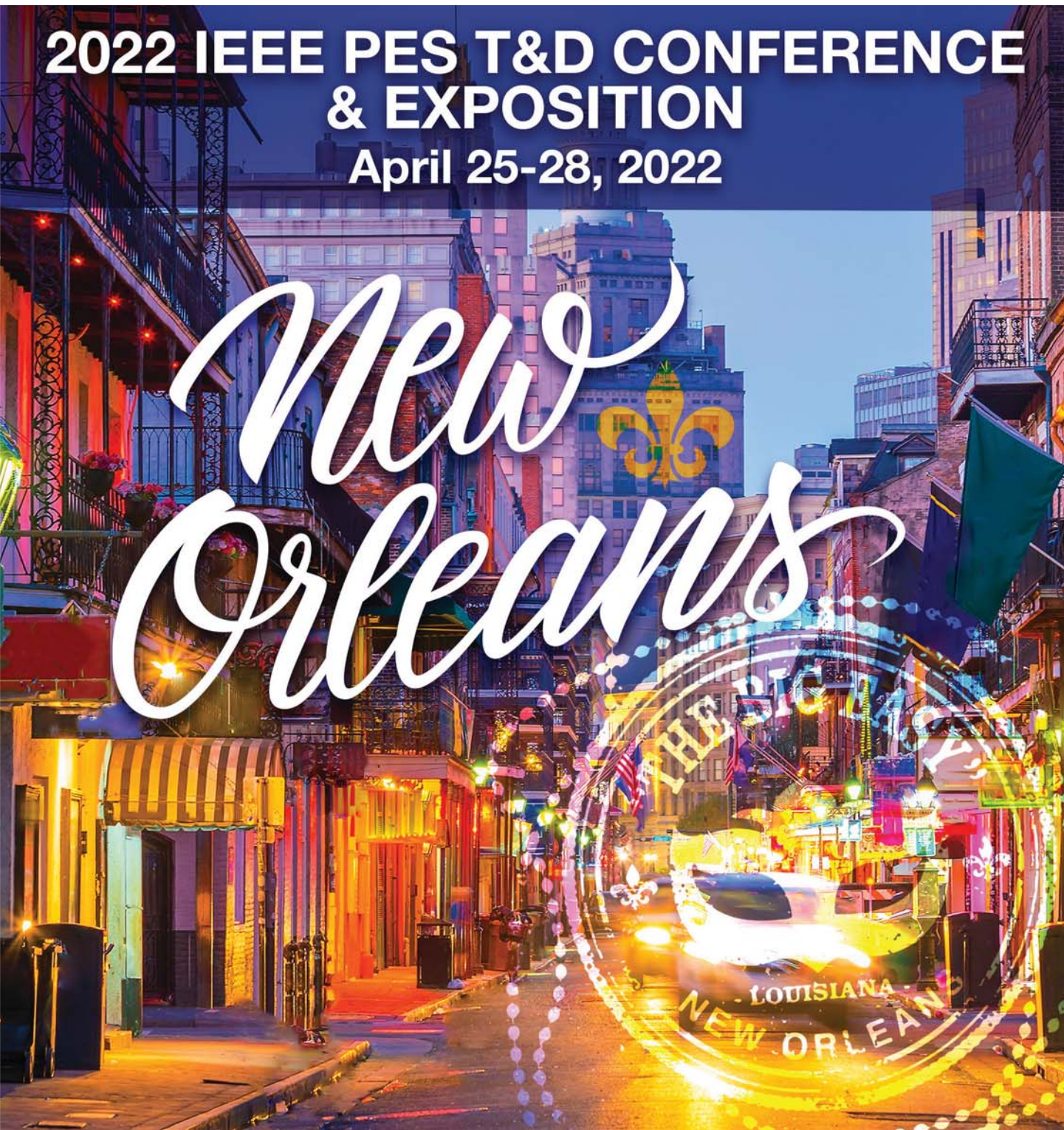

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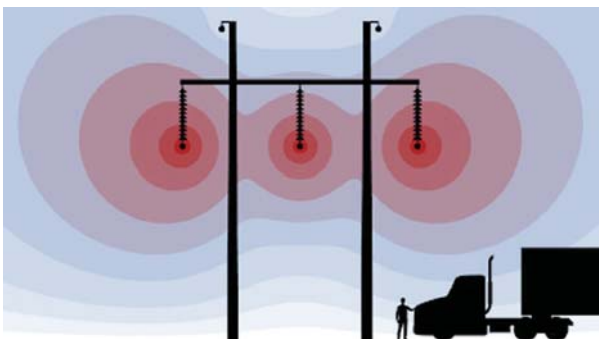

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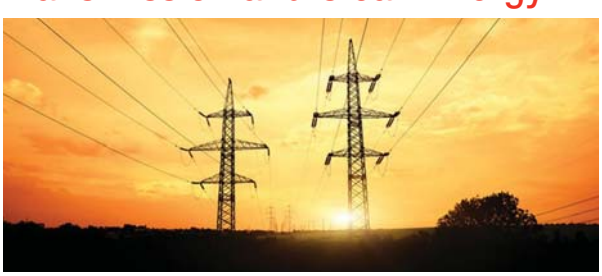

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# Could Fleet Electrification be the Next Big Grid Disrupter?

Since early in the 20th century, it's been said that Americans have a "love affair with the automobile." This love affair has changed little in 100 years, but automobiles sure have, and more drastic change is on the way. The transition from combustion engines to electric batteries has begun and will be enormous for not only vehicle owners and manufacturers, but also electric utilities. Electricity generators, which for many years were the largest greenhouse gas (GHG) emitters in the U.S., relinquished their No. 1 position to the transportation sector in 2016. According to the Environmental Protection Agency, the transportation sector accounted for about 29% of U.S. greenhouse gas emissions in 2019. Although the percentage fell some during 2020 due to lockdowns and restricted travel, it has since climbed and when 2021 data analysis is completed, many experts expect to see emissions levels close to those of 2019.

Passenger cars along with medium and heavy trucks account for about 62% of the transportation sector's total GHG emissions, globally. Rail, two and three-wheelers, buses and light commercial vehicles along with aviation and shipping make up the remaining 38%, according to Statista. These statistics explain why auto manufacturers are increasing EV offerings for passenger cars, as well as commercial fleet vehicles as residential and commercial & industrial (C&I) customers signal that they no longer want to be part of the climate change problem, but instead part of the solution.

U.S. utilities have reduced carbon dioxide emissions by 40% since 2005, according to the Department of Energy, but they still have a long way to go to meet their net-zero carbon goals. This is a challenging and expensive task and becomes even more challenging when coupled with the addition of hundreds of thousands of EVs and the infrastructure needed to charge them. If transportation electrification occurs as quickly as many believe, this transition to EVs could become a major grid disruptor likened to the integration of intermittent renewable energy.

So far, electric passenger car charging has been easily absorbed into the grid and hasn't disrupted utility operations. That could change, however, as C&I customers with fleet vehicles begin to transition those fleets to electricity. Like utilities, they also have sustainability and net zero carbon goals.

I recently spoke to David Schaller, director of Industry Engagement at North American Council for Fleet Efficiency (NACFE), an organization that works with the North American freight industry to improve efficiency, drive technology advancements, and decrease environmental impact. NACFE is dedicated to doubling freight efficiency, and believes fleet electrification is key to meeting that goal. Schaller said the transportation industry is a long way from electrifying large (Class A), long-haul trucks, but the electrification of local and regional transport trucks is already occurring. He pointed out that about half of all Class A trucks sold in the U.S. do not have "sleeper cabs," which means those trucks leave from and return to the same location daily. These types of fleets will consume a lot of electricity and are ripe for electrification.

The organization's website is loaded with good information and you might find the "Run on Less – Electric" demonstration page particularly interesting. It highlights the zero-emission goods movement that is already underway, and contains information and data gathered in 2021 from electric fleet vehicles operated by 13 companies in the U.S. and Canada. These electric fleet vehicles service real routes with real freight. In other words, these are not pilot programs being run by fleet owners, but are in service vehicles. The vehicles in the demonstration together cover market segments that contain about 5.2 million vehicles in North America, Schaller said. He emphasized that these companies, as well as many others, are on their way to converting to full electric fleets.

During *T&D World's* Virtual Black Sky Hazards & Grid Resilience event in November, Oncor's David Treichler, director of strategy and technology, delivered a keynote address in which he talked about potential fleet electrification in Oncor's service territory. Treichler said Oncor has identified 24,000 existing customers that are also fleet owners, and most have not yet electrified those fleets. Those customers own more than 305,000 commercial fleet vehicles that serve more that 13% of the country's fright movement, Treichler said.

Treichler explained how many customers' distribution logistic centers are clustered close together near the DFW and Alliance airports, which can be problematic. He talked about how one Oncor customer approached the distribution utility with questions about providing power to a potential new facility that would, among other things, serve as a distribution center for 435 trucks. Those trucks, if all are charged overnight, would require 40 MW of power for just that one building. He explained that because these buildings are so close to one another there is little room for new infrastructure, such as transmission lines and substations needed to bring power into these industrial areas.

I could continue with more statistics and examples about fleet electrification and the challenges electricity providers will likely face, but I think you get the point. I'll close by letting you know that *T&D World* plans to publish several stories on fleet electrification in 2022. We also are working on a business intelligence report on the same topic; so, if you receive a survey from us in your inbox soon, please complete or, if you're not the right person to do so, please send it along to the correct person. In addition, we will cover this topic and reveal some of the findings from our business intelligence report at our upcoming *T&D World Conference and Exhibition*. Transportation electrification is coming and we at *T&D World* plan to keep you informed as the pace picks up. TDW

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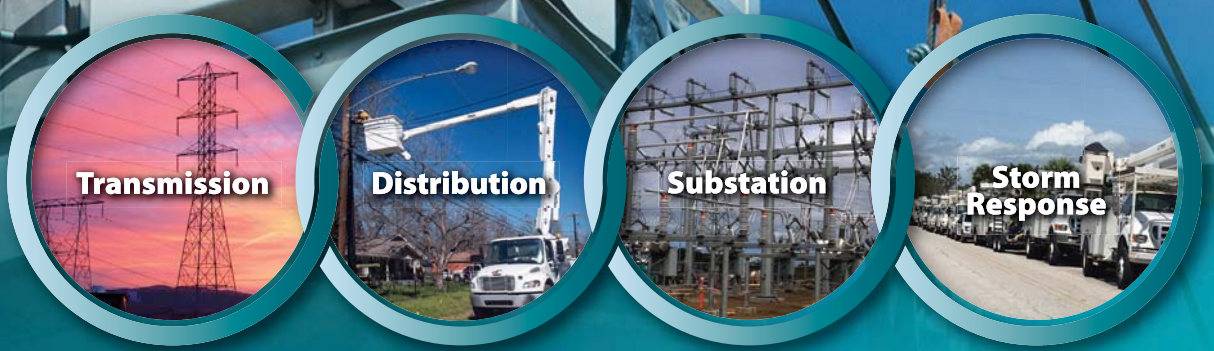


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# Raising the Bar for Grid Reliability

The 2021 State of Commercial and Industrial Power Reliability Report issued by S&C Electric Co. shows that monthly outages among five major industry categories including manufacturing, healthcare, education, small franchises, and retailers doubled in 2020. More troubling may be the data reveal outages on the increase include the short duration variety not captured by the closely monitored SAIDI and SAIFI utility reliability indices. As we wade deeper and deeper into a pervasively digital world, is it time to reassess how we define and maintain system reliability?

The IEEE Guide for Electric Power Distribution Reliability Indices (Standard 1366) is used universally to evaluate distribution service reliability. Possibly the most frequently monitored and reported indices include System Average Interruption Frequency Index (SAIFI), which is how often the average customer experiences an interruption; and System Average Interruption Duration Index (SAIDI) defined as the total number of minutes of interruption experienced by the average customer. These indices relate to sustained interruptions defined by IEEE as an interruption of greater than five minutes.

jose1983/Getty Images

S&C's survey indicates that a growing number of commercial and industrial customers are significantly impacted by momentary outages and power quality issues. Residential customers also report dissatisfaction about momentary outages that disrupt the sensitive electronic components now common in household appliances. IEEE uses the Momentary Average Interruption Frequency Index (MAIFI) to characterize short interruptions. It may be time for utilities to put greater emphasis on MAIFI and criteria related to power quality to gain greater insight regarding overall service quality.

S&C found that C&I companies are increasingly taking measures to track outage frequency, duration, and costs to pursue compensation or compel utility corrective action. In defense of electric service providers, the growing complexity of electric networks is not necessarily within their control. With predictions of a 10-fold increase in DERs between 2020 and 2030, supply volatility is increasing. We are not seeing counterbalances via increased demand load flexibility and storage options are not of system balancing magnitude. The solution according to some experts is the same movement that got us to where we are today: digitalization.

Siemens believes the digitalization of our electric infrastructure, including analog processes and data, is a major step in our transition to the future power grid. Aided by digital sensors, and IOT connectivity: data analytics, AI and automation will transform the industry, improving reliability and resiliency. Speaking during a Siemens-sponsored T&D World webinar titled "Adaptable, Secure and Resilient Grids: What Do AI and Automation Offer?", Exelon reps shared their vision for using analytics to work with data inputs from GIS; operating systems; asset and work management; outage management and reporting; network modelling; energy management; AMI; weather monitoring and customer systems. The potential results from such deep data dives cover a broad spectrum, including optimized network modeling tools; assessments of asset maintenance effectiveness and life predictions; identification of high-risk assets and circuits; outage, storm damage and time of restoration predictions; and much, much more.

Exelon's efforts are demonstrating transferable program opportunities for improving public and worker safety, lowering O&M costs, and increasing customer satisfaction as well as improving reliability and resiliency. A notable example is the use of data analytics and AI in the areas of vegetation management (VM) and outage prediction. Most utilities trace about 20% of their outages back to vegetation-related causes even though vegetation management routinely tops the list of ongoing maintenance costs. Exelon is using VM analytics to control spending and for outage risk prediction and recovery planning.

Capitalizing on the growing interest in using data analytics to modernize utility VM, AIDASH has combined satellite imagery and AI to facilitate remote monitoring and inspection of ROW conditions and perform a host of sophisticated planning, prioritizing, and review activities. Innovative, case-specific, pretrained algorithms, satellite surveillance imagery and other source data are combined with real-time location, weather, soil, and tree species data to determine clearance and growth rates of vegetation along power lines; identify danger/hazard tree and high-risk areas; plan trim cycle/line clearance; and plan use of herbicide and tree growth regulators. In addition, AIDASH platforms can be used to im prove emergency avoidance, preparedness, and response. Disaster-prone areas can be identified, and avoidance/disaster recovery can be planned in advance. Further, near real-time post-event satellite imagery can be obtained to facilitate damage response and restoration.

Customer expectations regarding reliability and resiliency provide a convincing rationale for utilities to use MAIFI in addition to SAIDI and SAIFI to demonstrate their on-going service improvements. Proactive companies are increasingly using cutting edge digital technologies to plan for, analyze, diagnose, control and maintain their grid systems. AI and automation are rapidly expanding the areas of our business where we can make meaningful reliability and performance improvements, which in turn will continue to raise the bar. TDW

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# Is Residential Storage Worth It?

Last month I was very efficient with my time management and got all my work completed more than a week ahead of my deadlines. That meant I had some extra time on my hands, which gave me a chance to catch up on my reading and get some chores done. The first order of the day was running some errands, but as luck would have it, I got distracted by something going on down the street.

There were three trucks parked in front of a neighbor's house. Each was wrapped in colorful advertising proclaiming now is the time for adding solar to your roof. The yard was cluttered with boxes, mounting brackets, reels of cable, and miscellaneous odds-and-ends hardware. My neighbor had signed up for rooftop photovoltaic (PV) panels. This isn't the first house in the neighborhood to get PV panels installed, and if the surveys are correct it will not be the last.

Photo by Gene Wolf

All this activity got me thinking about how many homes in the area have added rooftop solar panels in the past year. The downside of each installation is the influx of solar hucksters going door to door peddling solar deals. They must be fairly successful judging by the growing number of solar panels popping up on roofs. That switched my thinking from chores to some papers I had put off reading.

My first technical paper was a disturbing study about utility-scale wind farms and solar ranches being dangerous to the environment. The uptake was utility-scale renewables take up too much space. Space that is needed for necessities other than electricity. It was a real gloom and doom scenario, but the authors had painted themselves in a corner.

They had not taken into account that technologies are not static. In the 1990s we saw wind turbines were rated about 750 kWs (kilowatts), but today turbines are pushing 20 MWs (megawatts). On the solar side, the efficiency of today's monocrystalline PV panels are increasing too. Modern panels efficiency are over 20%, whereas early panels' efficiency were in the single digits.

## Untapped Resources

My next paper serendipitously answered the first. This one from the University of Cork in Ireland provided a different perspective on rooftop solar. Their paper said, "They did a high-resolution global assessment of rooftop solar photovoltaics potential using big data, machine learning and geospatial analysis of global rooftops." I was hooked, these are some of my favorite tech-toys!

In one section, the authors reported they had done a global calculation of all the existing rooftop areas. Because of space, I zeroed in on the portion focused on the U.S. rooftops. The folks at Cork determined that if all the rooftop area had PV panels installed on it, the output would be sufficient to match the current U.S.'s total electricity generation. The installed behind-the-meter (BTM) solar is breaking records every year, and it will be interesting to watch what happens.

## Economics Factor

Of course the sun doesn't shine 365/24/7, so it's going to require energy storage. That too is increasing BTM, but it's expensive. A report published by Lawrence Berkley National Lab (LBNL) last year pointed out cost doesn't appear to matter to the customer. Researchers found that residential batteries didn't make sense economically, but residential battery installations are increasing. LBNL said customers installing batteries were driven by considerations other than economic such as resilience associated with backup power.

LBNL noted that in 2020 about 550 MWs of the installed storage was paired with solar. Going deeper, Berkley looked at four locations in the US, and compiled a standard configuration for solar-plus-storage. LBNL said it was "7 kW PV paired with 5kW/10 kWh battery storage, which could serve, on average 60%-80% of a typical customers' daily consumption over the course of a year."

Because I'm an engineer, I made a spreadsheet with my home's monthly/yearly power consumption. Then I calculated rooftop PV alone, and PV-plus-storage. I went to my utility's webpage to see what the incentives they offered for various solar programs. Based on what I found, it turned out I would be better off keeping the solar-plus-storage and using it to reduce my monthly electric bill. I'd save money on electricity, and I'd have backup in the event of power outages.

I'm not ready to run out and have PV installed yet, but I'm ready when someone rings the doorbell to sell me solar. Plus I learned a lot about the economics of the BTM solar marketplace. TDW

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## Massive Wind Project Connects 1.05 GW To Transmission Grid In New Mexico

Onshore wind projects in the gigawatt (GW) range are becoming more common in many parts of the world, and one more has been added to the US western transmission grid. In early January of this year, the 1,050 megawatt (MW) Western Spirit Wind Project began commercial operations. According to Pattern Energy, and its partner New Mexico Renewable Energy Transmission Authority (RETA).

Western Spirit Wind Power Project. Courtesy Pattern Energy.

A different approach was taken with this wind project, rather than building the project in the traditional staged approach used by other developers, this project was built in one phase. The Western Spirt project consists of four wind farms stretching across three counties in east central New Mexico with a combined capacity of 1.05 GW. The four Western Spirit Wind windfarms have a total of 377 GE wind turbines. Those turbines ranging from 2.3 - 2.8 MW in size, and with different tower heights to optimize their wind capturing ability at each facility.

Adding to the complexity of the project, the four windfarms needed extensive transmission assets to connected them to the New Mexico transmission grid. As a result, a 155 mile (250 km) 345 kilovolt (kV) transmission line was built as part of the project. And like the windfarms, the transmission line was developed jointly by Pattern Energy and RETA.

According to Robert E. Busch, Chairman of RETA, "This is the largest transmission upgrade to the PNM system since the 1980s and is increasing grid reliability by harnessing New Mexico's natural resources." The transmission line connecting the Western Spirit's windfarms to the New Mexico transmission grid will be owned and operated by the Public Service Company of New Mexico.

U.S. Senator Martin Heinrich said, "The largest renewable energy project in American history is now up and running — right here in New Mexico. Western Spirit encompasses four new utility scale wind sites that connect rural communities in central New Mexico to local customers and other major energy markets beyond our state's borders. This project literally changed the map of our state's energy landscape, allowing New Mexico to help power our nation with clean electrons."

Western Spirit Wind will provide clean, renewable energy to California and New Mexico through long-term power purchase agreements with the Los Angeles Department of Water and Power, San José Clean Energy, East Bay Community Energy, California Choice Energy Authority and member cities, and international energy company Uniper Global Commodities. Western Spirit Wind will also provide power to New Mexico municipalities, including Los Alamos Department of Public Utilities, through the Uniper Global Commodities power purchase agreement.

"This is a big day for New Mexico as we open access to new sources of clean and affordable energy to consumers across the state and region," said Mike Garland, CEO of Pattern Energy. "Wind power has already begun flowing on the line and later this month we will complete our Western Spirit Wind projects — the largest single-phase renewable energy buildout in U.S. history — utilizing this new line and other infrastructure to bring on a full 1,050 MW of clean renewable power. Thanks to New Mexico's mighty winds — some of the strongest wind resources in the entire country — will now generate pollution-free clean power for thousands of homes."

## Virtual Power Plants Bring Community Solar & Storage To Renters In Texas

There is a lot of innovation taking place behind-the-meter, especially when it comes to adopting technologies like solar plus storage, microgrids, and virtual power plants (VPP). Usually low and middle-income renters are unable to take advantage of these technologies. If they could, it would reduce their energy bills and let them take part in clean energy projects. That is changing in Texas.

Flexible energy provider, PearlX Infrastructure LLC (PearlX), and global leader in smart energy technology, SolarEdge Technologies, Inc. (SolarEdge) announced an innovative program. They have formed a collaborative for a series of first-in-kind residential clean energy projects for renters throughout Texas.

Dubbed "Project TexFlex", the program deploys groundbreaking community solar & storage VPPs. These systems are enabling communities in the region to empower tenants with cost-effective and resilient clean energy. Participating tenant subscribers will gain access to solar + storage on-site, offering them a low-cost clean energy source and the ability to mitigate the impact of blackouts with grid independent backup power.

Project TexFlex will launch its initial VPP at 2410 Waugh Apartments in the Montrose neighborhood of Houston in the first quarter of 2022. There are several other installations planed across Texas, California, and other U.S. states throughout 2022. Described by PearlX as a "win-win-win," each VPP provides load-serving and resiliency benefits to consumers.

The collaborators point out that Project TexFlex has the capability to reduce grid strain and outages, while increasing energy resilience across the state. Energy production is becoming distributed, but production still needs to be centrally controlled for grid stabilization. VPPs makes this possible by enabling cloud-based, real-time aggregative control, management and reporting of a pool of distributed energy resources. This is particularly critical and valuable in the wake of the "Big Freeze" of February 2021, which placed grids under huge strain and caused mass power outages. In launching this Project, PearlX and SolarEdge are creating a widely replicable, decentralized model that will facilitate Texas' accelerating energy transition, while offering safeguards against grid failures. TDW


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# Grid-Forming And The Next-Gen Grid

## Wind turbines, solar panels and batteries have a commonality.

The future is a fascinating subject. When it comes to digital technology, however, the crystal balls and Ouija boards are having a hard time keeping up with the latest developments. When it comes to the next-gen widget, it turns out predictions tend to be running behind what is actually happening. There are so many good candidates in the power grid that it's hard to pick one. There is, however, one grid element that has been getting a great deal of next-gen interest: energy storage.

Dalrymple BESS. Photo courtesy of Hitachi Energy.

More specifically, it's battery energy storage systems (BESS), which has a rather unique position when it comes to the grid. It's on the transmission system, distribution network, and behind-the-meter. It's also a critical element for making wind and solar more grid friendly. BESS are considered by some as renewable resource. So, there is a lot of speculation as to what can be expected for the next-gen BESS.

Without getting too technical, let's say these devices have one thing in common. They produce direct current electricity that needs to be converted into alternating current electricity for use on the power grid. That is done by using inverter-based technology, which is becoming a problem as their numbers increase.

There is a problem, however, these inverter-based devices are replacing massive rotating machines (e.g., generators and turbines). As a result, the grid is losing the inertia these generators produce. Inertia is a form of kinetic energy storage that comes from large synchronous (i.e., the rotation of the shaft is matched with the grid frequency) machines. This kinetic energy provides short term balance between the supply and the load. Before getting into that discussion, let's dig a little deeper into energy storage in general.

### Transformational Experiences

*T&D World* produced its first energy storage supplement in 2009. The technology was mostly pumped-storage and lead-acid batteries, and there was a lot of activity around renewables. When the second energy supplement came along almost a decade later, the changes were amazing. The emphasis had switched with energy storage becoming an integral part of more sophisticated applications. That's when BESS became part of distributed energy resources. It was a gamechanger and gave a hint of things to come.

By incorporating BESS technology on both sides of the meter, suppliers tapped into grid stabilization services. Grid resilience started trending, which opened new opportunities for BESS technology. It moved from a niche player to a major force on the power grid.

Interestingly, the 2009 supplement quoted a research organization predicting the global energy storage market would grow from around US$ 329 million in 2008 to more than US$ 4.1 billion by 2018. Well, it did! It actually grew beyond that prediction to about US$145 billion in 2018 according to a recent Fortune Business report. The report also expected the global market spending to reach US$ 211 billion by the end of 2026.

BESS applications are definitely a growth technology. It will continue based on the push for decarbonization with renewable resources. That brings us back to the concerns with electronics-based, inverter-based renewable resources. Fortunately the technology has been improving and there are advanced inverter applications available to address the issues.

### Grid-Following vs Grid-Forming

An insight from the NREL (National Renewable Energy Laboratory) comes in the form of a publication saying, "Today's electric power systems are rapidly transitioning toward having increasing proportion of generation from nontraditional sources, such as wind and solar power, as well as energy storage devices." These resources are connected to the grid through grid-following inverters. That's another clue for where the next-gen energy storage is headed along with wind and solar renewables.

This is a good place to talk about inverter technologies. Grid-following inverters track the voltage angle of the grid to control their output. These grid-following inverters rely on the fact that the system voltage and frequency are stabilized by inertia (i.e., rotating masses) sources. BESS using grid-following inverters don't handle large grid disturbances well. They typically shut down until the disturbance has passed,

and require the grid to reestablish after a blackout before reestablishing themselves.

As more large fossil-fueled generating plants are retired and replaced by renewables, the grid needs more stabilizing inertia sources. That is where grid-forming technology comes into play. Grid-forming inverter technology can establish grids and strengthen operating grids. It has an independent internal frequency reference, which allows grid-form inverters to form an island grid.

When grid-forming technology is paired with advanced automation and controls, it makes possible virtual synchronous machines. They can be used to provide services large grids need to operate with lots of renewables. This technological innovation is why grid-forming inverters are starting to generate interest and gain traction for next-gen status.

John Glassmire, senior advisor for Hitachi Energy's Grid Edge Solutions, provided some actual experience with grid-forming technology including virtual synchronous machines in the real world on the Australian transmission grid. Glassmire reports, "Most battery energy storage deployed globally offers partial network stability, but the next generation of battery energy storage – particularly energy storage that uses grid-forming energy storage with virtual synchronous machine technology – is critical for enabling renewables to fully displace fossil-based synchronous technology."

Glassmire continued, "For example, Australia pulls 24% of its electricity from renewables, a huge accomplishment for a country of this size. Australia is continually progressing toward net zero emissions, but the output of these renewables are variable. As the installed wind and solar capacities grow, there is a need for new integration technologies. As part of Australia's commitment to renewables, Hitachi Energy took part in Australia's Energy Storage for Commercial Renewable Integration, South Australia (ESCRI-SA) project by providing a large-scale grid-edge solution leveraging microgrid technology."

According to Glassmire, "Hitachi Energy supplied a 30MW BESS on the lower end of the Yorke Peninsula in 2018 on a long radial feeder. The ESCRI-SA BESS is a grid-forming system built on Hitachi's virtual synchronous generator platform, which strengthens the grid by providing inertia, high fault current, and fast power injection, as well as competitive market services. The Hitachi system is also capable of seamlessly transitioning into island operation when faults occur on the upstream feeder. The island power supply comes from the nearby 91 MW Wattle Point windfarm and distributed solar."

Before leaving the ESCRI-SA project, Glassmire pointed out, "The virtual synchronous machine offers an extremely valuable service to the grid. It mimics the behavior of old school technologies like synchronous machines and synchronous condensers, but entirely through power electronics. They can even mimic more sophisticated and newer devices like a STATCOM that stabilize grids with benefit of also providing energy and ancillary services. A BESS with a grid-forming

inverter including a virtual synchronous machine is a different animal from one with a grid-following inverter system. The automation and controls are a key element to using grid-forming inverters in large utility grids"

## Growing Interest

Late last year, another grid-forming project was announced in Australia. The Australian utility AGL broke ground on the Torrens Island 250MW/250MWh grid-forming BESS project in November 2021. The battery will be supplied by Wärtsilä with over 100 grid-form inverters supplied by SMA. AGL expects the battery to be fully operational in early 2023. AGL said the BESS is designed to be increased to 1,000MWh in the future. They expect the BESS to take part in Australia's National Electricity Market.

*The old-school inverter-based technology can't provide the inertia needed to generation and load stability of massive rotating machines.*

With the expanding interest in grid-forming technology the U.S. Department of Energy (DOE) announced it is providing funding for the US$25 million public-private Universal Interoperability for Grid-Forming Inverters (UNIFI) Consortium. DOE said, "The Consortium brings together leading researchers, industry stakeholders, utilities, and system operators to advance grid-forming technologies." The Consortium will be led by NREL (National Renewable Energy Laboratory), EPRI (Electric Power Research Institute), and the University of Washington.

One of major tasks of the Consortium is the development of standards for the hardware needed for these next-gen inverter-based technologies. Interoperability is a key concern for any emerging technology. We have seen in the past that new technologies must play well with each other if they are to be accepted by the power delivery system. That is the reason so many manufacturers such as, Danfoss, Eaton, General Electric, Hitachi Energy, Schneider Electric, Siemens Energy, SMA, and others are interested in the UNIFI project.

The next-gen of inverter-based BESS is here and just in time considering what's happening. The penetration of wind, solar, and BESS resources is increasing and causing concern by those responsible for a stable grid. When these three resources exceed 60% or more of the online generation capacity operators get nervous. The old-school inverter-based technology can't provide the inertia needed to generation and load stability of massive rotating machines.

Grid-forming inverters, however, are available to address these concerns, which are happening more often than might be expected. It's all about adding virtual inertia in a world where clean energy replaces fossil-fuel massive rotating machines. In this case, the next-gen grid-forming BESS is here today! TDW

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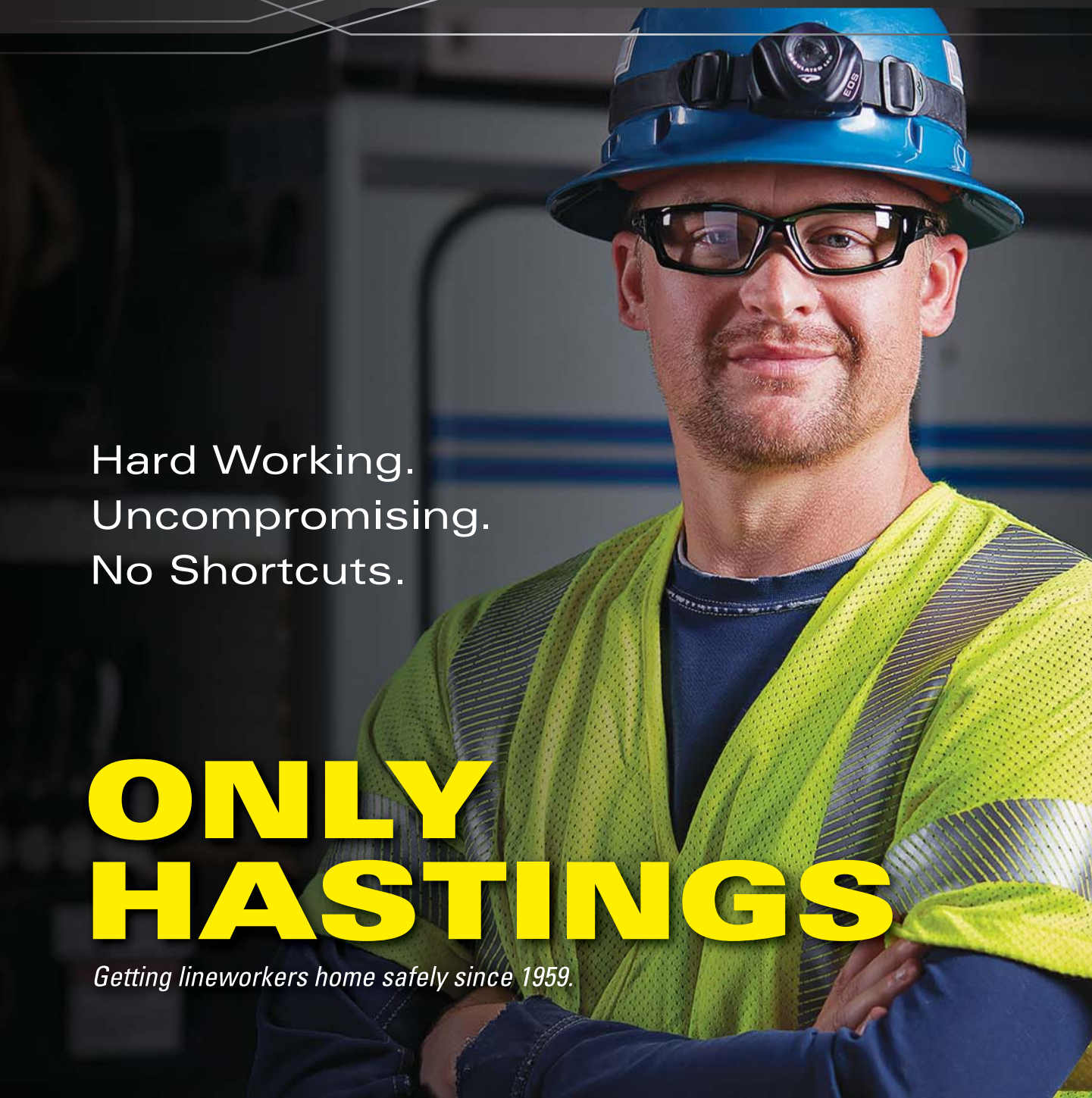

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# Purpose, Connection and Discovery in New Orleans

## The IEEE PES Transmission and Distribution Conference and Expo returns in 2022 with a theme based around power in our lives.

By **NIKKI CHANDLER**, Associate Content Director

After two years of virtual events, postponements and cancellations, the IEEE PES Transmission and Distribution Conference and Expo is set to open live and in-person this April in New Orleans, Louisiana, U.S. COVID-19 came on the scene in early 2020, and IEEE PES judiciously canceled its 2020 event that was to be held in Chicago in April of that year.

This year, the event plans to follow all precautions and regulations required by the city of New Orleans and in accordance with the CDC guidelines to make for a safe and exciting event.

"Folks in the industry are anxious to get together," said Carl Segneri, vice president, business development for M.J. Electric, and IEEE PES North America, T&D Director. "The pace of change is incredible, and T&D is excited to help capture these industry trends by bringing the key players, contributors and stakeholders together to learn, socialize and network."

Segneri said that the city of New Orleans is committed to a very successful Mardi Gras this year. "We plan to ride those coattails. We continue to monitor the evolution of the situation but remain optimistic on proceeding with our plans."

In addition to IEEE Power & Energy Society, the conference and expo is supported and planned by volunteers from the industry, including leadership from a local host utility, which helps ensure insights and solutions delivered to attendees are relevant and impactful to their day-to-day work. Entergy will be the host utility this year, and according to Segneri, the local organizing team under the leadership of Entergy's Michelle Bourg has put a lot of effort and passion into making this "a conference that people want to attend."

The area around the Ernest N. Morial Convention Center conference center has benefited from some major aesthetic and transportation upgrades as well, said Segneri. The convention center is home to America's largest contiguous-space exhibit hall with 1.1 million sq. ft. of exhibit space. It is minutes from the world-famous French Quarter and the iconic Mississippi River.

Exhibitors showcase their products and services during live demonstrations on the show floor. Photos courtesy of Ellen Dallager Photography.

"They are ready for us. New Orleans is a vibrant city that knows how to party," Segneri said.

The theme for the 2022 event is based around power in our lives, as the reliance on the electric grid "grows more critical than ever before," said Segneri. "Our marketing messages have stressed the Power theme: Power in Purpose, Power in Connections, Power in Discovery."

IEEE PES stresses how the T&D community has shown resilience throughout recent challenges, including the pandemic and climate-related disruptions. By attending this event, utility professionals can prepare for what's ahead through educational sessions, technical tours and exploring technologies.

Utilities have the options this year of taking advantage of a Utility Bundle registration package. "Utilities can register 10 employees for $1000, an incredible savings," Segneri said. "Utilities can buy as many bundles of 10 as they wish. We sold over 110 bundles for the 2020 Conference, so we know it is a desirable option."

## Power in Education

By attending the 2022 IEEE PES T&D Conference and Exposition, utility professionals can learn from world experts while also earning professional development hours or continuing education units. The conference includes poster presentations, forums, panel discussions, super sessions and tutorials.

"The IEEE T&D Conference provides an opportunity for engineers, practitioners and academics to bring their best practices, research results and futuristic tools to the attention of power engineers in the technical conference part of the T&D Conference," said Saifur Rahman, Ph.D., past president of the IEEE PES and a Joseph Loring professor and director of the VT Advanced Research Institute.

Over the course of three days, attendees can learn about everything from artificial intelligence to distributed energy resources. The opening session will kick off with a panel moderated by Jessica Bian, VP at Grid X-Partners and current IEEE PES president. The panel of industry icons includes Ed Schweitzer III, owner and founder of Schweitzer Engineering Laboratories; Paul Hinnenkamp, CEO of Entergy; Allison Silverstein, independent consultant and industry strategist with key contributions including work at FERC and DOE; and Damir Novosel, president of Quanta Technology and previous president of IEEE PES. The panel topic will be The Past Powering the Future. "It's a look at what we predicted in the past, how it has it turned out and where we are going," Segneri said.

The super sessions are the anchor of the broad technical program. They will cover three topics this year: data analytics, resiliency and the future grid.

Panel sessions this year cover numerous topics, but some key presentations include:

## EVENT SCHEDULE 2022

| | |
|---|---|
| **Sunday, April 24** | |
| 12:00 p.m. – 5:00 p.m. | Registration Open |
| **Monday, April 25** | |
| 7:00 a.m. – 5:00 p.m. | Registration Open |
| 7:30 a.m. – 5:00 p.m. | Tutorials, Plain Talk, Building Business Relationships Workshop |
| 9:00 a.m. – 2:30 p.m. | Technical Tours |
| 1:00 p.m. – 3:00 p.m. | Ethics Session |
| 6:00 p.m. – 9:00 p.m. | Conference Opening Reception at Mardi Gras World |
| **Tuesday, April 26** | |
| 7:00 a.m. – 5:00 p.m. | Registration Open |
| 7:30 a.m. – 5:00 p.m. | Plain Talk |
| 8:30 a.m. – 9:30 a.m. | Opening Session |
| 10:00 a.m. – 3:00 p.m. | Technical Panels Sessions |
| 10:00 a.m. – 5:00 p.m. | Exhibits Open / Innovation Stages and Smart Cities Pavilion |
| 11:30 a.m. – 1:00 p.m. | Conference Luncheon in the exhibit hall |
| 3:00 p.m. – 5:00 p.m. | Super Session 1 |
| 5:30 p.m. - 7:30 p.m. | Women in Power and Young Professionals Reception |
| **Wednesday, April 27** | |
| 7:00 a.m. – 5:00 p.m. | Registration Open |
| 7:30 a.m. – 5 p.m. | Plain Talk |
| 9:00 a.m. – 4:00 p.m. | Tecnical Tours |
| 10:00 a.m. – 6:00 p.m. | Exhibit Open / Innovation Stages and Smart Cities Pavilion |
| 10:30 a.m. – 11:30 a.m. | Super Session 2 |
| 1:00 p.m. – 5:00 p.m. | Technical Panel Sessions |
| 4:30 p.m. – 6:00 p.m. | Networking Reception in the exhibit hall |
| 5:00 p.m. – 7:00 p.m. | Poster Session and Reception / Student Poster Contest |
| **Thursday, April 28** | |
| 7:00 a.m. – 2:00 p.m. | Registration Open |
| 8:00 a.m. – 10:00 a.m. | Super Session 3 |
| 8:30 a.m. – 10:30 a.m. | Technical Tour |
| 10:00 a.m. – 3:00 p.m. | Exhibits Open / Innovation Stages and Smart Cities Pavilion |
| 10:00 a.m. – 12:00 p.m. | Technical Panel Sessions |
| 3:00 p.m. – 4:00 p.m. | Closing Reception and Raffle: Welcome to Anaheim in 2024 |

"The combination of a world-class technical program and the most influential manufacturers and suppliers in the industry make the T&D Conference the one conference that you have to attend," Segneri said.

## Power in Technology

In addition to the technical program with paper and panel sessions, the event also features a large-scale expo showcasing equipment, software and services representing distribution, transmission and generation areas of the electric power industry.

"As an academic working on research projects to explore solutions to the issues the power industry will face in the future, I always enjoy hardware displays that show the state-of-the-art equipment ready to enter the market," said Rahman, who urges the conference attendees to find the time to walk the show floor as much as possible. "I always ask the engineers why they build something the way they did it."

The show floor offers opportunities to see new technology in action.

The T&D Expo has the largest collection of exhibitors covering the broad range of transmission, distribution, substation, smart grid, distributed generation, etc., according to Segneri. " Our exhibitors often use the T&D Conference to launch their latest and greatest products and innovations."

The expo will feature an "Innovation Stage" this year that provides a unique forum on the show floor where state-of-the-art technologies will be debuted and practical product applications discussions will take place. While on stage, presenters will share case studies that offer insights into emerging trends and share valuable best practices. "Bringing these discussions to the show floor will add excitement and energy to the area," Segneri said.

One of the new features at the 2022 IEEE PES T&D Conference and Exposition is the Smart Cities Pavilion, which will highlight


By walking the show floor at the Expo, attendees can discover the latest products and technology in the transmission and distribution industry.

innovation in the industry. IEEE PES had originally planned to introduce the pavilion at the 2020 event, but now we will get a chance to experience it.

"The Smart Cities Pavilion fits extremely well into our theme and the driving trend in the industry," Segneri said. "Utilities can't just focus on their delivery system infrastructure; they have to incorporate upgrades that meet the emerging customer needs for information and system integration. The Smart Cities Pavilion highlights this aspect of one of the fasting emerging trends in the industry."

IEEE PES has played a lead role in organizing conferences, workshops and awareness building events for several years in the smart city space.

"PES is the lead IEEE society that helps to organize the annual IEEE Smart Cities Conference globally," Rahman said. "These are technical conferences with papers, panels and posters. But we have not had a chance to display the hardware and software solutions which make the smart city work the way it is supposed to. Due to the layout of our T&D Conference, which offers a large exhibition space, there is now an opportunity to highlight such hardware and software solutions selected from the distribution part of our industry."

## Power in Experiences

In addition to attending the expo and learning about new techniques and best practices at the conference, registrants can also sign up for a technical tour for an immersive experience. IEEE PES has offered technical tours for its T&D conference dating back to the late 1980s, but in recent years, the organizing committee has been able to increase the number and selection of tours, which often sell out.

"We select the tours to offer our guests the opportunity to see some great technical sites as well as local venues of interest," Segneri said. "The tours are designed to last for no more than a half a day to give attendees enough time to attend the T&D conference technical program events and spend as much time as possible on the exhibit floor."

For 2022, attendees can select from a wide variety of technical tours:

- Enhancing grid resilience with HVDC and FACTS
- Fire mitigation and grid resiliency
- Design, visualizations, and the control room of the future
- Future-proofing the energy workforce: A people-first approach to strategic talent management
- New Orleans Only Solar Microgrid Apartment Complex

## Power in Connections

By attending the IEEE PES T&D Conference and Exposition in person, professionals will finally be able to make live connections with several networking opportunities. The opening conference reception on Monday evening, April 25, will take place at Mardi Gras World for an "unforgettable evening wrapped in the joy and passion that is New Orleans." Situated on the banks of the Mississippi River, Mardi Gras World is part entertainment venue, part float design studio, where over 80% of the floats that journey down New Orleans' Streets during Carnival season are designed and built.

"If you have not seen this place, you will be blown away by the floats, artwork and history that makes Mardi Gras one of the most fun events in the world," Segneri said.

Other networking opportunities to meet old friends and make new acquaintances include networking lunches, another networking reception, a closing reception and various exhibitor events.

By registering for the IEEE PES T&D Conference and Exposition, professionals can build new connections and expand their knowledge, Segneri said. He said if they can only go to one electric utility conference, then the IEEE PES T&D Conference is the best place to go. "Can't wait to see you in New Orleans in April." TDW

**To see the latest exhibitor list and floor map, as well as the full schedule for the show, visit *https://www.ieeet-d.org.***

## Switchgear Monitor

Dynamic Ratings has launched the new Switchgear Monitor. The Switchgear Monitor can monitor six bays with a single monitor, making it scalable across all medium-voltage switchgear lineups. Waveform capture technology is used for each bay's trip and close coils, providing open, close, arcing and interrupting times. Motor starts, currents and run times are also monitored and recorded. Integration of partial discharge technology from the Dynamic Ratings Switchgear and Cable Monitor (SCM) product enables partial discharge monitoring of switchgear bus for PD tracking and faulty connectors providing the industry's most comprehensive condition-based monitoring solution.

**Dynamic Ratings | www.dynamicratings.com**
**Booth #7833**

## Cable Terminating, Jointing

Compaq International is engaged in development, manufacturing and marketing of cable terminating and jointing solutions up to 66 kV. The comprehensive portfolio includes a finely tuned product range of cable connection systems in heat shrink, cold shrink, slip on, cast resin and hybrid technologies for screened or unscreened polymeric cables as well as paper-insulated cables; screened separable connectors that are easy to use and safe; tubings, tapes and wraparound sleeves like bus bar tubing, taps, stress control tubing, medium and heavy wall tubing's and wraparound sleeves for medium-voltage applications using heat shrink and cold shrink technologies. The company is well-known in both national and global market for manufacturing cost-efficient and robust solutions. Compaq uses the most advanced materials and design concept to lead the modern technology.

**Compaq International Limited | www.compaqinternational.com**
**Booth #8012**

## Power Line Construction and Maintenance

PowerGrid is a provider of overhead distribution and transmission power-line construction and maintenance. It also provides vegetation management and right-of-way clearing to complement its core services. These efficiencies, combined with the company's Collective Storm Response program and GridTech Substation and Drilling services, make PowerGrid a suitable choice for meeting the needs of organizations. Its Core Management Team has more than 350 years combined experience providing transmission and distribution power line construction services for some of the largest utilities in the country. This experience has afforded the company the dexterity and ingenuity to answer the call to meet all of its customers' challenges.

**PowerGrid Services | www.powergridservices.com**
**Booth #4510**

## Diagnostic System

The precision instrument, mini-ATOS, is a professional multifunctional power transformer and substation diagnostic system. This compact and intelligent instrument can perform many routine and advanced tests such as winding resistance (WR), dynamic resistance measurement (DRM), turns ratio (TR), frequency response of stray losses (FRSL), magnetic balance, and other diagnostic parameters. With the built-in fully automatic multiplexer, only a one-time connection is required for nearly all functions, which saves a considerable amount of time. The portable, rugged case is suitable for use anywhere onsite or in a laboratory. It is specially designed for fast and easy measurements with the high precision and quality of all Raytech instruments.

**Raytech USA, Inc. | www.raytechusa.com**
**Booth #5049**

## Modular Equipment Enclosures

BMarko Structures provides modular equipment enclosure solutions for a vast amount of different industries. Each of the projects are 100% custom-built to the customer's exact specifications. As a cost-effective option, BMarko Structures' custom metal buildings and shipping container conversions are widely adaptable to a variety of uses to fulfill your project's needs. BMarko's buildings and equipment enclosures have been used for numerous different applications such as eHouses, power distribution centers, motor control centers, modular data centers, battery storage buildings, modular skids, generator housing, pump houses, water treatment plants, SCADA buildings, and offices. BMarko has sent structures all over the United States from Washington to Maine, and everything in between. The company will work with the customer's team to ensure all state-specific regulations are followed and have your building delivered on site and on time.

**BMarko Structures | https://bmarkostructures.com**
**Booth #3550**

## Ultra-High Voltage Transformers

Shihlin Electric can produce the highest level of 345-kV 1260-MVA nuclear energy level ultra-high-voltage transformers. The products are supplied to large-scale power plants, public construction and technology factories, and play a key role in the transmission and distribution system. Shihlin Electric has a global marketing network, customized services and after-sales service system, supplying major private customers around the world, covering the United States, Canada, Australia, the Philippines and ASEAN countries. Main selling products:

- 345-kV (oil) power transformer
- Power transformer (161-kV grade and below)
- 161-kV SF6 insulated power transformer
- Oil-immersed distribution transformer
- Energy efficiency and protective environment oil-immersed transformer
- Pad-mounted transformer
- Pole-mounted transformer

**Shihlin Electric | https://en.seec.com.tw/**
**Booth #8552**

## Substation Construction & Line Drilling

GridTech Substation & Drilling is a one-stop service provider in the distribution and transmission industry. With a vast experience in substation construction and transmission line drilling, the company provides solutions to difficult problems that arise on complex projects. GridTech Substation & Drilling was built on integrity with a solution-driven management Team. With more than 40 years of experience in the industry, the company has developed lasting relationships with clients based on trust, collaboration, and project delivery. At GridTech we know that attention to Safety, Quality, and Schedule is a priority in every successful project.

**GridTech Substation and Drilling | https://gridtechpower.com/**
**Booth #4510**

## Engineering, Construction and Maintenance

Elecnor Hawkeye is a turnkey service provider in the energy sector working with utilities, manufacturers, developers, and governmental agencies across the United States. The company offers engineering, construction, and maintenance solutions to the electricity, gas, and telecommunications sectors. Over the past 20 years in business, Elecnor Hawkeye has built a reputation for customer satisfaction, environmental stewardship, and on-time/on-budget projects. Elecnor Hawkeye's core service offerings include, but are not limited to, electrical overhead transmission and distribution, natural gas infrastructure, electrical underground

transmission and distribution, substation, directional drilling, and renewable power/electricity generation. The company said it "proudly defines and applies the most effective and corrective mechanisms to minimize our impacts on the environment."

**Elecnor Hawkeye LLC | www.elecnorhawkeye.com**
**Booth #7614**

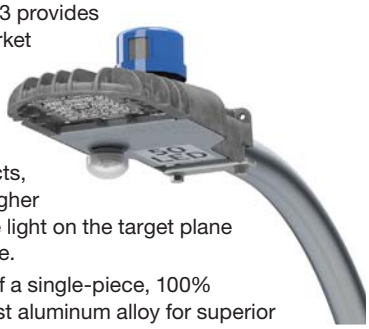
## Composite Core Conductors

Lamifil's ACCC ICE+ range are lightweight and strong composite core conductors, combining good efficiency and excellent sag behavior under heavy mechanical loads. They are developed with the most severe wind and ice conditions in mind, withstanding a 2-in. full-density ice load all while improving the economics of the transmission grid. ACCC ICE+ conductors feature a high strength temperature resistant composite core that can work continuously at 180°C. Trap and/or z-shaped aluminum zirconium wires in a closed design are stranded around the core. Using Lamifil's soft thermal aluminum or high tensile strength aluminum zirconium strands makes this conductor up to 10% at (at 63% IACS) or 15% (at 61% IACS) stronger, respectively, than a standard ACCC design. At low operating temperatures, ACCC ICE+ conductors are up to 25% more efficient than ACSR. Composite core conductors can be designed and optimized for maximum electrical or mechanical loads by choosing the right combination of aluminum and core type. Next to the standard series, custom designs are possible. Finally, ACCC ICE+ composite core conductors are easy to install with conventional methods and use exactly the same fittings as the normal ACCC conductors.

**Lamifil Inc. | https://lamifil.be/**
**Booth #8213**

## Site & Area Luminaire

EnergyLite of Solais Lighting Group has launcheed GridLite3 (GL3), a site and area luminaire. Designed with reliability, durability, and maintenance in mind, the GL3 provides top-tier performance the market demands — while delivering long service life, modularity, and a variety of mounting solutions for any application. As with all EnergyLite products, optic distributions provide higher light utilization, yielding more light on the target plane with lower backlight and glare.



The GL3 is constructed of a single-piece, 100% recycled, low-copper die-cast aluminum alloy for superior

thermal management with AAMA2604-compliant polyester TGIC super-durable powder coating for exceptional corrosion resistance. To withstand the harshest environments, the optical and electrical chambers are rated to IP66 resistance. The GL3 replaces 200-600 W equivalent HID fixtures and ranges from 12,000-41,000 delivered lumens, all while providing efficacies up to 165 lm/W.

All mounting options are tested to 3G vibration standards and offer installation versatility. The extended site arm provides universal mounting to both square and round poles, as well as a wall-mount option. The horizontal tenon with integrated slipfitter attaches quickly and easily to tenons up to 2 ⅜" in diameter. The knuckle provides 0-90° adjustability mounting to tenons up to 3" in diameter. Accessories include a variety of light control shields, motion sensors, and photocells, as well as optional DALI-2 drivers for two-way communication. The GL3 also features the new Zhaga Book 18 (ANSI C136.58) receptacle for low voltage sensors and communication, which can be configured to function with EnergyLite's proprietary ambient light sensor or ambient light sensor with IR communication.

**EnergyLite (of Solais Lighting Group) | energylite.com**
**Booth #7939**

## Electrical/Mechanical Shunts

Classic Connectors USA introduces its new line of permanent, full-tension, transmission-class ClampStar-engineered, electrical/mechanical shunts, with built-in corona protection up through 800-kV. A unique combination of both saddle (constant electrical interface utilizing Belleville washers while mechanically maintaining conductor shape) and Frusto-Conical (68,000 lbs. of penetrating force) keepers provide the most cost-efficient, performance-effective, permanent upgrade solution for extending the life of your critical conductor connections. This dual-keeper design results

in tensile performance at or above 95% of the RBS (full-tension) on conductor diameters from 0.814-in. (20.67 mm) to 1.912-in. (48.56 mm). The complete line of ClampStar-engineered, electrical/mechanical shunts are available for the following corrective applications: midspan splice, dead-ends, conductor strand repair and strand breakage at suspension clamps on both distribution and transmission systems, covering conductor ranges from #6 thru 2515 kcmil (ACSR) and 2750 (AAC). Classic Connectors also offers a complete line of shunts and repair units for both overhead shield wire and optical ground wire applications in both insulated and non-insulated versions. Prevent unplanned outages and wildfires resulting from downed lines while improving the safety of the general public with ClampStar.

**Classic Connectors USA | https://classicconnectors.com**
**Booth #7221**

## Arc Flash Protection

Arc flash protection by the pioneer:

- AQ-100 arc flash protection relays, arc light sensors, and light & pressure sensors.
- AQ-1000 resettable arc quenching device for low voltage applications of up to 690 V, as fast as 4 ms total arc clearing time of faults up to 100 kA.
- SIQuench resettable arc quenching device for medium voltage

applications of up to 24 kV, as fast as 5 ms total arc clearing time of faults up to 50 kA.
- Accurate protection relays:
- AQ-200 series protection relays.
- Full range of reliable, high performance, and easy-to-use feeder, motor, generator, transformer, and line protection.
- Power management:
- AQ-S254 alarm annunciator.
- AQ-P215 power monitoring device.

**Arcteq Relays LTD | www.arcteq.fi**
**Booth #5228**

## Infrastructure Projects

Oldcastle Infrastructure is a provider of products and services for infrastructure projects across North America. Operating with more than 3000 people in over 70 production facilities across United States, Canada and Mexico, Oldcastle Infrastructure is positioned to support projects at every stage and make a meaningful impact in our communities.

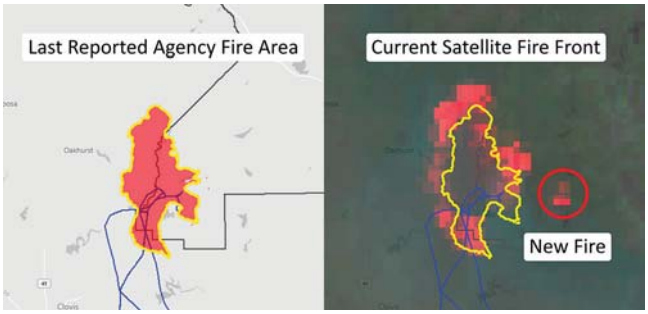
- Cable trench system and accessories (Plastibeton)
- Cable duct system
- Fire walls and security walls (Trufirewalls)
- Sectionalizing cabinets
- Switchgear pads
- Pedestals
- Transformer box pads
- Vaults and underground enclosures
- Pole top extensions

**Oldcastle Infrastructure | oldcastleinfrastructure.com**
**Booth #8757**

## Wildfire and Weather Monitoring

Indji Systems offers a patented solution that gives advanced warning of hazardous weather and wildfires that disrupt utility operations. The three-step approach provides tools to help utilities plan for upcoming weather hazards, respond to current conditions threatening grid assets and investigate damage quickly, allowing operators to have confidence about lightning caused damage or fires.

- Plan – Asset specific forecasts, advanced forecast radar and forecast lightning provide storm forecasts in advance for crew scheduling, construction and maintenance planning.
- Respond – See a live view of all current wildfire and weather threats specific to the utilities' own lines with the Asset Threat Window. Receive alerts when natural hazards exceed the user defined threat thresholds.
- Investigate – Use the Lightning Fault Analyst for early lightning fault correlation and outage location response.
- Indji will have a drawing and be demonstrating how the Indji Watch hazard monitoring and alerting solution can help your utility prepare for natural weather hazards.




**Indji Systems | www.indjiwatch.com**
**Booth #7623**

## Distribution Management

To meet power system challenges of the green economy, a greater control over distribution assets is a must. Present distribution networks are unprepared for the uncertainties of new technology, home solar, and electric vehicle (EV) adoption. Introducing PF-ONE, a grid-edge compensation technology, where active currents are injected to cancel reactive, harmonic, inrush and imbalanced load currents adaptively. With PF-ONE's unique abilities, distribution networks are autonomously tuned to meet load, voltage, power quality, and stability requirements. Increase distribution capacity, reduce technical losses, and make seasonal or time of day network adjustments a thing of the past. The PF-ONE infrastructure grade control brings all of these benefits to networks big or small at scale, without the need for communication. Smart meter devices incorporating PF-ONE compensation technology shield Power Utilities with full system compensation right to the grid's edge. Now installation is as simple as replacing a service meter.

**Vantera Incorporated | pf-one.com**
**Booth #3920**

## Rubber Insulating Products

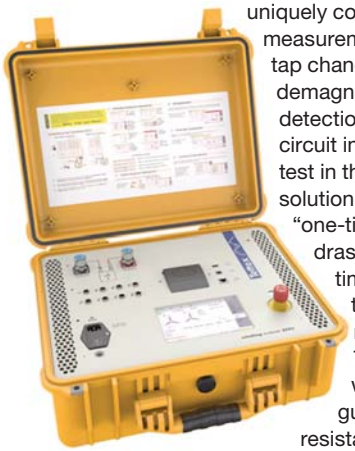
The Saf-T-Gard Voltgard Test Lab is the largest, independent NAIL4PET-accredited test lab for rubber insulating products in the United States and offers complete retesting and certification of rubber gloves, sleeves, blankets, line hose, covers, dielectric footwear, jumper cables, grounding sets, plastic guards, hot sticks, matting, hoods and hand tools – all to applicable ASTM standards. Moreover, the Saf-T-Gard Voltgard Test Lab developed


the Original Rubber Goods Change-Out Program, the industry's first professionally managed rubber goods change-out program, designed to minimize out-of-service time and save money by offering customers a start-to-finish solution that monitors, tracks and manages the rubber insulating products' in-service use and testing intervals so that workers can focus on their job. This process includes cleaning, visual inspection, electrical testing, markings according to customer safety protocols and shipment to the customer warehouse or job site. Plus, Saf-T-Gard has the largest inventory of in-stock rubber insulating gloves and related products. Whether it is replacing failures in the lab, if you are adding new crews, or storm repair, count on Saf-T-Gard to have it in stock. And be sure to ask about our Emergency Storm Response Program.

**Voltgard a Division of Saf-T-Gard International | www.saftgard.com**
**Booth #4511**

## Transformer Winding Resistance Analyzer

The WA 2293 is a winding analyzer that is optimized for testing three-phase power and distribution transformers. This test set uniquely combines winding resistance measurement, transformer turns ratio, tap changer dynamic resistance, core demagnetization, transformer type detection, magnetic balance, short circuit impedance, and heat run test in the fastest single instrument solution on the market. A simple "one-time-connection" system drastically reduces measuring time, and once connected, all tests can be performed in a row without any reconnection. The built-in simultaneous winding magnetization method guarantees fast and reliable resistance measurements. The high output power of the device will help to magnetize the transformer faster and reduce testing time, even for large power transformers. The 2293 is housed in a rugged and portable case, making it perfect for on-site testing. A 7-in. color touchscreen can be used with a gloved hand or stylus and test results can be viewed on the device or exported to a thumb drive via USB or to a laptop via ethernet.



**HV TECHNOLOGIES, Inc. | www.hvtechnologies.com**
**Booth #7138**

## Parallel Resonant AC Test Sets

High Voltage, Inc. is an American test equipment manufacturing company located in rural Copake, New York. The company's HPA line of ac testers are available with outputs up to 300 kV ac and power levels up to 40 kVA and can be customized with various levels of control sophistication. The company's new PAR line of ac dielectric testers are designed to meet the needs of those who need power levels up to 250 kVA, to be able to test their highly capacitive test loads. Using ac resonant technology outputs of 50 kV at 5A (for example) are possible with an input of only 230 v, 90 A. That is an input of 20 kVA for an output of 250 kVA. (Model PAR-50250FC5)


The PAR models consist of a control section and a high voltage section. While large, they are transportable by van or trailer for field work. The control section includes the input breaker, variable (motorized) input control, a PLC controller, and connections for controlling the hv section. The high-voltage section is a steel tank with a phenolic output bushing. Inside this tank is a variable-core reactor in an insulating oil bath with an air space at the top to allow for thermal expansion. The variable reactor looks similar to a transformer but has a moveable core that allows the inductance value to vary to match the capacitance of the load, thereby achieving resonance. This effectively cancels the load capacitance, as far as input power requirements are concerned. Once in resonance, the input voltage is increased until the desired output voltage level is achieved. For a capacitive load that must be tested at power frequency the PAR reduces power requirements, as well as test equipment size by one tenth to one thirtieth, compared to a test transformer.

The HVI PAR family of resonant as dielectric testers are suitable for power frequency testing of power cables, rotating machinery, bushings, instrument transformers, transformers, shunt reactors, and many other products.

**High Voltage, Inc. | www.hvinc.com**
**Booth #5831**

## Optical Sensing Platform

As the grid turns digital, we need to accurately monitor and measure more of the grid in real-time and in more places if we want to predict outages, locate faults prior to grid disruption, and improve the integration of renewables. Micatu's Gridview optical sensing technology platform, winner of the 2021 S&P Global Platts Global Energy Award for Commercial Technology, utilizes light passed through an optical crystal to provide unprecedented situational awareness for utilities and for commercial and industrial manufacturers. Optical sensing provides the highest data fidelity, accuracy, precision, and next-level harmonics measurements for grid visibility, making it a compelling solution that bridges the gap between yesterday's one-way, analog grid and today's need for digital two-way, real-time data. Micatu's Gridview optical sensing platform measures voltage, current, vibration, and temperature with unprecedented accuracy, without being an ignition source. Since the optical sensors measure with light instead of passing electrons, Gridview enables electric grid operators to avoid equipment overheating and violent, explosive failures. With overhead, underground, and groundless options available, optical sensors can be easily deployed anywhere they are needed and require only firmware upgrades to leverage advances in chip and software designs.

**Micatu, Inc. | www.micatu.com**
**Booth #5857**

## Touchless Monitoring

Systems With Intelligence Inc. is a global provider of touchless monitoring solutions for electric utility applications. Our substation-rated systems collect and analyze the asset health data that allows utilities to increase safety, reliability and reduce operating costs. Coupling thermal monitoring and visual imaging technology with advanced analytic algorithms, Systems With Intelligence solutions automate asset health monitoring and provides the data to support condition based maintenance applications that allow utilities to implement condition-based maintenance programs that reduce travel to site and costs. Support for industry protocols allows our system to interface with SCADA and asset management applications providing a seamless flow of data from asset to control center.

**Systems With Intelligence Inc.**
**www.systemswithintelligence.com**
**Booth #7951**



## Liquid, Powder Coating

Cloverdale Paint Inc. said that is has "literally saved days" in tank processing for several manufacturers with its products. Visit Booth #4334 to see how. world-class liquid and powder coating systems engineered to surpass IEEE C57.28, 29 & 32 specifications for customers all over North America. Complete systems for ISO12944 C5 and CX Extreme for those serving global markets using these specifications as part of their product portfolio. The company has 40 years' experience with developing custom coating solutions for power transmission and distribution. The company's coatings improve worker safety, reduce operating costs and maximize throughput.

**Cloverdale Paint Inc.**
**www.cloverdalepaint.com**
**Booth #4334**

## Real-Time Monitoring, Analytics

LineVision provides electric utilities with the real-time monitoring and analytics needed to secure the future of the grid. LineVision's patented non-contact sensors collect critical information to unlock additional capacity on existing transmission lines, provide insight


into conductor health, and detect anomalies and risks. LineVision's platform is rapidly deployed at scale without the need for scheduled outages, live-line work, or specialized installation equipment. Results from deploying LineVision systems on existing transmission infrastructure have demonstrated that it can safely increase power line capacity by as much as 40%. This means that utilities can effectively double the current rate of renewable integration on the existing grid. Find us at IEEE PES T&D to learn more about how LineVision is helping our utility partners around the world lead the energy transition by increasing the capacity, resilience, and safety of the grid.

**LineVision Inc. | www.linevisioninc.com**
**Booth #5942**

## Meta-Aramid Paper Products

The G-Flex line of meta-aramid paper products by The Gund Company is a cost-effective alternative to Nomex. G-Flex Meta Aramid paper YT510 offers high inherent dielectric strength (more than 20 kv/mm), mechanical toughness, flexibility, and resilience. Manufactured from 100% aramid fibers, G-Flex is recognized by Underwriters Laboratories (UL) as a 210°C insulation, has full UL approval (File #: E521153), and a VTM-0 Flame Rating. G-Flex Meta Aramid paper has long-lasting thermal

stability and can be used for many hours at high temperatures while maintaining dimensional stability. When temporarily exposed to high temperatures up to 300°C, G-Flex will not melt, become brittle or soften. It is inherently flame-resistant and does not self-burn or melt in the room air, is not combustion-supporting, and has the property of self- extinguishing. Meta-aramid fiber has a stable chemical structure. It is resistant to most strong inorganic acid and to alkalis at room temperature. Other products in the G-Flex line include flexible laminates (i.e., DMD, NMN), wire sleeving, felts, cordage and surge ropes, and insulating tapes. Applications include stator slot liners, phase insulations, coil wrap, conductor wrap, lead wire protection, insulation barriers, and other insulation applications for motors, generators, transformers, electronics, and switchgear.

**The Gund Company | www.thegundcompany.com**
**Booth #8457**

## Insulators

PPC Insulators is a global state-of-the-art electrical insulators manufacturer, celebrating 135 years of experience and innovation. Specializing in insulator design for substations, overhead line, and precipitator applications up to 1200 kV AC and 800 kV DC system voltages, the company delivers quality products and services from its local inventory and operations in the United States and Canada:

- Station Posts are manufactured using isostatic process and offer designs up to 1300 kV BIL in a single piece and 2050kV BIL in a two-piece design.

- The Cap & Pin replacements are designed to directly replace old Cap & Pin Posts.
- Suspension Insulators offer a conical head and heat-cured alumina cement.
- RTV Coatings are available from the factory or as an in-field service with the application of world-recognized CSL Silicon materials.
- Distribution product offering covers the full line of Pin Types, Spools, Strains, and Line Posts.

**PPC Insulators | www.ppcinsulators.com**
**Booth #8441**

## Network Planning on Geospatial Platform

ETAP Grid offers an integrated network analysis, system planning and operations solutions on a progressive geospatial platform for simulating, operating and optimizing the performance of smart grids. ETAP's electric digital twin serves as the active blueprint of the grid and is the foundation for unified engineering and a real-time platform that seamlessly integrates multiple applications to accelerate productivity, increase efficiency and enable digitization of power systems at every stage of the electrical life cycle.

- Modeling - Model, configure, manage & visualize electrical networks
- etapApp - Collect field data & synchronize via mobile application
- Analysis - Plan, simulate, and predict system response
- Safety & Protection - Evaluate electrical safety and system protection
- eprotect - Centralized enterprise protection asset management
- Optimization - Improve efficiency, reduce energy costs and minimize losses
- ADMS - Digital-twin based planning, eSCADA, DMS & OMS eOTS –
- Operator Training Simulator iDLS - intelligent Distribution Load Shedding
- iSUB - Intelligent Substation Automation
- netPM - Model and manage projects collaboratively

**ETAP | https://etap.com/**
**Booth #5029**

## Composite Structures

Creative Composites Group designs and manufactures composite structures for utility infrastructure applications, such as transmission and distribution poles, light poles, and crossarms. Compared to those made from traditional materials (e.g., wood, steel, concrete), they offer better resiliency and easier maintenance, both of which make for a superior long-term investment.

One significant benefit of utilizing fiberglass composite distribution and transmission poles is their inherent corrosion resistance. Fiberglass poles will not rot, rust, or spall when faced with extreme weather conditions. Additionally, fiberglass poles can play a vital part in storm hardening strategies due to their resilience when facing high-speed winds. After seeing an increase in pole failures due to deterioration and an increase in dangerous pole fires, many electric companies and utility companies are looking to use fiberglass for their poles and crossarms to reduce the risk of pole top fires and short-term damages. Unlike other fiberglass poles on the market, our addition of the FRP FireSleeve gives its composite poles an advantage. The FireSleeve acts as a shield, reacting to heat and promoting cooling during a fire to protect the pole from extreme temperatures. Our FRP poles, fitted with the FireSleeve, have demonstrated the ability to withstand heat in excess of the glass transition temperature [at which carbon chains begin to move] without post-event permanent loss of strength. That means utilities can inspect a pole's temperature profile post-fire, keep it in service, and be confident it will remain structurally sound.

**Creative Composites Group | www.creativecompositesgroup.com**
**Booth #6544**

## Transformer Services


With more than 50 years of experience in the transformer services industry, Emerald Transformer provides a wide range of transformer services, including remanufactured transformer

stock, repairs, decommission, field technical services, parts, PCB disposal and recycling. Emerald Transformer provides comprehensive repair, refurbishment, and OEM warranty services on all types of electrical equipment. This ranges from minor transformer repair, reconditioning, and rewinds to complete refurbishment for reclosers, oil circuit breakers, SF6 breakers, circuit switches, controls, regulators, and substations. Emerald said it guarantees the highest quality and workmanship of its products and offers a 5-year warranty. Repair services are provided at multiple facilities that serve customers throughout the country with professional pickup, delivery, and customized handling on every job. Regularly scheduled shipments among its nationwide network of facilities enables it to provide delivery services at competitive prices. The company's veteran technicians, some working with Emerald for more than 20 years, perform multi-point testing and inspections that result in a low failure rate. The company uses rigorous testing standards, high-quality materials, and an experienced team for reliable transformers. In addition, the skilled field technician teams can perform on-site diagnosis and repairs throughout the United States.

**Emerald Transformer | www.emeraldtransformer.com**
**Booth #7559**

## Test and Measurement Instruments

AEMC Instruments manufactures professional electrical test and measurement instruments for the industrial, commercial and utility marketplace. Chauvin Arnoux founded in 1893 and AEMC Instruments (part of the Chauvin Arnoux group) founded in 1976 provide current measurement probes, power quality and energy analyzers, ground resistance testers (including a tower testing system) and insulation resistance testers. The full product line also includes clamp-on meters, transformer ratiometers,


power quality meters, harmonic power meters, data loggers, multimeters, light meters, micro-ohmmeters, oscilloscopes, cable testers, environmental testers, thermal imaging cameras and numerous other electrical test instruments. In addition to the product offerings, AEMC offers a one-day accredited course in ground resistance testing and a 3-day class in power quality analysis. Since 2020, AEMC now offers a 2-day, 2 ½-hours-per-day technical training online webinar in ground resistance testing and insulation testing. Also, it offers free monthly informational webinars on electrical, thermal and energy topics. The products are backed by more than 125 years of experience in test and measurement instruments and encompass the latest international standards for quality and safety. AEMC products can be purchased through a worldwide network of distributors. It also offers custom products on an OEM basis.

Stop by AEMC's Booth #4055 at the IEEE PES Transmission & Distribution Expo and talk to knowledgeable professionals on solutions for your application or discuss a particular product you are interested in. As an added bonus, take a chance to win one of our free meters each day.

**AEMC Instruments | www.aemc.com**
**Booth #4055**

## Energy Management Solution


NovaTech Automation utility products, including the Orion Automation Platform and Bitronics Measurement and Display, now provide solutions for a wider range of application inside and outside the substation. The new OrionMX is the smallest Orion and suitable for pole top, protocol conversion and secure IED access. The latest Bitronics pole top monitoring products and display products move beyond panel metering and leverage Bitronics durability and design quality. NovaTech products can be combined with professional services for configuration, packaging, installation, commissioning and training to reduce the time to implement projects. The solutions provide customers with immediate returns and long-term value.

**NovaTech Automation | novatechautomation.com**
**Booth #4649**

## Power Quality Recording

Power Monitors will have several products available for viewing and individual consultation at the IEEE PES Transmission & Distribution Expo, including the new Seeker. PMI's Seeker provides advanced cloud-based power quality recording with integrated wireless communication and digital I/O in a small weatherproof, line-powered device — without batteries. Designed for PQ investigative work, smart grid distribution monitoring and remote control applications, the Seeker is a one-size-fits-all PQ solution. What can you do with the Seeker?

- Investigate power quality issues remotely
- Troubleshoot and test distributed generation
- Track and tune CVR and volt/VAR systems
- Monitor DER distortion and real/reactive power; disconnect based on threshold exceedances
- Implement custom SCADA control schemes using the Seeker's DNP interface, PQ measurements, and digital I/O
- Monitor end of line voltage

**Power Monitors Inc. | www.powermonitors.com**
**Booth #7913**

## Pole Hardware

The 1200 series Add-A-Link band from Hughes Brothers Inc. is suitable for adding attachments onto existing poles without having to drill holes. It can go on any size pole and is more cost-effective than a chain band. Hughes' made-in-America band is easy to modify for special conditions. It ships with additional links and bolts for field adjustment to actual pole diameter. The standard dead-end strength is 20,000 lbs.

**Hughes Brothers Inc.**
**www.hughesbros.com**
**Booth #4138**

## High-Voltage Recloser

G&W Electric, a global supplier of electric power equipment since 1905, has launched its Viper-HV Recloser up to 72.5 kV. The market's first high-voltage pole top recloser supports faster overcurrent protection through fault isolation and automatic restoration for temporary faults on overhead sub-transmission lines. Uniquely designed as a self-contained system featuring three-in-one capabilities of a recloser, CTs, and integrated internal voltage sensors, the Viper-HV provides utilities improved performance on a pole to automatically clear any temporary faults and isolate only that section of the grid to protect additional lines from going down and preventing an entire region from losing power. The Viper-HV offers utilities installation flexibility through a variety of configurations, including phase-over-phase and cross-arm versions to match existing line infrastructure. G&W Electric offers site-ready designs with pre-installed accessories and flexible solutions tailored to meet environmental challenges. Without the need for oil or gas, the Viper-HV reduces routine maintenance and improves personnel safety.

**G&W Electric | www.gwelectric.com**
**Booth #6228**

## Transmission Tower Tags

Since 1948, Tech Products, Inc. has been a part of the utility industry, working with lineman, engineers and safety personnel to improve identification products. Its newest invention is the Everlast transmission crossing signs. In conjunction with several transmission companies and large utilities, Tech Products has come up with simple signals to alert helicopter pilots when a transmission line will cross and cause a hazard to himself and his crew. The importance of alerting the crew of coming hazards along the transmission line is immeasurable. It is important to use signals that are large, recognizable and easily understood. The basic two symbols will be the "X" for when the lines will be crossing and an arrow for the direction the helicopter pilot should follow to avoid hazards.


**Tech Products**
**https://techproducts.com/**
**Booth #7523**

## Measurement and Monitoring

CONDIS will showcase a complete measurement line, including primary and secondary substation equipment. The company will have an expert present a distributed electromechanical sensor technology, designed to improve the visibility and control of complex medium-to-high voltage power networks. This system enables the real-time monitoring and remote control of grid assets such as overhead powerlines to mitigate the outages that can be potentially caused by wildfires or the integration of renewables. The solution covers a wide range of monitoring applications in one single technology by combining several sensors such as temperature, strain, voltage, and current sensors. The company also provides engineering services for the data acquisition, processing, and protocol conversion of IEC 61850, IEC 60870-5-104, and others. CONDIS group, through its daughter company Elvexys, delivers vendor-independent substation design tools that enable the control and supervision of data in a SCADA system.

**CONDIS | https://condis.ch/**
**Booth #4439**

## Multi-Fiber Data Connectors

Phoenix Contact has introduced a series of robust multi-fiber data connectors. The new M17 MPO fiber-optic connectors are suitable for real-time data transmission in intelligent power grids, where reliability, signal integrity and uptime are critical. The robust interfaces feature high-quality fiber optics, which provide stable bandwidths over long transmission distances. This plug-and-play solution comes complete with fully assembled trunk cables, distribution boxes, and breakout cables. Trunk cables are available in standard lengths up to 200 meters. Distribution boxes with one or two MPO connectors and up to 72 LC duplex front connections enable quick and easy installation without additional tools. Breakout cables are also offered for custom configuration or use in alternative enclosures, such as control cabinets. The breakout cables are designed for front mounting of one M17 MPO connector on the panel, with breakout IP20 LC or ST cables inside the enclosure.

**Phoenix Contact USA, Inc. | www.phoenixcontact.com**
**Booth #8713**

## Steel Structure Solutions

Osmose comprehensive steel structure solutions provide utilities with options to today's rapidly growing concerns surrounding the health of these steel assets. Services range from large fully integrated program solutions including structural assessment, mitigation, analysis and fully engineered restoration methods to even small à la carte project options for smaller concerns. The results of this scalable approach provide utilities with a complete understanding of the health of their steel assets from the top of the structure to below-grade. The goal is to deliver effective, life-extension and restoration solutions in one integrated program and develop economic efficiencies of scale that save money while providing system integrity, resiliency, and dependable reliability.

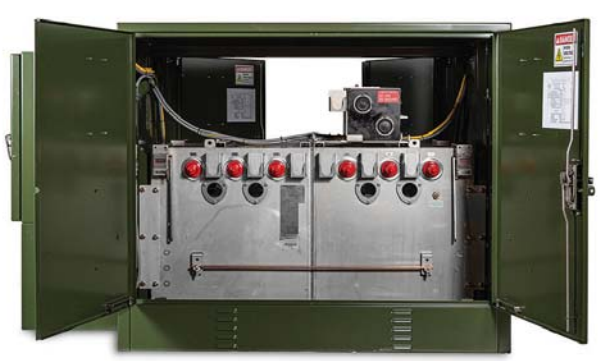
**Osmose | www.osmose.com**
**Booth #3249**

## Engineering, Procurement and Consulting

Black & Veatch knows construction and has been innovating since the earliest days of building America's heartlands and infrastructure throughout the world. Every project it undertakes harnesses the latest advances in materials, project management and sustainability to bring clients quality, efficiency and safety. The company delivers a full spectrum of contracting and services-based solutions that suit risk profiles and capital budgets. Black & Veatch offers straightforward advice, lean and productive outcomes, and assets that deliver the most value over their lifecycle. Black & Veatch is a 100% employee-owned global engineering, procurement, consulting and construction company with a more than 100-year track record of innovation in sustainable infrastructure. Since 1915, it has helped clients improve the lives of people around the world by addressing the resilience and reliability of our most important infrastructure assets.

**Black & Veatch | www.bv.com**
**Booth #8721**

## Padmount Switchgear



Eaton's ISG-SD solid-dielectric padmount switchgear offers a compact, reliable and efficient solution to protect, control and isolate underground distribution equipment. ISG-SD switchgear contains no oil or $SF_6$ gas, which means less monitoring and maintenance, and reduced impact on the environment. By replicating the shape, footprint, bushing patterns and phasing of air, oil and $SF_6$ gas insulated switchgear, retrofits of outdated switchgear are fast, efficient and cost significantly less. Units feature a visible open isolation point (VOIP), which, by a single operating handle in one operation, de-energizes, isolates the circuit and provides a clear view to open contacts.

**Eaton | www.eaton.com**
**Booth #6813**

# Fleet Electrification Provides Great Opportunity — If Done Right

A case study by National Grid estimates potential demand associated with full electrification and suggests several critical next steps for utilities to start preparing now.

By **GIDEON KATSH**, National Grid USA, and **JONATHAN HOU**, Hitachi Energy Ltd.

The transportation sector is the largest source of greenhouse gas emissions in the U.S., accounting for 29% of all emissions in 2019. While much attention has been given to the electrification of light-duty passenger vehicles, the electrification of larger medium- and heavy-duty vehicles (MHDVs) presents a promising decarbonization opportunity. Medium- and heavy-duty trucks account for almost one-quarter of all greenhouse gas emissions from transportation in the U.S. These include fleets operated by private companies, such as logistics operators managing freight trucks and last-mile delivery vans, or public fleet operators, such as municipal transit authorities offering public bus service. Beyond carbon, MHDVs are much more intensive polluters in the areas they operate, with significantly higher amounts of other pollutants such as particulate matter.

Analysis by Bloomberg New Energy Finance (BNEF) demonstrates the scale of the electric fleet transition: In the net-zero scenario of BNEF's 2021 Electric Vehicle Outlook, about 90% of all MHDVs globally will be electric vehicles (EVs), with the remainder being hydrogen fuel cell and other zero-emissions technologies. This transition will create a substantial increase in electric demand, requiring not only a large build-out of renewables and


Electric Nissan E-NT400 Concept Truck at the International Motor Show for Commercial Vehicles in Germany. In the net-zero scenario of Bloomberg's 2021 Electric Vehicle Outlook, about 90% of all medium- and heavy-duty vehicles globally will be electric vehicles Photo by Typhoonski, Dreamstime.

other zero-emission generation to fuel these EV fleets but also T&D infrastructure to deliver the clean electricity to fleet depots and on-route charging plazas, where chargers will need to be installed in sufficient supply.

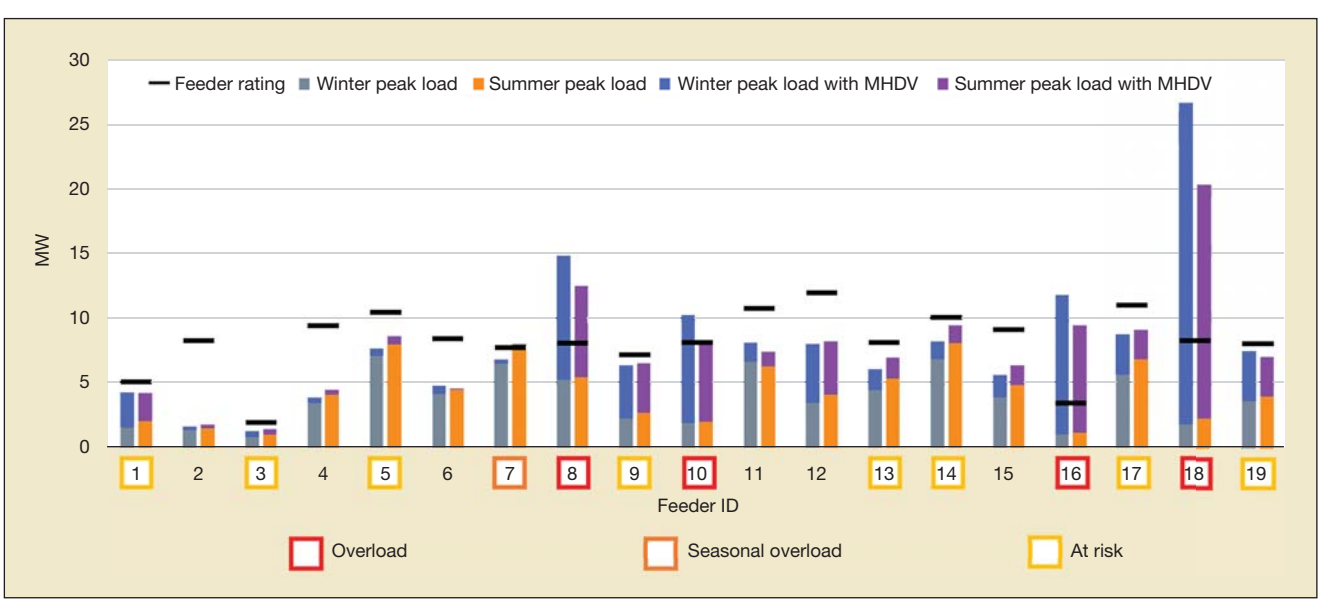
How can the electric grid support a fully electric future for MHDV fleets? To understand this, it is necessary to first understand the scope of potential impacts on the grid — how much demand could be added and where?

## Fully Electric Fleets

National Grid and Hitachi Energy Ltd. recently teamed up to study the impacts of fully electric fleets on the power grid. This joint study, "The Road to Transportation Decarbonization: Understanding Grid Impacts of Electric Fleets," analyzed potential impacts from fully electric fleets in a specific area of National Grid's electric service territory in the Northeast U.S. The case study identified actual fleets, estimated the potential demand associated with full electrification (taking into account different vehicle classes, operation requirements and charger types) and mapped those demand requirements to National Grid's existing distribution system to identify future constraints. It revealed electric fleets could have significant loads that would impact distribution systems and proposed several actions to support the transition to EVs.

The analysis provided a bottom-up view of electrification needs. The process involved the following:

- Identifying over 50 individual fleets in the study area, including the largest and most impactful vehicle fleets that were identifiable (many other smaller commercial operators were not included)
- Estimating fleet sizes and vehicle classes and then assessing vehicle charging needs, in both summer and winter, at each fleet depot to fully charge vehicles overnight
- Mapping each fleet location to the nearest electric distribution feeder (the circuit extending from the substation to the local neighborhood)
- Aggregating electricity demands at the distribution feeder and comparing this demand estimate to the feeders' load ratings and available load capacities in summer and winter.




Installing EV charging infrastructure can have a dramatic effect on the load, as shown here. The analysis identified more than two-thirds of the distribution feeders studied could eventually need to be upgraded when nearby fleets fully electrify.

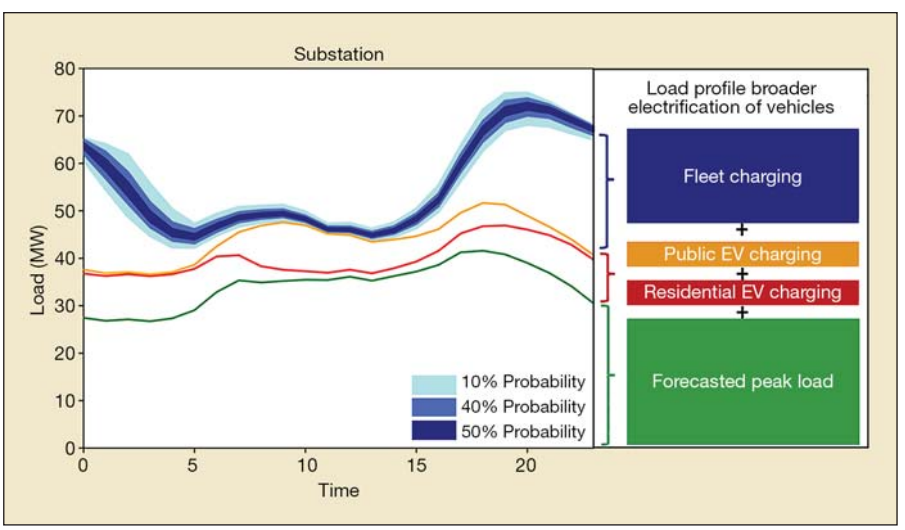
## Case Study Takeaways

A striking takeaway of the case study was the scale of potential load: One distribution feeder sees a tenfold increase of its peak load under a full EV scenario, triple the available capacity on the line. This is because of the cluster of fleets on the line — 10 sites and over 400 electric MHDVs. These fleets likely cluster as a result of the access to transportation infrastructure (such as highway corridors), commercial zoning (such as distribution centers) and other factors.

The analysis identified more than two-thirds of the distribution feeders studied could eventually need to be upgraded when nearby fleets fully electrify. This was only for the studied fleets, which were some of the largest and easiest ones to identify. Other smaller fleet operators would add their load on top of this, as would residential and public vehicle charging and other electrification load, such as electric heat pumps.

The case study also revealed these impacts would not be limited to the feeder level, and the magnitude of impacts of fleet electrification in cluster areas would be large even compared to other electrification-driven increases. One substation that supports several fleet-heavy feeders could see a 60% increase in peak load from fully electric fleets, compared to an additional 20% load increase from the full electrification of residential and public charging. While not all feeders would support fleets, planning must incorporate potential impacts for those that do.


In a different program, Highland Electric Fleets and National Grid used a Thomas Built Buses Saf-T-Liner C2 Jouley electric school bus equipped with a Proterra Powered battery system discharged nearly three megawatt-hours of electricity stored in the bus to the regional electric grid over the course of 30 events this summer. Courtesy of National Grid.

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This analysis was National Grid and Hitachi Energy's first step to understanding the impacts electric fleets will have on the electric grid and establishing proper frameworks to enable the transition to electric transportation. Proper planning and coordination can have significant value and help to ensure infrastructure is built economically and on time to support these needs. Further analysis is underway examining infrastructure needs and, later, policy needs. Already, though, several recommendations stand out to encourage electric fleets.

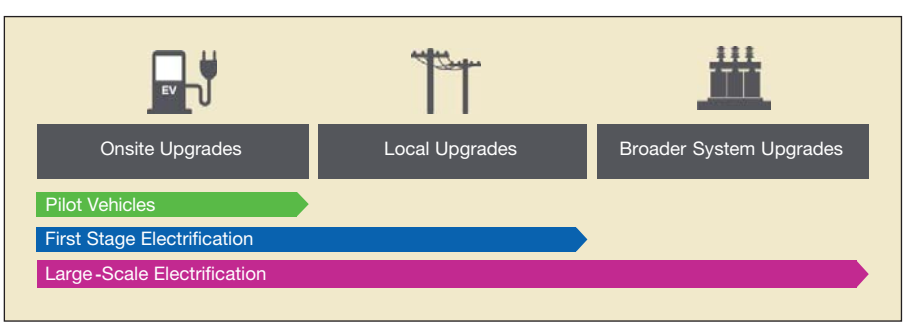
## Critical Next Steps

It is clear the electrification of large fleets around the U.S. will have a major impact on power grid performance, and the effects will be felt well before full fleet electrification. It is important utilities start planning for this inevitability now with a full, end-to-end approach to bolstering the grid. Fleet electrification needs should be addressed in tandem with other needs, and this will require collaboration across multiple stakeholders, including utilities, regulators, policymakers, fleet operators, suppliers and communities.

How can this coalition accelerate fleet electrification? The study suggested several critical next steps:

1. **Act now to plan for fleet needs promptly**. The clustering effect of fleets emphasizes how important it is to understand where fleets are located and the number and type of vehicles transitioning to electric operation. Right now, utilities largely lack that level of visibility.


Electric school bus chargers built and designed by Proterra. Courtesy of National Grid.




Fleet electrification needs should be addressed in tandem with other needs, and this will require collaboration across multiple stakeholders, including utilities, regulators, policymakers, fleet operators, suppliers and communities.

To plan for a fully electric future, this needs to change. Utilities, fleet operators, logistics operators, and other stakeholders should work together to identify where fleets are or are likely to be located and expected timelines. Utilities should work with system operators and regulators to begin forecasting and planning for the medium- and long-term impacts of fleet electrification in their service territories. Only by proactively understanding where impacts will be felt can utilities determine where grid infrastructure and other solutions must be implemented to enable fleet charging needs in a timely manner.

2. **Develop end-to-end solutions**. Solutions that should take this approach include transmission, distribution and distributed energy resources (DERs) in addition to charging programs. Different charging strategies can reduce the magnitude and duration of peak loads associated with fleet charging, suggesting that managed charging will play a role in supporting EV adoption, reducing system-wide costs and improving overall system reliability.

Considering long-term needs and timelines could lead to new thinking about solution requirements, more efficient solution development and the more rapid achievement of a net-zero future. Today, fleet operators are at the start of their decarbonization journeys and addressing issues individually. Soon, the impacts of fleets could scale up and lead to broader, system-wide issues requiring more comprehensive solutions. Working with fleet customers (as utilities already do through fleet advisory services) and planning further into the future would lead to holistic plans and projects that could meet long-term fleet needs and accelerate electrification. Hitachi Energy and National Grid already are considering how to achieve this.

3. **Address multiple needs at once.** When it comes to grids, nothing happens in a vacuum. Every event, every charge and every outage has an impact on operations across the system; adding millions of EVs to the grid is no small event. National Grid and other utilities continuously invest in their electric networks. Today, those investments largely address asset condition issues, but they are increasingly geared toward supporting the integration of clean energy into the grid — through grid-enhancing technologies, EV make-ready programs, transmission upgrades and more. In New York state, for example, utilities have proposed transmission investment plans to address bottlenecks and constraints for renewable energy in tandem with projects for reliability, safety and other purposes. Fleet electrification should be addressed in tandem with these other needs to increase efficiency, identify opportunities for synergies and reduce costs.

Further, many large commercial MHDV fleet operators have regional and national coverage across multiple states and utilities. Collaborative regional planning is needed to accelerate interstate MHDV electrification requests.

4. **Collaborate and share learnings**. Wide-scale fleet electrification will require collaboration across many parties, including

utilities, regulators, policymakers, fleet operators, suppliers and communities. Electrifying fleets will have economic, climate and public health benefits, especially in areas where large numbers of MHDVs operate. Infrastructure to support fleet electrification is an investment in these communities, which means they need to have collective buy-in to both the process and end goal. This should include public education campaigns, public commenting, government interactions, public-private partnerships and other activities designed to get everyone rowing in the same direction.

## Building Momentum

The recent US$1.2 trillion U.S. Infrastructure Investment and Jobs Act, which provides billions of dollars for EV charging infrastructure and fleet decarbonization, could provide a springboard for investment to deliver electric fleets of the future. To make the investment count, a plan is needed for how to deliver the clean and reliable electricity that will fuel those fleets.

The case study from National Grid and Hitachi Energy provides one critical piece of that road map by showing how substantial grid impacts could be and how they will be highly location specific. The electric industry can ready the grid for fleet electrification, but it needs to start planning now and collaborate closely.

Much is already happening to drive the shift toward electric MHDVs. Policymakers are issuing directives to procure EVs and phase out combustion engines; vehicle economics are approaching, if not already at, cost parity; and vehicle manufacturers are expanding their lineups, including increasing the number of MHDVs. The recently passed infrastructure bill will lead to significant investments to support EV adoption and charging needs. The grid will be ready to support these vehicles, and a framework to proactively plan for and integrate them into the system will help this to happen faster and more economically. TDW

**Editor's note:** To learn more, download the joint study from Hitachi Energy and National Grid at *www.nationalgridus.com/media/pdfs/microsites/ev-fleet-program/understandinggridimpactsofelectricfleets.pdf*.

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### For More Information

Hitachi Energy | *www.hitachienergy.com*
National Grid | *www.nationalgrid.com*

A surveyor peers through a theodolite at an outdoor construction site. Underground obstacles must be considered when burying power lines. Photo by Dmitry Kalinovsky, Dreamstime.

# Overhead or Underground Transmission? That is (Still) the Question

Part one in a two-part series examines where things stand with the challenges of using underground high-voltage ac lines to transmit bulk electrical power.

By **ROBERT G. OLSEN**, Washington State University, and **JON T. LEMAN**, POWER Engineers Inc.

For years, the electric utility industry has been questioning whether to use overhead or underground systems for transmission of power using high-voltage transmission lines. Issues driving this discussion range from aesthetics to audible noise and electromagnetic field exposure, to susceptibility and storm damage. It often has been noted that lower-voltage distribution networks are common in newer construction, and cities usually have no option but to use high-voltage underground systems to transmit bulk power. More recently, high-voltage overhead transmission lines have been implicated in starting wildfires. As a result, electric utility executives have promised to review policies for deciding whether to use overhead or underground power transmission systems.

There is also new discussion at the national level about power grid upgrades to support increased electrification. Given this background, it is important to revisit issues relevant to decisions on whether to use overhead or underground transmission. Utilities must understand specific issues to consider when evaluating the use of alternating current (ac) high-voltage cables for long-distance transfer of electrical power. These include issues related to both design and construction as well as the operation of these systems. Emphasis should be placed on challenges with the use of underground high-voltage ac lines to transmit bulk electrical power.

## Environmental Siting

The environment in which a 100-kV or higher transmission line is to be placed may preclude (or at least make very difficult) either the installation of overhead or underground transmission. For example, long distances across deep water or restricted overhead space in urban areas may preclude the use of overhead transmission. On the other hand, mountainous or hilly terrain or wetlands may preclude the use of underground transmission. Once feasibility is determined, it should be noted underground cables take up less right-of-way than overhead lines and have less visual impact on the environment.

Crews cut into a residential street to lay underground lines for street lights in Alameda, California. In California, utilities are committing to multi-million dollar undergrounding projects as a way to prevent wildfires sparked by overhead transmission and distribution. Photo by Sheila Fitzgerald, Dreamstime.

However, excavation for underground transmission can be disruptive and is not always easy. Underground obstacles must be considered. However, in recent years, horizontal directional drilling technology has mitigated some of these problems. Obstacles that may be encountered include bedrock near the surface, streams, railroads, other utilities, sanitary and storm sewers, streets and highways. All of these can add to the difficulty (and cost) of siting an underground transmission line. Once installed, the underground area must be safe from accidental contact by construction equipment, and vegetation must be managed to

A cable truck unloads spools of power cable in Salo, Finland, during an overhead to underground transmission project. Undergrounding lines is often touted as a way to cut down on outages due to severe weather. Photo by Taina Sohlman, Dreamstime.

avoid roots and rodents from interfering with the system.

Finally, in any location, permitting, political constraints and factors such as archaeological sites may determine whether overhead or underground transmission must be used.

## Material & Construction Costs

Overall, the cost of constructing a high-voltage underground transmission line varies from on the order of four times to on the order of more than 10 times the cost of an overhead transmission line. These costs include the generally more expensive underground cable compared to the cost of overhead conductors, materials associated with its burial in the earth (for example, installing the cables in ducts enclosed in concrete), and continuous excavation (or horizontal drilling) for underground transmission vs. poles, tower structures and foundations for overhead transmission.

In addition, underground transmission systems usually include several items that contribute to these higher costs. Relatively frequent splices are needed to join cable sections, because there are limits to shipping and weight restrictions on cable reels and to the tension a cable can withstand as it is pulled during installation. A concrete vault often is needed to house the underground splices because of their complexity, and they require careful craftmanship and quality control. Sheath bonding schemes also are implemented within the cable vaults. By contrast, splices for overhead transmission lines are relatively simple to install and require no special housing.

Underground lines are connected to overhead lines or substations by means of special termination structures. Porcelain or composite insulators or housings, often called potheads, contain the actual connections between the in-earth and in-air portions of the line, and care must be taken to prevent moisture ingress and manage electric field distributions where semiconducting layers and insulation are peeled back from the cable. Like splices, these termination enclosures require quality craftmanship to minimize the risk of insulation degradation.

In addition, it is common to place lightning arresters close to the terminations to protect the underground cable from overvoltage damage that can be caused by nearby lightning strikes. Sheath voltage limiters (SVLs) are arresters installed to protect against overvoltages between the underground sheath (concentric neutrals).

Finally, in pressurized gas or dielectric fluid-filled systems, pressurizing plants are required.

All these additional items add to the cost and complexity of an underground system. However, cross-linked polyethylene (XLPE) transmission cable technology largely has replaced pressurized cable systems and made the maintenance of the transmission cable system less complex.

## Electric Fields & Insulation

Generally, electric fields between the conductors of an overhead transmission line are much smaller than those between the electrodes of an underground cable. This is because the voltage between conductors a and b (for a given voltage class) is the same whether the transmission line is overhead or underground, while the electric field between the conductors is related to the voltage in the following way:

$$V_{ab} = -\int_a^b \overline{E} \cdot \overline{dl}$$

Hence, if the distance from a to b is shorter, as in an underground cable, the average electric field must be larger. Conversely, the average electric field for overhead lines is smaller. It is these electric fields that cause insulation breakdown and, hence, transmission line failure. Because overhead transmission lines have smaller electric fields in the space between conductors, it is possible to use natural air as the insulating medium.

However, underground conductors with larger electric fields must be placed in a medium that will not fail during normal operation of the transmission line. These include inert gases like $SF_6$ or nitrogen, dielectric oil or solid dielectrics like XLPE. In the case of XLPE, high-quality manufacturing controls must be used to eliminate any contaminants or voids in insulation that could lead to local electric field enhancement, deterioration of the insulation and ultimate breakdown of the cable.

These necessary insulating medium and manufacturing controls add to the cost of this type of cable.

## Heating & Cooling

Any transmission line conductor will have finite electrical resistance and carry a high electric current. This results in heating of conductors because of ohmic losses (that is, i2 R losses) and losses due to hysteresis and eddy currents in steel pipes, sometimes used for mechanical protection of underground cables. Dielectric losses also contribute to the heating. Because of these heating effects, overhead and underground conductors are operated at temperatures much higher than the ambient temperature.

Therefore, cooling of the conductors (overhead or underground) is an important issue. Overhead conductors are cooled through thermal radiation from the air and convection from wind. Given these relatively efficient cooling mechanisms, the current-carrying capacity of a given overhead conductor (that is, its ampacity) generally is larger than that of a comparable underground cable conductor. Further, the maximum operating temperature for specialized overhead conductors varies near 100°C (212°F) to more than 200°C (392°F).

The steel pylon of a high voltage electric power transmission line. Mountainous or hilly terrain or wetlands may preclude the use of underground transmission Photo by Stephan Pietzko, Dreamstime.

The less-efficient cooling of non-pressurized underground transmission lines is a more limiting factor in their operation because — absent a separate cooling system — all heat must be removed via thermal conduction through the materials (for example, soil, concrete and electrical insulation) in which the conductors that form the cable are embedded. Hence, the maximum current carried by underground conductors generally is more limited.

Further, maximum operating temperatures of underground cables are approximately 90°C (194°F), although short-term emergency ratings may be as much as 140°C (284°F). One additional issue designers of underground systems must face is preventing soil moisture from being removed. Moisture is needed to keep the thermal resistance of the soil constant to help cool the cables. In some cases, a separate cooling system may be needed to allow larger currents (and larger power transmission) than would be possible otherwise.

## Environmental Risks and Reliability

Overhead transmission lines are subject to damage from lightning, tree falls, severe windstorms, excessive icing and earthquakes. In most cases, lightning only causes intermittent outages, given the lightning protection systems associated with these lines. However, damage from other environmental stresses may cause transmission line failures that require maintenance.

Underground transmission lines may be subject to lightning strikes, flooding and earthquakes as well as damage from human digging.

The network of high-voltage overhead transmission lines tends to be quite reliable. In fact, because of the interconnected nature of the transmission system and requirements that it operate in the presence of a single or often multiple contingencies (that is, the loss of one or more transmission lines), most transmission line failures do not result in noticeable consumer outages. More specifically, according to one Australian study, well-designed overhead transmission lines operating at voltages greater than 110 kV have low total outage rates of about 1 per 100 km (62 miles) of line per year.

Consistent with this, a presentation from NEI Electric Power Engineering Inc., posted on the New Hampshire Public Utilities Commission website, states that transmission line failures are the cause of only about 2% of consumer power outages. The remainder are a result of subtransmission and distribution facilities. Statistics show underground transmission lines are more reliable than overhead lines, but the time and cost to fix underground lines is much more than overhead lines. Estimates of repair rates for XLPE transmission cables from the Wisconsin Public Service Commission indicate the chance of an issue on underground cable requiring repair is 1 out of 1600 per km per year. A similar rate for pipe-type cables is 1 out of 500 per km per year.

Given appropriate equipment, identifying the approximate location of a fault on either an overhead or an underground transmission line generally is generally a straightforward process. However, while locating the specific site of a fault on overhead transmission lines can be quick because the components are visible, the same process for underground transmission lines is much more difficult

and time consuming because it can require opening vaults and excavation before inspection. Nevertheless, some newer technologies such as fiber-optic acoustic sensing are leading to more efficient detection of faults on underground cables.

The real difference between overhead and underground transmission comes in the duration of outages. While outages on overhead lines usually last less than a day, the typical duration of an XLPE outage is five days to nine days. The specific duration of outages varies widely, depending on the circumstances of the failure, availability of parts and skill level of available repair personnel. A faulted cable section must usually be abandoned or replaced. The latter requires replacement of the entire section between bounding vaults.

## Line Life Expectancy

Overhead transmission lines have been known to survive without replacement for nearly 100 years. In the past, underground transmission lines generally had shorter life spans for a variety of reasons. High-pressure fluid-filled (HPFF) cables had mechanical issues with splices. However, these were corrected and installations from the 1960s continue to operate with no need for wholesale replacement of the cable. XLPE cables had early problems associated with moisture ingress and higher temperatures. Again, these were corrected and XLPE systems installed in the late 1980s, early 2000s and 2017 at respective voltages of 230 kV, 345 kV and 500 kV are still operating at the time of this writing.

According to the Wisconsin Public Service Commission, the assumed life of underground pipe-type or XLPE cable is about 40 years, although this number appears to be related more to financial issues rather than hard data from experience. Further, this number might increase as experience with installed systems accumulates.

One possible method for quantifying this issue further is to examine the warranty given to power cables by the manufacturer. Extrapolating service life accurately may not be possible, but warranties can provide an idea of how long companies are willing to stand by their product.

## External Electric & Magnetic Fields

As mentioned previously, electric fields are related to voltage. Higher voltage produces stronger electric fields. Electric fields of underground cables above the earth are (at least partially and usually nearly completely) shielded by the cable neutral and other metallic layers, concrete and soil. Hence, when all shielding is considered, electric fields in accessible locations generally are not an issue with underground transmission lines.

However, electric fields can be substantial in the vicinity of overhead transmission lines and must be managed according to utility policy or local regulations, where they exist. Magnetic fields are created by current and not shielded by typical earth material. The strength of the magnetic field from a single conductor increases as conductor current increases and decays as the inverse distance from the conductor. If equal and opposite parallel currents are located close together, the magnetic field is partially canceled and decays as the inverse square of the

distance from the two currents. The closer the spacing between the currents, the more the cancellation.

Generally, underground transmission lines produce lower magnetic fields than overhead transmission lines because the underground conductors are placed closer together. However, it is possible to access points close to the underground conductors and, at these locations, the magnetic field may be larger than that of overhead conductors because of their proximity. Underground lines enclosed in steel pipe can have significantly lower magnetic fields than overhead lines or other kinds of underground lines because the steel pipe has magnetic shielding properties that may further reduce the field produced by the conductors.

## Coming Up

Part two of this two-part article series will explore electrical operation issues. These occur primarily because typical ampacity ratings preclude the use of cables at loadings at or near surge impedance loading. This is because the surge impedance of cables is typically on the order of ten times that of overhead lines resulting in very large surge impedance loading. Hence, for underground lines the reactive power consumed by cable inductance will never be sufficient to compensate for that supplied by cable capacitance. This leads to both hard and practical length limits for underground transmission lines, especially at higher voltages. TDW

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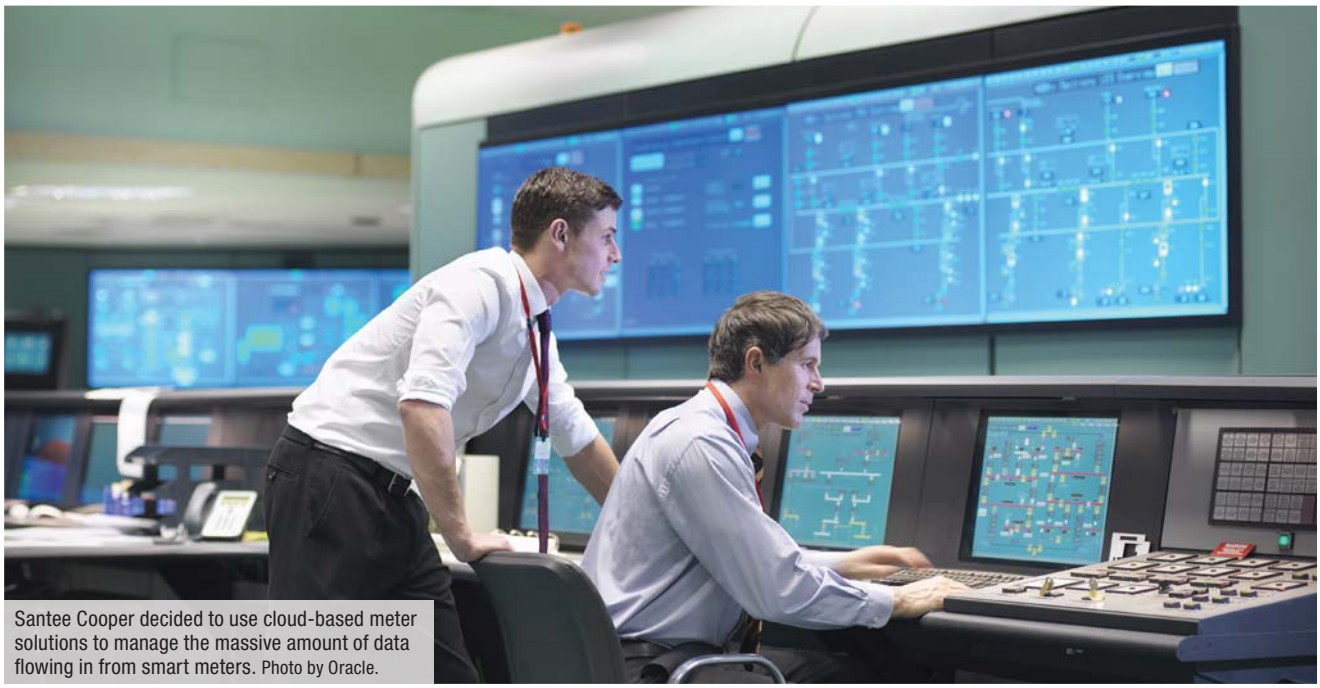
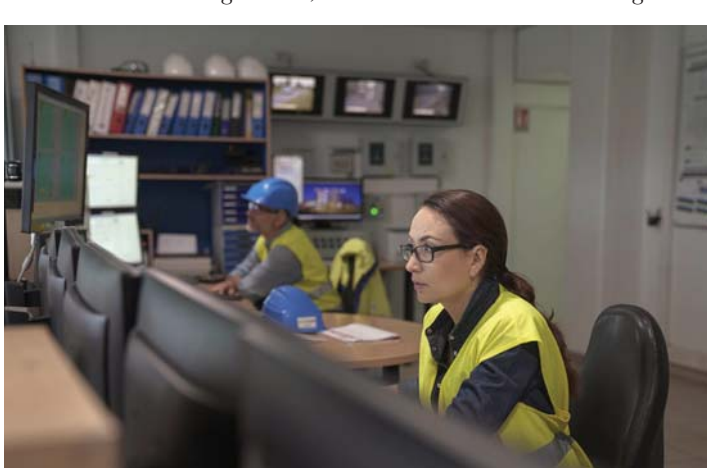


Santee Cooper decided to use cloud-based meter solutions to manage the massive amount of data flowing in from smart meters. Photo by Oracle.

# Santee Cooper Boosts Reliability Planning Capacity

South Carolina utility navigates aging infrastructure and tight budgets with smart solutions, including with cloud-based metering, mesh network.

No matter a utility's focus, reliability planning is a constant business and societal imperative. The inherent pain of aging infrastructure has not been made easier with decreased revenues and increased operating costs, especially throughout the pandemic. Beyond the demands of shareholders and regulators, utilities must also meet rising customer expectations while minimizing system outages under increasingly extreme weather circumstances.



With software as a service meter data management (SaaS MDM), Santee Cooper cut the burden on its IT department, freeing up resources to focus on support. Photo by Oracle.

State-owned public power utility Santee Cooper (also known as the South Carolina Public Service Authority) is an essential community development partner that provides generation, transmission, and distribution services directly to more than 200,000 residential and commercial customers. The vertically integrated utility also serves wholesale customers across a large portion of South Carolina.

Santee Cooper needed to find a way to extract additional layers of operational efficiency and maintain or improve system integrity. The scope of reliability planning continues to evolve as utilities expand from traditional physical network infrastructure priorities to a growing pool of edge technologies, from smart meters to IoT sensors and customers' home energy devices.

## Operational Innovation

"Being an electric utility in South Carolina presents many challenges when it comes to service reliability," said Dom Maddalone, chief information officer, Santee Cooper. "From tropical storms and hurricanes, to flooding and tornadoes, problems can regularly arise. Santee Cooper

prides itself on maintaining a strong reliability standard regardless of what comes their way and technology is key in helping us do so."

Santee Cooper ranked first in grid reliability compared to investor-owned utilities in South Carolina and 9th among 475 utilities and cooperatives (or in the top 2%) nationally, according to 2020 data compiled by the U.S. Energy Information Administration.

By heavily focusing on the success of the communities it serves, Santee Cooper is also leading a green energy transformation across its dynamic energy portfolio. Since 2001, the utility has focused on helping customers increase their energy efficiency through its Reduce the Use and EmpowerSC programs. On the generation side, the initiatives extend beyond traditional generation plants to include more than 710 MWs of contracted and online solar power, 29 MW of landfill gas generation, 74 MW of biomass generation (aligned well to the state's significant forestry industry), early wind energy projects, and their original hydropower facilities (with 142 MWs capacity) that date back to Santee Cooper's 1934 origins.

Asset management modernization lets utilities optimize their maintenance and operation while improving performance. Photo by Oracle

## Solution

Mindful of its energy diversity, Santee Cooper decided to launch a smart metering program and mesh network as fundamental components of a connected, customer-centric grid. "This strategy was essential to our goals of building a stronger network to support customers' increased use of technology and the energy that technology uses," said Maddalone. "To use electricity more efficiently and economically, our customers need to have more insight into how they use electricity and what it costs. Advanced meters provide benefits like daily usage data, outage information, and lower costs."

A factor for Santee Cooper included selecting a system that would provide vital reliability upgrades through enhanced outage management performance. The utility also had to install a mesh network to alert them of problems with equipment before or at the exact time as a problem. This would allow Santee Cooper to get ahead of outages or be able to restore them even faster.

A better workforce mobility strategy helped Santee Cooper verify that workers in the field had the information they need. Photo by Oracle.

Additionally, it wanted a system that could flexibly scale to support future priorities such as network resource management and customer service initiatives.

"To manage and get value from the massive data sets that come with a smart, connected network, Santee Cooper turned to a cloud-based meter solution," said Maddalone. "By doing so, we bypassed traditional on-premises MDM (Meter Data Management) installations in favor of a SaaS offering designed to flexibly scale with a rollout of 200,000 smart meters."

By selecting a new cloud service, Santee Cooper decision makers knew they would have an advanced, always-up-to-date metering platform. System benefits included access to the latest features, enhancements and security patches through regular updates, meaning they never need to update their MDM again. Device management ensures meter and devices are inventoried, managed and integrated into workflows, which will be particularly helpful as distributed energy resources (DERs) expand.

With their SaaS MDMS, Santee Cooper will also be able to reduce the IT burden of their data-intensive, mission critical system, freeing those resources to focus on business innovation and support.

## An Unexpected Interruption

When March 2020 rolled around, Santee Cooper had to rethink how it needed to work during the pandemic. The smart meter deployment team, consisting of meter readers, meter installers and meter technicians, was no exception. They couldn't have stayed on target to hit their milestones without this dedication to customers.

Although they work separately from other employees much of the time, the team members had to make changes to keep the project moving and on track. To help reduce the risk of spreading COVID-19, team members had to change their schedules so they weren't all in the office at the same time. They also were on high alert and cognizant of their surroundings when they were physically changing out meters at customer locations to avoid any close contact with others. Safety suddenly meant something more than it did a few months before.

"It was incredibly important to us to keep working toward the goal of installing smart meters in order to provide customers with this important, updated technology," said Maddalone. "We knew the new tech would help maintain excellent, reliable service and keep customers' bills accurate, among other things."

The project's efficiency during the COVID-19 pandemic, with the utility and its partners working together over web conferencing to deliver a successful virtual go-live, demonstrated the potential of SaaS to improve reliability in times of crisis. As a result, IT teams and end users can remotely manage, support, and use solutions without being on site.

## Results

While Santee Cooper originally planned to upgrade all meters by 2023, the smart meter rollout is now complete, with more than 196,000 AMI meters successfully installed. The new SaaS metering solution is already delivering additional reliability outcomes. Santee Cooper recently completed an integration with its outage management system, which will leverage meter data to make recovery after an outage event faster and more precise.

"With these upgrades, the advantages Santee Cooper is seeing are many," said Maddalone. "For example, we are getting notification of outages without the customer being at home, and we are able to get electricity restored in some cases before customers are even aware they had an outage. From a security standpoint, we are able to find tampering issues faster. The privacy of customers' electric usage data is protected and will remain private with advanced meters."

They also are finding intermittent problems faster. As a result, Santee Cooper can redirect a customer to get an electrician if it appears likely to be a customer issue based on viewing the analog readings. The utility is now looking ahead at the potential of meter data to enhance reliability for theft detection, integrating DERs, distribution management, customer-facing programs, and more.

Information lifecycle features now help Santee Cooper manage the massive data sets as their metering program advances, while a smart grid gateway ensures the utility can collect, clean and process data from all meter types and vendors as their program expands. Native billing integration between the smart meter service and Santee Cooper's current customer care and billing system is resulting in seamless, successful billing on day one after go-live. Additional cloud benefits include robust cybersecurity, easy scalability, data redundancy, development/test/live environments, with built-in autonomous databases and high-performing hardware.

"The value proposition fits well with Santee Cooper's strategic technology roadmap, enabling us to remain agile as our metering program and energy grid evolves," said Maddalone. "We have always had a strong sense of customer service. The more capabilities and features we can provide—these seem to appear first in the cloud—the better off our customers will be." TDW

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**DAN BYRNES** (*dan.byrnes@oracle.com*) is senior vice president of Product Development for the Oracle Utilities Global Business Unit. He is an Oracle veteran who came to the company from PeopleSoft, where he was responsible for the product management of CRM across communications, media, and utilities. Prior to joining the Oracle Utilities Global Business Unit, Byrnes spent five years responsible for Industry Product Strategy across Oracle eBusiness, PeopleSoft, JDE, Siebel, Business Intelligence and Integration.

# ELECTRIC UTILITY OPERATIONS

MARCH 2022

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## TECO Streamlines Storm Response

# CONGRATULATIONS TO OUR MARCH FEATURED LINEMAN!

## Raymond 'Vinny' Zichmiller

ComEd

- Born in Chicago and has a younger sister.
- Married and has a daughter who works as a pediatric occupational therapist. He also has an eight-month-old grandson who "looks really cute in a crocheted ComEd lineman costume."
- Enjoys spending time with his family, especially his grandson, and working on home improvement projects.
- Has two cousins who worked for ComEd.
- Can't live without telescopic extend hot sticks, wireless phasers and battery-operated impact wrenches. The new hybrid bucket trucks and rear lot carts were also welcomed.

### Early Years

I needed a job after two years in the military. ComEd was hiring, and my first job was as a red lineman out of Maywood headquarters, which is a regional office within the Chicago region.

### Day in the Life

My current title is an overhead electrician specialist (OES). I perform switching routines and troubleshoot outages. In a typical day, I either work on switching or cover an area to do house tickets. I also mentor new OESs.

### Challenges and Rewards

Being away from family is one challenge, especially when working on holidays. The nature of our business requires flexibility in the light of unpredictability. For example, we must work longer hours during storms. On the flip side, my wife is happy when I get to work overtime. I also enjoy learning about new equipment, which makes our jobs more efficient.

### Memorable Storm

Following one tornado, I worked for what felt like several days straight to restore power. It was windy and raining, and too many poles and wires were down to even count. Many houses also sustained significant damage. But my most memorable moment was on Dec. 25, 1989, when I got called into work for storm conditions. I went to work and told them that I had to be off the next day because my wife was going to the hospital for a planned delivery of my daughter. At 5 a.m. on Dec. 26, 1989, a foreman had to come to the field and pick me up because my wife called and said that she was ready to have the baby.

### Memorable Moment

Once there was a hostage situation at a house in Northlake, Illinois, and I had to work with the police for about five hours to shut the power off and restore it when it was over. The offender eventually surrendered with no injuries or incident.


In his more than 50 years in the line trade, Raymond "Vinnie" Zichmiller has seen a variety of technological advancements.

### Technology of the Trade

Currently, we continue to install innovative solutions such as distribution automation and voltage optimization devices. ComEd remains dedicated to enhanced system performance, improving reliability and grid modernization throughout the organization. Linemen play a huge role in the storm and system hardening directly when we're upgrading and replacing our wood poles and wires. In short, our primary focus is to create a safe work environment for our employees and customers we've privileged to serve.

### Story Behind the Nickname

While at work, a crew leader saw me, stopped and said, "it's Vinnie Babarino." Several employees were around, and ever since then, the name stuck. Apparently, John Travolta, who played the character, Vinnie, in "Welcome Back, Kotter," copied my hairstyle or resembled me a bit. Shortly after, the company needed me to come in and called my house. My wife answered the phone and they naturally asked for Vinnie. She told them they had the wrong number because no one by that name lived there. The same thing happened when my daughter was old enough to answer the phone. In the office, I'd occasionally get referred to as Ray or Raymond — my real name — and employees said they didn't know who that was.

### Plans for the Future

It is exciting, challenging, and rewarding. I began this great career on June 4, 1971, and celebrated my 50th service anniversary this past June so my future plans are retirement. It has been interesting to watch our utility and industry evolve from the time I started. The core of all technology, advancement and day-to-day life would not be what it is today or continue to advance without electricity and the linemen and linewomen dedicated to their craft. It's been an amazing 50 years witnessing the evolution, powering through changes and advancement and most importantly, powering lives. 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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With the call-out system, TECO can track the location of work crews not only during storm restorations, but also on blue-sky days.

# Streamlining Storm Response

## TECO's high-tech response restores power for nearly 40,000 customers in 12 hours.

By **AMY FISCHBACH**, Field Editor

With only a few minutes' warning, one of Tampa Electric Co.'s (TECO's) most memorable storms erupted over Tampa, Florida, in November 2018. The unexpected storm, which developed suddenly, included multiple "microbursts" with tornado warnings. Several areas sustained intense wind damage, including heavy debris that contacted equipment.

After crews left for the day on a Friday evening, about 40,000 — or 5% — of TECO's customers lost power due to extreme weather conditions. To call line crews back to work, the utility used an automated alert system. About 150 line workers restored power overnight, and by 5 a.m. the next morning, less than 500 customers remained in the dark.

### Streamlining the Call-Out Process

Back in the 1980s, dispatchers called line workers individually to confirm they could return to work. In the 1990s and early 2000s, TECO used a more automated callout system that it created, but it was inconsistent, said Cherie Jacobs, media spokesperson for TECO.

"Sometimes the system contacted more people than we needed; other times it didn't contact anyone at all," Jacobs said. "Starting in 2015, we began using software to manage our workforce, and the 2018 storm was our first 'all hands-on deck' call-out. Within minutes, we knew who was returning to work, which truck they were in and where they were located. It allowed us to begin restoration work faster."

From a cell phone or tablet, TECO can broadcast a message or a call to work — it can be to everyone or targeted to specific departments or individuals. Within two or three minutes, TECO knows who is coming to work and where they are heading. Every night, the utility receives an electronic report detailing who was working, which trucks they were in and where they were located.

The high-tech callout process helps dispatchers track the status of crews during normal work hours to see who can take overtime in the event of an emergency. After business hours, when a dispatcher needs a crew for an emergency, the system automatically identifies only available workers by following a utility's callout rules exactly; contacts workers via phone and/

or text, and records how every person responds.

Using software to schedule line crews has also been extremely helpful during the pandemic, Jacobs said.

"We use it during 'blue sky' days—not just storms," Jacobs said. "Every day our crews are different, and it has helped with contact tracing when someone tests positive for COVID-19. It has helped to manage our workforce effectively."

## Responding to the Instantaneous Storm

Unlike Hurricane Irma, which TECO battled a year earlier, there was no warning for the November 2018 storm. Consequently, no crews had been held over as is the case when expecting bad weather.

Following a severe weather event, TECO can quickly mobilize its line crews with the callout system to restore power swiftly to its customers.

At 3:15 p.m., TECO received the first alert that the storm could be problematic. At 3:21 p.m., a wall of red and orange stretched across radars and red alerts began going out. By 5:15 p.m. the violent and sudden storm had passed and 38,972 TECO customers were out of power. At 5:47 p.m., with an automated callout, TECO issued an all-hands call for every line person – about 40 crews.

As TECO launched its callout, Ronnie Crossen, senior technology analyst for TECO, worked with Luke Diruzza, manager of distribution engineering and operations, and his team to tap into TECO's crew management system, which complements the callout platform. With the crew manager's virtual dashboard, TECO began immediately modeling the best response based on where each crew was coming from and other projects planned for unaffected service territories within the TECO system. In the meantime, the callout system successfully reached 254 people with 101 arriving on the property in less than 30 minutes. Additional linemen began filing in soon afterward.

Crews reported to their normal work location, and Diruzza, Crossen and supervisors across the territory were able to collectively log in to the crew management tool to create different scenarios in seconds by moving crews around the virtual board to see how each movement of crews had a positive or negative chain reaction on restoration time, other service territory's workloads and the availability of trucks and equipment. Each move of the crews was done to fine tune the best, safest, and fastest restoration response.

"A lot of people need this information, and at many levels," Crossen said. "Automating crew management makes for a centralized location for everyone—executives to lead line supervisors—to extract the information they need. Hours would've been spent trying to do this modeling manually, no question."

TECO was able to find resources down to an individual with a special certification (e.g., lead electrician, search-and-rescue, or a Doble-certified worker) and drag that person's icon together with a crew who needed the specialty and immediately launch the request to pair them up.

"By automating our resources, we can store all those skill sets as well as the real-time location of the person or crew," added Crossen. "We might not call on someone with a certain specialty for six months; with a manual system, you can misplace that record of what a person can do and forget where they're located. By automating and storing our crew data, we can remember and put at our fingertips everything and everyone to work the storm."

By 8:30 p.m., everyone, including contractors, were in place to bring back power. Throughout the restoration, storm management at TECO could track progress on each circuit with tracking icons on its virtual map of crews' progress and total hours worked. Knowing how long each crew had been working at any moment helped TECO plan for any potential rest that might be required without sacrificing momentum.

## Storm Response Strategies

Over the last few years, Tampa Electric has improved its storm response by implementing the following practices:

1. Using drones to assess damage to certain equipment after a storm.
2. Making reliability improvements to certain critical power lines, including upgrading equipment and ensuring proper lightning protection as well as installing some lines underground.
3. Investing in improved technology for better tracking of mutual-assistance crews.
4. Securing early contracts with certain vendors, to ensure better pricing.
5. Strategically locating damage assessors before a storm hits, which will speed assessment.


TECO is continuously improving its storm response practices to reduce outage times and improve the productivity of its field workforce.

## Lessons Learned

The crew manager process enables TECO's managers to forecast crew and equipment needs hours (or even days) in advance. In addition, the system allows managers to record and play back scenarios after the restoration event. That playback is akin to a sports team watching film from its last game to analyze how well it performed.

Crew management increases the accuracy of response and gives the utility more lead time in identifying which resources it might need because it can visualize any number of restoration scenarios on its digitized planning board, in seconds.

Each step TECO took — every callout and crew-building decision — was recorded for either playback after the fact as a best-practice sharing or a report on the outcome for the Public Service Commission (PSC). If the PSC wanted to know how many callouts had been made, how long the response took or how many crews were engaged, TECO not only had the information but also could serve up the data in a report within minutes.

Within seven hours, TECO had restored 20,000 customers by relying on its automated callout and crew management system. And by 5 a.m. the next day, all but a few hundred TECO customers had power restored. Without an automated system, TECO estimates the restoration would've taken at least 24 hours instead of less than 12. With a storm of this scale, there were also contractor resources, so cost-recovery efforts and accounting would've taken weeks of administrative time.

Capturing data about the number and make-up of crews, the nature of their work and how long their activities lasted is a linchpin for supporting a utility's cost recovery, according to TECO. Whether a utility is a cooperative, IOU or part of a municipality, managers are generally capturing the same data.

An IOU, like TECO, will have a private carrier to which managers will submit data such as crew counts, amount and type of equipment damaged (and replaced) as well as the number of hours crews worked. Government agencies, regulators and utilities want a precise accounting of what it takes to restore service after a storm, especially a major event. Utility executives look at the impact of restoration on their balance sheet. TECO had a well-documented, minute-by-minute account of the crews, resources and equipment tapped for restoration and delivered electronically to whomever required the data. That kind of information also created a systematic way for storm managers to request, manage, track, and release external resources.

After the storm, TECO replayed the steps taken to understand what was done well and where improvements could be made. The replays go up and down the chain of command and, when necessary, get implemented as an improvement for the field. In the case of this storm, execution was nearly flawless. Managers noted some callouts were not accepted immediately and this related to employees failing to update their information within the system as well as extenuating situations in which the employee wasn't able to respond to a call or text.

## Reflecting on Accomplishments

Since 2015, TECO has achieved a 5,500-hr reduction in annual callout time, and completing a callout has dropped from 25 minutes to six minutes.

"We've had callouts for five workers after hours that we completed in 43 seconds," Diruzza said.

Load growth has risen by 2% for TECO, and managers are working to keep headcount stable. TECO's system is playing a part in making operations efficient enough to manage more work without increasing the number of crews.

As of 2020, the average callout is less than six minutes to assemble a four-person crew. Since 2015, there has not been a grievance about the callout system. TECO can also keep an eye on callout acceptance rates if they fall below 50%. Managers then coach workers back to (or to exceed) the 50% goal.

The system has also eliminated calls into the dispatchers by line workers looking for details about a callout; instead, the callout process automatically describes the nature of the callout and location for lineworkers. This, said TECO, has helped its dispatchers focus on storm restoration and develop plans for multiple circuits, instead of fielding those calls.

"Routine and predictable work can go to our contractors," said Diruzza. "Our automated approach to crew management records what type of callout is happening, so we can discuss why choices were made and improve if necessary whether that's daily operations or a major event like the November storm." TDW

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

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# Parting Shot

Photo by **SNOHOMISH PUD**

After four days of restoration, Snohomish PUD crews spotted a perfectly positioned rainbow as they finished up repairs on Camano Island in Washington State.

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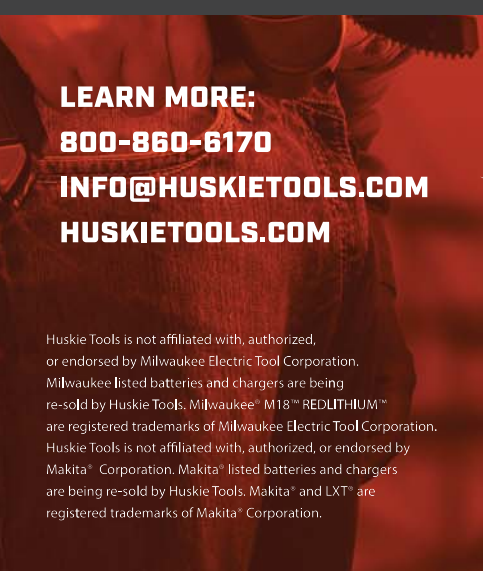

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Statnett line worker installs 420-kV insulators aided by helicopter. Photo by Statnett.

# Sustainable Composite Tower Design

## Norway's Statnett designs a tower using novel materials in new concept.

By **ARILD K. BERSTAD** and **KJELL HALSAN**, Statnett SF; **ERWIN PLATENKAMP**, DNV; and **CHRISTIAAN ENGELBRECHT**, Engelbrecht Consulting BV

The global transition toward creating a greener and more environmentally friendly society requires transmission system operators (TSOs) to consider refining their existing installation methods, increasing their focus on worker safety and investigating the possibility of using new tower materials. To satisfy dual objectives is now a tough challenge many TSOs face.

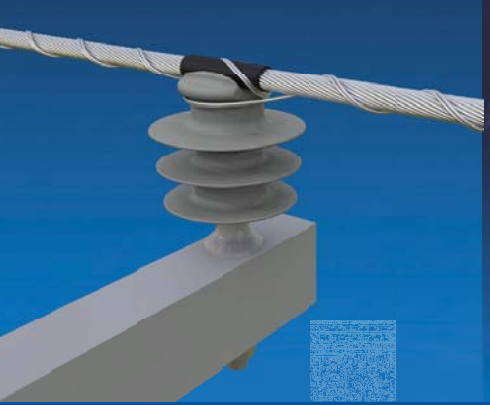
The transmission system in Norway crosses remote areas, which has a considerable impact on line construction, especially in mountainous terrain and areas without access roads. Helicopters are used extensively to transport materials and in the erection of supporting towers. Reducing the time spent erecting and working on transmission line towers as well as minimizing the use of helicopters and the carbon footprint would result in a win-win solution. Any new tower type should offer the same service life and system reliability of today's towers as well as be aesthetically acceptable.

Statnett SF is collaborating with DNV and Engelbrecht Consulting BV to investigate the use of transmission line towers made of composite materials, namely fiberglass. Generally, the use of composite towers is limited to supporting circuits rated 132 kV and below. Statnett completed its first 132-kV transmission line section with composite poles in 2014. The collaborative research program is focused on a conceptual tower design that uses fiber-reinforced polymers (FRP) to support conductors on a 420-kV transmission system.

### Composite Materials

Composite materials have been used in transmission lines before, in both towers at 132 kV and insulators at 420 kV. However, using FRP on a complete tower for a 420-kV transmission line is completely different. While dry composite materials have an electrically insulating surface, it becomes partly conductive when wet. In effect, FRP towers are essentially nonconductive but they become (semi) conductive when wet, presenting challenges in terms of the electrical design.

This characteristic means the separation distances on the tower must be taken into consideration. The specified air gaps need to ensure all flashovers go over the insulator string or to designated



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points on the tower. Tower sections where field concentrations occur that potentially accelerate material degradation also must be avoided.

In addition, an independent earthing system needs to be included that provides an electrical path to earth for any of the fault currents that might arise on the transmission line during its service life. This earthing system must be designed in a way that prevents it from overheating, irrespective of the type of overhead line fault and subsequent fault current.

In Norway, all transmission lines must conform with the European standard, EN 50341-1, and national normative aspects for Norway, NEK EN 50341-2-16. At 400 kV, this standard assumes a fully conductive support structure. Thus, several additional requirements must be included to deal with the application of composite materials.

The following measures must be taken into consideration:

- FRP tower material cannot conduct lightning and power frequency fault currents, so this must be considered in the earthing design.
- Air gaps in the tower require detailed coordination to avoid any flashover directly to FRP material.
- Special consideration needs to be made for the electric field concentrations to avoid accelerated material degradation.
- Tower must be safe for workers to climb, while restricting access to the public.

Despite these challenges, the use of composite towers exhibits great promise, as larger sections can be flown to a site and built by a ground-based workforce more quickly than constructing a sectional tower above ground level. This also means the use of a helicopter can be greatly reduced, increasing worker safety and lowering installation costs.

**Main electrical requirements for composite tower.**

| | |
|---|---|
| Nominal system voltage | 400 kV |
| Maximum System Voltage | 420 kV |
| Lightning impulse withstand level | 1425 kV |
| Switching impulse withstand level | 1050 kV |
| Wet power frequency withstand level | 630 kV |
| Electrical distance (phase-phase) | 3.20 m (10.50 ft.) |
| Electrical distance (phase-ground) | 2.80 m (9.19 ft.) |
| Fault current (amps, duration) | 30 kA 1.0 sec. |
| Maximum temperature, earthing connections | 90° C (194° F) |

## Design Approach

For this project, a design methodology had to be developed. The electrical design parameters for steel towers were altered to accommodate all aspects of the composite tower. This served as the design basis on which other elements were added.

The rest of the project was divided into several work packages, each constituting a separate milestone. The workflow was set up as an iterative process, meaning design changes and revisions could be consolidated into the design as it moved forward. Elements having the largest potential impact on the tower design (such as material selection and insulation coordination) were addressed

The laboratory test set-up for the 420 kV insulators. Photo by Statnett.

first and locked before proceeding on to elements with a smaller impact. This meant as the project progressed, the design team could encircle the final design with all the detailing necessary. It also was vital to determine a workflow that could support an expected service life of 70 years.

During the early stages of planning a transmission line, not every key design parameter is known. For example, in Norway, pollution levels have been quite low historically but wind and ice loading on the conductors severe. Composite towers may not initially be suitable for all climatic conditions and loads, so it was essential to identify this tower type's limitations.

The tower material was designed for ambient temperatures between –50°C and +60°C (–58°F and 140°F) as well as an average annual horizontal irradiation of approximately 950 kWh/sq m (88 kWh/sq ft). The completed tower was designed for wind loads up to 44 m/s (144 ft/s), ice loads up to 10 kg-m (6.72 lb-ft) and low pollution levels.

## Composite Material Testing

The composite materials and their formulas are subject to strict confidentiality. Therefore, it can be difficult for a purchaser to ensure proper quality, especially when seeking the most appropriate material available from several manufacturers. Similar composite samples can display vastly different characteristics and behavior when subject to the same tests. Statnett's goal was to establish a test regime that would enable a purchaser to qualify or disqualify composite samples based on a standard set of test requirements. The tests also set out to try and provide an indication of any type of challenge that might arise from the different composite material test samples during service life.

A series of tests were first conducted on two composite material samples provided by each manufacturer. One striking and noticeable difference identified when subject to the dye penetration test (IEC 62217) was the difference in water ingress seen between each of the two samples. It was evident samples tested from one manufacturer were much more porous and, therefore, more susceptible to water ingress and subsequent internal freezing. The porousness would increase the mechanical stress applied to the composite material and reduce the expected service life.

From the early tests completed, Statnett was able to make some in-house system voltage-independent recommendations for linemen working on composite towers:

- Drilling holes should be kept to an absolute minimum.
- All drilled holes should be sealed to avoid any water ingress.

In addition, eelectrical field grading of components would be necessary to avoid the risk of tracking and erosion on higher-voltage transmission lines — just to specify that that the concern is on the surface of the material.

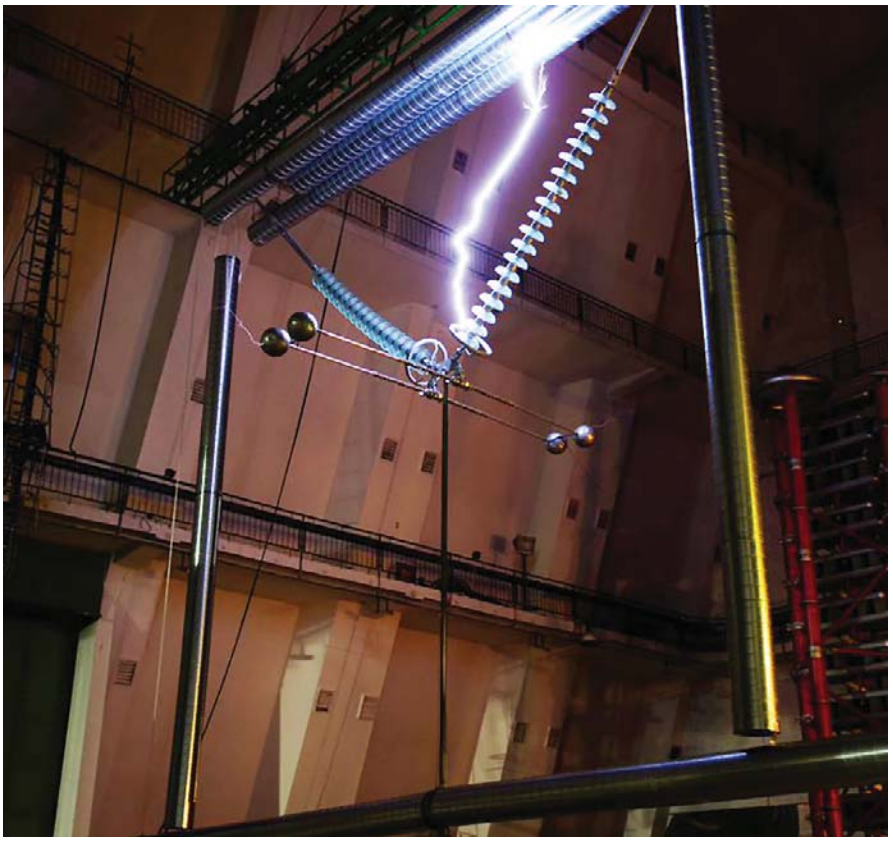
## Prototype Testing

This project required the qualifying theoretical designs to be subjected to full-scale testing. Therefore, a test on a completed 1-to-1 composite model involving full-scale testing using tubes was conducted in Prague in 2018. The prototype developed for testing was built using aluminum tubes to simulate a wet structure. This ensured the tests would be based on conservative results. Although the conductors were static, all other components in the model could be moved individually, allowing the modeling and testing of all relevant electrical separation distances.

Lightning and switching impulse tests were performed on the full-scale prototype tower. The aim was to determine the minimum air clearances necessary to ensure no flashovers occurred directly to the composite section of the tower. To pass the test, the impulse-withstand voltages for both lightning and switching had to be equal to or higher than Statnett's conventional steel towers.

For the impulses, an up-down sequence and subsequent impulses with respective correctional factors were used to determine the lightning and switching impulse-withstand voltages. While the lightning impulses used 20 impulses, the switching impulses used 40 impulses, as the flashover path during a switching surge is less predictable than lightning.

The prototype tower used glass cap-and-pin insulator strings, and it was found lightning impulse flashovers tended



420-kV insulators subjected to laboratory impulse voltage tests. Photo by Statnett.

## Into The Unknown

The testing program required to qualify and disqualify composite material samples exposed large differences in seemingly identical products. Nevertheless, the testing methodology was able to identify valid composite materials for use on all voltage levels.

One of the key aspects of this project was the ability to use existing theoretical knowledge to design a tower using composite materials that would satisfy Statnett's future policy, with respect to 420-kV overhead transmission system lines:

- Refining existing methods employed to install structures supporting the conductors on the overhead transmission system.
- Using lightweight transmission line towers comprising composite materials that are aesthetically and environmentally acceptable with a minimal low carbon footprint.
- Economically maintaining system reliability and customer service. TDW

to hug either side of an insulator string. However, Statnett's policy is to install mainly glass cap-and-pin insulator strings, as they are easily replaced and have a proven service record glass cap-and-pin insulator strings, as they have an low failure rate, and shattered insulators requiring replacement are easily detected. Hence, Statnett already had decided that when 420-kV composite towers were used in service, the overhead line conductors would be insulated by glass cap-and pin insulator strings.

During this series of tests, it also was noted the insulator flashovers tended to go upward. Therefore, the separation distance between the tower guy wires below the lowest-phase conductor could be reduced. Conversely, it was found the horizontal distance to the tower structure needed to be increased. As a result of these observations, it was evident detailed insulation coordination would be necessary when using composite material towers on high-voltage transmission lines. To limit overvoltages, the use of surge arresters on overhead lines supported by composite towers is recommended.

The tests on the prototype showed the flashover strength and path could be significantly influenced by relatively small design features. Not only were they vital to qualify and prove the concept, but they also helped to improve the confidence of those responsible for ensuring the design would satisfy the objectives of this project. The tests also confirmed the theoretical calculations and provided valuable input for optimizing the design before the full-scale test.

The final composite tower design was electrically qualified by full-scale lightning and switching impulse testing in 2021.

**ARILD KVAMME BERSTAD** (*arild.berstad@statnett.no*) graduated from Bergen University College while working as an electrical engineer in Statnett SF's transmission line department. As a senior engineer, he is committed to the maintenance of existing transmission lines, ensuring the lights stay on. Berstad is cited as the main author of the CIGRE paper, "Electrical Design and Testing of Composite Towers for 420 kV," which received a Best Paper Award during the CIGRE 2020 e-session.

**KJELL HALSAN** (*kjell.halsan@statnett.no*) is the section manager of the electromechanical section in Statnett SF's transmission line department. He has extensive experience with electromechanical design of transmission lines, having participated in various research projects on the electrical components and design of transmission lines. Halsan is coauthor of many reports on research projects and, for many years, has been active in several working groups in CIGRE, both as a convener and member, and is currently convener of the B2-CAG study group.

**ERWIN PLATENKAMP** (*erwin.platenkamp@dnv.com*) is a senior overhead line consultant and currently leads the overhead lines group at DNV. As a consultant, he participated in the development of the new high-voltage pole WINTRACK in the Netherlands for TenneT BV, a transmission system operator. He has been a consultant and project leader for various overhead line projects around the world. Platenkamp is an active member in CIGRE work groups and co-authored brochure 818, "Transmission Lines with Fiber-Reinforced Polymer (FRP) Composites."

**CHRISTIAAN ENGELBRECHT** (*c.s.engelbrecht@ieee.org*) is a specialist in insulation coordination with more than 25 years of experience. Currently, he is an independent consultant and associate of DNV in the Netherlands and the Electric Power Research Institute in the U.S. Engelbrecht is an active participant within CIGRE and IEC working groups and has authored several journal and conference publications.

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Rooftop solar installations in a residential area. A DERMS provides centralized monitoring and control of DERs connected to a distribution grid by forecasting, monitoring and managing the operation of each DER to satisfy operating and business objectives. Photo by Bryan Roschetzky, Dreamstime.

# DER-Enabled ADMS

ESTA International has introduced a new concept that combines the best features of DERMS and ADMS into one system.

By **ROBERT ULUSKI** and **STUART BORLASE**,
ESTA International LLC

Distribution system operators face a growing need for distributed energy resource situational awareness. One part of advanced distribution management system (ADMS) functionality that currently lacks adequate consideration is the modeling and management of distributed energy resources (DERs). At most utilities, monitoring and control of DERs from within the distribution control center typically is limited to monitoring metered outputs of large utility-scale energy resources and performing transfer tripping of these resources as backup protection against islanded operation. Most existing demand-response management systems (DRMS) and load management facilities can monitor some controllable loads; however, controllable load information is seldom provided to distribution system operators and ADMS applications that would benefit from having this information.

A stand-alone distributed energy resource management system (DERMS) provides services for managing grid level events, but it is not suitable for managing localized distribution system problems and optimizing the reliability, efficiency, and performance of individual substations and feeders. The latter capability is primarily the responsibility of the ADMS. Many of the ADMS applications require near-real-time information about the operating status and electrical outputs of DERs to accurately determine the distribution feeder electrical conditions and identify control strategies that may be used to avoid or mitigate the consequences of any operating problems.

Most currently available ADMS solutions do not have enough near-real-time information about DER contributions to support these capabilities. For this reason, ESTA International LLC introduced a new concept — the DER-enabled ADMS — that combines the best features of DERMS and ADMS to differentiate it from the separate stand-alone systems.

## DERMS Defined

DERs are nontraditional energy resources either connected directly to the distribution grid and owned by the distribution operator or connected behind the meter and owned by commercial, industrial, or residential customers. Nontraditional energy resources include generation powered by renewable sources (for example, solar power), customer cogeneration facilities, backup diesel generators, energy storage (including battery energy storage systems and electric vehicles with vehicle-to-grid capabilities) and controllable loads (demand response and load management, including electric vehicle chargers).

A DERMS provides centralized monitoring and control of DERs connected to a distribution grid by forecasting, monitoring and managing the operation of each DER to satisfy operating and business objectives. The DERMS also manages the operation of DERs based on directives from the grid control entity or regulatory body and handles compensation of DER

asset owners for their participation in grid control events. To date, DERMS generally has been limited to managing demand-response (DR) facilities (that is, controllable loads). However, as the penetration level of distributed generation and distributed storage increases, DERMS also will need to manage these resources.

DERMS includes both technical and commercial functions.

*Technical functions:*

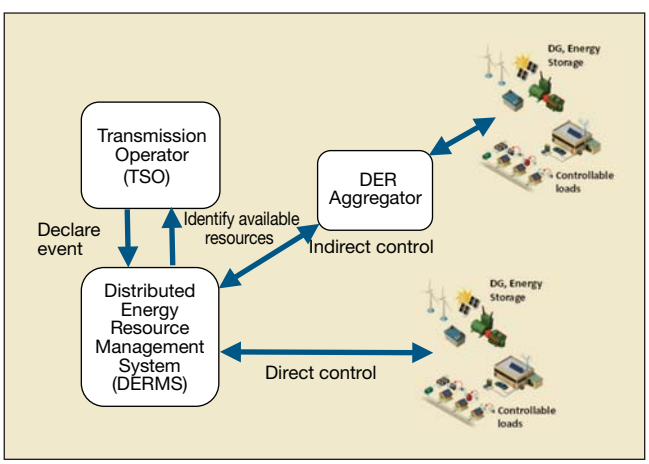
- Monitoring the current operating status and output of all DERs
- Forecasting future DER availability and output
- Broadcasting control commands/requests to participating DERs across the grid as required during grid events
- Verifying DERs have provided the expected response

*Commercial functions:*

- Registering new participants
- Managing customer opt-in and opt-out requests
- Handling incentive payments to customers.

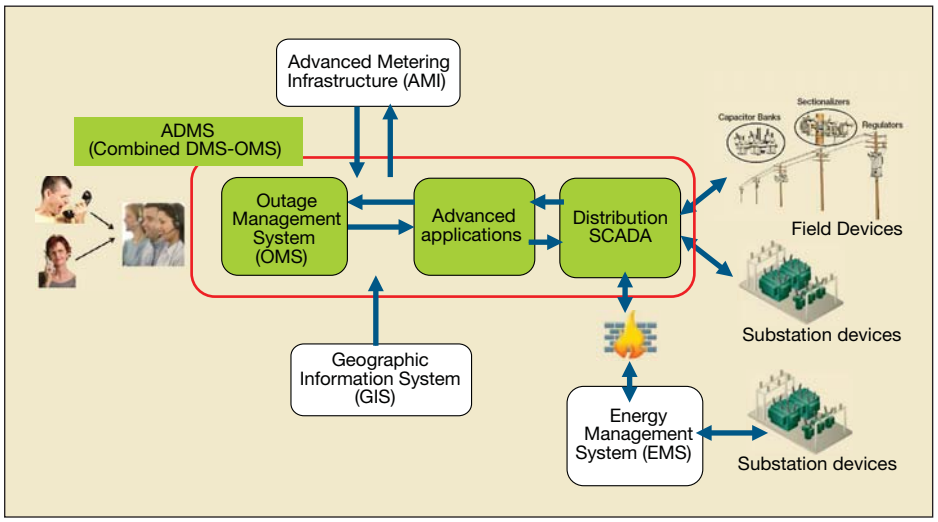
To date, DERMS functionality most commonly has been implemented in a stand-alone system by third-party aggregators that specialize in the grid-level management of customer-owned assets. Aggregators enable owners of small-scale DERs that do not meet minimum asset size requirements to participate in regional power grid markets, such as frequency regulation and other ancillary services. Aggregators serve as a middleman between the end customer and grid market operator to insulate the customer from the complex rules of metering

A power control system at a solar power facility. As the penetration level of distributed generation and distributed storage increases, DERMS also will need to manage these resources. Photo by Framestock Footages, Dreamstime.

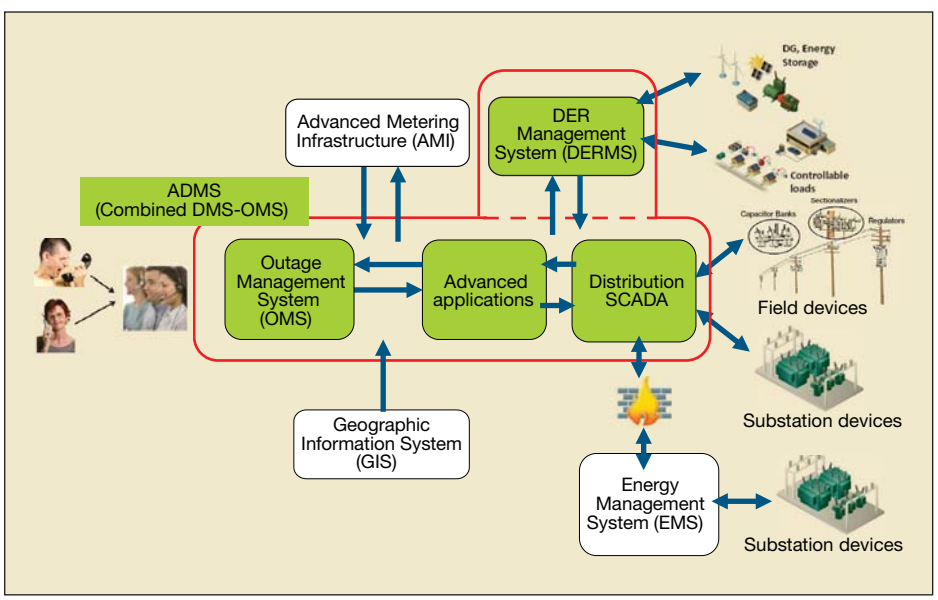



DERMS conceptual architecture.

Control room for power distribution infrastructure. Many advanced distribution management system applications require near-real-time information about the operating status and electrical outputs of DERs to accurately determine the distribution feeder electrical conditions and identify control strategies that may be used to avoid or mitigate the consequences of any operating problems. Photo by Ongpruksar, Dreamstime.




Simplified ADMS depiction.




ESTA International's concept of the 'DER-Enabled ADMS.'

and verification and to handle incentive payments. With this approach, aggregators and distribution operators each need some level of DERMS functionality to manage the commercial and technical functionality of DERMS.

## Impact of DERs

Currently, lack of DER awareness by the ADMS has not been a major problem because the DER penetration level — defined as total electrical capacity (MW or MWh) of the DERs as a percentage of the total energy consumption by the load — at many electric utilities is too small (<10%) to have a significant impact on distribution system electrical conditions. However, as the DER penetration level increases, the impact on distribution feeder electrical conditions can be significant.

Determining the DER penetration level at which significant operating problems can occur requires an engineering design analysis. As a rule of thumb, DERs may become a significant operating concern when the DER penetration level exceeds 30%. In addition, Federal Energy Regulatory Commission (FERC) Order 2222 requires electric distribution utilities to ensure the addition of DERs will not impact system reliability, power quality and safety.

Possible operating problems that may be experienced at higher DER penetration levels include but are not limited to the following:

- Load masking — Feeder load measurements available on the ADMS for the substation end of a feeder are actually net loads (actual customer load, supplied by DERs).
- Reverse power flow — If DER output (distributed generation output or energy storage discharging) on a feeder exceeds total feeder load (which may occur during lightly loaded conditions), reverse power flow (back toward the substation) can occur.
- Voltage reduction and excessive voltage regulator operation — Distributed generators with intermittent output level (such as solar photovoltaic generators on a partly cloudy day) can produce additional voltage regulation problems.
- Protection system coordination difficulties — High penetrations of distributed generators may produce a significant amount of fault current that can alter the coordination of feeder protection systems and distribution automation schemes, causing possible mis-operation of these systems and unnecessary customer outages.
- Localized overloading due to electric vehicle (EV) chargers — Heavy EV charging activities can produce localized equipment overloading, especially at public charging stations and neighborhoods where clusters of EV chargers exist.

## ADMS Shortcomings

The ADMS is a decision support system to assist distribution control room personnel with monitoring and control of the electric distribution system in an optimal manner while improving safety and asset protection. ADMS typically includes supervisory control and data acquisition (SCADA) facilities for distribution assets (such as transformers and switchgear), application software (such as on-line power flow and volt-VAR optimization) for near-real-time analysis and optimization of the distribution system and

outage management functionality, plus interfaces to external systems such as geographic information systems and advanced metering infrastructure that furnish information required by the ADMS applications.

The current approach to monitoring and control of DERs by the ADMS typically is limited to near-real-time metering and transfer-tripping larger (utility-scale) generators that are required (by IEEE 1547) to disconnect during distribution line outages, to avoid islanded operation. Monitoring and control of other DERs (including smaller DERs such as rooftop solar generators, controllable loads and energy storage) usually is not implemented in the ADMS for the following reasons:

- Most DERs are customer owned and operated, and customers are not obligated (by standard connection agreements) to supply the utility with remote monitoring and control capability for these DERs.
- Adding remote monitoring and control facilities (including communication equipment) for many small-scale DERs is cost prohibitive for the utility, especially when the DERs are located on the customer side of the meter (behind the meter).
- ADMS has not been designed to handle the commercial aspects of DER management, such as registration of customers, verification of customer participation in system events and compensation for participating customers.
- Most DERs do not support com munication protocols such as DNP3 that are commonly used by SCADA systems. Typically, DERs will support protocols and standards designed specifically for DER monitoring and management, such as OpenADR and IEEE 2030.5, and industrial standards like Modbus. Many other protocols (some proprietary in nature) may be used by smart appliances and other controllable loads located behind the meter.

## The DER-Enabled ADMS

Incorporating detailed, real-time DER information in the ADMS electrical model improves situational awareness and ensures the electrical impacts of all types of DERs are accurately accounted for in the ADMS advanced applications. The table on the following page compares a stand-alone DERMS and stand-alone ADMS to the capabilities of a DER-enabled ADMS.

There are three basic approaches to accomplish the DER-Enabled ADMS:

1. Add DERMS to an existing ADMS application suite. With this approach, the complete set of DERMS capabilities, including communication facilities to a very large number of customer-owned DERs, would be fully and seamlessly integrated as another application on the vendor's standard ADMS suite of applications. This approach would be like incorporating outage management system (OMS) functions into the DMS product suite, which occurred a decade ago.

The benefits of this approach would be simplified and efficient access to DER models and information by the ADMS advanced

**DERMS and ADMS comparison.**

| | DERMS | ADMS | DER Enabled ADMS |
|---|---|---|---|
| **Primary User** | DER aggregators | Distribution operators | Distribution operators, DER aggregators |
| **Commercial Functions** | Register new DERs and manage incentive payments to DER owners | None | Register new DERs and manage incentive payments to DER owners while ensuring that all individual resources in the DER aggregation are technically capable of providing services |
| **Modeling** | Store and maintain basic details about DER type and capacity<br><br>Store and maintain customer account number and/or associated distribution service transformer | Store and maintain a real-time, as-operated model of distribution system from transmission connection point to low-voltage side of distribution service transformer<br><br>Store load profiles for customer load estimation | Real-time, as-operated model of electric system, including all DER types and sizes |
| **Monitor and Control Functions** | Monitor or estimate output from all participating DERs<br><br>Initiate global demand response control actions in response to events declared by regional transmission organization/independent system operator (RTO/ISO) | Monitor electric distribution assets and output from large, utility-scale generators<br><br>Initiate local and global control actions for electric distribution assets to improve reliability, efficiency and overall performance | Monitor output from distribution assets and all DER types and sizes<br><br>Initiate local and global control actions for all electric distribution assets and all DER types and sizes |
| **Forecasting** | Predict future DER capacity | Predict future loads | Predict future load and DER capacity |
| **Advanced Analysis** | Currently none or very minimal | On-line power flow, volt-VAR optimization, fault location isolation and service restoration, and other applications using as-operated model of electric distribution system assets | On-line power flow, volt-VAR optimization, fault location isolation and service restoration, and other applications using as-operated model of electric distribution system assets and all DER types and sizes |
| **RTO/ISO Interface** | Provide available DER capacity for upcoming events<br><br>Identify locational pricing | None | Provide available DER capacity for events<br><br>Under FERC Order 2222, inform RTO/ISO of possible impacts to reliability and safety during upcoming event |

application function as well as a similar user interface to all functions, providing a consistent look and feel for all applications used by the distribution operator. The downside of this approach would be a significant software development effort (with the associated risk), including adding the capability to communicate with potentially millions of customer-owned DERs. The result would be a product that is significantly less mature than existing DERMS products.

2. Add ADMS functionality to an existing DERMS application suite. With this approach, the complete set of ADMS application functions (including the electrical model) would be added to an existing DERMS product. The benefits of this approach, a fully integrated product suite, would be the same as those mentioned in the first approach. This approach would also have a similar downside; a significant and risky development effort would be required that could result in immature ADMS functionality.

3. Interface a separate DERMS to the ADMS, a bolt-on solution. This approach would interface an ADMS from an established ADMS vendor with a DERMS system from an established DERMS supplier. This interface would enable the ADMS to receive DER information and initiate DER control actions when needed. The DERMS would handle the functionality it was designed for, including communicating with potentially millions of DERs and handling the commercial aspects of DERMS, such as customer registration and incentive payments. The ADMS applications would benefit from having detailed information about DERs, such as DER status and output as well as forecast capabilities, which would be included in the ADMS electrical model.

## The Right Fit

DERMS solutions are available from vendors specializing in only DERMS software as well as from vendors specializing in ADMS software. The decision to implement a stand-alone DERMS or a

DER-enabled ADMS will depend on the owner and manager of the DERs and use cases that must be supported by the DERMS.

Distribution operators with an existing ADMS could consider adding DERMS functionality as part of the overall single-vendor software implementation, but there may be challenges in a seamless upgrade path and with the cost and effort to upgrade the existing ADMS.

Furthermore, DERMS may not support the required commercial functionality. While it may seem like an easy path to upgrade or keep to a single-vendor solution, distribution operators should follow the needs analysis, stakeholder buy-in, design, specification and procurements steps with a sole-source procurement as they would with a new or upgraded ADMS.

A distribution operator may not initially place much emphasis on the commercial aspect of a DERMS but may later decide to also be a DER aggregator to participate in the wholesale energy market. In that case, the distribution operator should consider an upgrade path to include the capability to future-proof the DERMS by including both technical and commercial functions. A separate bolt-on DERMS for the distribution operator might be a better choice because it would be easier to modify and upgrade while the DERMS landscape is still maturing.

The distribution grid will continue to become more complex as the number of DERs and microgrids increase, with a continued need for the distribution grid to become more proactive in handling changing operating conditions while ensuring reliability and quality of service to customers. The DER-enabled ADMS will likely play an increasingly important role in the management of the distribution grid of the future. TDW

More rooftop solar capacity is being installed every year. As the DER penetration level increases, the impact on distribution feeder electrical conditions can be significant. Photo by Photographerlondon, Dreamstime.

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**Hollie Geitner, Director of Communications, Duquesne Light Company**

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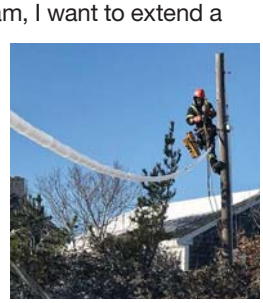

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# A Once-in-a-Generation Moment

Looking back, 2021 was the year transmission policy stepped into the spotlight. Federal Energy Regulatory Commission Commissioner Allison Clements, didn't mince words in her keynote at an October meeting organized by WIRES, the trade association dedicated to promoting investment in transmission, "we are at a once in a generation moment" to "go big" and "pivot the ship" on transmission reform.

Throughout 2021, policymakers, legislators, and regulators broadly recognized the need for a significant expansion of the nation's transmission infrastructure driven by clean energy goals, an increasingly electrified economy, and the need for a more resilient electric grid. Indeed, estimates of the country's transmission needs are eye-popping. Studies have shown that the United States will have to build out the grid by 60 percent by 2030, and may need to possibly triple it by 2050. To put that in a dollars and cents perspective, a recent report sponsored by WIRES estimated that $230 to $690 billion in investment in the nation's transmission system will be needed by 2050 just to meet anticipated electrification needs alone. Accomplishing all of this will require a herculean effort.

In response to projections like these, in November 2021 Congress passed and the President signed into law the infrastructure Investment and Jobs Act (IIJA). The IIJA includes provisions such as a limited level of funding support for the development of high-voltage transmission capacity and modifications to strengthen the Department of Energy (DOE) and the FERC backstop siting authority. On the regulatory front, FERC initiated the transmission Advance Notice of Proposed Rulemaking (ANOPR) proceeding to consider whether there should be changes to the transmission planning, cost allocation, and generator interconnection processes to better meet the future needs of the grid. FERC is now sorting through hundreds of comments in response to the ANOPR and considering next steps.

While 2021 was a significant year for transmission policy, 2022 has the potential to be even more impactful. On the legislative front, Congress continues to consider additional legislation that would build upon the initial progress in the IIJA and include more investment to improve and expand long distance, high voltage transmission as part of the Build Back Better Act. While these legislative efforts send a strong signal of support for large scale regional and interregional transmission, they constitute only a small portion of the total transmission investment needed in the coming decades.

Instead, the real action in 2022 is likely to be on the regulatory, rather than the legislative, front. Already this year DOE announced its Building a Better Grid Initiative to implement the IIJA in conjunction with previously enacted authorities and funding. The goal of the DOE Initiative is to identify critical national transmission needs and support the buildout of long-distance, high-voltage transmission facilities to meet the critical national transmission needs through collaborative transmission planning, innovative financing mechanisms, coordinated permitting, and transmission related research and development.

In the meantime, look to FERC to follow up on its transmission ANOPR with a proposed rule (or rules) sooner rather than later. Indications are that the Commission wants to get a final rule (or rules) out by the end of the year – a highly ambitious timetable. The stakes are high. The issues FERC has teed up in the ANOPR are complex, and FERC has not tried to tackle major transmission policy reform in a meaningful way in more than a decade. Moreover, it seems all but certain that there will be disagreements among the Commissioners as to what direction FERC should take on transmission policy. A sharply divided transmission rule would likely invite judicial challenges and provide little policy certainty to the transmission owners and developers who will ultimately have to build the transmission infrastructure the country needs.

Separate and apart from the ANOPR, FERC has other avenues for spurring development of transmission infrastructure. Given the long lead time for getting transmission built and the large amount of capital investment required for transmission projects, adequate and durable transmission policies that consistently and emphatically send strong signals to promote needed transmission investment are crucial. Unfortunately, FERC's track record on some of these critical matters has not been good. Proceedings related to transmission incentives and rate of return policy have been pending at FERC for many years, and there is a discouraging, and fairly longstanding, lack of consistency and agreement among the Commissioners on what direction to take. The simple fact is that when it comes to promoting investment in transmission, no policy is of greater import than the methods used to set rates of return on those investments. And to the extent additional incentives are needed to spur particular transmission development and construction activity, FERC must use its incentives authority to make it happen. Consistent, adequate rate of return and incentives policies will be indispensable to advancing the ball on transmission development.

It is now obvious the country will need the equivalent of a moonshot effort on transmission investment in order to meet the nation's critical clean energy, electrification, and resilience needs within the coming decades. While some initial, and potentially helpful, steps were taken by Congress and regulators last year, as matters currently stand, we are not even close to building the electric transmission infrastructure needed to achieve these goals. Look to the steps taken in 2022 to see whether legislators and regulators are serious about meeting those needs or not. TDW

**LARRY GASTEIGER** is executive director of WIRES.

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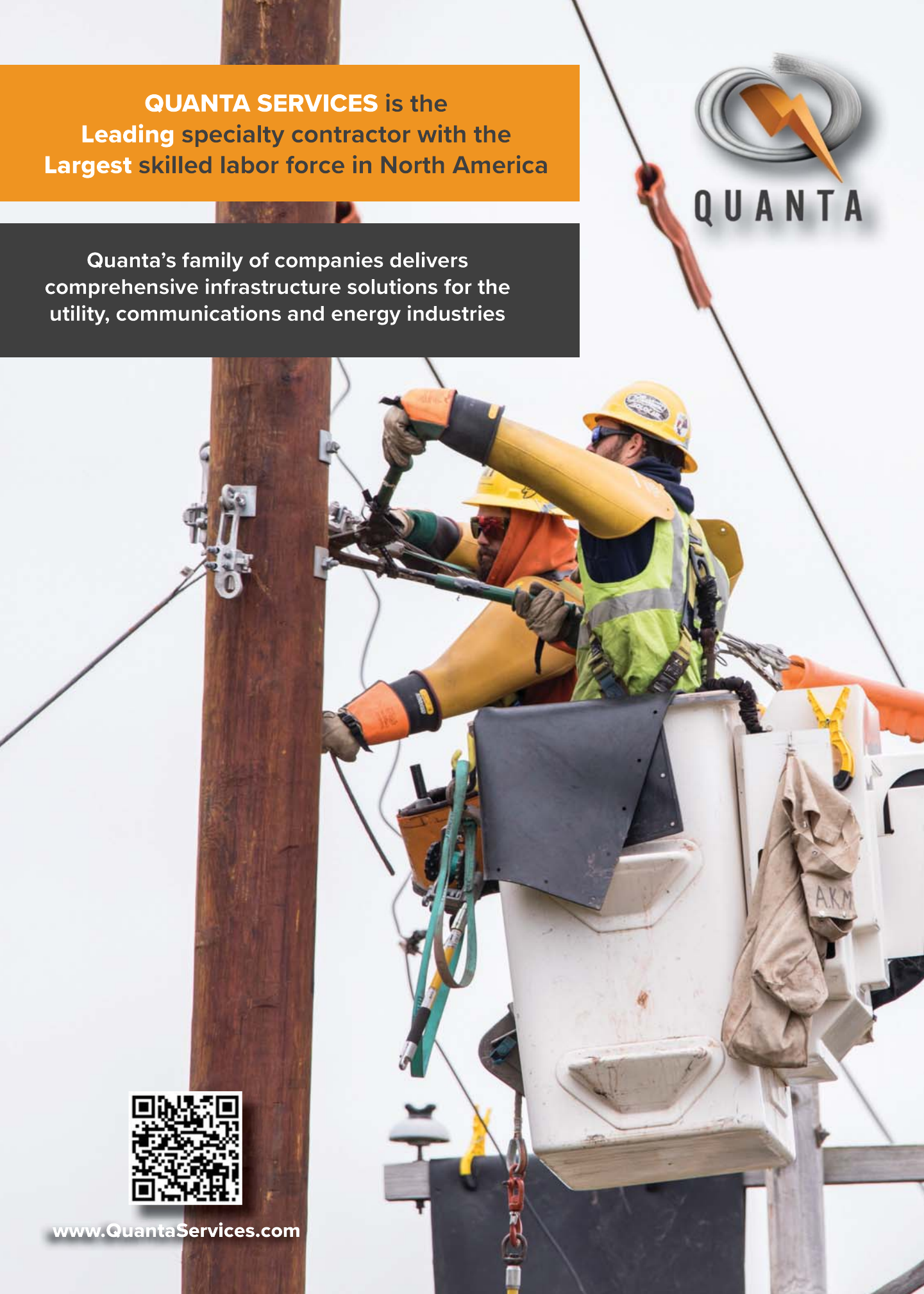
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