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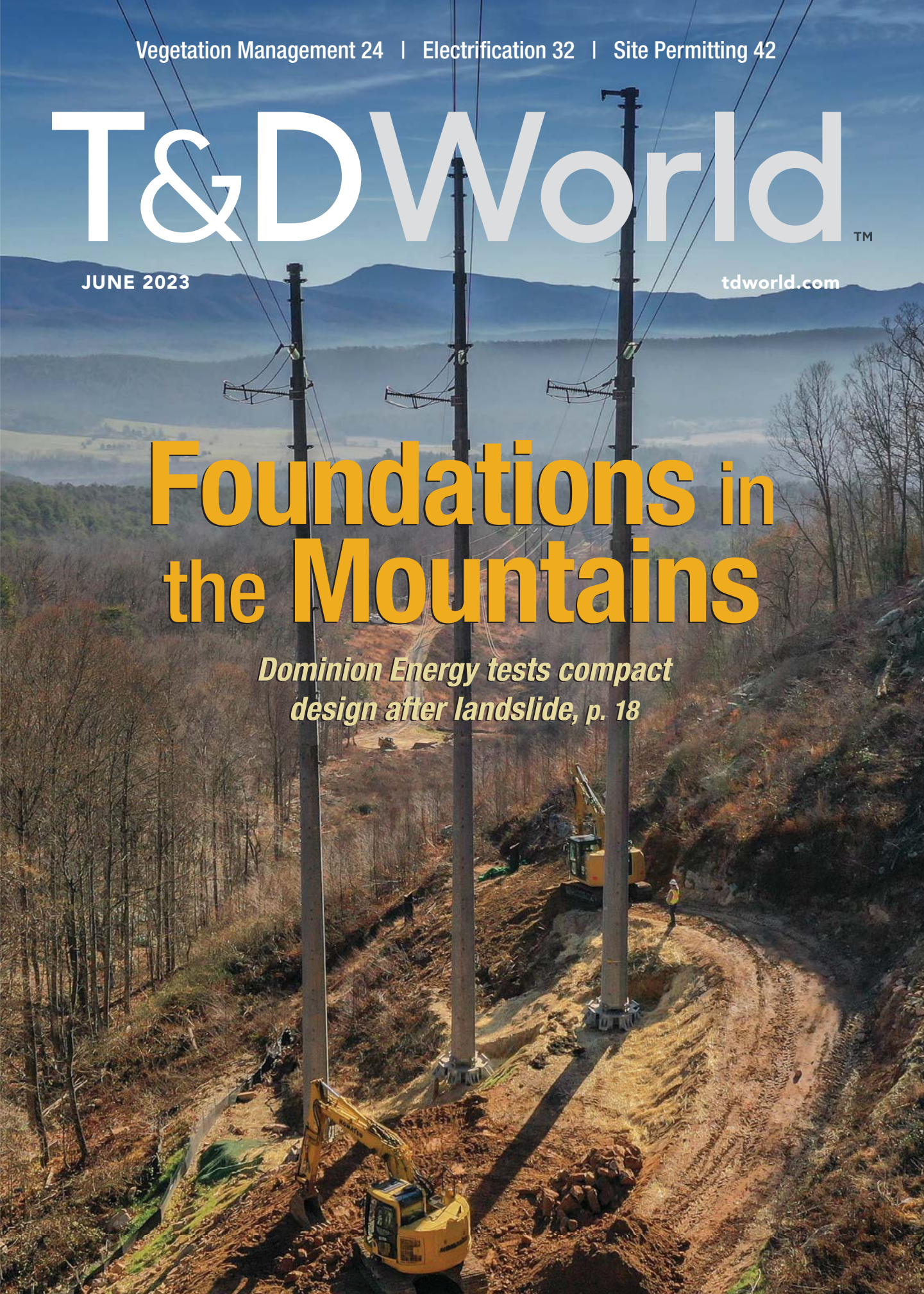

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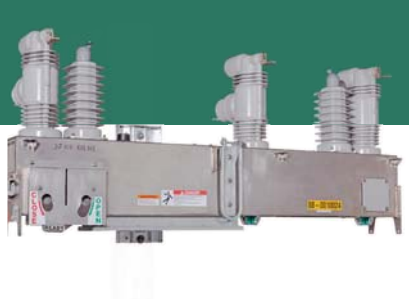

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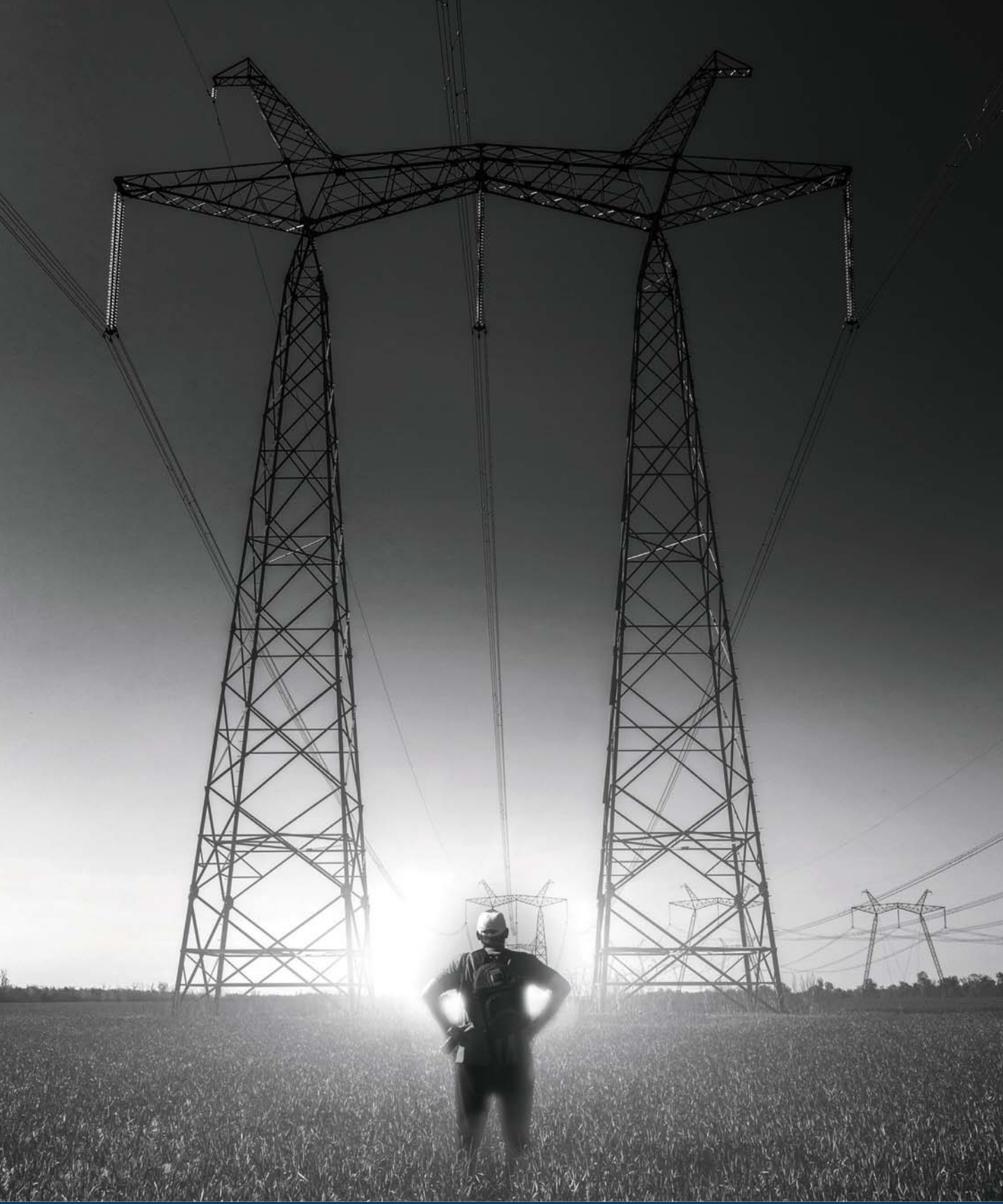

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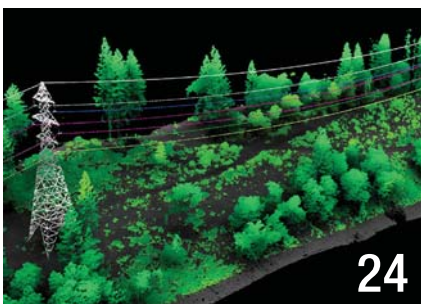

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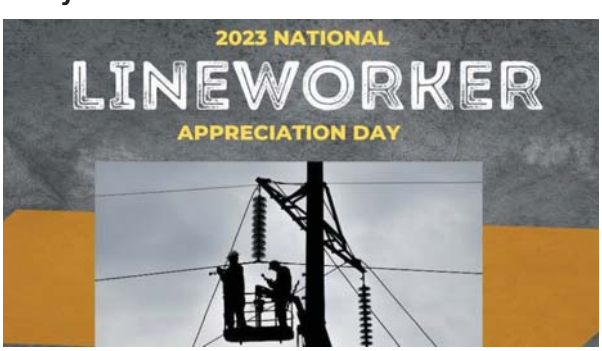

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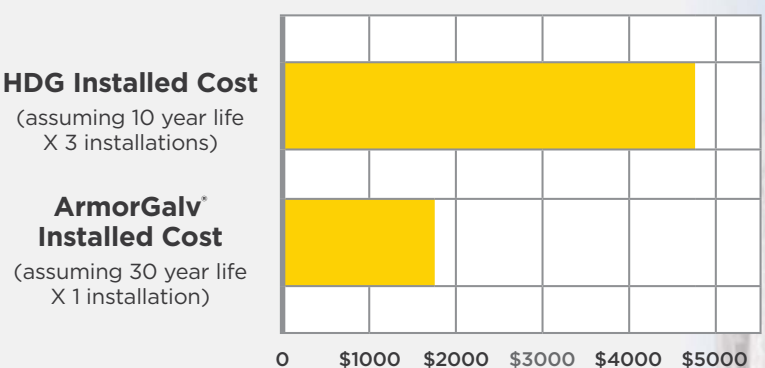

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Promises and Problems of Electrification

As the push to decarbonize continues in the U.S. and much of the world, electric utilities and power producers are working toward net zero carbon emissions. They've improved infrastructure efficiency while increasing their reliance on zero carbon renewable generation sources. Electrification, another strong decarbonization initiative, is taking hold, creating the need for more generation and grid capacity.

The move to EVs, both passenger cars and fleets, is well underway and many experts believe EV adoption is going to happen sooner than predicted. Another growth area is the trend toward total electric homes and commercial buildings.

These initiatives almost certainly will reduce the use of fossil fuels and lead to measurable progress in our quest to decarbonize. Even in the best-case scenarios, however, it will take time and trillions of dollars. The U.S. Department of Energy reported late last year that independent estimates reveal that the U.S. needs to expand electricity transmission systems 60% by 2030 and may need to triple current capacity by 2050.

Some locations in the U.S. might meet President Biden's goal of 100% clean electricity by 2035, but I don't see the entire country being fueled by zero carbon sources 12 years from now. No matter how much we would like for it to be different, natural gas and nuclear baseload generation will for many more years be the bridge — a very long bridge — to 100% clean energy. In fact, I believe nuclear energy should remain a permanent part of the zero-carbon generation mix.

I've written before about the dire need to upgrade and build new transmission and distribution infrastructure. Grid owners and operators recognize and understand the challenges and so far, they've managed to meet those challenges as more intermittent renewable energy has been added to the generation mix and as they've seen their loads grow. The pace and the challenges are intensifying, however, creating an urgency for which most are not prepared.

The challenges with connecting intermittent renewable energy to the grid has commanded attention for years, but challenges and opportunities associated with electrification haven't garnered much attention until more recently.

I, therefore, want to share some insight from a panel discussion I heard in April at the IEEE Grid Edge Conference. Panelists Kevin Geraghty, San Diego Gas & Electric's chief operating officer, Elliot Mainzer, California Independent System Operator's chief executive officer, Colton Ching, Hawaiian Electric Co.'s senior vice president, planning and technology, and Mark Lauby, NERC's senior vice president and chief engineer, discussed their views on electrification. A few things that became clear early in the discussion were that predicting and managing electrification is an enormous challenge, and outlooks and strategies often vary widely based on regions served and customer types.

SDG&E's Geraghty pointed out that in a place like Las Vegas, you can predict growth by looking at the dirt (i.e. vacant land) around the city. That's where most of the load growth will occur, he said. In Southern California it's different, load growth is created by customers' behavioral changes. As an example, he explained that a primary source of electrification, which is directly related to climate change, is the addition of air conditioning to homes and other buildings in SDG&E's service territory.

Ching of HECO, which serves five of Hawaii's six islands, said electrification is the biggest challenge the utility will face in the next 20 years. Ching said electrification will change the way HECO serves customers, as well as require it to educate customers with the goal of changing the way customers think about their own electricity use and the way they do business.

NERC's Lauby predicted that electric vehicles (EVs), both passenger and fleet vehicles, will be responsible for the largest initial load growth in the U.S. He said EVs and EV chargers must be grid friendly. Lauby also believes that utilities should receive government incentives to support and enable the e-mobility push, and that electricity providers need to "get in front of" the fast-growing EV Revolution.

Mainzer, speaking for CAISO, which operates 80% of the state's transmission system, talked about the mammoth task of decarbonizing the fourth largest economy in the world by 2045. He discussed the amount of new capacity that will be needed for EVs alone. For me, however, one of the most important comments was about the impact climate change has on long-range planning. Mainzer said that historic weather patterns and past events are no longer a predictor of the future, and that generation and transmission planning must include a "buffer" for the unknown, unpredictable events that are sure to occur.

The panelists also agreed that utilities must be proactive. They must change their historical wait until it's needed approach to a "build it and they will come" approach. Geraghty said that utilities are responsible for creating models to convince regulators and policy makers that they know where the load growth will be, not just for EVs, but for all electrification initiatives, including those related to commercial and industrial customers.

The panelists discussed a lot of important information and presented many insightful perspectives, too much for me to cover in this column. But I want to leave you with one more tidbit. They agreed that the grid is changing rapidly and the need to adapt is urgent. Utilities must stop looking for the perfect technologies and solutions available today. They must instead choose solutions that will work today while also leaving an opening for new technologies that will become available in the future.

"If we are looking for the perfect technology we will miss out and it will be too late (to adapt)," Ching said. TDW

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SCAN ME

8 Projects that Signal the Future of Microgrids

Just when you thought you knew what microgrids are, they are changing.

Not the basics. A microgrid is still at its core a self-sufficient energy system that serves a discrete geographic footprint and uses one or more distributed energy resources. If it's connected to the central grid, it can disconnect during a power outage and reconnect when the grid comes back up.

So how are microgrids changing? As you'll see from the projects below, they are becoming more complex — incorporating new types of fuels and different combinations of resources that allow them to better serve a broader range of customers.

Here are eight microgrid projects that signal new directions for the technology:

1. Schneider Explores New Resource for Microgrids — River Currents

A selling point for microgrids is that they can use just about any form of generation, making them able to reap the benefits of local resources. Mostly, however, they use solar, batteries and fossil fuel generators. But Schneider Electric has begun incorporating an unusual resource into microgrids built in remote areas — river currents. The first project is being built in Igiugig, Alaska.

2. University to Install a Unique Microgrid and Community Solar Combination in Washington, D.C.

A new microgrid being built by Scale Microgrid Solutions and Urban Ingenuity will accomplish the unusual feat of serving its host — a Washington, D.C., university for deaf and hard of hearing students — and powering a community solar program. The microgrid will be capable of providing Gallaudet University, which has about 1,400 students, with almost all of its electricity during a grid outage. In addition, it will serve the District of Columbia community solar program, available to Washington, D.C., residents, nonprofit organizations and small businesses.

3. Oakland, California Library Pilots Unusual EV Microgrid

It's nothing new for microgrids to include electric vehicle (EV) charging stations. But it is unusual for microgrids to use charged EVs as power sources. Even more unusual is the use of hydrogen-electric buses. The Oakland Public Library project is trying out both. With $3.2 million in funding from the California Energy Commission, the project will demonstrate the value of bidirectional electric vehicle charging to make what project partners call a vehicle-to-building resilience hub at the library.

4. Duke Energy Pairs Microgrid and the Grid for More Reliable EV Charging

This is another example of the growing use of microgrids to serve electrification. In this case, utility Duke Energy is demonstrating at a depot in Mount Holly, North Carolina, how to charge commercial EV fleets from both a microgrid and the grid. The Mount Holly project is designed to help speed the electrification of commercial fleets, a growth market for both utilities and microgrids. Some EV fleet owners are turning to microgrids out of concern about grid reliability or because they want to manage costs or emissions with on-site energy resources.

5. Air Station Miramar Increases Microgrid Islanding Time to as Much as 21 Days for Base the Sizeof a Small City

Marine Corps Air Station (MCAS) Miramar has completed a test demonstrating that it can increase microgrid islanding time so that the whole base — made up of hundreds of buildings — can be islanded for up to 21 days. This was accomplished using an innovative backup system, a milestone that generated excitement for those who have been working toward this moment for years.

"I've been trying to do this backup generator project for so long," said Mick Wasco, utilities and energy management director for MCAS Miramar, based in San Diego. "It was painful and complicated to accomplish. I put years of effort into this, so when it finally happens, it's truly amazing and fun to see it come together."

6. Here Comes a Federated Microgrid for JFK Airport

The new microgrid being built at JFK Airport is actually four microgrids rolled into one. The four microgrids, also called power islands, can operate separately or collectively as one microgrid, making it a federated microgrid. And that's just one of the intriguing features of the 11.34-MW microgrid in New York City.

7. Enchanted Rock to Build California's Largest RNG Microgrid for Microsoft

The 100-MW microgrid represents a growing trend of offsetting use of fossil fuels with RNG, a fuel made from capturing methane produced by decomposing waste from livestock, water treatment, food and other sources. Texas-based Enchanted Rock was one of the microgrid companies early out of the gate in using RNG, which allows developers to offer energy that is cleaner than fossil fuels with similar reliability.

8. Horizon Power Announces DERMS Rollout for 34 Microgrids

Horizon Power plans to launch distributed energy resources management system (DERMS) technology across its microgrids in Western Australia to ease the integration of customer- and utility-owned distributed energy resources. The DERMS technology "enabled more than four times the amount of rooftop solar to be installed than in a traditional energy system." TDW

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EV-Charging Blue-Light Special In Automotive

Better planning would have had me writing about Earth Day a couple of months ago, so it would have been in the April issue. Coverage was limited in February, but now it's April. Earth Day is the major story, and the material is fascinating from a trending technology viewpoint. One trending topic struck a chord with me — the need for a network of EV (electric vehicle) fast-charging stations.

It's one of reasons there is so much buyer's resistance when it comes to purchasing an EV. Finding a charging station can be a major issue. It's not easy to install one for a homeowner and a real problem for renters. The stories about going cross-country can be shocking without some extremely careful planning, but there's hope. The hope comes in the form of news releases from Walmart and other retailers.

Retail Segment Getting Busy

Walmart's Vishal Kapadia, senior VP of Energy Transformation, made an announcement recently. Kapadia said Walmart was planning to add thousands of fast-charging stations to its existing network of over 1,300 fast-charging stations. I had been following all the news about the company's environmental awareness with the installation of rooftop solar, but somehow I had missed the fact they had a network of fast EV charging stations.

The release went on to say that Walmart and Sam's Club have an existing network of fast-charging stations located at 280 of their locations across the country. The company has decided to add thousands more charging stations to that network through 2030. With more than 5,000 stores and clubs located within 10 miles of approximately 90% of all Americans, this is going to be a gamechanger when it comes to making fast-charging stations available to the general public.

Along with Walmart, there have been a flood of announcements from companies like TravelCenters of America saying they are installing about 1,000 charging stations in their facilities. 7-Eleven reported plans to establish one of the largest fast-charging networks in North America. GM, EVgo, and the Pilot Company (Pilot and Flying J travel centers) are partnering to build a national fast charging network. Plans call for 2,000 charging stations in their facilities.

Planning & Standards

A blog from EEI's (Edison Electric Institute) National Electric Highway Coalition (NEHC) told about a recent publication from the Great Plains Institute. The report was titled "*United States EV Fast-Charging Corridor Road Map*." This road map presented an interesting picture of building a full coverage national network of fast-charging stations. *Editor's note* – the

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NEHC membership consists of more than 60 investor-owned, municipal electric companies, and electric cooperatives, which continues to grow.

The NEHC blog said their membership's companies "have invested more than US$4 billion in customer programs and projects to deploy charging infrastructure and to accelerate electric transportation." Another news source provided an update from the federal government about the Bipartisan Infrastructure Law. They reported on progress with the promise made by the administration of providing 500,000 EV chargers for the highway infrastructure by 2030.

After eight months of debates, an agreement has been reached on the standardization of EV connectors. It's been agreed to utilize the CCS (Combined Charging System) type connector with an adapter for Tesla's proprietary connector. The debate also covered the standardized payment options — seems like a good idea.

In addition they added a single method of identification (i.e. protocols) that will work with all chargers and the variety of EVs. That's really going to be interesting when you consider all the communication standards and governing bodies involved with those protocols. There is also a requirement that the charging stations work 97% of the time, which is a current problem with many existing charger stations.

Not to be a downer, but the standardization issues can be hard to handle. At the last counting there were over nine different connector types serving several power levels and voltage types. The CCS connector mentioned in the bipartisan news report is supported by the U.S. and Europe while Japan utilizes the CHAdeMO connector, and China employs the GB/T connector.

There wasn't any information on the protocol standardization effort, but I remember the work involved with smart grid protocol standardization. It proved to be challenging, but it was manageable. It did, however, take time, which slowed down some smart grid technological deployment. It's enough to give you a headache, but we need to keep track of what's going on. The power grid has a massive stake in the outcome! TDW

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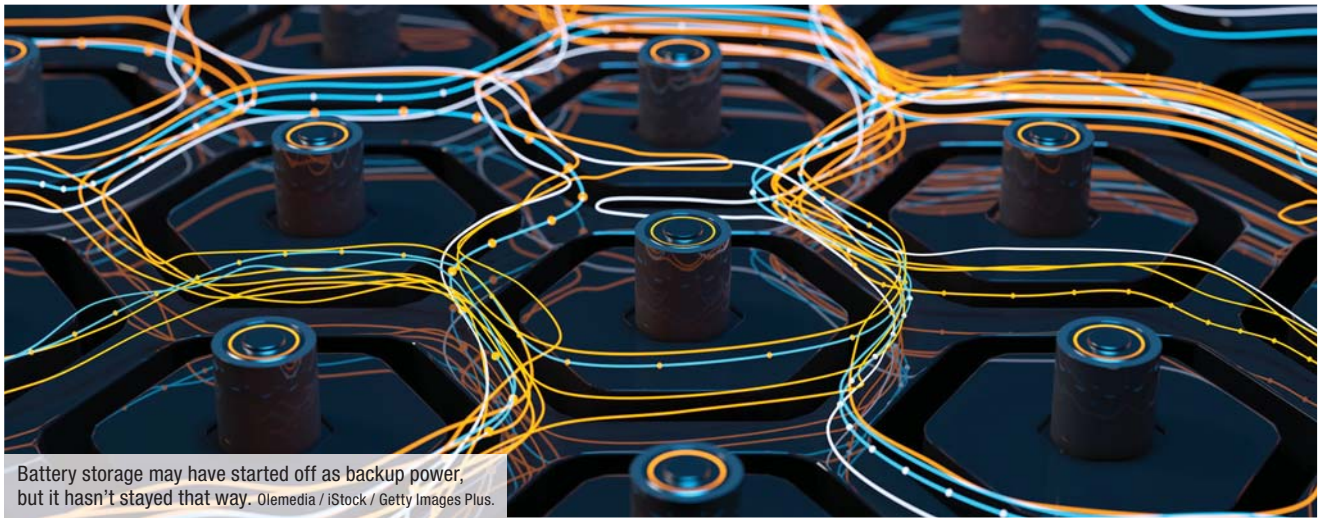


Battery storage may have started off as backup power, but it hasn't stayed that way. Olemedia / iStock / Getty Images Plus.

Battery Storage Can Be Challenging

Artificial intelligence (AI) continues to grab headlines as it steadily moves into the mainstream of technological applications. There's so much important data being generated every day that humans can't handle it. We need help in the form of sophisticated algorithms and cutting-edge computer power to make sense of it all. The simple fact is AI makes work easier and speeds things up!

This was brought into focus when March news reports announced the numbers of grid-scale battery storage projects commissioned in 2022 had broken records. The first thought that came to mind was, how could all the 2022 data be sorted in such a short time? That thinking was followed by the material must be estimates or forecasts. Wrong again, the reports weren't generalized information at all, they contained real substance. Reading further, several of the marketing companies gave away their secret.

They used state-of-the-art AI technology to produce case studies faster than previously thought possible. A little more digging found this process goes by several names, but basically it's AI-driven marketing research. In less than two months, these AI powered platforms combed through mountains of data giving a clear picture of what had taken place on the transmission grid in 2022. What happened with the grid-scale battery storage sector was amazing and caught "Charging Ahead's" interest. Let's look at what stood out in those first reports and articles.

Energy Storage Increasing

For starters, the transmission interconnection queues are an obstacle for battery storage deployment (see *https://tdworld.com/21255605* for more details). Lawrence Berkeley National Lab (LBNL) reported nearly 2,000 gigawatts (GW) of proposed new power generation and battery storage capacities were in those queues by the end of 2022. That's a lot of gigawatts, but the report went on to say 95% of those ensnared gigawatts consisted of battery storage, solar and wind generation.

Putting numbers to the percentages revealed the entrapped battery storage was roughly 670 GWs. That's a pretty good indication there is a strong interest in adding substantial battery energy storage systems (BESS) to the transmission system. Not all of these projects will make it out of the queue. Traditionally only about 20% become operational, but still that's a lot of batteries.

In the BESS category what capacity was actually installed in 2022? Those hard-working AI minions easily dug out those figures. Several reports place the BESS global capacity commissioned last year was roughly 17.5 GW/38.2 gigawatt-hours (GWh). In the U.S. the American Clean Power Association said the U.S. deployed approximately 4 GW/12.2 GWh of battery storage capacity in 2022 with about 54% being stand-alone projects and 46% co-locate with existing power plants.

When the 2022 figures are added to the existing U.S. battery storage capacity, it brings the total U.S. storage capacity to 9 GW/25 GWh. Before moving on, several researchers had an interesting side note concerning the 2022 U.S. figures. It seems that the total 2022 installed capacity figure almost equals the combined amount of battery storage added to the grid in 2020 and 2021 — truly a record breaking year!

More Than Backup

That's why BESS technologies are one of the major trending technologies on the modern power grid, and it appears to be just getting started. Battery storage may have started off as

backup power, but it hasn't stayed that way. Storage technologies have been made profitable by the ancillary service marketplace, and that has been the game changer. It has captured the attention of developers and aggregators too.

They see the attractiveness of adding legacy battery storage assets to the mix, but it's not easy. Legacy storage systems have some enormously complex issues ranging from a variety of battery technologies and a wide range of battery ages. They live on both sides of the meter and were never designed with today's applications in mind.

Managing this variety of legacy systems is a challenge, which brings us back to AI-driven technology and applying it to battery storage management applications. What we're talking about is sophisticated and smart battery control hubs. Hubs that are designed to optimize grid-scale BESS no matter the vintage or variety of the battery storage asset.

Looking Closer

To better understand what is involved with this complex technology, "Charging Ahead" went to the experts. We spoke with AutoGrid's Tad Piper, senior vice president, Strategy and Corporate Development and Sruthi Davuluri, head of Policy and Market Development. They supplied insights not available in the general informational publications. Ms. Davuluri started off our discussion saying, "Batteries are dynamic devices capable of changing their power output in seconds. That allows them to move from being a power source in wholesale electric markets to a wholesale power consumer when excess power is available."

Continuing, Davuluri said, "This is important because battery storage provides more features to the power grid than just backup power. With proper management, a BESS helps utilities delay adding infrastructure without negatively impacting their systems and saving T&D costs. Also, a state-of-the-art BESS management application lets the owner/operator provide services in the lucrative ancillary markets. The owner/operator can develop a positive cash-flow by supplying frequency support, voltage regulation, Volt/VAR optimization, and load leveling to name a few services. In addition, the technology can address wind and solar generation's intermittency issues, making renewables dispatchable. It's important to manage the battery's inherent technical constraints to meet these needs."

Piper explained, "When clouds pass over a large solar array, the power output can drop multiple megawatts in a matter of seconds, which can cause grid instability issues. Variable winds have the same impact on wind farms. With an AI-driven energy storage management system (ESMS), we can manage and control dynamic capacity for many different scenarios and types of energy storage systems. It doesn't matter whether it's a nicad-based system, a flow battery, or lithium-ion batteries that are becoming the storage technology of choice. It makes no difference."

Piper continued, "AutoGrid's ESMS can control a BESS providing fast-responses with quick injections of power. Most importantly, AutoGrid's ESMS supports environmentally friendly goals. It enables battery storage full participation in the markets thus reducing a utility's need to run fossil fuel-powered generation. That is a big positive for utilities meeting their zero-carbon goals."

Davuluri said, "Battery storage facilities have been on the transmission and distribution grids for many years now and those batteries are aging with special needs and considerations. Operational parameters associated with batteries change with age, and the owners need to consider the best way to operate those elder batteries. It's a balancing process complicated by the aging factors. Modified operation parameters must be considered to prolong an older battery's remaining life and capacities, which is where optimization comes into play. The technology must weigh the benefits of how it is using the battery versus straining the battery's remaining life."

Piper concluded, "Energy storage technologies are advancing, becoming more affordable, and making available newer and more diverse applications. It doesn't matter if the BESS is on the transmission or distribution system or which side of the meter it lives on. Wherever the battery storage is located, the ESMS has the ability to efficiently control all aspects of that battery no matter the age, size, or battery technologies efficiently. A smart ESMS like AutoGrid, critically supports asset owners' ability to manage one, ten, or hundreds of storage devices and balance the demands of onsite requirements and energy market participation."

Flexible and Resilient

As a non-wire alternative, grid-scale battery storage offers the modern grid a lot of value when it's an integral part of the network providing innovative services. Peak shaving, capacity firming, and load leveling are a few of the features BESS applications provide, which can assist utilities in delaying infrastructure investments. In addition, a well-managed BESS can supply a host of ancillary services like frequency balancing, renewable capacity firming, active power control, and microgrid capabilities that increase its resiliency.

It's all about flexibility and because of its popularity the costs are dropping, which adds to attractiveness. Battery storage is booming right now, and setting records every quarter especially when it comes to grid-scale BESS. They are found throughout the grid and when it comes to battery storage there is no edge of the grid. Manufacturers such as ABB, AutoGrid, Fluence, GE, Hitachi Energy, Siemens Energy, and others are developing ESMS products that are designed to make battery storage operate wherever they are found.

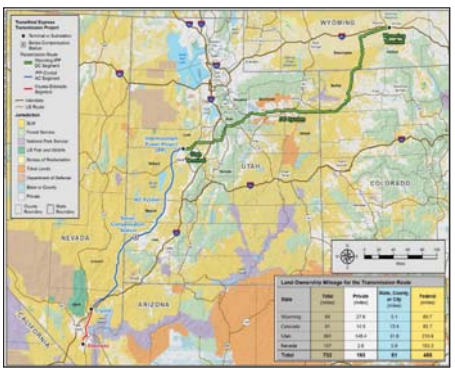
Research and Markets published a report in March, 2023 estimating the global grid-scale battery storage market will reach a cumulative capacity of 499.1GW/1,340 GWh by 2030, which will be worth about US$71.98 billion. There is also considerable growth expected in AI-driven software platforms to manage the growing use of BESS applications.

It's a turning point for battery storage technology. The technology and everything associated with it is evolving and shifting to meet our grid's changing needs. Understanding what is available and how it works is our challenge! TDW

INTERIOR DEPARTMENT ISSUES NOTICE TO PROCEED FOR THE TRANSWEST EXPRESS TRANSMISSION PROJECT

The Bureau of Land Management, U.S. Department of the Interior, has issued its Notice to Proceed for the TransWest Express Transmission Project – providing TransWest Express LLC with the final federal authorization needed to start construction on this critical energy infrastructure.

The TWE Project will be the Western power grid's largest transmission addition in decades. The interregional, 732-mile high-voltage system will connect three planning regions, while adding 3,000 MW of transmission capacity to facilitate the delivery of diverse renewable energy supplies and to make the grid more reliable and resilient.



TransWest Express Transmission Project.

About two-thirds of the TWE Project is located on federal land. The NTP represents the last step of the BLM authorization process that began in 2008. It demonstrates that TransWest has fully satisfied the stipulations and requirements described in the BLM right-of-way grant and the BLM Record of Decision, which followed the preparation of an Environmental Impact Statement.

Notably, TransWest has secured 100% of the linear rights-of-way for the TWE Project, as well as the necessary authorizations from the four states and 14 counties hosting the TWE Project.

"We appreciate the federal, state and local agencies and all of the other stakeholders who collaborated and diligently worked through the process with us to reach this day," said Bill Miller, president and CEO of TransWest.

The TWE Project has Siemens Energy Inc. on board as the HVDC technology supplier, conditional approval to join the California ISO balancing authority area, the initial capacity allocation process complete, the Western Electricity Coordinating Council rating process complete, and partnership agreements in place with the International Brotherhood of Electrical Workers and the International Union of Operating Engineers. The TWE Project's HVDC and HVAC segments will connect to the existing grid in Wyoming, Utah and southern Nevada. The project will provide the region with new access to wind-generated electricity from Wyoming. ■ —*T&D World Staff*

AEP, ALGONQUIN CALL OFF KENTUCKY POWER DEAL

Word that AEP and Algonquin are moving on from their transaction plans comes just days after PNM Resources Inc. and Avangrid Inc. extended the deadline for Avangrid to buy its New Mexico-based peer in a deal valued at more than $8 billion. The hangup there is approval by the New Mexico Public Regulation Commission: The previous members of that body turned away the transaction's proposed benefits agreement and the New Mexico Supreme Court still needs to send the companies' appeal back to a reconstituted commission for another hearing.

The leaders of American Electric Power Co. Inc. and Algonquin Power & Utilities Corp. have spiked their agreement to have the latter's Liberty Utilities Co. buy AEP's Kentucky Power Co. business for about $2.6 billion.

Algonquin agreed in October 2021 to buy Kentucky Power, which serves about 165,000 customers in 20 counties in the eastern part of the Bluegrass State. Kentucky and West Virginia regulators approved the purchase plan last May and July, respectively, but the Federal Energy Regulatory Commission said in December that Algonquin had provided inadequate assurances that its buy wouldn't result in higher transmission rates. AEP and Algonquin filed a new application with the body in February and set April 26 as the deadline at which either company could call off the deal.

As it turns out, both companies agreed to walk away (and neither will owe the other a termination fee) as the deadline neared, with Algonquin President and CEO Arun Banskota also citing "the evolving macro environment" as a factor.

For their part, AEP President and CEO Julie Sloat and her team said they are "implementing a refreshed long-term strategy" for Kentucky Power—suggesting they will not soon bring the subsidiary back to market—and will in June file a new base rate case that, if approved, would take effect in January.

"We are working diligently to reimagine our strategy with the goal of not just supporting Kentucky but being an essential part of its economic and energy future," Sloat said in a statement. "We believe there are opportunities ahead for our Kentucky operations, and we will focus our efforts on economic development, reliability and controlling cost impacts to customers."

Leading those efforts will be Cindy Wiseman, Kentucky Power's newly named president and COO. Wiseman has been with AEP since 2008 and has moved from communications into senior external affairs and customer service roles. She joined the Kentucky Power team about five years ago.

Shares of AEP (Ticker: AEP) didn't move much on the news and closed the day at $93.29, up nearly 1% from Friday's last trade. Algonquin shares (Ticker: AQN) fell 1.5% to $8.50 April 17; they have lost about 20% of their value over the past six months. ■

— Geert De Lombaerde

SOUTHERN PRESIDENT: VOGTLE COMPLETION WILL SET STAGE FOR M&A REVIEW

Southern Co. President Chris Womack plans to turn his team's attention to reviewing its mergers and acquisitions options—with the chance of being a seller and/or a buyer—once it has brought to market the long-delayed Vogtle 3 & 4 nuclear power project. Speaking to analysts and investors after Atlanta-based Southern reported first-quarter earnings, Womack said completing work on Vogtle will, along with Southern not needing to raise equity in the near future, free up time and attention for his team to review Southern's portfolio of companies and look to boost the company's valuation.

We're really going to focus on [...] unlocking our full potential," said Womack, who took over as president a month ago and is preparing to assume Tom Fanning's CEO role at Southern next month. "We are large enough to [remain] a standalone. At the same time, we'll also look at the market and look at our hand from both a buyer's and seller's perspective."

Womack's comments about possible acquisitions and divestitures come as a number of utility peers around the country are working on or contemplating deals. The leaders of regional neighbor Dominion Energy Inc. late last year launched a broad strategic review of its businesses while on the West Coast, PG&E Corp. is looking to sell up to half of its non-nuclear generation assets.

Not all transaction plans have gone swimmingly, though: Just in the past few weeks, American Electric Power Co. Inc. and Algonquin Power & Utilities Corp. pulled the plug on their plan for the latter to buy Kentucky Power Co. while the leaders of PNM Resources Inc. and Avangrid Inc. have extended their deal deadline a second time.

Southern's subsidiaries—Alabama Power, Georgia Power, Mississippi Power, Southern Power and Southern Company Gas—combined to generate nearly $6.5 billion in operating revenues during the first three months of this year, a decrease of 2.5% from early 2022 in large part to a very mild winter across much of the Southeast. Net income for the quarter fell to $862 million from $1.0 billion in the prior-year period.

Also contributing to the lower numbers was an unexpected drop in industrial activity as manufacturers pulled back. While weather-adjusted sales to residential and commercial customers rose 1.2% and 1.8%, respectively, industrial sales fell 0.8% after adjusting for the closure of a large factory in Southern's service area. Fanning, Womack and their team had been looking for industrial sales to climb 2% but CFO Dan Tucker told analysts a number of housing-related manufacturers have been pulling back.

Over the medium term, however, Womack and Turner see good things ahead on the economic development side of their business. ■ — *Geert De Lombaerde*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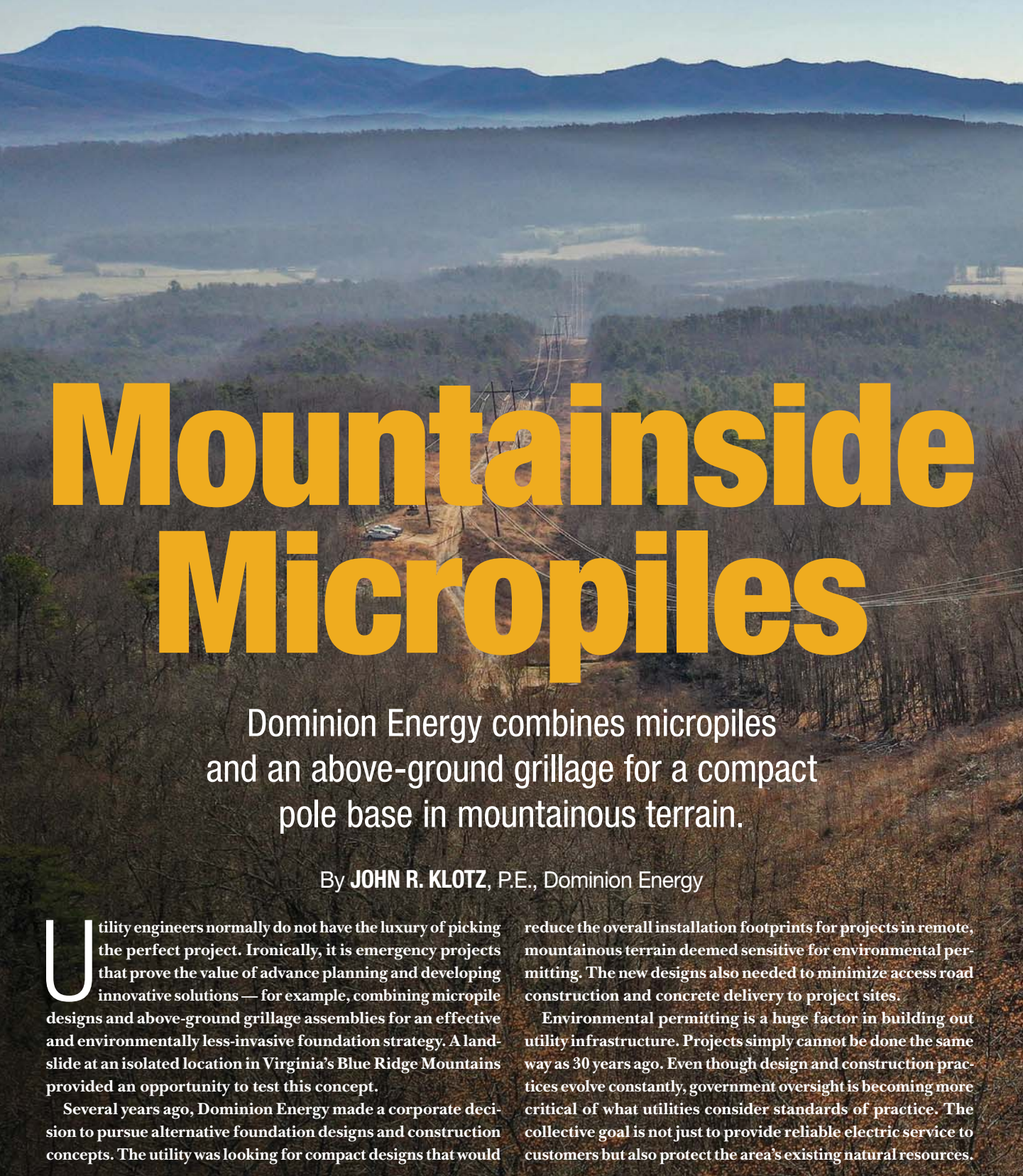


Mountainside Micropiles

Dominion Energy combines micropiles and an above-ground grillage for a compact pole base in mountainous terrain.

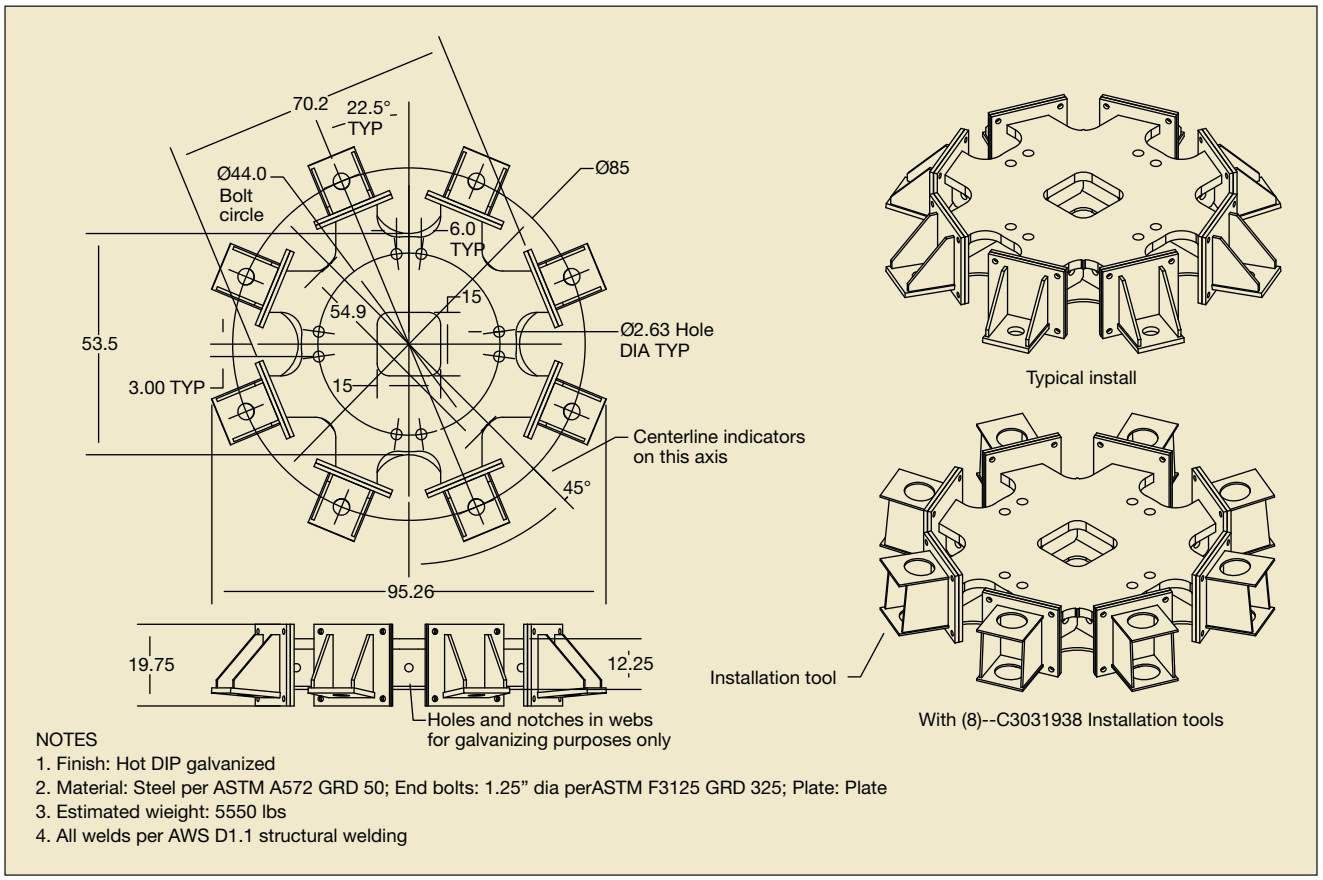
By **JOHN R. KLOTZ**, P.E., Dominion Energy

Utility engineers normally do not have the luxury of picking the perfect project. Ironically, it is emergency projects that prove the value of advance planning and developing innovative solutions — for example, combining micropile designs and above-ground grillage assemblies for an effective and environmentally less-invasive foundation strategy. A landslide at an isolated location in Virginia's Blue Ridge Mountains provided an opportunity to test this concept.

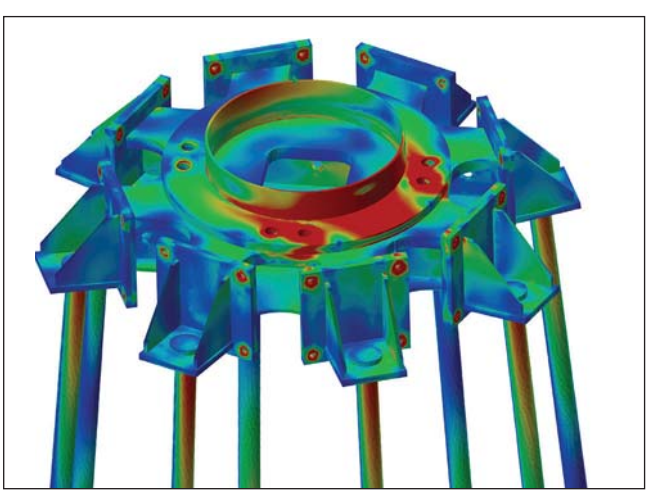
Several years ago, Dominion Energy made a corporate decision to pursue alternative foundation designs and construction concepts. The utility was looking for compact designs that would reduce the overall installation footprints for projects in remote, mountainous terrain deemed sensitive for environmental permitting. The new designs also needed to minimize access road construction and concrete delivery to project sites.

Environmental permitting is a huge factor in building out utility infrastructure. Projects simply cannot be done the same way as 30 years ago. Even though design and construction practices evolve constantly, government oversight is becoming more critical of what utilities consider standards of practice. The collective goal is not just to provide reliable electric service to customers but also protect the area's existing natural resources.

A landslide at an isolated location in Virginia's Blue Ridge Mountains provided an opportunity to test a combination micropile and above-ground grillage assembly. Environmental permitting is a huge factor in building out utility infrastructure. Even though design and construction practices evolve constantly, government oversight is becoming more critical of what utilities consider standards of practice. Photo by Hubbell.



A typical grillage design. Graphic by Hubbell.



Dominion micropile-grillage arrangement, shown in Finite Element Analysis (FEA). Photo by Hubbell.

Dominion often is faced with using right-of-way routes through leftover land such as mountains and swamps. Considerable effort is spent on being as flexible as possible for all interested parties, including government agencies, tribal nations, property owners and customers. Addressing these accommodations requires innovative approaches that, while effective, may add time and cost to projects.

Long-Term Planning

In the summer of 2021, Dominion was a year and a half into planning and designing 115-kV transmission lines from the Balcony Falls substation to the Skimmer interconnect in the Roanoke, Virginia, U.S., area. This mountainous 10-mile (16-km) line was originally constructed almost 100 years ago with wooden H-frame poles.

The utility was well into the design process with the vendor, Hubbell Power Systems Inc., on a fabricated steel-pole base. The foundation concept was a unique combination of micropiles and an above-ground grillage. Two load tests were performed and the geotechnical conditions were deemed favorable for successful installations.

While the design work was being completed in early fall of that year, an urgent situation developed at another site. A landslide was discovered below an existing structure about 45 miles (72 km) to the northwest. Emergency remediation at this site quickly became the priority.

Even though the two situations were not altogether similar, the general parameters of the two installations were close enough to consider using the fabricated pole-base design. The utility found surplus steel poles in storage that met every design and construction requirement. The emergency site would serve as a pilot project for the micropile-grillage foundation concept.

Micropile-Grillage Pole Base

Structural framework designs for pole foundations are often used in areas with soft soil, which offers low load-bearing capacity. One or more tiers of wood or steel beams are connected to distribute the load over a wider area. Sometimes called a grillage, they are normally buried in the ground.

Typically, above-ground grillages are secured to the soil with helical piles. Each pile has a central steel shaft and several helical plates, screwed into the ground like a wood screw. Helical foundations can go 5 m to 15 m (16 ft to 49 ft) deep. This design uses much less concrete than drilled shaft foundations and is commonly used in remote or difficult-to-access areas with poor soil conditions.

However, helical piles cannot be used in rock, which is where drilled and grouted micropiles come into play. A machine drills a hole with a diameter under 12 inches (305 mm), hence the term "micro." In the center is a bar with an expendable tip. The drill head stays at the bottom, and the hole is filled with high-strength cement grout.

Micropiles use the rock itself for the foundation. The center bar transmits the load to the bearing rock. This solution is considered a friction foundation, with the grout bonded to the rock. Micropiles can be placed at an angle and provide greater load capacity. They can be used as direct support for smaller structures or as part of larger ground reinforcement.

Connecting micropiles to a grillage is not a common strategy. However, it can serve as a workable solution for mountainside locations. The initial concept for the Dominion project used eight micropiles arranged in a circle around the grillage, and 3-D models were used to analyze stress conditions and deflection in the grillage when subjected to load — enabling the utility to further refine the design before making final production drawings.

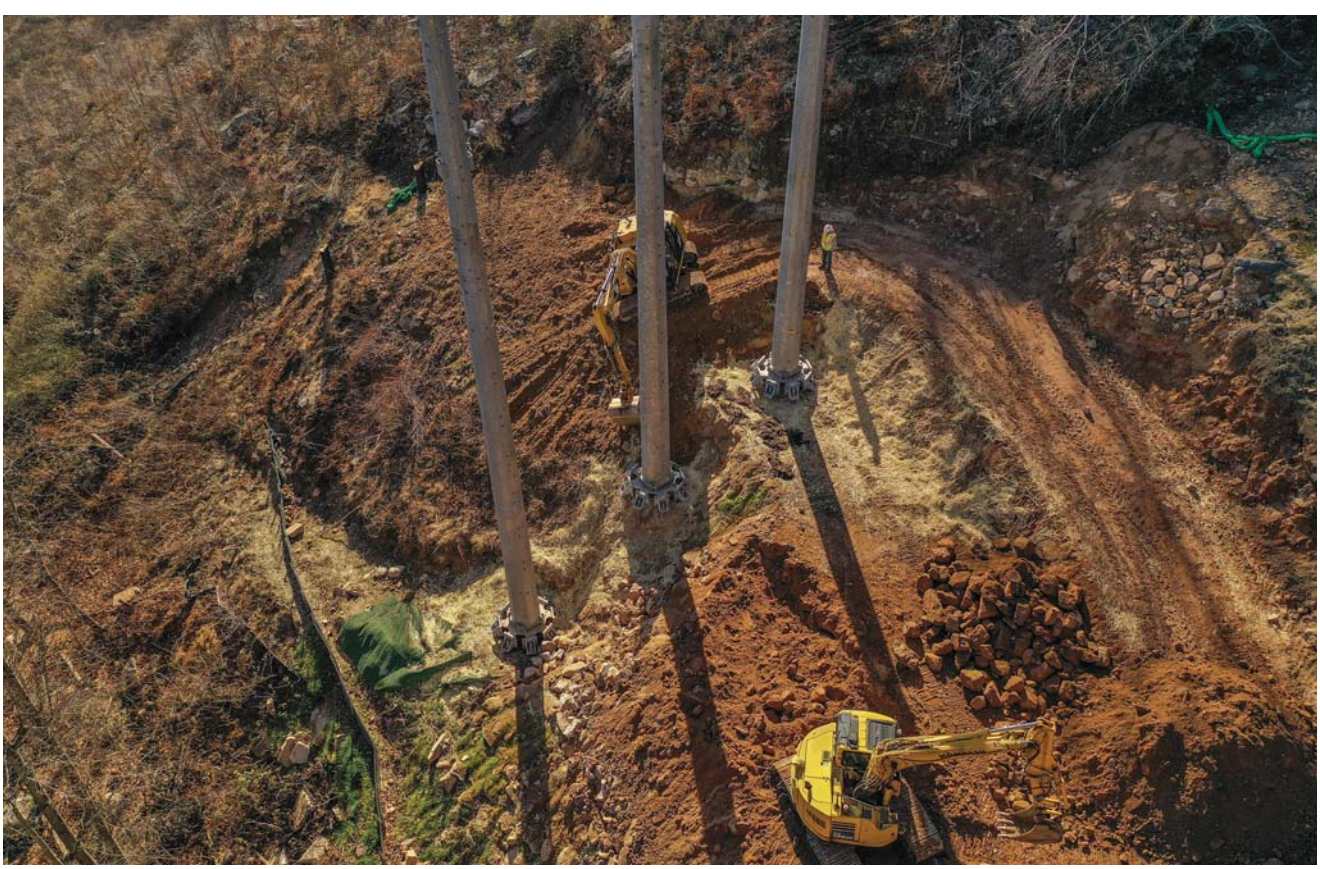
Value Of Collaboration

Consistent partnerships ensured a practical approach and ultimately facilitated successful projects. Dominion already enjoyed a good working relationship with the grillage vendor. Although Hubbell had worked extensively with helical piles, the company had less experience with micropiles. Dominion's engineering and construction staff had confidence Hubbell's considerable grillage experience would result in an effective design.

The engineering collaboration set the project apart. The Dominion engineering team used the Hubbell engineering team as a sounding board for developing solutions. Schnabel Engineering performed the geotechnical engineering and micropile design, and Technical Foundations Inc. was the installation contractor. Working with experienced vendors provided consistency to the project. A collaborative, uniform design required less evaluation work, and it was easily modified for other conditions. The landslide site installation displayed this flexibility; the grillage was easily adapted for this project even though the design was originally intended for another site.

Once the design was set, the order for the grillages went through Anixter International Inc. The micropiles used standard parts, sourced separately. The steel poles were already in stock, which was key to a timely response.

For remote mountainside locations, it is helpful to bring small- to medium-sized equipment. In theory, designing a compact solution would enable the use of existing inspection paths in



Structural framework designs for pole foundations are often used in areas with soft soil, which offers low load-bearing capacity. One or more tiers of wood or steel beams are connected to distribute the load over a wider area. Connecting micropiles to a grillage is not a common strategy. However, it can serve as a workable solution for mountainside locations. Photo by Hubbell.

the field and reduce the amount of new road construction. Reducing road construction also saves time and money.

Using helicopters to bring in equipment was considered, as their high cost can sometimes be absorbed into the overall project cost. However, several factors made it more practical to proceed with standard road building for this particular location. The drilling equipment, concrete and poles were all trucked in.

Results For The Future

The installation ran into an additional challenge. While rock makes for a solid foundation, it can be an unknown. The landslide site rock was high in quartzite. Quartzite is much denser and heavier than the test sites were, which slowed down drilling.

Despite challenges and delays, three new micropile-grillage pole bases were safely set in December 2021.

Every issue the teams faced offered opportunities to develop solutions. The engineering collaboration was fruitful. Dominion always seeks the optimal place between design and cost, and the landslide project ended up being the proof-of-concept trial for the micropile-grillage arrangement. This innovative design will potentially save the utility time in upcoming projects.

A second project, involving about 40 micropile-grillage pole bases, is under consideration for use in late 2023. This project will incorporate the lessons learned from the landslide project to develop protocols. For example, performing full-scale load tests on the site rock will provide essential information to drilling teams. Adjusting the micropile designs based on each site's subsurface characteristics will allow for optimal installations. Detailed specifications for installing micropiles are currently in development.

From One-Off To Off The Shelf

The results of the landslide emergency remediation helped Dominion's engineering team to learn how to improve future designs. The collaborative effort spent in planning this project will save the utility time and money in the future. Dominion's goal is to develop a permanent solution to handle both emergencies and projects with major environmental constraints.

The utility hopes to develop a family of designs that can be successfully applied across a range of applications and conditions. The grillage concept used on the landslide project offers the flexibility to handle a variety of settings. This approach helps to keep the power on for customers while being sensitive to the concerns of all stakeholders. Compact concepts like the combination micropile-grillage pole base have the potential to deliver. TDW

JOHN R. KLOTZ, P.E., (*John.R.Klotz@dominionenergy.com*) is a consulting engineer with Dominion Energy. He holds a BSCE degree from Virginia Tech. He serves on several American Society of Civil Engineers Structural Engineering Institute committees. He also has contributed to Electric Power Research Institute Inc. projects on groundline corrosion and vibratory caisson foundations.

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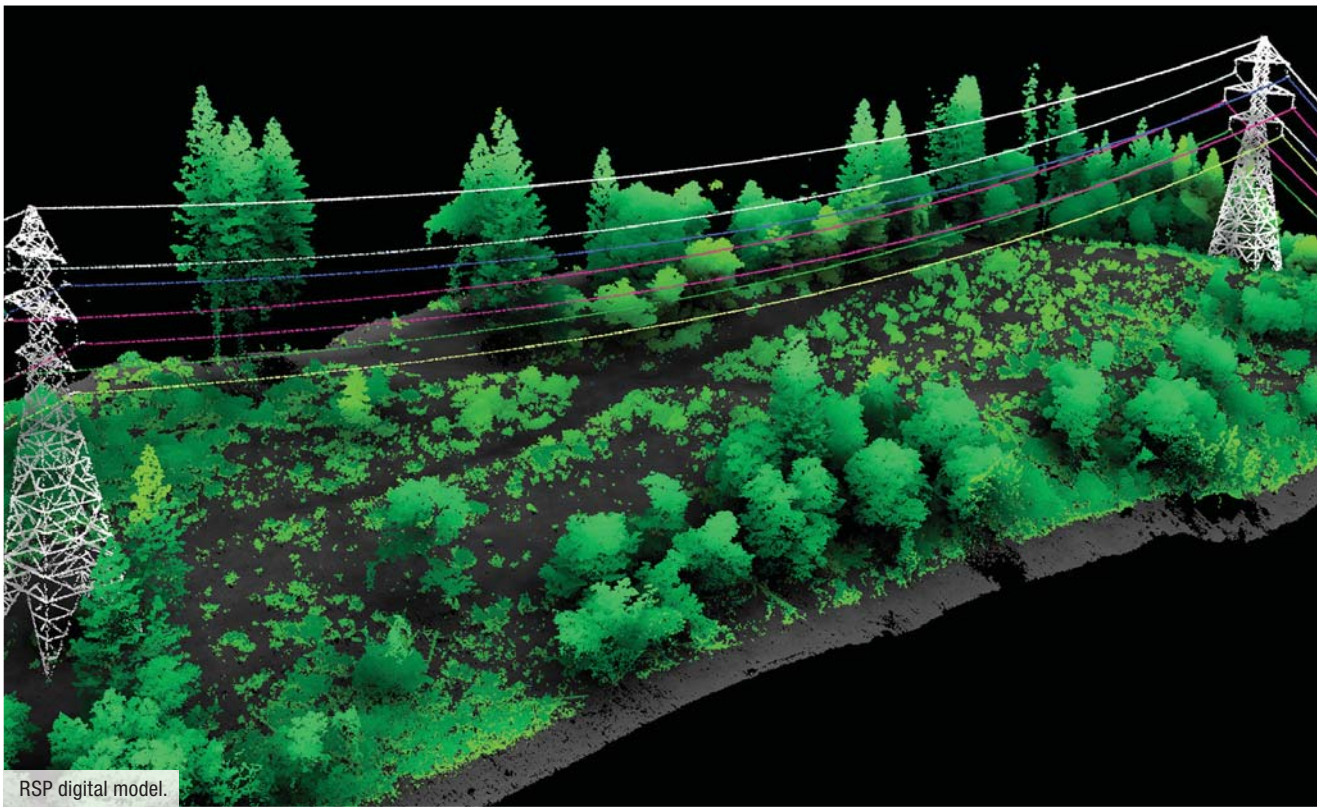


RSP digital model.

Transmission Vegetation Management Transformation

In part one of this two-part series, Duke Energy shares how a remote-sensing program has transformed the way it manages vegetation.

By **JACK GARDNER**, Duke Energy Corp.

Utility maintenance strategies typically fall into one of three different categories: interval or time-based maintenance, condition-based maintenance or predictive maintenance. Transmission vegetation management (TVM) programs traditionally have relied on interval/time-based maintenance approaches along with specification documents to plan and execute vegetation management work.

In 2017, Duke Energy Corp. began a business transformation to address the ever-increasing challenges of safely and effectively managing vegetation along its transmission corridors. This journey included a shift toward a more data-driven operational strategy, as well as organizational realignment, adoption of innovative technologies, and development of new processes and procedures.

This transformation provided the opportunity for the utility to transition from an interval-based maintenance approach to a condition-based strategy, with predictive elements to drive reliability and program effectiveness. To help ensure the transition would be sustainable, Duke Energy implemented an enterprise-wide remote-sensing program (RSP) and developed the Work Planning, Analysis and Scheduling System (WorkPASS) to manage and execute the work.

These innovative programs and applications have enabled Duke Energy to migrate away from manual processes and tools, such as spreadsheets, to more advanced processes that leverage technology.

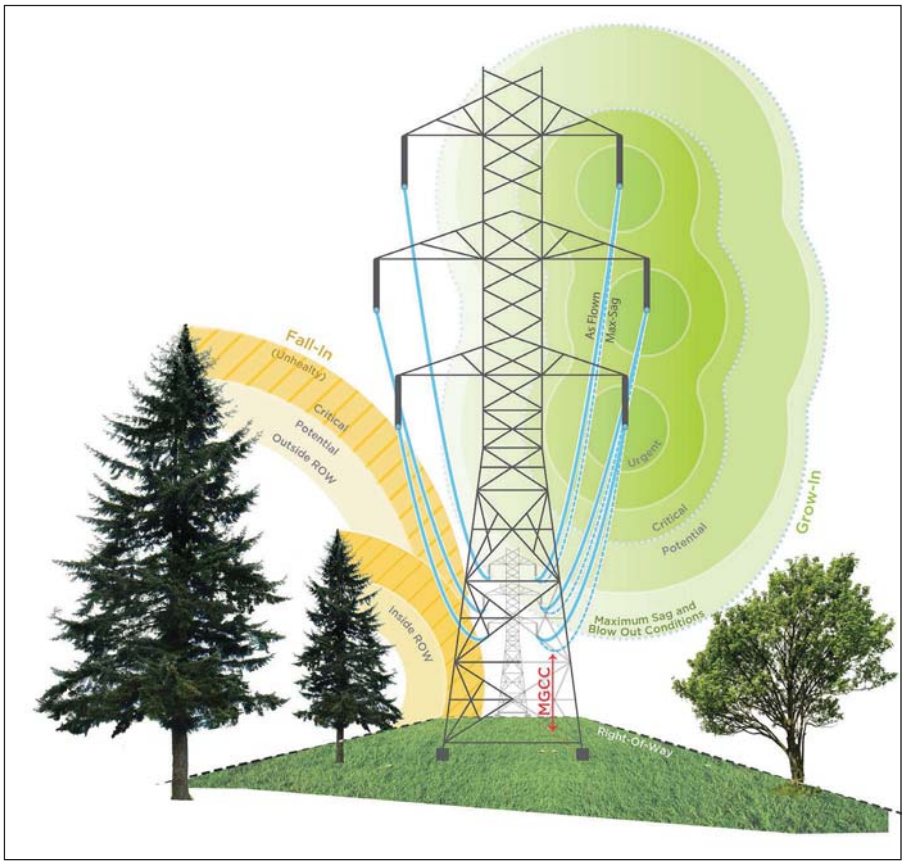
The new technology also provides field access to the data through mobile geospatial application (GIS) solutions. These applications enable the TVM team to better manage system integrity and reliability over a multiyear horizon and enhance the utility's integrated vegetation management (IVM) strategy, while also balancing the needs of Duke Energy and property owners.

Part one of this two-part article series focuses on the utility's development of a remote-sensing program.

Reasons For Change

The Duke Energy TVM organization is responsible for managing vegetation across six states (North Carolina, South Carolina, Florida, Indiana, Ohio and Kentucky). The organization includes four geographic operating regions (Carolinas East, Carolinas West, Florida and Midwest) responsible for managing transmission vegetation work execution. In addition to the four regions, the organization also includes a group responsible for providing enterprise TVM strategy, technology solutions, and common processes and procedures. The TVM team plans and manages vegetation work on more than 31,000 miles (49,890 km) of transmission lines, comprising approximately 6% of the total North American Electric Reliability Corporation (NERC) FAC-003 applicable circuit miles in the U.S.

Duke Energy has a well-established and industry recognized TVM program, which has maintained a disciplined and consistent approach to managing vegetation along the utility's transmission rights-of-way (ROW).



Duke Energy RSP threat modeling.

Point cloud image of reactive finding location.

Until recently, TVM's approach to managing vegetation along transmission lines has relied on interval-based maintenance with specifications that describe what work needs to be performed.

An interval-based maintenance approach has served the industry well for decades, but the regulatory and public environment has evolved rapidly. While resource constraints were typically the primary challenge for TVM programs in the past, the industry has seen utility commissions, regulators, legislators and property owners become more engaged, resulting in increasing expectations for the program.

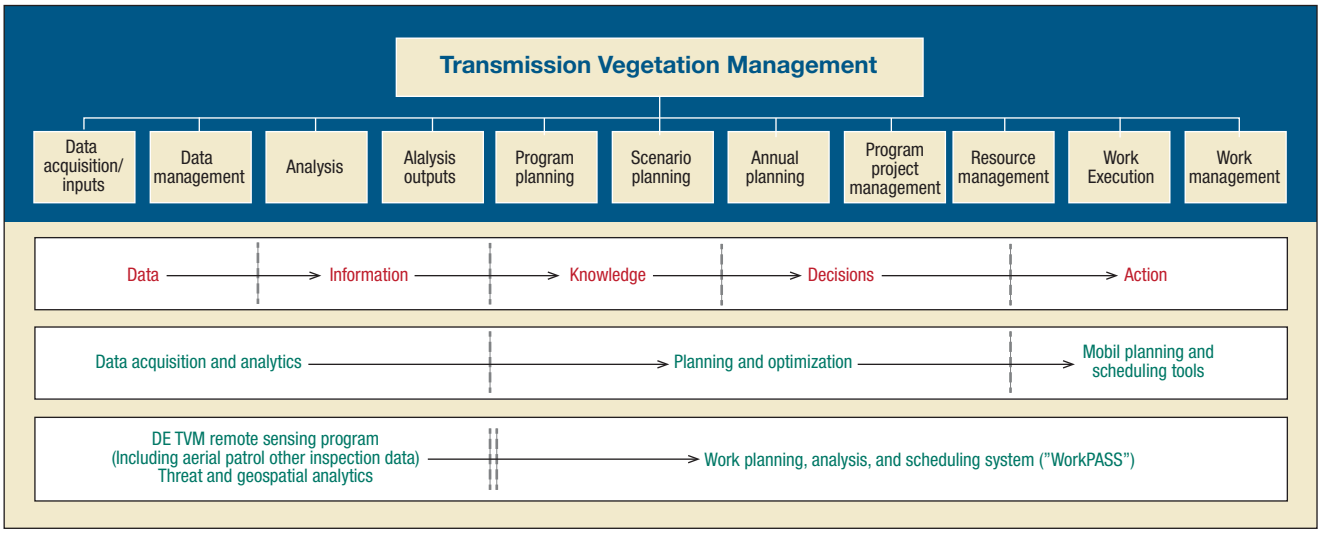
As these challenges and expectations evolved, TVM determined that continuing to perform work as it has in the past (that is, managing the program manually through spreadsheets and performing maintenance using an interval and specification-based approach) was no longer a sustainable approach. Duke Energy needed to transform the way it planned and executed work.

The TVM team embarked on a transformation to establish a sustainable path for the future. The TVM business transformation initiative included changes to operational strategy, organizational realignment, technology solutions and program documentation. Key to the success of this journey was the implementation of data-driven technological solutions, along with analytical capabilities, to sustainably manage increasing expectations by performing the right work, at the right place, at the right time.

Business Transformation

While many actions were associated with TVM's business transformation, two key actions proved critical to the sustainability of the initiative: strategic focus and organizational alignment. The team took a strategic focus using advanced data to identify and address potential vegetation threats and eliminate the previous reliance on a specification-based approach that could over- or under-prescribe the work required to address true threats.

While the strategic focus provided directional guidance, the organizational alignment changes needed to support the new strategy included the creation of a central TVM Strategy and



High-level TVM program workflow tasks.

Support (TVM SAS) organization. TVM SAS, which combined personnel from the TVM regions and the utility's vegetation governance organization, was created to develop an enterprise approach for TVM programs and implement innovative and cost-effective technology solutions. Prior to the creation of this group, TVM processes, procedures, and operational practices varied across the regions and technological innovation was a low priority.

Technology Initiatives

Two technology-related efforts were initiated to support the transformation: implementation of an enterprise RSP and WorkPASS. The RSP initiative was established to create a digital model of lines that can be analyzed to predict potential vegetation threats over the next six years to eight years.

Predicted threats from these analytics provide the data necessary to support a condition-based maintenance approach. The WorkPASS initiative was established to develop and provide the necessary tools and applications to effectively manage and execute a condition-based maintenance program focused on reliability and program effectiveness.

Cutting Down Risk

While some level of inherent technical risk is associated with technology implementations, Duke Energy TVM's experience with previous remote-sensing and technology solution initiatives led to three issues being identified as potential risk factors:

- Sheer volume of data and the ability to manage it
- Solutions not being designed to fully meet use-case needs
- Limited capability to produce concise actionable deliverables for execution.

These risk factors were determined to be controllable when considered and addressed during the early stages of initiative planning. The following guidelines were used to mitigate the risk factors and provide general direction for the RSP and WorkPASS initiatives:

- Provide tree-canopy polygons
- Analyze threats under all rated electrical operating conditions
- Document reactive work threats
- Predict vegetation threats over a six-year to eight-year period
- Provide capability to manage and transfer large datasets
- Develop predictive reliability-risk analytics
- Provide scenario-planning capabilities for annual work planning
- Create optimized annual work plans
- Create an application that supports an end-to-end approach for the corridor (planned), floor and reactive management programs
- Support work unit and should-cost predictions
- Support multiyear work planning
- Provide actionable deliverables for execution (that is, predicted work units per stem at the tree-canopy polygon level)
- Support field mobile access

WorkPASS overview.

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- 6,000 ft. of PE-12 rope

View of threat data used for field work planning.

- Support assignment of work for execution
- Provide completed-work reporting capability
- Meet business-case objectives.

Establishing the RSP

After identifying the guidelines, Duke Energy began developing the RSP program with an evaluation of remote-sensing options, which included satellite imagery, photogrammetric detection and ranging (PhoDAR), and light detection and ranging (LiDAR). The results determined LiDAR was the best option to meet the accuracy and resolution requirements of the TVM use case and supported the use of PLS-CADD engineering models to identify vegetation threats under all rated electrical operating conditions. In addition, the LiDAR option also supported additional use-case needs associated with transmission line engineering and asset protection.

The methodology used to manage the threats was the next key decision point for Duke Energy's RSP initiative. Across the industry, different approaches have been used for each unique program, some of which were tree inventories. Based on the size of Duke Energy's program, as well as limits with remote-sensing technology, a tree inventory did not completely align with the utility's strategic direction, and a volumetric approach (threat polygons) did not meet work assignment needs. Based on the evaluation, Duke Energy selected tree-canopy polygons, which were attributed with highest threat as the basis for managing threats.

Once a remote sensing data source was determined and the method for managing threats was established, requirements related to RSP data capture and processing were defined. The capture requirements included average LiDAR points per square meter, survey absolute locational accuracies, relative accuracies for the LiDAR point cloud, ground control points, LiDAR point cloud feature coding, minimum corridor processing delivery widths, coordinate systems and many other factors related to imagery. The processing requirements were established to include the creation of tree-canopy polygons, tree-canopy tops representing the highest point within the canopy polygon and vegetation threat polygons. The deliverable requirements supported the ability to associate vegetation threats at the tree-canopy polygon level.

The final step of the RSP was to establish requirements for vegetation condition and threat analysis. With an expectation that all rated electrical operating conditions of the conductor be considered (which meets FAC-003 requirements), vegetation threat modeling was built around "max sag," "as-flown" and "design blowout" conductor positions. Threats from vegetation, using one or more of the conductor positions, were to be predicted for the next six-year to eight-year period and categorized as "grow-in," "blowing together" and/or "fall-in" threats.

Foundational Data

The RSP deliverables provide the foundational data needed to support a condition-based management approach. By requiring the threats from vegetation to be predicted over a six-year to eight-year period, the RSP deliverables support multiyear work planning and enable Duke Energy to understand and prioritize work on a condition (which indirectly accounts for time) and threat-type basis. Further, this approach is foundational for the utility's risk analysis.

Editor's note: The remote-sensing program is one of two major developments Duke Energy pursued as part of its vegetation management transformation journey. Learn more about the development of a work execution system, WorkPASS, in the next issue of *T&D World*. TDW

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Change Anxiety

Could rapid EV adoption break the grid? Industry voices make predictions (and new technologies) as utilities brace for impact.

By **JEFF POSTELWAIT**, Senior Editor

Marketers for electric vehicles often talk about change anxiety, or the feeling of fear that prospective EV owners may have about finding a place to charge their vehicle — on long road trips in particular. Some utilities today are experiencing "change anxiety," or the feeling that they may be caught unprepared for a coming wave of EV adoption.

These discussions are happening just about everywhere today, including at the National Rural Electric Cooperative Association, which featured quite a few sessions on the impact of EVs on grid reliability. If more utility people are talking about EVs, it's because, for one thing, the profile of the EV user is beginning to shift.

Another factor is the growing industry chatter about EV fleets for commercial, industrial and institutional customers such as universities, governments, armed forces and utilities themselves.

C&I entities adopting fleets of thousands of EVs at once could have a much heftier impact on overall EV numbers than individual consumers opting to go electric. The International Energy Agency has called the sales growth of EVs "exponential." A total of 14% of all new cars sold were electric in 2022, up from less than 5% in 2020, the IEA said in its 2023 Global EV Outlook.

According to the McKinsey Group, around 48 million EVs would create an annual charging demand up to 230 billion kWh and require installing nearly 30 million chargers. That survey is limited to the U.S., which is only in third place for new EV sales, with China and the E.U. in the top two spots.

An electric vehicle's charge readout. DC fast-chargers are capable of putting more stress on transformers and the greater the power grid than Level 1 chargers that take hours to bring a vehicle to full charge. ID 208622518 © Studiostockcreator | Dreamstime.com

Several vehicles use Tesla branded fast-chargers near a gas station overlooking the Interstate 10 Freeway in Santa Monica, California. According to some surveys, the global electricity demand of EVs may soon reach three times the electricity used by the state of California. Photo provided by Margot Davis, Ubicquia.

These are not small numbers, so a touch of alarmism among those whose job is to keep the lights on is understandable. The pace of EV adoption seems to be entering its long-predicted speeding up phase.

Overloading Grid Assets

Jow Ortiz, general manager, Utilities, for Ubicquia, said utilities are concerned about the sheer size of the predicted EV loads, adding that today they can't detect EV load at the transformer level and proactively plan for it.

"They are seeing overcapacity circuits and failed transformers due to EV load even today," Ortiz said. "They are concerned about fleet EV operations that can require a significant distribution grid infrastructure investment to accommodate — do they have

the funding to make these investments and will they be recompensed for doing so?"

Other concerns include low quality inverters being used in EV charging systems that backfeed electrical transients into the grid that can overheat and damage distribution transformers. Peak demands are worsening as Level 1 chargers are replaced with Level 2 fast chargers, which enable drivers to charge more quickly at a hidden cost to grid operators.

It should be noted this comes at a time when transformers of all kinds, from the large pad-mounted units to less powerful pole-top varieties, are seeing longer lead times for replacements due to a combination of fast-growing demand and supply challenges.

A study by *Car & Driver* found that the charging capacity required to supply a large passenger vehicle travel center or truck stop site would be "roughly equivalent to the electric load of a small town."

BYD vehicles charge at a parking garage in Singapore. BYD is an EV maker with headquarters in Shenzhen, Guangdong, China, which is the country currently leading the world in new EV sales. ID 265728310 © Naruto4836 | Dreamstime.com.

"The electric utilities would need considerable distribution system upgrades, along with transformer capacity, to support these EV connections," Ortiz said.

Rapidly expanding EV adoption could have a cascading effect on energy systems everywhere, requiring a massive buildout of charging infrastructure as well as grid modernization technology, said Jason Plane, utility segment manager – North America, for Eaton.

"However, electrification is not just about adding new load to the grid (or building, industrial or home energy systems). It requires that existing energy systems work smarter and harder to meet demand while accelerating decarbonization and optimizing how energy is consumed through intelligence, control and automation," Plane said.

The biggest inhibitors to EV adoption are being solved, Plane said, clearing the way for adoption number to keep gaining momentum.

Charging stations for electric vehicles a long trip through Estes Park, Colorado, near Rocky Mountain National Park. The concern for finding a place to charge a vehicle on a road trip or in general is sometimes called "range anxiety." Photos provided by Margot Davis, Ubicquia.

"Most EVs today have a range of 250 miles (400km) and as battery technology continues to improve, cars will go ever further. More charging infrastructure is coming thanks to policy directives, government funding and incen-tives. The economics of going electric also prove out, with savings for consumers in both fuel and maintenance," Plane said.

These economic shifts are leading to a change in the profile of the typical EV user that most of us picture in our heads: a college-educated, urban early adopter, said John Glassmire, global product manager for e-mobility, Grid Edge Solutions at Hitachi Energy.

"Historically, the stereotypical profile of an EV user has been a homeowner in an urban area, and from a state like New York or California that has more aggressive emissions standards and decarbonization goals. However, with decarbonization efforts on the rise and an uptick in the passing of policies — like the Biden Administration's recently announced standards for a national EV charging network — the profile of the EV user is evolving," Glassmire said.

As EVs become more widely available, and businesses and communities electrify their private and public vehicle fleets, we might see concentrated areas of EV chargers that will require new infrastructure solutions to meet their high-power demands, he said

"We'll also see a shift to accommodate the charging demands of public transportation in both private and public charging hubs," Glassmire said. "Medium-duty fleets of vehicles, like those that handle last-mile delivery for goods and packages, are just beginning to benefit from what EVs have to offer. EVs enable medium-duty fleets to meet emissions goals, reduce vehicle operating costs, and operate more efficiently and sustainably, offering next-level flexibility and reliability with the availability of new smart charging infrastructure."

Preparing for the EV Rev Up

Located in Virginia, the Rappahannock Electric Cooperative services 22 counties from the Blue Ridge Mountains to Chesapeake Bay. The cooperative serves more than 170,000 connections over 17,000 miles of line the cooperative has areas of high density and rural areas throughout.

Eugene Hamrick, Rappahannock's Director of Enterprise Analytics and Innovation, said C&I customers as well as residential customers in his service territory are going electric in greater numbers.

"Growth has varied, but more and more members, both residential and commercial have started to purchase electric vehicles. Most of our employees don't go a day on the road without seeing a Tesla, that was not the case 4 years ago," Hamrick said.

Most of REC's infrastructure is designed to support air conditioners, heat pumps, and at the most electric furnaces. Adding a level

2 charger at an average of 7.7 kW can essentially double the biggest draw of electricity and could greatly expand peak demand, Hamrick said.

"Adoption is low at around 1% but we anticipate a significant amount of adoption in the late 2020's and early 2030's increasing anywhere from 15% to 40% over the next 15 years," Hamrick said. "Grid resiliency is top of mind and one of the biggest challenges to prepare for is 'Can we sustain every residential Level 2 charger charging at the same time right before a winter storm?'"

To address these concerns and others, REC developed BrilliT, an IT, cybersecurity and data analytics unit. Hamrick said in preparation for the impact of EVs, BrilliT developed an analytics model and several business intelligence dashboards to identify, analyze and provide key actionable insights around EV member readiness.

This includes analysis of DC fast chargers at key locations, transformer loading analysis to keep an eye on transformers serving Level 2 chargers, a ZIP code level analysis of EV adoption including forecasting and more.

"It is essentially and part of REC and BrilliT's analytic strategy to proactively understand and put in place rate incentives to shift charging to off peak times to help control and reduce wholesale costs to the membership. Not doing so and not utilizing the data to make an impact could result in enormous increases in energy costs from coincident peak," Hamrick said.

Mail and parcel delivery vehicles owned by Deutsche Post DHL Group charge their batteries in Germany. The E.U., taken as a whole, is the No. 2 leader in new EV sales, sandwiched between China and the U.S. ID 159180064 © Björn Wylezich | Dreamstime.com.

Quickening Pace

Maria Kretzing, director of Innovation, Product Management at Bidgely, said everyone should expect demand to increase by at least 30% to 40% in the coming years. As EV penetration gets closer to 50% in the 2030s, we could see a doubling of electricity demand.

"Now the important thing about that is where the demand will come from. Current adoption rates and trends will not create the same ratio of increase across the grid, and we're going

to see early demand spike in very specific places. Hotspots will pop up because adoption is a localized effect where in large cities, or even states like California, you're going to see the effects there far, far sooner than you'll see them in the Midwest," Kretzing said.

When "Will EVs will break the grid" conversations happen, Kretzing said, most focus on the entire grid system, and not the individual distribution points, such as the neighborhood transformer.

"Utilities are very concerned with this. They're wary of overloading transformers where high EV adoption areas, what we call hotspots, are developing. They need to take immediate action to accommodate this new load, such as up-sizing a transformer. We're already seeing problems like this in California," Kretzing said.

S&P Global Market Intelligence estimates that EVs globally could soon require more than three times the energy demand currently used by California (between 525 TWh and 860 TWh), which as is often pointed out, is the world's fifth largest economy.

If utilities can evolve to bring on these new EV enabling technologies, there are a lot of tools available to help meet this exponential demand, Glassmire said.

"If improperly managed, the power that would need to flow through the grid could potentially create serious issues. However despite the scale of this challenge, with coordinated and managed charging – particularly charging optimized to align with grid capacity and renewable production – many of these challenges would be overcome," Glassmire said.

Flexing Data Muscles

Using analytics systems, developing new forecasting models and leveraging distributed energy resources where it makes sense to do so, utilities may be able to stay on top of growing demand.

"EV adoption will come faster and sooner than you think," Glassmire said. "The longer we wait to prepare the grid for electrification, the more expensive it will become; the time to invest is now."

Utilities can improve reliability and local capacity by deploying renewable microgrids and other grid edge solutions to meet the needs of clusters of charging stations and other DERs.

"EVs are, in effect, a new distributed energy resource for the grid. In many cases, they will also serve as critical infrastructure since they are used to drive people and businesses around. However, they are also flexible and can be dispatched based on the capacity of the grid and other local DER when they are plugged in," Glassmire said.

However, despite the availability of new technology, utility transformation to meet the demands of the EV industry is not without its challenges, ranging from financial questions, to the need for new business models, to the need for updated regulations and policies to deploy the necessary technology.

"An overarching challenge is that electrification is likely to appear sooner and grow faster than many anticipate.

If utilities can evolve to bring on these new EV enabling technologies, there are a lot of tools available to help meet this exponential demand," Glassmire said.

Ortiz said the technology solutions to meet the growing EV adoption will include re-modeling grid infrastructure to support more grid capacity along major highways and roadways that support fleet operations and extension of sub-transmission grid solutions deeper into the distribution grid.

"Additionally, distribution transformers that support EV charging infrastructure will need to be sized with adequate capacity to accommodate these new loads – in many cases requiring 3 phase distribution transformers where single phase transformers have historically been placed," Ortiz said.

Other technology solutions will require a means to accurately measure the EV charging loads — both demand and consumption loads with timestamps.

A row of Ford F-150 Lightning all-electric pickups are for sale. A greater variety of EVs models capable of doing different jobs is driving growth in the electric fleet sector for commercial, industrial and institutional electricity customers. Photo by Jonathan Weiss, Dreamstime.

"Transformers today do not have means to measure EV load separate from other electrical loads. Solutions like ours that can be retrofitted to existing distribution transformers to monitor transformer loading and health will become requisites to enable EV charging sites to include 'smart transformers.'" Ortiz said.

EV charging infrastructure can also back feed harmonics and other electrical distortion back onto the distribution transformers, which can create excessive heating of the transformers. Being able to detect both the presence of EV attachment loads to the transformer and whether there are electrical disturbances fed back into the transformers will become necessary for utilities, Ortiz said. TDW

A charred landscape at Discovery Bay, California. Utilities around the U.S., including some of the largest in California, use grid planning-software with powerful modeling capabilities and analytics, providing grid intelligence. ID 118092823 © Joe Decker | Dreamstime.com

Innovative Technologies Fortify The Grid

CAL FIRE's guidelines can serve as a relevant template for utility risk management programs across North America.

Utilities the world over are strengthening distribution systems to reduce wildfire risk. Yet the reality is that updating T&D systems is a complex effort. Equipment manufacturers can help, specifically by designing and testing solutions in close coordination with the California Department of Forestry and Fire Prevention (CAL FIRE).

Preventing wildfires is a vital part of CAL FIRE's focus. Although its guidelines may only directly apply to California utilities, it provides a relevant template for utility risk management programs across North America.

Codes and Standards

The California Power Line Fire Prevention Field Guide outlines procedures to minimize the risk of catastrophic wildfires caused by electrical power lines and equipment. The field guide also details testing processes and a list of qualified equipment that meets CAL FIRE exemption requirements. According to the field guide, utilities can be exempt from these requirements only if they apply solutions approved by CAL FIRE to reduce wildfire risks.

Obtaining a product exemption from CAL FIRE is a major achievement. Manufacturers must follow rigorous testing procedures and demonstrate their products' ability to operate while managing the energy to minimize the possibility of generating a wildfire.

An important aspect of reducing wildfire risk is deploying the right type of equipment.

Transformers and Laterals

In many parts of the U.S., expulsion fuses are used to clear fault currents. However, they pose a particular wildfire hazard with pole-type transformers and overhead laterals.

Current-limiting dropout fuses that have been granted permanent exemption by CAL FIRE from pole clearance requirements can help utilities to reduce risks (compared with traditional expulsion fuses) over large areas quickly. Exemption tests typically are performed at a utility test lab with a fire marshal in attendance, providing third-party verification.

With these fuses, clearing both low-current and high-current faults is totally self-contained within the fuse housing. When a dropout fuse experiences a fault current, arcing across the internal spark gap melts the trigger wire and releases the dropout actuator. This causes the fuse to fall open in the cutout, providing a visible indication of fuse operation without any flammable byproducts.

Full-Range Fuses

Full-range, current-limiting fuses are alternatives to expulsion fuses used in a wide variety of aerial and ground-level distribution applications. From the minimum continuous current to the maximum interrupting rating, they can successfully interrupt any normal 60-cycle current that melts the fusible element. Like current-limiting fuses, full-range fuses are designed to provide environmentally safe operation.

Some manufacturers' full-range fuses do not require derating in elevated temperatures. For applications requiring higher load capacity, some full-range fuses can be used in parallel to double current ratings.

Bolster Overhead Distribution

Overhead distribution systems cover a lot of ground, much of which can be in dry or drought-stricken areas. Installing arresters that provide both surge and fire protection can help to reduce risk. These arresters efficiently isolate from the line and drastically reduce the risk of fire released during an end-of-life event. Additionally, they maintain power to downstream equipment.

Leading arrester systems feature an arrester module and an energy-limiting device (ELD). The ELD prevents the arrester system from being isolated early, increasing the amount of surge energy discharged to ground and away from the equipment being protected. The best arrester housing is made of nonflammable polymers that also prevent biological growth on the exterior surface. Some manufacturers may offer line and ground terminal wildlife guards with their arrester systems. These provide additional protection from fires caused by birds or other animals that inadvertently bridge the voltage potential across the system.

Right-Sizing Solutions

There is no one-size-fits all approach to reducing wildfire risks. Eaton, for example, works with utilities on approaches that prioritize speed, added intelligence and cost efficiency. Adding CAL FIRE-exempt solutions is a critical step, and there are additional ways to strengthen the grid now and into the future.

For instance, advances in products designed to support underground power systems are becoming a more cost-effective option for some applications. In particular, solid dielectric switchgear enables utilities to move overhead lines underground in high-risk areas.

Adding intelligent grid automation schemes also can help to automatically and remotely isolate and manage impacted service areas following an event. Solutions like feeder automation software work with recloser controls to isolate the impacted areas of the grid and automatically reconfigure the system to reduce the scale of power outages.

Further, utilities around the U.S., including some of the largest in California, use grid planning-software with powerful modeling capabilities and analytics, providing cutting-edge grid intelligence. In tandem with high-fidelity monitoring, these platforms provide new levels of accuracy and precision for voltage and current — painting a more detailed picture of what is happening on the grid. By implementing these technologies

A transformer undergoing testing at Eaton's Experience Center. An important aspect of reducing wildfire risk is deploying the right type of equipment. Photo by Eaton.

An Eaton energy-limiting fuse. Current-limiting dropout fuses that have been granted permanent exemption by CAL FIRE from pole clearance requirements can help utilities to reduce risks over large areas quickly. Photo by Eaton.

A CAL FIRE helicopter fills its bucket. CAL FIRE's guidelines can serve as a template for utility risk management. ID 57373832 © Nathanphoto | Dreamstime.com.

across the distribution system, utilities can monitor threatening environmental conditions and equipment health closely for analysis and corrective action.

Additionally, some manufacturers provide intelligent inventory management programs that help to provide fast supply of equipment to restore power. These programs monitor inventory levels before, during and after an emergency. Further, rapid-response storm-recovery services mobilize engineering resources within hours of a catastrophic event to coordinate a comprehensive plan for grid restoration.

Industry Collaboration

Developing effective wildfire mitigation strategies is a high priority for utilities around the globe. While local regulations and systems can differ greatly, the urgent need to mitigate risk remains constant. The electric utility industry is coming together to forge alliances and unify thinking to tackle these highly complex problems.

Utilities across the U.S. are expanding and accelerating their wildfire prevention efforts and seeking solutions to strengthen the electric grid. As they do, CAL FIRE's guidelines can serve as a template for utility risk management. In addition, many states and local municipalities are developing regional requirements.

Furthermore, investments in research and development to advance grid modernization and address wildfire threats are essential. Such research involving utilities, industry and government organizations, research labs and manufacturers is helping the industry by innovating, testing and deploying new approaches to complex challenges such as wildfire prevention. TDW

CHRIS DECKER is a product line manager at Eaton. He has worked with utilities for more than 20 years to help optimize the reliability and safety of overhead and underground distribution systems.

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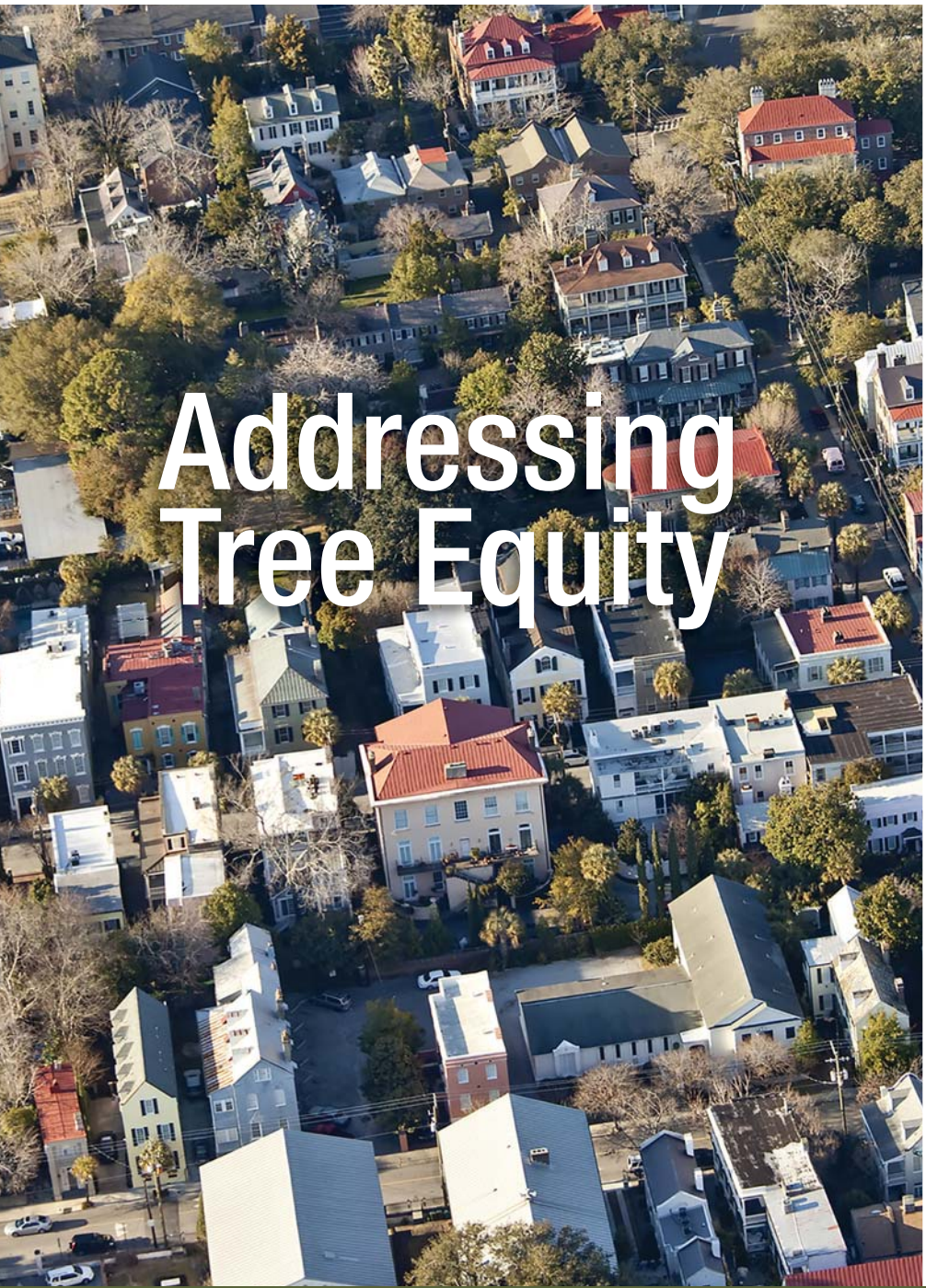
Addressing Tree Equity



OUR JUNE FEATURED LINEWORKER

Tim Hanna

IBEW Local 145

- Born in Moline, Illinois, and now lives in Rock Island.
- Married to his wife, Kathleen, and they have three children: Eliza, 14; Lily, 12; and James, 10.
- Enjoys camping with his family in their fifth wheel, fishing and woodworking. He is building a new garage with space for a wood shop.
- Can't live without his pliers and battery-operated tools, which save excess strain on his shoulders and wrists.

Early Years

My dad owned an HVAC business and was a sheet metal worker so I always assumed that's what I would do. After school, I bounced around to a lot of different jobs and never really enjoyed any of them. One thing or another came up and I never went to work for my dad. In the meantime, I got married and needed a better job to support my new family. My dad knew a few lineworkers and mentioned it might be a good fit for me. I didn't know anyone in the trade, so I searched online and found that Local 145 represents the contract lineworkers in my area. It took a year-and-a-half to get the call. Honestly, I had forgotten I applied. When they called, I thought maybe one of my friends had put me down for a reference. I started at L.E. Myers on a distribution job. I worked for them for my entire apprenticeship and was fortunate to be close to home.

Lineworker Tim Hanna works out of a crane basket on a transmission job for L.E. Myers.

Challenges and Rewards

One the biggest challenges our industry is facing is the perception that tasks can't be performed quickly and safely. Shortcuts are never acceptable, and we need to eliminate that mindset. One of the things we try to instill in our apprentices is to trust your gut. If it doesn't feel right or if you're asking yourself "should I be doing this?," the answer is almost always no. Don't be afraid to ask questions. It doesn't make you stupid or less of a man to admit you don't know something. Most importantly there are only two things you can never replace — your time and your life. Get the most out of both.

Safety Lesson

When I was working with a contractor, I attended a safety meeting. The company had experienced a fatality, and I was unaware that the lineworker who lost his life was good friends with one of the other guys in the meeting. Part way through, the contract lineworker broke down.

As I watched some of the other guys come together to comfort him, I realized it isn't just us that get hurt. It's our families and friends. Every time I read about an incident this is confirmed for me. That's one of the reasons I got involved with the apprenticeship. As an instructor for the apprenticeship's Saturday school, I help members of our local get their crane certification.

Going forward I will continue to encourage everyone in our industry to keep learning. Someone told me a long time ago that the end of your apprenticeship is really the beginning of your education. I think that's very true.

Memorable Storm

I restored power following a small local windstorm in Bettendorf, Iowa, right across the Mississippi River from my hometown. The neighborhood had been out for a couple days. The line that fed it ran through wooded rear lots. We'd been working in the heat for well over 16 hours. The entire neighborhood seemed to be out on the street, hanging out, drinking, grilling and just having a good time. Around dusk we finally got all the wire back up.

As the apprentice, I got the task of throwing the fuse in. I got the extendo stick in the eye of the fuse door and as I sent it home, the lights in all the houses came on and the loudest cheer went up across that neighborhood. TDW

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Addressing Tree Equity

Utilities in creating equitable and sustainable urban environments.

By **LAUREN CIESLEWICZ**, The UVM Company

Despite the benefits of urban trees, many low-income and minority neighborhoods lack adequate tree cover. This disparity, known as "tree equity," has become a pressing issue in recent years as cities address systemic inequities in their urban environments. The disparity can be attributed to a range of factors, including historical disinvestment in these neighborhoods, a lack of access to resources and services, and structural barriers to community engagement and decision-making.

The lack of tree cover in these neighborhoods has negative impacts on the health and well-being of residents. Communities with lower tree cover are often hotter than those with more trees, leading to increased instances of heat-related illness and higher energy costs for residents. Additionally, neighborhoods with lower tree cover often have higher levels of air pollution and associated health problems. By addressing tree equity, utilities can be at the forefront of a movement that would have cascading impacts on low-income and underserved communities.

Combating Climate Change

Ecologically, trees provide valuable ecosystem services such as improving air quality, reducing stormwater runoff and providing habitat for wildlife. Trees also help to mitigate the urban heat island effect, which is caused by the absorption of heat by hard, impervious surfaces.

By providing shade and cooling the air, trees can help to reduce the temperature in urban areas, making them more livable for people and wildlife alike. Evidence also shows that urban trees can offset a significant portion of a city's carbon emissions. For example, a study conducted in New York City found that the city's urban forest sequestered an estimated 2.2 million metric tons of carbon annually, equivalent to the emissions from more than 450,000 cars. Similar studies in other cities have shown comparable results, highlighting the critical role that urban trees can play in mitigating climate change impacts. Furthermore, trees can also help to reduce energy consumption, particularly during hot summer months. By providing shade and cooling the air, trees can reduce the need for air conditioning, which can help to reduce energy consumption and associated greenhouse gas emissions.

In addition to their ecological benefits, trees also provide important economic benefits. Trees can increase property values, attract businesses and reduce energy costs. Studies have shown that homes with mature trees can sell for up to 20% more than homes without trees. Trees can also reduce energy costs by providing shade in the summer and windbreaks in the winter, helping to reduce heating and cooling costs.

From a social perspective, trees provide numerous benefits as well. Trees can improve the quality of life in urban areas by providing opportunities for recreation, improving mental health and reducing stress levels. Trees also provide a sense of community and can help to promote social cohesion in urban neighborhoods. In addition, trees can provide cultural and historic value, representing a connection to the past and contributing to the character of a neighborhood.

Planting Trees in Urban Areas

While UVM is necessary for ensuring the safe and reliable delivery of energy and other utilities, the cost of this work is often passed on to residents through higher utility bills. In neighborhoods that lack tree cover, the cost of UVM can be unfairly borne by residents who do not benefit from the ecological, economic and social benefits of trees. This can exacerbate existing disparities in access to resources and services, further entrenching structural inequities in urban environments.

Recognizing the importance of tree equity, many cities have taken steps to address this disparity. One example is the "Million Trees" program in New York City, which was a successful

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initiative to plant one million new trees across the city, with a focus on low-income and minority neighborhoods. Other cities have implemented programs to increase community engagement and decision-making in tree planting and management, helping to ensure that residents have a voice in how trees are planted and maintained in their neighborhoods.

It is no secret that trees play a vital role in the urban environment, providing various ecological, economic, and social benefits. As cities continue to grow and expand, it is crucial to recognize trees' critical role in creating livable, sustainable and resilient urban environments. Through thoughtful planning, management and investment, cities can maximize the benefits of trees, creating vibrant and healthy communities that benefit people, wildlife and the environment. Equally important, utilities and regulators must ensure that the cost of UVM-related expenses is distributed fairly and equitably.

Making a Difference

Trees represent the single greatest threat to electric reliability. They have been the cause of massive electric-related fires in the West and they pose public and worker safety threats when they grow too close to energized power lines. To address these problems, utilities spend billions of dollars annually pruning or removing trees.

Beyond that ongoing maintenance effort, many progressive utilities have also established programs that focus on planting trees for energy conservation to reduce customer energy consumption and mitigate the need for building more generation capabilities.

To address these issues, the UVM industry must acknowledge and understand tree equity and the reach of its impact on low-income neighborhood- For example, UVM professionals can search the Tree Equity Score Map to see how their service territory ranks on the equity scale. This resource can help prioritize and focus utility efforts. This starting point should then lead to the development of tree planting initiatives, i corporating right tree, right place criteria supported by the utility. These initiatives should seek to address canopy coverage disparities while also maximizing trees' environmental benefits. Equally important, the programs should result in filling empty spaces with trees that do not ultimately require ongoing maintenance work or pose a threat to electric infrastructure.

Utility companies and UVM managers have a critical role to play in this effort, and by incorporating right tree, right place criteria and supporting tree planting for energy conservation initiatives in those neighborhoods, they can help ensure that the benefits of trees are distributed fairly and equitably and that the integrity of electric infrastructure is also enhanced. TDW

LAUREN CIESLEWICZ (*Lauren@theuvmcompany.com*) is a program manager at the UVM Company.

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Parting Shot

Photo by **FRED LOPEZ**

More than 70 apprentices and 12 journeyman teams, including one senior team, from Duke Energy's Florida service area participated in the Florida Lineman's Rodeo on April 1 in Winter Garden, Florida. Fifteen Duke Energy lineworkers from Florida secured spots to compete in the International Lineman's Rodeo in Bonner Springs, Kansas, this October.

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Identify Environmental Impacts Earlier With GIS

GIS solutions can help utilities to overcome environmental permitting delays in overhead electrical distribution.

By **LYNDA MILFORD**, CHA Consulting Inc., and **ANDY GUMKOWSKI**, Avangrid Inc.

The field work is complete, circuit designed and reviewed, and materials ordered and delivered to the project site. All seems on track after the work orders are released and construction is scheduled, but then it is determined poles must be replaced in the middle of a wetland. Where is the environmental permit?

When an environmentally sensitive area is identified at a project site just prior to construction, the project can come to a halt. Environmental permits, which can take months to obtain, are required. Time is money, so utilities must streamline a slow and often disjointed environmental review process to meet critical deadlines.

(Left) Example of area of environmental concern where Web application assessment tool can be utilized. (Right) Pole located in environmentally concerned area assessed utilizing web application.

Permitting Process

Avangrid Inc., a member of the Iberdrola Group, partnered with CHA Consulting Inc. to improve how its utilities navigate the environmental permitting process. The goal was to create a unified desktop application to improve the environmental review process by increasing documentation completion efficiency, so environmental impacts could be identified early in the design process — saving time and money.

CHA used Esri's ArcGIS Online (AGOL), a cloud-based mapping and analysis program, with ArcGIS desktop to create an interactive system that layers environmental geographicinformation system (GIS) data over circuit-scoping areas that define a project's work. The web tool was designed to improve what was a slow, manual process to allow for different user roles, including viewers and editors, that all Avangrid's contractors could operate.

The previous process was tedious, requiring the environmental department at Avangrid to reach out to internal distribution construction managers to obtain available scoping documents for a proposed circuit. Depending on the location of the circuit, these documents could be obtained from one of several different construction managers. Once the scoping documentation was secured, the environmental department would need to visit multiple websites to review any potential environmental impacts on the project.

With the potential for multiple types of users, from office personnel to construction personnel, it was imperative the solution be easy to use and enable collaboration between multiple users at different locations. Additionally, with AGOL, data could be secured with sharing permissions. Sharing data with password-restricted users would enable Avangrid's data to stay protected from the open public. Then users could

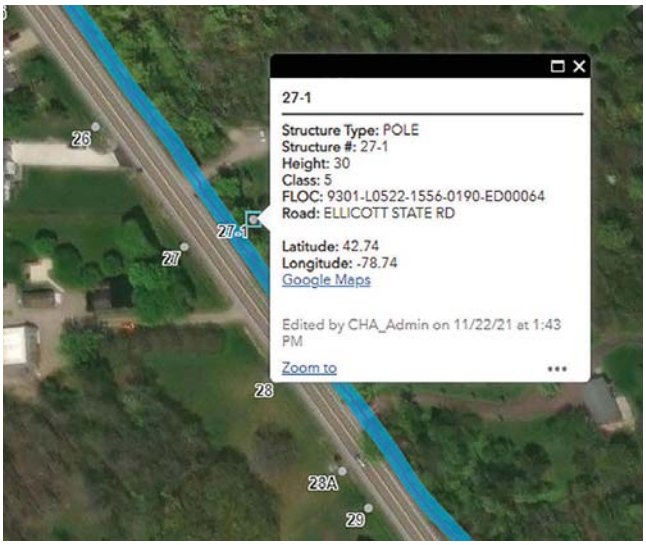
access the data through a web browser in the office or on a tablet in the field, bringing the process to users' fingertips while conducting field surveys.

Data Layering

Avangrid provided circuit data in shapefiles format, including circuit conductors, structures, devices, transformers and outage interruptions. Then it was determined what information was freely available to layer into the mapping from New York state (NYS) databases. Most data was available through the NYS GIS Clearinghouse website as a downloadable s hapefile, geodatabase or web mapping service (WMS), which collects georeferenced map images over the internet. A map server typically produces these images from data provided by a GIS database.

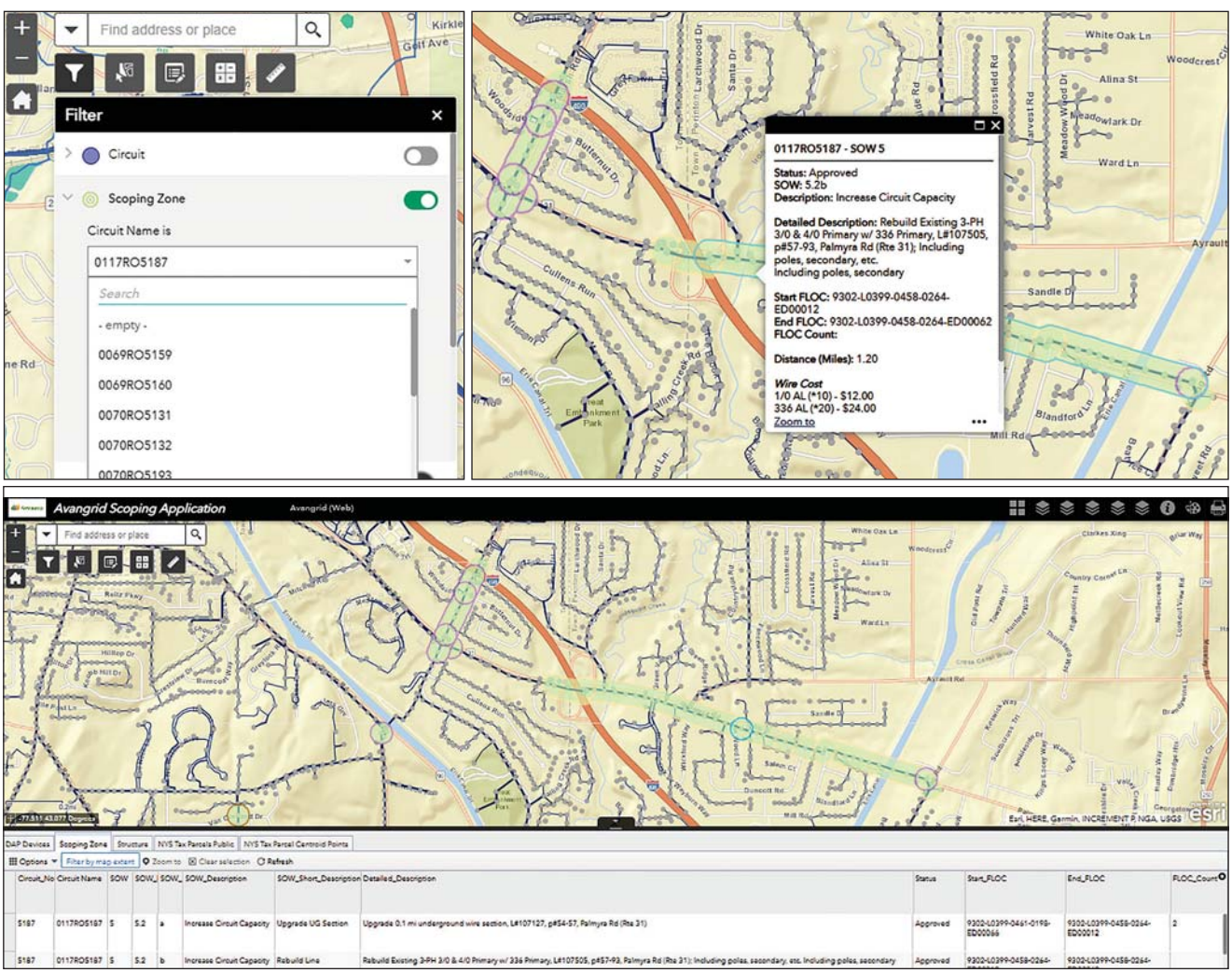
Some of the major sources of interest were through the NYS Department of Environmental Conservation:

- Stormwater mapping
- Wetland mapping
- Environmental resources mapping
- NYS cultural resource information system (historical and archeological information).

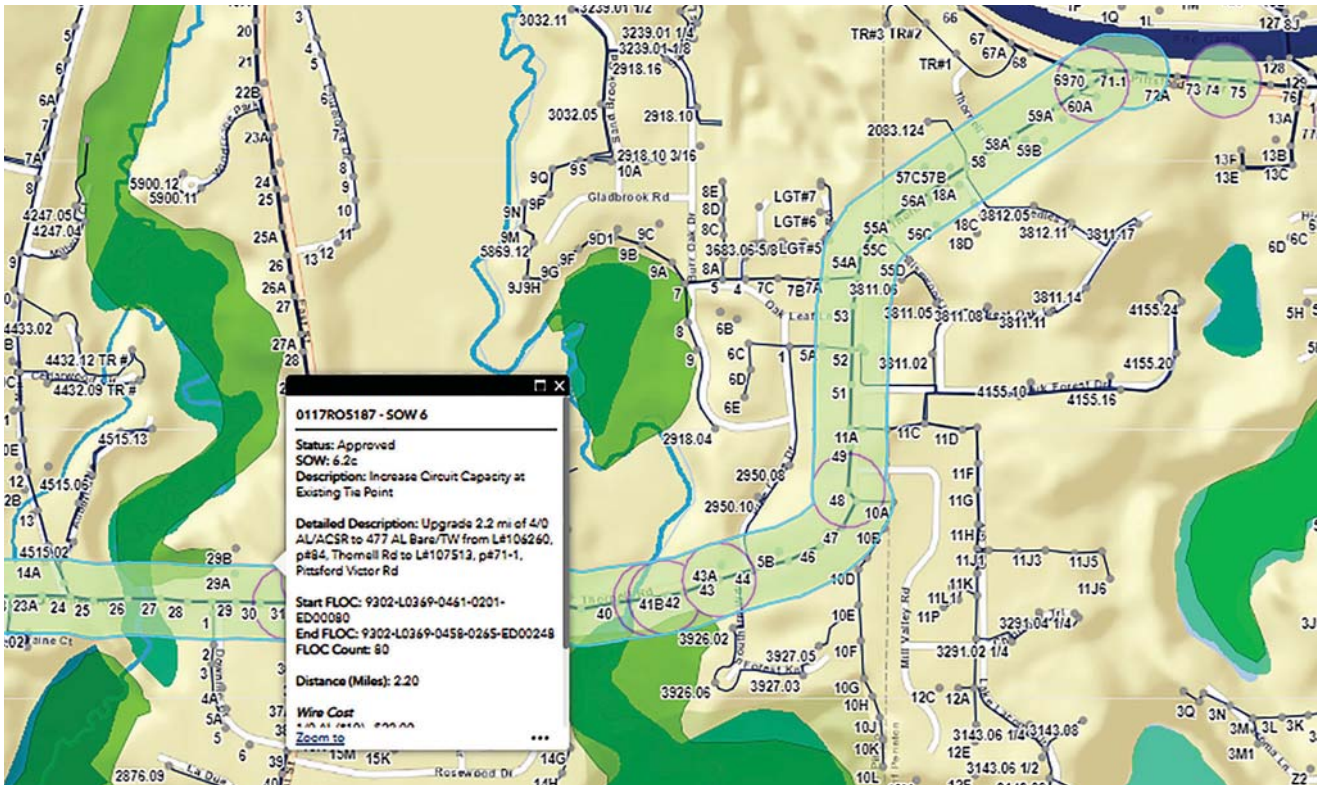


Avangrid GIS Structure information viewable in the Web Application with Satellite imagery utilized as a basemap. Hyperlink will launch to the google maps location.

When determining the type of data needed, it was important to remember each state differed in what was publicly available.



Avangrid Web Application: Individual circuits are searchable with a filter. Each circuit scope of work delineated with a clickable area which can be viewed in a pop-up on screen or table format at the bottom of the screen. The table can be exported to an excel spreadsheet.



Defined proposed work area with Wetland Mapping layered in utilizing the web tool for environmental evaluation.

Much of the information would be county specific and either freely available or available for a small fee, which would need to be considered. For this project, a collection of geodatabases and WMS were used to create a web map to drive the web application, which was then released to Avangrid's environmental team.

The environmental web tool cut down on the need for multiple visits to different federal, state and county websites, and at times physical offices, to parse data from these sources and evaluate the environmental impact of key infrastructure projects. This key step in Avangrid's compliance process was simplified into an efficient and time-saving procedure that facilitates a better understanding of project scope overall.

Web Application

Once the environmental-specific information was collected, layers in the web map — such as symbology, pop-ups, visibility ranges and more — were created and customized based on discussions with Avangrid, with the intent to create a user-friendly interface. Hyperlinks were added as a feature, specifically a link to launch Google Maps at pole structures. This gave viewers access to the street view, if available, to assess work locations visually.

After the map was established, it was used to create the web application with more custom functionality, such as the ability to search, filter and measure. Scoping documents for each of the specified Avangrid projects were provided to CHA, and a process was developed to create work zones or mitigation zones for each circuit and program at pole locations based on the type of project and work being performed.

Using ArcGIS desktop and the geoprocessing buffer tool, a geodatabase feature class was created for the scoping zones. The buffer tool placed a 200-ft (61-m) buffer around each pole location. This buffer gave Avangrid a bubbled look that they were already accustomed to with the original scoping maps. Each feature class created was customized to enhance the planning and review process. The geodatabase includes domain values for some of these attributes. These domain values allowed for drop-down lists to help with data collection and editing continuity.

Environmental Data Review

To start an environmental review, the Avangrid user goes into the web application and uses filters to select a particular circuit and base map, such as a street map, topographic map or even

an aerial-image base map. They can then on layers containing poles, conductors and devices imported from Avangrid's GIS system, which contains asset information. From there, a filtering system was added to review whatever circuit was required at that time. After filtering to the desired circuit, scoping layers can be turned on and environmental layers overlain to show where environmental concerns — such as wetlands, remediation sites and petroleum bulk storage sites — overlap with a proposed project.

In areas where environmental concerns are noted, the bubbled scoping can be selected to review attributes containing the project scope. Attributes can be reviewed in multiple ways, including through a pop-up, in a table format, or downloaded and exported to Excel to make data manipulation easy. Specific work-scope items, such as replacing poles or upgrading conductors, can be noted explicitly in the attributes.

The reviewer can reach out for additional detailed information once a full field survey is completed to determine whether changes need to be made to a design to avoid requiring a permit or to limit environmental impacts. For example, if a pole was being replaced in a wetland because of equipment replacement, but the pole was in good condition, a decision could be made not to replace the pole. If a wiring upgrade was being performed and the path was through an archaeologically sensitive area, a different pathway could be chosen to avoid that area; this would eliminate a potentially time-consuming and costly environmental review.

Program Gains

Many advantages were recognized as part of this program:

- With any cloud-based service, the more data stored, the more expensive the hosting fee. It was advantageous to use a WMS when available rather than upload individual shapefiles or geodatabases to save on storage costs. Avangrid can view and use the mapping system without wasting valuable storage space on its AGOL account.
- A WMS is maintained by the host server. As data is updated in the WMS, in this case by NYS, it also is updated in the maps when refreshed. This approach helps to save on maintenance costs because data does not have to download and reload in the mapping system regularly — only at established intervals for maintenance to ensure the data is accurate.
- Enabling users to see the proposed scope of a project layered with environmental data accelerates the process, so a review can be completed earlier in the project. This allows for discussions on adaptations to the scope, saving the utility time and money.
- Some counties' rights-of-way (ROW) can be layered into the web map, enabling the ROW department to find parcel numbers and addresses to assist with the process.

An additional and unexpected benefit was the ability to layer parcel and tax map data directly into the tool, thereby facilitating a quick project overview for the management of our ROW and easements. This enhanced collaboration between our environmental, compliance, engineering and projects departments. The environmental web tool is now an integral part of the distribution project team's process to deliver distribution projects in an accurate and timely manner.

Meeting Deadlines

With environmental permitting becoming increasingly important to ensure regulations and construction timelines are met, it is critical to be aware of potential impacts early in the life span of a project. Using Esri's AGOL with ArcGIS desktop, a collaborative system was designed. It provides an interactive, user-friendly way for a variety of users — including viewers and editors — to investigate potential environmental impacts.

Avangrid's environmental and ROW permitting departments can review a project's scope while also identifying and analyzing the proximity to pertinent environmental data. The new process using the GIS web tool has allowed time to seek permits or determine other potential solutions to make necessary project revisions in environmentally sensitive areas. The user-friendly tool has significantly improved Avangrid's environmental review process, ensuring contractors and construction schedules are aligned to meet deadlines. TDW

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For More Information

CHA Consulting Inc | *www.chacompanies.com*

AWM installed by traditional method, line cart.
Photo by Statnett. Photographer, Trond Isaksen.

Statnett Uses Robots to Install Warning Markers

Norway's state grid operator uses a new method to install aircraft warning markers on high-voltage transmission lines.

By **LIVIA DICKIE** and **BORIS ADUM,** Statnett SF

In January 2014, a fatal accident involving a helicopter ambulance occurred in Sollihøgda, Norway. An investigation into the accident concluded the helicopter hit an overhead line that was difficult to see from the air because it had no aircraft warning markers (AWMs) installed. As a result of this finding, that same year the Norwegian Civil Aviation Authority updated its regulations on marking flight hazards. This update directly affected Statnett SF, the transmission system operator (TSO) responsible for the design, construction and operation of the Norwegian transmission system. With operating voltages of 420 kV, 300 kV and 132 kV, Statnett's overhead lines span more than 11,000 km (6,835 miles).

According to the updated regulations, all existing overhead line spans with a height aboveground of 60 m (197 ft) or more for over 100 m (328 ft) in length must be marked with AWMs. To fully comply with these regulations, Statnett would have to install more than 3000 AWMs on existing unmarked transmission line spans. Additionally, the specification for the AWMs was updated to require all markers be covered with reflective sheeting on at least 50% of their outer surface. As a result of this new requirement, all existing markers on Norwegian transmission lines would have to be replaced.

The TSO would have a limited number of summer seasons in which to complete the necessary work before the regulations went into effect. Therefore, it needed to find a more efficient way to install AWMs.

Existing Installation Method

The primary method used to install AWMs in Norway at the time was from a line cart or during the restringing of shield conductors. It was not considered feasible to meet the necessary deadlines using these methods, so alternative methods were sought. A workshop was held with subject matter experts to review different AWM installation methods being used around the world:

- Working from a platform attached to a helicopter skid
- Working from a platform suspended beneath the helicopter
- Robot-based solutions and more.

These techniques were assessed based on three criteria:

1. Health and safety, with ideally no work at height
2. Speed of installation (10-plus markers per day or at least one span a day)
3. Cost effectiveness, with the goal of reducing the cost per marker installed by more than 20% compared to the current cost. Eliminating the need for outages was considered the most cost effective.

The team concluded there was no single existing solution that met all the criteria. Several initiatives were set in motion to maximize efficiency and increase the rate at which markers were being installed. One such initiative was a research and development project to investigate the use of AWM installation robots.

Prototype robot in early stages of development. Photo by Statnett. Photographer, Livia Dickie.

Innova technician Tore Serigstad uses robot to install marker on transmission line with 30° slope during factory testing. Photo by Statnett. Photographer, Livia Dickie.

Installation Robots

The goal of the installation robots project was to investigate the possibility of using robots to install markers on existing unmarked spans that met the requirement for marking. The solution would need to be safe, fast and cost competitive compared to commercially available alternatives. It had to be tested and ready for use within 12 months, so time restraints were a significant factor in many design decisions. This work was undertaken with support from Best Paths, a European Union (EU) funded project consortium. One of the goals of Best Paths was to develop innovative live-line working techniques for use on existing alternating-current overhead transmission lines.

In the years prior to the updated regulations in 2014, an extensive type-test program had been carried out for markers. In some areas, Norwegian transmission lines are exposed to heavy icing, up to 100 kg-m (67.2 lb-ft). This resulted in a high requirement for marker slip-loads. In addition, because of terrain topography, some overhead line spans are exposed to very high levels of Aeolian vibrations. This high level of exposure to vibrations in addition to fatigue type tests resulted in all approved markers being installed on armor rods or using elastomer lined clamps. The type-test program for markers is time consuming

Jonny Aal and Tormod Aarekol inspect lift attachment points for insulated rope before first live-line installation. Photo by Statnett.

After successfully installing AWM on test stand, robot is in final stages of preparation for first live-line installation. Photo by Statnett. Photographer, Livia Dickie.

because it includes a 25-week artificial ageing test and an Aeolian vibration fatigue test. Therefore, because of time restraints, the robot would need to work with one or more of these already type-tested and approved markers.

An investigation into existing AWM installation robots was carried out and several interesting robots were identified. However, fundamental differences existed between the AWMs these robots installed and the markers that had been type-tested and approved for use in demanding Norwegian weather conditions. Furthermore, it was not considered feasible to either modify these existing robots to install the type-tested AWMs or modify the type-tested markers so they could be installed by the existing robots. Both options would have required a lot of redesign. Therefore, Statnett concluded the best strategy was to design a new robot that could install the already type-tested and approved Norwegian AWMs.

Statnett's Robot

The first step was to define the three key requirements for the AWM installation robot:

- The robot had to work with the AWM markers that had already been approved and type-tested with only small modifications. Markers with elastomer-lined clamps were chosen to avoid the need for robotic installation of armor rods.
- The robot had to be hung beneath a helicopter. Many tower locations in Norway have limited or no access by vehicle. Tower locations that require AWMs are typically in more mountainous regions.
- The AWMs had to be installed one at a time to minimize complexity.

Design work started with a proposal for the operating principal for AWM installation:

- The AWM would be designed in two halves that could be lowered onto either side of the overhead line shield conductor.
- The AWM could be installed using four T-bolts. The T-bolts would be inserted into a slot on one-half of the AWM, and when the two halves are pressed together, they would pass through slots on the opposite half.
- The T-bolts would be rotated 90 degrees, where they meet an edge that prevents further rotation.
- The torque being supplied would continue tightening the nuts until reaching the required value.

A partner company, experienced with designing and manufacturing industrial robots, was invited to join the project team. The following solution was proposed:

- A robot would be lowered onto the shield conductor and two sensors, one on either side of the robot, would register when the weight of the robot was resting on the shield conductor.
- When the robot's wings sink, the weight on the wings would push the two halves of the AWM together and a third sensor would register when the two halves were pressed together.
- An adjustable time delay would be used. If the robot were lifted before the time delay finished, the installation process would start again without error. This delay would

Robot installing AWM above live-phase conductors using ZECK-pulling robot to measure distance between AWMs and act as visual aid for helicopter pilot. Photo by Statnett. Photographer, Livia Dickie.

give the pilot time to ensure the robot and helicopter are positioned correctly before the installation starts.

- Finally, motors would rotate and tighten the four bolts to the required torque and signal lights would indicate when installation was complete.

Gravity would be used to press the two halves of the marker together, so the robot would never be locked onto the shield conductor. This was an important safety feature in the design. The helicopter could lift the robot at any time during installation, but installation would not be successful if lifted too soon. Using gravity to press the marker halves together would make the design safer for use with a helicopter but also considerably heavier and, thus, more difficult to modify for use with a drone. Given the time restraints, the focus was on a solution that could be used commercially without delay, so a relatively heavy, helicopter-based solution was acceptable.

With no control or signal cables between the robot and helicopter, the process of installing AWMs would be fully automated. The robot would be prepared for installation by inserting the two maker halves and four bolts, as well as pressing an arming button. Two signal lights on the top of the robot would indicate the robot was armed and keep the pilot updated on status during installation. Critical errors, such as one or more of the motors not reaching the required torque before a maximum time limit, and non-critical errors, such as more rotations than expected before reaching the required torque, also would be communicated by the signal lights.

Prototype Testing

A full-scale prototype and AWMs from two different manufacturers were produced for testing. Then 3-D computer models were used to verify compatibility and confirm dimensions before the prototype robot and AWMs were manufactured. The design proposed for the robot placed requirements on the AWM clamp dimensions. While clamp manufacturing techniques placed limits on the thicknesses and orientations of some surfaces, in some cases, solutions were technically possible but changes were made to reduce the long-term manufacturing costs of the AWMs. For example, the number and size of surfaces that required machining was kept to a minimum. In some cases, 3-D printed models of clamps were used to confirm compatible AWMs were manufactured.

Prototype testing initially took place indoors using a crane. AWMs were installed on conductors with three different diameters on both a horizontal span and a span with a 30-degree inclination. After indoor testing, the prototype was tested outdoors using a helicopter on a full-scale 300-kV test transmission line. The operation was classified as "precision delivery above-ground level," which requires certain pilot qualifications and experience. Use of the robot was described by the pilot as a demanding but repeatable operation.

Installation Projects

Following prototype testing, the robot and AWM designs were updated, and three robots were built for use in AWM installation projects. A test stand was built to enable testing of the robot directly prior to the installation on the shield conductors commencing. The maximum distance allowed between markers is 70 m (230 ft). Several different solutions for measuring the distance between each AWM were used. The first was GPS based and another solution was to have personnel climb to the top of a tower and measure distances using a range finder.

A dedicated position AWM robot also was built that could be delivered to and collected from the shield conductor using a helicopter. It was remote controlled, could measure the distance it had traveled along the wire and could move between the AWM locations in less than a minute. This was judged to be the most effective solution.

After extensive testing, training and design updates, the robots were used to install markers on a shield conductor above the live-phase conductors, an operation classified as live-line work. When being used above live-phase conductors, the position AWM robot was evaluated by pilots as mandatory, as it was

such a useful visual aid when lowering the installation robot.

The majority of AWMs installed using robots were done so by contractors who provide price offers based on two different methods, their own preferred method and the use of the robot. The robot is only chosen if it is the most cost-effective method. Several factors influence the cost effectiveness of the different installation methods, including the location of the transmission line in Norway, the distance to the nearest airport and accessibility by road to tower locations, to name a few. The largest savings from this project have not been those associated with the AWM installation robots but rather the pressure in the market caused by the introduction of a new and cost-competitive alternative.

The robots are now included in the list of products available for hire by Innova, the company that assisted with both the robot design and production. The AWMs were manufactured by Mosdorfer GbmH, a member of the Knill Energy Holding, and Proizvodna OSO d.o.o., a member of the Dalekovod Group. The drawings that define the interface between the robot and AWMs are publicly available, making it possible for alternative suppliers to produce robot-compatible AWMs.

Project Progress

To date, over 400 AWMs have been installed using the installation robots, 15 on a custom-built test stand, 40 on test spans and 359 permanently installed on overhead transmission lines — nine of which were installed with the line in service as a live-line work. Installation takes approximately one minute, with 30 AWMs a day found to be realistic using two robots and one helicopter. If more than 30 AWMs a day will be installed, then an additional pilot is recommended. The failure rate of the final solution was less than 1% and — after the adjustable time delay was increased, giving the shield conductor more time to come to rest before the installation process started — no more installation failures occurred.

The robots designed and produced for this project have now been used to install hundreds of AWMs on existing unmarked Norwegian overhead transmission lines. Developed under very tight time restraints, the solution is reliable and cost effective as well as reducing the need for personnel to work at height. TDW

BORIS ADUM (*boris.adum@statnett.no*) holds a MSME degree from the University of Zagreb in Croatia. He worked for 10 years at Dalekovod d.d.o. on testing and in the research and development in the mechanical laboratory before joining Statnett SF in 2012. Currently, Adum works in the transmission line department at Statnett SF on overhead line and accessories specifications. He has participated in several research and development projects and is an active member of CIGRE.

LIVIA DICKIE (*livia.dickie@statnett.no*) was awarded bachelor's degrees in electrical and electronic engineering and computer science by the University of Western Australia. She conducted a university honor's project investigating the use of robotic solutions in unmanned power transmission substations. Dickie has research and development experience from working for the Defense and Science Technology Organization (DSTO) in Australia and also worked for four years at the Australian transmission system operator, Powerlink. She joined Statnett SF in 2010, where her current responsibilities include substation control systems.

Temporary Cross Arm

The Temporary Cross Arm, which is manufactured from solid fiberglass, offers a load capacity of 150 lbs per side with a 34.5 KV rating phase to phase. The arm includes two standard conductor holders with insulators that accept conductors up to 1 1/16-in. O.D. In addition, the conductor latches are hot stick operable and are also available with larger 2 5/8-in. conductor holders. The two-piece assembly makes installation easy and fast. The mounting base includes a ratchet and strap assembly that is lightweight, while the U-Shape design fits conveniently over the pole top pin. Captive bolts and washers on the arm assembly enable the arm to be mounted to the base without the need for tools.

Hastings | *www.hfgp.com*

Adjustable Body Belt

The Buckingham Manufacturing's 6-D Adjustable Body Belt has the low-profile construction of a 2-D Body Belt, with the functionality of a 4-D stacked Body Belt, reducing surface area and overall weight. With the addition of the multi-hole D-ring, the 6-D belt will allow the use of any WPFR device on the market.

- The multi-hole D-ring (patent-pending) provides numerous points of connection for both your primary (WPFR) and secondary lanyard(s). Numerous points of connection allow the user to climb, work, and transition in several different configurations.
- 2 ½-in. offset connection points prevent the WPFR device and secondary lanyard from binding on each other.
- The center connection point provides the user with a larger area to connect and disconnect a secondary lanyard.
- Offers an adjustable man-rated belt strap and an adjustable work positioning D-piece that allows the user to customize the size and feel of the belt.
- Low profile construction of a 2-D Body Belt, with the functionality of a 4-D stacked Body Belt, reducing surface area and overall weight.
- Includes pouch tabs, accessory ring and snap, and tape thong.

Buckingham Manufacturing | *buckinghammfg.com*

Sensor Bushing for Switchgear

Siemens Smart Infrastructure has expanded its medium-voltage portfolio with a solution that paves the way for smart switchgear. Due to its conformity with the instrument transformer standard IEC 61869, the SIBushing can be connected to the SICAM FCM plus (Feeder Condition Monitor), a multi-functional, short-circuit and earth-fault indicator which uses detection algorithms to indicate the direction of the cable fault. Applicable for medium voltage distribution systems up to 36kV, the SICAM FCM plus with SIBushing delivers unrivaled transparency and high-precision measurement of distribution systems, resulting also in the consumption of significantly less power, compared to conventional instrument transformer technologies.

Designed for compact, intelligent secondary substations, the SICAM FCM plus provides system operators with a solution for fast fault location and more transparency in the distribution grid. It is suitable for grounded, isolated, and compensated networks. Moreover, SICAM FCM plus offers reduced cost of installation and minimal maintenance, while its adaptive integrated temperature compensation algorithm enables high-precision measurement without calibration and adjustment to the primary operating voltages and currents.

Also being unveiled at the event is the SIPROTEC 7SY82, a multifunctional protection device with LPIT inputs. This universal protection device joins the renowned SIPROTEC 5 product family of field devices for protection, control, monitoring, and measuring applications in electrical energy systems.

Siemens Smart Infrastructure | *www.siemens.com*

Line Scan Cameras

Emergent Vision Technologies, a maker of high-speed GigE Vision cameras and vision technologies, introduces a new 100GigE line scan camera, the Pinnacle LZ-16KG5. Through its 100GigE QSFP28 interface, the camera reaches a top single line rate of 400KHz and a trilinear rate of 133KHz. Line scan cameras are useful in applications where a large object, an object that is continuously moving, and/or an object that must be photographed in high resolution needs to be photographed.

Available in monochrome and color versions, the camera features the 16Kx16 Gpixel GL5016 CMOS image sensor, with a 5 x 5 µm pixel cell size and an 81.92 mm sensor scanning width. Both GigE Vision and GenICam compliant, the camera allows cable lengths from 1 m up to 10 km without costly fiber converters/repeaters. Emergent Vision Technologies has also introduced the TLZ-9KG5 time delay integration (TDI) 100GigE line scan camera, which is based on the Gpixel 9K 256 TDI GLT5009BSI CMOS image sensor. The new TLZ-9KG5 allows end users to reach line speeds up to 608 kHz and trilinear rates up to 200 kHz at 9K resolution. This model is also available in monochrome and color options while still being GigE Vision and GenICam compliant. .

Emergent Vision Technologies | *https://emergentvisiontec.com/*

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At @EdisonIntl and @SCE, we've made a commitment to the development of robust diversity, equity and inclusion initiatives. @LACountyFire1 is an example of a partnership that shows how we can enhance the representation of communities within an organization.

San Diego Gas & Electric
Our service crews go beyond their responsibilities to aid not just our customers but also our local wildlife. Recently, our crews teamed up with Project Wildlife led by the San Diego Humane Society to safely return a young osprey to its nest, as it had fledged too early and found itself in a dangerous situation near Lake Murray. Thank you for all that you continue to do for our community.

Steve Sullivan, President of Connecticut Electric Operations, Eversource Energy
We're gearing up for Eversource Energy's Regional Rodeo at the end of the month and we hope you'll join us!

Diane Leopold
Chief Operating Officer at Dominion Energy
What a whirlwind (pun intended!) trip to visit our partners in the Coastal Virginia Offshore Wind Project! We visited the Nacelle, Blade, Transition Piece, Offshore Substation, Monopile, and Subsea Cable factories, along with tours to learn about installation logistics via a visit to both the Installation Vessel Simulator and one of the largest ports handling offshore wind.

Florida Power & Light
Excited to join the #CoMotion in Miami. We're introducing our new electric vehicle fast-charging mobile trailer to support EV drivers during hurricane season. This trailer can charge up to six vehicles at a time to help drivers charge up after a storm.

AD INDEX

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Two Years After the Colonial Pipeline Attack

This year marks the second anniversary of the Colonial Pipeline hack, which resulted in a nationwide state of emergency, airline and commercial fuel disruptions, and consumer panic-buying, skyrocketing the price of gas. The May 2021 hack infiltrated some of the pipeline's systems, ultimately shutting it down for several days. The Colonial Pipeline hack is the largest publicly disclosed cyberattack against critical infrastructure in the country, and it taught us the subtle nuances of attacks on critical infrastructure, the detriment of shutting entire systems down, and how we can be better as a nation in protect critical infrastructure from cyber threats.

Attacks on Critical Infrastructure

Industrial Control Systems Cyber Emergency Response Team (ICS-CERT) reports that cyberattacks against U.S. critical infrastructure have doubled since 2015. Most attacks on critical infrastructure systems come from outside of the country — and in the Colonial Pipeline's case, Russia — either in an effort to boost their country's advantage on the world stage, or simply because systems critical to public safety and order and much more profitable.

Achieving cybersecurity resiliency in the OT environment has much more to do with preserving safety and keeping systems online and producing, otherwise known as reliability. While data security is the primary focus of information technology cybersecurity, data security is not as important as safety and reliability in OT.

What We Learned from the Colonial Pipeline Hack

There is an ever-thinning line between IT and OT systems. For instance, the ransomware attack that impacted the Colonial Pipeline stole data, locked computers and limited access to the billing systems within the corporate IT environment. Nevertheless, Colonial needed to shutter the OT operations for two distinct reasons. The first being that Colonial did not have a clear understanding of the interdependencies between its IT and OT, its overall security posture, and it was not certain that the incident could not promulgate its way more directly into the OT systems. Second, while ransomware itself did not make its way into the OT environment, it locked up a critical system within the IT environment that certain OT systems needed access to function properly, essentially shutting the OT down by proxy.

The shutdown lasted a total of five days, translating to about $1 billion worth of impact to the company. Take into consideration the price of oil per barrel and the number of barrels lost, plus the $4.4 million paid for the ransom, and a $1 million penalty issued by the Department of Transportation's Pipeline and Hazardous Material Safety Administration for Colonial's "ad-hoc approach" to restarting the pipeline system.

So, what did we learn? Shutdowns to critical infrastructure can result in significant impacts to the industry as a whole.

Eric Goldstein, executive assistant director for cybersecurity for the Cybersecurity and Infrastructure Security Agency said that the Colonial Pipeline hack was a "clarion call" to companies that might not have viewed hacking as a critical business risk. In many ways, Colonial is the equivalent to the Deep Water Horizon for oil drillers in the ocean, and the Exxon Valdez for oil spills and environmental impacts. Huge problems due to unforeseen shutdowns and lack of preparation.

Our Nation's Infrastructure Can Do Better

One major problem is the lack of monitoring and detection within critical infrastructure systems, which could detect *disruption*. When it comes to cyber sabotage, the goal is to disrupt or degrade, as opposed to process shutdown. Only thinking 'system shutdown' is emblematic of traditional, old-school thinking for risk management. Attackers don't always try to shut down the entire production of milk, instead they degrade the pasteurization enough to get people sick. And the latter is what people now need to monitor for.

Our nation's infrastructure is in dire need of improved preparedness upfront. OT cybersecurity programs need to be established and must include baseline risk assessment, asset inventories, as-built architectural maps, updated incident response plans and constant testing. But these programs can't get caught up in the "rat race" of constantly monitoring vulnerabilities and attempting to patch systems that, by design, are not meant to be constantly patched and updated.

OT systems must apply cyber-informed engineering (CIE) and consequence-driven, cyber-informed engineering (CCE) to protect the company's critical function or mission, which is what matters most. CIE and CCE ensure that when an adversary attacks, the lifeblood of the company continues to operate, even though some less critical components may be impacted. We saw the exact opposite with the Colonial Pipeline where the main pipelines were shut down and only a few tributaries remained online.

Further iteration and innovations have been made to CIE and CCE that have allowed firms to achieve meaningful results in a matter of weeks. But it goes without saying that critical infrastructure systems must employ additional monitoring to supplement what is not covered by CIE and ensure their systems are secure to learn from and avoid such calamities as the Colonial Pipeline hack. TDW

MATT MORRIS is global managing director of 1898 & Co.

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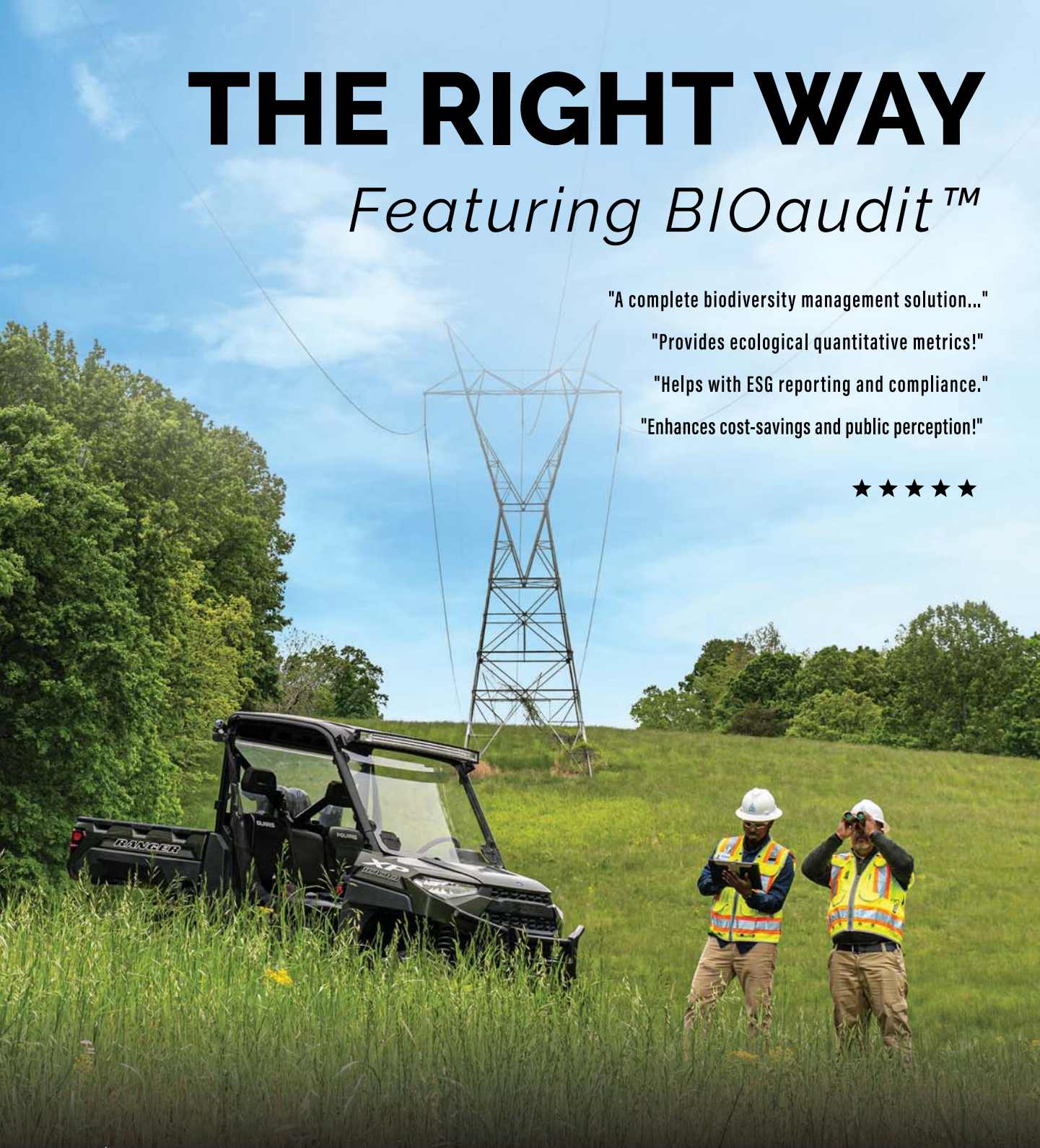

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The Past and Future of Safety in UVM

The science of safety has changed much since the early 1900s, and yet, we still see some of the old practices used in our profession. What started with Frederick Taylor's T*he Principles of Scientific Management* was somewhat furthered by the work of Herbert Heinrich's classic work in 1931, *Industrial Accident Prevention: A Scientific Approach*, which drove most of the safety world for the greater part of a century.

Although "Taylorism" brought forth some good ideas from the production aspect of work, it created or at least strengthened, the divide between the worker and management. An extreme simplification of the Taylor view was that the worker wasn't smart enough and, therefore, should play no role in the planning of the work. Heinrich's work added to this by, in essence, blaming workers for their "behavior" and creating an oversimplification of the relationship between behaviors and outcomes. This led to the graphic of the safety pyramid, or triangle, which attempted to explain the relationship between behaviors, low-severity, and high-severity incidents.

The fundamental flaw with the safety pyramid concept is that it assumes that the same underlying behaviors cause low-, medium- and high-severity injuries or fatalities. This faulty thinking led to a connection between the severity of incidents; that is, the more lower severity incidents occurred, the greater likelihood of a severe one or fatality. The data just didn't support this connection.

Reflecting on the History of Safety

As we moved forward, other research continued to shape our view of safety. For example, B.F. Skinner's scientific view of human behavior showed how employees' actions are shaped by being rewarded for wanted behavior and punished in some capacity for unwanted actions. In the 1970s, we began to target the behavior of the employee. It made sense at some level — if we can change the behavior of the individual employee, we can reduce the incidents. Change the shape of the triangle at the bottom, and then change the shape at the top. Focus on the employee, and all incidents can be prevented. We all believed it to be true, and it seemed to reduce incidents as we tracked and recorded them. The logic error proven through testing this theory was that "behaviors" are not "beliefs." Behaviors are learned because of specific conditions. If a worker's conditions change, so do their behaviors.

Tom Krause and others began to tackle the inconsistency with the safety pyramid. They found that the safety triangle is not predictive. One of the key things they found relates to a topic many of us in the UVM space are spending many resources on — reducing serious injuries and fatalities (SIFs). Their research indicated that reducing the number of lower severity incidents (the bottom of the triangle) does not correlate to reducing SIFs (the top of the triangle). There is no relationship between the bottom of the triangle and the top.

Taking a New View

Next, we come to cognitive dissonance around the key concepts of how we practice safety in the field. We see an overall reduction in recordable incidents, but we're not noticing a similar reduction in SIFs. At this point we start to look at things differently. We also start hearing from different researchers and thought leaders who changed the shape of safety including David Woods, Erik Hollnagel, Sydney Dekker, Todd Conklin and Shane Bush. We begin talking about capacity and resilience instead of just compliance and OSHA recordability.

When we speak of resiliency, we speak of the ability to fail safely. When we focus on capacity, we focus on adding meaningful defenses to the work environment to create safer processes — not safer people. Workers want to be safe. In the "new view" of safety, we find ways to create conditions in which they can use their expertise to achieve this goal. Workers will make mistakes — all humans do. However, a mistake should never cost someone their life. A resilient system with capacity for error allows workers to be human and still go home safely at the end of the day.

For successful application of this approach, it is vital to remember workers are the experts in their tasks and conditions. If we only focus on reprimanding the workers when something doesn't go to plan, we lose the opportunity to learn from the experts, and ultimately improve the system. If we develop systems separated from those diligently working within them, we create safety on an island, and our solutions prove fruitless. Safety is a support function of operations. Safer work environments will be created only with a thorough understanding of the conditions surrounding the work, and the interconnected relationship between those conditions, worker behaviors and outcomes. TDW

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Moving From Compliance to ROW Stewardship

Environmental protection isn't just good for compliance — it's good for business, too.

By **JILL GOLDEN**, The Davey Tree Expert Company

As one of the most highly regulated industries, utilities have a track record of upping their utility vegetation management (UVM) game and proving their willingness to become good environmental stewards. A growing list of endangered and threatened species coupled with encouragement from various wildlife programs is providing the impetus for utilities to move toward even greater participation in conservation efforts.

Utility corridors are shown to provide suitable habitat for insects, birds, plants, mammals and species of conservation concern. As such, utilities have a unique opportunity to help preserve the natural ecosystem by promoting the health of pollinators and wildlife habitats.

Cultivating biodiverse habitats is not only beneficial for the environment, but it's also in the best interest of utilities. In fact, this is a chance for utilities to push their environmental protection efforts beyond just a "feel-good" effort or a compliance initiative. By integrating ROW habitat conservation best practices and new protocols into their management plans, utilities can make a real impact in helping thwart the decline of rare and endangered species, including several pollinator species.

Pollinator species need habitats to help sustain their population — and people need pollinators. That's because, according to the U.S. Department of Agriculture, 90 percent of fruits and vegetables depend on pollinators. Protecting pollinators means protecting the ecosystem and ensuring a global food supply.

"It's no secret that pollinator populations have declined dramatically in the past 25 years, and their continued decline could impact the function of native ecosystems and pollination of our food production systems," says Adam Baker, Ph.D., technical advisor and pollinator ecologist at The Davey Tree Expert Company's Davey Institute. "All land use sectors — including utilities — are desperately needed to play a role in helping restore food and habitat resources for butterflies, bees and other pollinators."

For some utilities, putting a stop to a decline in pollinators might require re-thinking traditional ways of managing vegetation in the ROW. Instead, utilities might want to consider implementing

A monarch butterfly nectars on teasel.

A hummingbird moth nectars on monarda.

scientifically defensible, long-term vegetation management strategies supporting biodiversity and encouraging healthy pollinator habitats.

Butterflies and Biodiversity

With an estimated 10 million acres of utility corridors, utility vegetation managers are well positioned to cultivate ROW habitats that support biodiversity, as well as provide flyways for migratory birds, monarch butterflies and other imperiled species.

IVM's Environmental and Economic Benefits

- Reducing vegetation management maintenance and utility customer costs over time
- Improving worker safety, compliance, and transmission reliability
- Building community partnerships and engaging surrounding communities
- Establishing better habitat quality
- Combating the decline of species important to the ecosystem
- Eradicating invasive, non-native species that suppress biodiversity
- Increasing the abundance of floral and host resources that pollinators need
- Reducing runoff and preserving geological features, such as wetlands and agricultural areas
- Creating connectivity to contiguous landscapes
- Cultivating positive public perception while inspiring future generations
- Boosting and strengthening employee engagement

Not only will cultivating biodiverse ROW habitats support botanical and pollinator communities, but it is also likely to benefit utilities, too. This is especially important with respect to potentially qualifying for participation in certain wildlife programs.

Programs like the Monarch Conservation Candidate Agreement with Assurances (CCAA), Wildlife Habitat Council and Million Pollinator Garden Challenge among others, encourage utilities and others to participate in conservation and monitoring of managed lands in support of the health and proliferation of adult and larval insects, including the monarch butterfly (Danaus plexippus).

As an example, utility lands qualified and enrolled in the Monarch CCAA program are exempt from certain limitations and regulatory restrictions surrounding the monarch's population status — now and in the foreseeable future. That's good news, of course, for utilities. Equally good, says Baker, is that utilities that opt to diversify ROW vegetation can improve habitat quality and build upon their sustainability initiatives.

"Not only is there the benefit of possibly becoming certified by various wildlife organizations like Monarch CCAA," explains Baker, "but when utilities create a diverse landscape next to public areas, they can enhance the proverbial bang for their conservation buck by creating tangible evidence of goodwill for and within the community. The public can appreciate when a utility has cultivated a place where monarch butterflies, warblers and other wildlife are thriving. They may also enjoy other amenities, such as bike paths and walking trails that meander through ROW habitats."

But that's not all. Here are two other ways that are proven to support successful operation:

- Long-term reduction in maintenance costs: Over time, establishing and maintaining a stable community of appropriate plants requires less maintenance than traditional cyclical approaches.

An azure butterfly nectars on honeyvine.

A leaf-cutter bee lands on a flower.

- Increased employee engagement: When employees understand and appreciate that a habitat program benefits their community, the environment, and their company's bottom line, they have a greater sense of pride that, in turn, causes them to become very engaged with both the process and the outcome.

Preserving the Natural Ecosystem

Utilities can facilitate this level of participation in conservation and monitoring of their managed lands by taking a multifaceted approach using both UVM and integrated vegetation management (IVM).

Traditional approaches to UVM typically involve reliability-

Common milkweed is shown in in the fall. Milkweed is the sole host plant to the monarch butterfly's caterpillar, but keeping milkweed as part of the landscape is important to more than just monarch butterflies.

focused controls and cost-effective vegetation removals to meet short-term compliance needs. IVM is a specialized component of UVM focused on using site-specific approaches to achieve multiple objectives — like diversifying vegetation to preserve the natural ecosystem while also achieving reliability, compliance and cost control requirements.

The U.S. Environmental Protection Agency (EPA) defines IVM as "… the practice of promoting desirable, stable, low-growing plant communities — that will resist invasion by tall-growing tree species — through the use of appropriate, environmentally sound and cost-effective control methods. These methods can include a combination of chemical, biological, cultural, mechanical and/or manual treatments."

Benefits of IVM

If a utility's only goal is compliance, it would manage its lands differently than a utility that's committed to both environmental stewardship and playing an active role within the communities they serve, Baker says.

"By taking a more holistic approach that combines UVM with IVM, our customers are creating more diverse habitat landscapes that naturally support imperiled species while also combating invasive species to improve reliability and sustainability," he says.

IVM is proving to have significant and far-reaching benefits. Not only does an IVM program on a ROW promote safe, reliable and cost-effective electric power, according to the EPA, it also helps "reduce wildlife habitat fragmentation and allow species to be geographically diverse, remaining in areas they might otherwise be excluded."

The Science of ROW Conservation

Author Stephen Covey said to "begin with the end in mind," and that concept can apply to improving ROW stewardship.

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Butterfly weed appears in an actively managed IVM site located in Maryland.

"Practicing environmental stewardship by transforming ROWs into conservation areas is simple, not easy — but it is worth it," says Scott Eikenbary, project manager for the Davey Resource Group (DRG), a subsidiary of The Davey Tree Expert Company. "You can't simply eradicate non-desirable plants and put in a bunch of host plants. It takes a lot of commitment, monitoring and patience to understand what exists in the ROW before transforming it, to assess the biodiversity and to track changes over time. It also takes an upfront investment to develop long-lasting strategies that support the goal of creating environmental and ecological sustainability. We recommend a cost-benefit analysis that shows how costs are reduced over time. But keep in mind that IVM is not just a monetary investment; it's also an investment and commitment to society and the environment."

"Practicing environmental stewardship by transforming ROWs into conservation areas is simple, not easy — but it is worth it."

When it comes to stewardship, the more diverse the plant community, the better. That's why assessing biodiversity and tracking it over time in relation to IVM practices is so important.

Pollinators and host plants are often used as indicator species to assess environmental health, Baker added.

"At Davey, we employ scientifically defensible methodologies to monitor, track and assess the health of the ecosystem and its response to IVM practices," he says. "We also developed technology-based solutions that enable reliable and consistent collection of key data points."

Methods for baseline data and continuous monitoring for changes in ecosystem function and potential disturbances to habitat include, but are not limited to, these nondestructive sampling and quantifying methods:

- Surveys to track the number and species and abundance of butterflies, bees and other pollinators
- Vegetation surveys that assess the number and type of floral (nectar and pollen) resources
- Counts of keystone plants that may be indicators of habitat health and quality
- Visual assessment of habitat features, such as snags, brush piles, bare ground and wetlands

Coreopsis grows in a meadow restoration site along a gas line right-of-way recently enhanced with pollinator-friendly native plant species.

- Scorecards to measure habitat quality and composition
- Invasive species presence

By employing a robust protocol like IVM, utilities can go beyond meeting compliance standards, and, instead, develop a science-based action plan in support of environmental, social and corporate governance goals. They can also better engage the public in their environmental initiatives, as well as verify and report results for participation in ecological certification programs like Monarch CCAA, Habitat Wildlife Council and others.

The benefits of establishing habitat on ROWs far outweigh any potential drawbacks. This opportunity for utilities to assess biodiversity, track changes over time, evaluate successes and promote sustainability can transform a ROW from a parcel of land into something far more valuable: a true asset that benefits the utility and the customers and communities it serves. TDW

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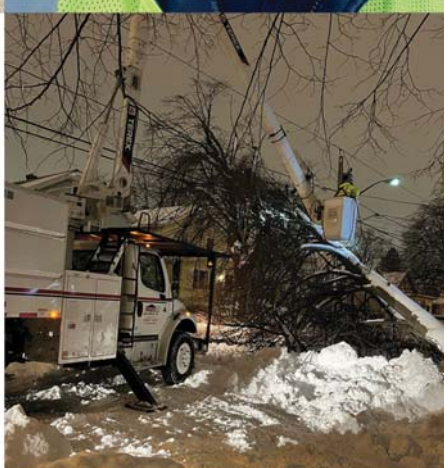


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The planting of a golden shower tree (*Cassia fistula*) is an example of successful trees (four years of growth originated from a bagged seedling) in Port of Spain, the capital of Trinidad and Tobago. (Inset) The vibrant blooms of golden shower trees are important for pollinators.

Lessons from Tropical Frontline Regions

U.S. utilities can better understand tree biomechanics and climate change through international research.

By **DR. ANAND PERSAD**, ACRT Services

Today's fast-paced world requires an understanding of not only the relationship between green assets, biodiversity and mental/social health, but also the need to implement dynamic strategies in a changing climate. The utility, urban forestry resources and management programs are of growing importance to the communities they serve. The readiness of the arbor-resiliency programs is tested during more extreme and frequent weather events.

In the United States, the strategies are evolving as utilities gather data and employ newer technologies, ranging from advanced plant health-care detection tools to mapping and the use of satellite data. Companies are using this data to better inform and guide work planning and deliver arboricultural, ecological and economic return on investment. Globally, the urban tree canopy cover and tree resources are now of special concern due to the interconnectedness of climate effects.

In this light, the nation is now paying attention to and becoming appreciative of the lessons learned from frontline regions of the world. These areas tend to have longer growing seasons and sometimes more heightened and apparent climate effects. In addition, they have experienced, or are experiencing, even more challenges and changes in vegetation and a higher frequency of erratic weather systems.

Plants respond to change and evolve with sites as conditions change, resulting in more rapidly occurring plant dynamics and/or plant migration. As climate effects are not always apparent, research narratives in these frontline areas, such as island nations and the global south, can help Americans understand the relatable challenges that may come their way.

Exploring International Regions

For several years, researchers have looked at changing plant populations and plant dynamics in utility and urban areas through several international frontline regions. Sea level rise is a global phenomenon. Apart from water levels rising, the secondary effects of salinity intrusion and loss of biodiversity to more salt-tolerant plant communities are very telling. A drought's primary effects of stunting, defoliation and branch dieback may cause loss of structural integrity. Secondary effects may include the rise of tree pests and pathogens. Conversely, in many cases, heavy rainfall and flooding lead to whole tree failure, broken branches and pathogens associated with earlier tree mortality.

Under these dynamic conditions, the management of urban trees regularly pruned for sight, safety and reliability will rely on real-time data and analytics. In past decades, cycle- or time-based programs not only sufficed but were effective. To continue building upon this foundation, more effective and dynamic programs and integrated approaches are needed. With site conditions changing rapidly, programs must be effective at the tree species level with system-wide efficiency.

Considering Tree Resources as a System

In agriculture, it's easier to consider a systems approach. As in many cases, it may be a monoculture of plants or a limited mixed crop situation. These agro-ecosystems can be monitored and

Yohann Govia of Trinidad and Tobago's Ministry of Agriculture Land and Fisheries, points to an endemic double (*Warszewiczia Coccinea*) Chaconia tree, the national tree of Trinidad and Tobago, that is biomechanically suited for urban environments.

Outplants of nursery-raised trees (Serianthes nelsonii) with officials of the Guam Plant Extinction Prevention Program (GPEPP).

managed. Although cropping in climate resiliency efforts has considerable challenges, its core objective is to raise plants from seeds to seedlings to the whole plant, then yield. This process may be relatively short-term in nature, but still wholly-related to the arboricultural process.

The similar, longer-term objective in the exploration of tree systems is to realize the near-full or full potential of trees. The current estimates in the urban and utility space for tree survivorship to maximum age potential are much lower than ideal (45 to 60 percent longevity or yield of tree ecosystem benefits on average by some estimates). To improve these statistics, we can start by upping our acceptability levels as agriculture demands a higher success level.

In terms of limitations, apart from site, care of seedlings, and plant establishment, seed stock has often been touted as a limiting factor. To build tree resources globally, this must be addressed. In several tropical frontline areas, seed stock is derived from naturally occurring and other local plantings and reintroduced to the landscapes via area nurseries as seedlings grown in bags. These smaller seedlings take off with relative ease and can adapt to sites with sometimes higher survivorship compared to planting larger trees. Notably, trees in the tropics are often planted in areas where similar species are already doing well in adjacent locations.

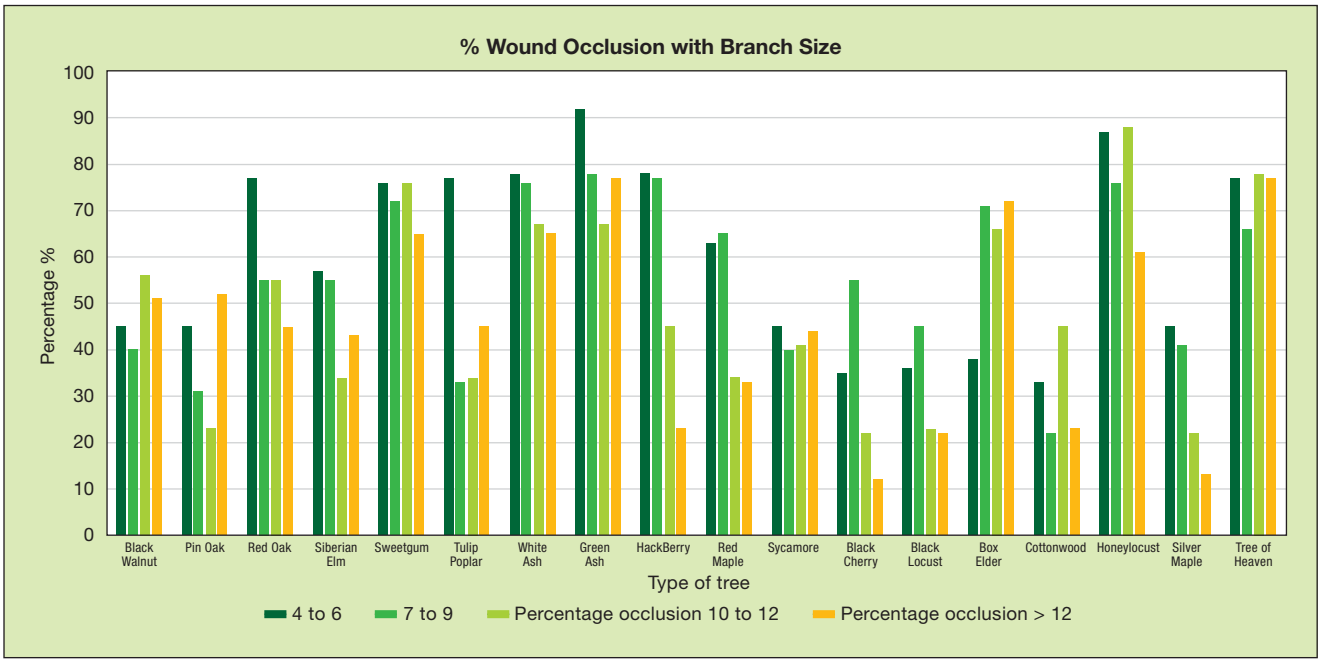
In the United States, seed stocks, planting systems and care for the establishment are very important and need to be continuously addressed while building capacity for future tree canopies in cities. Nurseries can propagate superior plants and while plant quality can be improved, attention to plant species and microsite conditions is now of additional concern and should accompany the "right tree right place" philosophy to give better survivorship and maximize overall tree lifespans.

Pioneer species, such as ironwood (*Casuarina equitsifolia*) in Micronesia, are strong trees individually and are stable in stands with the ability to tolerate high wind loads.

Tree Structural Assets as a Factor of Stability

Tree-inherent properties, including growth rates, branch aspect ratios and percentage branches with included bark are all indicators of tree potential for strength or failure. By assembling a database of recently planted trees, attaching inherent properties and comparing them to more established trees, it's possible to begin to understand biodiversity and its relationship to tree species and structural tree integrity assets as trees grow in a particular geography. Trees planted in ecosystems or in stands generally fare better in high wind-loading environments,

To capture this data globally, Tree Biomechanics International (TBI) was formed and is a growing series of



Pruning cuts with percentage eclosion three years after pruning treatments. In most species, larger branches had less ability to heal. The exceptions were sweetgum, boxelder and tree of heaven species.

sites that come together for tropical tree structural research. TBI sites are found in Belize, the Caribbean, Micronesia, Mexico, Columbia and other countries including the global south.

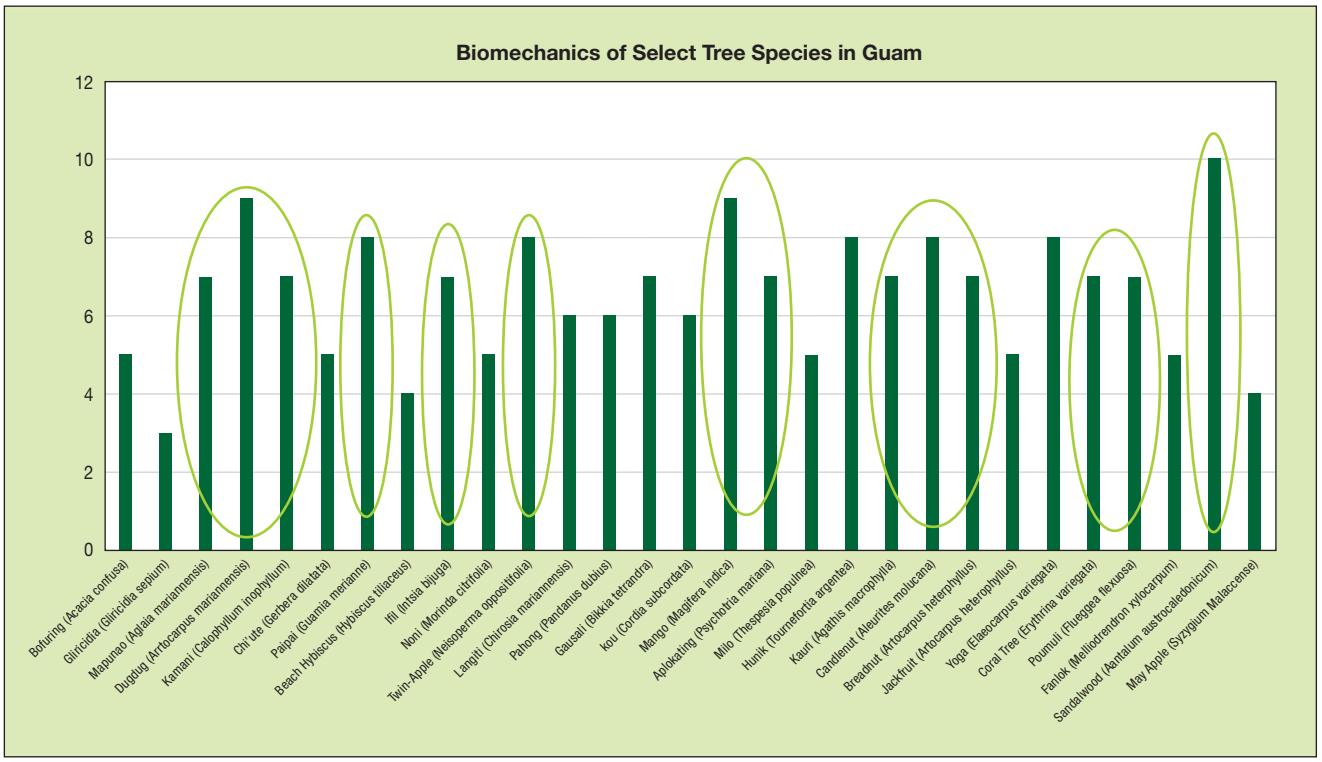
TBI's aim is to gather data on tree structural characteristics in these tropical species and better understand the survivability of trees based on structure. With that data, researchers knit together the successes and challenges of trees in these areas that are historically subjected to heavy loading, high moisture, drought and other climate impacts.

Are there lessons that can be applied here in the United States? As the country experiences warmer winters and longer, hotter summers, for many species, the impact is already occurring. The fall season in temperate areas allows for trees to regroup energy and heal wounds such as accidental branch breaks, stem wounds and pruning cuts.

With reduced fall seasonal times, will this be a factor for tree survival and future tree structural integrity? Wound eclosion (healing in pruning cuts) is being measured across several sites in the United States, and several species of trees are beginning to demonstrate higher eclosion rates compared to others. This may be a more cohesive parameter to figure out what species are becoming more successful at surviving climate change

Zoning in on Tree Biomechanics

Conventional edge-hardening efforts often rely on visual tools and management cycles based on system analytics over time. However, dynamic climate readiness and programs dictate a need for adaptability, additional metrics and overall system-level solutions and can borrow from national and international case studies on tree biomechanics.



Attaching a biomechanical stability score to tropical trees, coupled with structural integrity and tree inherent assets, can pinpoint the species that may impart more tolerance to loading.

At a tree biomechanics workshop in Guadalajara, Mexico in August 2022, the group observes a fractometer, a mechanical measurement device determining characteristic values of bending and compression strength of wood evaluating samples taken from tropical ash (*Fraxinus uhdei*) trees.

This tool can assist in mapping efforts on the stability of edge and corridor trees and its implementation can be an additional layer to better understanding trees in rights of way (ROWs). These data also capture stability in relation to flooding, wind, rain, snow and ice loading, or the relationship of the tree structure to drought effects and insect and disease impacts.

The inclusion of tree biomechanics considerations in ROW forestry programs means that system foresters can better engage climate readiness at a level that provides greater emphasis on tree structure and stability. The lessons learned from frontline regions can inform processes in the United States. For example, the biomechanical scoring systems in tropical areas based on survivorship, coupled with plant inherent characteristics, can be adapted for temperate trees.

Collaborating with government agencies both within the United States and internationally allows the Research, Science, and Innovation (RSI) department through ACRT Services to draw inspiration. Participating in global collaborative initiatives, as opposed to limiting research domestically, allows the team to produce better products, be better informed analytically and ultimately, better understand climate readiness. Climate is a global issue, which must be kept in mind with the continued work toward climate resilience. TDW

DR. ANAND PERSAD (*apersad@acrtinc.com*) is the director of the Research, Science and Innovation (RSI) team at ACRT Services. He is the research committee chair for the Utility Arborist Association, chair of the International Society of Arboriculture Science and Research Committee and actively works with city, state and federal organizations. He earned his Ph.D. in invertebrate ecology/entomology from the University of the West Indies.

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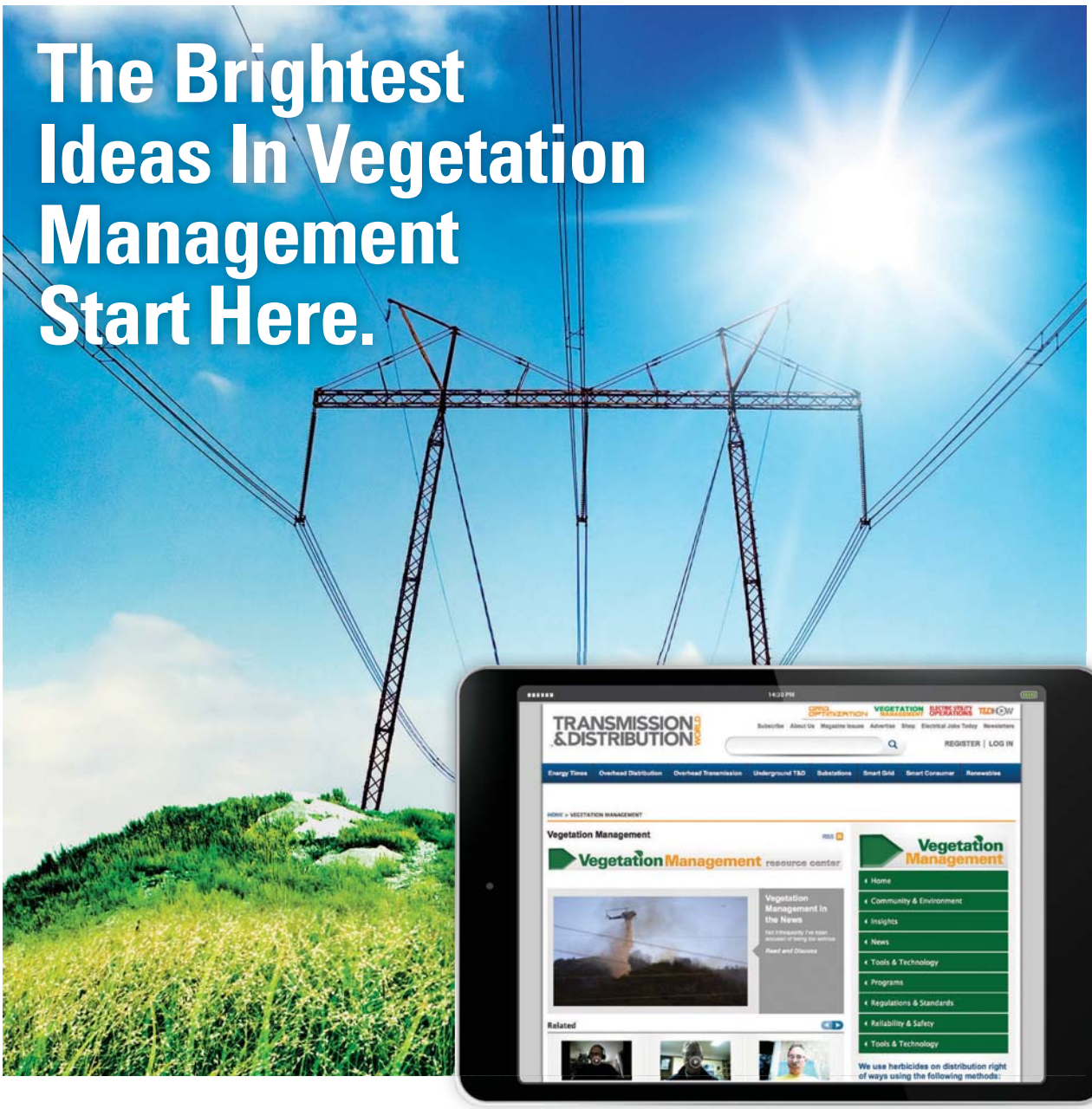

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This drone shot depicts property and utility line damage in Fort Myers, Florida, after Hurricane Ian.

A New View of Safety in Storm Restoration

When severe weather rolls in, vegetation management crews must prepare to respond in a safe manner.

By **STEVEN POWELL**, Lewis Tree Service

Severe storms of all types — from wildfires to hurricanes and derechos to Nor'easters — are seemingly becoming more frequent, more intense and causing more damage to utility power systems than ever before. Despite the significant work being done by utilities and their contractors to harden systems and reduce the impact of weather-related outages, one destructive storm after another appears to have become a nearly year-round phenomenon. Storm is the new norm. With every storm, the first responders are called upon to work together to clear roads, remove trees, repair infrastructure and restore power for sometimes millions of customers. Crews face perilous conditions as they travel to job sites to perform their heroic work. Every move is in a dynamic, high-risk environment, so new tools for creating safety while performing restoration work are critical.

According to Deloitte's 2022 Power and Utilities Industry Outlook, more than 3,100 extreme weather events occurred globally during the 2010s and more than 3,500 events happened between 2000 and 2009 — compared to just 711 in the 1970s. Deloitte's 2022 Power and Utilities Industry Outlook reports that these unprecedented and unpredictable extreme weather events can badly disrupt the utility supply chain, challenging the grid's reliability and resiliency and affecting utility business operations across the globe.

Spotlight on Safety Tools for Storm Response

In the wake of severe weather, line crews and vegetation management teams must focus on safety in the field. Here are just a few ways that Lewis has kept a focus on safety during storm work.

After-Action Reviews. Despite 16-hour workdays in 90-degree heat, Lewis crews and their utility partners on line and vegetation management teams conducted AARs at the end of each workday to share close calls, learnings and tips to prepare for the next day. Within Lewis, the AARs were submitted to the safety team each night to be reviewed and shared across all corporate and operations teams on daily storm calls. These AARs are also stored in a repository for reference and sharing on future storms. A common theme in AARs submitted by several crews was managing the pressure building due to rising tensions in the general public and adverse encounters with homeowners stressed by the storm.

Peer Check. A Lewis crew member working in the Florida area approached contractors providing fuel services to ask them how they were doing and discovered they had been working all day without eating. The Lewis worker went to the staging area and brought back lunch and water for the fuel crews.

Team Building. Recognizing the potential emotional impact of Lewis workers missing Christmas Eve and Christmas Day with their families while responding to Winter Storm Elliott in Buffalo, New York, a Lewis general foreman opened his home to out-of-town crews to spend Christmas eve together.

Situational Awareness, Forecasting and Reframing. After a 20-hour day that included two-hour trips on both ends of moving from a staging area to the assigned work zone, Lewis team leaders voiced a concern about starting the following day at the 6 a.m. time requested by their assigned utility forester. Escalating the request to Lewis management and eventually to a decision-maker in the utility, the crews were given permission to prioritize their rest, allowing them to start fresh at noon the following day.

Another example of situational awareness is when utility and Lewis crews discuss a gameplan and stop many times in the process of installing grounds, testing lines and performing tree removal and line restoration work before giving the okay to work.

The problem seems to be getting worse. A U.S. interagency report projected that due to climate change, future extreme events causing power outages will be more frequent and last longer. Responding to the Deloitte survey, the majority of power and utility industry respondents have already noticed an impact. Fifty-one percent said extreme weather has affected the reliability of electricity delivery in their territory more than usual in the past year. More recent data backs up the claim. Florida Power & Light Company (FPL), America's largest electric utility serving more than 12 million people, experienced damage impacting more than 2.1 million customers from Hurricane Ian in October 2022. A month later, Tropical Storm Nicole hit the east coast of Florida, affecting more than 480,000 customers. The economic impact to FPL's system from just these two storms exceeded $1 billion.

Ratcheting Up Safety

When storms hit and the power goes out, oftentimes, line crews and vegetation management crews are the very first responders to move into an impacted area. Tree crews remove branches, fallen trees and other debris from roads, power lines and structures so police, fire and medical responders can move in, and utility workers can begin to restore essential power to homes and businesses.

This drone photo shows Lewis crews conducting pre-job safety briefing in Fort Myers, Florida, before starting a day of restoration work following Hurricane Ian.

A Lewis crew works to remove trees from power lines after Hurricane Ian.

"It's often a chaotic situation filled with a great deal of uncertainty and hidden hazards," says Leslie Kass, CEO of Lewis Tree Service. "What was once a pristine tree-lined street with solid utility infrastructure can become a scene of twisted branches, downed wires, broken poles and flooded roads in no time. While safety is always a top priority at Lewis, in these situations, the safety methods utilized by our restoration crews are of utmost importance."

In supporting utilities in Florida impacted by Hurricane Ian in 2022, Lewis assembled an on-the-fly workforce of more than 1,200 craftworkers, safety specialists and field leaders from across the company's 27 state service territory.

Three Phases of Restoration

Like many companies, Lewis leaders have a list of key performance indicators (KPIs) guiding their actions and tracked to measure success. When called upon to support their utility partners in response to an impending storm, the Lewis team quickly builds an ad hoc organization led by an operations vice president who uses a unique set of "Storm KPIs" for the duration of the event. The action often starts days before a predicted weather event is due to strike and doesn't end "until the last crew safely returns home," Kass says. Central to the Lewis KPIs are safety objectives including special attention to three distinct phases of action by every crew — mobilization, working and demobilization.

"We realize that keeping people safe throughout a storm response involves sometimes different areas of focus depending upon which phase of a storm our crews are in," Kass says. "During the mobilization and demobilization phases, we emphasize things like the importance of 360-degree inspections of our vehicles, the roles of driver and co-driver, situational awareness of road conditions and careful navigating in staging areas, fueling stations and parking lots. We also recognize that workers have unique and different physical and emotional conditions when traveling into a storm, moving to or from a work site or after being released to head home. Our safety team does a great job of providing tailgates and information appropriate to each phase to help our crews stay sharp and prepared."

Heightened safety actions in route to the staging areas and going home are critical, especially when crews are relocating to an impact zone different from their normal work location. Having and using tools and techniques to work safely during storm response can create safety issues in a situation where typical methods and procedures have their limits. Dennis Brown, president and COO of Lewis, has seen his share of storm scenes in his more than 30 years in the industry.

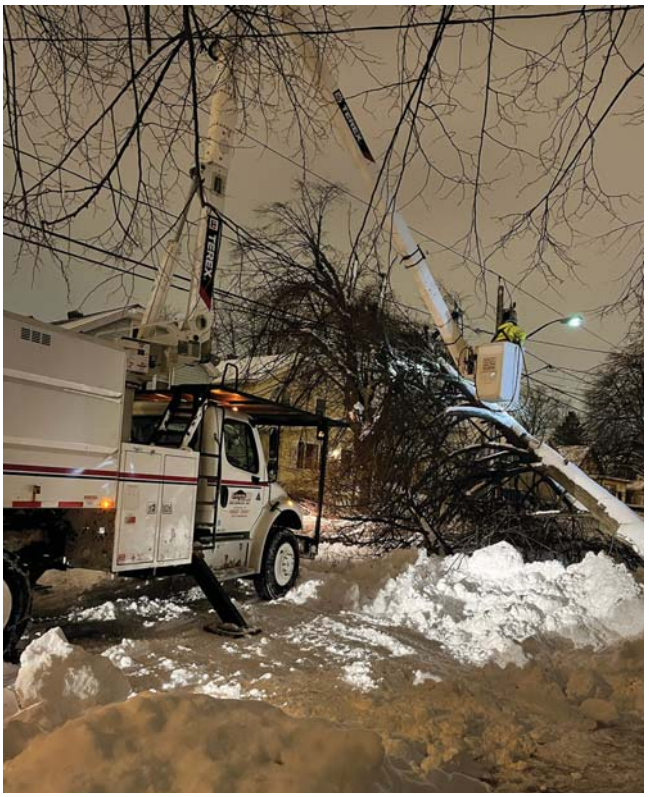
"Just because the power may be out in a neighborhood or business doesn't mean lines on the ground aren't energized," Brown says. "And trees laying across lines and poles can shift with the wind or flooding, so approaching the work from the perspective of 'safety first, safety always' is imperative."

Sometimes, the downed lines aren't even accessible via roadways due to flooding, so crews need to wade into these areas hand-carrying their tools.

"In places like Florida and Louisiana, the risks in these situations can even include displaced alligators, snakes and sharks,"

Lewis workers, carrying equipment to the work site, wade through a flooded area in Florida.

Lewis crews conduct after-action reviews in a staging area after a work day during the Hurricane Ian restoration.



A Lewis crew works in single-digit temperatures at night after Winter Storm Elliott.

Brown says. "In addition to the tools needed to perform their work, special safety methods and techniques help to de-risk these difficult situations."

Human Performance in Action

Beth Lay, director of resilience and reliability, has been equipping crews with special safety tools since she came to Lewis in 2018. Following a fatality that occurred the week before she started, Lay began laying the foundation for a culture change. This shifted the focus from safety audits, incident investigations and blame-and-punish responses to accidents. This would allow leaders to learn from work done right and respond to failures with curiosity. They could also pose questions designed to drive learning rather than inhibit it.

Deploying tools with names like, "Uncertainty Gauge," "Press Pause," "Peer Checks" and "After-Action Reviews (AARs)", Lewis crews, field leaders and safety personnel work together to identify hidden risks and potential surprises and provide input to refine and improve processes and methods. They're empowered to call in others, including peers, field leaders and utility partners, without retribution anytime their uncertainty exceeds their comfort level continuing the work at hand. Risk hides in the differences, so Lewis pairs travel crews with local leaders to help them navigate local conditions and customer specific needs. For example, if an out-of-town crew is bringing its convoy into an unfamiliar area, a local leader will meet them and guide them into the work location.

Nowhere are these tools more important than in the ambiguity and stress incumbent in weather disasters. Lewis crews employed these human performance tools in storm response efforts throughout 2022 — both formally and informally — resulting in more than 500,000 hrs of work without incident.

Learning for Storms and Blue-Sky Days

It's not the known risks that lead to injuries and fatalities, but rather the situations with the greatest uncertainty, according to Todd Conklin, author, safety speaker and human and organizational performance consultant. The aftermath of severe weather creates circumstances of almost infinite uncertainty for the utility and tree workers called upon to restore power, and with it, calm and order.

The Safety-II/human performance principles and tools used by Lewis crews not only help to bring order to the chaos of storm work, but also apply equally to the blue-sky work. It often seems routine and ordinary, but can be highly variable and fraught with risks, surprises and uncertainties. Beyond elevating worker safety, these new safety tools of the trade also boost the productivity and performance of the crews.

To help utility customers ride out the next storm with less damage and safer restoration, it's imperative to listen, learn and stay curious, Lay says. For example, they must discover what crews are concerned about, what challenges they are facing and where they need help.

"This is the way to make discoveries, find opportunities and improve performance," she says. "That's how to create a human-centered safety and human performance culture." TDW

STEVEN POWELL (*steven.powell@lewistree.com*) is the director of marketing and business development for Lewis Services.

Filling a Need

Tulane University launched an educational initiative to identify challenges and drive change in the UVM industry.

By **LAWRENCE J. KAHN**, Tulane University Law School

In the United States, utility vegetation management (UVM) is a multi-billion-dollar-a-year industry. Case in point: California utilities alone spend between $3 billion and $5 billion annually performing this work.

Utilities invest in UVM for many key reasons. For example, they trim and remove vegetation to prevent wildfires and outages. In addition, the law requires utilities to take certain measures to ensure the safe and reliable delivery of utility services. This includes mandatory or required vegetation management to avoid violation of such laws and regulations and to minimize legal risks.

As anyone involved in UVM can attest, however, the industry's laws, regulations, ordinances, rules and practices vary significantly. What may be true on one side of an invisible line may differ from what is true on the other side of that line. The laws and regulations pertaining to this practice can conflict with one another and are often unclear. Importantly, certain violations carry along with them not only fines and penalties, but also potential criminal violation as well.

In 2020, the law school created UVMI with the mission to serve as a center for the understanding, development and improvement of law, policy and practice of UVM. (Inset) Lawrence Kahn is the director of Tulane University Law School Utility Vegetation Management Initiative.

When UVM is not performed as needed, disaster is not far behind. For example, many of the most damaging wildfires have resulted from tree and power line conflicts in not only California and the West, but also in Texas, Georgia and Florida. The 2003 Northeast Blackout also resulted from this same issue.

Nationwide, the U.S. Department of Energy has estimated a total of $100 billion or more in annual lost business productivity alone from power outages. This doesn't include damages, insurance, tax revenue, household losses or other losses due to power outages caused by tree and power line conflicts – the primary cause of as much as 70-80% of all outages.

Tragic loss of life and severe injury is also directly attributable to the failure to maintain vegetation away from utilities' infrastructure. On average, one arborist or line worker dies in this country each week because of utility line clearance or related work, according to the U.S. Bureau of Labor Statistics. Additionally, hundreds of deaths — many of them children — result each year from tree climbing too close to utility power lines.

Mission, Vision and Values

For years, government, industry and advocacy groups have sought guidance on addressing these challenges. Tulane University Law School, through the Utility Vegetation Management Initiative (UVMI), has now answered this call.

In 2020, the law school created UVMI with the mission to serve as a center for the understanding, development and improvement of law, policy and practice of UVM. The goal of the program is to promote the creation of safe and environmentally sound co-existence among people, infrastructure and the natural environment while also ensuring safe and reliable delivery of energy and other utility services.

The UVMI's vision is to earn its role as the unquestioned center for excellence in every aspect of law, policy, and

practice impacting the intersection between utilities and the environment by studying, educating and advocating the fair, well-reasoned and science-based understanding of global, national and local factors influencing proper decision-making in all aspects of UVM. In doing so, it aims to aid and assist government, courts, industry, NGOs and the public-at-large.

The UVMI's core values serve to focus all decisions and actions, and no decision or action is taken without reference to these core values:

- **Intellectual honesty.** All positions taken shall be supported by intellectually honest, fair, well-reasoned and science-based information developed by unbiased research free from undue influence aimed at any particular result.
- **Security.** People and the natural world have the right to safe and peaceful co-existence that includes reliable delivery of utility services (including energy and the infrastructure that supports it) without endangering human life, property or the environment.
- **Dignity, Fairness and Compassion.** The highest purpose of public policy, and the laws, regulations, ordinances and rules that flow from such public policy, is the establishment of fair and proportionate plans for the allocation of risk and expense in society without the undue sacrifice of community values, and for the provision of compassionate, fair and dignified justice to resolve inequities.
- **Tireless Dedication to Purpose.** A continually urgent moral imperative exists to prevent conflicts between utility (including energy) delivery systems and vegetation to avoid tragic losses of life, property, infrastructure and the natural environment, and the key to enduring successful prevention is the wise adherence to core values.

Tulane Law School UVMI students attend a demonstration of utility line clearance work presented by Entergy Louisiana and ABC Professional Tree Services.

Making a Difference

To further its mission and vision, the UVMI has engaged in several projects to expand knowledge and serve as a valuable resource. For example, the students have taken on research projects and have prepared papers for publication. Other projects include:

Compendium of UVM Laws. The UVMI is compiling all the laws, regulations and ordinances relating to UVM. It has completed an initial North American survey, which is now being compiled and updated. For the first survey, it involved Mexico, Canada and the United States, but it is looking to add more countries to this compendium.

Third Party Verification of Remote Sensing Technology. The UVMI conducted an independent, unbiased pilot field study on the use of satellite technology to determine the effectiveness of satellite technology in improving data accuracy and decision-making for UVM. The results of this pilot, proof-of-principle field study are presented in a report that is now ready for publication.

In the study, the UVMI identified a test plot within the southeastern United States covering about 70 square miles and containing 54.3 line miles of distribution line made up of 1076 spans. AiDash, Inc. provided analysis as to the threat level at each span, as well as a factor relating to efficient work.

This predictive analysis was turned over to a team of arborists from Plank Road Forestry, who were tasked with determining the accuracy of the predictive analysis and, when the prediction was correct, to determine whether it would have been discovered during a standard inspection.

The findings on the pilot study with respect to many of the most critical factors was that the predictive analysis was accurate more than 95% of the time. More importantly, though, in 55 cases, a standard Level 1 inspection would not have revealed the existence of the tree and power line conflict, and in one of those cases, even a Level 3 inspection would not have revealed the conflict. This meant that the satellite technology was able to find a potential power outage, wildfire or electrocution risk that would not have been found with a standard inspection about once every mile of distribution line.

Model Municipal Tree Ordinance. The UVMI is working together with the Arbor Day Foundation to attempt to develop a model municipal tree ordinance that will promote the planting and protection of public trees and encourage tree planting while simultaneously meeting the needs of utilities to trim and/or remove incompatible trees (or find engineering solutions) to avoid tree and power line conflicts.

California Office of Energy Infrastructure Safety Scoping Meeting. California's newly formed Office of Energy Infrastructure Safety had a public scoping meeting in early 2023 to initiate a discussion to organize all the state's electric utilities in a unified effort to combat California's wildfire risk. The UVMI was invited to help lead the scoping meeting and to serve as a resource for the state and the utilities.

Through research, education and outreach, the UVMI is striving to identify challenges and help utilities and stakeholders to proactively work toward a brighter future for the UVM industry. TDW

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Utility Technology Investments: Point-Counterpoint

To find the right technology to manage their vegetation management programs, utilities must keep several key points in mind.

By **CHRIS KELLY**, Clearion

Today's utility environments are operating under increasing complexity. Once-distant innovations are rapidly coming to the forefront and ushering in an era of unprecedented collaboration among formerly siloed organizational disciplines.

With a shifting regulatory environment, increased community engagement, emerging ESG goals and a heightened focus on operational safety, effectiveness and efficiency, electric utilities are embracing tools like artificial intelligence (AI) and remote sensing more than ever before. While even the most forward-thinking utility professionals cannot accurately predict future technology requirements, key considerations — unique to each utility — can help pave a clearer path forward.

Understanding the Technology Landscape

While affordability is always a principal concern, today's utility customers are investing in solutions that are scalable, interoperable and offer the most value to their internal and external stakeholders.

Taking the steps to ensure your utility is moving in the best-in-breed direction, you also are helping to save the environment one tree at a time. Birdlkportfolio/Getty Images

Before diving into the pros and cons of differing technology investment strategies, it's important to provide a high-level overview of solution alternatives.

- Best-of-breed often refers to the leading technology solution in a particular niche. Best-of-breed software solves a nuanced problem or serves a specific purpose. Think of tax preparation. Businesses, like consumers, often mix and match specialized technology offerings to ensure they are using the best tools to get the job done.
- Best-in-class solutions typically optimize a function or series of related functions. For example, online banking or human resources information systems manage onboarding, payroll, benefits and more. Best-in-class solutions within a department or business function are highly integrated, efficient and provide a single-view of information for business intelligence.
- All-in-one solutions are unified, large-scale platforms encompassing all the critical data and functionality across an organization. Examples include enterprise resource planning systems for financial management, supply chain management, inventory management and more. All-in-one solutions offer bolt-on modules for additional functionality under a single platform.

When it comes to vegetation management technology, it can be useful to frame considerations across these broad alternatives.

- Best-of-breed: dedicated work planning or arborist tools or LiDAR/satellite data processing and analytics.
- Best-in-class: vegetation work management solutions with field operations maps and workflows spanning supervisors, field crews and leadership.
- All-in-one: enterprise work management systems.

But which alternative is right for you? Will you lose flexibility if you build a wide range of functions into a single vendor platform? Will you lose speed and efficiency or add complexity by integrating different software platforms?

Evaluating Technology Investments

It can be daunting for functional managers, who may not be technology experts, to evaluate solutions in today's fast-moving and highly competitive environment.

To determine what is right for your organization and avoid

The latest technology stacks are available now in all formats, including the desktop, mobile and hand-held devices.

Loaded data, courtesy of Overstory, is used to analyze all vegetation on Earth to prevent wildfires and power outages, enabling smarter infrastructure management and safer communities.

avoid a costly pilot or risk a failed implementation, you must first explore how work is done, who is impacted and how key decisions are made. Here are some key factors to consider during this process.

Identify the critical challenge you are trying to solve. A counterpart at a nationwide healthcare organization once joked, "We get more accomplished in one year than others can in a week." Unfortunately, many of us can relate. When it comes to large-scale technology implementations, unending change requests can lead to scope creep and missed completion dates. Much of this can be circumvented through stronger front-end planning and prioritization.

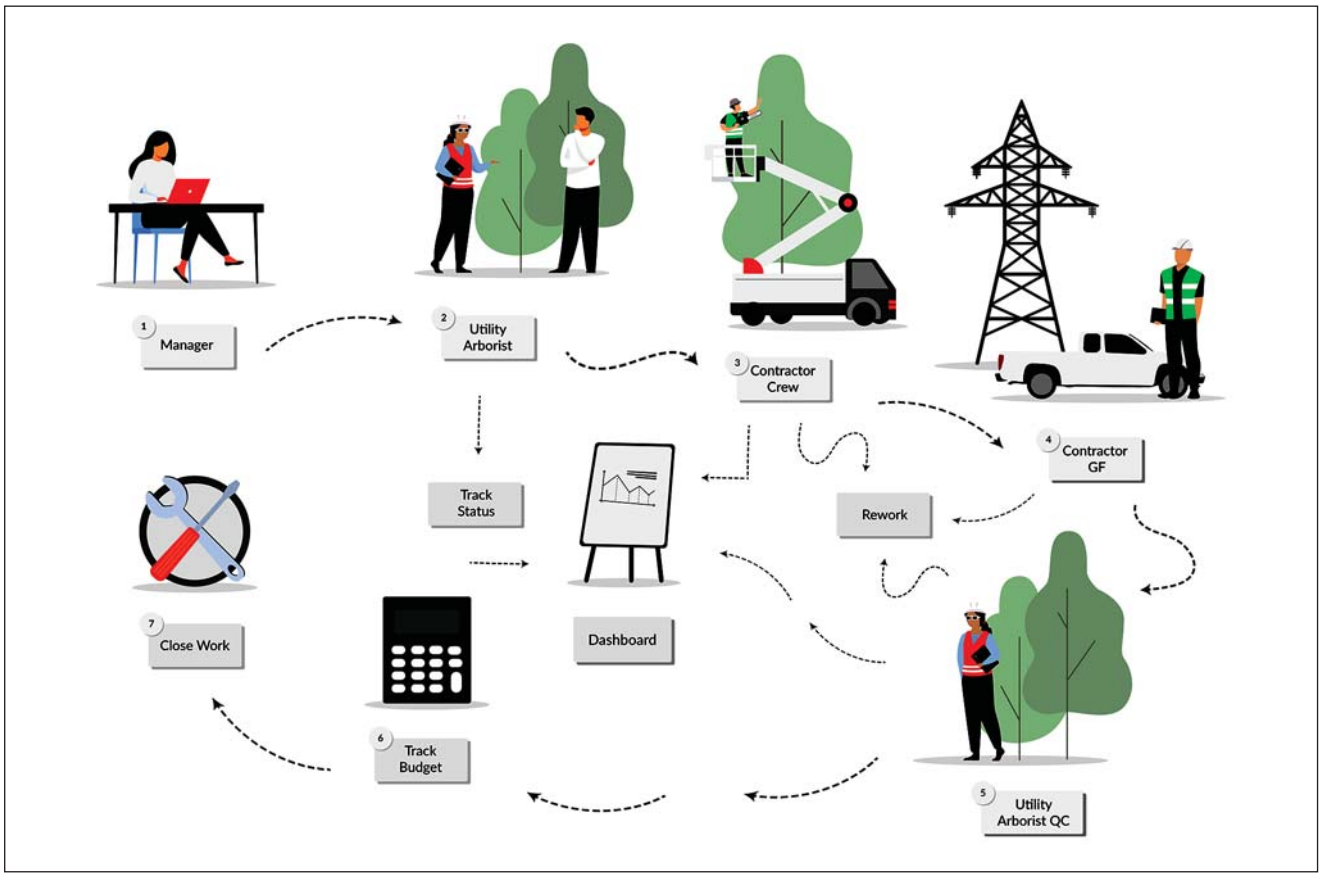
Agreeing that we need to increase operational or field efficiency is not enough. In vegetation management, that may mean shortening the cycle time between audit and close or streamlining crew workflows to reduce customer response times.

It is important for the solution to be designed and built for how a utility will be using it (i.e., not adapted from another use case). Accordingly, when gathering user requirements, it's wise to determine how well versed a potential partner is in understanding similar work environments from a variety of vantage points and solving related challenges.

Determine how broad the use cases are. Gone are the days when vegetation management departments were a stand-alone function. From investor-owned utilities to smaller cooperatives and municipalities, many departments within an organization must exchange data.

Beyond vegetation management, one of the first steps in scoping technology requirements is to gather input from each of the relevant user groups within an organization.

- Vegetation management may need solutions for work planning, scheduling, dispatching and auditing.
- Customer care may seek solutions for processing customer tickets or managing different notification requirements across operating regions or companies.
- Billing and contractor management teams may need production data by vendor.
- Finance may need a record of expenses.
- Environmental management and legal teams may seek compliance with endangered species management and habitat preservation.



Seek out technology solutions that solve your workflow challenges throughout the work cycle.

- Fleet and ESG teams may want quantifiable emissions reduction data.
- Investor relations may be looking for proven data on how the utility is achieving sustainability goals and serving as good corporate citizens.

Asking the Right Questions

Gathering broad-based requirements allows utilities to begin asking incremental questions of the users and their processes to determine what elements can and should be managed in the same system. Deeper dive questions may look like the following:

- Does it make sense to use field operations software to capture environmental data or denote pollinator habitats?
- Would a single platform make sense for work planners, crews and auditors or for rapid dispatch of customer ticketing and notification of rework from auditing?
- Are contractor timesheets needed in the system? Why or why not? If yes, do they need to tie to work completion?

- Is your utility embracing remote sensing/AI solutions but still needing to support manual field processes?

Because every environment is unique, these questions don't have one right answer. Framing and answering these types of questions with work groups allows utilities to design a solution that supports not only the necessary requirements but also other important data elements when and where they make sense. This also enables companies to determine where to draw the line.

Identify the key functional users. When weighing the pros and cons of implementing best-of-breed solutions versus best-in-class or all-in-one technology, it's important to consider the key functional users of each element of the solution set. If shared, a consistent user experience is a worthwhile investment. Utilities can lose millions per year in lost field productivity due to poor usability at the additional cost of employee and contractor morale.

Diagramming the collaborative processes across the organization is recommended to provide a unified view, remove fragmentation and silos and ensure critical data flows freely across teams.

Figure out what decisions will be made with the data and how quickly they will be made. In general, day-to-day work management processes require more granularity of data than, for example, the data rollup required for a monthly financial close. During your discovery process, it's critical to determine the level of detail required by each decision maker, and associated timing, and use that as a guide to design the optimal system.

Onsite team meeting includes technology training the field workforce.

Stay Updated on Technological Advances

Before building a complex, real-time, front-end system for native integration to your enterprise work management system, determine if a simple integration of relevant information, without custom coding, is doable, effective and efficient. You must also understand the maturity or fast-moving nature of the technology. Innovation is driving the world, and utility technologies are no exception. For example, consider the impact of cybersecurity, mobile operating systems and mobile device management in the industry.

Technology built years ago is no longer supported and/or needs to be rewritten. Pay attention to how well any commercial vendor is staying current with the underlying technology and how much custom code for your organization is being built upon it. Staying up-to-date and maintaining compliance with custom solutions in fast-moving technologies can become a challenge.

In addition, some technologies such as AI, machine learning and even remote sensing are in their infancy. Tying your company to a specific technology at an early stage while another model may prove to be superior longer term may be detrimental.

Consider how rapidly data acquisition is changing with LiDAR and satellites. Also think about how quickly remote sensing and machine learning models are extracting intelligence regarding clearance, tree species, tree health and more. Also ask yourself how quickly, if ever, these will become the primary tools for planned maintenance work or managing customer tickets, notifications and capturing customer interactions. An important balance is in play today with sky-based programmatic innovations and ground-based customer experience strategies that should not be overlooked.

The best companies in the field are innovating rapidly. The key to success is parsing out what elements of the proposed solution are already becoming commoditized (such as data acquisition) versus those that are continuing to innovate (such as image processing and data intelligence). Next you must ensure you establish clarity around what that means to your organization's ability to manage the technology over time.

Finding the Best Fit

When doing research, you must also consider a vendor's area of expertise. While many solution providers are building the business of tomorrow today and technology convergence is on the rise, their foundational strengths and depth of industry knowledge are likely to differ (e.g., remote sensing, satellite imaging, data analytics and technology integration).

Odds are in your favor that each provider will readily maintain its areas of expertise. But what innovative approaches or new frontiers might your vendor miss if it is looking through a single lens? Take the time to analyze each vendor and discuss, with your larger discovery team, what foundational strengths are critical to your success longer term. Center your approach upon these strengths. In addition, investigate each potential partner's pilot success rates and longer-term technology adoption. These are critical inputs to help you assess technology sustainability and potential maintenance requirements over time.

For example, placing a best-in-breed remote sensing bet may pave the way for innovation with a partner of choice for some utilities. For others, a configurable, best-in-class vegetation management platform incorporating remote sensing data from a range of providers provides the longer-term flexibility they need.

You must also evaluate the level of burden on your utility's IT resources. In today's utility environment, a heavy emphasis is placed on data- and cybersecurity. Couple that with system integrations, upgrades, optimizing for interoperability and managing too many tools in a tech stack can lead to administrative nightmares and skyrocketing costs.

At many utilities, changes to large enterprise systems are frowned upon due not only to expense considerations but also potential adverse impacts on other key functions these systems support (e.g., inventory and financial reporting). Building custom, front-end applications for enterprise asset/work management systems may tie the hands of a vegetation management department looking to innovate its business processes. Reducing complexity by thinking through the long-term administrative burden upfront is mandatory.

Implementing the right technology solution to meet your specific needs requires a host of in-depth considerations and planning — especially since the range of options has grown substantially in the past few years with no signs of slowing down. It takes significant effort to answer these fundamental questions and discover the ideal boundaries for the range of systems and software that can deliver value to your utility vegetation management programs. TDW

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Screen captures from the app in the actual Area of Interest show four vegetation layers in LiveEO's Vegetation Management Insights program.

Satellite Data for Managing Vegetation Risk

Liberty Utilities launched a pilot project to identify high-risk vegetation near power lines with satellite imagery.

By **JASON GROSSMAN**, Liberty Utilities, and **NICK FERGUSON**, LiveEO

On a crisp, clear day in November 2020, a team gathered in Joplin, Missouri, to confirm what everybody hoped: that by using specially trained artificial intelligence (AI) to analyze satellite imagery, it would be possible to overcome the problems of scale confronting every utility vegetation manager: too many trees located over too many miles too far away.

At that point in time, LiveEO had already done many field validations. Its Vegetation Management Insights program locates and measures individual trees, and its vitality monitoring module assesses tree health on three continents. During this project, however, the company was testing a new species identification technology to track seasonal changes in foliage and identify the genus. While this AI technology had yielded positive results in Europe, the data-hungry algorithm required extensive training when applied to a new environment. Rural Missouri, with its dense, high-variety forests, was a new playground.

Missouri woodlands in the fall include a low vitality area.

For Liberty, the pilot represented the company's second foray into the world of satellite imagery. The first satellite project had failed to meet the needs of its already well-established integrated vegetation management program, but the utility was determined to give it another shot.

Launching the Pilot Project

By using AI to analyze satellite imagery, the utility could infuse technological innovation into its vegetation management program. Liberty aimed to improve processes and gain efficiencies by

Risk analysis is performed on Liberty's distribution lines in LiveEO's vegetation management software.

taking a quick, reliable snapshot of vegetation conditions along the entire grid. In addition, the utility was also searching for a tool capable of prioritizing risks and generating work orders to tackle them.

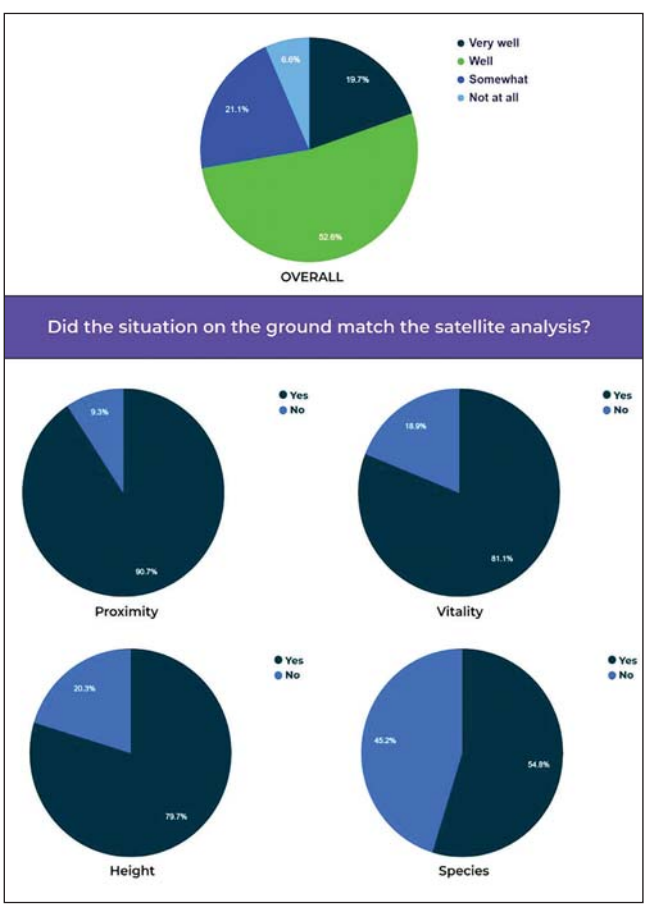
At the start of the pilot project, the team traveled to several areas of interest to inspect specific locations and validate the assessments made by the company's Vegetation Management Insights solution. For example, they checked the information available in the app against what is known as the "ground truth," or the reality on the ground.

The inspections zoned in on three key factors—tree location and height, essential to measuring vegetation-conductor distance and fall-in or grow-in potential; tree vitality, which singles out potential fall-ins most likely to fail; and tree species, a determining factor in growth rate. The species is also a critical piece of work order information in the event of a cutback.

During the project, the utility's employees tested the mobile app in the field. For added reassurance, the app includes a feedback function by default, not just for validations, but also to allow contractors in the field to flag inaccuracies or errors. As the mechanism by which AIs improve themselves, feedback is critical to machine learning. Making it as easy as possible for users to provide feedback to the algorithms ensures the machine analysis gets increasingly more accurate every time it is used.

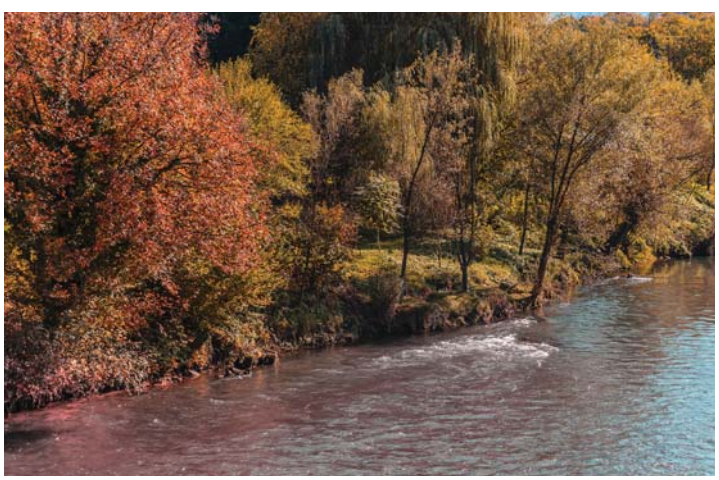
Evaluating Trees in Decline

Height and location proved highly reliable for the most part. A few miscalculations occurred near steep embankments, but they were quickly rectified. The most challenging aspect was getting everyone to agree on the height of the trees. To provide



This shows the results of Liberty's 2022 LiveEO pilot project and the ground truth validation.

Missouri's forests feature high tree density and species variety.



Steep embankments can pose a challenge for height measurement.

Larin McCulley, Tom Waddington, Jason Grossman and Todd Lushinsky were on site during the pilot project.

guidance, an experienced field validator volunteered to step in as a human yardstick.

Traveling across the service territory, the team began evaluating trees flagged by the app as "in decline." In several cases, the trees' low vitality was obvious. These trees clearly needed some attention to eliminate the risk of an outage, and even an inexperienced ground patrol would have spotted them straight away.

This was not the case with all the trees in decline. With a satellite resolution of 50 cm, even minor limb dieback showed up. The team required a more in-depth visual inspection to confirm the vitality decrease picked up by the AI. Even so, it was beneficial to highlight these declines before the process began. The accuracy of the plant vitality and change detection highlighted changes that weren't readily identifiable with the naked eye.

While walking away from the ailing tree, it occurred to the team that their vision of the environment was almost magically augmented, allowing them to see things that human sight alone could not. As that first day wrapped up and they made their way back to their vehicles, they reviewed the events of the day.

They may not have achieved perfect results, but they targeted areas for improvement. Because the model had performed so well on species it recognized from previous projects, it suggested it was a matter of calibration and training. LiveEO's project manager defined the steps to improve the AI's training on dense/high-variety woodlands like in Joplin, Missouri. For a start, they knew they had to double the length of their local species list.

Meanwhile, the team from Liberty talked numbers: would the day's results hold up their projections? With the time and money they'd save cutting overflights, how many more of those critical fall risks could they get to — all of them? It felt like the conversation was only starting.

Over the following months and a series of reruns, species identification accuracy improved in large steps. Seeing how fast the AI technology evolved and improved felt more exciting than the high accuracy the established modules had displayed. This was no regular tool Liberty was adding to its tool kit. This tool was self-improving, and it was a fast learner too. TDW

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Utility Arboriculture and Technology Transform VM

When I started my utility arboriculture career in the early 1990s, many North American utilities had decentralized vegetation management programs run by operations managers, light-duty lineworkers or others without arboricultural training. The predominant perception was that it wasn't "rocket science," and anybody could do it without training. In those early days, I was informed many times that money spent on foresters or arborists was better spent "trimming trees."

That perception was wrong then, and even more so now. Vegetation management is essential to utility operations. Failure in vegetation management has been an existential threat to utilities. Conflicts between trees and power lines have resulted in catastrophic fires, ruinous blackouts, public electric contacts, enforcement action from regulators and tarnished corporate reputations. Utilities have fallen into bankruptcy and chief executives have lost their jobs as a result. Now, vegetation management is often the largest utility operations and maintenance budgetary line item, and the contribution provided by utility arborists is indispensable.

Gaining Knowledge

The knowledge required for an effective vegetation management program is formidable. In addition to demanding command of dynamic natural systems, this work requires an understanding of program management, budgeting — often for tens of millions or hundreds of millions of dollars — remote sensing, communication, safety and the fundamentals of electrical systems, according to the *Utility Arboriculture: The Utility Specialist Certification Study Guide* published by the International Society of Arboriculture.

The criticality of VM is evident from the articles presented in this *T&D World* Vegetation Management Supplement, which is published in partnership with the Utility Arborist Association. This issue features articles about environmental stewardship, biodiversity, the cost-effectiveness of integrated vegetation management (IVM) and chemically facilitated biological control. Alongside this content is collaboration with and leadership for utility tree workers to promote safety and professionalism. This supplement also includes articles featuring technological innovations from satellite imagery to artificial intelligence.

Investing in Technology

Technological developments are transforming vegetation management. A premise of IVM best practices is to base prescriptions on data, according to "Utilities & Vegetation Management in North America: Results from a 2019 Utility Forestry Census of Tree Activates & Operations," a 2021 University of Wisconsin-Stevens Point publication. Vegetation managers can apply this principle by taking information supplied through remote sensing to deploy resources to areas of greatest risk. Moreover, technology can a help overcome the constraints imposed by insufficient human resource pressure. Technology drives efficiencies that can bridge the gap between need and resource limitations.

As essential as these technological advances are, they cannot replace competent field professionals. Practitioners on the ground are necessary to augment remote sensing, ensure quality control and deliver optimal programs. For example, remote sensing is unable determine tree flaws that can be identified through tree risk assessments.

Misuse of technology may drive vegetation management programs into a detrimental hotspot paradigm. The articles in this supplement by Jill Golden and Dr. Anand Persad provide insight into the importance of developing diverse, compatible plant communities through IVM. The method is not only cost effective, but it also has an added benefit for creating early successional habitat that benefits pollinators, ground nesting birds and other species for which habitat has been dwindling in recent decades due to development, agriculture and human preference for trees and forests. Technology by itself can't deliver that result.

Focusing on Training

State-of-the-art IVM requires training. Credentials such certification and tree risk assessment from the International Society of Arboriculture are crucial. University of Wisconsin-Stevens Point, the Utility Vegetation Management Association, and the Utility Arborist Association have collaborated on a two-year Utility Vegetation Management Program. This program should be promoted by progressive utilities and contractors for their employees wishing to advance their vegetation management careers, according to Tomaszewski and Miller in the "2022 UVM Professional Development Program" article in the *UAA Arborist Newsline*.

It's clear that money spent on arborists is not better spent "trimming trees." Professional vegetation management is central to enabling utilities to deliver safe, flawlessly reliable electricity while advancing environmental stewardship, all of which are core values of progressive utilities. *T&D World* recognizes the importance of vegetation management and has wisely selected articles for this supplement. They offer a blend of topics that provide information on the skills necessary to transform utility arboriculture to the benefit of arborists, utilities and the public. TDW

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