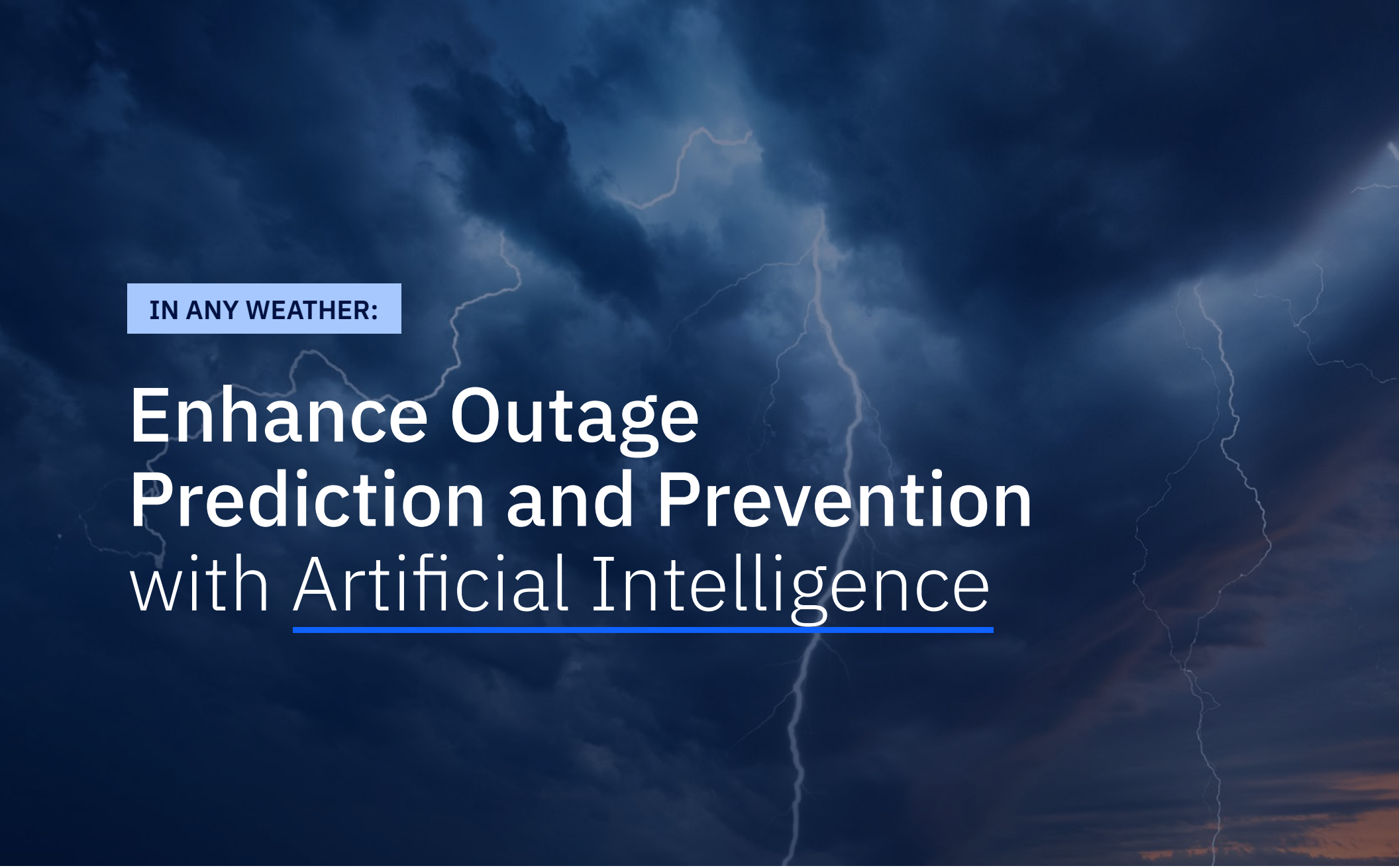

IN ANY WEATHER:

# Enhance Outage Prediction and Prevention with Artificial Intelligence

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Trimming trees and otherwise managing vegetation encroachment near power lines are the foundation of preventing weather-related power outages. In warm weather, tree limbs can grow to overhang or brush up against utility assets. These limbs can break under the weight of winter snow and ice, be blown down in strong wind or severe storms, or spark fires in dry conditions.

For instance, in early August 2020, tropical storm Isaias brought power outages to 2.5 million utility customers in New York, New Jersey and Connecticut. Most of these outages were caused by trees and branches falling on power lines in high winds. In some locations, power restoration took a week or more.

Plant growth is a leading cause of power outages. According to the Electric Power Research Institute, in one year vegetation caused 92% of weather-related U.S. power outages. The North American Electric Reliability Corporation reported that in 2019, 24 sustained transmission-system outages were caused by vegetation contact with high-voltage

power lines (only two of those outages appeared unrelated to weather). Costs are huge: One White House study estimated that across a decade, weather-related outages cost the U.S. economy $18 billion to $33 billion per year. Just in California, utilities spend about $1 billion annually on vegetation management — nearly all determined by schedules, not observed conditions and possible risks under different conditions.

When utilities decide how to allocate finite resources to mitigate outage risks, their plans are only partially based on current

**Weather-related outages cost the U.S. economy**

**$18-$33 billion per year.**

data and forecasts. Experience and cyclic schedules still substantially shape utility plans for vegetation management and preparation for outage response. Meanwhile, climate change is bringing more severe weather year-round in every region, while also making ordinary weather patterns less predictable.

So, despite their best efforts, utilities often incompletely assess where the greatest risks of vegetation- and weather-related outages exist along their transmission and distribution networks. Also, the advance notice they receive of upcoming severe weather often is not either or specific enough for optimal preparation. This can lead to more (and more costly) outages, wasted mitigation or emergency preparation, declining reliability scores, damaged customer trust, and increased public and regulatory scrutiny.

Fortunately, new artificial intelligence (AI) and machine learning technology — combined with a continuous stream of highly granular weather data, geospatial data, and satellite imagery — can help utilities target tree trimming more efficiently and effectively. This solution also provides far more specific warnings of weather events, much earlier. Several utilities are working with IBM to leverage insights from this type of solution to enhance power-system resilience and reliability.

“Tackling vegetation management and outage prediction together — instead of separately, the way it’s often still done at utilities — significantly reduces operational expenditures,” said Robbie Berglund, weather solutions global business unit executive for IBM Energy & Utilities.

This playbook explains how data-driven, timely, AI-augmented situational intelligence helps utilities minimize risks to people, assets and the bottom line — while also enhancing customer service and speeding power restoration.

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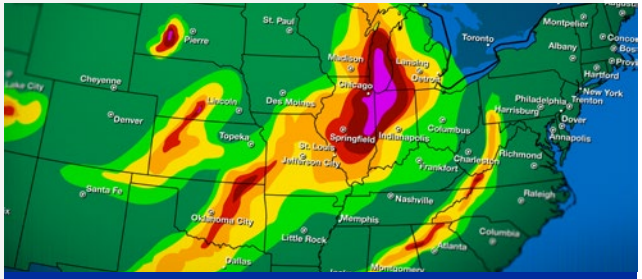


# 1. Better Planning with Rich Data and Intelligent Analysis

Advance notice of the likely location, extent and power-system effects of severe weather events can empower utilities to mobilize restoration resources exactly when and where they will be needed, for faster outage recovery. IBM's solution predicts weather events seven days in advance, giving utilities substantial time to prepare.

"If we believe bad weather is imminent, it's essential to determine where we think our repair crews and resources will be needed most," said Tony O'Hara, chief technology officer and vice president of engineering for Canadian utility New Brunswick Power. "For an extensive restoration effort, we can be spending in excess of a million dollars per day on mobilizing people and equipment With advance notice about weather events, we can pre-posture our system. We can do specific activities that will make our system more resilient to that weather."

Similarly, data-driven insights can make vegetation management more targeted and nimble. "Shifting from routine scheduled inspections to a condition-based approach relies on far more sophisticated analysis than is currently used for predicting outages and monitoring vegetation growth," said Stuart Ravens, chief analyst for thematic research at GlobalData.

At many utilities, vegetation management and outage prediction have always been costly, time-consuming, complex and largely manual endeavors. Most utilities update their vegetation data and imagery via staff and contractors who use trucks, planes, helicopters and drones to collect imagery and data. In many parts of a power grid, this snapshot of field conditions may occur only once per year or every few years. Utilities also purchase data and imagery from satellite and weather services. This tends to be obtained periodically, not continuously, and it's typically analyzed manually.

Utilities use all of this information update their existing in-house models to predict where vegetation might most likely cause outages throughout the coming year under

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various weather scenarios. Often, these models are developed not by staff or industry experts but by local colleges or universities.

“It’s usually graduate students who build outage and vegetation models for utilities,” said Rob Boucher, senior offering manager for The Weather Company, an IBM business. “They’re smart and skilled, but they lack industry knowledge. So they’ll devise very qualitative measures, like how leafy the trees in a grid box look. That’s not really the level of information needed to plan which trees to trim.”

By contrast, IBM collects highly granular data and imagery (from satellites, weather services and other resources) to help utilities ascertain how close vegetation is growing to power lines — not just at one point in time, but over time. IBM’s models use machine learning and AI algorithms, which are trained with high-resolution historical and current satellite imagery.

“The Weather company’s core competency is weather, and it’s now combined with IBM deep industry expertise and skills in analytics and AI,” Berglund said. “The real breakthrough for utilities is our vegetation model, the way we extract data about trees from high resolution imagery. The output from our vegetation model feeds into our outage-prediction model, along with weather data. Our algorithms apply machine-learning techniques to keep learning and improving from a continuous stream of rich data.”

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**Rob Boucher**
senior offering manager for
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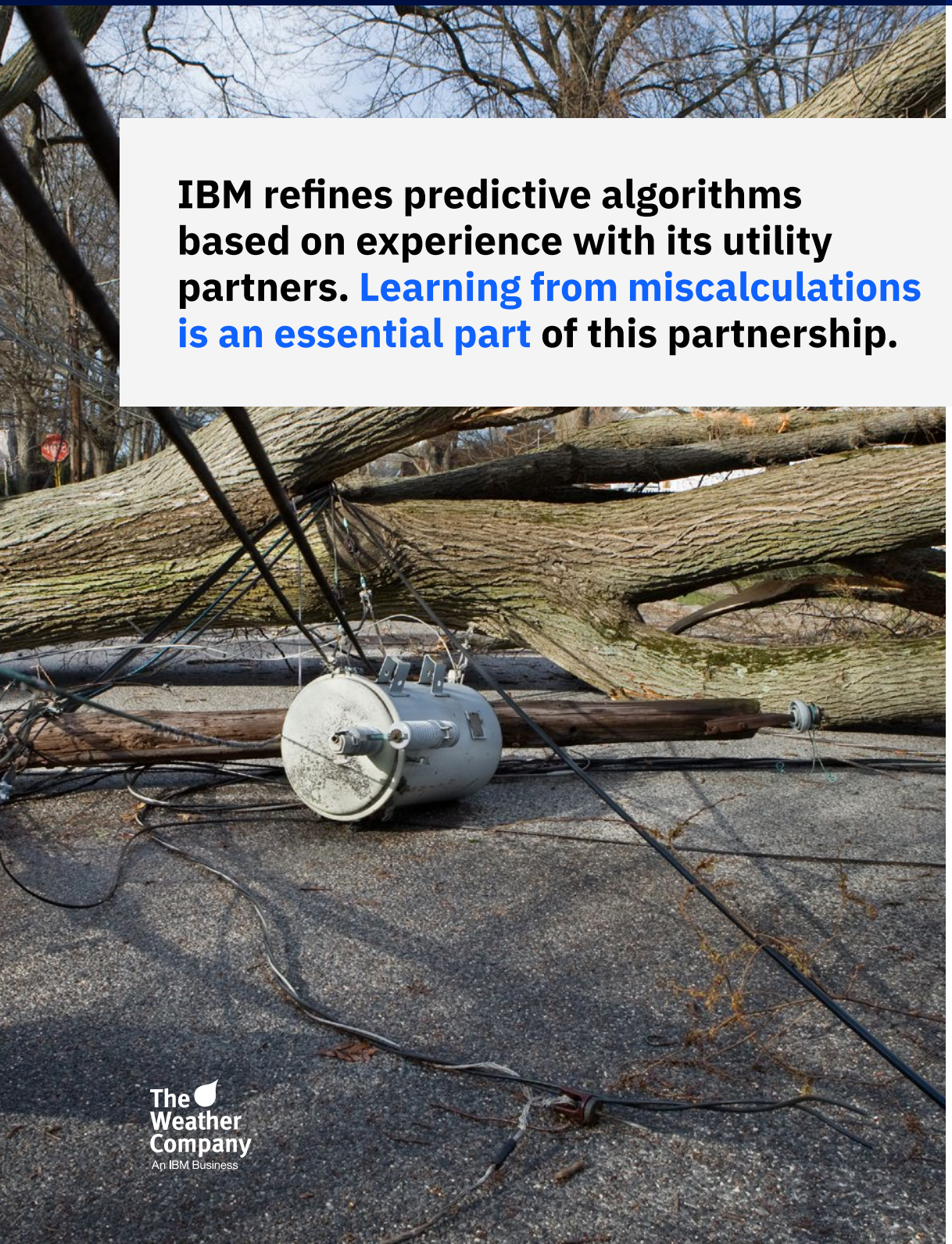


**IBM refines predictive algorithms based on experience with its utility partners. Learning from miscalculations is an essential part of this partnership.**

When generating outage predictions, IBM's algorithms can consider important nuances. For instance, it's essential for utilities to understand not just where the leaves are but also when they fall off the trees. Leaves increase wind resistance and hold moisture, so risks of downed power lines are much higher before the leaves fall. This has a big effect on outage predictions related to severe weather.

IBM refines predictive algorithms based on experience with its utility partners. Learning from miscalculations is an essential part of this partnership. For example, Boucher noted that a few years ago, unusually wet and warm summer weather in southeastern Canada left leaves on the trees throughout New Brunswick much later than usual.

"They had a big windstorm in mid-October, and it caused much larger outages than either IBM or NB Power expected," Boucher said. "The leaves created more surface area for the wind to push against. Lots of trees were uprooted, and branches came down. We all learned from that how to better train our models about the relationship between vegetation and outages. You can't just assume the leaves will be down by a certain date."

# 2. How New Technologies Extend Utility Capabilities, Opportunities

Advanced technology for processing data, as well as for modeling and prediction, requires vast IT resources — well beyond what is available to IT and data-analysis departments at all but the very largest utilities. Hosting this type of predictive service in the cloud supports the speed, granularity and scaling needed to make predictions specific and actionable.

“Humans can’t process imagery nearly as fast as utilities need data,” said Bryan Sacks, head of work and asset optimization solutions for IBM. “If you give foresters all the detailed satellite imagery for 100,000 square miles and tell them to circle all the trees in each image, they wouldn’t be able to do that in a year. And when it’s finally done, the data would be stale and irrelevant. AI can tell you instantaneously where all the trees are. Then, foresters can focus on helping utilities manage the places where trees present problems, which is where they can really make a positive difference.”

“We have the technology, expertise and resources to help utilities see more than they can today,” Sacks said. “Before, utilities were challenged to assess the state of vegetation. They either had too little data, or incomplete or old data — or else they had so much data that it was hard to interpret. AI allows you to look across a vast dataset and pick out the important stuff. It’s your eyes across your service territory.”

Sacks emphasized that these intelligent, data-driven resources are designed to complement, not replace, the insight and expertise of utility personnel. People are essential to the system. The workforce of every utility represents a wealth of institutional knowledge, so the most experienced employees can be the most valuable teachers of AI algorithms. Their participation in refining predictive algorithms can be a powerful way to capture and extend their contribution to the organization well after they retire.

“We want to give the experts in charge of making decisions some tools to make better decisions,” Sacks said. Continuing to train these tools with data-driven and human insight also

empowers their eventual successors, so algorithms and experts continue to learn from and validate each other.

IBM is working to enable utilities to connect their vegetation-management and outage-prediction systems with other common internal systems for asset management, workforce and work-order management, distribution automation, enterprise resource planning, and outage restoration.

This can streamline the process of turning data and insight into action.

Also, some level of automated access to this data could enhance collaboration with vendors and contractors, as well as other utilities, government entities and emergency-response agencies.

“When utilities do not precisely manage outage risks like vegetation or understand exactly when and where outages are likely, they’ll probably have to look to nearby utilities for mutual aid,” Berglund said. “That gets expensive.” By contrast, utilities with access to specific, data-driven predictions will be in a better position not only to help themselves but also to support neighbors in times of need.

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# 3. Building Trust in New Technology

The accelerating pace of change and disruption inside and outside the electric-power industry is spurring more utilities to become agile and adaptive and to overcome obstacles to change. Adopting new digital technologies that learn, adapt and suggest is a sometimes challenging but usually necessary step in the evolution of utility culture and operations.

Building trust in new ways of working can be a challenge. Historically, utilities have been fairly slow to change, especially to adopt new technology.

Utilities tend to incrementally build the trust they require to make significant changes. However, once trust in a new technology becomes established in one part of the organization, it can spread to support additional projects, departments and goals. Outage prediction and vegetation management, while important and resource-intensive, may appear to be relatively easy and safe places to start exploring the potential of data-driven, AI-augmented insights for complex operations.

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Pilot projects can be essential to demonstrate the value of a new technology and build support for it across the utility. For this reason, IBM often initially focuses on creating a model of vegetation growth using high-resolution satellite imagery for just a small area.

“We select part of their service territory, utilities give us data for their assets there, and we run our models,” Sacks said. “Then we give them our data, and we drive with their arborists and foresters out to the target area to check how well our model reflects what we can see in the field.”

**"...we can keep an eye out for them, everywhere, all the time, and tell them about developing problems before outages happen."**

**Bryan Sacks**
head of work and asset optimization solutions for IBM

Often, IBM's data predicts field conditions that utilities didn't expect. "Most utilities can't afford to survey their entire network every year or season.  So they often discover that trees have grown faster or slower than expected in some areas," Sacks said. "That changes the risks to power lines, which should shape their tree-trimming plans. However, often they only know the last time the area was trimmed, and that's about it. If they see more outages happening in an area, that indicates overgrowth — but they don't really know until they go look. Instead, we can keep an eye out for them, everywhere, all the time, and tell them about developing problems before outages happen."

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# Conclusion: **Steps Toward Innovation in Utility Operations**

Traditionally, utilities have been highly siloed organizations — prioritizing stability over innovation. This compartmentalization can hinder useful synergies and efficiencies. For instance, while outage prediction and vegetation management are closely related, traditionally they are managed and budgeted separately.

"Deploying AI and machine learning to support both vegetation management and outage prediction is an innovation project," Sacks observed. "Simply thinking differently about existing processes represents significant progress." For instance, a utility might first use AI data to adjust scheduled tree-trimming cycles. One area with greater growth might be trimmed more often, and others less frequently if conditions warrant. "The utility gets better results for the same spend," Sacks said.

Building a new, intelligent workflow requires input from everyone involved in those operations. "You can't have an IT department implement this kind of system and then toss it over the fence to the operational departments," Sacks said. "Engage your vegetation- and outage-management teams from the very beginning. Encourage them to work with IT to inform and reality-check the algorithms. They'll trust the new process more if they know that their voice really counts."

Early planning conversations around applying AI and machine learning to predict and prevent more outages should include:

- **All involved departments, operational and otherwise.** For instance, finance can provide insight on budgets and measuring savings.
- **High-level and front-line employees.** From managers to arborists, everyone's experience is important information.

Also, utilities should assess their existing models, data sources, processes, resources, capabilities and

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regulatory requirements. What has their track record been for predicting and managing outage risks? This becomes the basis for measuring future progress.

At the same time, utilities should carefully examine vendor claims about how AI works and what it can realistically offer. In a recent article, Ravens noted: "From the outset, utilities will have to pay close attention to model management, data management and change management to make analytics-based vegetation management a reality. Without strong information management, analytics-based vegetation management could be another analytics project that fails to live up to its initial promise. Done well, it could reap millions in savings and improve grid reliability."

Ravens also observed, "Utilities are getting better at innovation than they used to be. They're hiring heads of innovation from other industries and looking outside their industry for useful tools and lessons. The industry culture is becoming more ready to capitalize on artificial intelligence."

Utilities that are moving today to apply AI in meaningful, useful and innovative ways can realize long-term advantages in operations and business. Trimming precisely the right trees so fewer power lines come down during storms may be the beginning of a long, fruitful collaboration with algorithms.

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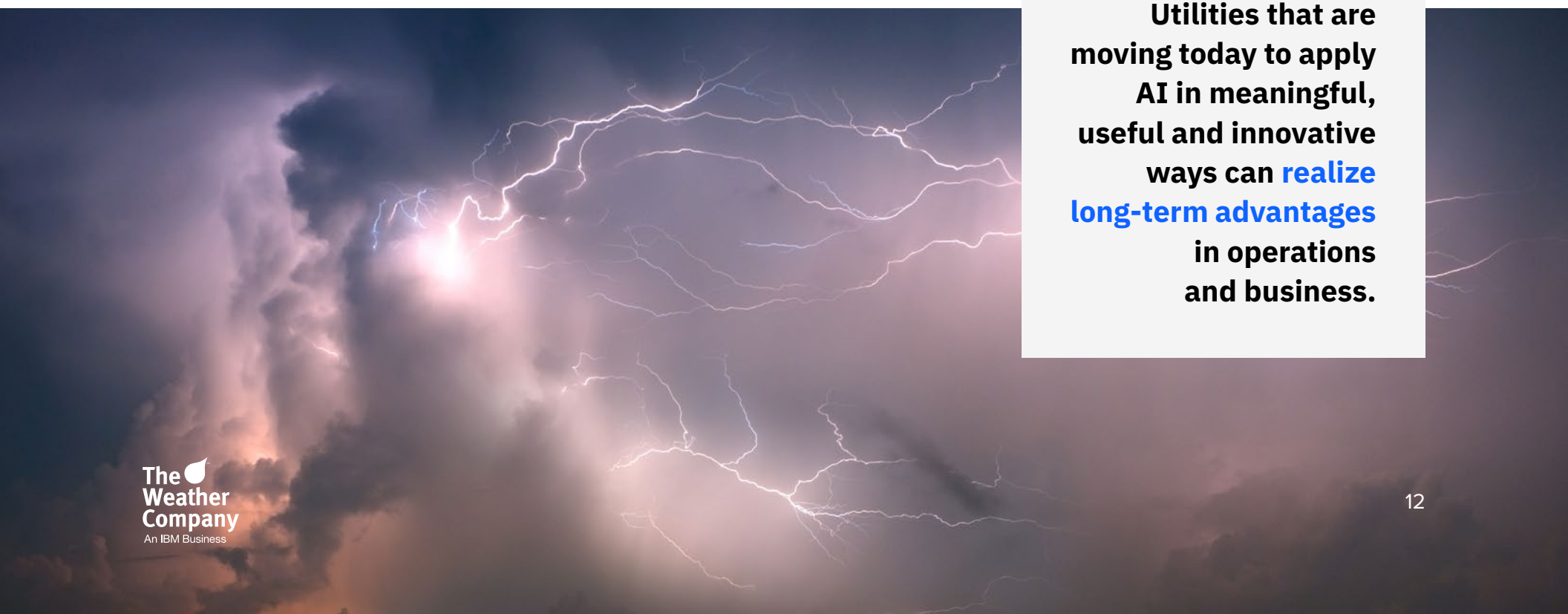

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