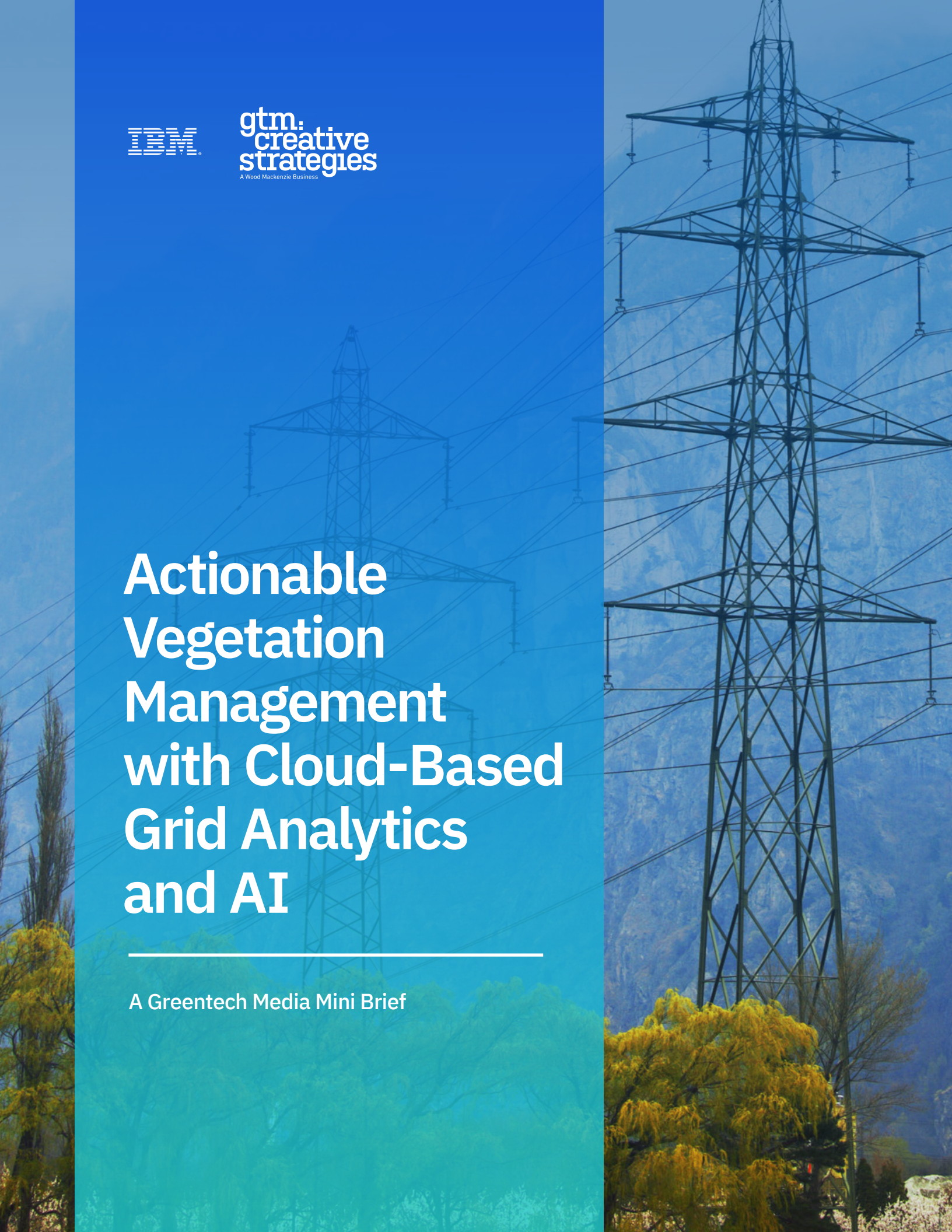

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Actionable Vegetation Management with Cloud-Based Grid Analytics and AI

A Greentech Media Mini Brief

Like so many other aspects of the utility industry, vegetation management is in the midst of a paradigm shift.

Traditional utility vegetation management practices for both transmission and distribution infrastructure have largely been based on a shared time-based or reactive approach. This has meant either pruning and cutting bushes, trees and grasses after a power outage or preventatively clearing vegetation near lines, transformers and other grid equipment at regular and fixed intervals.

Cycle-based vegetation management is often dictated by regulatory compliance. For example, utilities with high-voltage transmission lines of 200 kV and higher must follow the North American Electric Reliability Corporation's requirements that power line rights-of-way undergo annual inspections. Distribution system vegetation management has also been largely cycle-based, with utilities required to submit their plans to state regulators for approval. Historically, keeping costs in check was often at odds with more comprehensive vegetation management programs, as reactive programs simply required more cutting.

Optimization enabled by sophisticated analytics is changing that paradigm. While regulations require many utilities to continue cycle-based vegetation management, there is a clear shift toward at least some level of condition- and risk-based practices, and vegetation managers are now poised to take advantage of the digital advancements that have impacted so many other areas of utility operations.

At its most basic level, condition-based vegetation management is possible when data collection and analytics produce an updated, granular picture of where vegetation poses a threat to grid infrastructure as well as the intelligence to effectively address those risks.

Vegetation managers are now poised to take advantage of the digital advancements that have impacted so many other areas of utility operations.

High costs and regulatory pressures drive change

The move toward condition-based vegetation management is being driven by the inadequacy and costliness of the status quo as well as rapid advances in technology.

A significant expense. Vegetation management is an expensive, yet critical, line item as utilities look at ways to transform their business models. For example, California's three investor-owned utilities collectively spend at least $1 billion annually on vegetation management. Additionally, vegetation causes more than 90 percent of weather-related outages on the distribution grid, according to the Electric Power Research Institute, and tree contact is a leading cause of outages on transmission lines, according to the Federal Energy Regulatory Commission.

Regulatory focus on reliability. Changes in the regulatory environment are also prompting more utilities to consider ways to evolve their vegetation management practices. For example, at least 19 states and Washington, D.C. have implemented or considered a move from traditional cost-of-service ratemaking to performance-based ratemaking. Instead of granting utilities a rate of return based on their capital expenditures, performance-based ratemaking financially rewards utilities based on their ability to achieve certain metrics, including fewer and shorter-duration outages.

Advances in data collection and advanced analytics. The availability of low-cost sensors, advanced metering infrastructure and sophisticated analytics is reshaping how utilities do everything from engage with their customers and maintain grid equipment to respond to storm outages. Vastly improved data collection and storage, advanced analytics and artificial intelligence (AI) have the same potential to transform vegetation management.

By delivering near-real-time intelligence about where vegetation poses the biggest risk to grid infrastructure, technology empowers vegetation managers to prioritize their decisions and resources in ways that have the most impact. Importantly, the technology solutions available to vegetation managers allow them to incorporate condition-based vegetation management while still maintaining their existing work processes, tools and expertise.

Taken together, these factors have elevated the role of utility vegetation managers in reducing outages and improving grid reliability. In the following sections of this paper, we will examine how technology advancements help optimize vegetation management in ways that:

- Can be done at scale
- Increase frequency and efficiency
- Dramatically improve effectiveness at no additional cost

Data from the trees and clouds

The only way to cost-effectively implement condition-based vegetation management is by having access to large amounts of detailed historic and current data as well as the analytics needed to intelligently act on all of that information.

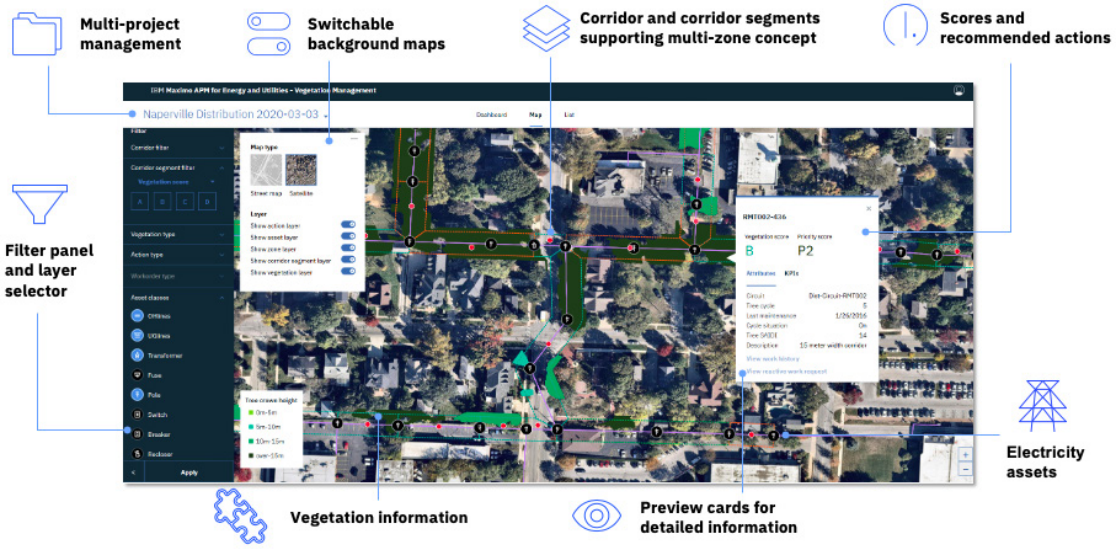
Here's how IBM's Vegetation Management solution combines rich and relevant data with the AI and advanced analytics required to produce actionable insights:

Built on a foundation of geospatial data. IBM's vegetation management leverages IBM PAIRS Geoscope, an innovative platform developed to be a central, cloud-based repository for huge geospatial-temporal data sets. Geospatial-temporal data is critical for effective, condition-based vegetation management because it provides a detailed representation of the physical world and how it changes over time. This data platform includes vital information that vegetation managers need, including satellite imagery, historical and current weather conditions and soil moisture levels.

Continuously updated imagery. In 2020, IBM entered into a partnership with a satellite imagery provider to enhance IBM's Vegetation Management solution with higher-resolution images; each pixel in the imagery captured covers less than 1 meter. The frequent capture and granularity of the imagery

used in the solution provides vegetation managers with the kind of on-the-ground information they need to make smart decisions about where to send crews. It's also information that can meaningfully improve traditional cycle-based management as well as approaches that rely on new applications of light detection and ranging technology (LiDAR), which can create valuable high-resolution 3D representations of vegetation but is expensive at scale. However, accurate and updated imagery can allow vegetation managers to pinpoint where it makes sense to dispatch LiDAR-equipped drones or airplanes to provide closer inspection of problem spots that may need attention.

An up-close view of vegetation in relation to utility assets. Effective vegetation management depends on understanding where vegetation is growing in ways that could negatively impact utility infrastructure and taking action based on that valuable insight. The IBM Vegetation Management solution makes that possible by overlaying a view of vegetation and its proximity to a utility's assets.



Source: IBM Vegetation Management

Optimize and execute with newfound precision

A more holistic view

Even the most up-to-date and high-resolution satellite imagery and data are not sufficient by themselves to fully optimize the work of vegetation managers. Data becomes powerful when advanced analytics, including AI, are applied in ways that transform it into meaningful information that can be understood and acted on based on the unique priorities of specific individual utilities.

Make no mistake—simply having access to a holistic view of the current state of vegetation across a utility's transmission and distribution infrastructure provides a level of visibility that vegetation managers historically have not enjoyed. Knowing where trees and bushes are, the maximum and average tree heights, and where vegetation is encroaching on transformers and other equipment can trigger a manager to mobilize a crew to address any immediate problems.

But holistic visibility is just the start. The vast majority of vegetation professionals manage their service territory on a corridor or circuit level. Advanced analytics allow vegetation managers to apply business rules and key performance indicators (KPIs) that take into account a holistic view while prompting action at a hyper-local level. That holistic view benefits not only vegetation managers but also grid operators who can gain a deeper understanding of where vegetation-related incidents could have the biggest impact.

IBM's Vegetation Management solution integrates disparate information and presents it in a highly visual and usable format on dashboards.

Here's what that can look like:

Decisions based on business objectives. Every utility has its own unique grid infrastructure. Advanced analytics give vegetation managers the ability to create and customize business rules and KPIs that trigger actions to address the most high-risk locations across their service territory. For example, KPIs such as the age and criticality of a line, whether it has experienced an outage in the past, how close it is to vegetation, or how dense or tall surrounding vegetation is can be used to prioritize when and where trimming or spraying is needed. These KPIs can also help to inform safety practices for utility crews and support regulatory compliance.

User-friendly interface enables better and faster decisions across more territory. One challenge many vegetation managers face is that the information they need to make decisions is spread across multiple spreadsheets and computer systems. IBM's Vegetation Management solution integrates disparate information and presents it in a highly visual and usable format on dashboards. For example, the business rules and KPIs that utilities establish can be translated into an overall vegetation score that is then visualized using different colors across the corridors overseen by vegetation managers. Managers can then filter by corridor, vegetation or other metrics to prioritize decision-making. For instance, the color red alerts a manager to the need for immediate attention, while green indicates there is no immediate cause for concern.

Customized recommendations based on institutional expertise. Vegetation scores are also helpful because utilities can customize the specific actions that different scores require. Although the IBM solution provides standard recommendations about how to address certain scenarios, utilities can customize those suggested actions to leverage the expertise and best practices that vegetation managers have learned are most effective in their service territories. By incorporating this knowledge into the solution, utilities can institutionalize the expertise of their vegetation managers.

Better outcomes at a lower cost

At a time when nearly all utilities are trying to contain or lower operational costs, many are under pressure to find cost efficiencies in even critically important tasks like vegetation management.

With advanced analytics, utilities can find cost efficiencies while also delivering better outcomes. Sophisticated analytics paired with high-resolution imagery and frequent capture allow for everything from enhanced monitoring before and after storm events to more accurate auditing that can inform the bidding process and regulatory compliance.

Continuous improvement and refinement. Over time, it becomes possible to refine and adapt trimming cycles to reflect actual conditions on the ground and emerging trends related to vegetation growth projections, weather forecasts and grid infrastructure changes. The ideal approach to vegetation management constantly evolves because the factors that influence it are forever in flux. By adapting management practices using a mix of data, analytics, utility expertise and existing work processes, it is possible to eliminate unnecessary work and target limited resources to address the biggest risks.

Improved bid process, inspection and auditing. The ability to drill down to get a more granular and real-time perspective about individual corridors that need attention can significantly improve the contractor bidding process, the effectiveness of the actual work, and the auditing and inspection needed to ensure it was carried out properly.

For example, vegetation managers can provide contractors with specific information about how dense and high vegetation is so that vendor bids more accurately reflect the cost of the work, including the labor hours and equipment

Source: IBM Vegetation Management

required. Frequently updated imagery also makes it easier for utility managers to inspect contractor work and respond to regulator requests for proof of compliance.

Better allocation of resources. By incorporating condition- and risk-based vegetation management into existing processes, utilities can accomplish more with less and ensure they allocate funding to where it has the most significant impact by better aligning labor hours with budgets based on KPIs.

Already, utilities across the globe are embracing this new paradigm in vegetation management. Oncor Electric, the largest distribution utility in Texas, conducted a trial to ensure that the data being collected about vegetation around certain transmission and distribution circuits was accurate. The data produced actually alerted the utility's forestry group to trees it didn't know about that could potentially pose a problem.

The pilot highlighted the value of using large amounts of data, analytics and AI to monitor vegetation and prioritize high-risk areas in a more cost- and time-efficient way. The exercise ultimately prompted Oncor to modify its trimming plans in ways that improve public safety and service reliability.

Conclusion

As a wide range of changes and challenges continue to buffet the utility industry, it has become clear that an effective response can be found in the increased use of data and analytics through digitalization.

After years of receiving relatively little attention, vegetation management is now a focus of utility investments in advanced analytics. The potential to improve reliability and customer satisfaction through these initiatives is significant and includes:

- Actionable, customized insights that improve efficiency and outcomes
- Improved regulatory compliance
- Better allocation of limited resources
- Enhanced bidding process and auditing
- Reduced outages and heightened customer satisfaction
- Continuously optimized vegetation practices

Today, IBM offers a solution that covers the vegetation management process from generating robust vegetation insights to prioritizing work projects that help decision-making, planning and operations support to auditing. Taking a modular approach, IBM can also provide application components and integration services that address specific parts of the vegetation management value chain based on client requirements and existing solutions landscape.

Learn more about how IBM's Vegetation Management solution can help you increase efficiency in vegetation management, improve customer satisfaction and support the safety of citizens and workers.

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