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Sharper intelligence for a safer world

Powerline inspection in a warmer world: What to expect and how to prepare

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Climate change: A clear, present and grave danger

In 2021, more than 6.6 million acres burned in US wildfires. That's an area the size of Vermont aflame, with the fires ravaging communities, destroying property, and – in the most tragic cases – taking lives.

And fires weren't the only cause of devastation – on the other extreme, Texas was hit by uncharacteristically harsh winter storms for the state. An underprepared electrical grid collapsed, leading to 70% of those served by ERCOT losing power - each for an average of 42 hours in subfreezing temperatures. This Southern Freeze also led to loss of life – 151 by the state's count, though the true number is likely to be much higher.

Though occupying opposite ends of the extreme weather spectrum, the two events share a key factor in common, besides the devastation they caused. Each is an example of extreme weather events that experts predict will increase in frequency and severity due to climate change.

And – to be clear – this is not a US-only phenomenon. From Argentina, to Greece, to India, Algeria and Australia, almost every region of the world suffered. As we enter into 2022, there can be no doubt: climate change is both real and inescapable; it is a clear, present, and grave danger to us all.

However, there are steps we can take to head-off the worst effects of climate change, and to more successfully prepare for and endure what cannot be avoided. With a global, systemic threat like climate change, those steps will stretch to every corner of our lives and economies, but here we will focus on our sphere of expertise: power transmission and distribution infrastructure.

Electric utilities in the US and beyond have a significant role to play in the fight against climate change before, during and after extreme weather events. For example, though electric utility infrastructure has historically been responsible for less

than 10% of reported wildfires, fires attributed to power lines consist of roughly half of California history's most destructive fires.

Not only can poorly maintained power infrastructure cause these disasters, but it can also hamper efforts to endure and recover from extreme weather events. In the aftermath, utilities are responsible for ensuring safe, consistent, and affordable power supply to communities – and a swift return to service in the event of a Public Safety Power Shutoff (PSPS). This is a challenge under volatile conditions, but critical for minimizing threat to property and life.

Seen from this angle, climate change is but one facet of a trifecta of risk factors that create an unprecedented challenge for utilities. Not only is power infrastructure asked to stand up to harsher conditions due to extreme weather, it is also hampered due to being a distributed, underinvested and aging asset covering more than 7 million linear miles in the US alone. In parallel, utilities must keep pace with increasing and shifting electrical load profiles thanks to the rise of renewable power generation, and greater electrification demand throughout the economy.

Even though rapid action is required to mitigate climate change to reverse current trends and avoid the worst of global warming; it will require a multi-decade effort. In short, there is no choice but to immediately plan for the impacts of a warmer world, to develop innovative solutions while also utilizing the tools and technology currently available to utilities to help safeguard the communities they serve - as well as their own futures as businesses.

This paper will showcase how powerline data is key to better emergency preparedness and response. Among the recommendations, digital twin technology will take centerstage. Its ability to centralize and connect vast streams of data to create a digital counterpart of a utility's real-world assets will set the gold standard for risk mitigation.

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The time to act is now

In the US, President Biden's Infrastructure Bill provides $7 billion in funding and regulatory reforms to help enable flexible long-distance, high-voltage interstate power lines.

The aim is to transform the US power grid into an interconnected 'system of systems' where electricity can be seamlessly moved between states and more remote distributed energy resources. However, this will also vastly expand the powerline infrastructure that requires inspection and maintenance.

2022 brings growing challenges to grid resilience. The pressure is on for powerlines, as the US Department of Energy projects a 38% increase in demand for electricity by 2050, in part driven by the growth in electrification of transport.

Meanwhile, grid decarbonization and the associated fragmentation and decentralization of power sources means grid vulnerabilities will become widely dispersed. This comes at a time when climate change will pose an ever greater risk to utility networks: 90% of energy executives already report that extreme weather represents a financial threat to grid stability.

Extreme weather: The role of powerlines

Fast-growing vegetation and over-hanging branches close to powerlines pose significant risk in wildfire scenarios and high winds. Understanding the live network enables allocation of resources and maintenance to trim fast-growing vegetation in the right places at the right times. Faster and better decision-making equals lowered risk.

Prevention is the best cure

Emergency response

When disaster strikes, time is of the essence. An effective response plan with intelligent prioritization and smart use of scarce resources requires efficient real-time data collection from multiple sources. From the field crew and network monitoring systems that inform outages, to helicopters in the air and customer complaints, an integrated data approach can not only cut operational expenses but is vital to limit damages – to the environment, to assets and to people.

Reducing impact

Without an extreme weather plan in place, powerlines can be an exacerbating hazard and lead to unacceptable power outages for communities. In the US, between 2000 and 2019, there was a 67% increase in major power outages from weather-related events. Utilizing preparatory technologies such as digital twins can help to mitigate this risk.

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Get it wrong, and the risks are exponentially high - from the safety of communities and employees, and the financial burden of asset repairs and fines, to the reputational impact on utilities.

Fortunately, in 2022 we have the tools available to reduce and mitigate these risks.

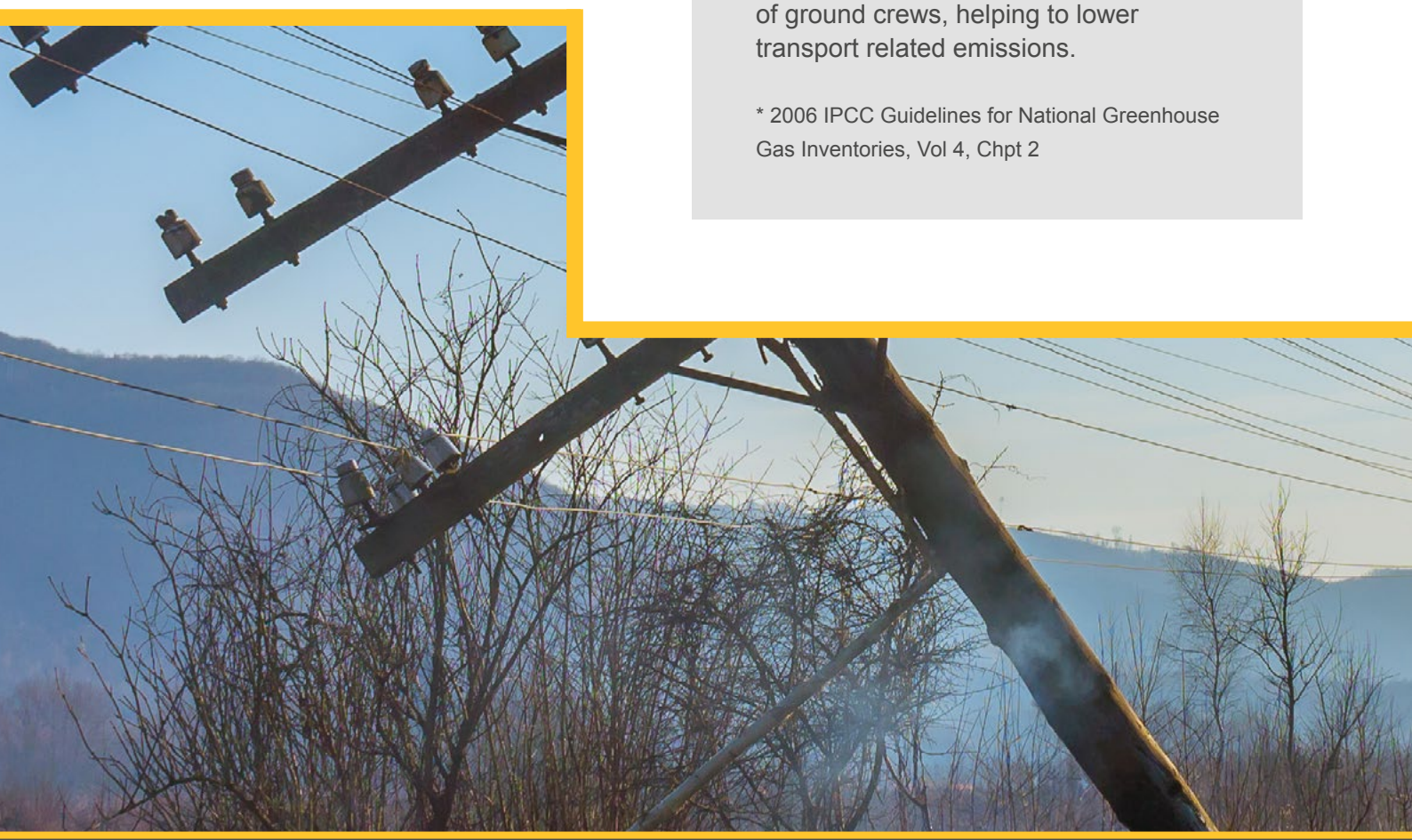
How proper powerline management reduces emissions

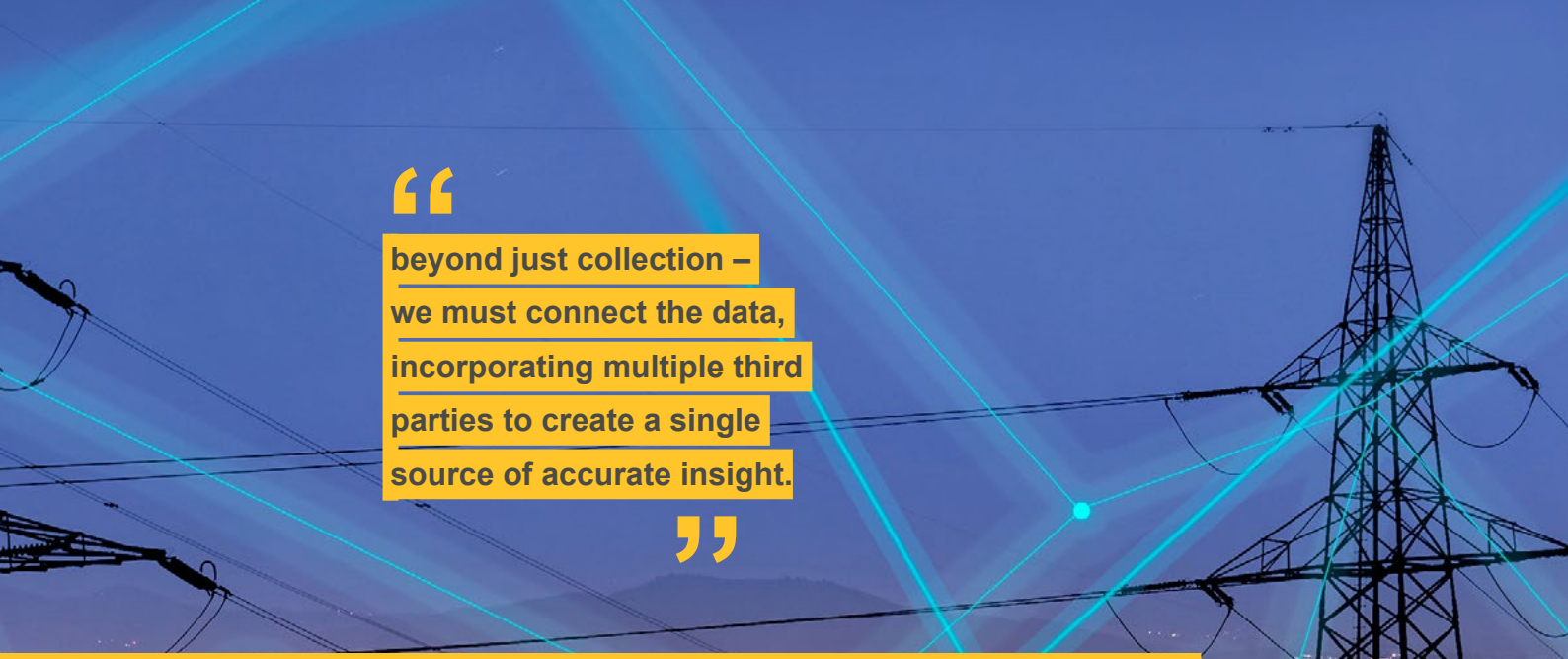
T&D utilities may feel as though their role is reactive rather than proactive when it comes to climate change: peers in the power generation sector are responsible for lowering emissions, while powerline operators have to deal with the fallout of global warming. However, powerline management can also prevent greenhouse gas emissions in a number of ways. For example:

- For every wildland-acre that is prevented from burning, an approximate average of 31.6 metric tons CO2-equivalent per acre reduction in greenhouse gas is realized* and an approximate average of 5.6 t CO2-equivalent per acre per year greenhouse gas forest-sequestration is preserved.

- Smarter, more efficient powerline inspection methods reduce deployments of ground crews, helping to lower transport related emissions.

* 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol 4, Chpt 2





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Powerline management: Traditional tools vs modern best practice

Next generation data collection

To meet tomorrow's extreme weather challenges, utilities must be able to centralize information for accurate analysis and prediction of where inspections and maintenance are needed, before problems arise.

This requires the collection of significant data and analytical organization that translates this into insights to build out a comprehensive understanding of assets and surroundings.

Traditional, resource-intensive methods of data collection involving teams 'walking the line' to manually inspect for signs of wear, damage or potential risks won't cut it when data requirements reach this scale.

Indeed, best practice has largely replaced traditional processes with advanced digital options that allow for increased scale and accuracy, and the breaking down of data silos.

All too often, multiple inspections are conducted to inform different types of maintenance; though with the right technology in place, this can be wrapped into one efficient session.

From collection to connection

Secondly, beyond just collection – we must connect the data, incorporating multiple third parties to create a single source of accurate insight.

For example, incorporating multiple sensor systems into a single payload – be it delivered by helicopter or drone flight – means technologies such as LiDAR, hyperspectral imaging, and AI component detection, can be utilized across vast distances. Mapped to digital twin technology, these can generate insights-based actionable reporting and best-practice disaster preparation plans.

Utility insights in Real Time: 4D Living Digital Twins

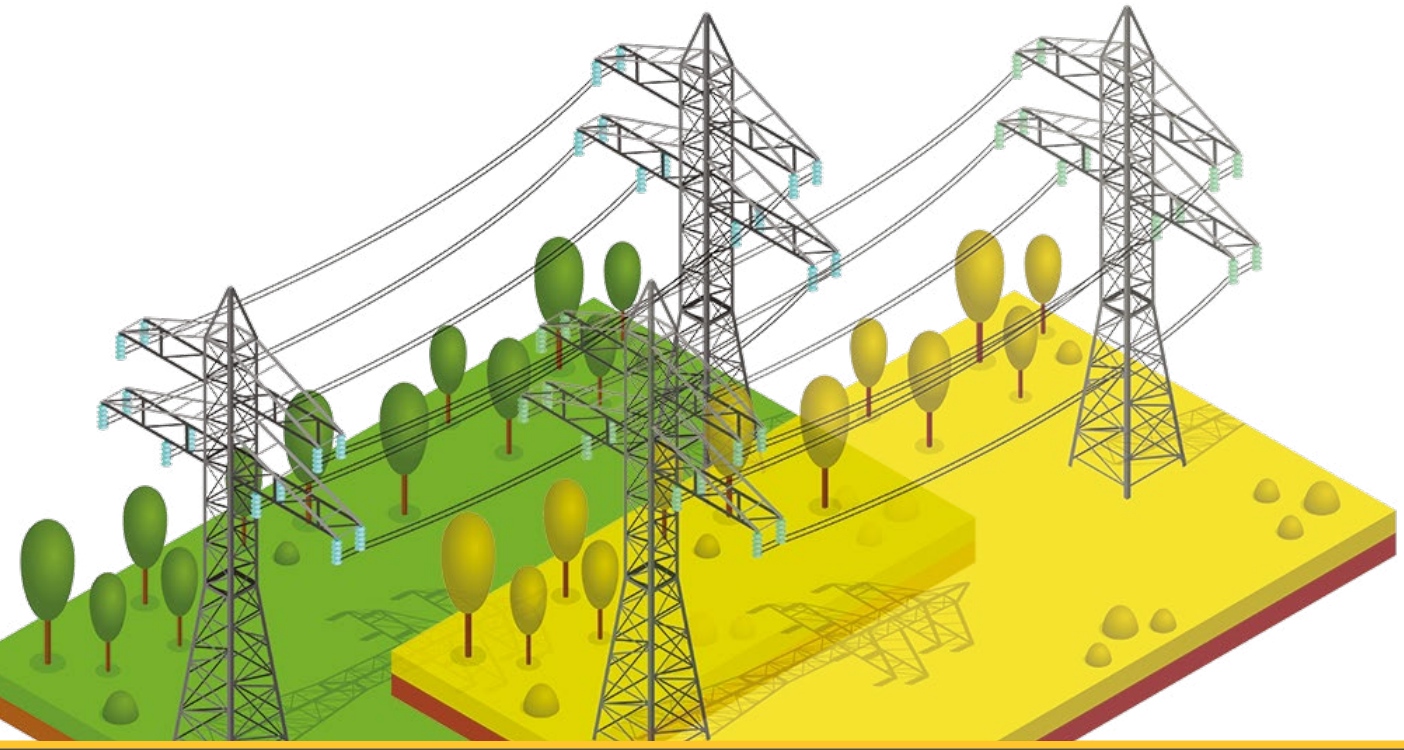
Smart technology is at the root of longevity for utility providers. No longer an exciting future prospect, cloud-operated AI technology maturity has meant digital twins are now taking center stage.

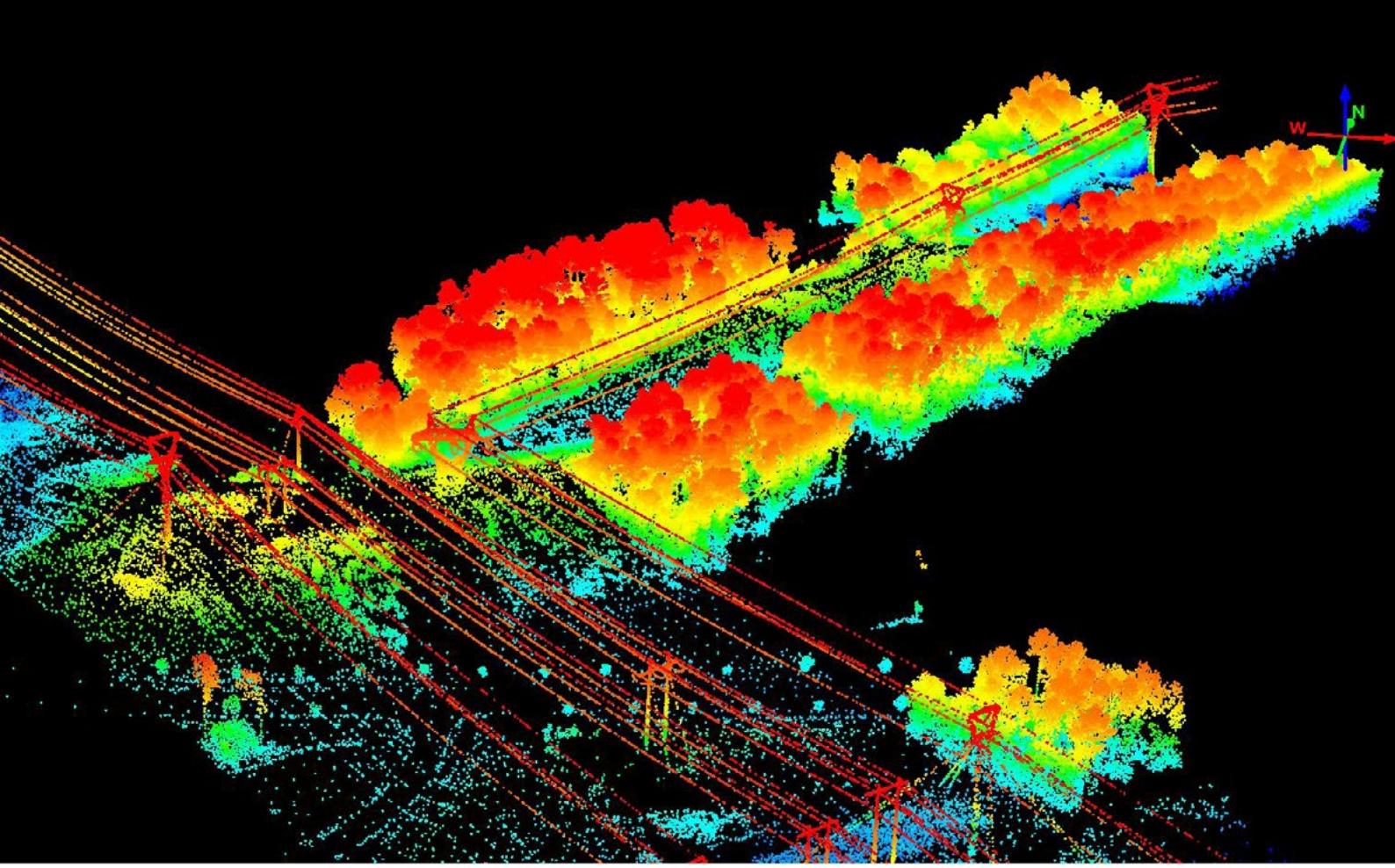
Reaching far beyond a spatial 3D model, ‘Living Digital Twins’ (LDTs) are cloud-based, highly detailed four-dimensional (4D) virtual replicas of a utility’s electric network, incorporating the fourth dimension of time with artificial intelligence-based algorithms.

Leveraging real-time aerial and ground data, as the surrounding environment and the asset itself changes, an LDT monitors and updates the model in real-time. This continuous change detection allows remote inspectors to monitor network risks, highlight qualitative differences and identify statistical patterns, while analyzing and prioritizing them in accordance with infrastructure-related needs and local regulatory requirements.

With an LDT providing a baseline, combining historical data with incoming live data creates network risk scenarios and allows for optimized resource and budget allocation, minimized risk and the highest safety standards. With this, a best practice future vegetation clearance and asset inspection plan can be made, resulting in smart, risk-based decision making.

Ultimately, this helps utilities identify problems faster and more cost-effectively by cutting down on ‘routine’ operational sweeps. For example, when it comes to vegetation risk assessment, utilizing historical risk statistics allows operators to target vegetation management in the most effective areas, whether that be due to close vegetal proximity to assets, density of fast-growth species or other factors.





How utilities can get optimal value from living digital twins

The nature of living digital twins means the longer they have data feeding in, the more mature and accurate the insights become. In summary – there's no time to waste if utilities want to get the most from this technology.

Digital twins are also enabling automated powerline inspection through advanced drone technology, particularly for beyond visual line-of-sight (BVLOS) inspections. Operators can train a fleet of sensor-equipped drones to fly the lines almost constantly, returning automatically only to recharge their batteries.

Not only is such a set-up far cheaper and safer to operate than a comparable fleet of human inspectors, it provides more detail at more regular intervals, facilitating the benefits of better planning, inspection, maintenance and vegetation management.

Perhaps most importantly when we think about the climate emergency, digital twin technology can be used to model 'what if' scenarios to gauge the effects of different scenarios in real life. For example, if a hurricane strikes at point X, what will be the effect on assets at point Y? If a downed pylon sparks a fire at point A, what residences are nearby and what does an evacuation plan look like?

When disaster does strike, through the digital twin, the network is documented, making for fast and efficient rebuilding of destroyed assets, strengthening previously weaker areas. Put simply, predictive capabilities are worth their weight in gold when it comes to disaster prevention and response.

Staying ahead of the curve: Insights into action

Digital twin infrastructure resource management (DTIRM) can be used as a baseline to link all utility activities and data sources to create a holistic view across the network. But these insights are only valuable if they are actioned effectively.

Utilities can create opportunities to work in a smarter and more streamlined manner. Instead of time-based inspections in line with traditional cycles which can be ineffective, inspections and mitigation measures are issue-based, gleaned from predictive analytics. This improved accuracy helps to lower operational costs and improve safety for crews by taking a highly predictive approach to vegetation management for the scheduling of safe and efficient inspections. Set against key KPIs, outcomes become measurable and resources are optimized for an overall healthier grid, meaning day-to-day asset productivity is improved, alongside better preparedness for weather emergencies.

With wildfire risk now posed to millions of properties across the US – 2,040,060 in California alone are at high to extreme risk from wildfires – this preparedness reduces threats of events such as these by proactively tackling causal issues such as overgrown vegetation. And equally, it allows for superior disaster response. Proving invaluable in shortening turn-around times during an emergency, the intricate, detailed understanding of the grid, assets and its surroundings, means digital twins provide an element of order in a chaotic situation and can guide the utility and emergency services alike in mounting an informed response. It does this by collecting information from different data sources and visualizing disaster status and the areas most impacted so that utilities can triage. In the event of a Public Safety Power Shut-off, this supports in reducing disaster impact on communities by returning to power distribution as quickly as possible; while also protecting the bottom line of utilities with minimized time offline.

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Laser-focus on vegetation management

Transmission utilities in areas of high wildfire risk are in a constant struggle with nature to keep the vegetation that surrounds powerlines and other assets in check. With August 2021 being the highest month on record for carbon dioxide released from burning forests, scientists are concerned that areas with dense vegetation are becoming a source rather than a sink of greenhouse gases, with nearly 2 million metric tons of greenhouse gas sequestration capability lost in the US' western states alone. On top of this, experts are warning the impact of smoke from longer-lasting more frequent wildfires could have serious health impacts.

Utility providers should seek out proactive, rather than reactive, asset maintenance and utility vegetation management (UVM) plans that model and forecast risks to eliminate hazards before they become a problem. These plans should be developed based on identified risks and subsequent growth modelling. This allows division of issues into segments of vegetation risk which allows for effective prioritization of issues and optimization of workload. For example, the most profitable approach is to trim vegetation as late as possible – before it becomes a hazard – to keep both costs and risk down. By informing line crews and arborists how to efficiently interpret and execute those plans, utilities can close the loop by providing the ability to audit the results, while also ensuring compliance with federal and state regulations and with internal operational guidelines.

A comprehensive digital twin will achieve this by incorporating the grid assets – a network of powerlines and pylons isolated on an otherwise blank screen – with the immediate surroundings, including local structures, roads, waterways and trees.

If the LDT is continuously enriched with vegetation data on factors such as the species, growth rate and health of a tree, then the utility can use it to assess and track the risk from any given twig or branch neighboring one of its assets and prioritize the dispatch of vegetation management crews accordingly.

Threat vs. solution: how to win the battle

As extreme weather continues to impact power supply consistency and poses potential damage to aging assets, threats to powerline management continue to evolve and – if global warming continues – will worsen.

Fortunately, by design, AI insights become better over time as the algorithms are refined and the datasets grow to become more representative, giving utilities the ability to set realistic KPIs and demonstrate improvement year on year, all the while keeping up with evolving risks.

In addition to the right tools, utility companies need the right mindset. Powerline inspection must be viewed as a strategic function at all levels – particularly by senior management – rather than a tactical maintenance task. Institutional silos must be broken down in order to maximize data value.

By taking this approach, spend shifts from operating expenses (OPEX) – in the sense of day-to-day trouble shooting – to capital expenditures (CAPEX) – an arguably more valuable, sustainable approach as an investment in powerline inspection capabilities that provide a framework of long-term success for utilities.

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Developed with utilities, for utilities

Utilities need a partner that can support them on the road ahead, from an efficiency and productivity point of view, but also importantly when it comes to operating in an increasingly volatile climate scenario.

Sharper Shape is already helping tier 1 utilities in the US and further afield globally navigate the impacts of climate change, accelerate their journey to net zero, improve grid resiliency and enhance overall operational performance. Our technology helps utilities to minimize risks both of and from extreme weather events, such as wildfires.

As a global provider of automated aerial inspection and asset intelligence software solutions, we focus on Infrastructure Resource Management, with an emphasis on the electric utility industry.

For utilities, we provide cutting edge answers for these crucial operational needs:

How to continuously secure the flow of power:

- To know everything that goes on in the network, plan ahead in an optimized way, while taking the highest levels of safety, efficiency and accuracy.
- Being fully compliant and keeping the network interruptions as short as possible to reduce penalty fees.

How to do it as cost effectively as possible:

- The need to optimize OPEX budget network planning, risk assessments and smart decision making
- The need to get the maximum value from data
- The need to be as profitable and compliant as possible, while maintaining a high public opinion and customer satisfaction

Sharper Shape's unique technologies have been developed with utilities for utilities to answer their specific pain points and needs while upgrading their system maintenance programs to increase safety, enhance efficiency and reduce costs.

Our flagship solution Sharper CORE uniquely collates all automated collection, inspection and reporting capabilities in a single, powerful AI and ML- driven software platform, providing the utility with a 4D Living Digital Twin.

While other solutions use visualization and storage methodologies, we have architected Sharper CORE to be a true Living Digital Twin; a 4D, AI, and cloud-based model of utility and critical infrastructure assets, that enables capabilities far beyond traditional visualization. As infrastructure assets and the surrounding environment change, our LDT captures these changes and updates them in near real-time, able to ingest and incorporate all ongoing data collections by any third party, from the ground and the air. The real-time digital twin brings temporal insights to the operators on a scale previously unseen.

Combined with our innovative aerial sensor imaging payload, cutting-edge AI and ML algorithms provide wildfire risk assessment, specific asset preventative maintenance and UVM prescriptions. In fact, the LDT allows us to predict and simulate risks at network and circuit area levels, right down to spans and individual component issues. This enhances planning on where and when to allocate maintenance budgets for optimal risk mitigation. We then work closely with utility companies to ensure preventative maintenance and vegetation management plans can be followed, thereby ensuring that wildland fire risk is mitigated, greenhouse gas emissions are reduced, and our electric network is 'hardened'.

The future is in the power of data – and how effectively it is used. That's why we are committed to helping utilities evolve and positively impact their collection, inspection and reporting capabilities through the use of LDTs. In doing so, we ensure that down the road, utilities will be able to fully utilize the benefits offered by this innovative technology.

As our clients continue to evolve, so do our products, integrating more cloud-based computing, storage, and AI cognitive algorithms to enhance insights and reduce delivery times. We are adding new capabilities that were not possible even a few years ago, using

sharper intelligence, to create a safer world.