WHITE PAPER

Wildfire Mitigation Best Practices for Electric Utilities

Cost. Control. Compliance

APRIL 2022

AIDASH

Chapters

Introduction

The ever-increasing intensity and frequency of wildfires in the past decade across multiple continents have pushed electric utilities to look for extensive wildfire and risk mitigation strategies. However, wildfire risk mitigation remains a complicated and staggering challenge for utility companies. Certain parts of the world, like Western United States, Canada, Australia and Central Africa, are wildfire-prone and have witnessed some of the most devastating fires in the recent past.

On average, wildfires burn up to 5 million acres of land in the United States each year. While they can start naturally or by humans, wildfires are also sometimes caused by power utility infrastructure. Human-induced ignitions start most wildfires. Electrical power lines constitute a significant majority of these fires, the third most common cause behind equipment use and debris burning. Power line fires are estimated to occur hundreds of times each year, a recent study suggests.

Not only are wildfires becoming more common and impacting humans and wildlife in the areas, but they're also becoming more and more costly. Total potential exposure for single-family residences to wildfire damage in California alone is greater than $240 billion. There are multiple stakeholders in this game, including but not limited to power utilities, governments and other regulatory bodies that collaborate to mitigate risks to save lives, property, costs and liabilities.

Experts suggest that global warming and climate change have intensified the scale and frequency of wildfires in the past two decades. Increasing heat, unpredictable shifts in rain and snow patterns and other climate-related changes have increased the likelihood that fires will start more often and burn more intensely and widely than they have in the past.

While it might be impossible to prevent climate-related wildfires for utilities, vegetation-related wildfires can be prevented and controlled by implementing the right strategies. Vegetation management, infrastructure monitoring and other such practices need a rehaul to meet today's urgencies using today's technologies.

This White Paper highlights all of the above causes, effects and real-world solutions for electric utilities that can help mitigate wildfires and other risks involved. The content also outlines methods utilities should undertake to reduce costs, financial risks and improve reliability associated with power line-initiated wildfires.

Readers will also benefit from real-life examples that detail how other power utilities use novel, state-of-the-art technologies, like satellite analytics and Artificial Intelligence, to prevent such wildfires.

CHAPTER ONE

Wildfires and Power Utilities: The Constant Struggle

California, Oregon, Alaska, Montana, Arizona – These are just some names of the states where wildfires have entirely blazed out of control in the recent past. Wildfires happen in every corner of the world, but no other developed country is as affected as the United States.

Western US, especially California, has witnessed larger fires in each of the last few years coupled with more intense burning and destruction. Forests and grasslands cover large chunks of land in the United States and are a significant part of the natural ecosystem. As a direct consequence of human-induced climate change, these vegetation tend to dry up quickly, especially during the dry season, causing wildfires to spread rapidly when such unfortunate instances occur.

Besides burning large pieces of land and polluting the environment, wildfires inadvertently lead to mass-scale power outages. Often, power utilities fearing the occurrence of a wildfire are left with no choice but to roll blackouts, infuriating customers in the process.

10%

Of all wildfires in California are caused due to utility ignitions..
- Elizaveta Malashenko, former Deputy Executive Director, CPUC

50%

Of the most destructive fires in California since 2015 have been linked to a large utility's electrical network.

$30B

Damage from deadly California wildfires in 2017 and 2018 cost a large power utility $30 billion in liabilities, pushing it to the brink of bankruptcy.

25%

Of the wildfires associated with power distribution systems are preventable

Fallen Power Lines: A Top Cause for Utility-led Wildfire Ignitions

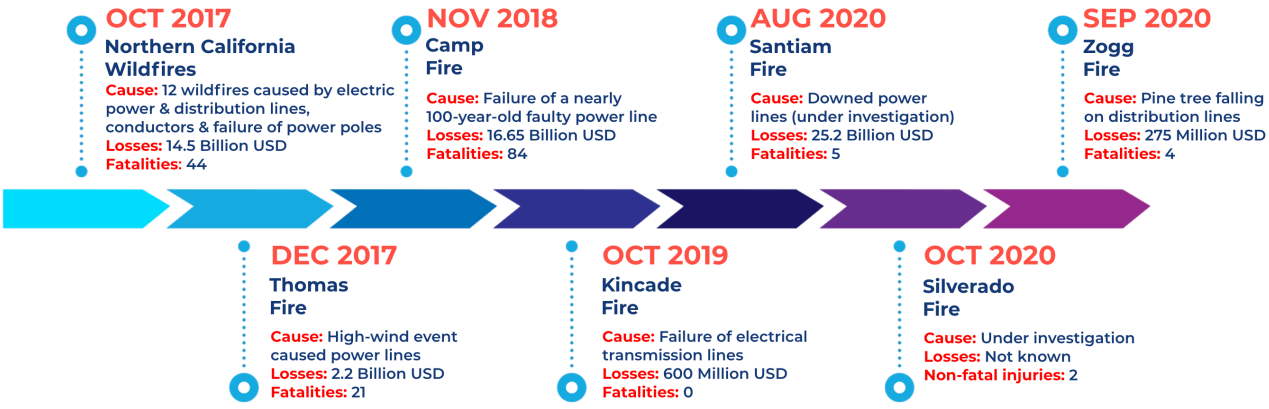
Fallen power lines rank among the top causes of wildfires, ranking as the third most common cause of wildfires in California. In some cases, it only takes a branch falling from a tree and striking a power line to create sparks. Nearly 10% of wildfires result from fallen power lines, which equates to roughly 400 fires per year in California.

Over the past six years, over 1,500 Californian wildfires were caused by fallen power lines, including the deadliest fire in history—the Camp Fire, which destroyed over 18,000 structures and took 85 lives. The prominent California utility company, Pacific Gas & Electric Co. (PG&E), has faced lawsuits for its responsibility in igniting a series of wildfires in 2017 and 2018 (including the Camp Fire). In 2020, PG&E paid an $11 billion settlement to resolve all insurance subrogation claims from these fires.

Power utilities are in business to provide reliable electricity to customers. Naturally, when that does not happen, customer complaints skyrocket. Blackouts not only disrupt daily life and companies but are also a glaring reminder that power utilities have failed in their mission.

Often, high winds cause tree branches to fall on utility infrastructure, generating sparks, leading to fires. While sometimes, power lines may also fall on dry grass and vegetation, igniting a fire in the process. One might argue that the US grid is old and needs to be updated to avoid such mishaps. But it is worth noting that the US grid is one of the largest, longest, albeit oldest, still working power grid in the world. Updating the grid will mean not only huge expenses that go beyond budget but also very tedious work.

Recent Electric Utility-Led Wildfire Ignitions: A Timeline



Climate Change Fueling More Wildfires Than Ever

Once confined mainly to a single season, fires have become a continual threat in some places, burning earlier and later in the year in the United States and abroad. They have ignited in the West during the winter and well into the fall. They have arrived earlier than ever in Canada and have burned without interruption in Australia for almost 12 months.

There's enough and more evidence that climate change is real and is fueling longer, bigger and more intense wildfires. Here are **3 points** to support this statement -

EVER-INCREASING HEAT - Ever-increasing heat coupled with snow melting and changing rain patterns have detrimental effects and contribute to such anomalies.

DENSELY POPULATED HIGH-RISK ZONES - According to sources, 84% of the fires in California in recent years have been started by humans. This might happen more if areas are densely populated.

WARMING AIR TEMPERATURES - Warming air temperatures make it easier for fires to ignite. California's average temperature has trickled up by 3-degree Fahrenheit, which explains why fires frequently occur in the state.

Most of the western USA suffers from being labeled as a wildfire-prone zone and California being the Silicon Valley of the world, is no different. Here are a few recent instances that show why wildfires need to be prevented and the kind of detrimental effects they have on power utilities and the economy:

- According to a Wildfire Mitigation Strategy report, **53%** of ignitions were caused by contact with foreign objects, out of which 35% are from contact with vegetation
- The second most common cause of all ignitions is equipment failure
- 2020 saw **9,600** occurrences of fire and cost the economy a record-setting **$12 billion**
- There have been nearly **5,000 fires** in California since the beginning of 2018
- In 2018, **Camp Fire** led California's largest utility company to file for bankruptcy protection amidst **30 billion USD** in potential liabilities owing to wildfires in 2017 and 2018
- A major utility company that serves around 16 million customers started rolling blackouts in parts of Northern California to reduce wildfire risks

CHAPTER TWO

Variables Influencing Wildfire Mitigation for Power Utilities

With awareness comes action. Wildfire mitigation is the collective responsibility of all stakeholders - including power utility supervisors, policymakers, municipalities, public safety organizations and academia. The urgency of the problem often catapults them towards hasty implementation of solutions. But that's not the ideal approach for obvious reasons. It's almost impossible to implement an effective and efficient program overnight for such a complex problem. To mitigate such a threat, utilities must be equipped with a robust strategy.

The stakes are high when it comes to wildfire risk mitigation. Several key factors influence the decisions of stakeholders:

VEGETATION MANAGEMENT

Trees coming in contact with power lines have caused many significant wildfires in the recent past. Vegetation management continues to be a sore thumb for most utilities even today. From removing high-risk trees and overhangs to clearing Rights-of-Way effectively, the process of vegetation management is complex and very costly, yet ineffective. Many variables, such as vegetation type, speciesgrowth rates, density, forest clearance history, location, climate factors (drought, high winds), soil conditions, etc., impact the effectiveness of wildfire strategies. If vegetation management fails, all other strategies to prevent ignitions can fall flat. A proactive vegetation management program is critical in high fire risk areas.

NO COST-EFFECTIVE APPROACH

More often than not, costs play a major role in shaping the wildfire strategies for utilities. It depends on the nature of the utility: whether it is a large investor-owned utility or a smaller municipality-owned utility, its location, its transmission and distribution network in line miles. There has been a longstanding debate about burying powerlines underground, but it is a very expensive solution. Undergrounding high-voltage power lines can cost up to $5 million a mile and cost large utilities with expansive networks over $100 billion. Many large utilities have also faced massive liabilities in the past pertaining to wildfire damages.

STATE REGULATIONS AND ACCOUNTABILITY

After the Camp Fire in 2018, utilities have come under increased scrutiny from regulatory bodies like the California Public Utilities Commission (CPUC). Mandatory wildfire mitigation planning processes have been imposed on utilities along with a Governor-appointed Wildfire Safety Advisory Board to guide and track efforts of utilities' mitigation efforts. The plans now have to include metrics gauging their effectiveness in reducing wildfires and other mitigation measures that had been set forth by last year's passage of state laws. In addition, other state agencies are getting involved.

ASSET MONITORING AND INSPECTION

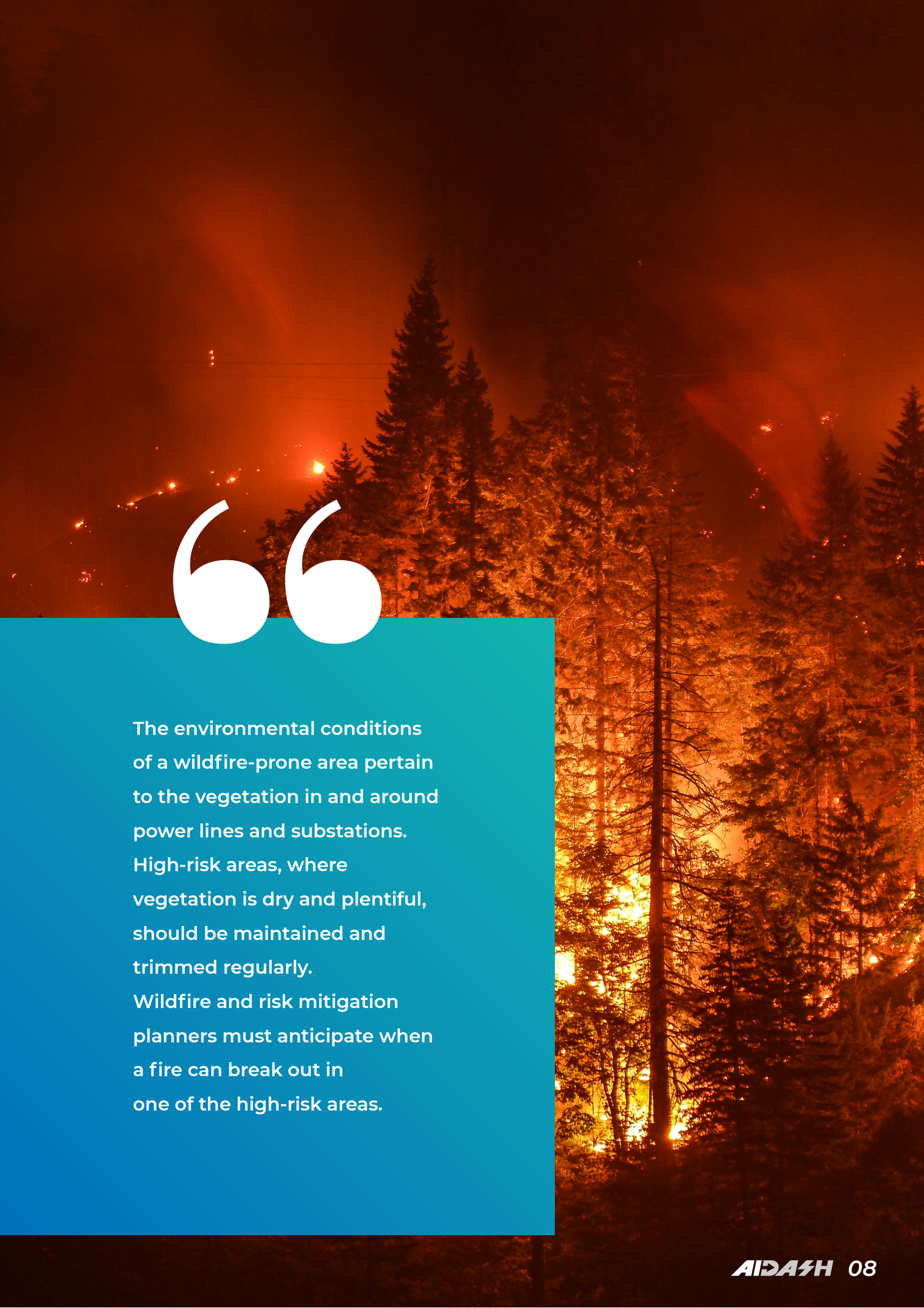
Aging grids are one of the biggest concerns for wildfire risks. Constant inspection and repair of aging power system infrastructure minimize the risk of ignition in high fire risk areas. Inspections of distribution poles, transmission structures, pole-mounted equipment and substations should be conducted to identify potential risks. But, are asset monitoring and inspection activities being optimally performed? If not, how can they be enhanced so that they can align with wildfire mitigation strategies? These parameters often impact decision-making.

DATA AGGREGATION AND VISIBILITY

Data from assets provides visibility into the state of the power system so that operators can quickly adjust the power supply and prevent fire risk conditions. Consequently, utilities must shutoff power in response to an increased fire hazard as per regulatory advisories. While pre-emptive power shutoffs become necessary, it is often a major cause of customer dissatisfaction. To enable a more robust wildfire strategy, data is key and so is visibility. In the absence of both of these, decision-making is often incomplete.

CURRENT TECHNOLOGIES OFFERING ONLY LIMITED PROTECTION

Fire mitigation technologies are still either new to the marketplace or provide limited or partial assistance in solving this complex problem. While a one-size-fits-all approach will not work, the challenge is to find the right combination of technologies to address possible gaps. Specific technologies can help reduce risk in each of these stages by identifying vulnerabilities (such as high-risk geographic areas or aging infrastructure), detecting incidents in a timely manner and efficiently deploying and managing response assets. In the recent past, utilities have been using helicopters, drones and LiDAR technology to survey and monitor vegetation and power lines, but have they been effective? Let's find out.



The environmental conditions of a wildfire-prone area pertain to the vegetation in and around power lines and substations. High-risk areas, where vegetation is dry and plentiful, should be maintained and trimmed regularly. Wildfire and risk mitigation planners must anticipate when a fire can break out in one of the high-risk areas.

The three stages of wildfire risk life cycle

PREVENTION

Prevention attempts at minimizing the possibility of a wildfire. Vegetation management, asset monitoring and hardening, steel pole conversion, RoW clearance and other such activities are part of the preventative programs.

DETECTION

Detection aims to limit the occurrence of a wildfire by decreasing time to intervene. Initiatives include increasing the frequency of patrols and implementing new-age detection technologies, such as satellite imagery.

RESPONSE

Response aims to reduce the impact of a wildfire. Response initiatives include upgrading response procedures to include automated messaging and emergency preparedness tools and monitoring patrols, weather data and more.

CHAPTER THREE

Emerging Technologies Enabling Wildfire Risk Mitigation

Industry 4.0 is here. This is the era of automation of traditional manufacturing and industrial practices using modern smart technology. We're in the midst of a complete digital transformation and new technologies - like Machine Learning and Artificial Intelligence - are changing the way core industries function.

After a careful analysis of a utility's wildfire risk situation and identifying gaps, it is necessary to develop a strategy that will help the organization achieve its vision. To do that, it is pertinent to decide how to deploy technology to execute each stage of the wildfire risk lifecycle.

According to an insightful article on "A holistic approach to meeting wildfire mitigation goals", a variety of technologies exist to achieve the respective goals:

- Prevention technologies include 3D vegetation survey data analysis, accessing satellite data, hardening infrastructure, threat indices, asset health assessments, power diversion/shutoff procedures, microclimate data and data correlation algorithms.
- Detection technologies include thermal cameras with AI ignition detection, real-time threat models, first responder/emergency team communication procedures and satellite image monitoring.
- Response technologies include predictive fire spread models, response team planning, satellite image monitoring and community outreach platforms/ alert systems.

Remote Sensing Technology

Among the many technologies available for utilities out there, remote sensing technology has proved to be groundbreaking in ways more than one. Remote sensing is a crucial geospatial technology that helps acquire information about an object or phenomenon without making any form of physical contact, typically using satellites or air-bound devices.

Popular Remote Sensing Tools

SATELLITES make remote sensing the most accessible technology globally. Being the most reliable data source worldwide, they have been used in the geospatial space for almost six decades now. They are used widely in environmental monitoring forecast and research, mapping, aircraft monitoring, military intelligence, predicting forest fires, optimizing solar panel energy, and so much more.

AERIAL PHOTOGRAPHY is all about taking photographs from an aircraft or any airborne flying object. In airborne remote sensing, downward or sideward-looking sensors are mounted on an airplane to obtain images of the Earth's surface. It is now used for cartography, power line inspection, movie production, surveillance, vegetation, and ocean mapping. Aerial Photography can be conducted in various ways by airplanes, helicopters, unarmed aerial vehicles (UAVs), and other airborne objects.

LiDAR, a portmanteau of light and radar, is used to measure distances by illuminating the target with a laser and measuring the reflection with a sensor. First introduced in the 1960s, its first applications came in meteorology, although now used in agriculture, archaeology, geology, conservation, etc.

The Rise of Satellites

Technological advancements and pathbreaking innovations have ushered in a new era of earth observation, making satellites more relevant to businesses and the public good. Today, satellites as small as SIM cards and costing as little as $2,000 can send terabytes of images of the planet daily.

Data collected from satellites can play a crucial role in wildfire mitigation. Electric utilities are already using high-resolution satellite imagery and Synthetic Aperture Radar coupled with AI and analytics for vegetation management - and succeeding at it. Similarly, vegetation growth, trim cycles, identification of hazard trees and other vegetation-related activities can be performed in wildfire-prone areas as well along transmission and distribution networks. But more on the how later. Let's first find out how satellites are better than any other remote sensing tool out there.



Features	Satellite	Drones w/ LiDAR	Helicopter w/ LiDAR
Resolution	12-inch High Resolution	VHR	VHR
Perspective	Overhead	Overhead	Overhead
Bands	MultiSpectral, Mono, TriStereo, SAR, Hyperspectral	Visual, LiDAR, additional bands can be added	Visual, LiDAR, additional bands can be added
Speed of Data Acquisition	Instant	Very Slow	Fast
Geographic Coverage	Entire Planet	Localized	Regional
Regulatory Approval Needed	None	Required	Required
Historic Data	Available	Not Available	Not Available
Clearance Detection	Yes	Yes	Yes
Change Detection	Yes	No	No
Costs	**$**	**$$$$**	**$$$$**

The most significant trend driving the earth observation industry is the growth in the availability of data, which has been fueled by an exponential growth in the number of satellites. Satellite imagery can prove instrumental in preventing, detecting and responding to vegetation-related wildfires and that too remotely. Let's find out how satellites are blazing the trail in this space:

HIGH-RESOLUTION IMAGERY – Satellites today offer 30-cm Very High-Resolution multispectral imagery as well as Synthetic Aperture Radar (SAR) Imaging.

SAR – SAR is unique in its imaging capability. It can "see" through the darkness, clouds, and rain, detecting changes in habitat, levels of water and moisture, effects of natural or human disturbance, and changes in the Earth's surface after events such as earthquakes or sinkhole openings

SPEED – Almost instant and non-stop inflow of data is available via satellites

PERSISTENT SURVEILLANCE CAPABILITIES – The ability to revisit the same place repeatedly and get the same image quality regardless of weather and day or night is only possible via satellites.

CHANGE DETECTION – Long term datasets allow experts to examine an area over time, see what changes (if any) are indicated, and determine the cause. Not only are the data of use in studying the past, but they can be used to forecast future changes based on past trends.

1/10TH CHEAPER THAN DRONES - As far as costs are concerned, large-area mapping is most affordable with the help of satellites. In contrast, drones and aircraft-based data collection have very high operational costs.

COMPLIANCE - No regulatory compliance or approvals needed.

> **Every once in a while, a new technology, an old problem, and a big idea turn into an innovation.**

CHAPTER FOUR

Wildfire Mitigation Models Powered by Satellite Analytics and Artificial Intelligence

Satellite data needs to be processed and analyzed using advanced machine learning algorithms and Artificial Intelligence to identify areas and perform change detection. With the help of Artificial Intelligence, powerful algorithms are used to process large volumes of data to identify areas of encroachment and potential failure points with better than human accuracy at scale.

With the successful utilization of AI, there is a much lower dependence on the ground-level workers to take reactive actions to minimize damage, as AI will enable a more proactive and predictive approach to vegetation management.

AI Development Process

DATA COLLECTION

Ground Data Collection
Build Historical Insights

PREPROCESSING

Clean dataset for modeling
Label points of interest for modeling
Development data pipelines

MODEL TRAINING

Train models on data set
Tune model for accuracy
Re-training as needed

MODEL VALIDATION

Test set performance
Field Validation Feedback

How do AI Models Work?

Combining high-resolution multispectral satellite images with Artificial Intelligence offers increased visibility on vegetation growth around transmission and distribution grids. This can help predict tree growth, plan cycle trims, and prioritize risk-based maintenance before anything else.

AI models can use the data to quickly and accurately process vast and complex inputs from geospatial and time-based datasets, helping utilities monitor the entire service territory for vegetation overgrowth and identify power line infringement.

These AI models can identify vegetation management activities, assess risk, and measure task completion for compliance and reliability.

With satellite data, the AI models use location, weather, soil, and tree species to identify and classify vegetation management tasks. These tasks are then prioritized as routine, preventive, or on-demand tasks.

A mobile app and a web dashboard are user access points that help stakeholders assign and execute tasks on the ground. This model optimizes future decision-making by combining field inputs, vegetation data, and pre-trained models for growth rate, trim cycles, and labor hours.

Popular Satellite and AI Models Today

DIGITAL ELEVATION MODEL

A digital elevation model (DEM) is a 3D computer graphics representation of elevation data representing terrain. There are several ways to create digital elevation models, but mappers and experts frequently use remote sensing rather than direct survey data. Here are a few use cases for the DEM with regards to Vegetation Management:

- Object height computation & 3D point cloud generation using stereoscopic satellite imagery
- Helps in detecting vertical clearance between power lines and trees
- Analytics on horizontal distances between hazard and distribution line computed against actual hazard tree height

Watch Video

SUPER RESOLUTION MODEL

In easy terms, Super Resolution is the process of obtaining a High Resolution (HR) image from a Low Resolution (LR) image. Deep learning and AI can estimate the High Resolution (HR) image from a small size, degraded image. This is particularly useful in improving satellite imagery to view power lines and trees with better clarity. Let's understand the functionalities of the Super-Resolution Model:

- The supervised satellite super-resolution model helps in generating high-resolution imagery from low-resolution satellite imagery
- Significantly improves AI model performance for attribute detection (tree, grass, buildings, etc.) via low- resolution satellite imagery
- Reduces error margin in computing & geo-encoding distances of hazards (e.g., tree encroachment) from power lines

Watch Video

The Super Resolution Model is a supervised AI model that can generate high-resolution images from low-resolution images.

“Using satellite technology allows us to concentrate our planning in the office rather than in the field. Human-based inspections are temporal and costly. Satellite imagery paired with circuit performance gives us a much more accurate picture of vegetation risk and helps us target hotspots and emerging threats. This is a game-changer”

AVISTA

David James
Wildfire Resiliency Plan Manager

CHAPTER FIVE

Cost.
Control.
Compliance.

For the 2022 fire season, the writing is on the wall. The West, despite a few days of intense winter, is far drier than it was leading up to last year's record-breaking fires. It's now time for electric utilities to be action-oriented and implement the right technologies that can mitigate wildfire risks. From remote monitoring and survey of vegetation along their T&D networks to complying with the regulations, it is now time to pack it all into an action plan.

To summarize the action plan, we've devised a 3C policy that can truly transform wildfire mitigation policies for your utility company. Read on to know what the 3Cs stand for:

COST

This White Paper talks at length about losses, liabilities and utility bankruptcies that have occurred in the past. But things are bound to change now, for the better. Instead of losses and liabilities, utilities can save costs by opting for the right wildfire prevention strategies and state-of-the-art technologies.

AiDash has developed the Intelligent Vegetation Management System (IVMS to empower utilities with AI and satellite technology. AiDash IVMS is already enabling large Fortune 500 utility companies reduce costs by 20% and improve reliability by 15%. Any electric utility company's wildfire mitigation strategy and vegetation management must go hand-in-hand for the best results.

AiDash Remote Monitoring & Survey System is another satellite-powered that has been exclusively designed for power utilities. The Remote Monitoring and Survey System provides stakeholders complete visibility of their Transmission and Distribution Lines, including vegetation hazards, RoW encroachments, wildfire risks and weather-related damage. It empowers them with the control they need for proactive and preventive operations and maintenance.

In addition, satellite analytics and AI-powered models can prove instrumental in preventing wildfires, thus minimizing power outages and revenue loss in the process. It will also eliminate instances of liabilities, saving billions of dollars.

CONTROL

The use of AI and satellite-powered models for wildfire mitigation will enable power utilities to gain complete control over their Transmission and Distribution network, power lines and the vegetation around it. So far, it has only been possible in bits and pieces using drones, helicopters and LiDAR. However, satellites will provide a 360-degree view and easy access to stakeholders, thanks to an AI-driven web dashboard and mobile app.

Moreover, the models can combine satellite data with ground truth to provide historical, present-day and predictive insights into vegetation growth, weather-related information and necessary measures to be taken before, during and after wildfire season.

COMPLIANCE

Several regulatory bodies have put electric utilities under a scanner, scrutinizing their every move regarding wildfire mitigation. Enhanced vegetation management, system hardening, system automation, asset repair and inspection, PSPSs are all part of mitigation plans that have been submitted to bodies like the California Public Utilities Commission.

Compliance is key when it comes to the prevention of wildfires and so is choosing the right technology. If we talk of drones and LiDAR technology, their biggest disadvantage is that the cost are very high due to the labor-intensive process of collecting the data. The compliance is often a complex process as regulatory approvals are needed to fly these UAVs. Another issue is that constant monitoring is not possible and there is a gap between data updates, which can often be anything between 5 to 10 years.

Satellites have completely revolutionized remote monitoring and survey of T&D lines. With its groundbreaking technology, they provide the most accurate, weather-independent imagery (SAR-equipped satellites can easily penetrate clouds, no matter how bad weather conditions might be). Their geographic coverage wavelength is the entire planet and needs no regulatory approvals. They can store historical data that can be used whenever necessary and improve ground-based efficiency and targeting, so you only visit the relevant areas.

Satellites in. ~~Drones & LiDAR out~~

Reduce Cost by 20%

Improve Reliability by 15%

Conclusion

Without exception, utilities are putting significant time, money and resources into discerning wildfire risk and implementing risk mitigation measures. Wildfires present a unique financial threat to US power and utility companies. After witnessing year-long wildfires, it's only wise to take the help of accurate, accessible and cost-effective technologies to mitigate these risks.

Satellite analytics and Artificial Intelligence are not futuristic technologies anymore. They have become more accessible and cost-effective than ever before. The future of wildfire mitigation strategies includes satellites and AI. And, it is also true that the future is now.

It is our collective responsibility to prevent wildfires, not just for business objectives, but also for the environment and humankind. AiDash believes that the right technology and the right intention can make it possible to accomplish this complex task at hand.

We hope this White Paper could validate why power utilities must adopt satellite analytics and AI-powered tools to manage vegetation around power lines and prevent wildfires in the process.

About AiDash

AiDash is an AI-first vertical SaaS company enabling satellite-powered operations and maintenance for utility, energy, and other core industries with geographically distributed assets. AiDash uses high-resolution, multispectral and SAR data from the world's leading satellite constellations that are fed into its proprietary AI models to make timely predictions for O&M activities. These AI models empower AiDash's full-stack applications and enable efficient planning, prioritization, execution, review and audit of O&M activities using satellite analytics.

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