VEGETATION MANAGEMENT

Harnessing the Grid for Wildfire Detection - Fiber Sensing from Above

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Tiffany Menhorn

Not your grandfather's wildfire anymore

The Wildfire season has changed. Once most active between the months of April through September, wildfires are now a threat year-round in the US. The fires are generally getting worse, too. According to the National Interagency Fire

Center (NIFC), of the 10 years with the largest acreage burned, all have occurred since 2004, including the peak year in 2015. This period coincides with many of the warmest years on record nationwide.

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Wildfires take a tragic human toll. The fire on Maui island on August 8, 2023, was the deadliest in modern history, taking 100 lives and wiping out the entire seaside town of Lahaina, while the infamous 2018 Camp Fire in northern California claimed 85 lives and burned more than 18,000 structures, mostly homes. There is a significant financial cost to fight wildfires; in 2022 alone, according to NIFC, the federal government spent more than $3.5 billion just on fire suppression. That figure does not include direct financial losses, or the cost of lost business revenue and personal income in the wake of fires. Since 2000, there have been 16 wildfire events that caused more than $1 billion each in direct damage. At the height of wildfire season in 2023, there were 53,610 wildfires in the U.S., burning 2,607,698 acres, a little less than the area of Delaware and Rhode Island combined.

Certainly, failing electric transmission infrastructure including towers and conductors can and have sparked wildfires. But frequently, bulk power system infrastructure is itself damaged by them, leading to power outages lasting hours to weeks. And the nature of the fires—burning a scar across huge swaths of land —creates more problems. The scorched, smoldering earth left behind may inhibit and delay access to repair workers for days, and result in lost revenue in the millions for utilities.

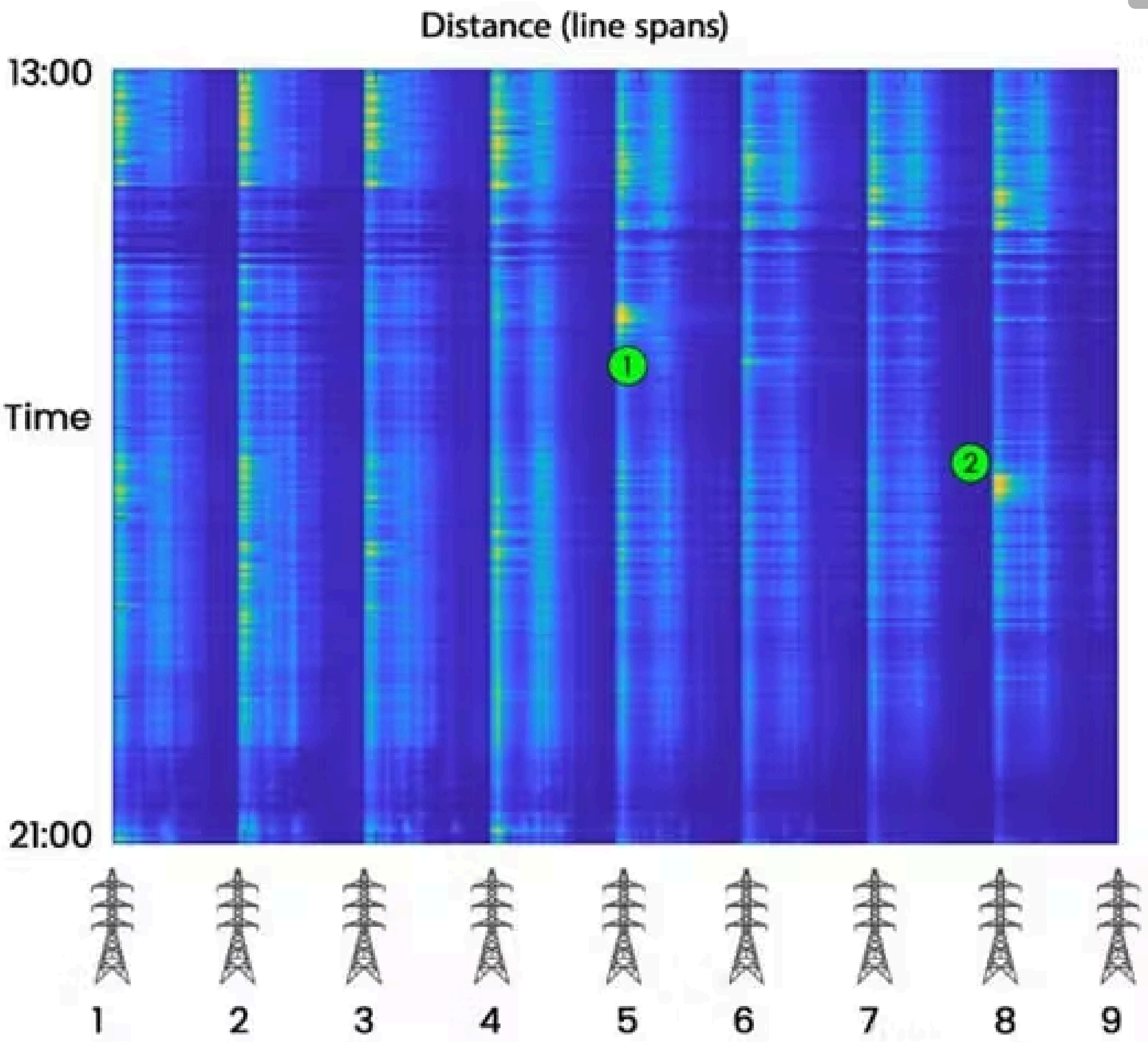
Early Wildfire Detection: A Critical Necessity

Early detection and immediate warning of wildfires is essential to a reliable and resilient electric grid. There are a number of technologies that purport to do this. However, while functional, these often present challenges in terms of efficiency and effectiveness. Satellite monitoring, though capable of covering vast areas, can be hindered by cloud cover and the delay in data processing times. Aerial surveillance, utilizing manned aircraft and drones, offers real-time imagery but is limited by flight times, weather conditions, and labor costs. Infrared camera's effectiveness is contingent on the installation locations and can be obstructed by terrain or vegetation. Finally, ground patrols, a traditional method, ensure direct human observation but are significantly limited by the ground they can cover and the speed at which they can respond to remote or inaccessible areas.

Optical Fibers - monitoring all along the power line

Fiber Sensing offers another, more efficient monitoring technology for utilities to detect wildfires in real time. Prisma Photonics utilizes the optical ground wire (OPGW), which can be found on top of the transmission network, turning it into a highly sensitive sensor. Optical fiber sensing uses the existing optical fiber, monitoring for changes in light reflected from the fiber. Laser signals are transmitted into the fiber from a substation, monitoring back reflections. When an external event, such as a large temperature change due to a moving fire front, hits the fiber, the reflections change, and an alarm can be triggered with the location. Prisma Photonics offers this power line monitoring without any new installations on the conductors or towers at all.
This concept was demonstrated with a brushfire that took place in August 2023 in the northern parts of Israel. A fire broke out near a 160kV line, which is monitored by PrismaPower, a power line monitoring suite. Starting at about 1:00 in the afternoon, the fire swept through the dry grass and trees, presenting a significant threat to local property and residents.

The raw data captured on that line’s fiber optic lines tells the story of the fire. The data is shown in a waterfall format, capturing the energy recorded on the optical fiber on top of the line. The image shows part of the line, 9 towers, with a few hundred feet in between them. The color shows energy levels, and the top portion of the waterfall image shows how the energy from the heating process travels from Tower 1(top left corner) over time (which is depicted as the Y-Axis) toward Tower 9. As the firefront moves and a breeze kicks in, some cooling of the lines and fiber can be seen in a cooler blue. Towers 5 and 8 show a burst of what appears to be a fire around the tower at a certain stage (points depicted in 1,2, respectively).

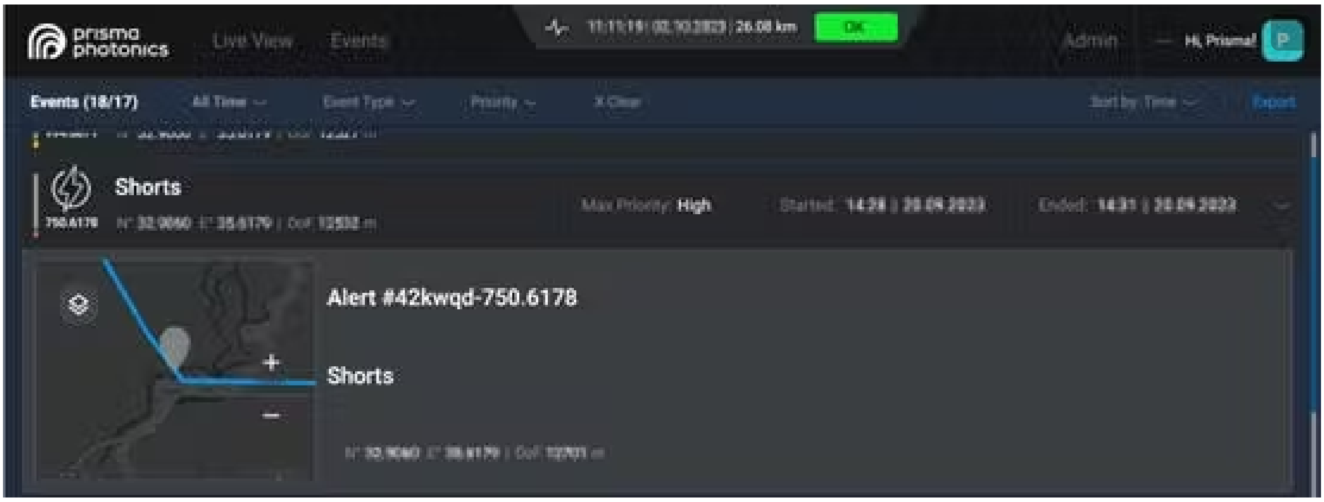


A waterfall depiction of wildfire raw fiber sensing data captured by PrismaPower transmission line monitoring suite

A firefighting plane circling above later that day observed the tower marked below with an arrow as tower #5 at one of the fire centers, which corresponds with the data captured by the fiber some tens of feet above the fire. The optical fiber was unharmed, and the data was captured by a fiber sensing unit residing in a cool communication room at a substation tens of miles away.

Firefighter plane photo of the burned area. Arrow marks power tower #5

The raw data shown above is fed into machine learning algorithms and AI models that can pick up different anomalies, such as strong and fast heat change, which is typical of a wildfire, and send an alert to a control center with tower locations to help direct transmission operators to the right place, saving time and in the case of a wildfire probably more than that. Other anomalies can be tracked such as, for example, short circuits, which were also detected on tower #5, most likely because of bad insulation due to soot and heavy ash particles in the air.

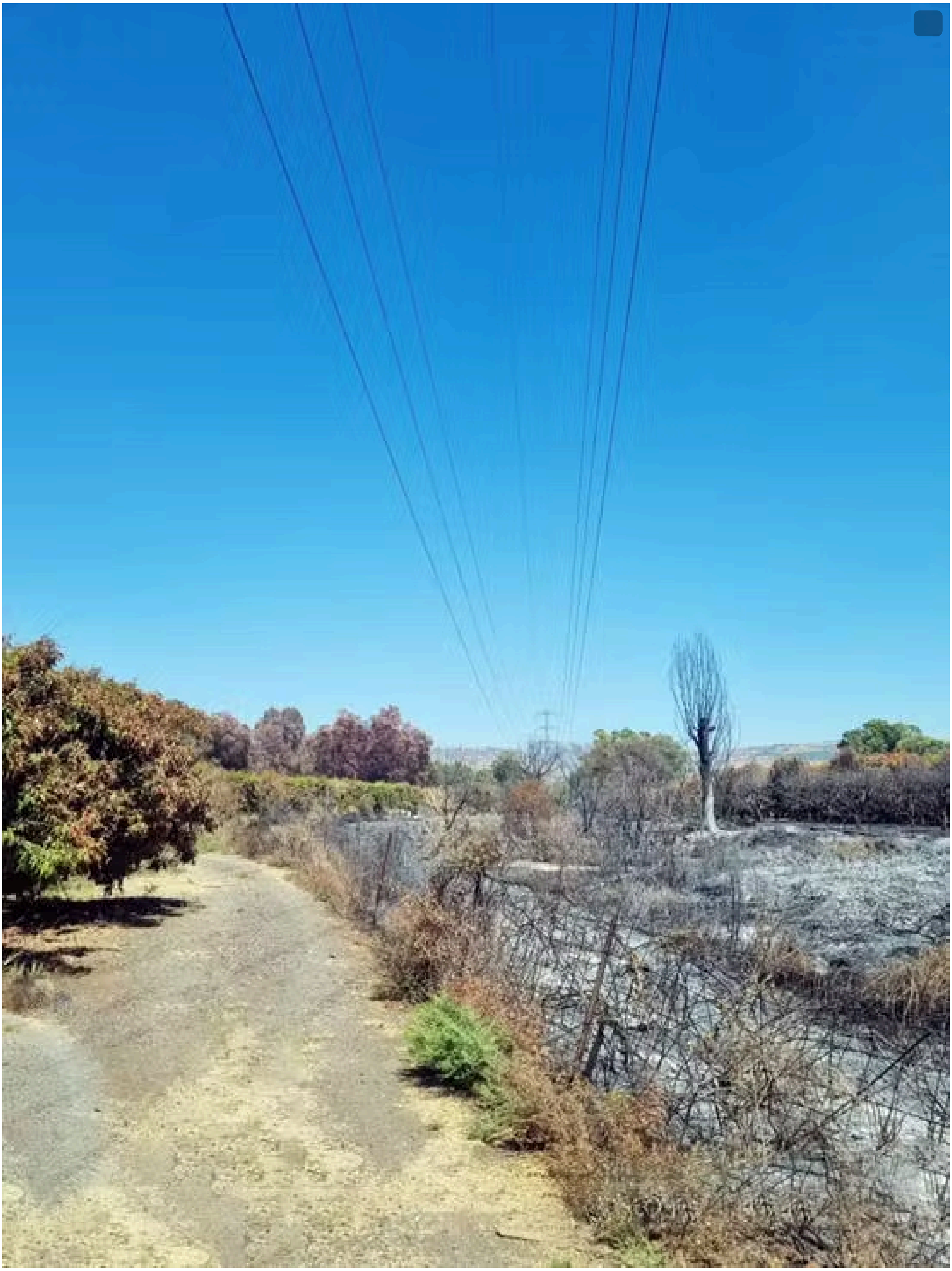


Aftermath

The ability to discover, track, and alert on a specific tower location without having to install more sensors while getting a real-time response without the regular challenges of traditional monitoring may open up new ways to monitor the vast countryside where transmission lines pass. In rural areas, where wildfires can start, growing in size and power before these are noticed - fiber sensing can become a unique tool to help transmission providers protect lives, the environment, and their assets.

As the climate warms, utilities will continue to face increased threats to operations and physical assets. Whether congested grids due to a global shift to electrification or more severe weather threatening transmission, grid operators are increasingly relying on technologies that can enhance insight through real time data.

The brushfire on Mt. Gilboa was one of those new, historically unprecedented threats to a power utility. And thanks to Prisma Photonics, utilities are now able to see those threats before a brushfire becomes a wildfire.



Charred land under the transmission lines

About the Author

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