Wildfire Mitigation and Its Importance to Utilities

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INTRODUCTION

WHY WILDFIRE MITIGATION IN AN ERA OF SERIOUS CLIMATE CHANGE MUST BE ADDRESSED WITH URGENCY AND INNOVATION

BY RACHELLE CHONG, FORMER COMMISSIONER, FEDERAL COMMUNICATIONS COMMISSION AND CALIFORNIA PUBLIC UTILITIES COMMISSION

As a former state regulator, the impacts of climate change and the new dangers it imposes on utilities, their facilities, and their surrounding communities, must be addressed swiftly in order to reduce the impact of powerline-caused wildfires. This issue becomes more pressing as the United States turns away from fossil fuels to reach Net Zero by 2050. As we electrify and decarbonize our transportation and building infrastructure, grid reliability and resilience will become paramount. We must ensure wildfire risks are addressed and reduced now on a proactive basis through emerging protection and prevention technology solutions.

Already, the electric industry is reevaluating its infrastructure requirements to prepare for climate change impacts. The Electric Power Research Institute (EPRI) has announced its Climate Readi Initiative, where it is developing science-based insights about the future power system and the climate environment it will operate in, in order to identify optimal adaptation and resilience investments.[1]

Under this laudable EPRI Initiative, to meet society's electricity decarbonization and climate resilience needs, the power sector is going to establish a standardized and consensus-based framework to inform infrastructure investment and deployment.

EPRI correctly observes, "It is not feasible to harden or upgrade every asset on the power system to withstand every extreme weather event or condition. Risk-based approach is needed to assess potential climate impacts to prioritize and select resilience investments. A proactive and informed investment to better withstand and recover from a climate event rather than reactive repairs under crisis conditions can result in lower overall costs in the long-term."

I must agree. Without assertive intervention, powerline caused wildfires will continue to increase in frequency and severity given increasing temperatures and droughts.

It's not just the fires that cause harm to human lives and property—it's the risk of fires, too. Given that wildfires have gotten more extreme with overall higher temperatures leading to drought conditions, utilities have taken extreme measures to reduce the risk of utility infrastructure causing wildfires. An example in California is the CPUC-approved practice of cutting power to high fire-risk threat areas in what is called Public Safety Power Shutoff (PSPS) or "de-energization" events. While these measures may prevent fires, these rolling blackouts may last hours, or as long as a few days in some more remote areas.

Losing power for more than a few hours, however, can have serious impacts on the health of vulnerable communities, such as senior citizens, persons dependent on medical equipment such as a CPAP machine to breathe, and persons with mobility impairments who use electric powered wheelchairs. In addition to impacts on these medically fragile persons, hospitals and medical clinics require reliable electricity to care for sick patients. Long power outages can completely shut down commerce, because bank ATMs, gas pumps, and grocery store checkouts do not work without electricity. Additionally, public safety is compromised as traffic lights are non-operational, and communications systems and cell phones run out of battery power, which may result in the inability to call 9-1-1 for emergency assistance.

Thus, it is time to put a studied focus on the issue of wildfire mitigation prevention strategies, to reduce the incidences of utility-caused wildfires. We should provide incentives and rewards for innovation in this space. In January 2019, California Governor Gavin Newsom issued a Request For Innovation Ideas (an RFI2) to create a swift so-called "Innovation Procurement Sprint" executed on behalf of the California Department of Forestry and Fire Protection (CalFire), to identify innovative solutions to the State's wildfire crisis, with a goal of working-solutions deployments within a year and final awarded deployments within 16 months. Citing California's experience of having some of the most destructive and record-breaking fires in the State's history, the Governor stated, "There is a pressing need for the State to identify innovative and sustainable solutions to address the State's challenges of severe wildfires and degradation of forest health. . . Innovation Procurement Sprints will occur in partnership between State agencies, working with the private sector and all appropriate levels of government and non-government entities, including but not limited to vendors, academic and scientific experts, and entrepreneurs ("solution providers") to spur innovation, promote collaboration, and entice partnership in solving the State's most complex business and technology challenges."[2]

To this end, should a utility develop an innovative technology that prevents utility-caused wildfires, regulators should be flexible about allowing a utility to fund the project. Unfortunately, the current regulatory cycle for funding electric utilities does not support swift action, with electric rate cases that occur every three to four years. Regulators should provide alternative proceedings outside the normal rate case cycle to provide a docket to focus on innovative actions and funding mechanisms to support them.

As the impacts of climate change continue to batter the planet and cause terrifying wildfires that destroy lives and property, it is time for the best part of the American spirit to innovate and find cost effective solutions. As Peter Drucker once said, "If you want something new, you have to stop doing something old."

TWO TECHNOLOGIES COMBINE TO DE-ENERGIZE POWER LINES AS THEY FALL

BY CARLOS L'ABBATE, CHIEF TECHNOLOGY & ENGINEERING OFFICER, ANTERIX™

In he technology world, we build on the work of our predecessors, applying their innovations to address new challenges. Occasionally that gets turned around, and we create a solution that doesn't really take off until it is enabled by a future innovation. That's the story of a potentially game-changing wildfire mitigation tool: how newly available private LTE networks made Schweitzer Engineering Laboratories' (SEL) Falling Conductor Protection (FCP) application work for electric utilities. And with those networks in place, the future is bright for increasingly secure, reliable, resilient, efficient, and safer grid operations addressed and reduced now on a proactive basis through emerging protection and prevention technology solutions.

Fuses and circuit breakers are built into the grid to protect the system from damage caused by short-circuit faults. High impedance ground faults caused by a fallen line, however, can be difficult to detect, and traditional grid protections may not immediately kick in. Consequently, a fallen, energized power line can remain on the ground for extended periods, and electrical arcing from the line can ignite nearby combustible materials like dry grass, trees, or leaves, resulting in a wildfire. And with climate change driving warmer temperatures and greater risk of drought, an arcing line may more likely find that dry combustible material.

De-energizing downed lines more quickly could greatly reduce the risk of wildfire. FCP is the culmination of the fantastic innovation from SEL. It is a technology that senses a broken line and automatically cuts power to the line so quickly that it is de-energized before it hits the ground—a period of about 1.4 seconds for a line strung 30 feet off the ground. To accomplish its task in time, the FCP application requires super-fast broadband data communications between disparate, remotely located elements. In early efforts, utilities would connect these elements with wired networks; this solution served the purpose but was not economically/geographically scalable, given the vast number of sensors and devices that needed to be connected over often huge distances. Making the application work for utilities—and realizing the benefits it offers in reduction of wildfire risk—required wireless broadband connectivity with extremely low latency, a communications network the utility could control and trust to support its critical grid management applications.

Enter private LTE, only recently available to US utilities because of newly accessible spectrum resources. A private LTE network can enable FCP to cut power to a falling line inside of a second, well before gravity would pull it to the ground. A study released in winter 2021, demonstrated that a private LTE network provides sufficiently fast communications to enable FCP technology and spelled out exactly what has to happen as the line falls (the study assumed a 25-foot drop taking 1.25 seconds). Here's a high-level description: first, sensors monitor at a rate of 30 times per second (every 33.3 milliseconds) the voltage or current traversing the line segment on which they are installed. Next, the data from those sensors is communicated within 200 milliseconds over a high-bandwidth, low-latency network to the controller. The controller then executes its automated calculations to evaluate the data and determine whether the line is indeed falling and, if it is, send out a trip message to shut off power to the line. That message travels over the communications network to protective relays installed on the line segment. Once the relays get the trip message, they take about half a second to physically de-energize the broken line. So that leaves about three-quarters of a second for all the sensing, calculation, and communication to occur. The study showed that private LTE meets that requirement.

Forward-leaning utility San Diego Gas & Electric (SDG&E), a subsidiary of Sempra Energy (NYSE: SRE), was an early supporter of FCP to help mitigate wildfire risk, which makes sense given the challenge within its service area. In a recent webinar with SEL, SDG&E notes that in its layered scheme of protections, FCP is the first to trip because it senses the break and cuts the power before the line hits the ground and the fault occurs.

For SDG&E, the need to implement FCP was a leading factor in its decision to deploy a private LTE network. As stated in the webinar, using private LTE to enable FCP "decreases FCP cost and increases security" and "simplifies deployment [with] less radio repeaters and cost [and] faster installation."

Deploying FCP over private LTE brings a range of other benefits, as well. As SEL points out in the webinar, the data creation, communication, and analysis capability required for FCP can help utilities scale the integration of distributed energy resources (DERs), particularly because the system now allows utilities to collect more detailed data:

Since we are already getting in synchro phasor data from the PMU-capable relays at the distribution center, the wide-area situational awareness solution can provide real-time monitoring, model validation using collected data, but also [renewable] energy monitoring. As the power system is evolving and growing, there is higher penetration of DER which requires data at a higher resolution to monitor system state.

With more granular data, SEL notes, "We can utilize this stream of information and take action in real-time."

With a private, low-latency wireless broadband communications platform in place, the prospects for future capabilities and efficiencies beyond wildfire mitigation are bright. Already San Diego Gas & Electric, Ameren, Evergy, Southern Company, and Lower Colorado River Authority have or will soon have private LTE platforms deployed in their service areas. Even beyond the benefits each of those companies will realize from their own deployments, additional possibilities arise if they and other utilities broadly adopt private LTE networks that can communicate (inter-operate) with each other. From enhanced support for mutual aid to real-time information sharing across utilities, the universe of use cases supported by such a "network" of private LTE networks is surely vast; many of them may even be hard to imagine today. And though the use cases utilities currently identify fall well within the capabilities of LTE, history suggests that the availability of private wireless broadband will spur new innovations benefitting from the further advances of wireless technology, for which LTE provides a clear evolutionary path.

Electricity is essential to modern life; wildfires caused by electric grid infrastructure are a growing threat to lives and property. With the help of technological innovations like FCP, utilities can help to decouple the two: they can continue to provide essential electrical service even as they reduce the risk of wildfires. Additionally, with private LTE, the communications platform that enables FCP, utilities can gain additional capabilities that support a growing range of utility initiatives.

HOW UTILITIES CAN DRAMATICALLY REDUCE WILDFIRE RISK

Rising temperatures, drought conditions, and dry vegetation are all major contributors to wildfires with possible ignition sources including lightning strikes, unattended campfires, and other man-made causes.

BY JONATHAN MARMILLO, CO-FOUNDER AND CHIEF PRODUCT OFFICER, LINEVISION

Searing temperatures are testing the electric grid like never before. Extreme-weather events, such as severe droughts fueled by climate change, have created ideal conditions for wildfires in the Western US.

According to the National Interagency Fire Center's Drought Monitor, as of July 8th, 2022, 56 "large" wildfires are currently affecting some 2.7 million acres in California, Arizona, and New Mexico. The agency estimates that more than 1,520,000 people live within 10 miles of an active, large wildfire.

Rising temperatures, drought conditions, and dry vegetation are all major contributors to wildfires with possible ignition sources including lightning strikes, unattended campfires, and other man-made causes. In fact, 90% of wildfires are caused by human impact. Unfortunately, one of the leading contributors to the problem is electric transmission and distribution equipment, which are responsible for close to 150,000 acres lost to wildfires, twice as much as any other cause. Even more jarring is that two of the three most devastating wildfires in American history were caused by power lines.

HOW DOES THIS HAPPEN?

DOWNED LINES

When power lines fall — due to high winds or other threats, they're usually still energized and will discharge their energy into the ground via an arcing until the utility can identify the fault and turn off the circuit, stopping the flow of electricity. If the ground that the broken power line is in contact with happens to be dry vegetation, which is becoming more and more common due to climate change and extreme droughts, (or, more recently, "mega droughts,") it can catch on fire, starting a blaze.

VEGETATION CONTACTS

Trees and other sources of vegetation pose a variety of threats to power lines. A falling tree can tear a line down and cause a downed line. Even if a power line doesn't fall to the ground, if a tree branch stays in constant contact with the conductor, it can ignite and can cause a fire. A pretty stark reminder of this threat can be seen here.

CONDUCTOR SLAP

Many types of overhead line conductors, the wire carrying the energy, are not coated with any type of dielectric material which would prevent the energy from escaping when in contact with a nearby object. In high-wind events, these conductors, which typically come in sets of 3, can experience significant side-to-side motion, called blowout. When this motion becomes asynchronous, meaning the conductors are swinging toward one another there is a chance they can touch, an event called "conductor slap." When this happens, a phase-to-phase arc takes place which can drop molten metal to the ground catching the vegetation on fire. This was sadly the cause of the ignition of the 2017 Cascade Fire in California which resulted in the loss of four lives.

Many of these tragedies could likely have been avoided by using best practices in fire control, and vegetation management, as well as modernizing aging grid facilities and utilizing the latest technologies available. Indeed, investments in power infrastructure were one of the centerpieces of President Biden's US$ 550 billion infrastructure plan, which included US$ 73 billion for investment in power infrastructure to make the US infrastructure resilient against the impacts of climate change, cyber and extreme weather events.

The need to expand and modernize transmission assets has never been greater. A recent Princeton study showed that grid capacity will need to double by 2035 for a zero net carbon grid and triple by 2050 to support the electrification of transportation, buildings, and industry. It is not just a larger grid that is required, but one that can withstand increasingly extreme weather events. Wildfires in the west have cost the U.S., billions in damages while highlighting the fragility of our aging infrastructure.

There are steps that utilities can take toward becoming more resilient, including installing grid-tech sensors to obtain accurate information on the conditions of their power lines. Further, sophisticated forecasting can help utilities understand what their power needs will be down the line. Currently, 99.9% of power lines aren't even monitored. Which, given the stakes in a world staring down climate change, is unthinkable.

LineVision has a suite of tools to inform utilities about the health and the sag of their conductors. Working in concert to provide a consistent flow of vital data and information, LineVision's technologies provide a data-driven and actionable level of situational awareness and predictive analysis — helping utilities and other grid participants anticipate potential failures, overcome capacity limitations, identify the need for proactive replacement, and provide overall better and safer performance.

At the same time, LineVision works in concert with existing data gathering, monitoring, and evaluation technologies such as drones, helicopter inspections, and vegetation management practices. Equipping transmission lines with monitoring needed to potentially prevent fires would cost a tiny fraction compared to the hundreds of millions in damages and economic loss caused by wildfires in California alone. In fact, equipping power lines with LineVision's monitoring systems would cost a fraction of the damage caused by even a single fire.

WILDFIRE MITIGATION: SCE'S APPROACH TO ISOLATING GROUND FAULTS

In lessons from Australia, California utility uses resonant grounding on its three-wire distribution system to prevent fires caused by phase-to-ground faults.

BY ANDREW SWISHER, CONSULTING ENGINEER, SCE AND JESSE RORABAUGH, SENIOR ENGINEER, SCE

California's wildfire risk has increased in recent years because of climate change, drought, increased development in the wildland-urban interface and the significant buildup of fuel, including on federal and state forest lands. The full magnitude of the increased threat and significance of its consequences did not become apparent until 2017, when the state experienced five of the most destructive fires in its history. This was compounded in 2018 by three more such fires. Eight of the 20 most destructive wildfires in California's history occurred in those two years, destroying more than 31,000 structures — double the number consumed by the other 12 fires. California's wildfire risk had increased to the point where the safety of its communities required additional measures.

In recent years, Southern California Edison (SCE) has focused most of its wildfire mitigation projects around the prevention of electrical faults by such measures as installing covered conductor and insulating spacers between phase conductors. These methods are highly effective at reducing the probability of

When a tree branch contacts power lines utilizing REFCL technologies, electrical tracking on the branch is seen rather than sustained ignition.

ignition by fault avoidance, particularly for contact-related faults and those involving two or more phase conductors. These measures prevent the majority of but not all incidents, particularly equipment-failure-related faults.

SCE needed additional transformative measures to minimize the chance of a fire when an unforeseen event occurs, such as a car hitting a pole, a transformer failing from a manufacturing defect or a large tree falling into a power line. Therefore, it benchmarked with utilities in the Australian state of Victoria, one of the most fire-prone areas in the world, to learn how rapid earth fault current limiters (REFCLs) can reduce the risk of ignition by faults involving a single phase conductor.

VICTORIAN LEARNINGS

Extensive testing of REFCLs by Victorian utilities has resulted in a set of criteria that, if followed, can reduce the risk of ignition for faults involving a single phase conductor by at least 90%.

These criteria start with the requirement of being able to detect faults as small as a half ampere and otherwise concern the speed at which voltage must be reduced once a fault is detected to prevent ignition.

The Victorian utilities then proceeded to test the best commercially available products capable of reducing ground current. These included resonant grounding with an arc-suppression coil, ground-fault neutralizers that use an inverter in parallel with an arc-suppression coil to further reduce the fault current, and faulted phase earthing, where the faulted phase is grounded immediately after a fault is detected.

Unlike with circuit breakers and fuses that have extremely sensitive settings, REFCL technologies have the advantage that power still can be provided to customers during ground fault events. Electric service reliability improvements can be realized with this system, most notably the lack of circuit interruptions or outages for faults transient in nature, as commonly seen with wildlife contact.

Only when a fault is permanent does a circuit breaker open to deenergize the customers. This means the system can increase the sensitivity of the protection and electric service reliability at the same time.

Of the REFCL devices tested, only the ground fault neutralizer met all the Victorian ignition criteria. Based on the success of that testing in the laboratory environment, the major utilities were mandated to convert 45 substations. This work is more than one-third complete, with Australian utilities having successfully converted 21 substations feeding more than 5500 miles (8851 km) of 22-kV circuitry.

Metallic balloons contacting power lines typically result in an intense arc flash. With a resonant grounded isolation transformer the ground fault energy was reduced to the point that balloons often don't even pop.

THREE-WIRE CUTS

While SCE actively is investigating the application of ground fault neutralizers for fire-ignition prevention, some limitations make it difficult to deploy on a large scale. One disadvantage of REFCL systems is, when in operation, the good phases experience overvoltage to the phase-to-phase voltage of the system at the same time the faulted conductor is deenergized. This has little impact on most new distribution equipment, as it has significant insulation margin, but older equipment sometimes must be replaced as part of the conversion.

The technology also only works if all the circuits fed by the substation bus are three-wire circuits without a neutral. This requirement is a prohibitive limitation for some, as most North American utilities build primarily four-wire circuits. However, SCE and, to some extent, other California utilities are well positioned as they built a grid with more three-wire distribution systems than are generally found in North American electric utilities. This practice is like that of most European and Australian utilities, where distribution transformers typically are connected between phases and the neutral does not leave the substation.

Even with the large amount of three-wire distribution lines SCE operates, major upgrades would be required for deployment. Much of the SCE's three-wire circuitry is outside the high-risk areas yet still must be modified to enable the ground fault neutralizer to operate. Often, this means replacing vintage equipment no longer in good enough condition to withstand the overvoltages. In some cases though, particularly with phase-to-neutral connected distribution transformers, this will require replacing equipment that otherwise would be good for decades of continued service. This conversion of four-wire to three-wire circuitry adds considerable scope at SCE beyond what was required in Australia because all 22-kV transformers in Victoria are connected phase to phase.

SCE also shares many other implementation challenges faced by Victorian utilities, including balancing system capacitance, substation physical footprint constraints and a host of equipment-specific issues, such as surge arrester and potential transformer ratings to name a few. For these reasons, SCE also has investigated other alternative technologies with similar benefits as part of its commitment to California's Wildfire Mitigation Plan.

Even low fault currents do not complete eliminate the risk of ignition, particularly when all the current is concentrated into a small contact area. In this case sustained ignition resulted from only 176 mA into a 14.5 inch test cell.

RESONANT GROUNDED SUBSTATIONS

The most common REFCL technology is resonant grounding, where an arc-suppression coil (Petersen coil) is connected to the transformer neutral to reduce fault currents to less than one-tenth of that found on an ungrounded system. Resonant grounding has been applied to thousands of substations and is particularly common in central Europe, where it is used to increase the reliability and safety impacts of ground faults. Unfortunately, resonant grounding at the substation was determined by the Victorian testing to be insufficient at reducing fault current to a level that would prevent ignitions. Even with currents under 10 A, contact from vegetation or dry grass consistently resulted in ignition.

When comparing the SCE system to the 22-kV distribution systems in Victoria, it was noted Australian utilities operate higher system voltages and longer distribution lines. Therefore, the fault current for resonant grounded distribution networks was found to be much lower for SCE than it was in Victoria. On some SCE substations, resonant grounding alone reduced the fault current to approximately 1 A. Where relays were timed to clear faults within two seconds, the Victorian ignition targets all were capable of being met.

Despite resonant grounding being an attractive option for these small substations, it presents a significant technical challenge. The faulted circuit must be identified with minimal fault current. Few products on the market even claim to be able to detect such small magnitude faults. While SCE is converting a substation to resonant grounding to determine whether implementation is practical, the protection is only certain to identify the appropriate circuit for substations with only one distribution line per transformer. In these substations, it is not necessary to determine the circuit on which a fault occurs; the circuit breaker can be opened just knowing a fault is present. The presence of even extremely low magnitude faults can be determined reliably with a measurement of.

ISOLATION TRANSFORMER

To further expand the range of circuits on which REFCL can be deployed economically, SCE developed a viable way of using resonant grounding for prevention of ignition by creating the resonant ground on the load side of an isolation transformer (patent pending). In this case, an isolation transformer is installed near the boundary of a high-risk fire area so all circuitry beyond the transformer is covered.

Resonant grounding an isolation transformer near the edge of a high-risk area rather than at the substation offers several advantages:

- Single line to ground fault current is reduced compared to installing the arc-suppression coil at the substation. When installed in the substation, the fault current is the sum of charging current of all circuits fed by the substation bus. When applied at an isolation transformer, the current feeding the fault is only the charging current of the circuitry downstream from the isolation transformer.
- Whenever a fault occurs, the overvoltage only happens on the load side of the isolation transformer, rather than every circuit fed by the substation bus. This reduces the conversion cost substantially, as four-wire circuitry with phase-to-neutral connected transformers and equipment not rated for the overvoltages can remain on the lower fire-risk parts of the circuit.
- Protection is simplified. It is challenging to determine which circuit a fault is on when the fault current is so low. When the isolation transformer is resonant grounded, protection for ground faults can consist entirely of voltage measurement on the neutral. When the voltage is above a set point, the circuit trips.

To scale this system to a wide range of circuits, additional problems need to be addressed. If a typical delta-wye isolation transformer bank were used, a phase angle difference would prevent paralleling with other circuits. This would limit applications to circuits without normally open ties to other circuits, and delta-delta or delta-zigzag transformers would be required. Also, to address aesthetic concerns, a pad-mounted solution would need to be designed for both the transformer and arc-suppression coil.

IGNITION TESTING

Before making the investment to develop and deploy the resonant grounding system with an isolation transformer, SCE had to empirically validate the system was effective in reducing incidence of ignition. While initial calculations suggested it would be effective, the lack of experience with such systems created some uncertainty in how they would perform. Thus, the utility decided to install and resonant ground an isolation transformer at its equipment demonstration and evaluation facility (EDEF).

This testing first showed the system could meet the Victorian REFCL criteria. The protection consistently opened the circuit within two seconds and, until that point, the natural reduction in voltage from resonant grounding was sufficient to meet the other requirement. This was the best evidence the system prevents ignitions in at least 90% of single line to ground faults, because the criteria are based on hundreds of tests in worst-case fire conditions.

The ignition criteria were developed with a ground fault neutralizer in mind though, so SCE also wanted to confirm the results by reproducing common ignition scenarios. Down wires in contact with dry grass and phase-to-ground contact from tree branches, guy wires and Mylar balloons were chosen as representative of ignitions seen in California.

In the faults with down wires in grass, two out of 24 tests resulted in ignition, one from only 126 mA into the grass. Even this probably understates the effectiveness though. Real-world scenarios typically result in a much longer length of conductor in contact with the ground than the 14.5-inch (368-mm) test cell. The longer length acts to reduce the current density and voltage on the conductor. Therefore, these results are likely to be conservative.

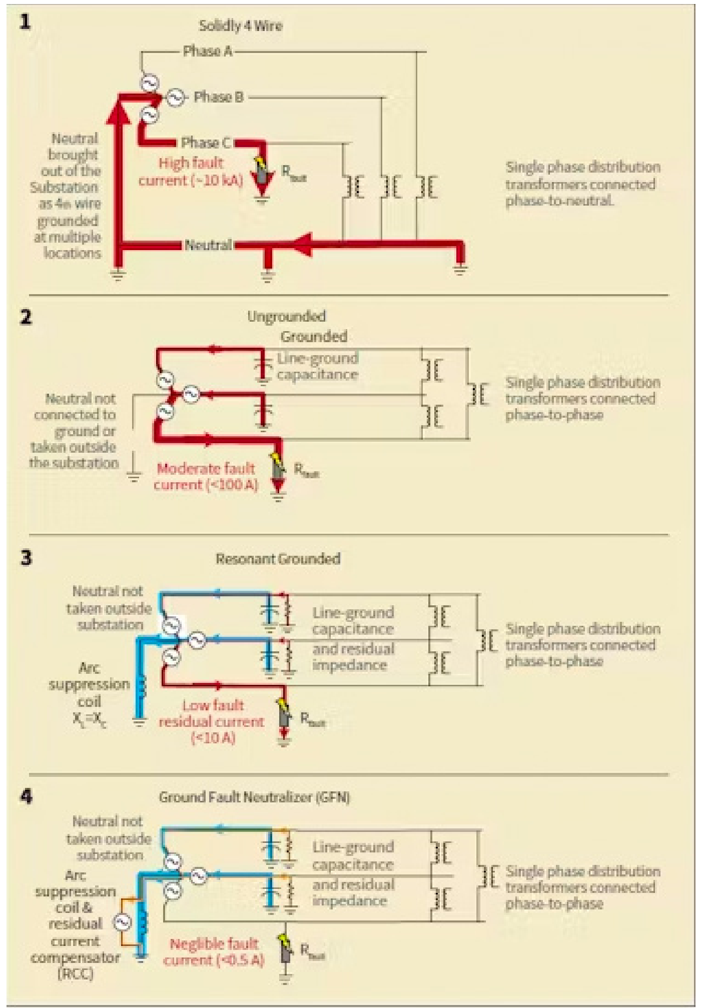
No ignitions were produced in any of the 29 phase-to-ground contact tests performed. No burning wood or falling molten metal particles larger than 2 mm were observed in any of the tests. Faults that were inches above dry grass did not even scorch the grass. The fault energy was low enough that, in some tests, the metallic balloons made contact for up to 15 minutes without even popping! Brief (approximately 2-msec) faults occurred and self-extinguished until enough metallic coating was removed that arcing stopped entirely.

REFCL PILOTS

This testing demonstrated resonant grounding can be a viable way to prevent fires if installed on a small substation or an isolation transformer. This is only the third technology demonstrated to be able to meet the Victorian REFCL ignition criteria.

As a result of these successes, SCE chose to add three REFCL pilots to its 2020-2022 wildfire mitigation plan: A ground fault neutralizer that builds directly on the work in Australia, a resonant grounded substation and an isolation transformer.

Initial rollout of the isolation transformer will be with ungrounded delta-wye connected transformers. This enables existing hardware to be used to meet the REFCL criteria on a section of a circuit. Development is ongoing to obtain delta-zigzag pad-mount transformers and arc-suppression coils sized to the distribution application. This technology will enable scaling to dozens or hundreds of installations.



1. Solidly grounded systems have a low resistance path back to the transformer neutral resulting in high fault currents. 2. Disconnecting the neutral from ground results in lower fault currents, but capacitive "charging" current on the energized phases still produces appreciable current that feeds into the fault. 3. Resonant grounding redirects more than 90% of the remaining fault current on an ungrounded system away from the ground fault and instead collects at the substation ground grid where it can be safely discharged. 4. The Ground Fault Neutralizer uses power electronics along with an Arc Suppression Coil to collapse the voltage on a faulted phase while redirecting power to the intact phases.

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WILDFIRE TRENDS AND WHAT THEY MEAN FOR UTILITIES

BY MICATU

2021 was another record-breaking year for wildfires in the United States, burning nearly 7.7 million acres of land. While the amount of land was not as high as what we saw in 2020, this past year has been a continuation of a concerning, decades-long trend; wildfires are becoming more frequent and more severe.

WHAT THE NUMBERS TELL US

For the past 60 years, we've seen the number of fires in the western U.S. increasing steadily. Since 2000, the number of fires that occur each year has consistently been 3-10 times the average frequency we saw in between the 1950s-60s. In fact, an estimated 61 percent of the total area burned since 1950 occurred since 2000.

Wildfires are not just becoming more frequent—they are becoming more extreme. Megafires are fires that burn more than 100,000. Over the past 2 decades, the number of megafire occurrences has increased drastically. Prior to 1970, there were no recorded occurrences of megafires but in recent years, we've seen as many as 14 occurring in a single year (2012).

In addition to the increase in frequency and severity of wildfires, the length of wildfire season has gradually grown. In 1950, wildfire season was typically 5 months, peaking in the summer. Today, wildfire season has increased to seven months in some areas. Longer periods of hot and dry weather create an increased risk of wildfires occurring during times of year that were once considered safe.

The numbers paint a clear picture of the increased risk of wildfires destroying land, uprooting families, and causing billions of dollars in damages. We are likely to see the frequency and severity of fires continue to rise in the coming years.

WHAT IS BEHIND INCREASING WILDFIRE TRENDS?

Most experts will agree that the number one contributing factor to more frequent and severe fires is climate change. As global temperatures continue to rise, climate change is resulting in more extreme droughts and heatwaves throughout the country. This creates the ultimate conditions to spark a wildfire. Something as small as a dropped match or a spark from malfunctioning equipment has the potential to ignite a flame that spreads, burning thousands of acres of land.

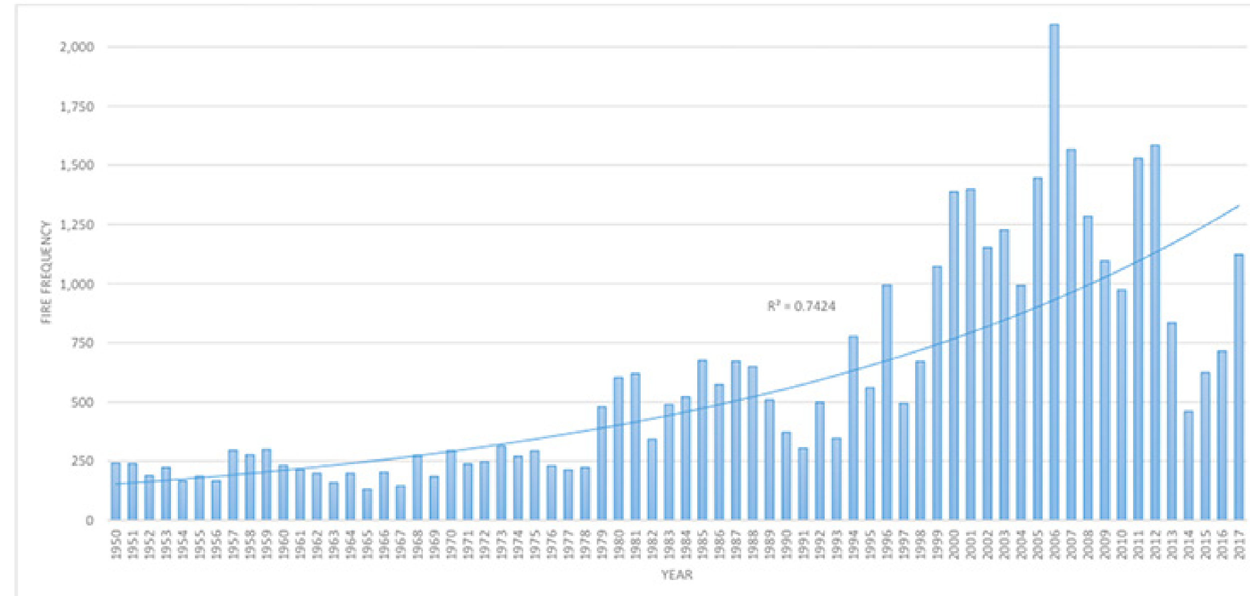
In addition to climate change creating the conditions for increasingly disastrous fire, it's possible that our own fire mitigation efforts have actually made the situation worse. Throughout the 20th century, there was an active legislative effort to halt indigenous burning practices in an attempt to improve ecology. Experts have now come to realize that these controlled burns may have been essential to managing naturally occurring wildfires. These prescribed fires created breaks that can stop fires from spreading and regular burning thinned vegetation, helping slow the spread of fires.

The US Forest Service now conducts controlled burns as part of its fire mitigation efforts, intentionally burning around 1 million acres a year across the country. This is not nearly enough. As of 2020, it was estimated that the agency had an 80-million acre backlog built up over years of fire mitigation and a lack of funding.

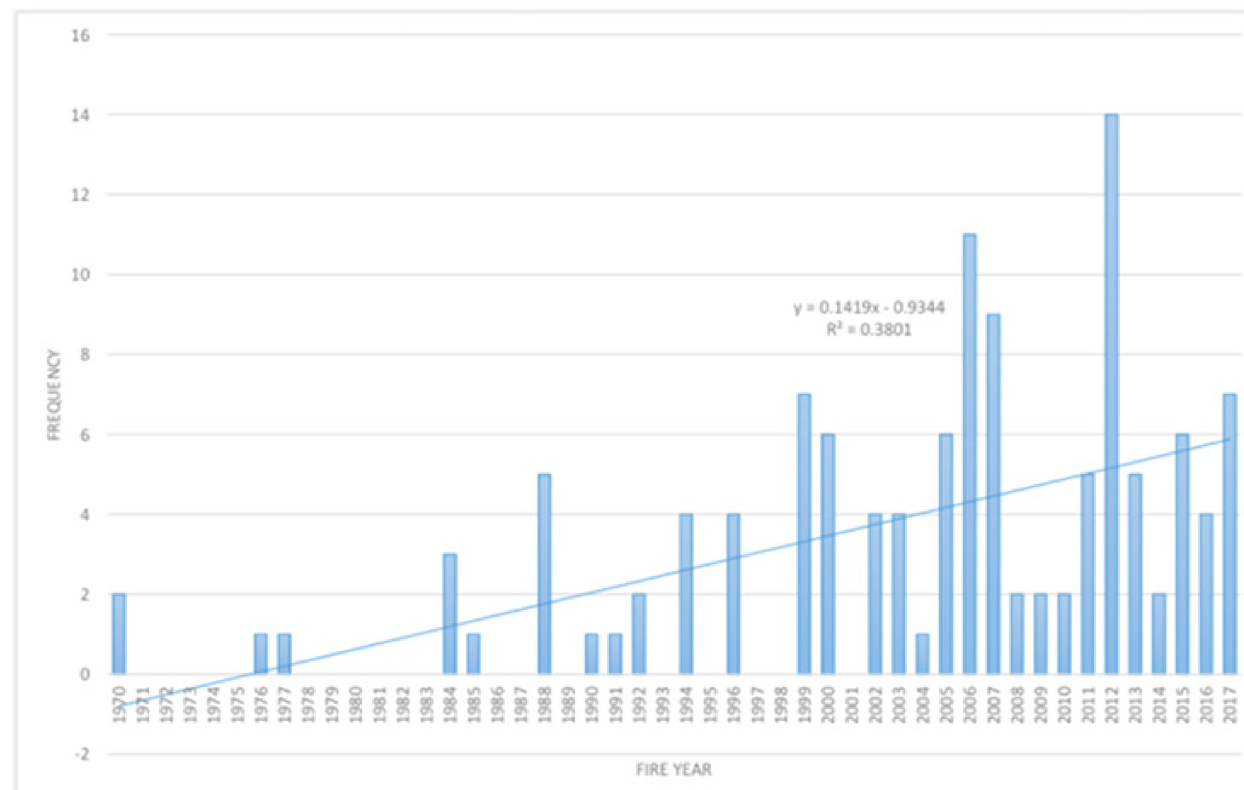
Controlled burns will be essential in preventing the types of disastrous wildfires we've seen in recent years but state and federal agencies are struggling to implement even their existing prescribed burns.

WHAT DOE THIS MEAN FOR UTILITIES?

Although there were many factors contributing to the conditions that led to the devastating wildfires we've seen in recent years, there has been a lot of media coverage around the role that utilities may have had—particularly in California where state investigators, in January, determined after a "meticulous and thorough



Source: NASA RECOVER/Keith Weber



Source: NASA RECOVER/Keith Weber

investigation" the equipment was ultimately responsible for the Dixie Fire which destroyed more than 1,300 homes and burned nearly 1 million acres of land.

The costs to a company found responsible for a utility-caused wildfire cannot be easily measured. Public perception and trust can have an impact that won't be fully felt for years to come but there are more tangible costs that utilities must now be conscious of. These largely fall into 2 categories: liability and mitigation.

LIABILITY

In many states, utilities can be held liable for damages resulting from utility-caused wildfires. In 2019, PG&E was forced to file for bankruptcy after paying out 25.5 billion dollars to address wildfire-fire-related liabilities. It was determined that PG&E power lines caused fires that burned hundreds of thousands of acres.

A simple spark can result in a flame that cascades into a wildfire that causes billions of dollars in damages. Utilities need to be aware of their potential liability if their equipment is found to be responsible.

MITIGATION

States are beginning to pass legislation requiring utilities to have fire mitigation strategies in place. No two strategies will look the same, but there have been examples of utilities spending billions to implement mitigation plans. PG&E estimates that, between 2019 and 2022, it will spend 11.7 billion dollars on strategies to mitigate wildfire risk.

HOW DO UTILITIES MOVE FORWARD?

Given the increasing trends in wildfires and associated costs of utility-caused fires, utilities have a big task ahead of them. Liability and mitigation go hand-in-hand. Utilities must have a plan moving forward to mitigate their risk of being held liable for a wildfire. In the coming years, the grid is going to need to evolve, new technologies will need to be implemented, and utilities will need the visibility to identify and address problems before they occur.

Legacy equipment will need to be replaced with new technologies to reduce potential ignition points and advanced sensors and data analytics tools will need to be implemented to allow a utility to detect a problem and take action before a flame is ignited. It is difficult to imagine exactly what the future will look like but we should all be aiming for a grid where a company can detect a downed power line and cut power to it before it hits the ground or identify a failing piece of equipment and replace it without the need to cut power to an entire region. We are not there yet, but emerging technologies offer utilities the opportunity to take huge leaps in advancing their fire mitigation strategies.

CONCLUSION

BY CARLOS L'ABBATE, CHIEF TECHNOLOGY & ENGINEERING OFFICER, ANTERIX

Though their perspectives differ, the contributors to this eBook present a compelling, cohesive vision of the wildfire challenge. We should all be focused on reducing the harm resulting from wildfires, even as wildfire frequency and severity is currently on the rise. Driven by climate change, this increase in wildfires may seem irreversible in the short run, but some utilities are taking action and showing the industry that currently available technologies can help mitigate this substantial risk. From grid visibility improvements to resonant grounding and falling conductor protection, there is a range of applications utilities are already deploying to help reduce wildfires.

Anterix is committed to helping utilities enable these and other technologies to reverse the wildfire trend. Our mission is to bring the power of private wireless broadband communications to the electric utility sector on the strength of our low-band 900 MHz spectrum holdings nationwide. The low latency, the high bandwidth, the security and control of private LTE networks enable utilities to deploy solutions like those described in this eBook. The private LTE network is the platform upon which these applications depend, and Anterix is committed to helping utilities obtain this foundational communications capability.

FOR ADDITIONAL LEARNINGS

RELATED RESOURCES

Industry Insights Webinar Episode: A Conversation on Wildfire Mitigation Tools Enabled by a Private Network

Whitepaper by Anterix and Schweitzer Engineering Laboratories: Wildfire Mitigation – Detecting and Isolating for Falling Conductors in Midair – Using 900 MHz Private LTE at Protection Speeds

Energy Central Special Issue with Anterix: Utility Guide to Private LTE

ABOUT ANTERIX

Anterix enables next-generation communications platforms that support grid modernization and cybersecurity strategies. Our 900 MHz spectrum supports secure, reliable, cost effective, and customized LTE solutions. Our vision unites utilities, networks, resources, and the power of information. Some call it a smarter energy future. We like to think of it as Utility Meeting Connectivity.

To learn more, visit Anterix.com

WANT TO LEARN MORE ABOUT WILDFIRE MITIGATION FOR UTILITIES?

Anterix and T&D World will expand upon the issues addressed in this eBook, during a webinar which will air on June 28th. More details on registration will be released soon.