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Reducing wildfire risk: A guide for utilities and municipalities

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Part 1: Assessing the rapidly changing wildfire mitigation landscape

As more people build homes, operate businesses, and spend leisure time in areas where forests and shrubs border urban areas, wildfire threats to properties and lives increase. Continued population growth into forest-urban interface areas and an increasing frequency of elevated fire weather conditions present major challenges to residents and businesses.

As populations expand, so do the support infrastructures that provide critical services such as electricity, heat and water. More people and new homes mean more power lines, substations, transformers and other electrical infrastructure crossing through lands that are subject to wildfire risks. Heightened risk awareness, prevention and mitigation are becoming increasingly important to ensure human safety and to reduce loss of property and forest acreage.

According to Verisk's 2017 Wildfire Risk Analysis, over 4.5 million residences in the U.S. are today at high or extreme risk of experiencing a wildfire. The National Interagency Fire Center reports that 8.8 million acres were scorched by wildfires across over 58,000 individual incidents in 2018 alone. Not only are wildfires becoming more common, but also more costly. Total potential exposure for single-family residences to wildfire damage in California is greater than $240 billion.

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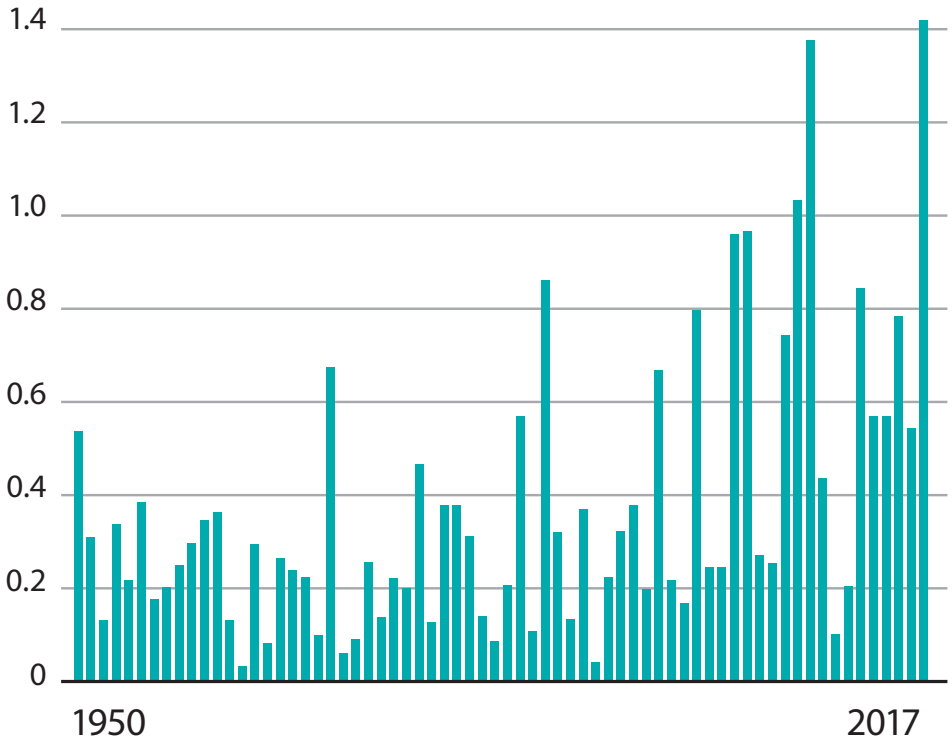
Not only are wildfires more destructive than they had been in the past, the frequency of wildfires is on the increase. The western U.S., for example, has experienced three times the amount of "large fires" (fires that burn 1,000 acres or more) than in the 1970s. On average, more than 1.7 million acres of land per year are being burned and wildfire seasons are also 78 days longer than they were in 1970. In California, 9 of its 10 largest recorded wildfires have occurred since the year 2000.

Rising temperatures dry out grasses and brush, making them easier to ignite. Strong winds also rapidly move fires and increase their size. As a result, injuries and death, evacuation, and property destruction (i.e., homes, cars, businesses) are all on the increase.

Ironically, the history of suppressing wildfires has actually made present-day wildfires worse. Over the last 100 years, every time a fire was successfully fought, vegetation that would have burned didn't burn. Lack of a controlled burn strategy has meant that fires are burning through places where accumulated plant matter provides extra fuel for these fires. In recent years, the United States Forest Service has been trying to rectify the situation by deploying a strategy of prescribed controlled burns where it makes sense.

Number of acres burned per year (in millions)



Source: Cal Fire

Lack of a controlled burn strategy has meant that fires are burning through places where accumulated plant matter provides extra fuel for these fires.

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Given the rapidly increasing risk of wildfire-induced damage and destruction, the topic of wildfire mitigation has quickly emerged as a high priority for regulators, municipalities and electric utilities. In fact, these key stakeholders are just at the beginning of the process of defining, planning and implementing measures to address this critical problem. The term "wildfire mitigation" in general refers to any of a variety of precautionary measures to protect buildings, land, and humans from a wildfire. These measures can include education, wildlife crisis management planning, and technologies that are both preventative and protective in nature.

One specific area of concern that has recently garnered much attention is how electric utilities, which manage thousands of miles of high- and medium-voltage power transmission and distribution networks, are addressing electrical system wildfire threats. Wildfires can result from faults occurring on a utility pole that send molten metal to the ground, igniting nearby dry brush, for example. In fact, Pacific Gas and Electric (PG&E), a California's largest electric utility, says it's "probable" that its equipment caused the Camp Fire in Northern California, the deadliest and most destructive fire in the state's history. In September of 2019, the utility giant announced it had reached an $11 billion settlement with insurance companies for claims stemming from the devastating 2017 and 2018 wildfires.[1]

1 cnn.com

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The key players actively involved in the assessment/planning, prevention, and protection aspects of wildfire mitigation include regulators, electric utilities, municipalities, funding agencies and technology providers. All face differing interests and priorities, and what may be a solution for one group in a particular geographical area, may not suit the needs of another. In addition, no one entity can address the wildfire mitigation challenge in a vacuum. Decisions made by one stakeholder will have a profound impact on how another plans, funds and implements a wildfire mitigation strategy.

In essence, wildfire mitigation is a puzzle in which various pieces are in motion, at different speeds and, sometimes, in different directions:

- Regulatory bodies – State and federal regulators are concerned with the development and enforcement of legislation for addressing wildfire-related issues as diverse as forest management, control of urban sprawl into fire prone areas, and definition of wildfire mitigation mandatory practices.

In the state of California, regulators allocate funds to utilities based on the success of their wildfire mitigation efforts. State law provides that the entity that causes the fire is fully liable for damage. Attempts to establish metrics that define wildfire mitigation effectiveness are currently underway, and the Public Utility Commission is mandating that the California utilities develop and submit formal wildfire mitigation plans.

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- Electric utilities – As new regulations are being formulated, they impact the way power system owners and operators both define and alleviate wildfire risks associated with their installed base of electrical transmission and distribution equipment. Their installed base of equipment and infrastructure covers wide geographical areas in the middle of nature, creating many possible points of vulnerability.

- Utilities across regions of the country are grappling with some tough decisions which involve de-energizing their infrastructure in order to cut down the risk of igniting fires during high threat periods. When some of the utilities deploy this approach, the resulting extended power outages disrupt normal home and business activities.

- Other utilities take a completely different view of the situation. When the geographical reach of their power networks is much smaller and more manageable, they view a cut off of the power as a last resort and are instead taking tactical measures to reduce the fire risks of their infrastructure. They are looking for a more focused approach to the problem.

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- Municipalities – For many municipalities, power availability is tied to the wildfire threat. If the sole source of their power is a traditional grid, a fire occurring hundreds of miles away may be enough cause for power to their town and city to be cut off. Municipal leaders have decisions to make regarding alternative backup sources of power should power from the main utility become unavailable. Critical infrastructures, such as hospitals, sewerage treatment plants, traffic control systems and security, must be kept online in the midst of high wildfire threat conditions. Some communities are exploring the ability to completely isolate themselves from the utilities should a wildfire paralyze the utility's ability to deliver power. More communities now want to own their own power systems in order to minimize their risk. Some of what is needed in terms of backup power generation may take years to develop, and funding will be required to secure these projects.
- Funding agents - How much will it cost to minimize wildfire risk? Insurance companies and financial institutions are faced with many unknowns regarding their own business risks in supporting utilities and municipalities that find themselves in wildfire prone areas. Are the preliminary approaches that are being pieced together to enhance wildlife mitigation efforts effective in limiting damages? Without funding and a viable financing model, the ability to make changes and to institute improvements becomes severely limited.
- Technology providers - Although some preliminary tactical wildfire mitigation technology solutions may already be in place, technology providers require more research to better address the dangers of sparking and the challenges of monitoring electrical networks. Ideally, solutions will need to be engineered to gather data and perform analysis in order to identify potential danger before a wildfire situation is allowed to develop. Point solutions may not be enough. Tiered end-to-end architectures may be needed to assure the highest levels of risk mitigation.

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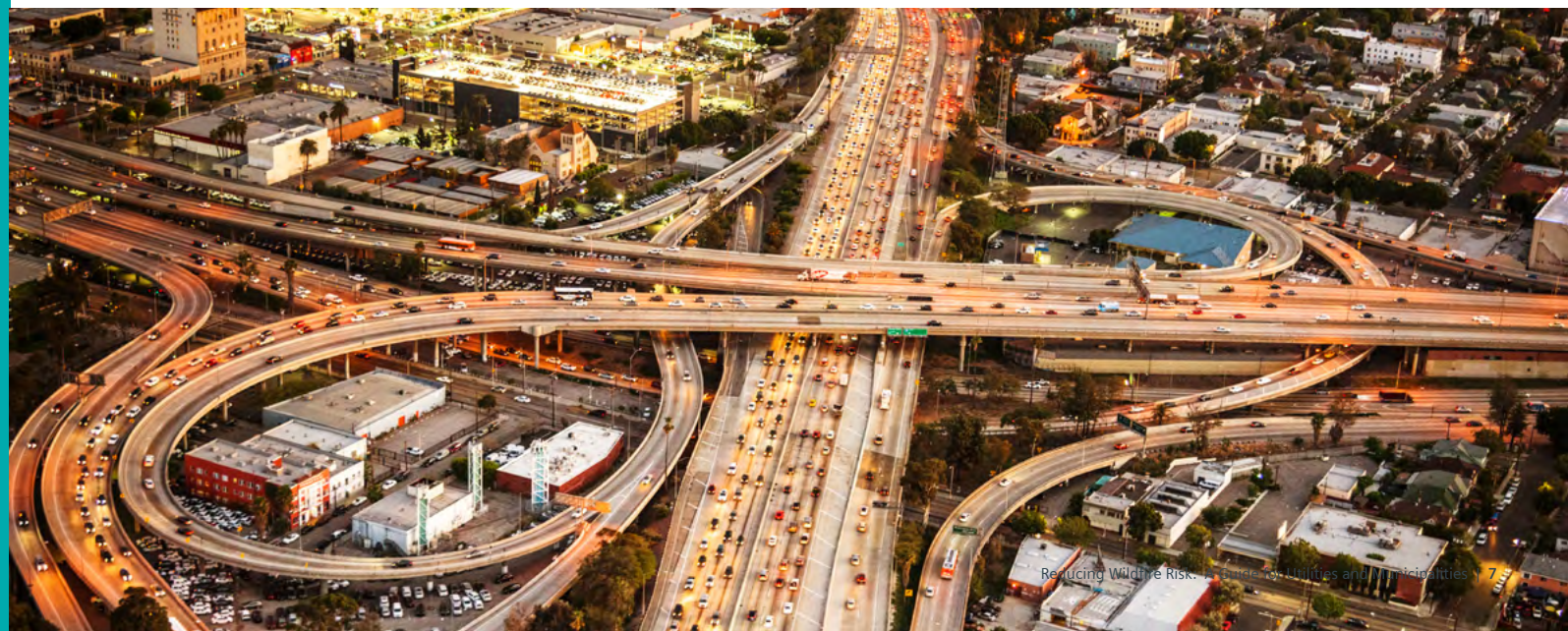

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Part 2: Tactical action plan for minimizing risk

For utilities and municipalities, education, planning and collaboration will help in formulating tactical action plans that reduce electrical systems-generated wildfire risks. Below are several steps for establishing an initial wildfire mitigation roadmap:

1. **Assess your situation –** Establish the ability to measure, quantify, and track risks. In the realm of electrical transmission and distribution systems, wildfire threats can be broken down into several categories.

Tree, tree limb, or other vegetation contact with conductors (wires) can result in fire ignition. Sometimes the conductors themselves will break down due to corrosion or a weather-related event and ignite a fire. In addition to live wires, other types of electrical equipment are capable of producing sparks. These include failed connectors, blown fuses, splices, or other connecting hardware, or defective poles, insulators, transformers, and capacitors.

Risks are not only limited to the electrical systems themselves. Outside forces, such as cars hitting poles and Mylar balloon contacts, can also trigger fires. Birds or rodents contacting energized conductors and then falling to the ground have also been known to cause an ignition.

Identify which of these risk factors is most likely and track incidences as they occur. Establish an approach for monitoring electrical infrastructure and explore tools that might be available today. Begin to seek out partners that have emerged as leaders in the electrical infrastructure management solution marketplace.

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New cloud-based software allows for data to be quickly and inexpensively analyzed in order to spot anomalies across large electrical networks.

2. **Pilot a point solution –** Establish programs and initiatives that will reduce risks. Begin to seek out vendors that have emerged as leaders in the wildfire mitigation evaluation and risk management solution marketplace. Secure funding for those projects that represent low risk and high return. During this time, begin to assemble a team of technical experts. Track expenses and quantify benefits during the pilot and test period. Leverage partners to fill in knowledge gaps where required.

3. **Explore the potential of digitalization –** Wildfire mitigation initiatives are relatively new, and in many cases modern digitalization solutions have yet to be applied to the problem. The cost of gathering data remotely from sensors that are capable of reading and tracking temperature increases within electrical systems has dropped dramatically. New cloud-based software allows for data to be quickly and economically analyzed in order to spot anomalies across large electrical networks. Look to use cases where such digitalized solutions have already been applied so that established best practices can be replicated.

4. **Monitor and prevent –** Remote monitoring now allows both utility operators and municipalities to either directly track significant wildfire environmental risks or to utilize qualified third parties staffed with experts to assess and report on the risks. Risk-related data and analytics can help to lead and embed a wildfire mitigation culture across utility and municipality organizations by providing easy to interpret dashboards that provide near real-time tracking information. Being more informed in turn helps to reduce the risk of both wildfires and of wildfire-related power outages.

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Part 3: Categories of technology point solutions available today

Siemens has taken great interest in developing solutions that address the electrical system aspects of wildfire mitigation. In high risk areas, like the western US and Canada, Australia, Latin America and Southern Africa, Siemens has piloted point products that serve as potential wildfire mitigation solutions. Below are some examples of product categories that can help to make a difference:

- **Spark risk mitigation –** Vacuum circuit breakers have been developed that are capable of reclosing operation to clear transient faults that would otherwise pop fuses. Reclosers are used on overhead distribution systems to detect and interrupt momentary faults. They automatically close the circuit breaker after it has been opened due to a fault. These circuit breakers can be remotely configured to eliminate reclose operations, thereby mitigating sparking risk from faulted lines. This remote control enables non-reclosing operation on high fire threat days. Electrical infrastructure assessments are also available where in-field experts identify equipment sparking risks.
- **Environmental analysis & hazard mitigation –** Aging electrical equipment can be upgraded over time to establish an installed base of less flammable components. For example, replacing mineral oil-filled reclosers with vacuum interrupters mitigates risk of flammable material expulsion in the event of a failure. Substation vacuum breakers can serve as a replacement for mineral oil-filled, air-insulated switchgear, which minimizes the amount of flammable materials at a substation site. In addition, mineral oil traditionally used in substation transformers can be replaced by cast-resin, core dry-type transformers to minimize the amount of flammable materials at a substation's site.

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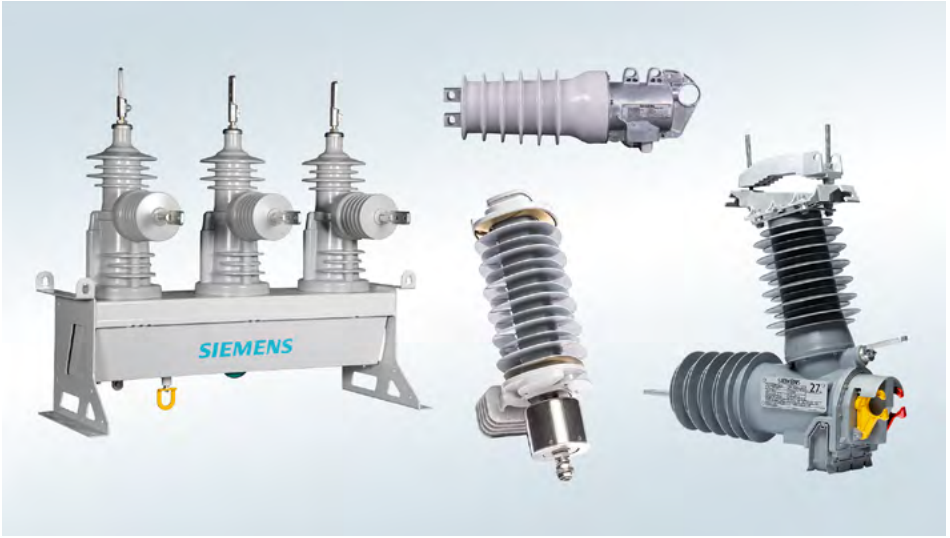

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- **Monitoring and control -** Supervisory control and data acquisition (SCADA) systems and feeder-automation solutions allow for power flows to be isolated and remotely controlled. This enables procedures for maintaining equipment to be safer and more predictable. In addition, these tools allow for adaptive, advanced control and network optimization with real-time monitoring through model-based software. In the case of municipalities, for instance, these tools support microgrids that enable islanding, black start, and grid resynchronization, based on real-time coordination of energy generation, storage and loads.

- **Safety solutions –** When utility linemen are servicing power lines, the mitigation of fuse popping events results in minimized labor risk. New tools now allow linemen to remotely open/close live circuits without the need of a hookstick, thereby mitigating human error risks. By monitoring the status of field equipment before it is physically inspected or maintained, technicians are in a better position to avoid catastrophic failure due to over-pressurized oil or gas buildup.

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- **Customized solutions for unique requirements –** As the domain of wildfire mitigation remains fluid due to lack of agreed upon standards and the unique requirements of individual communities, regulators and utilities, the option exists for rapid development of custom solutions. One recent example of such a deployment recently took place in Australia where bushfire prone areas are now subject to wildfire mitigation-related government regulations. In order to minimize risks, the regulator is requiring utilities to implement rapid earth fault current limiter (REFCL) technologies. These devices significantly lower the energy levels for single line to ground faults and reduce the potential for arc-flash (an event that can expel large amounts of deadly energy and generate temperatures that can reach as high as 35,000°F). REFCL technology can reduce the risk of electrical fires in a more cost-effective manner than replacing all the wires with covered conductors.

  At the time the regulations were enacted, the only solution available was deemed outdated and unsuitable for deployment. Interested parties approached Siemens and Trench, a wholly owned Siemens business, to develop a new product that could maintain voltage on a faulted conductor by identifying and compensating for fault conditions to limit fault energy. Siemens committed significant R&D investments to co-develop a solution with Trench, and to test a prototype within a compressed timeframe. Field trial units are currently underway.

The REFCLs significantly reduce potential for fire ignition in the event of ground fault scenarios by limiting fault current to 3–10 percent of that for an ungrounded system, all within a fraction of a second. They also provide enhanced fault detection for fast, reliable isolation of high-impedance faults.

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Part 4: Assembling and implementing a holistic wildfire mitigation architecture

Point solutions only begin to address the broad challenge of wildfire mitigation. Stakeholders including regulators, electric utilities, municipalities, funding agencies and technology providers need to develop strategies that address risks over the long term. This work will include publishing systematic approaches for mitigating wildfire ignition risks and for better managing the electrical system once wildfires have started.

From a technology provider perspective, Siemens is currently evaluating its portfolio of current technologies and reviewing R&D investments in order to build plans for developing a more layered and comprehensive wildfire mitigation technology architecture. Such an architecture will likely consist of connected intelligent devices, data consolidation and control, and software and analysis. Point solutions will serve as bricks or building blocks from which to expand into a multi-level architecture.

An early glimpse of how holistic systems can improve natural disaster-related resiliency is revealed in some of the new microgrid architectures. One example in particular is Blue Lake Rancheria, a century-old Native American reservation in Northern California. The native lands are equipped with a low-carbon community microgrid to help power government offices, economic enterprises, and a critical Red Cross safety shelter.

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Part 5: Strategic perspectives – Building an ecosystem of collaboration

When it comes to wildfire mitigation, no single entity can develop a strategy alone. The many interdependent parts of a wildfire mitigation make a regulator's decision, for instance, exert a tremendous influence on electrical utilities' operations, which, in turn, affect how municipalities address wildfire threats.

Collaboration is critical in order for the complexities of wildfire mitigation to be properly addressed. In essence, the emphasis needs to be the co-development of holistic solutions with contributions from affected parties.

As a leading technology vendor with expertise in both electrical and industrial control systems, Siemens can offer support on multiple fronts of the wildfire mitigation issue:

- Participation and contribution to wildfire mitigation-related forums and workshops sponsored by regulators, public utilities, investor-owned utilities, and municipalities for the purpose of developing wholistic solutions.
- Collaboration with municipalities to develop both electrical safety and backup power strategies.
- Development of funding options for microgrids and electrical infrastructure upgrade projects that involve wildfire mitigation.
- Design and development of both standard and custom products to help bolster fire safety, electrical system hardening, and grid monitoring solutions.

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Siemens wildfire mitigation solutions portfolio guide (a partial list)

Fusesaver - Single-phase, line or pole crossarm-mounted vacuum circuit breaker that is capable of a reclose operation to clear transient faults that would otherwise pop fuses. Fusesaver can be remotely configured to eliminate reclose operations to mitigate sparking risk from faulted lines.

Compact Modular Recloser (CMR) - Single-phase, line or pole crossarm-mounted, full breaking current rated vacuum recloser that is capable of reclose operations to clear faults on distribution feeders or laterals. CMR can be remotely configured to eliminate reclose operations or to mitigate sparking risk from faulted lines. Replaces traditional oil-filled reclosers. FLISR protection scheme compatible.

SDR Recloser - Three-phase, pole crossarm-mounted, full breaking current rated vacuum recloser that is capable of reclose operations to clear faults on distribution feeders. SDR can be remotely configured to eliminate reclose operations to mitigate sparking risk from faulted lines.

Dry-type transformer - Cast-resin core dry-type transformer for distribution substation applications that eliminates mineral oil traditionally used in substation transformers.

Distribution Feeder Automation System - Distribution feeder automation utilizes a differential protection scheme to enable fast fault location, isolation, and service restoration (FLISR) of distribution networks. SDFA controls a network of reclosers and enables remote control of distribution system operation characteristics.

Microgrid Solutions / Spectrum Power ™ MGMS - Each microgrid controller enables oversight of local network operations, enabling islanding, black start, and grid resynchronization based on real-time coordination of generation, storage and loads. With SP7 MGMS, applications can be built based off of model-based platform that allow for data insights and critical response to wildfires.

Sensegear / monitoring - Health monitoring for specific pieces of equipment within the substation (i.e., transformers, circuit breakers, GIS).

Rapid earth fault current limiter (REFCL) - REFCL detects and significantly limits the energy flow to Line to Ground (L-G) faulted lines. This reduces the possibility of a fire starting, or of a person or animal nearby receiving an electric shock. The system uses arc suppression coils to convert three-phase networks from solidly multi-grounded to impedance grounded, with the benefit of supplying inductive current to a fault that cancels out with capacitive current, thus minimizing fault energy.

Tank rupture-resistant transformers - Tank rupture-resistant products reduce the likelihood of an event where flammable material (mineral oil or ester fluid) is expelled

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