# Assessing the Broader Benefits of Investing in Wildfire Mitigation Measures

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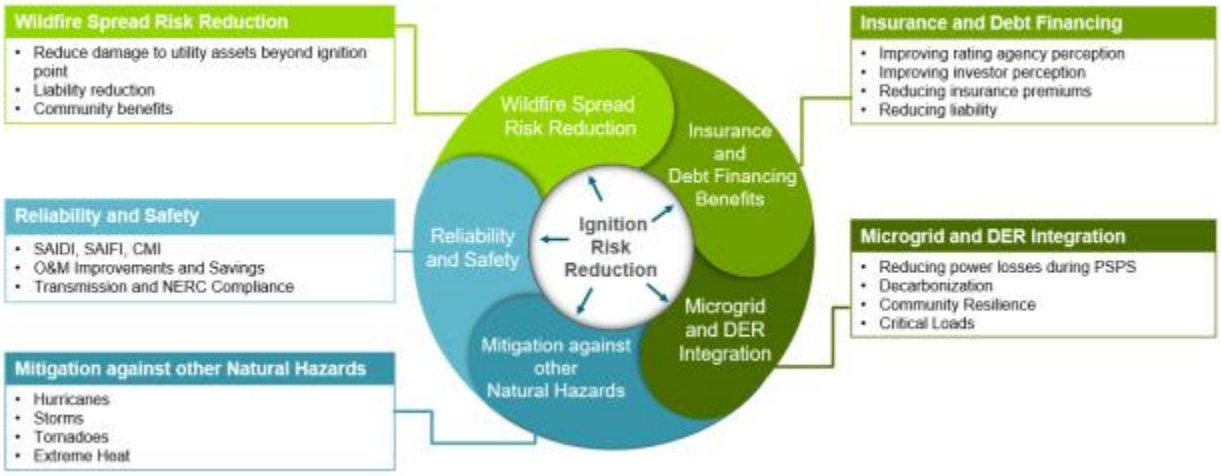
# Executive Summary

While once primarily limited to California and the American West, wildfires are putting stress on communities, as well as electric company assets and operations, in regions across the country as diverse as the Pacific Northwest, the Texas Panhandle, the Appalachians, and the Southeast. For electric companies, regulators, and investors, the increasing frequency and intensity of wildfires requires a new, holistic approach to wildfire risk mitigation. In the recent past, electric companies have relied on Wildfire Mitigation Plans (WMPs) as the means to develop and communicate a coherent wildfire response and investment plan to the communities they serve and their regulators.[1] Our analysis of representative WMPs shows that electric companies are investing in an array of wildfire mitigation measures, yet the discussion and accounting of benefits is frequently limited *only* to reducing the risk of ignition. While ignition reduction *is* a critical benefit, a new framework that incorporates currently unaccounted benefits can create a stronger rationale in justifying such investment plans to regulating entities and the public. These benefits include improved resilience against other natural hazards, increased safety and reliability, minimized risk of wildfire spread, reduced insurance costs for both the electric company and local residents and businesses, improved creditworthiness to enable debt financing, cost savings from optimal vegetation management and enhanced grid resilience through the integration of distributed energy resources (DERs). Figure 1 below summarizes these wide-ranging benefits of wildfire mitigation investments.

**Figure 1. Framework for Assessing the Broader Benefits of Wildfire Mitigation Investments**




*Source:* Guidehouse.

Wildfire mitigation measures like the undergrounding of conductors, installation of covered conductors, and grid modernization efforts often require large capital investments, and the ability to consider additional value streams when making the business case for these investments should lead to better regulator and investor perception and a more efficient regulatory filing process. This whitepaper provides recommendations to key stakeholder groups

[1] Edison Electric Institute Industry Wide Framework on Wildfires Wildfire Mitigation & Liability | (eei.org)

with examples of how a broader accounting of benefits can create better alignment across all stakeholder groups, resulting in greater safety, reliability, and cost efficiency for wildfire mitigation efforts. It is important to note that not all the wildfire mitigation measures discussed in this whitepaper will apply to every electric company—due to differences in geography, jurisdictional priorities, and other factors like the existing level of technology maturity and system topology.

# 2. Introduction and Background

## 2.1 Report Motivations and Structure

This EEI report examines the current decision-making and accounting processes associated with electric company WMPs—specifically the concerns that certain adaptation strategies may appear to have an unfavorable benefit-cost analysis (BCA) when viewed through the narrow lens of mitigating wildfire ignition risk. This paper argues that viewing wildfire mitigation efforts only through the lens of ignition risk does not provide a full accounting of the complex system benefits and that a broader view of benefits should be adopted. The goal of this discussion is to inform regulatory entities and other stakeholders about the challenges of the existing benefit quantification framework, especially as it pertains to grid hardening and typical wildfire mitigation measures. The total value of wildfire mitigation efforts is often larger than the current perception from an investment perspective, and creating better understanding and alignment of this value will lead to more cost-effective, timely, and safe overall outcomes.

Chapter 3 introduces key wildfire mitigation options that are considered by electric companies, with discussion of potential benefits. This discussion is not intended to imply that there is a single suite of mitigation measures that all electric companies should consider or adopt. Instead, a tailored approach and a unique mix of mitigation measures may be required for different service territories depending on environmental, geographic, demographic, and other factors.

Later, the paper provides a detailed discussion of the potential benefits that often are missing from current accounting, regulatory, and decision-making processes, in addition to the overall benefits of a broader accounting view. The paper also makes specific recommendations by stakeholder type. This will help to better align the holistic value of wildfire mitigation measures so that federal, state, and other economic regulatory entities can allocate resources to implement WMPs more efficiently and effectively.

## 2.2 The Regional Context of Wildfire Risk

Across the United States, wildfire risk has emerged as a growing challenge, with climate change creating unfavorable environmental conditions that enable bigger and more frequent wildfire ignition events. This trend is particularly important for electric companies working to reduce the risk of wildfires ignited by electrical equipment, with both regulatory entities and electric companies prioritizing wildfire mitigation initiatives.

The prevalence of wildfire events in particular parts of the United States depend on the climate zone, ecosystem, and other environmental factors in each region. Hot, arid regions of the Western United States are particularly susceptible, and climate change has further exacerbated the conditions that create increased wildfire risks: more frequent periods of high temperatures, high wind speeds, and altered precipitation patterns. Furthermore, changes in precipitation also contribute to ongoing drought conditions, increasing the amount of dried and dead vegetation that serves as fuel for large wildfires. This combination creates ideal conditions for ignition,[2][3]

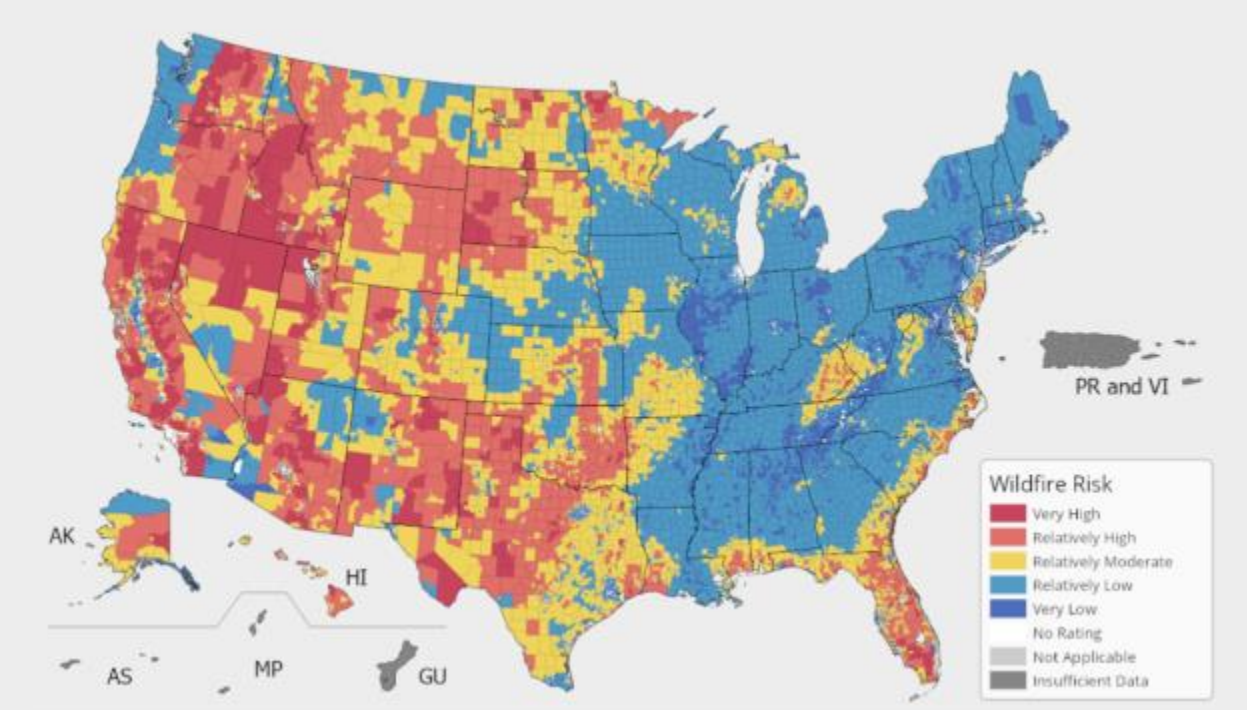
[2] Edison Electric Institute Framework for Industry-wide Action on Wildfire Mitigation, Wildfire Mitigation & Liability | (eei.org)
[3] USDA Forest Service. (n.d.). *Wildland Fire.* Wildland Fire | US Forest Service (usda.gov)

effectively prolonging the annual wildfire season. Additionally, the rugged terrain in certain regions can further impact wind patterns and windspeeds, intensifying wildfire spread.[4]

Higher levels of humidity and precipitation in other parts of the United States result in a comparatively lower risk of wildfire, as the conditions are not as conducive to wildfire ignition and spread. However—even in these places—climate change is increasingly having an impact, with more than half of the country's land area classified as relatively moderate, high, or very high risk, including in less arid regions like Florida and Hawaii.[5]

Figure 2 shows the 2023 annualized Wildfire Risk Index score across the United States. The Index score represents a community's overall risk and susceptibility for wildfires in comparison to the entirety of the United States.[6] Federal Emergency Management Agency (FEMA) classifies Western regions of the United States as "Very High" for wildfire risk.

**Figure 2 FEMA Wildfire Risk Index**




*Source:* FEMA. (n.d.). *Wildfire*. Wildfire | National Risk Index (fema.gov).

### 2.2.1 Analysis approach

The information presented in this whitepaper is the result of the following:

- Guidehouse, Inc's previous experience in assisting electric companies to develop wildfire gap analyses, WMPs, wildfire community outreach programs, and the regulatory

[4] US Forest Service. (2007). *MODELING WIND IN COMPLEX TERRAIN FOR USE IN FIRE SPREAD PREDICTION.* Modeling wind in complex terrain for use in fire spread prediction (usda.gov)

[5] EPA. (2022 July). *Climate Change Indicators: Wildfires.* Climate Change Indicators: Wildfires | US EPA

[6] FEMA. (n.d.). *Wildfire*. Wildfire | National Risk Index (fema.gov)

support associated with such efforts provided an initial framework to envision the conceptual need for a broader view on WMP accounting.

- Additional new research into the wildfire mitigation measures included in current electric companies' WMPs contributed a further state-of-the-market view.
- A wider comparative analysis of wildfire mitigation measures across the industry was used to further gauge and summarize the most prevalent measures.
- A research and literature review on the benefits beyond those typically included in wildfire benefit analysis provided a more comprehensive view of benefits accounting.

# 3. Representative Mitigation Measures

A review of the WMPs for various U.S. electric companies shows that wildfire mitigation measures can typically be grouped into three categories: *System hardening* (which includes selective undergrounding, covered conductors, and grid hardening), *Technology Integration* (including grid modernization and situational awareness), and *Operational Practices* (including vegetation management, enhanced inspections, Enhanced Powerline Safety Settings (EPSS), and Public Safety Power Shutoffs (PSPS).

At the outset, it is important to note that the wildfire mitigation measures implemented by electric companies across the United States vary in part depending on the unique nature of each electric company and their specific geographies. The assessment of the representative measures in this paper is not intended to imply that all companies should deploy all of these measures. A critical first step in the development of a WMP is a risk assessment. Company-specific risks should inform the selection of appropriate mitigation measures. It is unlikely that any individual electric company will—or should—incorporate all of the above measures into a mitigation plan.

## 3.1 System Hardening

System hardening measures are intended to improve the resilience of power systems even as the underlying stress caused by climate conditions continues to increase. Resilience is defined as the ability to withstand, prevent, and recover from disruptive events. Resilience—viewed in the context of an electric sector WMP—refers to the grid's ability to withstand, prevent, and recover from wildfires, promoting increased public safety, minimizing economic loss, and reducing asset damage.

### 3.1.1 Selective Undergrounding

Selective undergrounding is another way to mitigate the ignition risk that may be posed by exposed wire during certain weather conditions and in situations where other overhead hardening measures may not be sufficient or feasible. Undergrounding also supports improved reliability and resiliency in the case of storms and other adverse weather events. Undergrounding powerlines involves reconductoring sections of circuits into underground channels and can be effective in areas of high wildfire risk. However, in comparison with other mitigation efforts, selective undergrounding has relatively higher capital costs, and longer restoration times if equipment fails, primarily due to the time needed to locate the fault, and the limited accessibility to inspect, and repair underground cables. It is expected that the frequency and extent of equipment failures is significantly lower for undergrounding assets than overhead assets, and therefore improve overall reliability for customers. Over the lifetime of the undergrounded assets, there are a range of operations and maintenance costs that could potentially be avoided by undergrounding, such as, vegetation management, equipment inspections, and storm damage restoration work.

**Examples:** To date, PG&E has undergrounded more than 600 miles of conductor to mitigate ignition risk with plans for an additional 900 miles by 2026 per its approved General Rate Case (GRC). Undergrounding is approximately 98% effective at reducing wildfire risk.

Undergrounding 1,230 miles by 2026 will reduce 18% of the wildfire risk in PG&E's High Fire Threat District (HFTD).[7]

Selective undergrounding also is an important component of San Diego Gas & Electric's (SDG&E's) and Southern California Edison's (SCE's) overall grid hardening initiatives. SCE is undergrounding overhead distribution lines, particularly in those areas where covered conductors have not been deployed. More than 40% of SCE's distribution lines in high fire risk areas have been undergrounded as of April 2024[8], with plans to undertake further undergrounding.

### 3.1.2 Covered Conductors

In the course of normal operations, various types of system disruptions can occur when foreign objects come into contact with overhead electric conductor, causing issues both for electric companies and the communities they serve. When a wire comes in contact with a tree or when a foreign object falls or gets blown into a wire, there is a chance that sparks will be produced, or—in the worst case—that the wire could be severed and fall. This can lead to the ignition of a wildfire. Covered conductors can be an effective solution for addressing this risk, with a protective combination of internal semiconducting and external insulating UV-resistant layers protecting bare wires against damage that could lead to wildfire ignition. Used in tandem with vegetation management, covered conductors also may reduce the frequency of PSPS over time with demonstrated resiliency in high-wind events.

**Examples:** Covered conductors are used by electric companies in high wildfire risk areas in California. SCE's Wildfire Covered Conductor Program (WCCP) prioritizes the replacement of exposed wire with covered conductors and additional resilient infrastructure. According to independent assessments, the program has yielded a 71% decrease in faults on circuits utilizing covered conductors in comparison to solely using bare wire.[9] By the end of 2025, SCE intends to replace over 7,200 circuit miles of distribution primary overhead conductors with covered conductors.[10] SCE now has a standard to determine conductor replacement in and out of high fire areas with covered conductors. In addition to improving system performance, this strategy mitigates public safety risk by reducing the changes of someone coming into contact with downed or sagging wires.

NV Energy has deployed a similar program, using a tiered program to target specific areas with higher wildfire risk by installing covered conductors.[11] Because covered conductors can still be susceptible to some overhead contact risks and lightning strikes, the company intends to implement a mix of selective underground and covered conductors.[12] NV Energy's Covered Conductor Program (CCP) is comprised of tree wire. In NV Energy's first NDPP, the company piloted both the tree wire and spacer cable measures and selected tree wire for further deployment. The two generic configurations of covered conductor minimize risk associated with

[7] D.23-11-069, PG&E's 2023-26 GRC Decision
[8] SCE Undergrounding Factsheet Targeted Undergrounding in High Fire Risk Areas (sce.com)
[9] SCE 2023-2025 WMP. (p.252).
[10] SCE 2023-2025 WMP. (p.6).
[11] NVE NDPP. (p.41).
[12] NVE NDPP. (p.150).

vegetation contact and will be installed primarily in Tier 3 regions, which have the greatest wildfire risk.

### 3.1.3 Additional Grid Hardening Measures

Grid hardening has become a critical method of ensuring grid resilience and reliability. Beyond selective undergrounding and installing covered conductors, additional grid hardening measures to address wildfire risks include replacing conventional fuses with newer ones that are designed to contain sparks, installing stronger and fire-resistant poles, upgrading transformers, and reinforcing telecommunication assets. The goal of hardening is to ensure that physical assets are stronger and can withstand extreme weather conditions such as heat, wind, and other adverse conditions. These kinds of grid hardening measures can be effective because historic infrastructure design standards sometimes prove insufficient in the face of increasing and increasingly extreme wildfire events. Simply put, existing assets were not built to withstand the volatility associated with climate change.

**Examples:** California law requires SCE and SDG&E to set 10-year target goals as part of their WMPs, which typically include identifying grid design and system hardening priorities. Installing Rapid Earth Fault Current Limiters (REFCL) is an example of one of SCE's key grid hardening initiatives that reduces phase to ground faults thereby reducing damage from wildfires.[13] SDG&E's Expulsion Fuse Replacement Program integrates more fire-safe expulsion fuses approved by the California Department of Forestry and Fire Protection (CAL FIRE), therefore limiting the potential of an ignition event.[14] Additionally, SDG&E's sectionalizing enhancements enable efficient PSPS and subsequent restoration.[15]

As part of its grid hardening program, PG&E sometimes removes existing overhead lines and deploys remote grid generation technology. This alternative measure is a reasonable alternative where there are long overhead lines that serve relatively few customers, and the costs are high to harden and maintain the lines.

## 3.2 Technology Integration

Alongside system hardening measures, electric companies also implement various types of sensing, control, and software technologies as wildfire mitigation measures. The configuration of existing systems may necessitate different approaches to prioritizing and categorizing new technology investment programs, most of which likely involve capital investments. For the purposes of this paper, technology integration measures include grid modernization and situational awareness tools.

### 3.2.1 Grid Modernization

Many electric companies have invested in various forms of advanced grid solutions and grid modernization, while others are ramping up these efforts, often in part, to address resilience

[13] Southern California Edison. (2023 October). *2023-2025 Wildfire Mitigation Plan*. [SCE 2023-2025 WMP]. (p. 216). SCE 2023-2025 Wildfire Mitigation Plan

[14] San Diego Gas & Electric Company. (2023 October). *2023-2025 Wildfire Mitigation Plan*. [SDG&E 2023-2025 WMP]. (p.215). 2023-2025 WILDFIRE MITIGATION PLAN (sdge.com)

[15] SDG&E 2023-2025 WMP. (p. 157).

concerns, including wildfire risks.[16] Grid modernization measures include advanced Intelligent Electronic Devices (IEDs), trip savers, and Advanced Fault Location, Isolation, and Service Restoration (FLISR) controls. These investments commonly are intended to address more than one system need concurrently. For example, in California, grid modernization investments have focused on addressing wildfire threats, as well as increased distribution system visibility and control to facilitate and manage increasing penetration of distributed energy resources (DERs). Similarly, advanced distribution management systems (ADMS) provide system operators real-time visibility into the distribution system to support a range of DERs and enable control functions to be able to react to changes in weather conditions such as wind speed and precipitation that can increase wildfire risk. Grid modernization investments tend to be less capital intensive compared to system hardening investments. Other examples of grid modernization investments that enable wildfire risk mitigation are early fault detection (EFD) sensors to find a fault before it occurs, transmission open phase detection (TOPD) systems that de-energize a line before it hits the ground, and fast-curve settings that can turn off power within seconds in response to wildfires.

**Examples:** Arizona Public Service (APS) has implemented ADMS to improve the safe and reliable operations of its overall distribution system, while enabling increased levels of DER penetration. An ADMS provides system operators with real-time system visibility and control functions to be able to react to system disruptions like wildfires. PG&E is also in the middle of an ADMS program that is designed to help manage the increased operational changes required to operate the distribution grid safely during periods of elevated wildfire risk.

### 3.2.2 Situational Awareness

Situational awareness measures are deployed by electric companies in some high wildfire risk areas to better anticipate, detect, and forecast conditions conducive to wildfire ignition in their service territories. Situational awareness tools also support an electric company's ability to better anticipate, prepare for, react to, and recover from extreme conditions. Situational awareness measures may include alignment of operational processes with weather station outputs, leveraging wildfire modeling software, and installing wildfire detection cameras.

**Examples:** PG&E, SCE, and SDG&E have built a robust weather station network (over 3,000 terrestrial weather stations) to provide critical data about existing weather conditions. this, combined with advances in weather modeling, has allowed all three to develop models that help predict the location and severity of potentially hazardous weather conditions. A company-specific Fire Potential Index (FPI) model is also part of their efforts to improve situational awareness by establishing daily operations conditions to help inform operational decisions like whether to initiate EPSS and/or a PSPS.

PG&E, SCE, and SDG&E also have sponsored over 1,000 wildfire cameras within a public-private partnership called ALERT California that fully utilizes the academic resources of UC San Diego and other universities to build a network of AI-enabled cameras to provide 24/7 coverage across California. Notifications from these cameras are utilized daily by CAL Fire to quickly respond to all emergent wildfires.

[16] United States Department of Energy. (2024 April). *Pathways to Commercial Liftoff: Innovative Grid Deployment*. (pp. 10, 41). Pathways to Commercial Liftoff: Innovative Grid Deployment (energy.gov)

In its 2022 WMP Annual Report, Xcel Energy describes a pilot program in which the company installed three wildfire detection cameras with AI technology, a promising tool for improving situational awareness. These cameras can detect early signs of smoke and provide alerts in the case of an ignition event. In its 2023 WMP Annual Report, Xcel Energy explains how it took the learnings from the pilot and went forward with an additional twenty-one sites, with the intent to deploy more cameras in 2024. Xcel Energy also noted improvement in its situational awareness through the implementation of wildfire spread modeling software, integrated with notifications of probable fire activity that use satellite technology that senses temperatures and humidity.

## 3.3 Operational Practices

Beyond hardening and deploying new measures and technologies, electric companies also can implement operational practices to improve the functionality, stability, and resilience of the grid. Some operational practices may support reliability, storm preparedness, and restoration efforts, as well as benefiting wildfire mitigation. This white paper discusses the following operational practices: vegetation management, enhanced inspections, EPSS, and PSPS. Grid modernization technologies mentioned earlier in this white paper such as fast-curve settings can enable some of these operational practices.

### 3.3.1 Vegetation Management

Electric companies must manage the growth of vegetation around electrical equipment to ensure system reliability and resilience. This is a precautionary measure that also promotes public safety, helps to preserve nearby ecosystems, and protects infrastructure. Vegetation management has always been an important part of electric company operations and maintenance programs, but many electric companies are now implementing more advanced vegetation management measures focused on high-risk areas and equipment. Technologies like Light Detection and Radar (LiDAR) are being used by some electric companies to determine the proximity of vegetation to assets and to address other issues that could create fire hazards.

**Examples:** NV Energy has implemented a comprehensive four-year cycle maintenance program consisting of fuel management and pole grubbing to ensure that vulnerable assets are kept within combustible-free spaces.[17] NV Energy also has proposed resiliency corridors to allow for specific zones within maintenance areas to have different degrees of vegetation management, based on the needs of different asset types.

Electric companies like SCE and SDG&E have incorporated modeling and quantitative measures to inform their vegetation management efforts that include enhanced tree trimming and tree removal programs. Using a Vegetation Risk Index (VRI) and LiDAR helps to determine the overall health of the vegetation in a region in addition to informing assessments of the potential wildfire risk.[18] Additionally, SDG&E established a Wildfire Mitigation and Vegetation Management department in 2019 to oversee and support its WMP through collaborative efforts and monthly meetings.[19] Allocating new personnel and resources to vegetation management

[17] NVE NDPP. (p.82).
[18] SDG&E 2020 WMP. (p.43).
[19] SDG&E 2020 WMP. (p.148).

efforts enables electric companies to develop comprehensive plans and programs to minimize potential wildfire ignition and the associated customer impacts.

### 3.3.2 Enhanced Inspection

Enhanced asset management and inspection programs work to promote safety for the public and for electric company personnel, as well as improve electric grid reliability, by identifying and repairing assets and identifying other defects that could affect safety and reliability. Comprehensive transmission and distribution inspection programs are a key component of many electric companies' WMPs as equipment performance issues can be linked to increased wildfire ignition risks.

**Examples:** SDG&E's asset inspection programs consist of physical inspections, visual patrols, infrared inspections, and various specialty patrols. While some are risk-based, most inspections are on a schedule and their frequency is variable, ranging from monthly to every 10 years. For the transmission inspection program in particular, internal severity codes are used to prioritize repairs by considering the type of component and its surrounding terrain. In 2023, an estimated 0.188 ignitions were avoided per year due to the implementation of the 5-year detailed distribution inspection program. About 0.15 ignitions were avoided in 2023 through the transmission overhead inspection program.[20]

SCE deployed digital aerial inspections which allows findings (field observations, QA/QC) to be incorporated into the standard inspection form.

Advanced methods of inspections, such as Unmanned Aerial Systems (UAS), LiDAR and wildfire cameras deployed by Xcel Energy enable increased granularity in risk identification and mitigation. Furthermore, accelerating the implementation of mitigation measures—beyond established standards—can further support the proactive detection of potential equipment issues that require repairs or replacement.[21]

### 3.3.3 Enhanced Powerline Safety Settings (EPSS)

EPSS is a protective technology that allows line protection devices, such as line reclosers, to address faults of varying magnitude and rapidly de-energize the line. These faults may occur due to vegetation striking a line, animal interference, third-party interference (e.g., a vehicle hitting a line), or equipment failure. Circuits enabled with EPSS are configured to clear high-current bolted fault conditions at 100 milliseconds or less. EPSS settings also allow circuit breakers and reclosers to clear faults beyond fuses. This allows clearance of all fuse-protected circuit segments with ganged three-phase interruption to prevent backfeed into the fault, which could result in sparks

Additionally, when EPSS is enabled on three-wire distribution systems, Sensitive Ground Fault settings are implemented to help detect lower current fault conditions. This protection is generally set to identify 15 amperage faults within 15 seconds and de-energize the conductor to protect the line.

[20] SDG&E 2023-2025 WMP. (pp.185, 188).

[21] Xcel Energy. (2023 May). *WILDFIRE MITIGATION PLAN 2022 ANNUAL REPORT.* [Xcel Energy WMP 2022 Annual Report]. (p. 5). Wildfire Mitigation Plan 2022 Annual Report_FINAL_05-31-23.pdf (xcelenergy.com)

**Examples:** PG&E piloted an early version of EPSS in 2021 to address the threat posed by dry vegetation-driven fires that occurred on Non-Red Flag warning days. The program had a dramatic impact on reducing ignitions on the circuits that it was installed and, in 2022, PG&E implemented the program across all its High Fire Threat Districts and High Fire Risk Areas. More details can be found in Section 8.1.8.1.1 of PG&E's 2023-2025 WMP.

### 3.3.4 Public Safety Power Shutoffs

PSPS is a mitigation measure used to reduce wildfire ignitions that may be caused by energized electrical equipment. While this method can be used when the combination of high windspeeds and dry vegetation or fuel levels risk contributing to the spread of wildfire, preparations for proactively shutting of the power require significant advanced planning and coordination.[22] A PSPS de-energizes portions of the grid to limit ignitions and protect the public until the critical wildfire weather conditions have subsided. However, PSPS can result in community disruption, emergency response delays, and health and safety issues. Through the continued investment in additional wildfire mitigation methods and grid hardening, electric companies can reduce the frequency and impact of PSPS events through better informed operational decisions and by more narrowly targeting equipment operating during high-risk conditions.

**Examples:** Electric companies, such as SDG&E, have developed a comprehensive wildfire communication program intended to reduce the customer and community impacts of PSPS. The year-round communication program has a multi-faceted framework to maintain contact with customers prior to, during, and after an extreme weather event.[23] Furthermore, communication with emergency responders and government officials ensures that SDG&E can protect its vulnerable customers and advise public safety partners within impacted regions. Similarly, SCE has invested in improved communication measures to reduce the potential disruptive impact on customers. Through end-to-end automation solutions and sectionalization, SCE plans to better manage PSPS events and restore power more efficiently over the 2023-2025 WMP cycle.22 Covered conductors is an important investment that could reduce the frequency of PSPS by raising the criteria necessary to trigger it.

[22] SCE 2023-2025 WMP. (p.8).

[23] San Diego Gas & Electric Company. (2020 February). *San Diego Gas & Electric Company Wildfire Mitigation Plan*. [SDG&E 2020 WMP]. (p.135). Microsoft Word - SDG&E 2020 Wildfire Mitigation Plan DRAFT (sdge.com)

# 4. Benefits Beyond Ignition Risk Reduction

As electric companies adapt to the increasing impact of climate change and are actively working to reduce wildfire risk, it is critical to expedite regulatory approvals for wildfire mitigation investments. Most methods currently used to account for the benefits of wildfire mitigation measures emphasize avoided ignitions, and discount or avoid mention of the additional benefits associated with such measures.

Although using ignition risk as the leading metric in regulatory filings as well as academic literature has been an important starting point for assessing the benefits of wildfire risk mitigation measures, it is only effective as a relative metric to compare different mitigation measures against each other and has limited utility outside of the facts and circumstances of the risk factors that a company is seeking to mitigate, which themselves are not uniform across geographies and timescales. It should not be used as an absolute measure of the value of mitigation measures or the range of benefits that such measures will create for the energy grid where they are installed, and for the customers served by that grid. Some of the key benefits that currently are not captured by an ignition-reduction focused assessment are described below.

## 4.1 Operational Savings and Improvements

Wildfire mitigation also can provide operational cost savings that often are associated with other grid improvements. Electric company programs intended to reduce the risk of catastrophic wildfires also have in many cases improved operations and maintenance (O&M) processes.

For example, SDG&E's use of drone inspections at elevated fire risk locations is more efficient than ground-based technology for assessing for damage.[24] The ability to see damage not visible from the ground can result in O&M cost reductions, by minimizing the need for additional crews to walk along circuits to find equipment damage.

In its 2023-2025 WMP, SCE notes its intent to more broadly implement REFCL and early fault detection technologies to help detect and prevent faults. SCE's covered conductors are expected to reduce regular maintenance costs given the reduction in damage from a range of weather conditions.

## 4.2 Increased Public Safety

Public safety is the top priority driving electric company wildfire mitigation efforts. Previously, stakeholders considered safety to include internal practice improvements to protect the wellbeing of line workers as well as the public through informational campaigns such as safe digging and downed line awareness.[25] Climate change has shown the need to expand this view to include safety hazards associated with natural disasters. Electric companies—especially those located in high wildfire risk areas—are improving safety by implementing continuous risk assessments, deploying equipment that reduces ignition sparks, and revising their operating procedures. Measures that reduce the risk of wildfire spread such as vegetation management can reduce the consequences of catastrophic wildfire events for communities, save lives, avoid

[24] SDG&E 2023-2025 WMP. (p. 5).

[25] Gelbien, L., & Bertcher, K. (2023 April). *Wildfire's Legacy: Paradigm Shift to a More Resilient Grid.* Guidehouse. Paradigm Shift to More Resilient Grid | Guidehouse

power shut offs and reduce restoration costs. These real-life positive impacts on customers and communities is a major benefit of wildfire mitigation measures.

## 4.3 Reliability and Resiliency

In addition to financial considerations, there are many safety, reliability, and other operational improvements that often accompany wildfire mitigation measures. This section discusses the less-tangible benefits that are not always included in the calculations when making financial investment decisions relating to wildfire mitigation measures.

### 4.3.1 Reliability (SAIDI, SAIFI, CMI)

Closely related to safety, the array of electric company system hardening investments, vegetation management strategies, and inspection protocols—in addition to mitigating wildfire risk—also provide improvements relating to service reliability, with wildfire mitigation measures often strongly linked to reliability metrics. To measure reliability, indexes and metrics like System Average Interruption Duration Index (SAIDI), System Average Interruption Frequency Index (SAIFI), and Customer Minutes of Interruption (CMI) are commonly used throughout electric companies' WMPs.[26]

NV Energy's SAIDI metric increased by 25% between 2015 and 2018, due to a variety of factors, including extreme weather events, climate change, and aging infrastructure.[27] Within its NDPP, NV Energy has identified covered conductors, selective undergrounding, and non-expulsion fuse initiatives as providing high levels of reliability.[28]

Furthermore, in its 2020 WMP, SDG&E established a program called Protection Integration with Distribution Communications Reliability Improvements (DCRI). The DCRI program aims to improve the reliability of SDG&E's communication network to support efficient wildfire mitigation and public safety programs.[29] The program expands the use of a technology known as Falling Conductor Protection (FCP). The technology uses wireless communications and relays to de-energize damaged powerlines before the downed line causes potential ignition through contacting the ground. Overall, the DCRI program improves wildfire protection and telecommunication reliability.[30]

SCE estimates that covered conductors saved it 5 minutes of SAIDI time in 2023.[31]

### 4.3.2 Increased DER Integration

Investments in grid modernization can enable more distributed energy resources (DER) on the grid and the creation of microgrids, which can allow isolation of some customer loads from the

[26] SDG&E 2020 WMP. (p.143).
[27] NVE NDPP. (p. 97).
[28] NVE NDPP. (pp.147-148).
[29] SDG&E 2020 WMP. (pp. 89-90).
[30] San Diego Gas & Electric. (n.d.). *Improving Our Communications Network.* DCRI Cell Tower | San Diego Gas & Electric (sdge.com)
[31] SCE WMP 2023-2025

rest of the grid in the event of a fault. DER deployment can partially offset the impacts of PSPS during a wildfire event, as well as provide additional benefits to the broader energy grid and to customers.

Distribution automation sensors and controls originally designed for application wildfire mitigation, such as fault location, isolation, and restoration (FLISR) and volt-VAR optimization (VVO), are critical in integrating DERs. VVO enabled by devices such as advanced capacitor banks can help reduce voltage fluctuations and integrate a greater amount of DERs in the grid. For example, greater real-time visibility, when paired with other tools that allow operability of DERs, can help optimize deployment of resources such as distributed solar, energy storage, and demand-response to reduce large evening peaks seen in geographies with high solar penetration.

The first utility-scale microgrid in the United States was installed by SDG&E in Borrego Springs to help keep critical facilities in the area energized during extreme conditions that may trigger a PSPS.[32] SDG&E is actively working to build additional microgrids in high wildfire risks areas across its service territory. DERs and microgrids can support efforts to maintain energy access for critical community loads such as hospitals and shelters.

### 4.3.3 Mitigation of Other Natural Disaster Risks

Beyond wildfires, system hardening initiatives, technology integration, and operational practices within electric company WMPs often help to mitigate risks associated with other natural disasters. Though electric companies prioritize projects primarily to address wildfire risk, measures can often be coordinated to concurrently address multiple natural hazards.

For example, in addition to its benefits against wildfires, undergrounding is well accepted to reduce wind damage to electric grid assets caused by hurricanes. A study from Xu and Brown describes a cost-benefit analysis framework to evaluate overhead-to-underground conversion relating to hurricane damage in Florida.[33] Investments in tree trimming are another well accepted measure for reducing extreme weather driven outages including high wind events. A study based on the outage prediction model (OPM) shows an annual reduction of ‘trouble spots’ (locations with high outage frequency and duration) between 25% and 42% due to the tree trimming performed between 2005 and 2019.[34]

Similarly, NV Energy’s system hardening, situational awareness, and inspections support increased grid resiliency not only during wildfires, but also work to reduce the impacts from other natural disasters.[35] For example, selective undergrounding helps to minimize equipment failure risk during earthquakes, and reconductoring in Tier 3 regions of NV Energy’s service territory also allow for increased resiliency in the event of high winds.[36,37]

[32] San Diego Gas & Electric. (n.d.). *Microgrids.* https://www.sdge.com/more-information/environment/smart-grid/microgrids

[33] Brown, R., Xu, L., (2009 July). *A framework of cost-benefit analysis for overhead-to-underground conversions in Florida*. IEEE Power & Energy Society. (pp. 1-7).

[34] Taylor, W. (2022). *Dynamic modeling of the effects of vegetation management on weather-related power outages*. Electric Power Systems Research. (pp. 107840).

[35] NVE NDPP. (p.3).

[36] NVE NDPP. (p.147).

[37] NVE NDPP. (p. 27).

SDG&E's infrared transmission inspection program examines tie lines and energized structures to detect equipment defects that could become failure points during high wind events. Furthermore, the company expanded its emergency management operations to include an Operational Field & Emergency Readiness program, which manages SDG&E's After-Action Review program and supports efforts to improve community resilience in response to the impacts of a PSPS.[38]

Enhanced communication and community resilience can also enable effective response and recovery plans. For example, the locations of future earthquakes may not be predicted with much certainty, but having previously established response measures can promote a more efficient recovery strategy. SCE addresses emergency preparedness and response through its Business Resiliency (BR) All-Hazards Emergency Operations Plan (AHP). Designed to guide response personnel and company leadership in the event of any type of emergency, the AHP aims to facilitate efficient restoration of operations using an improved communications strategy.[39]

## 4.4 Compliance

Efforts to strengthen the grid or improve operational practices—in addition to providing the above benefits—can also help to improve an electric company's compliance with various regulations and requirements. This can also improve the transparency of investments and operational decisions in the eye of public and institutional stakeholders.

### 4.4.1 Transmission System and NERC Compliance Benefits

Wildfire mitigation measures undertaken by local electric companies can also provide broader efficiencies relating to the transmission system and can help with increased regulatory compliance. Since the North American Electric Reliability Corp. (NERC) standards became mandatory in 2007, the electric industry has continuously enhanced its coverage to identify and evaluate new threats to reliability, such as cold snaps, and geomagnetic disturbances (GMD). Subsequently, mitigation measures have been implemented to address these risks and enhance overall electric grid reliability, resulting in similar improvements for the broader transmission system—even if not formally incorporated into the NERC standards.

**Vegetation Management:**

As with localized wildfire mitigation measures, increased vegetation control practices also work to improve transmission system reliability by reducing the chance of 'grow-ins'—complementing the defense strategy of NERC Facility Design, Connections and Maintenance standards. The purpose of the Transmission Vegetation Management standard is to prevent vegetation-related outages—especially those initiated in the public Right-of-Way—that could lead to cascading events.[40] Vegetation measures included in electric company WMPs often contribute to practices that exceed the Minimum Vegetation Clearance Distance required in the NERC standard, resulting in enhanced compliance.

[38] SDG&E 2019 WMP (p.164).

[39] SCE 2023-2025 WMP (pp. 519-529).

[40] FAC-003

**Inspection Practices:**

The overall objective of detailed transmission line inspections is to minimize or eliminate vegetation-related cascading outages, safety, and other wildfire ignition risks. Activities focus on inspecting both overhead and underground transmission and distribution facilities, as well as substation facilities. Inspections use infrared detection systems, drones, and LiDAR to examine transmission structures, hardware, and conductor conditions. Frequently, issues relating to corrosion, vandalism, lose or missing hardware, improper clearance, and vegetation hazards can be identified early and then corrected, helping to reduce the occurrence and duration of outages.

Improvements in system automation and grid operations to prevent wildfires also can enhance physical security and compliance with NERC's CIP-014, Physical Security standards. The use of high-definition cameras in a company's service territory—including pan-tilt-zoom cameras—can provide 360-degree monitoring of company assets. Installation of weed barriers and crushed rock vegetation control to prevent ignition can also optimize defensible space around substations by enabling better surveillance.

**Fault Clearing:**

Adjustments to system protection to address wildfires—such as implementing high-speed clearing—can further improve system stability. Faster clearing of faults improves stability margins while reducing the chance that an electrical fault can remain energized long enough to initiate a fire. Better methods for high impedance fault detection on transmission systems and the replacement of legacy protection systems with more modern systems help improve system reliability and enhance compliance with NERC's Protection System Misoperation Identification and Correction standard.[41]

Poorly grounded substation equipment can slow fault clearing and introduce arcing at the ground connections, which—if not well designed and properly bonded—pose a fire ignition threat. Improved substation bonding of certain equipment components also forms a low impedance fault current return path when unbalanced faults occur. The low impedance return path maximizes the fault current flow, thereby decreasing the time needed for the protection systems to detect a fault condition and work to isolate the fault.[42]

**Forecasting:**

Improved forecasting and modeling can benefit system planning and emergency operations, providing better situational awareness and enabling operational planning aligned with NERC TOP-002, Operations Planning. The ability to collect and interpret data to inform decision-making around specific risks facing electric companies is a key component of situational awareness. In recent years, many electric companies have invested heavily in acquiring and using meteorological and land cover data to inform their wildfire related operations and planning processes. Such predictions better inform daily operations by helping stage crews in areas at

[41] PRC-004

[42] Substation equipment is installed with a grounding grid that bonds all metallic structures and equipment components to minimize voltage differentials between the various components.

higher likelihood of seeing outage activity driven by weather. These predictions also help to inform both transmission and distribution system planning.

**Hardening Telecommunications Infrastructure:**

The telecommunication sector—an integral component of electric company daily operations—may be the most vulnerable of all critical infrastructure. From the impact of extreme weather to the increasing risk of cyber-attack, this complex system could be at risk of significant disruption. Telecommunications networks play a significant role in monitoring and controlling all aspects of the electric grid—during both normal operations but especially during natural disaster emergency events. Reinforcing telecommunications infrastructure to address wildfires also benefits operational reliability. For example, installing a new static line incorporating a fiber optical ground wire cable can provide lightning and grounding protection to the transmission line and enables high speed communications, preserving the reliability of grid protection and grid operations circuits, while also providing more bandwidth for increasing data needs.

**Emergency Communications Protocols:**

Improvements in emergency response processes and better communication with local authorities to address wildfire responses can also improve an electric company's overall emergency response preparedness and enhance compliance with EOP-011, Emergency Preparedness and Operations. To address wildfire threats and response, electric companies have initiated greater communications with local emergency management agencies, tribal partners, telecommunications infrastructure providers, large customers, and other local partners. Communications protocols are especially critical during a wildfire event and resulting restoration efforts. Frequent updates to a company's Emergency Response Plan (ERP) and more frequent table-top exercises and drills can result in a more comprehensive and better-tested ERP that enhances the overall reliability of the transmission system.

## 4.5 Insurance and Cost of Capital

Investing in wildfire mitigation measures can have a significant impact in reducing the cost of capital and insurance premiums for companies in high wildfire risk areas. A case in point is improved bond ratings for PG&E from Fitch. After PG&E's continuing wildfire mitigation efforts and the relative lack of ignitions, this rating has improved to BB+ in April 2024. Fitch assigned a rating of BBB+ to PG&E's issue of First Mortgage Bonds maturing in November 2023.[43] In the comments accompanying this rating, Fitch mentioned two major reasons for the rating improvement:

- A "significant reduction in wildfires linked to PG&E equipment and fewer structures destroyed by PG&E-linked wildfires and associated liabilities post-2018, compared with 2017-2018."

- Anti-wildfire legislation enacted in California helping to facilitate ongoing management efforts to reduce wildfire risk and improve overall safety performance.

[43] Fitch Ratings. (2023). *Fitch Rates Pacific Gas and Electric Co.'s First Mortgage Bonds 'BBB'/'RR2'* Fitch Rates Pacific Gas and Electric Co.'s First Mortgage Bonds 'BBB'/'RR2' (fitchratings.com)

Eliminating wildfire ignition risk also can help local homeowner and business insurance eligibility. In California, insurers have begun to stop coverage in areas of high wildfire risk. By eliminating the wildfire ignition risk by undergrounding, electric companies could support the viability of private insurance in areas of high fire risk.

# 5. Comprehensive Assessment of Wildfire Mitigation Investments

The rising frequency and intensity of wildfires and the subsequent impact on communities and electric companies has resulted in the development of company-specific wildfire mitigation plans, which are also often required by regulators. Many of these WMPs and the associated filings (including rate cases) require a detailed quantification of the benefits associated with mitigation measures like undergrounding, covered conductors, and vegetation management. Frequently, the discussion of benefits is limited *only* to the reduced risk of ignition. While this information is essential, it is also not sufficient to capture the full array of benefits associated with implementing wildfire mitigation measures. Figure 3 below shows a recap of the important benefits of wildfire mitigation measures, beyond ignition risk reduction.

**Figure 3. Framework for Assessing the Broader Benefits of Wildfire Mitigation Investments**


*Source:* Guidehouse.

Beyond wildfires, mitigation measures can enhance the electric grid's reliability in the event of other natural hazards such as earthquakes and hurricanes. Investments in grid modernization technologies like trip savers enable PSPS to prevent wildfire ignition and spread but can also lead to O&M improvements and cost savings in the case of non-wildfire-driven power outages. Investments in microgrids and DERs can partially offset lost revenue from PSPS events and maintain electricity access for critical loads, enhancing community resilience. From a financial and reputational risk perspective, designing a PSPS program can also improve investor and bond-holder perception beyond the innate wildfire ignition reduction benefits.[44]

Wildfire mitigation measures are often capital intensive, and some measures like undergrounding can require investments of millions of dollars per mile—leading to increased scrutiny from intervenors during proceedings such as rate cases. Quantifying the benefits solely from the perspective of reduced ignition risk may not be sufficient to justify the value and

[44] CPUC. (2024). *Public Safety Power Shutoffs.* Public Safety Power Shutoffs (ca.gov)

customer benefits of these investments. Casting a wider net that incorporates the grid resilience, reliability, and community benefits will help accurately capture the real value that these investments create for customers, shareholders, and communities at large.

As this framework illustrates, wildfire mitigation investments have benefits beyond ignition risk reduction, supporting critical goals like reliability, and resilience against natural disasters. A comprehensive accounting of the benefits of these wildfire mitigation measures is in the larger interests of customers. Regulators should adopt a more holistic approach while assessing wildfire mitigation plans and companies should include a robust discussion of these other benefits when seeking regulatory approval for these investments. A few options exist to recognize and monetize these wider arrays of benefits e.g. a multi-hazard BCA would reflect measures such as undergrounding and vegetation management in more accurate light. We have already seen that natural hazards are connected with each other e.g. wind speeds could drive wildfire spread and wildfires can increase the risk of flooding by reducing soil's holding capacity. Moving from wildfire mitigation plans to resiliency plans can enable the adoption of multi-hazard BCA methodology.

Wildfires and ensuing damage is a societal resilience issue and will require an all hands-on-deck approach. Electric companies can do their part in reducing the risk of ignition, but in order to reduce the risk of wildfire spread and the economic impact of wildfires, landowners and local government entities also need to take action. Non-economic regulators at the state and county level such as Departments of Natural Resources could require large public and private landowners to do controlled burns and pro-active vegetation management. These regulators can also adopt stronger building codes as a pre-requisite to allowing construction in the wildland urban interface. Such changes could be done through rulemaking and/or legislative actions.

# Appendix A.

## A.1 About EEI

The Edison Electric Institute (EEI) is the association that represents all U.S. investor-owned electric companies. Its members provide electricity for nearly 250 million Americans and operate in all 50 states and the District of Columbia. As a whole, the electric power industry supports more than 7 million jobs in communities across the United States. In addition to its U.S. members, EEI has more than 70 international electric companies as International Members, and hundreds of industry suppliers and related organizations as Associate Members. Organized in 1933, EEI provides public policy leadership, strategic business intelligence, and essential conferences and forums.

## A.2 About Guidehouse

Guidehouse is experienced in supporting electric companies in various efforts related to climate risk and infrastructure resilience. This includes engagements that specifically pertain to wildfire mitigation planning and support, such as:

- **NV Energy Natural Disaster Protection Plan (NDPP) –** Guidehouse developed the inaugural NDPP including facilitation of meetings with identified stakeholders and open house communication with the broader public. Guidehouse provided regulatory case management, stakeholder engagement, project management, and expert Plan implementation services. The comprehensive set of natural disaster mitigation projects and programs aims to minimize and mitigate the impacts of catastrophic natural disasters and protect the public against risks relating to electric company infrastructure. The Plan conforms to the regulations, standards, and guidelines set by legislative mandates through SB 329 and regulations of the Nevada PUC.

- **Bear Valley Electric Services (BVES) –** Guidehouse was engaged by BVES to aid in developing and submitting its WMP to the California Public Utilities Commission (CPUC). Guidehouse examined existing mitigation plans and coordinated with the client to update a SB901-compliant submittal. In developing the Wildfire Mitigation Plan Report for CPUC filing, Guidehouse conducted field visits, risk assessments, and plan modifications.

- **Liberty Utilities (California) –** Guidehouse collaborated with Liberty Utilities to aid in the development and submission of its WMP to the CPUC pursuant to SB901. Guidehouse examined existing mitigation plans, performed a gap analysis, and contributed to plan modifications, developing metrics for ongoing assessment and improvement.

- **Confidential Client WMP Independent Evaluation Services –** Guidehouse performed an independent evaluation of a public owned electric company's WMP pursuant to CPUC Code 8387. Guidehouse reviewed the WMP to determine the comprehensiveness of the plan in relation to statutory requirements and industry practices for executing effective mitigation strategies.

- **Confidential Client Wildfire Mitigation Support** - Guidehouse assisted a large electric company in submitting a WMP to its state regulators. Guidehouse recommended significant improvements to the technical and operational strategies for wildfire mitigation. Guidehouse conducted benchmarking studies of fire mitigation plans, developed a series of wildfire mitigation approaches, and supported legal staff in the development of the regulatory filing.