Wildfire and powerline ignitions: California's evolving experience with destructive wildfire and risk mitigation policy in a varying and changing climate

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ABSTRACT

Wildfires are increasing in frequency and intensity globally. As the climate warms, California's wildfire activity is also increasing. California, a Mediterranean climate region, is impacted by two separate wildfire regimes – fuel and wind dominated wildfires. Korea's climate regime is very different, but wildfires are also on the rise (Chang et al. 2024), particularly wind-driven wildfires. In both regions, many of the wind-driven catastrophic wildfires are ignited by powerlines. In this paper, I explain the weather and climate mechanisms promoting catastrophic wildfires in California as well as how climate change contributes to wildfire activity through these mechanisms. I also address the evolution of power utility regulations by the State of California to promote safe and effective operation of the power grid with respect to wildfire. The 2007 Witch Fire played a pivotal role in transforming wildfire risk management towards a more proactive and evolving approach, particularly through litigation, leading to the development of public safety power shutoffs. I hope that, as California learns from its experience with wildfire, other regions around the world will also benefit from this growing experience with disaster and its proactive management.

1. CALIFORNIA WILDFIRES IN A VARYING AND CHANGING CLIMATE

As the Earth's climate warms, global wildfire activity – both frequency and intensity – increases (e.g. Abatzoglou et al. 2019). California experiences increasingly intense and destructive wildfires due to climate change and fire suppression activities (Williams et al. 2019, Goss et al. 2020, MacDonald et al. 2024). The most destructive fires are ignited by humans, often by powerlines, and are associated with dry gusty downslope winds – the Santa Ana and Diablo winds of Southern and Northern California, respectively. South Korea's wildfires are also on the rise (Chang et al. 2024) and the most destructive wildfires are also associated with powerline ignitions in dry gusty downslope winds – the Yanggang. What can we learn from California's long evolving experience with wildfires and with the State's constantly developing approaches to wildfire risk management, particularly focused on powerline-ignited fires?

California has always been impacted by wildfire and many species of native vegetation – like the iconic giant sequoia trees – rely on wildfire to germinate. Native Americans intentionally and regularly introduced fire to the landscape. Tribes have historically been part of nature and played a role of keystone species by significantly shaping ecosystems through their land management practices. These practices included controlled burns and helped create diverse and disturbance-dependent ecosystems, such as grasslands and open woodlands, which supported a variety of native species. By contrast, European settlers worked to suppress wildfires, which resulted in a gradual build-up of biomass that now supports occasionally enormous wildfires when wildfire gets out of control. People have also introduced invasive species that are more flammable than native vegetation and expanded settlements into the wildland, introducing sources of accidental ignitions to an increasingly flammable biomass. With the addition of climate change, large conflagrations in California are becoming more frequent and more intense (MacDonald et al. 2024, Williams et al. 2018, Goss et al. 2020).

To understand wildfire behavior in the State and the mechanisms by which human activity on global, regional and local scales influences wildfire, it is important to be aware of California's Mediterranean climate regime and to distinguish California's two distinct wildfire regimes: fuel and wind dominated wildfires. Distinguishing these regimes also helps to understand how and where wildfires may evolve in the future.

California is marked by a Mediterranean climate with its characteristic dry warm subtropical summers and midlatitude storms (frontal cyclones, cut-off lows, and atmospheric rivers) producing nearly all of the State's precipitation in winter. Much of California's precipitation falls on the windward (west- and southwest-facing) slopes of the coastal hills and mountain ranges, providing moisture for lush vegetation to grow – shrubs on the coastal ranges and forests on the higher mountains further inland. The most intense storms are atmospheric rivers (ARs), which depend on topography to produce their mostly orographic precipitation. These storms are occasional and a few of them (often two or three big ARs; whether they occur or not) typically determine whether a year is wet or dry. Because storms are typically few but occasionally intense, hydroclimatic variability in California, especially in Southern California, is greater than anywhere else in the United States (Dettinger et al. 2011). It is uncommon to receive climatologically averaged precipitation in any particular year. Most winters are either dry or wet. Wet winters, when abundant fuels grow, are often typically followed by dry and now warming summers, and then often by dry falls and frequently dry winters when these fuels remain dry and flammable. Dry gusty downslope winds – the Santa Anas and Diablos – typically start in fall and end in spring but they are primarily a wintertime phenomenon driven by synoptic variability characteristic of winter. These onshore downslope winds are tethered to the topography of this mountainous region and blow hardest on the same west- and southwest-facing slopes of the coastal topography where abundant vegetation (i.e. fuel) is present.

In California, **wildfires follow two distinct patterns** based on what primarily drives their spread and intensity and determines their seasonality. In essence fuel and wind dominated fire regimes set up different rules for how fires behave. It is important to understand these distinctions to understand how climate change impacts wildfire as well as how to effectively mitigate wildfire risk.

The **fuel-dominated wildfire regime** occurs mainly in Northern California's forests and the Sierra Nevada mountains. In these forested areas, the amount and arrangement of flammable material – e.g. fallen branches, dead trees, dense understory vegetation - determines how fires behave. As a campfire grows larger when more wood is added, fuel dominated wildfires burn hotter and larger when dry fuel is abundant. Frequent low-intensity fires kept vegetation in check and helped native species evolve to thrive in a regime of frequent fire disturbance. Decades of fire suppression have allowed fuels to build up to dangerous levels. Fuel-dominated areas tend to experience fires in the summertime, they are often ignited by lightning and burn intensely, often burning into the forest canopy to create devastating crown fires that can kill even large, mature trees. In mountainous terrain, such fires spread most intensely burning uphill. Climate change directly impacts fuel dominated wildfires by reducing snowpack and contributing to its earlier melt that results in drier soil going into warmer summers further impacted by more frequent heat waves. The excessive heat increases vapor pressure deficit causing vegetation to dry out through increased evapotranspiration – loss of moisture by evaporation – while vegetation is less able to replenish moisture from increasingly drier soils. Fuel dominated fires thus burn hotter and larger (Williams et al. 2019).

In contrast, the **wind-dominated wildfire regime**, occurring primarily in California's coastal scrub and chaparral landscapes, operates under very different rules. Here, the decisive factor is the powerful downslope Santa Ana winds of Southern California (Guzman Morales et al. 2016) and Northern California's Diablo winds (McClung and Mass 2020). Accentuated by the region's sloping topography, these hot, dry offshore winds can produce gusts well in excess of 100 km/hr in wind-prone locations and create extreme fire conditions. Much like how blowing on embers can quickly reignite a campfire, these strong dry gusty winds can drive fires forward at remarkable speeds even in regions with relatively low fuel loads, such as shrubs and grasses. Downslope winds in California typically start in October and peak in December/January decreasing through the spring. The most destructive fires in coastal regions almost always coincide with downslope wind events, typically in fall before the first rains of winter. California's downslope winds originate in the high desert of the Southwestern United States, blow towards the coast and accelerate on the lee slopes of coastal topography, warming and drying on their way to sea level. These winds push wildfire downhill – against the natural uphill burning tendency of fire – blowing the fire and sending embers and smoke towards the coast (Keeley et al. 2024, Aguilera et al. 2020, 2023), impacting the health of densely populated coastal communities (Aguilera et al. 2021). Fire fanned by strong gusty dry wind can leapfrog and spread extremely quickly in dry vegetation becoming practically unstoppable if it is not put out immediately. Extinguishing wildfire immediately when it starts in dry brush carpeting the hard-to-reach sloping backcountry is a tremendous challenge and is typically impossible. Huge wind-driven wildfires can enter dense urban communities built up to and into the foothills of the coastal ranges — exactly where downslope winds blow most intensely — where structures (mostly wooden due to the region's seismicity) become fuel which is often more flammable than the bushy vegetation on the slopes above. This was the case of the LA Wildfires in January 2025. Here, I will mainly focus on the wind dominated wildfires as these are most similar to the catastrophic wind-spread wildfires recently and currently (as I write this) impacting the east coast of South Korea.

Understanding the distinction between fuel and wind dominated fire regimes is crucial for fire management. In fuel-dominated areas, reducing forest density and clearing excess undergrowth through prescribed burns can effectively lower fire risk. However, in wind-dominated regions, such fuel reduction has less impact because the extreme winds can push fires through almost any amount of vegetation. Instead, management focuses on creating defensive barriers near communities and maintaining rapid response capabilities during wind events. A key evolving approach to fire prevention is reducing possibilities for accidental ignitions. Education and broad issuance of warnings have been successful in reducing accidental ignitions from most human sources (e.g. cigarettes and campfires) with the exception of powerline ignitions, which are associated with some of the most destructive wind dominated fires (Keeley and Syphard 2018, Vahedi et al. 2025, and other sources[1]). To address this source of ignitions, a policy of public safety power shutoffs (PSPS) was initially developed and implemented by San Diego Gas and Electric (SDG&E) and is being further developed and mandated for all California public utilities by the California Public Utilities Commission (CPUC) to reduce powerline ignitions as well as mitigate their impacts across the State. More background and information about PSPS is provided in Section 2 below.

Climate change is intensifying both fire regimes by creating longer fire seasons and more extreme conditions primarily via drier and more flammable fuels. Hotter temperatures and prolonged droughts dry out the vegetation, particularly impacting fuel dominated wildfires. Enhanced heat wave activity (e.g. Gershunov and Guirguis 2012) can enhance wildfire behavior during and following heat waves (Ruffault et al. 2020). A potential delay of the wet season (Pierce et al. 2013, Cayan et al. 2022) can persist dry fuels into December and January (as we have seen in 2017/18 and 2024/25) – the peak of the Santa Ana wind season – when wildfires can burn longer being spread by consecutive downslope wind events common in winter. This is particularly true in coastal Southern California, a region where the hydroclimate is especially variable and where the frequency of precipitation is expected to decline the most. On the other hand, Santa Ana winds are also expected to become somewhat less frequent in the fall and spring (Guzman Morales and Gershunov 2019) but tend to be warmer and drier (Gershunov et al. 2021). Meanwhile, the atmospheric circulation regimes that promote hot Santa Ana winds in winter are actually becoming more frequent (Guirguis et al. 2023). Together, all these changes are expected to lead to a longer fire season when even more devastating wind dominated fires, particularly in late fall and winter, are possible.

Here is a conceptual formula that describes the sequence of weather and climate events leading to devastating fire seasons:

EXCESSIVE RAIN in winter and spring followed by a DRY HOT SUMMER AND HEAT WAVES followed by DRY GUSTY WIND and IGNITION results in often catastrophic WILDFIRE

The LA fires of December 2024 and January 2025 provide a perfect example of an extreme and extended fire season resulting from the sequential interplay between excessive rain, a long hot dry summer, a delayed wet season, and dry fuels persisting into the peak of the Santa Ana wind season with plenty of human-caused ignitions. Atmospheric rivers (ARs) are the wettest storms that provide plenty of precipitation for fuels that eventually dry out in summer. AR precipitation is orographic – accentuated by the coastal hills and mountains – tending to preferentially fall on the west- and southwest-facing slopes of the coastal topography (exactly where Santa Ana winds blow the hardest) providing moisture for shrubs and grasses to grow. These fuels dry out during the long dry Mediterranean summers that are getting hotter and drier due directly to global

[1] Utility infrastructure has historically been responsible for less than 10% of wildfires, but powerlines account for roughly half of the most destructive fires in the California's history. Recent incidents, such as the Eaton Fire, highlight ongoing risks from aging and poorly maintained powerlines, with Southern California Edison acknowledging overdue repairs on towers flagged for ignition risks.

warming. Santa Ana winds (SAWs) impact the same slopes of the coastal topography creating conditions for wildfires, especially when the winter rains are late. In the winter 2024-25, the tardiness of the rains was unprecedented on a record spanning 150 years. When ARs return to rain on the fire scars, they reduce fire risk and may even extinguish fire, but intense rain can cause debris flows leading to local devastation — this is what happened in the aftermath of the Thomas Fire in January 2018. At the very least, excessive rain can damage water quality with toxic runoff from burn scars.

Climate change contributes via hotter and possibly longer summers with an expected later start to the wet season and more opportunity for dry fuels to persist into the peak of the SAW season -- December-January. It is difficult to precisely attribute any particular event with complex causes to climate change – the naturally varying climate is capable of producing ingredients for such disasters – but global warming provides the steroids that help make such events more likely. Global warming exacerbates wildfire risk primarily by creating drier conditions and longer fire seasons, making vegetation more susceptible to ignition and intense burning. The very late and enormous Thomas Fire (December 2017 - January 2018) and the deadly LA Fires (January 2025) provide glaring examples of such catastrophic emerging wintertime wildfires.

Ignitions in wind-dominated wildfires are almost always human caused as the downslope winds spreading such fires are windstorms under clear blue skies (Keeley et al. 2021). No lightning occurs under such conditions. As most sources of ignitions have declined over the years, powerline ignitions have emerged as the dominant cause of the largest Santa Ana wind-driven wildfires in Southern California (Keeley et al. 2021). Santa Ana winds can be strong enough to topple trees, break branches, contact sagging powerlines, causing arcing, which leads to sparks flying. When fires start in dry vegetation under strong winds, it is next to impossible to stop their forward progress, unless they are immediately put out. But extinguishing such wildfires *immediately* is also next to impossible in the sloping hard-to-reach backcountry bisected by powerlines delivering power to communities sprawling from the coast into the foothills.

Differences and to similarities with Korean wildfire. The east coast of South Korea, though under a very different climate regime impacted by the Asian monsoon, is also a mountainous coast that experiences downslope winds that feel like California's Santa Ana winds (Abatzoglou et al. 2020). A particularly relevant feature of Korea's east coast climate is the phenomenon of föhn winds, locally called Yanggang. These warm, dry winds occur when air descends the eastern slopes of the Taebaek Mountains, creating sudden temperature spikes that can be quite dramatic, sometimes raising temperatures by 10°C or more in just a few hours. Although caused by different synoptic weather patterns, Yanggang winds feel similar to the Santa Ana (warm, dry, gusty) providing conditions for wind-dominated wildfires on South Korea's east coast like those provided by California's Santa Ana winds. Eastern South Korea's wildfire season tends to peak in spring due to the combination of occasionally extreme dryness and strong downslope winds that, as they do in coastal Southern California, transport smoke and impact health in the populated coastal region (Lee et al. 2022). As are coastal Santa Ana wind-driven wildfires, Yanggang-driven wildfires are typically human caused. As I finalize this text, catastrophic downslope wind-spread wildfires are wreaking disaster in Southeastern Korea, impacting lives, livelihoods, ecosystems, and even sites representing historic and cultural heritage of Korea. Having dwarfed the disastrous wildfire seasons of 2019, 2020 and 2022, the current wildfire season is once again unprecedented.

2. CPUC WILDFIRE PREVENTION POLICY HISTORY

The California Public Utilities Commission (CPUC) has been regulating power utilities through the passage of the Public Utilities Act in 1912. Originally called the Railroad Commission, it gained regulatory authority over electric and gas utilities, among other sectors. This expanded role came about during the Progressive Era reforms under Governor Hiram Johnson, when there was a strong push to regulate monopolistic utility companies and ensure fair rates and service for California residents. In 1946, the Railroad Commission was transformed into the CPUC and began establishing a comprehensive regulatory framework for power utilities, including rate setting, safety standards, and service requirements. As we shall see below, regulation was reactive for decades until litigation following recent catastrophic wildfires motivated CPUC's modern additionally proactive and rapidly evolving policy in regulating power utilities to operate more safely with respect to accidental fire ignitions.

Traditional CPUC regulations of power utilities are based on an engineering approach to safety. The CPUC requires specific clearances between power lines and vegetation, detailed specifications for pole strength, wire tensions, and regular inspection cycles. CPUC audits utilities' compliance with these requirements and issues fines for violations. This traditional approach has several limitations. First, it is largely reactive rather than proactive. Much like only fixing a roof after it starts leaking, the CPUC would often strengthen requirements only after problems occurred. Second, the regulations were relatively rigid and uniform across different areas, not accounting for how wildfire risk varies dramatically across different regions and weather conditions. The CPUC also traditionally focused more on ensuring reliable power delivery than on preventing fires. This created a conundrum - utilities were required to keep the power on as much as possible, which sometimes conflicted with fire safety concerns. This traditional approach emphasized prescriptive rules rather than performance-based standards. Utilities were told exactly what to do (like maintaining specific clearances) rather than being held accountable for outcomes (like preventing fires). While this made compliance straightforward to measure, it did not necessarily lead to the best safety outcomes. This system worked reasonably well for many decades when wildfires were less frequent and severe. However, as power infrastructure ages, development pushes communities further into fire-prone areas and climate change increases fire risk, the limitations of this traditional approach are becoming increasingly apparent. Specific catastrophic wildfires ignited by powerlines and the litigation that ensued have motivated development of a more proactive approach.

CPUC's traditional regulatory approach to power line fire safety began transitioning to the current evolving proactive system over the last two decades. This transition is a fascinating example of how disasters and litigation can drive regulatory change. The transformation began to accelerate after a series of catastrophic fires in the late 2000s. The 2007 Witch Fire in San Diego was one of the first major catalysts. The Witch Fire began on October 21, 2007, during extreme Santa Ana wind conditions that were well predicted by the National Weather Service with all appropriate fire weather warnings — high wind advisories and red flag warnings — issued in the days preceding the extreme wind event. The fire was sparked when SDG&E power lines came into contact with each other multiple times during extreme winds, creating arcing that ignited the vegetation below. The fire eventually burned 197,990 acres, destroyed 1,650 structures, and caused two fatalities. The conditions that led to the fire - high winds, low humidity, and aged infrastructure - revealed critical vulnerabilities in how utilities were managing fire risk.

When investigations revealed that SDG&E's power lines had sparked the Witch Fire as well as two more wildfires, and that other fires were also ignited by powerlines throughout Southern California during that extreme Santa Ana wind event, it became clear that traditional maintenance-based regulations were not enough to prevent catastrophic fires under extreme weather conditions.

In the aftermath of the Witch Fire, SDG&E faced significant litigation, liability, expenses, and regulatory scrutiny. Investigations revealed that the utility's existing practices for managing their infrastructure during high-wind events were insufficient. This realization and the costs borne by the company via litigation, prompted SDG&E to become the first California utility to develop and implement a comprehensive Public Safety Power Shutoff (PSPS) program. SDG&E requested permission to perform PSPS in 2008, which was granted in 2012 by CPUC with guidelines for implementation. Leading up to mplementation, which began in 2013, SDG&E used the lessons learned from the Witch Fire to create a data-driven approach to power shutoffs. They invested heavily in developing an in-house meteorological capacity including weather monitoring technology, installing over 170 weather stations throughout their service territory. This network allows SDG&E to track wind speeds, humidity, and temperature in real-time, providing much more precise information about when dangerous fire conditions occur.

The company, in collaboration with academics, also developed specific criteria for when to implement PSPS, based directly on the conditions that led to the Witch Fire. These criteria include wind speed thresholds, humidity levels, and the condition of local vegetation. This systematic approach became a model that other California utilities would later adopt. The implementation of PSPS wasn't without controversy. Local communities initially pushed back against the planned outages, arguing they created their own public safety risks. However, SDG&E's experience with the Witch Fire allowed the company to make a compelling case that temporary power shutoffs were preferable to the risk of catastrophic wildfires. Discussions involved community forums and education campaigns, solicited stakeholder feedback and broadly-cast collaborative efforts[2]. PSPS can be implemented flexibly at the circuit level and can last between minutes and multiple days averaging to 1.75 days[3], consistent with the duration of an average Santa Ana wind event (Guzman Morales et al. 2016). The PSPS and wildfire risk trade-off is considered for each circuit by dividing the wildfire risk score (potential benefit of PSPS) by the PSPS risk score (public harm caused by outages). This helps prioritize circuits based on relative risks and benefits[4]. SDG&E has not ignited any destructive wildfires since 2007 and the power utility has been working with CPUC to evolve the efficacy of PSPS.

A second wave of change came after the devastating fire seasons of 2017 and 2018 throughout California. The Wine Country fires of 2017, the Thomas Fire of 2017/18 and the Camp Fire of

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[2] https://www.sdge.com/sites/default/files/R.18-12-005%20SDG&E%20Second%20Progress%20Report.pdf
https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/safety-and-enforcement-division/reports/2023-psps-pre-season-report/sdge-2023-psps-pre-season-report_public.pdf

[3] https://www.psehealthyenergy.org/preventing-wildfires-with-power-outages-the-growing-impacts-of-californias-public-safety-power-shutoffs/

[4] https://www.sdge.com/sites/default/files/regulatory/2024-07-05_SDGE_2025_WMP-Update_R2.pdf

2018 were all ignited by power infrastructure. These disasters dramatically demonstrated that the existing traditional regulatory framework was inadequate for modern conditions. The Camp Fire, in particular, the deadliest wildfire in California's history, showed how aging power infrastructure could lead to catastrophic consequences - the fire destroyed the town of Paradise and resulted in 85 deaths. The Thomas Fire — unprecedented in size for California at the time and still the largest fire in Southern California at 282,893 acres — killed two people and burned through December and into January extending California's wildfire season into the peak of the Santa Ana wind season due to delayed winter rains. As in the LA Fires of 2025, the Thomas fire was preceded by a very wet previous winter, dry and hot summer, and a severely delayed start to the wet season, making it a harbinger for future wildfires (Syphard et al. 2018). When the winter rain finally came in January in the form of an atmospheric river, it put out the smoldering remains of the Thomas Fire and caused debris flows from the burn scar that killed 21 people.

Given that in all these cases, the extreme fire risk — certainly including the key ingredient of extreme dry downslope winds — was predictable and well-predicted by the National Weather Service, these disasters led to several key changes in how the CPUC approaches fire prevention. Having already engaged in a pilot PSPS program with SDG&E, the Commission evolved from purely prescriptive regulations to embrace more performance-based standards during fire-prone conditions when strong downslope winds are predicted to encounter dry vegetation. In 2018, by resolution ESRB-8, CPUC began mandating PSPS across all California investor-owned public utilities, providing expanded requirements and guidelines for implementation, public outreach and notification, and post-PSPS reporting. Since then, all California utilities became responsible for preventing fires through PSPS, in addition to following traditional rules and regulations regarding infrastructure maintenance and adhering to vegetation clearance requirements. We could say that, since maintenance is difficult, expensive and imperfect, PSPS is deemed necessary to provide additional protection tailored to local weather and vegetation conditions.

As PSPS evolved, other utilities learned from SDG&E's experience. After implementing their initial PSPS program in 2013, SDG&E continued to refine and improve their approach based on operational experience. In collaboration with academics, they developed and published the the Santa Ana Wildfire Threat Index (SAWTI, Rolinski et al. 2016). This index combines weather data, vegetation moisture levels, and historical fire data to create a daily rating of fire risk. The SAWTI became more precise over time as SDG&E gathered more data, allowing the company to make increasingly targeted decisions about power shutoffs.

SDG&E's also expanded its weather monitoring. Beyond just tracking basic weather conditions, the company began using artificial intelligence to analyze weather patterns and predict where dangerous conditions might develop[5]. They installed high-definition cameras throughout their service territory, allowing them to spot potential problems before they escalated into emergencies. This combination of predictive analytics and real-time monitoring represents a significant advance in how utilities approach fire prevention.

The company is also learning important lessons about community engagement. Early PSPS events revealed that simply shutting off power wasn't enough – help was needed for communities to prepare for and cope with outages. This led to the development of comprehensive community

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5 https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/safety-and-enforcement-division/meeting-documents/psps-briefings-february-2022/sdge-psps-briefing-feb-2022.pdf

support programs, including establishing community resource centers where people could charge devices and access basic services during shutoffs. They also created detailed communication protocols to give residents and emergency services as much advance notice as possible before implementing a shutoff. Examples of community outreach and temporary generation activities being performed, including distribution of generators and batteries to critical services (e.g. schools, telecommunications, etc.) and portable batteries to select households are provided in post-event reporting[6]. Other California utilities began studying SDG&E's approach after devastating fires in their own service territories. Pacific Gas & Electric (PG&E) and Southern California Edison (SCE) both eventually implemented similar programs, though their larger service territories and different geographic conditions presented unique challenges. SDG&E's experience helped these utilities avoid some early pitfalls and accelerate their own PSPS program development.

The evolution of SDG&E's programs also influenced regulatory policy. The California Public Utilities Commission used lessons learned from SDG&E's experience to develop statewide guidelines for PSPS events. These guidelines help ensure that power shutoffs are implemented consistently and responsibly across all utilities, while still allowing for regional variations based on local conditions.

In 2018, CPUC adopted Resolution ESRB-8[7] establishing guidelines for electric utilities to follow during PSPS events. This includes post guidelines on customer notification of PSPS; requirements for post-PSPS reporting covering decision criteria, notification methods and lessons learned; public outreach such as community education and informational workshops about de-energization policies; and mitigation measures encouraging utilities to minimize the scope of outages and provide support to critical facilities and compromised individuals. The resolution applies to all investor-owned utilities in California and aims to balance wildfire prevention with minimizing impacts on public safety and infrastructure. Per Resolution ESRB-8, following every episode of PSPS(s), usually associated with a Santa Ana or Diablo wind event, SDG&E, SCE and PG&E (California's investor-owned power utilities) submit a detailed justification to CPUC that includes a cost-benefit analysis evaluating wildfire risk reduction against the potential impacts of de-energization events[8].

Horing et al. (2023) analyzed widespread use of PSPS in 2019 and 2020 when outages ranged from minutes to six days, at times impacting as many as 1 million customers. Horing et al. (2023) attempted to monetize the effectiveness of PSPS and estimated that for every 1% of power curtailed, approximately 0.2% of capital stock losses are avoided. Power shutoffs were found to be "effective at limiting wildfire damage". California counties' economies were found

[6] For example: https://www.sdge.com/sites/default/files/2025-01/R1812005%20SDGE%20PSPS%20Post-Event%20Report%20Dec%209-11,%202024.pdf

[7] https://www.cpuc.ca.gov/consumer-support/psps/evolution-of-psps-guidelines

[8] https://www.cpuc.ca.gov/consumer-support/psps/utility-company-psps-reports-post-event-and-post-season. An example of a recent SDG&E report is available here: https://www.sdge.com/sites/default/files/2025-01/R1812005%20SDGE%20PSPS%20Post-Event%20Report%20Dec%209-11,%202024.pdf
The SCE report following the devastating wildfires of early January 2025 can be found here: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/safety-and-enforcement-division/reports/psps-post-event-reports/2025/20250104sce-psps-post-event-reportdeenergizedfinal.pdf

to be “significantly more sensitive to the impacts of wildfire than that of shutoffs”, so that “well targeted shutoffs can lead to a net benefit but widespread outages may lead to net losses”.

One particularly relevant aspect of the ongoing evolution is how SDG&E's program is adapting to changing climate conditions. As California experiences more frequent and severe drought conditions, SDG&E launched the Climate Resilience Center that fosters collaboration with academic researchers to help the company adjust its risk assessment models and PSPS triggers[9]. This ongoing adaptation process demonstrates how utility fire prevention programs continue evolving to address changing environmental conditions. Of course, all of the wildfire prevention efforts by SDG&E and California’s other two major power utilities end up costing Californians billions through rising energy costs[10]. However, this is much cheaper than reducing ignitions by undergrounding of powerlines (Footnote — estimated 15K / customer…).

The role of litigation in CPUC regulation of power utilities. The regulation of power companies in California to prevent wildfires has been significantly shaped by litigation, particularly following devastating fires caused by utility equipment. The turning point came after several catastrophic fires were linked to utility equipment, especially the 2017 and 2018 fire seasons. The Camp Fire of 2018, which destroyed the town of Paradise and was caused by faulty Pacific Gas & Electric (PG&E) equipment, became a pivotal moment. The resulting lawsuits involved PG&E as defendant and a host of plaintiffs including fire victims and families, the Town of Paradise, and several public entities. Investigations revealed systematic problems with how utilities maintained their equipment and managed fire risk. This included numerous infrastructure maintenance violations, negligent vegetation maintenance, and inspection failures violating CPUCs and the company’s own policies[11].

These lawsuits created pressure for change in several ways. They exposed specific problems with utility practices, such as delayed maintenance of aging equipment and insufficient tree trimming near power lines. The discovery process in these cases provided detailed evidence that helped regulators understand exactly what needed to change. For example, court documents revealed that PG&E had repeatedly delayed replacing aging transmission towers and hadn't adequately inspected equipment in high-fire-risk areas[12]. The litigation established liability and created financial pressure that made utilities more receptive to regulation. When PG&E faced billions of US dollars in liability claims, it filed for bankruptcy protection in 2019. This demonstrated to both utilities and regulators that the cost of preventing fires was less than the cost of liability for causing them. The bankruptcy process itself became a vehicle for reform, as the CPUC court made PG&E's emergence from bankruptcy conditional on improving its safety practices, particularly with respect to mitigating wildfire threat[13].

The CPUC used these legal proceedings to develop more stringent regulations. They created new safety certificates that utilities must earn annually, requiring them to demonstrate they're taking

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[9] https://www.sdgetoday.com/WCRC

[10] https://calmatters.org/environment/2024/12/pge-utilities-wildfire-prevention-customer-bills-california/

[11] https://www.utilitydive.com/news/pge-failed-to-properly-inspect-tower-that-caused-camp-fire-cpuc-safety-in/568407/

[12] https://www.kqed.org/news/11760156/report-pge-knew-about-extensive-power-line-problems-but-delayed-repairs-for-years

[13] https://www.cpuc.ca.gov/industries-and-topics/pge/pge-oversight-and-enforcement

specific steps to prevent fires. These include detailed inspection programs, vegetation management plans, and systematic replacement of aging equipment. The commission also gained authority to issue larger fines for safety violations and to take more direct control over utility operations if safety standards aren't met.

The litigation process also led to the development of Public Safety Power Shutoff (PSPS) protocols. These allow utilities to proactively shut off power during dangerous fire conditions — which are well predicted — though they must follow strict guidelines about when this is permitted and how to notify affected customers. This practice, while controversial, emerged directly from evidence in lawsuits showing that keeping power on during extreme weather conditions had led to numerous fires, including many of the most catastrophic wildfires.

In the aftermath of recent catastrophic wind-driven wildfires started by powerlines in other states (e.g. Oregon, Colorado, Hawaii) and ensuing litigation, other states are learning from the California experience with proactive mitigation of powerline ignitions[14].

CPUC's regulatory framework is certain to continue evolving. The LA Fires provide the most recent devastating example of policy and regulation not working well enough in extreme fire-weather conditions even given near-perfect forecasts of wind and timely fire risk warnings. Based on preliminary evidence, at least one of the two most catastrophic LA Fires (the Eaton Fire) appears to have been ignited by power infrastructure[15]. So, even in Southern California, a region that is well informed, experienced, and supposedly prepared for wildfire, catastrophic wildfire ignited by power infrastructure is still possible. PSPS implementation policies are certain to evolve further after incorporating experience amassing from the LA Fires as investigations are ongoing.

3. SUMMARY AND CONCLUSION

We have seen how one specific catastrophic wildfire — the 2007 Witch Fire — and ensuing litigation played a pivotal role in transforming one utility's approach to proactive wildfire risk management, particularly through the development of PSPS – Public Safety Power Shutoffs. Since October 2007, San Diego Gas and Electric had not ignited large wildfires. Meanwhile, other California utilities have ignited several catastrophic wildfires in recent years. The aftermath of other catastrophic wildfires across California, also included litigation and motivated regulation leading to CPUC-mandated PSPS for all California power utilities. SDG&E's pioneering PSPS program evolved and began to influence broader utility practices across California. One utility's response to disaster helped reshape industry standards.

The Los Angeles wildfires of 2025 provide a devastating example of policy and regulation not always working even given near-perfect forecasts of wind and fire risk.

Although climate change has likely contributed to the dryness of the vegetation and the delay of the winter rains, the natural climate of the region is capable of creating extreme fire risk in the middle of winter — the peak season for Santa Ana winds — even in the absence of climate change. With all its experience, fire management capabilities, proactive regulation, excellent

[14] https://www.publicpower.org/periodical/article/utilities-adopt-various-strategies-mitigate-against-threat-wildfires
[15] https://consumerwatchdog.org/in-the-news/new-york-times-power-lines-suspected-in-eaton-fire/

monitoring and weather forecasts, California is apparently still not adapted to its highly variable climate. Meanwhile, wildfire risks are expected to increase with future warming and with coastal population pushing into the coastal topography prone to extreme precipitation, extreme dryness, and extreme fire weather in the form of strong, dry, gusty downslope winds. Regulation encompassing development and power utility operations is certain to evolve — hopefully in pace with the changing global climate and the changing regional environment.

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