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April 11, 2021 VIA ELECTRONIC FILING

Caroline Thomas Jacobs, Director
Office of Energy Infrastructure Safety
California Natural Resources Agency
715 P Street, 20th Floor
Sacramento, CA 95814

RE: MUSSEY GRADE ROAD ALLIANCE COMMENTS ON 2022 WILDFIRE MITIGATION PLANS OF PG&E, SCE, AND SDG&E

Dear Director Thomas Jacobs:

The Mussey Grade Road Alliance (MGRA or Alliance) files these comments pursuant to the Procedures for Review of 2022 Wildfire Mitigation Plan Updates,[1] which authorizes public comment on the Large Utility WMPs (Wildfire Mitigation Plans) by April 11, 2022.

The Alliance is once again pleased to have the opportunity to provide feedback on California utilities' wildfire mitigation plans as the Office of Energy Infrastructure Safety (OEIS or Energy Safety) undertakes its first WMP cycle as an independent agency. The history of the Mussey Grade Road Alliance, a grass-roots citizen-based organization located in Ramona, California, and its efforts over 16 years to improve power line fire safety in California are described in MGRA's comments on the 2020 Wildfire Mitigation Plans.[2] As we stated then, the Alliance was the first party to call for wildfire prevention plans in 2009 at the California Public Utilities Commission (CPUC or Commission) and to advocate for this proposed rule through to Commission adoption.[3] and are we are pleased to see the level of completeness and complexity that the plans have achieved, thanks to guidance from Energy Safety and its Commission-based predecessor the Wildfire Safety Division (WSD).

[1] Office of Energy Infrastructure Safety; FINAL ATTACHMENT 5; Guidelines for Submission and Review of 2022 Wildfire Mitigation Plan Updates; Undated; p. 5.
[2] MUSSEY GRADE ROAD ALLIANCE COMMENTS ON 2020 WILDFIRE MITIGATION PLANS OF SDG&E, PG&E, SCE; April 7, 2020; pp. 1-3. (MGRA 2020 WMP Comments)
[3] D.12-01-032; pp. 45-55.

The job of critiquing and approving the WMPs has become more of a challenge over the past years as these so-called "updates" have mushroomed into immense documents totaling over 2,000 pages plus at least another 1,000 pages of supplemental files, data tables, and data request responses. Much of this material is highly technical. As a result, MGRA must be focused in its review. Consequently, there are many additional topics that need more specific attention that for lack of time we do not address. We are grateful to OEIS accepting public input and expanding the time available for review. Nevertheless, it is hard for all stakeholders, including OEIS, to adhere to a rather draconian legislative schedule while still providing a complete review of the WMPs. We do the best we can under the circumstances that, advertently or inadvertently, seem designed to rush the process.

The Alliance comments once again are authored by the Alliance expert, Joseph W. Mitchell, Ph.D.[4] Many of the topics he raised last year – wind and wildfire risk, power shutoff and shortcomings in utility modeling tools – remain active topics of discussion within both Energy Safety and CPUC frameworks. Dr. Mitchell presents additional data and information this year.

This is the first review of Wildfire Mitigation Plans under guidance developed by OEIS from the original requirements to approval. The Mussey Grade Road Alliance is fully committed to assisting OEIS with its formidable responsibilities in the Wildfire Mitigation Plan review process. We always endeavor to produce quality work that regulators can use. We ask that Energy Safety continue to acknowledge these contributions when it finds them helpful in its final review, as it has in past years.

The Alliance thanks Energy Safety for its efforts to improve utility wildfire safety diligence and performance. As always we use our experience to contribute our best thought and action to helping the OEIS perform its mission.

Finally it is a sad but true fact that California is known predominantly, both nationally and internationally, for its destructive and lethal wildfires ignited by utility equipment. The Alliance

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[4] M-bar Technologies and Consulting, LLC; http://www.mbartek.com; Email: jwmitchell@mbartek.com. Dr. Mitchell is also a board member of the Mussey Grade Road Alliance.

represents a community that was ravaged by an immense wildfire in 2003; the fire was not ignited by utility equipment. However, the searing experience of destruction lingers in the mind.

Furthermore, as California is presently experiencing drought again, the threat of wildfires, now year-round, lives in communities around the state – north and south, east and west. It remains of utmost importance that the OEIS be informed by Californians regarding this extraordinary threat of fires, and especially, by citizens of affected communities who have become subject matter experts at the CPUC and who care deeply about the wildfire issue.

We believe in small "d" democracy, the active participation of people in their government, and the promotion of that participation by the government itself. The OEIS and the CPUC are both beneficiaries of a process set up long ago to further the goal of inclusion. The issue of utility wildland fire safety needs to be solved for all who live here and, additionally, so that California is known for its strengths, not this continuing weakness. We appreciate being your partner in this work.

Respectfully submitted this 11th day of April, 2022,

By: /S/ ***Diane Conklin***

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WILDFIRE MITIGATION PLAN COMMENTS ON BEHALF OF THE MUSSEY GRADE ROAD ALLIANCE

The Mussey Grade Road Alliances' (MGRA or Alliance) Wildfire Mitigation Plan comments are authored by MGRA's expert witness Joseph W. Mitchell, Ph.D.[5]

1. INTRODUCTION

1.1. Overview, Organization, and Summary

The Mussey Grade Road Alliance provides comment on the 2022 Wildfire Mitigation Plans (WMPs) for Pacific Gas and Electric Company (PG&E),[6] Southern California Edison (SCE),[7] and San Diego Gas and Electric Company (SDG&E).[8] For the sake of comparison between utilities, all comments are provided in one document that for the most part uses the structure laid out in the templates approved in the 2022 Wildfire Mitigation Plan Update Guidelines Template.[9]

The Office of Energy Infrastructure Safety (OEIS or Energy Safety) has continued to expand the depth and breadth of its requirements for utility reporting, and as a result the document load remains voluminous and is difficult to review in the short statutory window allowed. We are grateful to Energy Safety for being flexible with the due dates for public comment, but even with the 1 ½ month (for PG&E) to 2 month review period (for SDG&E) it is impossible to do a thorough and adequate review. These comments will therefore be highly focused on specific topics.

MGRA is including utility data request responses as Appendix A of these comments. Even where we are not fully able to explore every issue that these cover in the comments, we hope that Energy Safety will review them as well in order to inform their own evaluation. The CPUC also conducted a number of wildfire-related proceedings in and 2021, some of which produced filings

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[5] M-bar Technologies and Consulting, LLC; http://www.mbartek.com; Email: jwmitchell@mbartek.com. Dr. Mitchell is also a board member of the Mussey Grade Road Alliance.

[6] PACIFIC GAS AND ELECTRIC COMPANY; 2022 Wildfire Mitigation Plan Update; February 25, 2022. (PG&E WMP)

[7] Southern California Edison Company; 2022 WILDFIRE MITIGATION PLAN UPDATE; FEBRUARY 18, 2022. (SCE WMP)

[8] San Diego Gas & Electric Company; 2020-2022 WILDFIRE MITIGATION PLAN UPDATE; February 11; 2022. (SDG&E WMP)

[9] ATTACHMENT 2; 2022 Wildfire Mitigation Plan Update Guidelines Template; December 13, 2021.

and data of direct relevance to the 2021 WMP reviews. Key filings from these proceedings are contained under Appendix B of this report.

1.2. Comparison with 2021 WMPs

MGRA made a number of recommendations as part of its 2021 WMP comments. Many of these were acted upon by WSD and later OEIS, either in its review of the WMP or in its comments on the utility quarterly report. Other recommendations were in one way or other implemented or obviated by utility actions. Some of MGRA's recommendations were not addressed but remain valid concerns in the 2022 WMP reports. MGRA's 2021 recommendations are summarized below:

Recommendation	**WSD/OEIS Action**	**Utility Action**	**Status**
Utilities should come to a common approach on covered conductor.	Issue-PG&E-21-09; Issue-SCE-21-04; Issue-SDG&E-21-03	Meetings resulting in a workshop report & Exponent review	Reporting complete; still needs review by OEIS and stakeholders. Still no common agreement.
Variations in RSE between utilities.	Issue-SDG&E-21-11; Issue-PG&E-1-28; Issue-SCE-21-02	Energy Safety working group.	Still active. Parallel effort in CPUC RDF proceeding R.20-07-013.
Utility risk models do not adequately represent correlation between ignition and spread.	Issue-SCE-21-11; Issue-SDG&E-21-01; Issue PG&E-21-04; Issue PG&E-21-06	Energy Safety working group.	Still active. Utility models still do not show wind as a significant predictive variable.
Technosylva fire spread model does not model larger fires and does not account for suppression effects.	Issue PG&E-21-02; Issue SCE 21-03; Issue-SDG&E-21-02	Energy Safety working group. Some improvements to Technosylva models.	Still active.
MGRA found that SDG&E data showed that outage rates for oaks were significantly lower than palms, cypress, and eucalyptus.	Issue SDGE-21-06	Reanalysis in 2022 WMP	Reanalysis complete; needs OEIS and stakeholder review.
MGRA warned against placing undue emphasis on third-party ignitions which do not correlate with extreme	Issue-SDG&E-21-01	Energy Safety working group	Still active. Non-catastrophic events still overweighted.

weather events, such as balloons and traffic collisions.			
Satellite detection validation	None	None	Active
Insufficient justification for shutoff thresholds	None	All utilities now adopting a PSPS consequence model.	Active
Egress issues and wooden poles	None	Utilities incorporating egress issues. Technosylva studying inclusion.	Active
MGRA raised concerns with PG&E's announcement of a 10k mile undergrounding program.	Required update in 2022 WMP	PG&E undergrounding plan released.	Active.
Bias of utility ignition models by PSPS	None	PG&E incorporates PSPS damage events.	Active for SCE, SDG&E.

Table 1 - MGRA recommendations made as part of the 2021 WMP review, WSD/OEIS and utility action on these topics, and current status.

1.3. Significant Findings in the 2022 WMPs

There have been a number of significant developments since the issuance of last year's Wildfire Mitigation Plans. The Office of Energy Infrastructure Safety is now independent of the California Public Utilities Commission (CPUC or Commission), and now has full authority over the WMP requirements, which have become more prescriptive and detailed. An auditing and review process is underway. In the meantime, 2021 was a year of severe drought that saw the ignition of the Dixie fire that grew to California's second largest fire[10] and was the first wildfire to cross the Sierra Nevada range. Soon thereafter, PG&E announced a major undergrounding program that will, if implemented, put 10,000 of its 30,000 lines in the High Fire Threat District (HFTD) underground.

During the course of the year, utilities have responded to OEIS feedback on the 2021 WMPs and have additionally started new programs and identified new challenges.

[10] CAL FIRE; Top 20 Largest California Wildfires; January 13, 2022. Downloaded 3/23/22.

1.3.1. Significant advances in wildfire safety

While most of this document will be dedicated to identifying portions of the utility Wildfire Mitigation Plans that need improvement, there are a number of advances that have been made over the last year that should be acknowledged:

- Utilities are developing and using operational probability of ignition models that incorporate wind effects.[11]
- SCE has run a successful pilot of Rapid Earth Fault Current Limiter (REFCL) technology, which in conjunction with covered conductor eliminates nearly all ignition sources.[12]
- Utilities are using machine learning (ML) in conjunction with weather station data to improve operational weather prediction capabilities.
- Technosylva fire spread modeling is being expanded to include building loss and fire suppression.[13]
- PG&E was able to reduce ignitions by 80% in areas where Enhanced Powerline Safety Settings (EPSS) were introduced.[14]
- PG&E's Enterprise Risk Model (ERM) has introduced 1) use of a truncated power law (Pareto) to describe catastrophic wildfire losses and 2) incorporates PSPS damage data as an ignition proxy.[15]

These items will be discussed in subsequent sections with regard to OEIS supporting best utility practices.

1.3.2. Major issues identified in the 2022 Wildfire Mitigation Plans

A number of significant issues were identified in the 2022 WMPs and will be addressed at length in the remainder of these comments. To summarize some of these issues:

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[11] SDG&E WMP; pp. 93-94.
[12] SCE WMP; p. 217-218.
[13] SCE WMP; p. 128.
[14] PG&E WMP; p. 738.
[15] PG&E WMP; p. 119.

- Utility risk models that are used to prioritize work and identify hazardous circuits have significant flaws. Specifically, they do not adequately account for the fact that high winds make ignitions far more likely. This issue was raised in MGRA's 2021 WMP review and discussed at some length,[16] and was identified by Energy Safety as an issue needing more clarification.[17] This problem was discussed in the November 17, 2021 OEIS Risk modeling workshop, where I stated that utility models are missing a conditional probability that ignitions from different drivers occur on the "worst weather days" being modelled. This idea has not been incorporated into any of the utility risk models used for planning and prioritization, and so these comments will describe the implications and possible solutions.
- The Technosylva model, while undergoing some improvements, still has limitations as a means to measure wildfire consequences. The limitations on fire size continue to bias risk estimates, overemphasizing the risk near population centers.
- The initiative by SDG&E to introduce smoke as a safety risk will prove to be a major new initiative in this and future OEIS and CPUC proceedings. It can be shown that SDG&E's estimate of wildfire smoke safety risk is a substantial underestimate and that the impact of wildfire smoke on population presents the dominant safety risk for most utility wildfires.
- Utilities have completed an analysis of covered conductor programs. Nevertheless, SCE's program remains much more advanced than other utilities. It appears based on initial SCE results that covered conductor may be significantly more effective at preventing ignitions than previously stated, which may mean that RSEs need to be re-evaluated.
- PG&E's proposed 10,000 mile undergrounding program is not supported by cost efficiency estimates when compared to other mitigations. PG&E's claim that undergrounding costs can be dramatically reduced lacks support.
- PG&E's EPSS program, while significantly reducing ignitions, has also impacted numerous customers in the same manner as PSPS events but without the mitigation that advanced notification provides.

[16] 2021 WMPs; MUSSEY GRADE ROAD ALLIANCE COMMENTS ON 2021 WILDFIRE MITIGATION PLANS OF PG&E, SCE, AND SDG&E; March 29, 2021; pp. 14-38. (MGRA 2021 WMP Comments)

[17] Issue-SCE-21-11; Issue-SDG&E-21-01; Issue PG&E-21-04; Issue PG&E-21-06

1.3.3. Wildfire mitigation activity at the California Public Utilities Commission

MGRA is involved in a number of Commission proceedings that have been operating in parallel with Energy Safety's WMP review process. Many of these proceedings have overlapping areas of interest where close coordination between OEIS and the CPUC is needed to ensure that utilities are not presented with conflicting requirements. Throughout the year, CPUC staff (often through Cal Advocates) have attended OEIS meetings and workshops, while OEIS staff have sometimes attended CPUC workshops. This continued cooperation is critical, because in order to implement the measures laid out in the WMPs, the utilities must obtain funding for them through the CPUC's General Rate Case (GRC) process.

Some of the current CPUC proceedings that have scope overlapping with the Wildfire Mitigation Plans are:

R.18-12-005 – The proactive de-energization proceeding regulating "Public Safety Power Shutoff", PSPS.

2021 Developments – Addition of post-season reporting requirements and creation of a template for post-event reporting.[18] Determination that PG&E was at fault for its website failure during the October 2019 power shutoffs.[19] The CPUC's Safety Enforcement Division (SED) is currently tasked with enforcement of the reporting requirements.

Overlap – PSPS metrics and reporting requirements.

Comment – This proceeding is currently dormant, and it is unclear whether the Commission will take further steps to regulate utility power shutoff. Currently, the utilities are subject to a self-reported "last-resort" threshold for shutoff, and there is no further action pending to ascertain the benefits and harms of power shutoff, or to come up with common practices for optimizing shutoff thresholds. Significantly more work is required on the topic of de-energization, and this will be discussed in Section 8 of these comments.

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[18] California Public Utilities Commission; Utility Company PSPS Post Event Reports; https://www.cpuc.ca.gov/consumer-support/psps/utility-company-psps-post-event-reports

[19] D.21-09-026.

R.20-07-013 – The successor to the S-MAP proceeding, now called the "Rate-Based Decision-Making Framework" (RDF), tasked with devising the guidelines and standards for risk evaluation in the Risk Assessment and Mitigation Phase prequel to each General Rate Case (GRC). While the S-MAP/RDF and RAMPs are designed to quantify all enterprise risks and mitigations, the risk from wildfire dwarfs all other risks combined.

2021 Developments – In 2021 the RDF proceeding completed its Phase 1, which was divided into four tracks representing technical requirements, safety operational and performance metrics, procedural requirements, and small and multijurisdictional utilities.[20] The proceeding delved into definitions related to the utility risk calculations, such as baselines, controls, mitigations, and others. This proceeding developed the Safety and Operation Metrics (SOMs) for PG&E in conjunction with the Enhanced Oversight and Enforcement Process adopted in D.20-05-053. PG&E also produced a report showing that truncated power law (Pareto) distributions adequately described catastrophic wildfire losses.

A second phase of this proceeding has now been initiated, and while its scope has not yet been determined it will likely work towards more uniformity and common definitions in the utility Multi Attribute Value Functions (MAVFs), and may address the anomalously high imputed Value of Statistical Life (VSL) of $100 M used by the major IOUs. The proceeding will also provide parties the opportunity to evaluate a consultant's report initiated by the Safety Policy Division (SPD). The Level4 report makes a number of recommendations for improvement of the risk calculation process, some of which would result in fundamental changes to how these values are calculated.

Overlap – Many of the metrics reported as per this proceeding are included with the metrics and data required by Energy Safety in quarterly and yearly filings. Significant portions of the WMPs deal with utility risk calculations – for the purposes of selecting mitigation programs, for the purposes of prioritizing work in the utility landscape, and for the purposes of operational decisions such as power shutoff. Uniformity and comparability of utility risk calculations has also been an issue raised by OEIS in 2021 workshops.

Comment – Many of the decisions that will be made in the course of this proceeding will fundamentally affect the way that utilities calculate risk in general and wildfire risk in particular. Energy Safety needs to be actively involved in this proceeding in order to ensure that risk estimation remains consistent within the CPUC and OEIS domains.

[20] D.21-11-009; p. 7.

Recommendation*:* If procedurally and legally possible, OEIS should become a party to R.20-07-013. If this is not feasible, there will be numerous opportunities for OEIS to attend and participate in workshops and to provide informal comments.

A.21-05-011 – SDG&E's RAMP proceeding.

2021 Developments - SDG&E's 2021 RAMP report was released during the 2021 WMP review process and concluded at the beginning of 2022, culminating in the release of SPD's Staff Evaluation report on Sempra's RAMP[21] and subsequent comment and reply cycle. Sempra is now preparing its General Rate Case application, which will be filed in May. The GRC should incorporate and address input from SPD Staff and intervenors. Largely, SDG&E's RAMP is consistent with what has been submitted in their WMP. One noteworthy item is the inclusion of smoke as a safety risk, with the imputed risk of one fatality per 10,000 acres burned. MGRA provided substantial feedback on this proposal and its implications. In short, while MGRA states that SDG&E erred in its calculation, it erred on the side of smoke being *less* impactful than it likely is, and that wildfire smoke safety impacts are likely to be much larger than other safety impacts.

Overlap – While SDG&E's WMP is largely consistent with its RAMP, substantive feedback by OEIS on SDG&E's practices as relating to risk are likely to inform SDG&E's GRC proceeding.

Comment – As the full implications of wildfire smoke effects are understood, it is likely that this will become a significant issue for both the CPUC and OEIS. This is an emergent risk, and will be discussed in Section 4.2.3. MGRA's analysis of smoke impacts is attached as Appendix B to this filing.

A.21-06-021 – PG&E's General Rate Case

2021 Developments – PG&E's GRC was initiated in 2021. Soon after the GRC was filed, the Dixie fire was ignited by vegetation contact with a PG&E line. Within weeks, PG&E announced its plans to underground 10,000 miles of line in the HFTD, throwing the entire premise of risk-based decision-making into question. PG&E was directed to refile its GRC along with its WMP in order to explain the impacts of its proposed program on its rate case and on its prioritization of other mitigations. PG&E's enterprise risk model (ERM) is now using a truncated power law (Pareto distribution) to characterize catastrophic fire risk.

[21] A.21-05-011/014; Safety Policy Division Staff Evaluation Report on SDG&E's and SoCalGas' Risk Assessment and Mitigation Phase (RAMP) Application Reports; November 5, 2021. (SPD SDG&E RAMP Report)

Overlap – PG&E's GRC filing is largely consistent with its WMP. Substantive feedback by OEIS, particularly with regard to PG&E's undergrounding proposal, is likely to have an impact on the course of PG&E's GRC.

Comment – The issue of PG&E's decision to move forward with its 10,000 mile undergrounding project will be discussed at length in these comments. PG&E's choice of a Pareto distribution to model catastrophic fire losses will also be discussed as a potential best practice.

2. ADHERENCE TO STATUTORY REQUIREMENTS

2.1. March 2022 State Auditor Report

On March 24, 2022, the California state auditor released a report on California's regulatory oversight of utility electrical system safety.[22] The report raised a number of issues with regard to the oversight of IOU safety by both the CPUC and OEIS, and made a number of recommendations regarding changes that should be made at the legislative level. Energy Safety management took issue with a number of the findings. While some of the issues raised by the Audit Report are outside of the scope of these Wildfire Mitigation Plan reviews, the report highlights a number of areas that the Auditor flags as being of specific concern and which are likely to receive additional critical focus and scrutiny in this year's review process.

Some of the items raised in the Audit Report that are of specific concern in relation to WMP reviews are:

- Insufficient speed in addressing the wildfire problem. The Report notes that "*even if all of the improvements they completed in 2020 consisted of replacing bare power lines in high fire-threat areas with covered or underground lines, they would have addressed only 4 percent of such lines*."[23]
- "*[T] the State must prioritize the areas utilities need to address first.*"[24]

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[22] Auditor of the State of California; Electrical System Safety; California's Oversight of the Efforts by Investor-Owned Utilities to Mitigate the Risk of Wildfires Needs Improvement; REPORT 2021-117; March 24, 2022. (State Auditor Report)
[23] Auditor Report cover letter.
[24] Id.

- The Auditor asserts that inadequate prioritization of mitigation should be (and have been) sufficient grounds for Energy Safety to reject a WMP.[25]
- Alteration of equipment settings, for example by PG&E's EPSS initiative, resulted in 600 unplanned outages in 2021 affecting 650,000 customers.[26] The Auditor notes that OEIS does not currently require these events to be reported in the same way as PSPS events.[27] The Auditor raises the concern that these outages are highly impactful because "u*nlike a planned shutoff, customers and public safety partners receive no warning of these outages before their power is interrupted*", which can be life-threatening "*for customers who rely on electricity to maintain necessary life functions*".[28]
- Until utility equipment can withstand fire weather conditions, "*de-energizing power lines will continue to be a necessary mitigation tool to protect the public*", citing hundreds of instances of wind-related damage described in the utility PSPS post-event reports.[29]
- The Auditor Report states that "bare" power lines are primarily responsible for wildfires and the need for power shutoff and suggests that measures such as covered conductor or undergrounding should be implemented.[30]
- The Auditor states that while undergrounding of lines is highly effective, it is significantly more expensive than covered conductor.[31]
- The Report calculates that replacing 40,000 miles of bare lines in high fire risk areas at a cost of $700,000 per mile would cost $28 billion.[32]
- The Report uses utility calculations of PSPS costs, though it notes that these do not take into account numerous customer harms such as impact on vulnerable customers, traffic incidents, loss of communications, and the potential for generator fires.[33]

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[25] Auditor Report; p. 41.
[26] Auditor Report; cover letter, pp. 31, 32
[27] Id.; p. 33.
[28] Id.
[29] Auditor Report; p. 14. It was originally MGRA's suggestion that the Safety Enforcement Division require standardized reporting of wind-related damage.
[30] Auditor Report; p. 20.
[31] Id; p. 25.
[32] Id; p. 30.
[33] Id; p. 15.

Using SCE's estimation of power outage costs, it calculates that PSPS costs to date have exceeded $21 billion in total.[34]

2.1.1. Analysis and implications of the State Auditor Report

While it is not within the scope of this review to analyze the Auditor's Report, the Report raises issues that should receive emphasis during this review cycle.

- The Auditor Report draws attention to the fact that there is still no widely accepted quantification of power shutoff consequences.[35] Since 2009, MGRA has urged the CPUC to develop a standard method for estimation of de-energization consequences so that the benefit of power shutoff can be weighed against its obvious harms. So far, neither the CPUC nor OEIS have taken action in this area and the lack of this information is now hobbling the State's ability to decide a course of action as utilities consider extremely expensive mitigation measures.
- The Auditor Report nevertheless attempts a crude cost/benefit analysis that would appear to favor the initiation of a covered conductor program.[36]
- The Auditor Report fails to observe that covered conductor, on its own, will reduce but not eliminate wildfire risk or the use of PSPS and that other mitigations may be necessary.
- The Auditor Report emphasizes the need for an accurate assessment of circuit risk, raising this to a critical issue.[37] This is of particular concern because there appear to be significant error in the manner in which utilities are currently assessing circuit risk. Energy Safety attempted to address these issues in its 2021 WMP findings and through subsequent workshops. However, problems were not resolved, and now after further analysis issues can be specifically identified. Detailed description of the issue and potential solutions are discussed in Section 4.2.1.

[34] Id.
[35] Auditor Report; p. 15.
[36] Id.
[37] Auditor Report; p. 4.

- A significant shortcoming in the Auditor Report is that it fails to note the significant impacts that recent utility rate increases are having on the public,[38] and that the extensive hardening programs that it suggests will further intensify this pressure.

4. LESSONS LEARNED AND RISK TRENDS

4.2. Understanding major trends impacting ignition probability and wildfire consequences

4.2.1. Influence of wind on ignition probability

A number of issues were raised in MGRA's 2021 WMP review with regard to the influence of wind on ignition probability. These issues were acknowledged by Energy Safety, and utilities were directed to investigate further and provide additional information back to OEIS (see footnote 17). A two hour discussion was held during the November workshop in which the issue of correlations between ignitions and consequences were discussed. In the 2022 WMPs, this issue remains unresolved. Utilities continue to use machine learning for ignition modeling and Technosylva for fire spread modeling and the results are roughly equivalent to those presented in 2021.

It is important to note that there are three independent domains where wildfire risk modeling is used:

- The Enterprise Domain. Enterprise Risk Models are used to compare wildfire risk against other enterprise risks, and for evaluating risk reduction of mitigations and their Risk/Spend Efficiencies (RSEs) at the program level. Examples are SDG&E's Risk Quantification Framework and PG&E's Enterprise Risk Model (ERM),
- The Planning Domain. This is used for identifying high risk circuits and prioritizing mitigation. It requires a wildfire risk model that is granular in geographic location,

[38] https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/affordability

such as PG&E's Wildfire Distribution Risk Model (WDRM),[39] SCE's Wildfire Risk Reduction Model (WRRM),[40] and SDG&E WiNGS-Planning model.[41]

- The Operational Domain. These risk models are used for making real time decisions during fire weather conditions, and so take into account live weather and fuel conditions. They are primarily used for making decisions regarding power shutoff or circuit trip sensitivities. SDG&E calls its model WiNGS-Ops, and PG&E has developed the Ignition Probability Weather Model (IPW).

While the Enterprise (in PG&E's case) and Operational risk models (for all utilities) seem to be capturing the extreme weather dependency of catastrophic fire probability, the Planning models do not. These inconsistencies will be described below. In fact, the Enterprise and Operational risk models, while still requiring various improvements, have made significant progress. The reason that the Planning Domain models are inconsistent with the other domains will be discussed in the following sections as well. The implications of an inaccurate planning risk tool are significant, in that it takes a utility some time to plan and stage mitigation work, and having to switch priorities between circuits will prove to be an expensive and time-consuming procedure, though not nearly as expensive in the long run as mitigating in the wrong location.

4.2.1.1. Review of 2021 WMP wind issues

MGRA's 2021 WMP Comments[42] dealt extensively with PG&E Wildfire Distribution Risk Model (WDRM), which found (and still finds) that wind is a poor predictor of utility wildfire risk for ignition events driven by utility damage and only a modest predictor for ignitions caused by vegetation damage. To the extent that the SCE and SDG&E models use similar approaches for their risk calculations used for planning and prioritization, this same critique applied to them.

Even as early as the turn of the century, the link between wind and catastrophic fire ignition had been acknowledged by a collaboration of fire agencies and utilities: "*The very same weather conditions that contribute to power line faults also lead and contribute to the rapid spread of*

[39] PG&E WMP; p. 88.
[40] SCE WMP; p. 30.
[41] SDG&E WMP; p. 18.
[42] MGRA 2021 WMP Comments; pp. 14-43.

wildfire. The most critical of these weather factors is high wind, which is commonly accompanied by high temperatures and low humidity."[43] This relationship was more recently acknowledged in the State Auditor Report, which states: "*Once the fire starts, the same weather conditions that contribute to electrical power-caused fires—the most critical of which is high wind—also cause the fire to spread rapidly and make it difficult to control. Since 2015 power lines have caused six of the State's 20 most destructive wildfires*."[44]

It should be acknowledged that not all catastrophic power line fires are ignited under high wind conditions. Under severe drought conditions and buildup of dry fuels, a fuel-driven fire may be ignited by any source and grow to very substantial size, as proven by the Dixie fire this year and the Butte fire in 2016. These ignitions are not correlated with a weather driver. In fact, most of the outages, ignitions, and wire-downs are not. However, the vast majority of *catastrophic* power line fires have been associated with wind, including the Camp, Thomas, Witch, Guejito, Tubbs, Kincade, Nuns, Atlas, Laguna, and others. MGRA's 2021 WMP analysis provided forensic detail for several of these fires showing that wind was linked to their ignition, and not only to the elevated fire hazard conditions that led to their rapid spread.[45]

As noted in the quote from the Auditor Report above, power line fires appear in Cal Fire's "Top 20" list for acreage burned, homes destroyed, and fatalities more frequently than would be expected from the fraction of wildfires they constitute (around 10%). MGRA's 2021 comments showed that this statistical anomaly was very significant.[46] MGRA also contrasted the 2003 and 2007 Southern California fire sieges. Both of these events had roughly the same number of major wildfires, but in 2003 no fire was attributed to power lines while in 2007 9 or 20 wildfires were attributed to power lines. Peak winds were roughly 80% higher in 2007.[47] Similar effects have been observed in Australia.[48]

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[43] OSFM, CDF, USFS, PG&E, SC Edison, SDG&E; Power Line Fire Prevention Field Guide; Mar 27, 2001
[44] Auditor's Report; p. 5.
[45] MGRA 2021 WMP Comments; p. 16.
[46] Id.; p. 17.
[47] Mitchell, J.W., 2013. Power line failures and catastrophic wildfires under extreme weather conditions. Engineering Failure Analysis, Special issue on ICEFA V- Part 1 35, 726–735. https://doi.org/10.1016/j.engfailanal.2013.07.006 (Mitchell 2013).
[48] Op. Cite; pp. 17-18.

MGRA also showed definitively that outage rates were a strong function of wind speed, as shown by academic analysis of historical SDG&E outage data (Mitchell 2013). MGRA's analysis also demonstrated that PG&E's "Outage Producing Wind" model (OPW) showed roughly steep variations of outage rates with wind speed, roughly consistent with Mitchell 2013.[49]

The MGRA analysis also performed a cross check of the risk model developed by PG&E for its EVM model, and arrived at consistent results once PG&E had corrected a coding error. Both the PG&E and MGRA analysis found that under high wind conditions, drivers from "external agent" causes that are not wind related (vehicle collisions, balloons, animals, 3rd party contact) were highly suppressed compared to ignitions due to equipment and vegetation, exactly what would be expected if winds were a wildfire cause.[50] MGRA then performed a similar analysis of SCE ignition data and found an even stronger correlation between wind and ignitions than in the PG&E data, which was particularly significant for fires starting at very high wind speeds, as shown in the figure below.

[49] MGRA 2021 WMP Comments; pp. 21-26.
[50] Id; pp. 26-30.

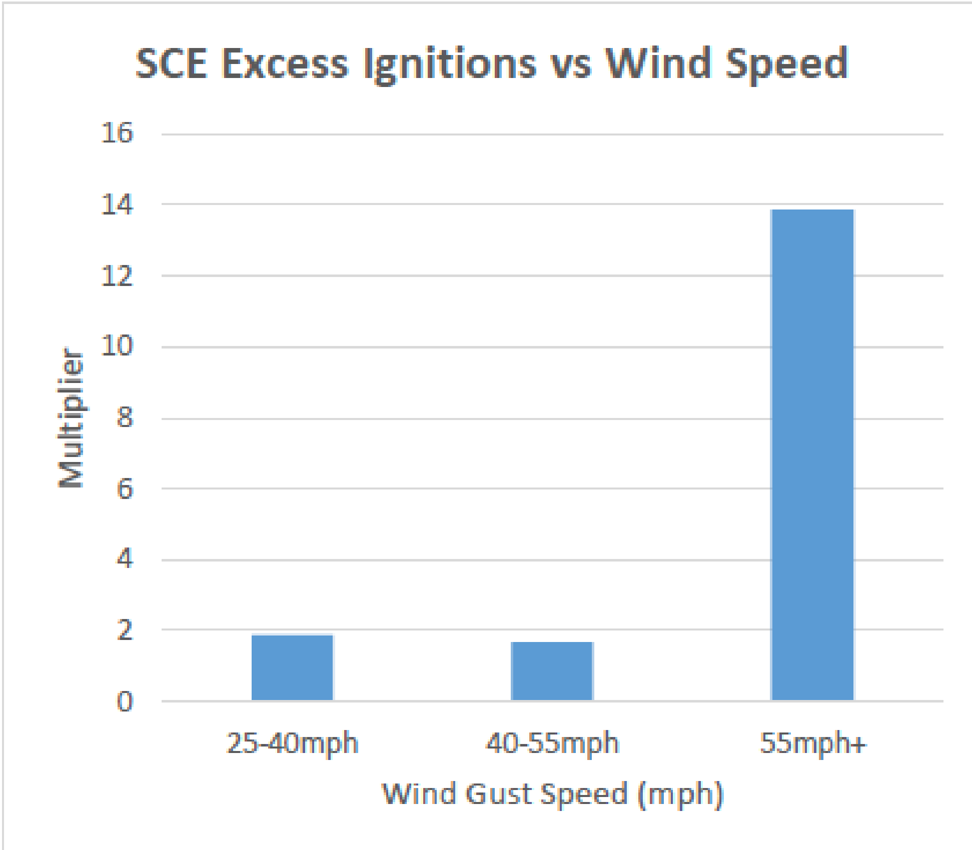

Figure 1 - Excess ignitions above ambient wind speed for SCE 2015-2020 ignition data as compared against Monte Carlo data using the same ignition locations. The "multiplier" is determined by dividing measured ignitions by expected ignitions in each bin. From MGRA 2021 WMP Comments; p. 32.

PG&E's ignition probability component of its WDRM v2 risk model was based on a Machine Learning approach that analyzed numerous variables and found that wind did not provide a major predictive role, particularly for equipment damage. MGRA's 2021 Comments asserted that PG&E's Ignition Probability Model was in error, primarily because it used averaged weather data rather than conditions occurring at the time of the ignition, and that it would under-predict ignitions likely to become catastrophic fires.[51]

PG&E's argument against the MGRA assertion was: "*As a planning model, the 2021 Wildfire Distribution Risk Model provides insights used to develop annual mitigation plans. It is a model trained to predict where ignitions are more likely to occur over the next year and not when they will occur. This is different than an operational model that would be used for a PSPS event*

[51] Id.; pp. 32-36.

where the likelihood of ignition for a forecasted weather pattern is the objective. For an operational model, peak weather values play a significant role in developing predictions. However, when modeling all ignitions over longer periods of time, prevailing wind speeds and directions play a different role. As long as there are a similar number of wind events in similar locations over time, the model is already accounting for wind impacts on annual ignitions. However, the majority of ignitions are not caused by wind as 95% of outages do not occur during NE wind days."[52]

MGRA noted that most catastrophic fires *do* occur on "NE wind days", and that the PG&E risk model should reflect this.[53]

4.2.1.2. PG&E, WSD, and Energy Safety responses

In its 2021 WMP Reply Comments, PG&E repeated its position that its WDRM model is correct. It stated that: "*nowhere do we assert or conclude that ignitions are independent of wind data. What we do assert is that multi-year models trained on all ignitions of a given type, during fire season within Tier 2 and Tier 3 HFTD areas, are empirically less sensitive to metrics of wind derived over similar time frames than other weather and environmental conditions*."[54] In other words, over longer time periods wind-driven ignitions are a small fraction of overall ignitions.

On May 4, 2021, the Wildfire Safety Division issued Revision Notices for the major utilities. It identified a Critical Issue (PGE-02) that found that "*PG&E does not adequately justify its significant re-prioritization of circuit segments targeted for mitigation. PG&E relies on the results of its 2021 Wildfire Distribution Risk Model ('2021 Risk Model') to justify these changes. However, PG&E does not provide adequate validation of its 2021 Risk Model*." WSD orders PG&E to provide "*its internal validation report, its 3rd-party review and validation, and any other available supporting materials that review and/or validate its 2021 Risk Model*."[55]

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[52] MGRA 2021 WMP Comments; Appendix B; Data Request Response PG&E WildfireMitigationPlans_DR_MGRA_010-Q06.
[53] Id.
[54] 2021-WMPs; REPLY COMMENTS ON THE 2021 WILDFIRE MITIGATION PLAN OF PACIFIC GAS AND ELECTRIC COMPANY (U 39 E); April 13, 2021; p. 19. (PG&E 2021 WMP Reply)
[55] The Wildfire Safety Division Issuance of Revision Notice for Pacific Gas and Electric Company's 2021 Wildfire Mitigation Plan Update and Notice of Extension of WSD Determination Per Public Utilities Code 8389.3(a); May 4, 2021.

In response, PG&E provided its own internal analysis of its WRDM model along with a 3rd party consultant review (E3 Report).[56] PG&E's internal report frames the prioritization problem as "*where is the probability of ignitions relatively high and relatively low, over planning timeframes*?".[57] In MGRA's Comments on the plan revisions, it suggests an alternative framing of the problem: "*where is the probability of* ***catastrophic wildfire*** *ignitions relatively high and relatively low, over planning timeframes*?"[58] MGRA also analyzed the E3 Report and uncovered what a fundamental error in both E3's and PG&E's characterization of wildfire: PG&E's model assumes wildfire ignitions are a Poisson process: "*It may be reasonable to characterize wildfire as a Poisson process; ignitions follow physical principals, and under certain conditions the probability to catch fire has a constant mean rate of occurrence.*"[59] A Poisson process is one that is "random" in time. While E3 recognized that wildfire may not be randomly distributed in time, it incorrectly understood the exact mechanism leading to time correlations, which as MGRA explains:

"*…catastrophic utility wildfire ignitions are not a Poisson process due to the fact they are driven by a common driver - wind, and hence tend to be clustered together in time during specific weather events.*

There are two models that contribute to catastrophic fire potential, and neither should be ignored. The model being assumed by PG&E's ignition model is that ignitions occur randomly according to specific time and spatial probability distributions, and if these just happen to occur during periods of extreme fire weather a catastrophic fire can result. The model that PG&E's analysis ignores is that an external driver event such as Diablo winds cause damage or vegetation contact resulting in ignition during periods when rapid fire growth is possible. While catastrophic fires are possible from both mechanisms, historically the great majority of catastrophic fires are initiated by extreme wind events. PG&E may want to consider handling these two ignition scenarios separately."[60]

MGRA concludes by recommending that "*WSD should initiate a working group to study analytical approaches to risk ranking on an ongoing basis to ensure that the utilities are solving for catastrophic fire ignitions*."[61] WSD issued two recommendations related to this issue:

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[56] E3 Review of PG&E's 2021 Wildfire Distribution Risk Model; May 2021.
[57] PG&E Internal Report; p. 66.
[58] 2021-WMP; MUSSEY GRADE ROAD ALLIANCE COMMENTS ON 2021 WILDFIRE MITIGATION PLAN REVISIONS OF PG&E, AND SCE; June 9, 2021; p. 5. (MGRA Revision Comments)
[59] E3 Report; p. 28.
[60] MGRA Revision Comments; p. 9.
[61] Id.; p. 11.

PG&E-21-02: "*The utilities must collaborate through a working group facilitated by Energy Safety to develop a more consistent statewide approach to wildfire risk modeling. After Energy Safety completes its evaluation of all the utilities' 2021 WMP Updates, it will provide additional detail on the specifics of this working group. A working group to address wildfire risk modeling will allow for:*

1. Collaboration among the utilities;

2. Stakeholder and academic expert input; and

3. Increased transparency"[62]

PG&E-21-04: "*PG&E must:*

1. Demonstrate that it appropriately accounts for wind speed in its Probability of Ignition models' input data sets. This shall be handled both within the Working Group set up in PG&E-21-02, as well as an individualized report.

2. Address discrepancies between its input data sets and those of peer utilities."[63]

4.2.1.3. The OEIS risk modeling working group and quarterly reports

A two-day Wildfire Risk Modeling Workshop was held on October 5, 2021 and October 6, 2021, with utility presentations the first day and a Q&A session held the second day. The OEIS risk modeling working group itself was initiated on October 27, 2021. Consequence modeling was discussed on November 17, 2021, and risk drivers and data were discussed on October 8th. There were also meetings with Technosylva held on November 15th and November 18th.

During the initial Q&A session representatives from each utility were asked specifically whether their wildfire models used time-specific wind data or averaged data. The answer from each utility was essentially the same: all three major utilities use time-averaged peak or average wind data for the circuit risk model used for planning. SDG&E stated that it used a static maximum wind speed for WiNGS. SCE stated that the weather variables it used were maximum, peak, average and standard deviation data provided from Atmospheric Data Solutions, and PG&E continued to reiterate that its model was correct.

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[62] WSD-021; Appendix 1.

[63] Id.

PG&E's third quarter report re-asserted that its WDRM model was correct. MGRA challenged this assertion in its comments on the Q3 report. MGRA's analysis uncovered what is the key error in PG&E's risk model:

"- *The great majority of PG&E's ignition events contributing to its POI model do not occur during severe weather events.*
- *Nevertheless, PG&E calculates potential consequences for these ignition events using the '400 worst weather days' from its meteorological history*."[64]

MGRA suggested the following solution:

"*PG&E should be weighting its risk calculations by a normalization factor representing the fraction of time that the Technosylva '400 worst days' weather conditions are applicable for that geographic point. Otherwise, it is greatly overestimating the risk from random ignitions.*"[65]

This point was reiterated in the subsequent technical workshops, but does not seem to have been incorporated by utilities in the 2022 WMPs. A more developed version of this solution is presented in the following sections.

4.2.1.4. All three major IOUs are using static aggregated weather data for circuit prioritization

Based on information provided in the 2022 WMPs and confirmation provided by utility representatives at workshops, it is possible to conclude that all three major IOUs have used time averaged wind variables as the basis of their probability of ignition models.

PG&E – WDRM v2 and v3

P&GE Definition: "*Wildfire Distribution Risk Model (WDRM) – This risk model is used to inform engineers where specific circuit segments rank in relation to all circuit segments within the HFTD areas.*"[66] Specific decisions based on this of this mode are for example "*to inform*

[64] 2021-WMPs; MUSSEY GRADE ROAD ALLIANCE COMMENTS ON THE 2021 WILDFIRE MITIGATION PLAN Q3 QUARTERLY REPORTS OF SDG&E, PG&E, AND SCE; November 15, 2021; p. 10. (MGRA Q3 Report Comments)
[65] Id.
[66] PG&E WMP; p. 433.

prioritization for the Undergrounding initiative."[67] As PG&E notes it figures heavily in its system hardening projects: "*This program targets the highest wildfire risk miles and applies various mitigations such as line removal, conversion from overhead to underground, application of remote grid alternatives, mitigation of exposure through relocation of overhead facilities, and in-place overhead system hardening. For 2022, the highest wildfire risk miles are separated into four categories:*

1. The top 20 percent of circuit segments as defined by PG&E's 2021 WDRM v2 for System Hardening,…"[68]

PG&E plans to incorporate near-miss data into its WDRM, estimating the "*risk as the probability of failure multiplied by the probability of an ignition given and failure multiplied by the wildfire consequence of an ignition. The near miss data was part of the failure data set used to train and test the 2022 WDRM v3*."[69] It's WDRM v3 will be more advanced in a number of ways and be able to analyze a broader spectrum of wildfire risks and scenarios. Nevertheless it does not appear to take into account correlation between ignition probability and the consequence model. Additional discussion of WDRM v3 based on PG&E data responses can be found in Section 4.2.1.10.

In an attachment to its WMP describing its position on WDRM, PG&E clings tenaciously to the work done in 2021 with regard to wind, still maintaining that it is accurate:
"*We agree that climate and meteorological factors are key to both asset failure prediction and the conditions that determine whether an ignition propagates to a wildfire. PG&E previously provided a detailed technical description in support of the treatment of wind in both the Probability of Ignition and Wildfire Consequence Models that are part of the 2021 Wildfire Distribution Risk Model (WDRM). PG&E believes that this detailed description explains and supports the current use of wind data sets in the 2021 WDRM.*

We understand that certain parties providing comments on the 2021 WMP believe that peak wind speed should be a key predictive factor in wildfire risk models. To be clear, we agree that peak wind speeds are a key contributor to failures, ignitions, and wildfires. However, peak wind speed data sets are not predictive in the current Probability of Ignition Models. The 2021 Revised WMP

[67] PG&E WMP; p. 524.
[68] PG&E WMP; p. 537.
[69] PG&E WMP; p. 766.

outlines the reasons why we believe this to be the case and ways in which the modeling teams continue to analyze and seek to improve the predictive power of the models with wind data."[70]

It is clear that PG&E maintains the usage of static weather data because its staff believe that this is the technically correct thing to do.

SCE –

MGRA raised similar issues regarding SCE's approach in its 2021 WMP analysis. OIES subsequently made the following finding regarding SCE's WMP:

Utility-21-11 - Unclear how SCE's ignition models account for correlations in wind speeds, ignitions, and consequence.

Despite an observed correlation between some ignition causes and high wind speed, SCE states that it 'does not have enough wind-driven outage data at the circuit level to make determinations about correlations between wind speeds and outage rates.' It is unclear how SCE accounts for this correlation between wind speed and ignitions in its probability of ignition models.

SCE must:

1. Fully demonstrate that its probability of ignition models accurately account for the correlation between wind speed, ignition, and consequence; and speeds and outage rates." It is unclear how SCE accounts for this correlation between wind speed and ignitions in its probability of ignition models.

2. Explain:

a. Why SCE finds that is does not have enough "wind driven outage data at the circuit level,"

b. Specify the data required "to make determinations about correlations between wind speeds and outage rates," and

c. Explain how and when SCE plans to obtain such data moving forward."[71]

In response to this Issue, SCE further explained its POI model in more detail in its Q3 Progress Report: "*The variables used in the POI models include minimum/maximum/mean/standard*

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[70] TN10634-9_20220225T144600_Section_46_Atch01; PACIFIC GAS AND ELECTRIC COMPANY 2022 WILDFIRE MITIGATION PLAN UPDATE; SECTION 4.6; ATTACHMENT 1; p.4.6-Atch1-4

[71] WSD-020-AppA pp. 15,16.

deviation of the historical wind/gust speeds at each pole and segment level."[72] As MGRA explained in its comments on the Q3 Reports that "*SCE is using aggregated weather variables, just as PG&E does. Their POI model may therefore be subject to the same problems as PG&E's, which overpredicts risk from non-wind events due to its use of "worst weather days" consequence modeling*."[73]

This feedback was apparently not addressed in the 2022 WMP because SCE cites back to their November progress report when discussing the relation between wind speed and ignition:

> "p. 115 - *SCE-21-11 Unclear how SCE's ignition models account for correlations in wind speeds, ignitions, and consequence*
> *In the Progress Report, SCE explained how wind speeds and wind directions are used as inputs to both POI and Technosylva fire consequence models. Wind speeds, wind directions, and other weather measurements are all important inputs into SCE's wildfire modeling efforts.*
> *SCE then clarified that it has sufficient quantities of data to draw correlations between wind speeds and wind-driven outages for a climate zone level (consisting of many circuits), but the correlation is more challenging at a circuit level as some circuits do not have enough data points (e.g., at least 10).*"[74]

MGRA requested fire climate-zone based wind correlation data from SCE, and it is provided as Data Request Response MGRA-SCE-012 in Appendix A. Two of these plots are shown below, and the dramatic non-linear influence of wind on outage rates is readily apparent.

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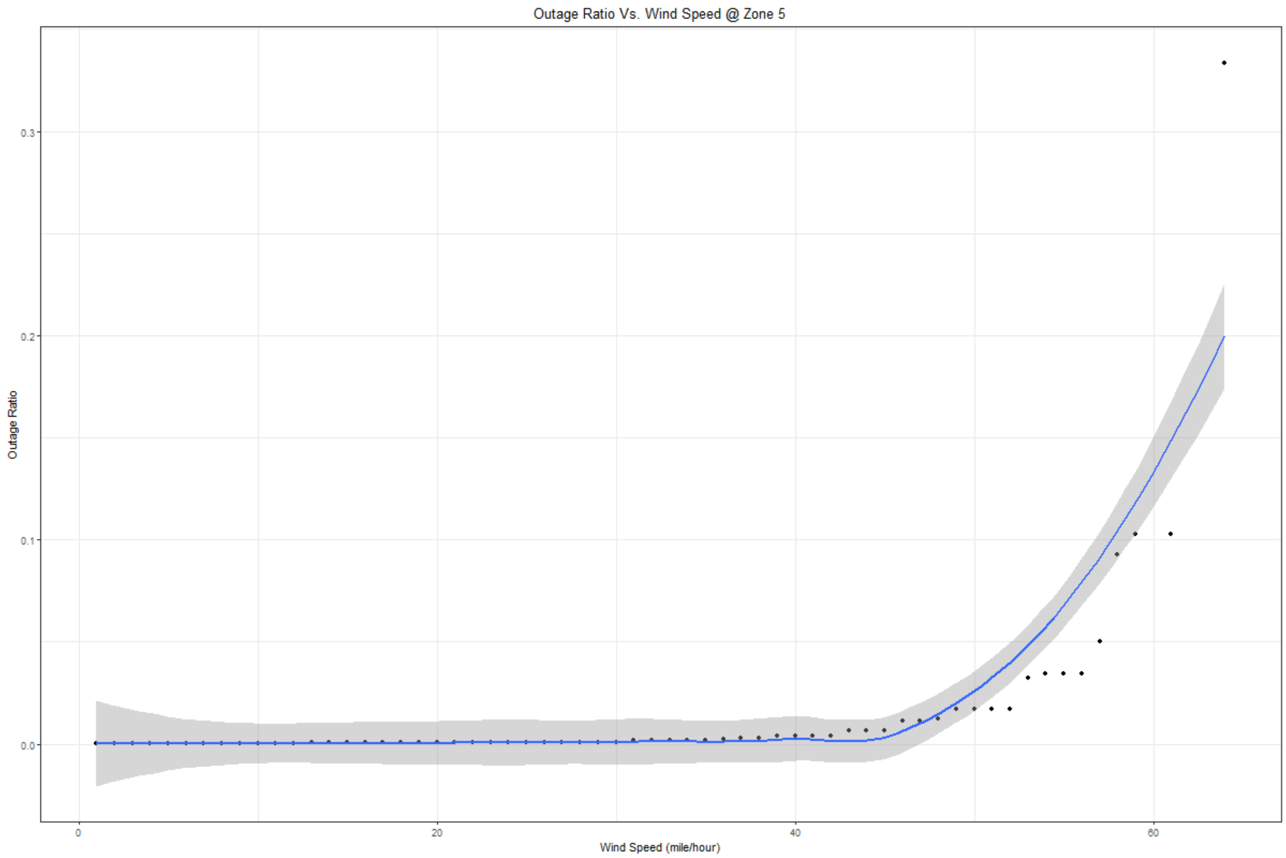
[72] Southern California Edison Company's Wildfire Mitigation Plan Progress Report Pursuant to Resolution WSD-020 (SCE Report); Southern California Edison Company's Quarterly Notification Pursuant to Public Utilities Code Section 8389(e)(7) Regarding the Implementation of Its Approved Wildfire Mitigation Plan and Its Safety Culture Assessment and Safety Recommendations (SCE QN); Update Change Order Report (SCE UCOR); SCE Table 12 update TN10430-2_20211101T165709_SCE_Q3_2021 (SCE Table Update); and SCE Q2 2021 QIU (SCE QIU); November 1, 2021.
[73] MGRA Q3 Report Comments; p. 12.
[74] SCE WMP; p. 115.



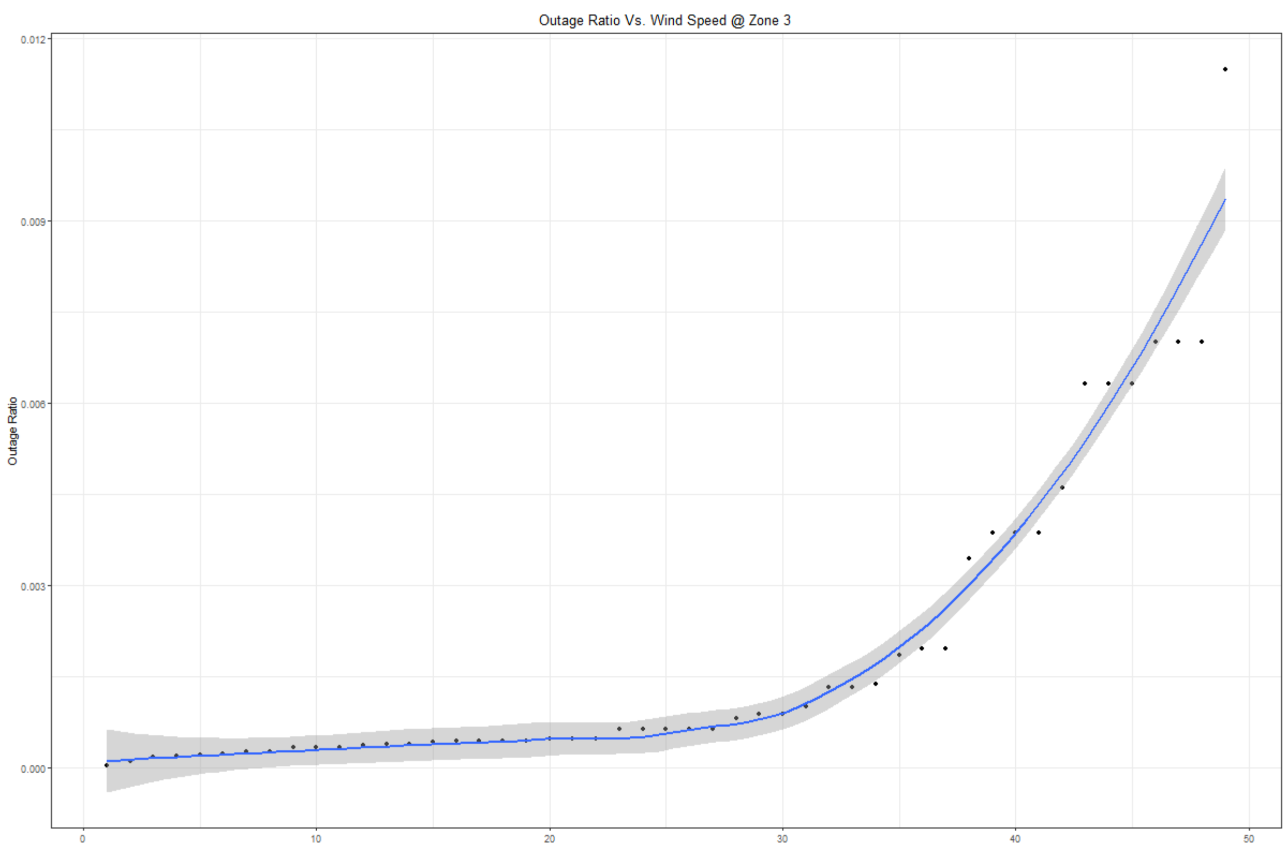


Figure 2 - Outage ratio per unit time as a function of wind speed in miles per hour for SCE "fire climate" zones 3 and 5.

SCE does not state whether or how they will apply this data to their circuit risk calculations going forward. In any case, it does not currently appear to have a significant effect on their risk drivers and rankings.

SDG&E –

SDG&E's WiNGS-Planning model apparently makes the same basic assumptions that the PG&E and SCE models do. In Energy Safety's review of SDG&E's 2021 WMP, Energy safety filed issue SDGE-21-01 Ignition Sources in Risk Modeling and Mitigation, in which it requires that: "SDG&E must fully explain:

1. How third-party ignition sources feed into SDG&E's risk models;

2. How ignition sources impact SDG&E's mitigation selection process, including:

a. How SDG&E prioritizes ignition sources;

b. If SDG&E treats third-party ignition sources that are not under SDG&E's direct control differently than other ignition sources, and if so, how;

c. How SDG&E targets its mitigations efforts to reduce ignitions that are more likely to result in catastrophic wildfire conditions."[75]

In explanation SDG&E explains that "*SDG&E's mitigation initiatives attempt to address overall ignition risks regardless of the cause, as it would be challenging and inefficient to shift programs frequently based on the cause. Additionally, the consequences of ignitions could be as catastrophic regardless of the cause of the ignition. SDG&E's ultimate goal is to lower the overall ignition potential across all cause categories, prioritizing sections of the system that show the highest potential ignition risks from any and all ignition sources*."

SDG&E's WiNGS-Planning tool also averages over time: "*SDG&E's WiNGS Planning model, a tool utilized to assess risk and mitigation effectiveness across its service territory, calculates the ignition likelihood at the circuit-segment level. The ignition likelihood metric calculated utilizes the total count of ignitions* ***across a specified span of time****, and factors in the specific likelihood of that ignition turning into a catastrophic wildfire (utilizing historical wildfire data), in order to compute the likelihood of a significant wildfire occurring for each individual circuit-segment.*" (emphasis added)

[75] SDG&E WMP; Attachment D: Detailed Report on Key Areas of Improvement; p. 1.

Apparently SDG&E, like the other major IOUs, averages all ignitions over time to obtain an average ignition rate that can be used for its probability calculations.

In conclusion, none of the utilities seem to have adequately addressed the issues raised by WSD/OEIS last year regarding how the potential for wind-driven fires is adequately incorporated into their risk models.

4.2.1.5. All major IOUs use "worst case" weather days for consequence calculations.

So far it has been established that all the major IOUs use ignitions from a wide variety of drivers and time periods, and that the POI models give no particular attention to "severe weather days". However, for their Technosylva consequence modeling, all three major utilizes use "worst case" fire weather conditions. with SDG&E using 141 worst weather days,[76] SCE using 400+ weather scenarios,[77] and PG&E using a "mixture of worst-case days, as well as offshore wind event days, PSPS days, days of catastrophic wildfire occurrence, and some typical hot and dry summer days."[78]

There is nothing particularly wrong with the use of worst case weather days per se. It is actually a good idea. "Worst case" weather days are when catastrophic fires almost always happen. It also makes little sense to spend valuable resources for fire simulations on wet or rainy days.

However, all three utilities make a critical error when they combine "worst case" consequences with a probability of an ignition from a driver or at a location that is unlikely to occur on a "worst case" event day.

4.2.1.6. Utility ignition rates are weather dependent

To understand exactly why this error is being introduced into the model one must go back to how the Bowtie model is being constructed. In the Bowtie model, risk is assumed to be a simple

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[76] SDG&E WMP; p. 101.
[77] SCE WMP; p. 30.
[78] PG&E WMP; p. 76.

product of probability and consequence. But the probability of *what,* and the consequence of *what* are not adequately defined. The probability of an ignition – any ignition – at a random point in time is predicted by the POI models. But that random point in time does not necessarily occur during the worst weather days. Furthermore, certain drivers, such as equipment damage and vegetation contact are more likely to occur on worst weather days, whereas other drivers such as balloons, animals, or traffic accidents have no amplification on worst weather days. Therefore, the current models ***overpredict*** risk for drivers that aren't more likely to occur on worst weather days.

This is illustrated by the following simple thought experiment:

Say that part of a utility service area hosts a type of bird that builds nests on utility poles in the late spring. These nests lead to a slew of faults and ignitions annually. A nearby region of the utility service area is a Diablo wind corridor, which sees a number of damage incidents when severe weather conditions occur every few years, though on the average fewer ignitions than in the bird nesting area. To calculate risk from the bird-nest ignitions, the utility models "pretend" that these incidents occur during the worst possible weather days. However, these ignitions do *not* occur during worst possible weather days, but instead during late spring when critical wildfire conditions are unlikely. The Diablo risk events, on the other hand, occur during critical fire weather days, so the utility calculation in their case would be more accurate. When looking at comparative risk, however, the bird nesting areas would be viewed as a greater fire risk than the Diablo wind corridor due to the larger number of ignitions, when in fact these areas present little to no catastrophic fire risk from this risk driver.

The bird nest example shows an ignition probability that is anti-correlated with catastrophic fire risk. Other typical fire risks may occur randomly through the year (a Poisson distribution) – such as vehicle collisions. Risks from randomly occurring events will also be artificially amplified by use of the "worst case" weather days in consequence modeling, since the probability that such an event happens to occur on a "worst case" day is relatively small.

This is not only a theoretical concern, but is clearly evidenced in the utility risk calculations. Below is SCE's Table 4-6, which shows its "ignition risk" scores for various risk drivers. Utilities calculate "ignition risk" as the outage rate times the probability that the outage proceeds to ignition.

Table SCE 4-6

List of SCE Wildfire Risk Drivers and Rankings

Cause Category	Sub-cause category	Average Outage 2019-2021	Ignition Rate 2019-2021	Adjusted Risk	Ignition Rank
D-EFF	Conductor damage or failure — Distribution	922	2.02%	18.67	1
D-CFO	Animal contact- Distribution	612	2.72%	16.67	2
D-CFO	Balloon contact- Distribution	953	1.75%	16.67	3
D-CFO	Veg. contact- Distribution	386	3.63%	14.00	4
D-CFO	Vehicle contact- Distribution	530	1.82%	9.67	5
D-EFF	Connection device damage or failure - Distribution	467	1.86%	8.67	6
D-CFO	Other contact from object - Distribution[25]	328	2.24%	7.33	7
D-EFF	Transformer damage or failure - Distribution	2688	0.27%	7.33	8
D-EFF	All Other- Distribution[26]	2563	0.26%	6.67	9
D-EFF	Wire-to-wire contact / contamination-Distribution	25	23.68%	6.00	10
D-EFF	Vandalism / Theft - Distribution	82	7.32%	6.00	11
D-EFF	Other - Distribution[27]	254	2.23%	5.67	12

SDG&E's table 4-6 shows similar results:

Table 4-6: Prioritized List of Wildfire Risks and Drivers

Cause category (final)	Sub-cause category (final)	Average Outage (2015-2019)	Average Ignition rate (Sum of Ignitions ÷ Sum of Outages)	Adjusted Risk (Avg. Outage x Ignition Rate)	Risk Ranking
Contact from object	Vehicle contact	96.4	3.73%	3.60	1
Contact from object	Balloon contact	95.8	3.76%	3.60	1
Contact from object	Veg. contact	43.8	7.31%	3.20	2
Contact from object	Other contact from object	46.0	3.48%	1.60	3
Equipment / facility failure	Other	14.2	11.27%	1.60	3
Equipment / facility failure	Conductor damage or failure	59.6	2.01%	1.20	4
Contact from object	Animal Contact	78.0	1.28%	1.00	5
Equipment / facility failure	Transformer damage or failure	54.2	1.48%	0.80	6
Equipment / facility failure	Lightning arrestor damage or failure	24.8	2.42%	0.60	7
Equipment / facility failure	Switch damage or failure	13.4	4.48%	0.60	7
Equipment / facility failure	Wire-to-wire contact / contamination	4.6	13.04%	0.60	7
Equipment / facility failure	Unknown	0.1.8	0.20%	0.60	7
Equipment / facility failure	Fuse damage or failure	70.8	0.56%	0.40	8
Equipment / facility failure	Anchor / guy damage or failure	1.8	22.22%	0.40	8
Equipment / facility failure	Vandalism / Theft	2.4	16.67%	0.40	8
Vandalism / Theft	Capacitor bank damage or failure	8.8	2.27%	0.20	9
Equipment / facility failure	Crossarm damage or failure	20.2	0.99%	0.20	9
Equipment / facility failure	Pole damage or failure	40.8	0.00%	0.00	10
Equipment / facility failure	Insulator and brushing damage or failure	7	0.00%	0.00	10
Equipment / facility failure	Recloser damage or failure	1.4	0.00%	0.00	10
Equipment / facility failure	Voltage regulator / booster damage or failure	0.4	0.00%	0.00	10
Contamination	Contamination	0.6	0.00%	0.00	10

PG&E's results for their enterprise risk are different, for reasons that will be discussed shortly.

As can be seen, contact from vehicles, balloons, and animals constitute a considerable portion of the ignition risk for both SCE and SDG&E.

To simplify the comparison between the SDG&E and SCE results, all distribution equipment failures have been summed into one category, and then the overall fraction of ignition risk represented by each driver is shown:

Driver	**Percentage**	
	SDG&E	SCE
Vehicle	17	7
Balloon	17	13
Veg Contact	15	11
Other Contact	8	6
Animal	5	13
Wire Contact	3	5
Vandalism	2	5
Equipment	33	42

Table 2 - Percentage of ignition risk represented by different risk drivers as per SCE's and SDG&E's Table 4-6.

If these percentages accurately represent the utility wildfire risk, one would expect that catastrophic fires would also follow this same pattern. Looking at SCE-related fires between 2015 and 2020 that are larger than 100 acres and with known (alleged) causes,[79] we see the following:

[79] Disclaimer: Some of these fires are still under active litigation, and SCE may contest any of these assignments. These "cause" designations are for illustrative purposes only and not intended for use in litigation or regulatory investigations.

Fire	Year	Cause[80]
Birchim	2015	Veg Contact
Cachuma	2016	Veg Contact
Erskine	2016	Veg Contact
Marina	2016	Equipment
Rye	2017	Equipment
Liberty	2017	Equipment
Holiday	2018	Veg Contact
Woolsey	2018	Wire Contact
Star	2019	Animal
Tenaja	2019	Wire Contact
Easy	2019	Equipment
Maria	2019	Equipment

Table 3 - Wildfires from 2015 to 2019 greater than 100 acres with allegedly "known" cause and allegedly related to SCE equipment**.**

None of these fires was caused by vehicle collision, 3rd party contact, or balloons, and only one was stated by SCE to have been caused by an animal. It is unlikely that the statistical distribution that SCE claims for ignition probability represents the statistical distribution for catastrophic fires. This is shown in the following simple Pearson Chi-squared analysis.

[80] Id. Additionally, investigations may not be complete or public, and sometimes press reports were used, of varying quality. Sources for fire cause attribution include:
SCE Ignitions 2015-2020; Amended_2015-2020 Reportable Ignitions
Erskine: https://www.bakersfield.com/news/erskine-fire-caused-by-power-line-fire-officials-say/article_bd1f7a02-bbc6-59e2-a47f-30fc7a99b744.html
Marina: https://thesheetnews.com/wp-content/uploads/2016/10/The-Sheet_10.22.16.pdf
Rye: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/safety-and-enforcement-division/investigations-wildfires/sed-investigation-report---rye-fire---redacted.pdf
Liberty: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/safety-and-enforcement-division/investigations-wildfires/sed-investigation-report---liberty-fire---redacted.pdf
Holiday: https://www.independent.com/2020/03/21/power-lines-started-holiday-fire-in-goleta/
Woolsey: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/safety-and-enforcement-division/investigations-wildfires/sed-investigation-report---woolsey-fire---redacted.pdf
Tenaja: https://www.firelawblog.com/2021/09/06/cal-fire-sues-utility-to-recoup-tenaja-fire-costs/
Easy, Maria: https://www.vcstar.com/story/news/local/2020/10/22/ventura-county-fires-easy-maria-caused-power-lines-simi-valley/3729055001/

Predicted and observed major fires for SCE, 2015-2020

Driver	Ign Risk %	Observed	Expected	Chi2	Yates
Vehicle	7	0	0.88	0.88	2.17
Balloon	13	0	1.52	1.52	2.69
Veg Contact	11	4	1.28	5.79	3.86
Other Contact	6	0	0.67	0.67	2.04
Animal	13	1	1.52	0.18	0.69
Wire Contact	5	2	0.55	3.85	1.65
Vandalism	5	0	0.55	0.55	2.00
Equipment	42	5	5.03	0.00	0.05
Total	100	12	12	13	15

P - Chi2	0.06213238
P - Yates	0.03409584

Table 4 - Pearson Chi-squared goodness of fit[81] comparing observed major fire causes against ignition probabilities. It can be seen that the probability that the observed pattern arises from the predicted distribution is low. Using the "Yates" correction used for sparse bins the hypothesis that the ignition probability distribution predicts catastrophic fire probability can be excluded with statistical significance ($P < 0.05$).

The SCE results suggest that the ignition probabilities for different drivers are not consistent with the observed causes of large fires. While the statistical significance is only marginal ($P < 0.05$ only when using a Yates correction), this same trend holds for SDG&E and PG&E as well. None of the major fires from SDG&E or PG&E equipment has been caused by vehicle collisions, animals, or balloons. SCE has been singled out because 1) it has a significant history of large recent fires and 2) PG&E has applied a correction to its ignition probability drivers.

As to PG&E's results, it explains that:

"*In the process of providing feedback to PG&E's 2020 RAMP Report, the Mussey Grade Road Alliance, a party to the proceeding, requested an analysis of ignitions by different drivers by local wind speed. From the analysis, it was concluded that ignitions resulting from both vegetation-related and equipment-related root causes are more likely to occur under higher wind speed*

[81] $\chi^2_{Pearson} = \sum(O - E)^2/E$ where E is the expected number and O is the observed. $\chi^2_{Yates} = \sum(O - E - 0.5)^2/E$. Probabilities were calculated with the Excel function CHISQ.DIST.RT, using 8 degrees of freedom.

conditions, and there is a strong correlation between high winds and RFW, during which destructive or catastrophic fires are more likely to occur.

In the 2022 ERM, PG&E incorporated lessons learned from analyzing ignition data that indicated the likelihood of an ignition occurring during an RFW varies by ignition driver. Based on PG&E's 2015–2020 CPUC reportable ignitions report, the percentage of ignitions occurring when an RFW is in effect is the highest for vegetation contact, followed by equipment / facility failure, and then all other drivers.

Also, since there is a higher likelihood for an ignition to develop into a large, destructive, or catastrophic fire when an RFW is in effect than when an RFW is not in effect, this results in a higher CoRE value for the vegetation-contact driver than the CoRE value for other drivers."[82]

As a result, PG&E's list of wildfire risk drivers is differently ordered than those of SCE and SDG&E:

TABLE PG&E-4.2-2:
WILDFIRE RISK DRIVERS

% Risk	HFTD				Non-HFTD				
Drivers	Distribution	Transmission	Substation	HFTD Total	Distribution	Transmission	Substation	Non-HFTD Total	Grand Total
Vegetation Contact	58.7%	0.5%	0.0%	59.3%	0.4%	0.0%	0.0%	0.4%	59.7%
Equipment / facility failure	31.2%	1.2%	0.1%	32.5%	0.5%	0.0%	0.0%	0.5%	33.0%
Contact from object	2.8%	1.3%	0.0%	4.1%	0.2%	0.0%	0.0%	0.2%	4.2%
Wire-to-wire contact	1.3%	0.0%	0.0%	1.3%	0.0%	0.0%	0.0%	0.0%	1.4%
Unknown	0.8%	0.1%	0.0%	0.9%	0.0%	0.0%	0.0%	0.0%	0.9%
Other	0.5%	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	0.6%
Utility work / Operation	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%
Vandalism / Theft	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%
Contamination	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%
CC - Seismic Scenario	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Grand Total	**95.6%**	**3.2%**	**0.1%**	**98.9%**	**1.1%**	**0.0%**	**0.0%**	**1.1%**	**100.0%**

Table 5 - PG&E Wildfire Risk Driver tables, assuming a RFW day filter. Note that Vegetation contact and Equipment Failure predominate and that "Contact from Object" (animals, balloons, vehicles) represents only 4% of the predicted risk.

Additional comment regarding PG&E's ERM will be provided in an upcoming section. Unfortunately, the same modeling assumptions that went into its ERM do not make it into the WDRM model, which still does not incorporate explicit correlation between driver and consequence.

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[82] PG&E WMP; p. 87.

4.2.1.7. Operational models correctly account for wind effects

While utility planning models and enterprise models (with the exception of PG&E's enterprise model) fail to properly account for the correlation between ignition probability and consequence, the IOU operational models generally do. Example data from PG&E's IPW model is shown below:

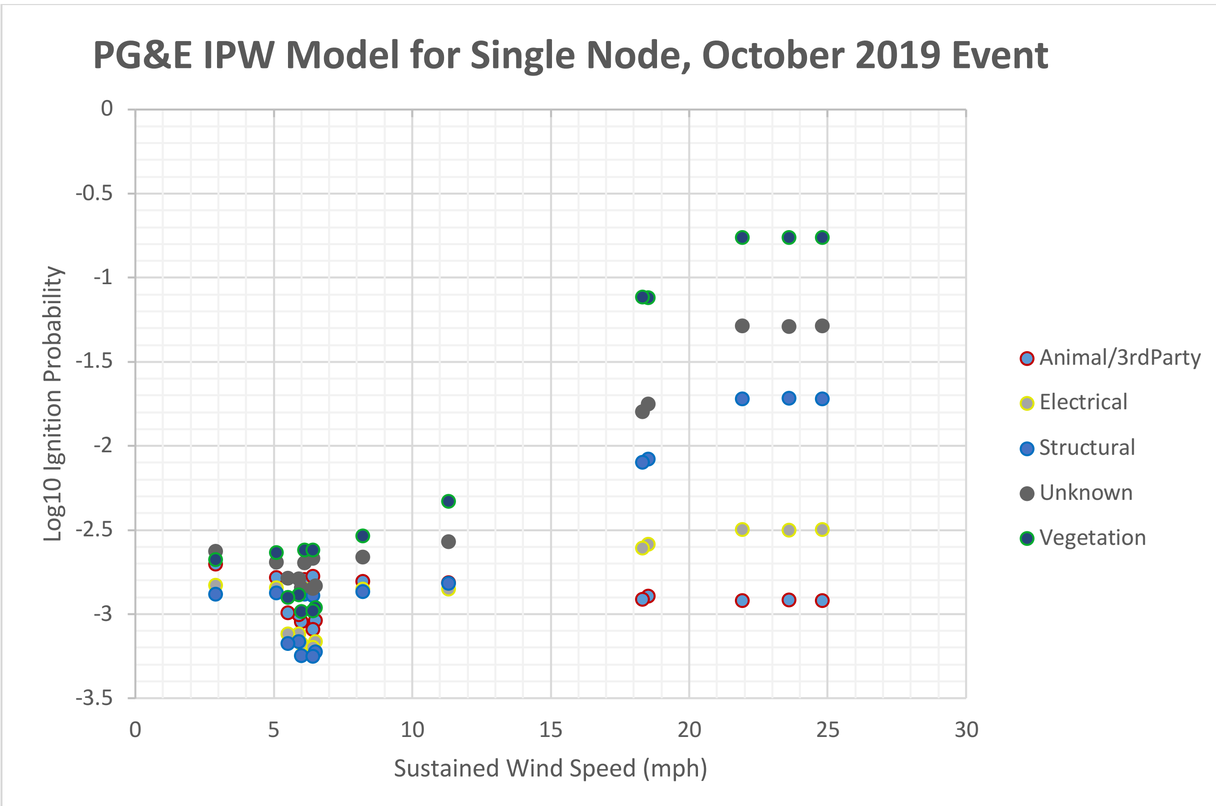

Figure 3 - Example data from PG&E's IPW model from one event from one node, showing ignition probability calculations for the October 8th/9th 2019 windstorm. Log10 of the probability for PG&E's five driver classes are shown plotted against sustained wind speed.[83]

As PG&E describes its IPW model, "*The IPW Model represents the next generation of distribution outage and ignition probability models building on the 2020 OPW Model previously discussed in the 2021 WMP, Section 4.2.A. The core IPW Model is a new multi-classification outage model, that now can forecast outage probability by specific outage causes. The probability of outage output for each class is transformed to an ignition probability (IPW) using outage to ignition rates for each cause class.*"[84] What is particularly noteworthy in Figure 3 is the degree to

[83] Appendix A: PG&E: WMP-Discovery2022_DR_MGRA_002-Q12 and WMP-Discovery2022_DR_MGRA_002-Q12Atch02; March 28, 2022.
[84] PG&E WMP; p. 189.

which ignition probabilities for different ignition drivers respond to wind, with contribution from animals and 3rd parties showing little response, structural causes showing a 10 fold increase when the wind rises from 6 to 20 mph, and vegetation drivers showing a 100 fold increase over the same range of wind speed.

Likewise, SDG&E incorporates wind into its WiNGS-Ops model,[85] including wind as a contributor to several drivers, and shows a very clear dependency on wind gust speed:

Figure 4-20: Wind Gust over PoI/PoF/PoI$_F$ metrics

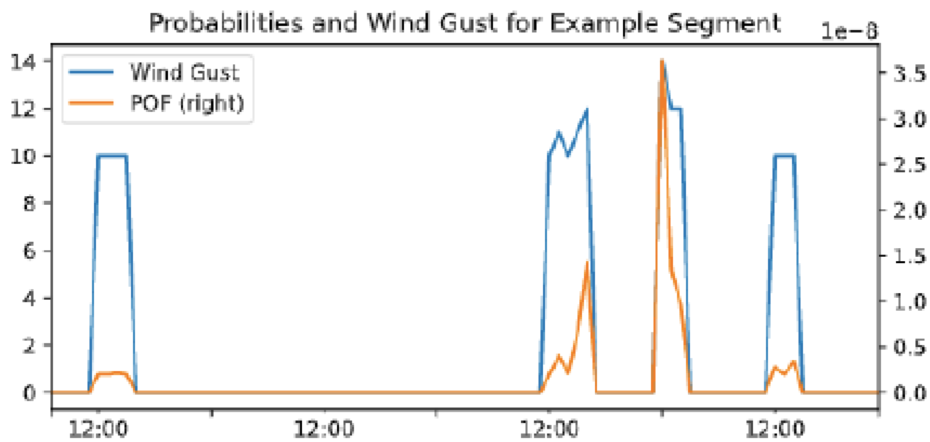

Figure 4 - Top half of SDG&E's Figure 4-20, which shows probability of failure as a function of wind speed**.**

SDG&E states that it uses this model for operational decision making, such as for PSPS decisions.[86]

4.2.1.8. Summary of the issue

For the conductor segment risk models used by the utilities to plan their hardening priorities, wind and wind-driven ignition vulnerabilities appears to be a minor contributor to risk as hourly wind data cannot be incorporated into the existing machine learning models. For their operational risk models used for de-energization, however, utilities have incorporated incremental wind data and their models show a very strong wind dependency, as expected. For enterprise models, only PG&E incorporates wind, indirectly, through the use of a Red Flag Warning criteria, yet this is enough to make a dramatic change to their predicted risk profile, with only 4% of ignition risk

[85] SDG&E WMP; p. 85-94.
[86] Id.; p. 94.

assigned to external contact from non-vegetation objects (cars, animals, balloons). In contrast, SCE assigns 39% of its ignition risk to such drivers and SDG&E assigns 47% of its risk to non-vegetation object risk drivers (cars, animals, balloon, other). By using RFW criteria, PG&E partially incorporates the missing conditional probability that an ignition happens during a "worst case" weather event day.

Incorrect weighting of risk at the circuit and segment level means that work will be done in non-optimal locations. People living downwind of marginal electrical equipment in high wind areas will experience elevated risk of utility wildfire and PSPS, while ratepayers will pay for hardening equipment that may not significantly reduce wildfire risk. Utilities may not bear the risk of this mistake, as they may be able to recover costs from ratepayers.

4.2.1.9. Correcting the methodology of risk models for planning

Fortunately, there are solutions to the errors in the utility planning methodology that can be handled within the existing utility frameworks. PG&E illustrates the risk modeling framework used by all of the major utilities:

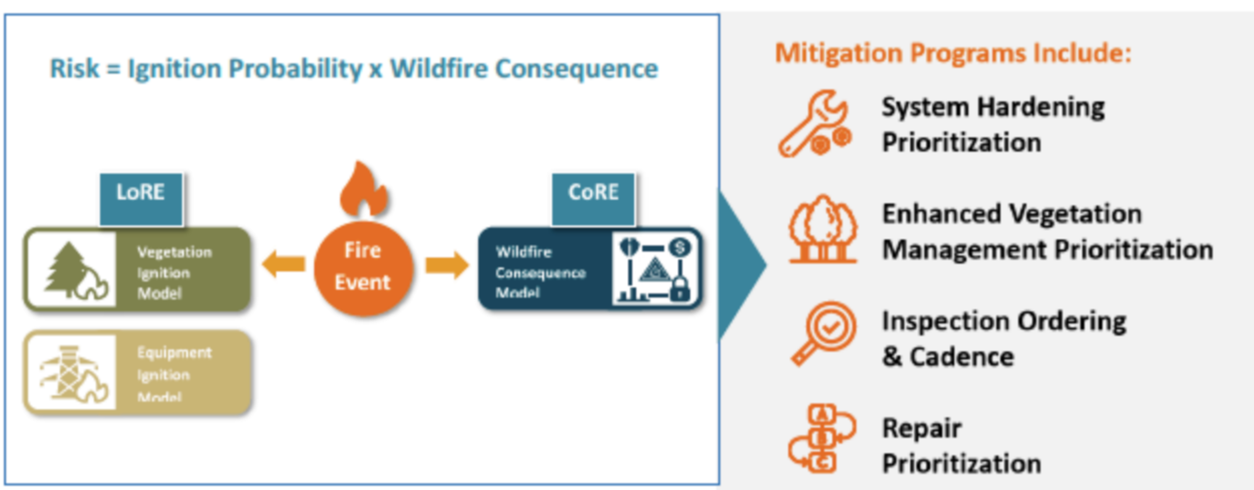

Figure 5 - Figure PG&E-7.1.B-1 - RISK MODELING FRAMEWORK FOR INFORMING WILDFIRE MITIGATION ACTIVITIES. Note that ignition models are independent of consequence models.[87]

The ignition models shown are independent of the wildfire consequence models, and furthermore the wildfire consequence models are selected for only "worst case" weather days. By

[87] PG&E WMP; p. 315.

performing this selection the model artificially amplifies risk drivers that do not occur at an elevated rate on "worst" fire event days. What is missing is a "conditional probability" component that relates the probability of the ignition to the probability that it will occur on a "worst case" weather day.

This can be visualized in the following manner:

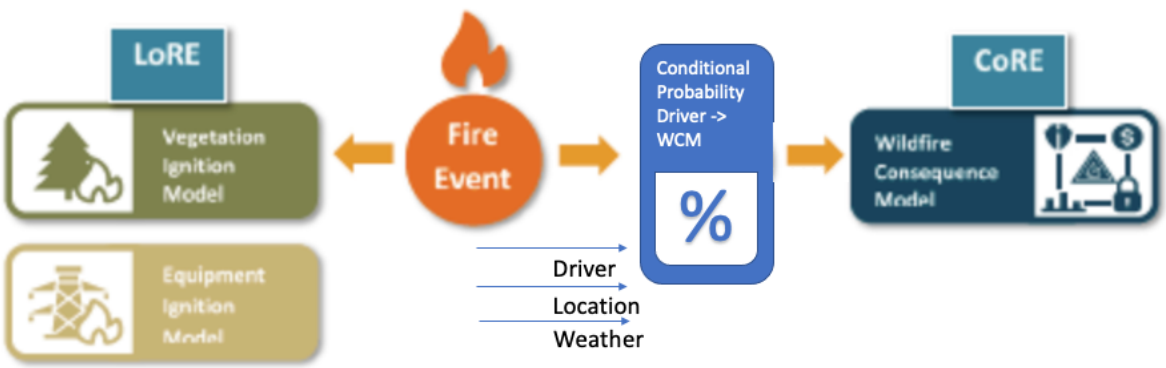

Figure 6 - The risk model can be corrected by applying a conditional probability that corrects for the fact that not all fire drivers are as likely create an ignition on the worst fire weather days. Sophistication of the approach can be enhanced by additionally adding location and weather data.

The simplest form of this correction would be to apply it on a per-driver basis: Certain ignition drivers are more or less likely to occur during the "worst case" weather day sample used for the Wildfire Consequence model. Therefore, each ignition type should be weighted by this fraction. As seen in PG&E's EVM model, such an approach will do much to reduce the inordinate and incorrect emphasis on animals, vehicles, and balloons. This could be applied as a simple per-driver correction.

It should also be noted that not all geographical locations are subject to the most extreme conditions on a "worst case" weather day, and likewise that geographic locations may have specific risk driver contributions. So the conditional probability correction could also potentially be calculated for every point on the landscape. Effects could then be averaged over all "worst" weather days.

The most sophisticated and likely the most accurate approach would be to apply conditional probability of ignition to each of the simulations used in the "worst case" weather days consequence model portfolio. Each of the "worst case" weather days used in the consequence model has a wind distribution for the landscape. As was shown in the prior section, utility operational models can now calculate conditional probability of ignition based on weather conditions and driver. This probability can then be calculated for each driver per simulation. The overall risk score would then be aggregated over all simulations.

One fine point regarding the latter approach is that it has the potential to double-count extreme events, which already occupy the ignition sample. As PG&E responded in a data request to its 2021 WMP, "*As long as there are a similar number of wind events in similar locations over time, the model is already accounting for wind impacts on annual ignitions.*"[88] While they are in the sample they are not appropriately weighted. One approach that might address this issue is to remove all ignitions that occur during the extreme event days used in the consequence model to obtain a "clean" ignition record to be used to predict baseline ignition rates.

4.2.1.10. Utility plans for incorporating conditional probability

Utilities were asked what their current actions and plans were for adjusting their planning risk algorithms to incorporate the correlation between ignition and consequence.

SCE apparently does not perform any adjustment.[89]

SDG&E applies a "Wind Speed Adjustment Factor" on a circuit level basis based on the historical maximum wind speed for that circuit. However, this adjustment is not based on driver type, and not all drivers are subject to wind effects. Additionally, it uses a historical maximum rather that a value associated directly with "worst case" weather days. SDG&E does not specify how it obtains its "Wind Speed Adjustment Factor" and there was insufficient time to obtain more information on it.[90] While adjusting ignition rates to the maximum wind speed incorporates some of the required correlation, it would be better if the wind speeds were instead tied to the wind speed used in the corresponding Technosylva consequence models.

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[88] MGRA 2021 WMP Comments; Appendix A; Data Request Response PG&E WildfireMitigationPlans_DR_MGRA_010-Q06.
[89] Appendix A; MGRA-SCE-003-Q01.
[90] Appendix A; MGRA-SDGE-WMP22_DATAREQUEST 4-Q02.

As will be described in the subsequent section, PG&E has made significant changes to both its consequence model and its risk calculation for planning purposes. While some of these changes may address issues MGRA has raised in the past, due to the complexity of the PG&E approach it is not clear exactly clear whether PG&E is applying a conditional probability adjustment or not. My interpretation is that PG&E is still not applying an adjustment, since "fire season P(ignition) is multiplied by a season estimate of wildfire consequence to option the wildfire seasonal risk score for each driver at each location."[91] Because the ignition adjustment is seasonal, one would not expect it to take into account specific days when ignition probability is greatly increased, except in the aggregate. Nevertheless more clarity is needed regarding PG&E's WDRM v3 model.

Recommendation:
Utilities should adjust their enterprise risk modeling to correct for the bias introduced by using "worst case" weather days in their consequence model. This may be done by applying a RFW filter (as PG&E has done) or by other corrections.
Urgency: Class A – Utilities and the Commission will be choosing between expensive mitigation strategies soon and need to accurately assess mitigation effectiveness.

Recommendation:
Utilities must adjust their per-circuit/per-segment risk modeling used for planning and prioritization to correct for the bias introduced by using the "worst case" weather days in their consequence models. This will require that risk drivers receive unique weightings. Utilities should attempt to apply this correctly over the landscape, since both drivers and weather conditions vary over the landscape.
Urgency: Class A – Utilities are carrying out expensive hardening programs and it is essential that these are carried out in the proper order.

Recommendation:
Utilities should investigate incorporating conditional probability per driver per consequence simulation, since this would allow current utility wind/outage models to be leveraged to provide the most accurate predictions.

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[91] Appendix A; MGRA-PGEWMP22_DataRequest4-Q06.

Urgency: Class B – This approach might conflict with current utility analysis pipelines and machine learning algorithms, and would need further study and development**.**

Recommendation:
SDG&E should provide additional explanation of how it calculates its Wind Speed Adjustment Factor, and it should ensure that a specific adjustment is applied to different drivers. It should consider using wind speeds used in the Consequence Model for its adjustments rather that maximum.
Urgency:
Class C: However, this calculation will have a strong bearing on SDG&E hardening programs, and should be completed prior to the initiation of major hardening efforts.

Recommendation:
Energy Safety should closely evaluate PG&E's WDRM v3 approach and ensure that it properly incorporates correlations between ignition probabilities and consequences for specific drivers during "worst case" weather days.
Urgency:
Class B: Once PG&E's model has been internally validated it should be reviewed by Energy Safety and stakeholders. No major hardening programs should go forward without proper prioritization.

4.2.2. Consequence model limitations

In its 2021 WMP Comments, MGRA extensively discussed the limitations of the Technosylva model,[92] which is used by utilities for consequence modeling. Last year's comments remain generally pertinent. While Technosylva's model undergoes continuous improvement, the fundamental issue that limits the accuracy and appropriateness of the model is the limited (8 hour) run time used in fire spread models, which tends to create fires much smaller than the catastrophic fires that have caused most of the damage from utility ignitions. The effect of this limitation is to create a bias that will tend to rank ignitions nearer to population centers with a higher risk score than they should have. The effect of megafires that ignite in the wild and then are blown down into the wildland urban interface is not well-modeled.

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[92] 2021-WMPs; MGRA Comments; pp. 48-55.

Another limitation of the Technosylva models is that it does not model fire suppression. This effect is particularly important during the fire's early growth period because most ignitions are suppressed by fire services, even during severe fire weather days. Technosylva is currently implementing a new feature to incorporate fire suppression effects,[93] but there is no report yet as to its methodology, accuracy or effectiveness. Another improvement to Technosylva's FireSim suite is the estimate of buildings destroyed by fire, rather than simply those within the fire perimeter.[94] Structure age has been associated with losses,[95] and is one variable that might readily be incorporated into the model, but is not currently used by Technosylva.[96]

It appears that PG&E's WDRM v3 model may correct for the shortcomings in fire spread modeling. While it still uses Technosylva fire spread modeling, it also incorporates VIIRS satellite data and historical catastrophic fire sizes to assign its CoRE:

"*For the 2022 WDRM v3, fire severity for a given day is assessed for 'destructive potential' vs. not, where destructive potential is assessed using Technosylva outputs of flame length and rate of spread (with threshold values that provide full recall of historically destructive fires) for historically worst weather and Rscores (4 and above) for all days in the June through November fire season. If either approach evaluates to destructive potential, the day/location is considered to have consequences consistent with the expectation value of MAVF CoRE assigned to fires from the VIIRS data set that also are flagged with destructive potential*."[97]

By using actual catastrophic fires for consequence modeling, PG&E may be avoiding the pitfalls of limited fire growth associated with the Technosylva model. However the approach is complicated and merits further attention by Energy Safety.

PG&E's WDRM v3 is not in production yet, and so its current consequence model still includes limited fire sizes. The effect of this limitation can be seen in the figure below, which shows PG&E's risk score estimates for its circuits near Sacramento and Lake Tahoe.

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[93] SCE WMP; p. 128.
[94] SCE WMP; p. 96.
[95] Syphard, A.D., Keeley, J.E., 2019. Factors Associated with Structure Loss in the 2013–2018 California Wildfires. Fire 2, 49. https://doi.org/10.3390/fire2030049
[96] Appendix A; MGRA-SCE-002-Q14
[97] Appendix A; MGRA-PGEWMP22_DataRequest3-Q01.

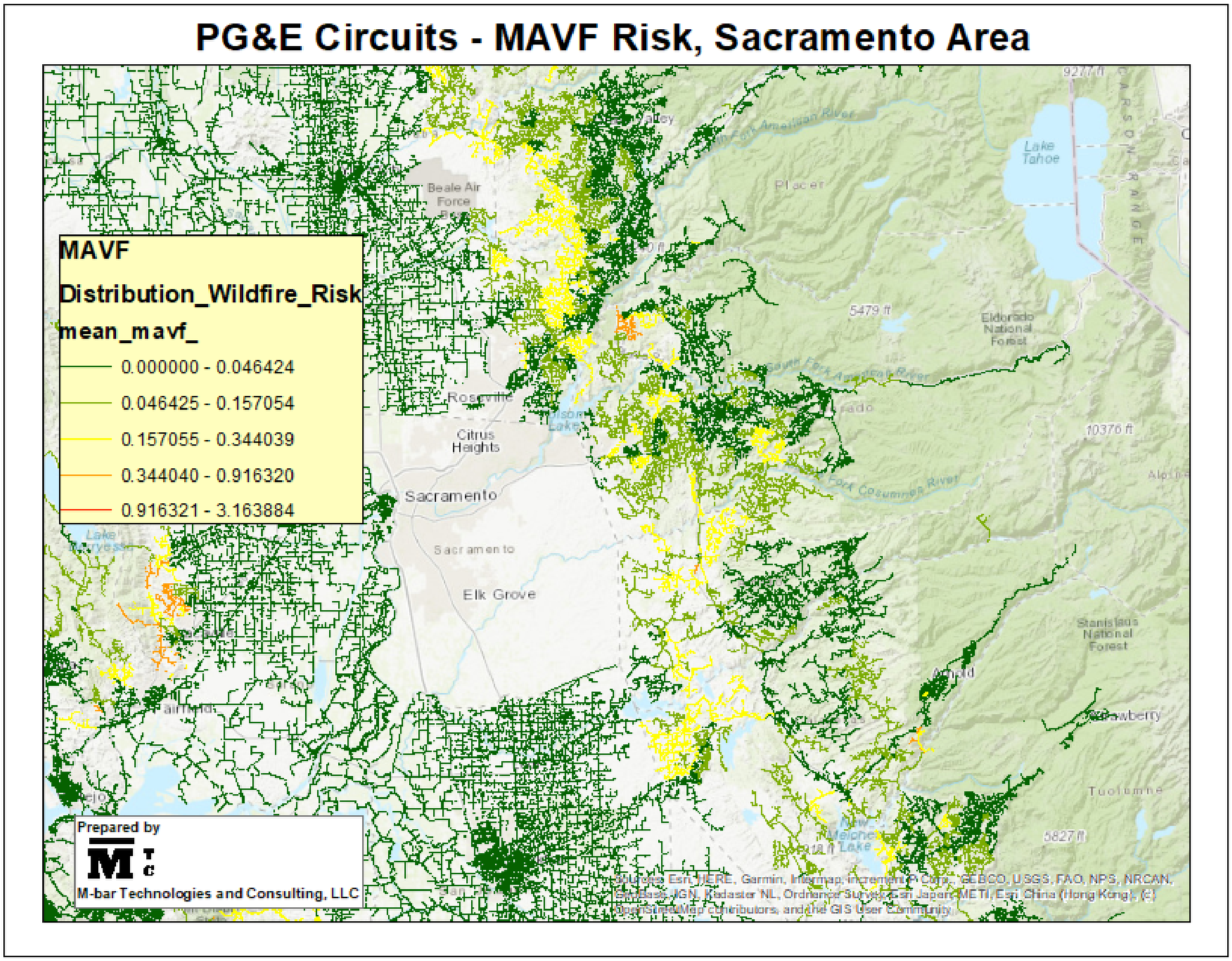

Figure 7 - PG&E's calculated risk scores using its WDRM v2 in the Sacramento / Lake Tahoe area.

As can be seen in the figure, there is a general trend that more remote circuits are ranked as having lower risk than those closer to more developed areas. This is expected from effects related to ignition probability noted in Section 4.2.1 and the bias introduced by smaller fire sizes due to the 8 hour limitation of the Technosylva fire spread modeling.

One conclusion that should be evident is that utility risk calculations for all utilities remain (or should be) in a state of flux and further changes and improvements should be expected. However, the result of this is that the "risk ranking" that utilities are using for major hardening projects cannot be assumed to be final. Hence the Auditor Report's demand that "the State must prioritize the areas utilities need to address first"[98] is actually quite difficult to implement, because

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[98] Auditor Report; cover letter.

the target is moving. With this in mind, utility hardening projects should proceed cautiously in order to allow full evaluation of alternatives and optimization of risk models to take place prior to the commitment of substantial ratepayer funds.

Recommendation:
Energy Safety should ask utilities to provide additional information regarding Technosylva's building loss and fire suppression models.
Urgency:
Class B – After the models are introduced.

Recommendation:
Energy Safety should ask Technosylva to incorporate building age into its building loss model.
Urgency:
Class C – 2023 WMPs.

Recommendation:
Energy Safety should closely analyze PG&E's consequence model that incorporates VIIRS and Cal Fire data as well as Technosylva to determine whether it accurately predicts catastrophic wildfire consequences better than Technosylva alone.
Urgency:
Class B – Once PG&E's WDRM v3 has been finalized.

4.2.3. Wildfire smoke health effects as a safety consequence

In its 2021 RAMP filing, SDG&E added a new component to its safety attribute to account for the effect of wildfire smoke on human health. To do this it incorporates an "Acres Burned" contribution to its wildfire safety risk model, and it includes this as part of its safety attribute, with a weight of 0.0005 per acre burned, equivalent to one fatality or four severe injuries per 20,000 acres.[99] MGRA extensively analyzed SDG&E's approach and found that while SDG&E makes

[99] A.21-05-011; APPLICATION OF SAN DIEGO GAS & ELECTRIC COMPANY (U 902 M) TO SUBMIT ITS 2021 RISK ASSESSMENT AND MITIGATION PHASE REPORT; May 17, 2021, and A.21-05-014; APPLICATION OF SOUTHERN CALIFORNIA GAS COMPANY (U 904 G) TO SUBMIT ITS 2021 RISK ASSESSMENT AND MITIGATION PHASE REPORT; May 17, 2021. (SDG&E RAMP); p. C-15.

some erroneous assumptions, the overall impact of wildfire smoke on health and safety is substantial and likely even larger than what SDG&E estimates.[100] MGRA's analysis of SDG&E's approach and the risk from wildfire smoke is excerpted from SPD's Report and is included as Appendix B-1 of this filing. The CPUC's Safety Policy Division stated that: "*SPD Staff agrees with MGRA's findings and recommendations concerning wildfire smoke consequences. MGRA finds SDG&E's incorporation of wildfire smoke as a safety risk to be innovative and an overall positive development, although there are several shortcomings in the SDG&E analysis…. We encourage SDG&E (and other utilities) to continue developing more comprehensive and complete measures of consequences.*"[101]

A number of studies in recent years have determined that wildfire smoke contributes significantly to hospitalizations and increased mortality. For example two recent publications show these effects. Aguilera 2021,[102] indicates that PM2.5 emissions from wildfire smoke are significantly more (up to 10 times more) hazardous than those from other sources. Another source, O'Dell et al,[103] claims that approximately 800 deaths per year in California are due to wildfire smoke, a number that MGRA points out is the equivalent of ten Camp fire death tolls per year.

Surprisingly, SDG&E's WMP very much downplays what is a fairly dramatic change to its MAVF function stating only that "*the inclusion of Acres Burned was introduced to more fully measure the potential impact from a wildfire. The burning of vegetation and pollution impacts of wildfire are also a serious health concern, and SDG&E has utilized academic and government work to understand and estimate those impacts*."[104]

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[100] A.21-05-011, A.21-05-014; Safety Policy Division Staff Evaluation Report on SDG&E's and SoCalGas' Risk Assessment and Mitigation Phase (RAMP) Application Reports; November 5, 2021. (SPD SDG&E RAMP Report) including Addenda at pp. 207-252.
A.21-05-011-14; MUSSEY GRADE ROAD ALLIANCE INFORMAL COMMENTS TO THE SAFETY POLICY DIVISION REGARDING SAN DIEGO GAS AND ELECTRIC COMPANY'S RAMP FILING; October 22, 2021. SPD Report; (MGRA RAMP Comments)
[101] SPD SDG&E RAMP Report; p. 12.
[102] Aguilera, R., Corringham, T., Gershunov, A., Benmarhnia, T., 2021. Wildfire smoke impacts respiratory health more than fine particles from other sources: observational evidence from Southern California. Nat Commun 12, 1493. https://doi.org/10.1038/s41467-021-21708-0
[103] O'Dell, K., Bilsback, K., Ford, B., Martenies, S.E., Magzamen, S., Fischer, E.V., Pierce, J.R., 2021. Estimated Mortality and Morbidity Attributable to Smoke Plumes in the United States: Not Just a Western US Problem. GeoHealth 5, e2021GH000457. (O'Dell et.al.) https://doi.org/10.1029/2021GH000457
[104] SDG&E WMP; p. 29.

SDG&E's most serious errors arise from 1) not using up-to-date references and 2) making a mathematical error when converting a Value of Statistical Life value used by European studies to the imputed VSL that is imputed from its MAVF function.[105]

MGRA performed its own analysis using two different methodologies based on the work of O'dell et. al and Liu, et. al.[106] O'Dell et. al. provide an estimate for California fatalities from wildfire smoke per year, at around 800. The average annual number of acres burned in California between 2006 and 2018 (the duration of the O'Dell analysis) is 917,000. Naively taking the ratio, there have been approximately 1,150 acres burned for every wildfire smoke fatality in California.

A different method MGRA investigated uses the work of Liu, et. al., which describes the health effects of smoke from the 2020 fire siege on residents of Washington state. Complicating this comparison is the fact that Washington was impacted by fires spread over three states: Washington (0.7 million acres), Oregon (0.9 million acres), and California (2.3 million acres). It should be assumed that health impacts were experienced by residents of all three states, but the study only includes those in Washington. Liu et. al. observes an excess of 100 deaths from this wildfire episode in the state of Washington, with a population of 7.6 million. Scaling this number to the residents of Oregon (4.2 million), and Northern California (15.4 million), one would expect a total of 360 excess deaths in the entire region. With acres burned totaling 3.9 million acres, this would yield a ratio of one fatality per 10,900 acres burned, about what half of what SDG&E is using.

In order to demonstrate the magnitude of wildfire smoke impacts against direct safety and financial impacts from fires, a rough estimate was performed using a "fatalities per acre burned" approach for a number of major historical utility fires. This was done using both O'dell (1000 acres per fatality) and Liu (11,000 acres per fatality), and also using two values for imputed VSL - $10 million (used by federal agencies) and $100 million (used by major IOUs).

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[105] MGRA RAMP Comments; p. 7.

[106] Liu, Y., Austin, E., Xiang, J., Gould, T., Larson, T., Seto, E., 2021. Health Impact Assessment of the 2020 Washington State Wildfire Smoke Episode: Excess Health Burden Attributable to Increased PM2.5 Exposures and Potential Exposure Reductions. GeoHealth 5, e2020GH000359. https://doi.org/10.1029/2020GH000359

Fire																	
	VSL	100				100				10				10			
	acre/ftl	11000				1000				11000				1000			
		Risk	Acres %	Fatl/Inj%	Cost%	Risk	Acres %	Fatl/Inj%	Cost%	Risk	Acres %	Fatl/Inj%	Cost%	Risk	Acres %	Fatl/Inj%	Cost%
Witch		2.02	26.7%	17.8%	55.6%	7.42	80.0%	4.8%	15.2%	1.21	4.4%	3.0%	92.6%	1.75	33.8%	2.1%	64.1%
Kincade		0.69	30.6%	4.3%	65.0%	2.81	82.9%	1.1%	16.0%	0.47	4.5%	0.6%	94.9%	0.69	34.0%	0.4%	65.6%
Laguna		0.93	51.5%	16.2%	32.3%	5.71	92.1%	2.6%	5.3%	0.36	13.2%	4.1%	82.7%	0.84	62.6%	1.8%	35.7%
Thomas		2.70	28.4%	2.2%	69.3%	10.39	81.4%	0.6%	18.0%	1.96	3.9%	0.3%	95.8%	2.73	31.0%	0.2%	68.8%
Camp		15.62	2.7%	17.1%	80.2%	19.80	23.2%	13.5%	63.2%	12.83	0.3%	2.1%	97.6%	13.25	3.5%	2.0%	94.5%
Tubbs		4.51	2.2%	14.6%	83.1%	5.51	20.0%	12.0%	68.0%	3.83	0.3%	1.7%	98.0%	3.93	2.8%	1.7%	95.5%
Butte		0.59	32.7%	10.2%	57.1%	2.52	84.2%	2.4%	13.4%	0.36	5.3%	1.7%	93.0%	0.56	38.2%	1.1%	60.7%
Redwood Valley		0.68	14.7%	41.0%	44.3%	1.67	65.5%	16.6%	17.9%	0.34	2.9%	8.2%	88.8%	0.44	25.1%	6.3%	68.6%
Dixie		3.41	77.1%	0.9%	22.0%	29.68	97.4%	0.1%	2.5%	1.02	25.9%	0.3%	73.8%	3.64	79.3%	0.1%	20.6%

Table 6 - Relative contributions of direct injuries/fatalities, smoke injuries/fatalities (Acres), and financial costs to losses from major historical power line fires using SDG&E's MAVF function. Uses acres/fatality derived from O'dell (100) and from Liu (11,000), and VSL of $100 M and $10 M.

The results dramatically show that the "safety risk" of direct injury or death from wildfire is usually many times smaller than the risk from wildfire smoke for every major fire. Also noteworthy from this analysis is MGRA's observation that "wildfires are expensive", i.e. that financial risk tends to dominate losses because relatively few people are killed due to evacuation of fire areas.

It should be noted that these are "toy" models that serve to demonstrate the magnitude of the effects. A rigorous wildfire smoke risk analysis would simulate the smoke plume and then use concentration/response functions such as those provided in Aguilera, et. al. to estimate hospitalizations and deaths. Feedback from academics involved in Aguilera indicated that the estimates provided by the two toy models shown above are likely to **substantially underestimate** overall health impacts from wildfire smoke, especially when taking into account Aguilera et. al.'s observations that wildfire smoke particulate PM2.5 smoke tends to be an order of magnitude more hazardous than other particulate PM2.5 smoke used in other health studies.

In conclusion, the impacts of wildfire smoke on public health is greatly underestimated and is likely the largest health and safety risk from utility wildfires. There are currently no accepted mechanisms to estimate this risk, but even crude methods show that it is a major problem and one that needs the urgent attention of Energy Safety, the Commission, and IOUs.

Recommendation:
OEIS should initiate a working group to explore the impact of wildfire smoke risk and solicit input from leading researchers in the field. This topic is currently scheduled to be taken up by the OEIS Risk Modeling Working Group, but only as one topic during a multi-topic discussion in July. More dedicated effort will be necessary.

Urgency:

Class B: Should be initiated soon after plan review.

Recommendation:

SDG&E's mechanism for calculating risk is in error, though in their favor they are the only utility to even attempt to estimate this risk. SDG&E should come up with an alternative method for calculating the "acres burned" normalization using measured and calculated public health effects from wildfire and wildfire sizes, using a range of values for fatalities and hospitalizations supported by recent studies.

Urgency:

Class B: Should be updated in its quarterly report. It is also likely that a modified estimate will be provided as part of SDG&E's GRC filing.

4.2.3.1. Wildfire smoke and power shutoff

MGRA's analysis of wildfire smoke effects also explored its relationship to power shutoff.[107] While the use of power shutoff as a wildfire mitigation will reduce the number of wildfires, there is also the potential that residents without power will be exposed to smoke during wildfire emergencies. Residents subject to power shutoff will be much less likely to have air conditioning, which thereby increases their exposure to wildfire smoke. Power shutoff is also likely to be coincident with Santa Ana conditions, when wildfires (whether originating from utility ignition or not) are more frequent. Residents are therefore statistically more likely to be subject to smoke conditions that they cannot mitigate if PSPS is widely used as a wildfire prevention mechanism.

I cursorily reviewed utility PSPS history and air quality records and did not find any historical cases where the PSPS coincided with wildfire smoke. Nevertheless, this remains a potential public health risk that utilities should incorporate into their PSPS risk estimates and operational decision-making process for PSPS.

[107] Appendix B-1; MGRA RAMP Comments; pp. 13-15.

Recommendation:

Utilities should include the potential for wildfire smoke exposure when estimating risks and benefits from power shutoff.

Urgency:

Class B: Should be described in the quarterly reports and operationalized before the peak of the fire season.

4.2.3.2. SDG&E's air quality monitoring program

SDG&E has initiated an Air Quality Index (AQI) program that will install six AQI sensors at key locations in San Diego County, greatly increasing the number of sampling stations in the area.[108] Given the potential for wildfire smoke to be the leading health and safety risk from both utility fires and with regard to exposure of de-energized customers, this initiative is important and should be carried out by other utilities as well.

Recommendation:

Energy Safety should identify the installation of AQI sensors as a utility best practice and encourage utilities to initiate or expand programs.

Urgency:

Class C: Should be included in 2023 WMPs.

4.3. Change in ignition probability drivers

4.4. Research proposals and findings

4.5. Model and metric calculation methodologies

4.5.1. Improvements to PG&E's enterprise risk model (ERM)

In MGRA's 2021 WMP review, it noted that PG&E was asked to perform a number of sensitivity analyses as part of its RAMP process.[109] This led to the discovery of some issues with PG&E's model and in the end led to some permanent improvements to PG&E's enterprise risk

[108] SDG&E WMP; p. 203.

[109] 2021-WMPs; MGRA Comments; pp. 26-32.

model, which were later incorporated into its GRC, filed in June of 2021. Specifically, the improvements to the PG&E model were:

- Removal of a cap on the maximum risk value that can be calculated by the MAVF function. The "maximum value" now used in the MAVF calculations represents only a scaling point by which risk attributes can be balanced against each other. This allows catastrophic events (with losses greater than maximum scale) to be incorporated into the risk calculation, and is important for risks having "fat tails" such as wildfire losses. All three major IOUs have now adopted this practice.
- In its transition from its RAMP to GRC, PG&E adopted a power law (Pareto)[110] distribution to describe catastrophic wildfire risks, as MGRA had been urging.[111] As part of the RDF proceeding, PG&E had analyzed truncated risk models as applied to catastrophic wildfire losses and found that they provided an adequate fit.[112] It has therefore adopted these into its MAVF calculation.[113]
- PG&E now incorporates weather into its risk modeling by incorporating a "Catastrophic/RFW" (Red Flag Warning) tranche. By singling out ignitions in this tranche, PG&E to some extent addresses the contingency problem, since RFW days conditions are much more likely to be similar to the "worst case" weather days used in the Technosylva calculations. As PG&E describes it: "*In the 2022 ERM, PG&E incorporated lessons learned from analyzing ignition data that indicated the likelihood of an ignition occurring during an RFW varies by ignition driver. Based on PG&E's 2015–2020 CPUC reportable ignitions report, the percentage of ignitions occurring when an RFW is in effect is the highest for vegetation contact, followed by equipment / facility failure, and then all other drivers. Also, since there is a higher likelihood for an ignition to develop into a large, destructive, or*

110 2022-WMPs; TN10634-6_20220225T144600_Section_43_Atch01; PACIFIC GAS AND ELECTRIC COMPANY ENTERPRISE RISK MODEL DOCUMENTATION AND USER GUIDE JUNE 30, 2021; p. 55.

111 2021-WMPs; MGRA Comments; pp. 42-48.

112 Appendix B-2; PGE-GRC-2023-PhI_DR_CalAdvocates_073-Q007_672297Atch01_672298; Power Law Distribution; September 3, 2021.

113 Appendix A: GRC-2023-PhI_DR_CalAdvocates_073-Q07; "In response to SPD's recommendation to consider power-law distributions to model Wildfire risk consequences, PG&E reviewed its modeling of catastrophic safety consequences and adopted a power-law (aka Pareto Type 1) distribution, which belongs to a generalized family of distributions known as Pareto distributions. PG&E also revised its financial consequence modeling and adopted a Pareto Type 2 distribution."

catastrophic fire when an RFW is in effect than when an RFW is not in effect, this results in a higher CoRE value for the vegetation-contact driver than the CoRE value for other drivers."[114]

- PG&E incorporates PSPS damage events as risks, using a conditional ignition probability. MGRA has been warning utilities that widespread use of PSPS will bias utility risk models because the most dangerous areas will produce no data during the most dangerous times.[115] PG&E has now resolved this issue by incorporating damage found during post-PSPS event patrols. This approach should be adopted by all utility risk models.

It would be beneficial if other IOUs would adopt these innovations, which are not specific to the PG&E service area. SDG&E, for example, continues to use a gamma distribution to describe catastrophic fire losses.[116] As MGRA noted in its comments on the SDG&E RAMP, "*There is no theoretical basis for the use of the gamma function to fit wildfire loss distributions. While empirical fits (fits based on existing data rather than a hypothesis) can be reasonable for interpolation, their accuracy depends upon the availability of data for the initial fit. Using empirical fits for extrapolation beyond values seen in historical data is dangerous and likely to lead to inaccurate results.*"[117]

Technically: "*The probability distribution selected by SDG&E is the gamma distribution,[118] with a 'shape parameter' (k) of 3 and "scale parameter" (θ) of 0.8.[119] SDG&E has calibrated its fit based on historical losses to have a median value of $2.1 billion.[120] Based on the selected distribution and parameters, SDG&E claims that 98% of its cumulative losses (P98) will be less than $6.0 billion.*[121]"[122]

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[114] PG&E WMP; p. 87.
[115] 2021-WMPs; MGRA Comments; pp. 37-39.
[116] A.21-05-011-14; Safety Policy Division; Staff Evaluation Report on SDG&E's and SoCalGas' Risk Assessment and Mitigation Phase (RAMP) Application Reports; November 5, 2021; p. 11, 205; and Attachment 1 (p. 206/295); MUSSEY GRADE ROAD ALLIANCE INFORMAL COMMENTS TO THE SAFETY POLICY DIVISION REGARDING SAN DIEGO GAS AND ELECTRIC COMPANY'S RAMP FILING; October 22, 2021; pp. 2-5. (SPD SDG&E RAMP Report)
[117] Id.; Att 1, p. 2 (p. 210/295)
[118] https://en.wikipedia.org/wiki/Gamma_distribution
[119] Appendix A; A.21-05-011-14; SDG&E Data Request Response MGRA-DR-003, Question MGRA-4.
[120] Appendix A; A.21-05-011-14; SDG&E Data Request Response MGRA-DR-008, Question MGRA-52.
[121] Appendix A; A.21-05-011-14; SDG&E Data Request Response MGRA-DR-008, Question MGRA-52.
[122] SPD SDG&E RAMP Report; Att-1; p. 3. (p. 211/295)

MGRA compared the gamma function used by SDG&E against a power law distribution with an exponent of -0.5 of its cumulative distribution, with and without a cut-off of $40 billion (since power laws with an exponent of this value do not converge). This comparison is shown in the table below:

Wildfire Losses, $ Billions	Gamma (3,0.8)	Power Law (-0.5)	Power Law, $40 B Max
2.1	46.3814%	49.8813%	51.0296%
2.64	61.6927%	55.3316%	57.8912%
3.33	76.3285%	60.1893%	64.0067%
4.19	87.9305%	64.5187%	69.4570%
5.27	95.2107%	68.3772%	74.3147%
6.64	98.6246%	71.8162%	78.6440%
8.36	99.7388%	74.8811%	82.5026%
10.52	99.9707%	77.6128%	85.9415%
13.25	99.9983%	80.0474%	89.0065%
16.68	100.0000%	82.2172%	91.7382%
21.00	100.0000%	84.1511%	94.1728%
26.44	100.0000%	85.8746%	96.3426%
33.28	100.0000%	87.4107%	98.2764%
41.90	100.0000%	88.7798%	100.0000%

Table 7 - Probability of wildfire losses less than specified amount using gamma distribution (SDG&E), power law, and power law truncated at $40 billion (MGRA). The gamma function values were calculated using Microsoft Office Excel's GAMMA.DIST function, and match the P95 and P98 values reported by SDG&E.[123]

While the calculation above successfully reproduces the P98 value of $6 billion reported by SDG&E, it can be seen that the probability of catastrophic losses above $10 billion become negligible in SDG&E's model but still have a 15% probability in the truncated power law model.

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[123] SPD SDG&E RAMP Report; Att-1; p. 4. (p. 211/295)

The most expensive fire in California, both in terms of lives and property, was the Camp fire in PG&E's territory with total losses estimated at approximately $16 billion.[124] This cost was mostly from the destruction of the town of Paradise, which is by no means unique in its wildland urban interface exposure. It is the nature of power law distributions that historical events provide only a lower bound, and that larger events should be anticipated unless a maximum landscape scale is being approached. In this context PG&E should be singled out for attempting to incorporate a scientifically supported and predictive model into its ERM, and OEIS should encourage other utilities to do likewise.

Recommendation:

Energy Safety should require that all utilities demonstrate that their enterprise risk models correctly calculate extreme wildfire losses with mathematically correct functions, such as power law or Pareto distributions, and should note PG&E's approach as a best practice. In cases where utilities uses an alternative function or method for calculating catastrophic wildfire losses, Energy Safety should require that the utility demonstrate that it is fully incorporating high end losses (of the magnitude of Camp fire and larger).

Urgency:

Class C, 2023 WMPs.

Recommendation:

Energy Safety should also validate that all utility enterprise risk models incorporate weather effects not only into their consequence models but also into the ignition probability component. PG&E's approach of tying its Catastrophic tranche to Red Flag Warnings should be further evaluated, since it introduces a correct correlation between weather-dependent risk drivers and worst weather days used in Technosylva calculations.

Urgency:

[124] Extreme storms, wildfires and droughts cause heavy nat cat losses in 2018 | Munich Re [WWW Document], n.d. URL https://www.munichre.com/en/company/media-relations/media-information-and-corporate-news/media-information/2019/2019-01-08-extreme-storms-wildfires-and-droughts-cause-heavy-nat-cat-losses-in-2018.html (accessed 4.3.22).

Class B for SCE and SDG&E, since their enterprise risk models do not demonstrate obvious weather dependencies. This is urgent because enterprise risk models will be used to evaluate high-cost mitigation programs currently under evaluation.
Class C for PG&E to more fully explain why its use of Red Flag Warnings as weather proxy is the optimal approach in its 2023 WMP.

Recommendation:
All utilities should use outages with conditional ignition probabilities, and also merge PSPS damage events into their risk event samples to avoid suppressing risk indicators from areas often subject to PSPS.
Urgency:
Class C – Next WMP. However, Energy Safety should warn utilities that PSPS bias should be removed from risk rankings prior to the initiation of major hardening programs.

5. INPUTS TO THE PLAN AND DIRECTIONAL VISION FOR WMP

5.1. Goal of Wildfire Mitigation Plan

5.1.1. Hardening programs and their impact on the public

As the 2022 OIES template states: "*The goal of the WMPs are shared across Energy Safety and all utilities: Documented reductions in the number of ignitions caused by utility actions or equipment and minimization of the societal consequences (with specific consideration to the impact on AFN populations and marginalized communities) of both wildfires and the mitigations employed to reduce them, including PSPS.*"[125]

Energy Safety's mandate is to work with utilities to reduce the impact of wildfires and mitigations. The CPUC, on the other hand is additionally tasked with ensuring that rates are affordable. There is no guarantee that a program that Energy Safety approves for a utility will be found to be affordable when utilities seek funding for the program at the CPUC. Some coordination between these agencies is required.

[125] 2022 Wildfire Mitigation Plan Update Guidelines Template; Attachment 2; p. 53.

However, with the introduction of major long-term hardening proposals by the utilities that are likely to cost many tens of billions of dollars, it would be wise for OEIS to take a broad view of the "*minimization of societal consequences*". Recent hikes in utility rates have alarmed the public and led to CPUC hearings.[126] While matters of affordability are in the CPUC domain, effects on the economic state of the population can also be expected to have significant impacts on their health and safety.

The following model for how a rate hike might impact the public health is put forward as an example for consideration by OEIS and stakeholders. Full disclaimer: I am not a public health scientist, economist, or sociologist. Therefore, no scientific or economic conclusions should be drawn for this example and it should be assumed that it can be subject to a wide range of valid criticisms. Nevertheless it makes a point.

It is widely accepted that income has an impact on public health. This can be observed in the following relationship between income and life expectancy in the US:

[126] https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/affordability

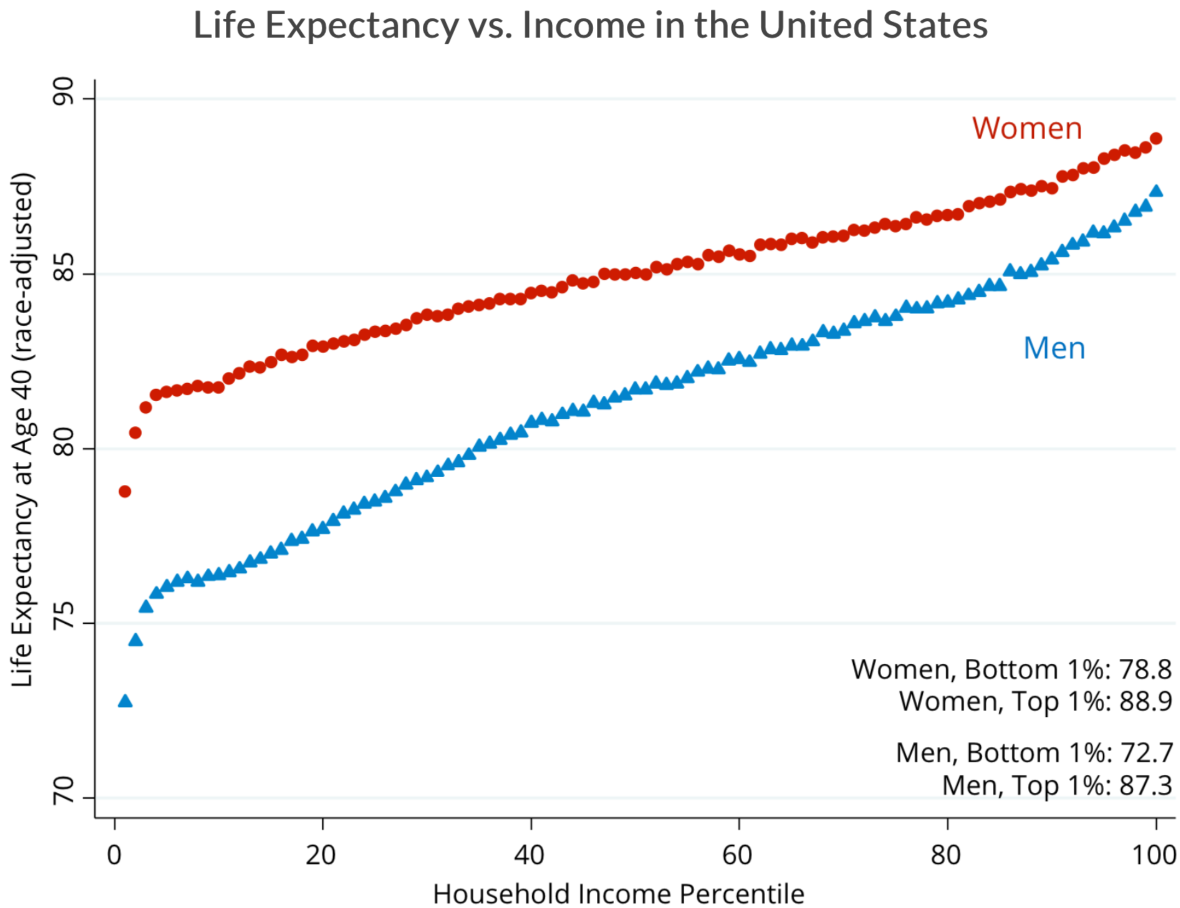

Figure 8 - Life expectancy versus household income in the US. Data from the Equality of Opportunity Project.[127]

In California, the 20% quintile is equivalent to a household income of approximately $25,000 and a 40% quintile is equivalent to a household income of approximately $50,000.[128] For men (chosen for this example due to greater sensitivity of life expectancy to income), there is approximately a three year life expectancy difference between the 20% quintile and the 40% quintile. Hence, in this income range, a difference of around $8000 a year is equivalent of an extra year of life expectancy.

If this is the case, then a $300 per year permanent increase in utility rates would cause a $300 decrease in income. This would be correlated with a $300/$8000 or .038 year decrease in life expectancy for this portion of the population. If the poorest 10 million Californians were affected

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[127] http://www.equality-of-opportunity.org/health/ and
https://opportunityinsights.org/ citing
The Association Between Income and Life Expectancy in the United States, 2001-2014 | Health Disparities | JAMA | JAMA Network [WWW Document], n.d. URL https://jamanetwork.com/journals/jama/fullarticle/2513561?guestAccessKey=4023ce75-d0fb-44de-bb6c-8a10a30a6173 (accessed 4.6.22).

[128] https://statisticalatlas.com/state/California/Household-Income

by this change, the number of equivalent years of life lost would be 380,000, or the equivalent of over 5,000 75-year lifespans.

As Energy Safety keeps in mind the potential for death and destruction that California faces due to wildfires and their consequences, it should keep in mind that the public purse is not bottomless and that all factors including affordability need to be balanced into the cost/benefit and risk/benefit decisions made regarding utility safety programs. Efficiency of wildfire mitigation programs must remain one of Energy Safety's guiding principles, as the substantial cost of these programs can affect the health of the most vulnerable.

5.1.2. Implications of utility rate of return on capital

Utilities are authorized by the CPUC to receive a rate of return on equity of approximately 10% for capital investments.[129] Utilities are therefore incentivized by the state to make capital investments. When massive capital projects are proposed by utilities, Energy Safety needs to consider that while these projects may improve public safety, they also benefit utility shareholders.

One specific example is PG&E's proposal to underground 10,000 miles of lines. Standard cost estimates would price this program between $30 and $50 billion,[130] though PG&E argues that it can bring the price down to $25 billion or lower. If this program is approved, PG&E would see an additional $2.5 to $5 billion in profit. Some controversy accompanied the announcement last week that PG&E's CEO Patricia Poppe, who proposed the undergrounding program, received over $50 million in executive compensation last year for leading the embattled company.[131] If PG&E succeeds in having its undergrounding plan approved, CEO Poppe is working cheap.

Likewise with regard to prioritization of circuits to be mitigated, utilities do not have an inherent incentive to rank these in the order of risk. If future risk calculations determine that other

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[129] D.19-12-056

[130] SCE WMP; p. 661. SDG&E 2022 WMP Appendix: Effectiveness of Covered Conductors: Failure Mode Identification and Literature Review; Exponent Inc.; p. 29.

[131] Avalos, G., 2022. PG&E's top boss harvests total exec pay that tops $50 million. Silicon Valley News. April 7, 2022. https://www.siliconvalley.com/2022/04/07/pge-ceo-patricia-poppe-total-exec-pay-tops-50-million-wildfire/

circuits should have been prioritized than those that have been addressed, utilities can expand the scope of their programs to include these additional circuits and may recover costs from ratepayers.

It is therefore essential that utility regulators ensure that the most cost-effective programs are chosen, since there is an inherent bias on the part of utilities to favor capital improvements. Regulators must also ensure that the execution of costly programs is correctly prioritized.

6. PERFORMANCE METRICS AND UNDERLYING DATA

6.1. Recent performance on progress metrics

6.2. Recent performance on outcome metrics

6.3. Description of additional metrics

6.3.1. Data confidentiality issues

MGRA's 2021 (and 2020) WMP comments noted that of the major utilities, Southern California Edison takes the most aggressive stance with regard to confidentiality.[132] MGRA strongly prefers to work with public data to ensure that all of our work products can be public, are compliant with the law, and respect legitimate utility property rights and security concerns. To this end MGRA has worked with all utilities to obtain data that has been appropriately filtered to address confidentiality concerns, and the results have been largely satisfactory from our standpoint.

One exception this year has been SCE's claim that consequence data obtained as a result of the Technosylva analysis is confidential. This issue arose with SCE's refusal to answer an MGRA data request:

"*Question 03:*

Please provide a GIS shapefile that indicates "high consequence" segments of the distribution system. (p. 5)

Response to Question 03:

This response would require granular locational information on high consequence risk line segments within SCE's HFRA. The requested information is confidential and therefore cannot be

[132] 2021-WMPs; MGRA Comments; p. 87.

provided without a NDA."[133]

SCE clarified that it was the consequence GIS layer itself, not the distribution segment location information (which it provides), that was confidential, and as support provided the confidentiality declarations it had provided to Energy Safety.[134] In these declarations, SCE Vice President Erik Takayesu declares that a "GIS layer showing wildfire risk" is defined as critical infrastructure and sensitive security information. He further attests that "*The wildfire risk modeling raster files contains ignition consequence results within SCE's High Fire Risk Area (HFRA) plus a 20-mile buffer adjacent to HFRA*" is confidential based on California Government Code 6255. The justification is:

"*Release of detailed asset and consequence of ignition data could make SCE's facilities vulnerable to attack and could be valuable information in planning an attack on critical infrastructure. Further, providing this information in addition to and in relation with Critical Facility information could further the consequences of such an attack. There is little to no benefit to making this information publicly available.*

Third, parties do not need this information to evaluate SCE's Wildfire Mitigation Plan. As such, the public interest in not disclosing this information far outweighs the public interest in disclosing it."

SCE's claim that wildfire risk geographic information is critical system infrastructure is false and fundamentally absurd. Wildfire risk is comprised of ignition probability and consequence. The elements that go into ignition probability are a measure of system quality, and are disclosed by all utilities, elements such as ignitions, risk events, and outages. The ignition probability component measures the threat *from* utility infrastructure, not *to* it. As far as the consequence component of risk, this has ***nothing whatsoever to do with utility infrastructure***. Consequence is a product of vegetation, weather, slope, population distribution, and numerous other factors that are properties of the landscape itself, not the infrastructure overlaid on it. All of this information is based upon public datasets. Determination of wildfire consequences through Technosylva modeling, as well as other predecessor models including REAX and the CPUC High Fire Threat District maps do consequence analysis through fire spread modeling. SCE's argument would apply equally to these efforts as well.

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[133] Appendix A; MGRA-SCE-002-Q03.
[134] Appendix A; MGRA-SCE-Verbal-01.

As far as the argument that a malicious agent could use wildfire risk information to do public harm, that is certainly true, but that risk is not specific to SCE's consequence layer, but rather would apply to any academic or government map of wildfire risk. A malicious agent could also use vegetation maps, detailed weather and wind data and Google Earth to plan attacks on public targets. Should all public geographic information related to wildfire risk be held as confidential? That is where SCE's argument leads. As to SCE's claim that its critical infrastructure could be a target of an attack using wildfire risk data (which strains credulity), only elements of its infrastructure that are ***not*** classified as critical are being disclosed publicly, so this claim has no merit.

It should be pointed out that both PG&E and SDG&E provide geographically-based risk information and do not share SCE's absurd position that risk maps are confidential. SCE has made formal legal attestation that information has been disclosed by these utilities (as well as by CPUC staff, Cal Fire, intervenors, and Energy Safety) in violation of California and federal law. Either SCE's attestations are false or a lot of people are in big trouble.

Finally, the claim that parties do not need this information to evaluate the Wildfire Mitigation Plan is belied by the Auditor Report, which inform Energy Safety and the CPUC that "the State must prioritize the areas utilities need to address first"[135] as utilities begin to roll out massive infrastructure projects. In order to evaluate the prioritization that utilities are using for their wildfire mitigation projects means that the risk must be understood and analyzed at the landscape level. SCE's confidentiality claims imply that this must not be a public process. To ban public discussion of whether utilities are properly prioritizing their work would greatly harm the public interest.

Recommendation:

Energy Safety should find that wildfire risk geographic data cannot be considered critical infrastructure under federal law and should not be classified as confidential based on California Government Code 6255.

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[135] Auditor Report; Cover Letter.

Recommendation:

Energy Safety should require that in addition to posting all data requests that utilities also be required to post all confidentiality declarations as part of the WMP review process.

Recommendation:

Energy Safety should create and publish an administrative process by which stakeholders can challenge and litigate confidentiality claims.

Recommendation:

Energy Safety should accelerate development of a public portal for GIS data, so that stakeholders do not have to request this data from utilities, so that utilities do not have to take extra effort to prepare special versions for stakeholders, and so that appropriate access restrictions can be automatically enforced.

6.3.2. Outages related to Fast Trip and Enhanced Powerline Safety Settings (EPSS)

PG&E's decision to change circuit breaker thresholds in response to fire weather conditions, a program that they call "Enhanced Powerline Safety Settings" (EPSS) is described in more detail in Section 8.2, as it effectively is an offshoot of the de-energization program. SCE and SDG&E have similar enhanced protection settings, and Energy Safety should review all of these programs.

With regard to metrics, however, EPSS provides some additional information regarding the state of utility systems. Outages that occur while the sensitive trip settings are in place are more likely to be associated with weather incidents, including vegetation contact and equipment damage. Hence, the location of these outages may be an indicator of where circuits are especially vulnerable to adverse weather conditions, and might also be used as a check on utility circuit risk rankings.

PG&E provided locations of outages associated with EPSS in a data request response to MGRA.[136] Quick observation of the location of these outages with respect to risk ranking does not show any particular likelihood that riskier circuits are more prone to EPSS:

[136] Appendix A; MGRA-PGEWMP22_DataRequest2-Q01

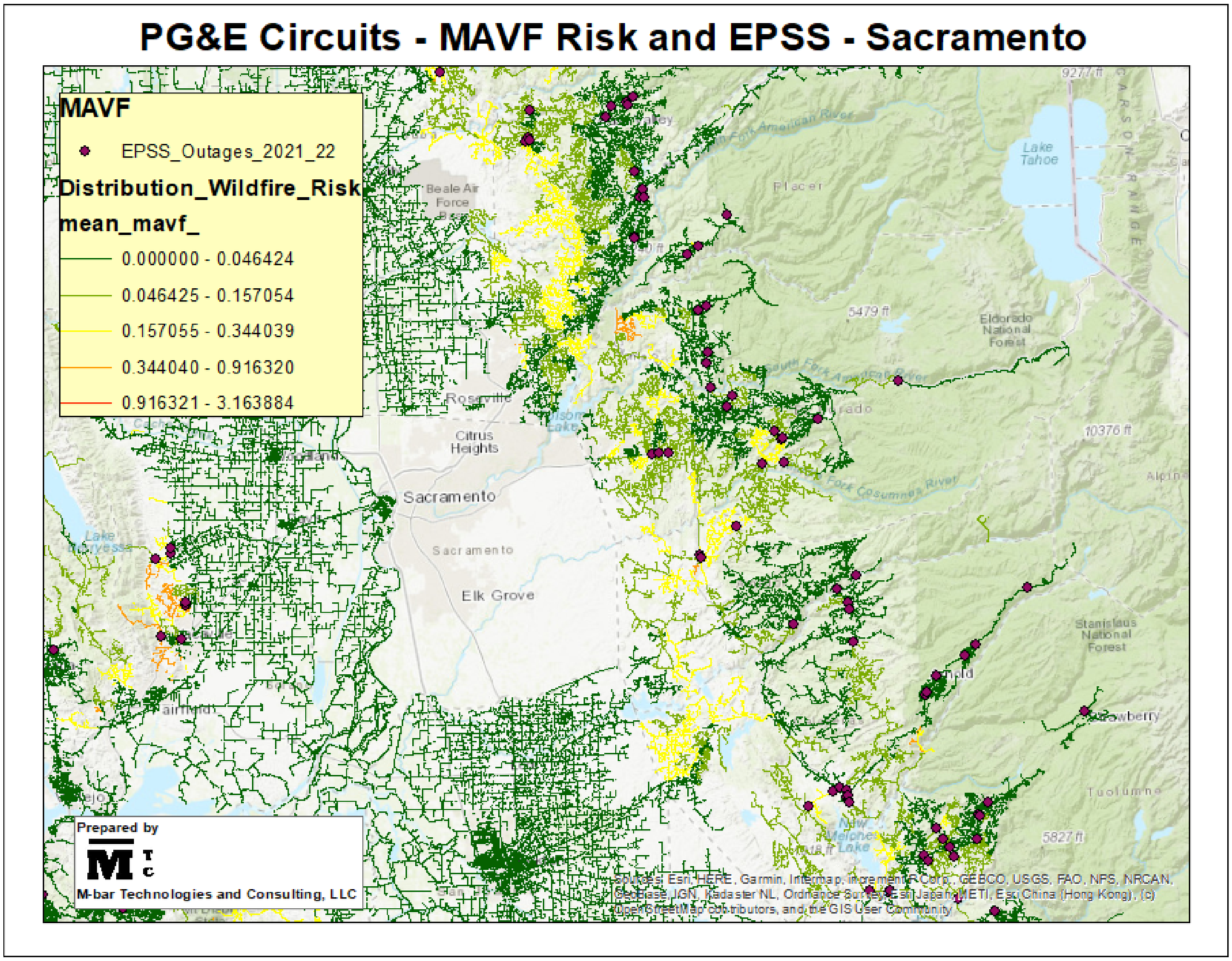

Figure 9 - This plot shows the area between Sacramento and Lake Tahoe. It shows where EPSS outages occurred (best location shown by brown dots) and the relative risk ranking of PG&E circuits in the area using their MAVF methodology.

In Figure 9, there doesn't seem to be an apparent relationship between where the EPSS outages are occurring and the calculated risk value of the circuit they occur on.

In order to check this over the entire PG&E service area, the non-zero MAVF risk scores for all circuits were collected and histogrammed in the chart below.

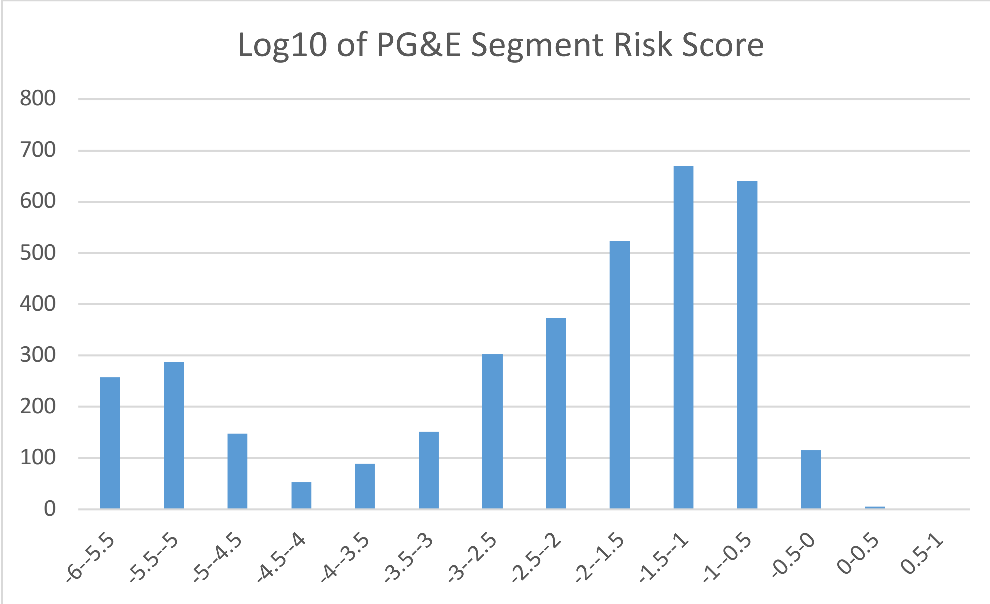

Figure 10 - This figure shows the total number of PG&E circuit segments with non-zero risk scores, binned by the log of their MAVF value.

As can be seen in the figure above, the majority of circuit segments in the PG&E territory have a calculated risk value between .001 (log = -3) and 3.2 (log = 0.5).

The circuits on which an EPSS outage occurred are shown below:

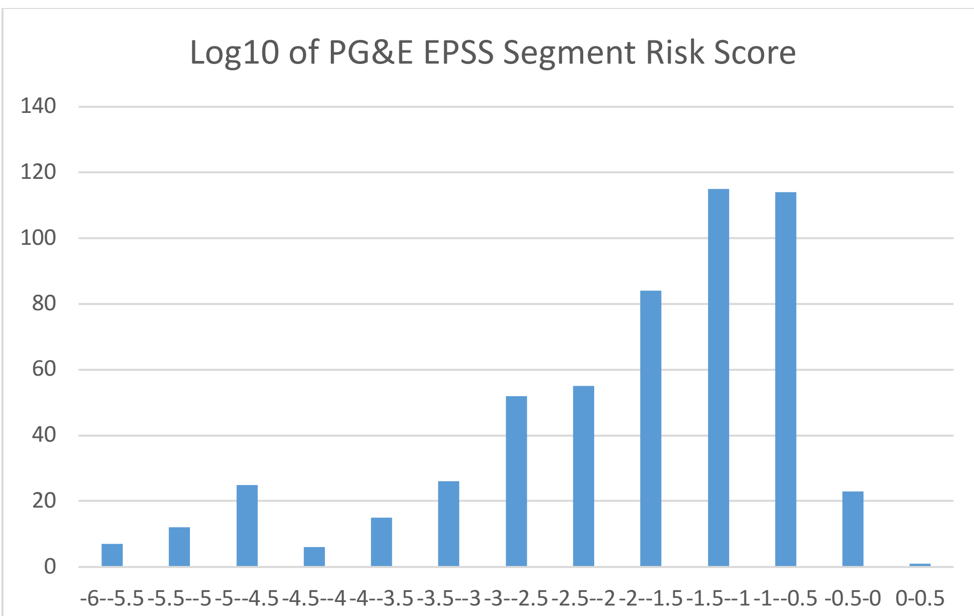

Figure 11 - The same as the previous figure, but this sample only includes circuit segments that experienced an unplanned outage because of enhanced trigger settings (EPSS).

The similarity of these distributions is notable. The one distinct difference occurs for very low risk values (smaller than 0.0001 or log -4). This might be explained if circuits of those risk values were less likely to be subject to EPSS.

It is surprising that the circuits experiencing EPSS outages have essentially the same risk properties as circuit that do not. There may be a number of potential explanations for this observation. Some hypotheses might be:

- The causes of EPSS outages occur randomly throughout the PG&E infrastructure and do not depend on environmental conditions.
- EPSS outages indicate areas of greater wildfire risk, but the PG&E MAVF risk score does not accurately track wildfire risk.
- The MAVF risk score properly takes environmental risks into account and the EPSS outages therefore follow the same pattern.

One might expect that outages occurring during adverse weather conditions would occur on circuits with greater weather exposure and a greater history of previous outages or ignitions, thus giving an excess on high-risk circuits, but instead they seem generally to occur on circuits drawn apparently at random from the population. Whether this particular observation supports or conflicts with the hypothesis that PG&E circuit rankings are accurate representations of wildfire risk will require further analysis.

Recommendation:
Energy Safety should require that all outages resulting for aggressive circuit breaker settings be logged either with a field in the outage table or as a separate GIS data set.
Urgency:
Class B for SDG&E and SCE.
Class C for PG&E. It has already released this data via data request but standards should be put into place.

Recommendation:
Utilities should be required to determine whether the additional outages detected when EPSS or Fast Trip settings are in place provide any additional information regarding circuit vulnerabilities to extreme weather conditions or the state of circuit health.

Urgency:

Class B, Q2 or Q3 should add an additional analysis of EPSS/Fast Trip settings.

7. MITIGATION INITIATIVES

7.1. Wildfire Mitigation Strategy

7.2. Wildfire Mitigation Plan implementation

7.3. Detailed wildfire mitigation initiatives

7.3.1. Covered Conductor

For several years, MGRA has urged the CPUC and WSD to guide the utilities toward a common understanding and strategy toward covered conductor and its proper place in wildfire mitigation.[137] In the three 2021 resolutions directed to the utilities, Energy Safety directed them to initiate a working group to study covered conductor. This effort is complete, and has resulted in the covered conductor report authored by the utilities[138] as well as a third party analysis by the Exponent consultants.[139] The work done by the utilities was comprehensive and complied with Energy Safety's request. Stakeholders were not invited to participate in this process. While it is understandable that faster progress can be made with fewer participating parties, there should be periodic opportunity for the public to be appraised of ongoing work and to ask questions.

While the work of the group so far has been good, a number of concerns remain. The most glaring is that with similar service areas the three utilities have taken a widely divergent approach to covered conductor. SCE has had by far the most aggressive approach, installing 2,500 miles since 2019.[140] Their activities in 2021 and 2022 are shown below:

[137] 2021-WMPs; MGRA Comments; p. 64.
[138] SDG&E WMP; Attachment H: Joint IOU Response to Action Statement-Covered Conductor; p. 561/699.
[139] SDG&E WMP; Attachment H: Effectiveness of Covered Conductors: Failure Mode Identification and Literature Review; Exponent, Inc.; December 22, 2021.
[140] SCE WMP; p. 290.

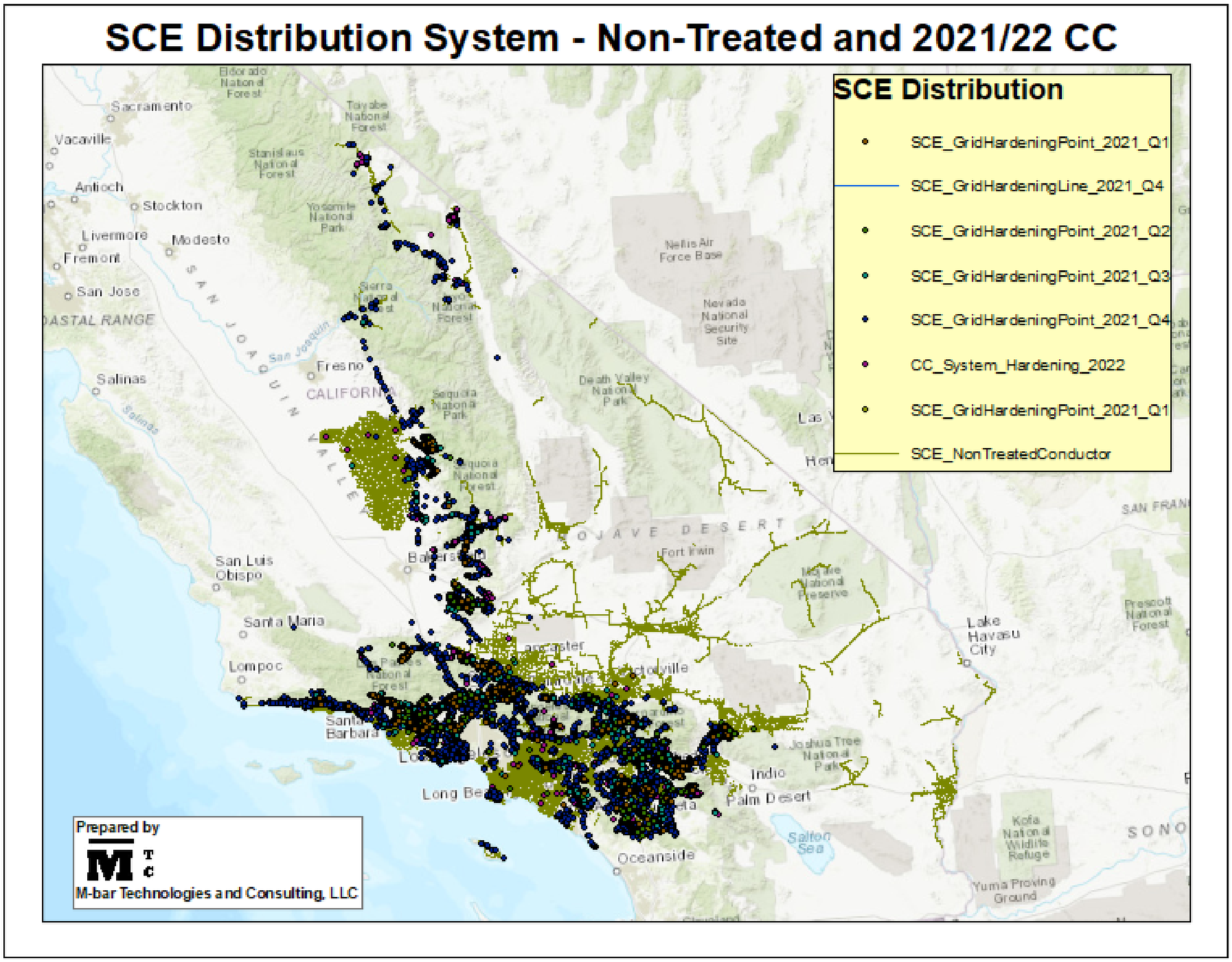

Figure 12 - SCE distribution system, showing hardening activities in 2021 and 2022 as points and the remaining unhardened conductor as olive lines.[141]

Edison seems committed to rolling out its covered conductor solution, with far lesser commitments from PG&E and SDG&E. As SCE explains, "*Covered conductor installation had the highest RSE, reduced more risk than bare conductors, was less expensive than undergrounding, and is quicker to deploy compared to undergrounding.*"[142] As we have noted previously, either covered conductor is a "good idea" or it isn't. While the utilities have – mostly – agreed on the technical aspects of covered conductor they have not moved towards adopting a common strategy.

Part of the hesitation appears to be what is claimed to be the limited effectiveness of covered conductor in preventing ignitions. Even SCE claims that it is effective in preventing only 60%

[141] Appendix A; MGRA-SCE-02-02.
[142] SCE WMP; p. 474.

effective in preventing vegetation ignitions.[143] In fact, even with SCE's extensive experience many of the estimates regarding covered conductor effectiveness for various scenarios involve guess work. For example: "*SCE analyzed the composition of historical wire downs from vehicle collisions and found that nearly all ignitions from a vehicle collision are caused by conductor contact. SCE testing established the covered conductor is effective against conductor-to-conductor contact. However, there is uncertainty regarding the effectiveness of covered conductor during a wire down due to exposed conductor at the dead-end or breakpoint. To account for this uncertainty, a mitigation effectiveness of 50% was assumed*."[144] The other utilities make similar conjectures, with PG&E estimating overall effectiveness at 63%[145] and SDG&E estimating effectiveness at 65%.[146] Pacificorp, which actually has experience with spacer cable systems reports effectiveness closer to 90% for drivers such as vegetation, vehicle contact, and equipment failure.[147]

SCE has the most experience so far, and with the 2,500 miles of line that it has currently deployed. As can be seen below, this reduces the fault rate:

[143] SDG&E WMP; Att. H; p. 9.
[144] Id.; p. 10.
[145] Id; p. 14.
[146] Id; p. 15.
[147] Id; p. 19.

Figure 8: SCE Faults on HFRA Circuits in 2021

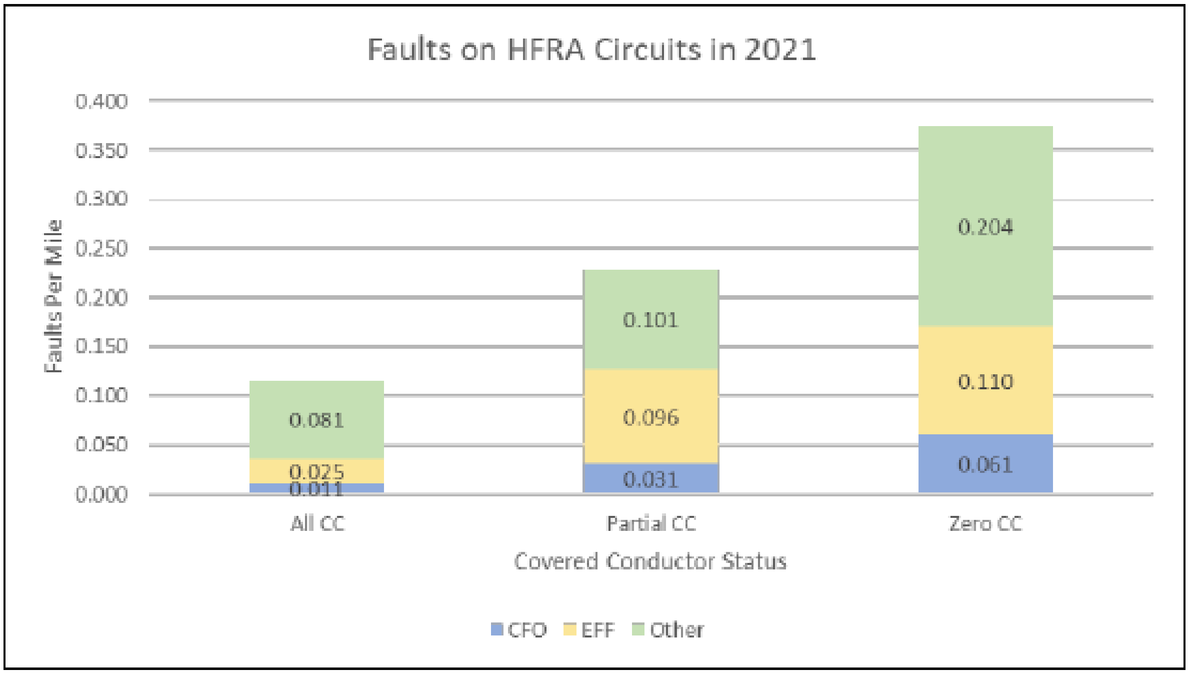

Figure 13 - SCE faults on HFRA circuits for circuits with, without, and partially with covered conductor. CFO is "contact from object" and EFF is "electrical facility failure"

Far more noteworthy is the following statement by SCE: "*SCE is measuring the overall effectiveness of covered conductor by comparing events (primary wire downs, primary conductor caused ignitions and faults) on fully covered circuits to bare circuits in its HFRA on a per-mile basis in current years. As of November 2021,* ***SCE's wire down and fire data does not show any events occurring on fully covered circuits**.*" (emphasis added).

Examination of SCE's Table data shows exactly how remarkable this observation is. Table 8 shows that in 2021 SCE had 13,887 miles of conductor in the HFTD2 and HFTD3 districts. During 2021, 48 ignitions and 398 wires down occurred in SCE's HFTD2 and HFTD3 districts. If we assume that 2500 miles of covered conductor were deployed during that period, the 11,387 miles of non-covered conductor was responsible for the 48 ignitions and 398 wires down, while the 2,500 miles of covered conductor were responsible for zero ignitions and zero wires down.

Ordinarily, I would drive the point home with a statistical significance calculation but in this case it isn't really necessary. Even if the full 2,500 miles were not deployed until the end of the year, the conclusion must be the same. While outages still seem to happen at some reduced level on covered conductor circuits, there appear to be additional barriers from those outages progressing to ignitions.

The utilities are therefore, intentionally or not, "low-balling" the effectiveness of covered conductor and therefore artificially repressing its RSE. This requires immediate attention by OEIS, especially since programs currently under consideration by PG&E and SDG&E are plan to use underground hardening, partially justified on the basis that the RSE for covered conductor is not substantially higher than for undergrounding.

Recommendation:
Stakeholders should be provided periodic review and input into utility-centric OEIS working groups so that they are kept apprised of status and have the ability to ask questions.

Recommendation:
OEIS should immediately validate SCE's current data regarding outages, wires down, and ignitions, taking into account its pace of deployment, with an eye to seeing whether effectiveness rates on the order of 60-70% are reasonable or whether effectiveness should be ranked much higher.
Urgency: Class A. All utilities are moving forward with expensive capital projects with the assumption that covered conductor is "good but not that good". These assumptions inform much of their long-term strategy and their WMPs. For utilities to have adopted such conservative assumptions in light of experience at SCE and Pacificorp is concerning, and needs to be fully understood and corrected if necessary prior to plan approval.

7.3.2. Undergrounding

The most effective, and expensive, wildfire mitigation program is to underground electrical lines. Until this year, undergrounding was viewed as a mitigation to be used under special circumstances, and it has historically affected a small fraction of utility infrastructure in the HFTD. However, this changes in July 2021 with PG&E's surprise announcement that it would underground 10,000 miles of line in its High Threat Fire District, as was noted during PG&E's review process last year. PG&E admits that: "*the Dixie and Fly Fires, as well as significant and dramatic changes in wildfire risk resulting from climate change, informed our decisions to implement the Enhanced Powerline Safety Setting (EPSS) program as well as our plan to underground 10,000 miles of* *overhead distribution lines*."[148] At that time, MGRA noted that this announcement risked making all other wildfire mitigation technology developments moot.[149]

PG&E's further explanation of its proposed program in its 2022 WMP does nothing to alleviate concern. It confirms that "*PG&E is making a fundamental shift in our system hardening work and using undergrounding as the preferred option after line removal or remote grid, where appropriate*."[150] It claims that the cost of undergrounding can be substantially reduced, but provides no substantial evidence that this is so. PG&E's case is illustrated in the figure below.

FIGURE PG&E-7.3.3-3:
UNDERGROUNDING COST TARGETS

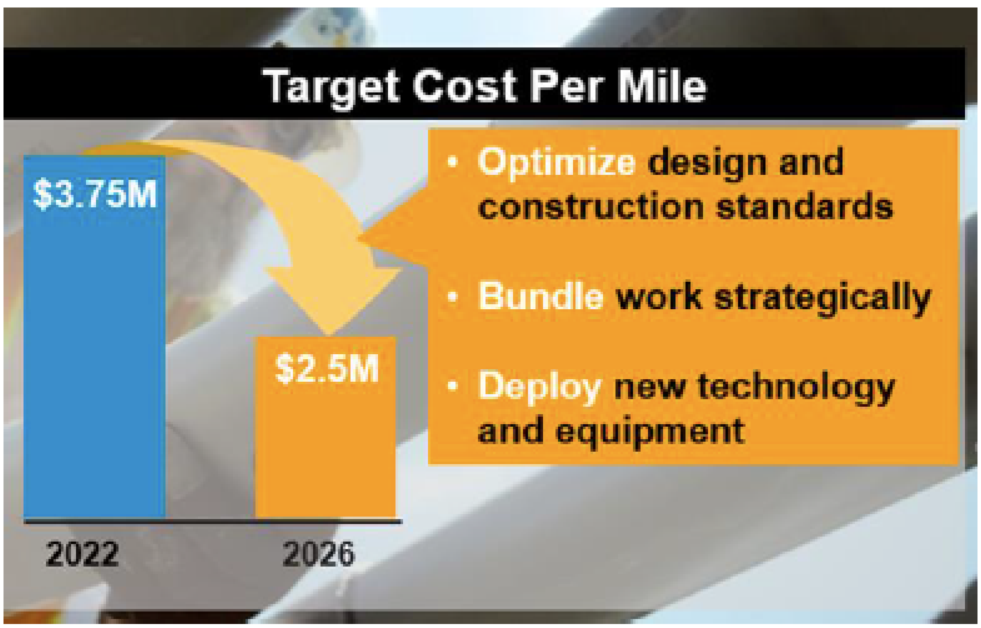

Figure 14 - PG&E's "explanation" of how it will reduce undergrounding costs.

PG&E's WMP contains no specifics as to how optimization, bundling, and new technology will effectively halve its undergrounding cost. Even if it achieves the targeted $2.5 million per mile (and there is no justification provided that it will), its overall cost would still be $25 billion.

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[148] PG&E Data Request Response; WMP-Discovery2022_DR_OEIS_004-Q04.
[149] 2021-WMPs; MUSSEY GRADE ROAD ALLIANCE COMMENTS ON PROPOSED RESOLUTION WSD-021; pp. 2-6.
[150] PG&E WMP; p. 525.

SCE, in contrast, notes that 87% of its top 100 riskiest circuits would cost between $3.5 and $5.5+ million per mile to underground.[151]

PG&E's RAMP up plan for undergrounding is aggressive, as shown in the following figure:

FIGURE PG&E-7.3.3-2:
CURRENT UNDERGROUNDING FORECAST

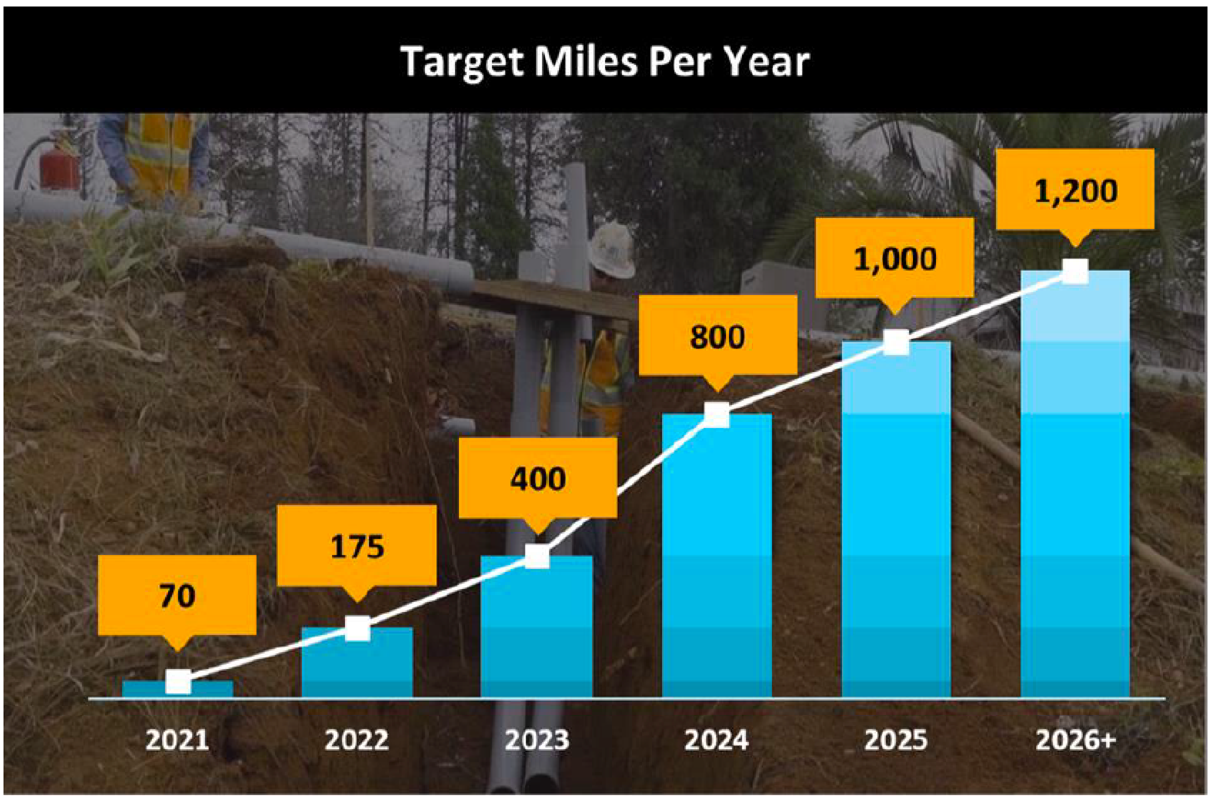

Figure 15 - PG&E's proposed schedule for accelerating its undergrounding deployment.[152]

It should be re-emphasized at this point that undergrounding of electrical lines is a capital project, and as such is a profit center for utilities, which earn a guaranteed return of 10% on top of their investment. PG&E (and other utilities) have an incentive for hardening projects. MGRA therefore issued a data request asking PG&E: "*Are the reviews of staff, management, or executives in any way tied to targets related to the successful completion of undergrounding projects*?"[153] PG&E refused to answer, stating that "the issue of annual performance reviews is not relevant to

[151] SCE WMP; p. 619.
[152] PG&E WMP; p. 528.
[153] Appendix A; MGRA-PGEWMP22_DataRequest2-Q14.

this proceeding." Executive compensation, however ***is*** of relevance to OEIS, and therefore Energy Safety should continue to pursue this question.

The PG&E undergrounding project has the earmarks of a top-down executive decision based on corporate priorities rather than safety concerns. It sets dubious goals without technical foundation, ignores standard practices for optimization of ratepayer safety and value, and, if implemented as planned, will provide a tremendous windfall to shareholders.

Should PG&E's effort succeed, there is no reason that other utilities won't follow suit, particularly SDG&E which has made less of a commitment to a covered conductor program than SCE. For instance, in 2021 SDG&E completed 20 miles of covered conductor and 25 miles of strategic undergrounding.[154] In SDG&E's RAMP proceeding, SDG&E proposed a substantial hardening program: 275 miles of undergrounding and 200 miles of covered conductor. Considering that SDG&E is far smaller than PG&E, its near-term undergrounding goals are comparable as a fraction of its network. SDG&E claims that it makes little difference if covered conductor and undergrounding are used because of similar RSEs.

Alternatives	Scope	Total Risk Reduction	RSE
Proposed	275 miles of UG 200 miles of CC	32.8%	100.35
Alternative 1: Underground	475 miles of UG	34.1%	85.11

Alternatives	Scope	Total Risk Reduction	RSE
Proposed	275 miles of UG 200 miles of CC	32.8%	100.35
Alternative 2: Covered Conductor	475 miles of CC	21.1%	93.36

Table 8 - SDG&E alternatives of all covered conductor versus all undergrounding, as presented in its RAMP.[155]

[154] SDG&E WMP; p. 4.
[155] A.21-05-011-4; Safety Policy Division Staff Evaluation Report on SDG&E's and SoCalGas' Risk Assessment and Mitigation Phase (RAMP) Application Reports; November 5, 2021. (SPD Report)SPD Report; Addenda at pp. 207-252
MUSSEY GRADE ROAD ALLIANCE INFORMAL COMMENTS TO THE SAFETY POLICY DIVISION REGARDING SAN DIEGO GAS AND ELECTRIC COMPANY'S RAMP FILING; p. 21. (MGRA

The problem, once again, is that the effectiveness of covered conductor may be substantially downplayed by the utilities. The fact that SCE has yet to record its first ignition or wire down on its new covered conductor system implies that RSE for covered conductor may need to be substantially higher. Additionally, with the addition of other technologies such as REFCL that supplement covered conductor protection any remaining vulnerabilities may be reduced to the equivalent of undergrounding at much lower cost.

SDG&E is planning to hire a contractor to conduct additional covered conductor tests to understand their response in high wind, especially in regard to clashing, and to do accelerated aging studies under heat and UV conditions to determine how this effects mechanical and dielectric properties.[156]

Recommendations:
Energy Safety should recommend against any major roll-out of undergrounding as a long term solution until questions regarding effectiveness of alternatives such as covered conductor and REFCL have been evaluated, and proper risk/benefit of other alternatives such as PSPS and EPSS have been incorporated as well.
Urgency:
Class C: Only modest undergrounding is being done this year. However, Energy Safety should put utilities on notice that major undergrounding projects will need to be fully justified from a technical and economic standpoint if future plans are to be approved.

Recommendation:
OEIS should immediately validate SCE's current data regarding outages, wires down, and ignitions, taking into account its pace of deployment, with an eye to seeing whether effectiveness rates on the order of 60-70% are reasonable or whether effectiveness should be ranked much higher.
Urgency: Class A. All utilities are moving forward with expensive capital projects with the assumption that covered conductor is "good but not that good". These assumptions inform much of their long-term strategy and their WMPs. For utilities to have adopted such conservative

SDG&E RAMP Comments)
Citing: SDG&E Data Request Response MGRA-DR-006-Partial, Questions MGRA-38 and MGRA-39.
[156] Appendix A: MGRA-SDGE-WMP22_DATAREQUEST2-Q23.

assumptions in light of experience at SCE and Pacificorp is concerning, and needs to be fully understood (or corrected) prior to plan approval.

Recommendation:
Energy Safety should request progress and final reports from SDG&E's third-party covered conductor tests.
Urgency: Class C – Next WMP.

Recommendation:
Energy Safety should investigate whether incentives to support and complete capital projects, particularly undergrounding, are part of utility compensation packages.

7.3.3. Rapid Earth Fault Current Limiter (REFCL)

In reviews of the 2021 WMPs, MGRA and other stakeholders had identified REFCL as a promising technology that could potentially, in combination with covered conductor, address nearly all of the utility ignition scenarios.[157] MGRA suggested that: "*WSD should require PG&E to develop a proposal for a 'moon shot' program that could mitigate areas exposed to expanded shutoff with REFCL within the next few years and potentially reduce the need for environmentally damaging expanded EVM*."[158] Ironically, MGRA's "moon shot" language was later echoed by PG&E's CEO in reference to the proposed 10,000 undergrounding proposal.[159] MGRA was and remains concerned that the emphasis on cost-effective solutions to the utility wildfire problem will be brushed aside in favor of capital-intensive (and therefore profitable) utility projects.

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[157] 2021-WMPs; MUSSEY GRADE ROAD ALLIANCE REPLY TO STAKEHOLDER COMMENTS ON 2021 WILDFIRE MITIGATION PLANS OF PG&E, SCE, AND SDG&E; April 13, 2021; pp. 10-11. (MGRA 2021 WMP Reply)
Also, in the SCE WMP, SCE states that "REFCL and covered conductor are complementary in nature (where both are feasible). When deployed in conjunction with covered conductor, which is effective at reducing energy from phase-to-phase faults, can significantly increase the mitigation effectiveness."; p. 297.
[158] Id.
[159] PG&E Aims to Curb Wildfire Risk by Burying Many Power Lines; Ivan Penn; New York Times; July 21, 2021.
https://www.nytimes.com/2021/07/21/business/energy-environment/pgeundergroundpowerlineswildfires.html

Since the 2021 WMPs were completed, there have been two major REFCL developments. Last fall, PG&E's results from its first pilot were received, and it had basically been a failure. As PG&E recounts: "*PG&E attempted to commission and test the REFCL technology in Calistoga. PG&E completed an elevated voltage stress test and one field ground fault test which demonstrated that REFCL technology can be effective at reducing fault currents to below fire ignition levels.*

After the initial positive tests, the Calistoga REFCL pilot demonstration was stalled due to the failure of the substation REFCL equipment. In addition, PG&E had difficulty obtaining replacement equipment from various overseas suppliers due to supply chain issues and the ongoing COVID-19 pandemic."[160]

While PG&E plans to rebuild and continue its pilot, it has no plans to further expand its investigation or rollout of REFCL at this time.[161]

SCE, however, announced the results of its successful REFCL pilot in its WMP. It installed and operated a Ground Fault Neutralizer (GFN) at its Neenach substation, Resonant Grounding on its Arrowhead substation, and an Isolation Transformer at its Stetson substation. Its system was able to successfully detect faults as low as 0.5 ampere. SCE plans to install GFN at its Acton and Phelan substations in 2023.[162] SCE notes that "*REFCL currently has the highest RSE score in SCE's WMP portfolio*,"[163] though it warns that actual costs may be higher. SCE lists the RSE for REFCL as 12,847.[164]

SCE's dedication to testing a variety of REFCL configurations and technologies and its apparent commitment to further exploring and developing this technology stand in stark contrast to the roadblock encountered by PG&E. While failures happen (especially with new technology), it is possibly not coincidental that PG&E's tepid commitment to REFCL R&D was announced at around the time of its massive undergrounding project proposal. Undergrounding obviates any need for REFCL. SCE, on the other hand, has already gone all-in on covered conductor, and REFCL provides a way to eliminate almost all of the remaining vulnerabilities that covered conductor fails to address.

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160 PG&E WMP; p. 556.
161 Data Request Response CalAdvocates-PGE-2022WMP-13.
162 SCE WMP; pp. 323-328.
163 Id. P. 325.
164 SCE WMP; p. 73.

SCE provides a comparison of REFCL with other hardening alternatives:

Table SCE 7-2

Efficacy of Mitigation Suites

Attribute	CC[90]	CC++	Undergrounding	REFCL++[91]	CC/REFCL++
Approximate Average lifetime cost/mile[92]	$0.5M-$0.6M	$1.3M-$1.4M	$1.6M-$5.6M[93]	$0.8 M-$1.8M	$1.3M-$2.4M
Deployment Speed[94]	16-24+ months	16-24+ months	25-48+ months	18-36+ months	18-36+ months
Phase-to-phase incandescent particle ignition[95] mitigation	High	High	High	Low	High
Phase-to-ground incandescent particle ignition[96] mitigation	High	High	High	High	High
Distribution Wire-down ignition mitigation	Medium	High	High	Medium	High
Equipment Failure mitigation	Low	Medium	High	High	High

Table 9 - Table SCE 7-2 shows the cost and efficiencies of mitigation suites proposed by SCE.[165]

For its ++ combinations, SCE combines "*fire-resistant poles installation, asset inspections, FC settings for CB relays, along with vegetation management activities (as necessary) including HTMP, pole brushing, and line clearing*."[166] These operational measures are included, it appears, to provide a sharp contrast to undergrounding costs, which do not have associated operating costs. SCE's analysis implies that regardless of any hardening, enhanced maintenance for overhead lines costs on the order of $0.8M per mile over the lifetime of the project.[167] SCE also notes that the low-end undergrounding costs of $1.6 M/mile would constitute less than 10% of the program.

It should be emphasized that covered conductor and REFCL, while they are needed in combination to give broad spectrum protection against wildfire ignitions, can be deployed independently in either order and still independently provide substantial additional protection. This provides significant flexibility to a utility deploying these programs.

For its own estimate of REFCL costs, PG&E estimated a $75M capex, plus $141M operating costs through 2026, for a project that would cover 14% of its 25,000 miles.[168]

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[165] SCE WMP; p. 218.
[166] SCE WMP; p. 217.
[167] Op. Cite.
[168] Appendix A; PG&E Data Request No.: MGRA_002-Q25.

This works out to only $21k per mile in terms of capital costs. Assuming that the $141M in operating costs is equivalent to 3 years of operation, annual operating costs per mile would be $13k, which would total $530k over a 40 year operating lifetime. PG&E's cost estimates therefore appear to be somewhat lower than SCE's.

SDG&E, for its part, is more skeptical of REFCL and not planning to execute a pilot at this time.[169] It claims that rebuilding infrastructure in its service area to be suitable for REFCL operation would be "incredibly costly" due to the wide distribution of phase-to-neutral loads on its system. It claims that implementation for a single substation would cost $26 million.[170] SDG&E claims that it has other technologies under development that it would prefer to rely on, and prefers to work with its industry peers while they develop and test more system-ready programs.

In conclusion, SCE's REFCL program has made the most headway in 2021, and complements its ongoing covered conductor hardening program. All IOUs caution that the deployment of REFCL is technically challenging and that it requires additional analysis and development. However, moving forward with extremely expensive undergrounding projects while the potential exists for a much cheaper and nearly as effective solution does not seem prudent, and we need to be cognizant of the fact that the more a capital project costs, the more utility shareholders will benefit from it. Elimination of the utility wildfire problem is a feasible goal, but regulators should have a hand in determining which "moonshot" gets public backing. Initial REFCL demonstrations show that it is a serious contender and OEIS should ensure it gets the attention it deserves.

Recommendation:

OEIS should begin a REFCL working group with a goal of identifying design configurations that would be most appropriate for California utilities, expanding potential pilot sites and goals, and identifying and solving potential problems and pitfalls. OEIS and SCE should lead this group. The group should present bi-annually to stakeholders regarding progress.

Urgency:

Class B, to begin after WMP reviews.

[169] SDG&E WMP; p. 80.
[170] Id.; p. 79.

Recommendation:

SDG&E, since it claims it has other technologies that may render REFCL unnecessary, should present these technologies in combination with covered conductor and compare them against REFCL in terms of both effectiveness and cost.

Urgency:

Class B, in one of the quarterly reports.

7.3.4. Vegetation management of at-risk species

MGRA's previous WMP comments had urged a review of what constituted an "at-risk" species and whether utilities are appropriately using vegetation contact statistics to justify trim distances and strategies.[171] In particular the MGRA analysis noted that SDG&E was not properly ranking risk species by outage rate per tree. As a result, Energy Safety directed utilities to meet and develop a common strategy for identifying and prioritizing at-risk species,[172] and this effort has now produced results. SDG&E worked with the San Diego Supercomputing Team to further refine and improve upon MGRA's 2020 analysis using scrubbed data and machine learning,[173] and their results qualitatively support the relative species risk rankings of the MGRA analysis. SDG&E also performed a statistical analysis of trim distance versus outage rate, which MGRA had been urging since 2019[174] and has finally produced a definitive study to support its vegetation management program.[175]

While it is gratifying that vegetation management programs now have a sound technical foundation, it is disappointing that nevertheless SDG&E continues to use the same "top five" criteria to define "at-risk" species even though the relative risk posed by these species varies by an order of magnitude:

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[171] 2021-WMPs; MGRA Comments; pp. 40-42.
MUSSEY GRADE ROAD ALLIANCE COMMENTS ON 2020 WILDFIRE MITIGATION PLAN Q3 QUARTERLY REPORT OF SDG&E, PG&E, AND SCE; September 30, 2020; pp. 5-7.
[172] Issue SDGE-21-06.
[173] SDG&E WMP; Attachment D: Detailed Progress Report on Key Areas of Improvement; p. 16.
[174] R.18-10-007; MUSSEY GRADE ROAD ALLIANCE COMMENTS ON THE WILFIRE MITIGATION PLANS; March 13, 2019; pp. 14-22.
[175] SDG&E WMP; Attachment E: Measuring Effectiveness of Enhanced Vegetation Management.

Table 4-14: Identified Risk Trees by Species

Species	Count	Pct of Total	Actual Outage	Avg Risk Probability	Risk Metric
Eucalyptus	59,184	34.6%	10	2.82 E-4	16.70
Palm-Fan	26,894	15.7%	11	3.66 E-4	9.84
Pine	28,189	16.5%	4	2.47 E-4	6.96
Oak	13,175	7.7%	1	1.24 E-4	1.63
Sycamore	5,999	3.5%	0	2.51 E-4	1.50
Palm-Feather	8,299	4.8%	1	1.50 E-4	1.25
Pepper (California)	6,045	3.5%	0	1.34 E-4	0.81
Tamarisk/Salt Cedar	2,617	1.5%	0	2.62 E-4	0.69
Cypress	1,617	0.9%	1	1.62 E-4	0.26
Pecan	1,750	1.0%	1	1.92 E-4	0.34

Table 10 - SDG&E analysis of risk metric as a function of species.[176]

With a risk metric ten times less than eucalyptus, ranked as the most hazardous, it is odd that the native species oak and sycamore retain their "at-risk" designation. SDG&E explains that: "*oak and sycamore trees have a known propensity for branch failure, which could lead to increased chance of vegetation/line contact.*

Certified Arborists and line-clearance-qualified-tree-trimmers apply this knowledge when determining which species should be targeted for enhanced clearances and removal to prevent outages."[177]

This criterion seems strange, since branch failures are a common cause of outages, and so it would be expected that we would see these branch failures show up in the risk metric.

SDG&E is careful to clarify that its "at-risk" designation is not a blanket condemnation of these species: "*It is important to note that SDG&E designates these species as "at risk" to facilitate targeted inspections. Species type is not a single determinant of whether enhanced clearances and/or removal is warranted. Clearances are determined by a holistic review of tree location, health, species, and growth pattern. Simply because a tree has been identified as requiring pruning or 'at risk' does not mean it will require enhanced clearance.*"[178]

[176] SDG&E WMP; p. 75.
[177] SDG&E WMP; p. 295.
[178] SDG&E WMP; p. 296.

In fact statistically SDG&E does apply a light hand in trimming, with only a 0.1% removal rate and 0.24% rate of trim to over 12 feet in 2022,[179] which we note is consistent with our limited personal experience in the Mussey Grade area. However, this begs the question of what the purpose of SDG&E's "at-risk" designation is, and raises the concern that a change of policy at the management level could lead to a much more draconian policy based on the "at-risk" designation.

Recommendation:
SDG&E should either re-define its "at-risk" designation to represent the most hazardous tree species, and not use an arbitrary "top five" definition of trees with dissimilar risk characteristics, or come up with alternative or additional terms to denote tree species meriting special inspection but not necessarily implying additional risk.
Urgency:
Class C – 2023 WMP.

8. PUBLIC SAFETY POWER SHUTOFFS (PSPS)

8.1. Directional Vision for Necessity of PSPS

8.1.1. Cost/benefit analysis for PSPS is urgently required for mitigation decisions

In their preparation of the 2020 Wildfire Mitigation Plans, utilities incorporated power shutoff as a mitigation with a very high Risk Spend Efficiency. MGRA[180] and other stakeholders argued that utility estimates of customer harm had not been reviewed and did not take into account a number of potential risks introduced by power shutoff. The Wildfire Safety Division concurred, and in WSD-002 stated:

"*Further, RSE is not an appropriate tool for justifying the use of PSPS. When calculating RSE for PSPS, electrical corporations generally assume 100 percent wildfire risk mitigation and very low implementation costs because societal costs and impact are not included. When calculated this way, PSPS will always rise to the top as a wildfire mitigation tool, but it will always fail to*

[179] SDG&E WMP; p. 5.
[180] 2020-WMPs; MGRA Comments; p. 43.

account for its true costs to customers. Therefore, electrical corporations shall not rely on RSE calculations as a tool to justify the use of PSPS."[181]

A number of developments have arisen since that resolution was adopted that suggest that review and modification of the original finding is necessary. Firstly, the utilities have proposed major hardening programs that will cost tens of billions of dollars. Secondly, the utilities are now applying a cost/benefit approach to operational decisions regarding power shutoff. Finally, the Auditor Report has stated that "*To prevent the need for power shutoffs, utilities must make improvements, such as installing covered power lines or moving them underground to increase power lines' resilience in high-wind conditions and reduce the likelihood of the power lines igniting a wildfire*."[182] The Auditor Report recommends that the Legislature strengthen the Shutoff Reduction Law to require that utilities identify measures necessary to prevent power shutoffs.[183] In order to determine what mitigations are appropriate to prevent power shutoff, it is critical that the cost of power shutoff be quantified so that it can be compared with mitigation costs.

PG&E, for example, describes its PSPS Risk-Benefit Tool, "*developed in collaboration with PG&E's Risk Management and Safety team and the Joint IOU PSPS Working Group ahead of the 2021 PSPS season, with alignment on the industry-standard methodology described in PG&E's RAMP and GRC workpapers…. The output of the tool is a ratio that compares the calculated PSPS potential benefit from initiating an event (i.e., mitigation of catastrophic wildfire consequence) to the induced risks associated with an event (i.e., impact to customers resulting from a PSPS outage)*"[184]

For these impacts PG&E calculates consequence values: "*Once the consequence values (safety, reliability, financial) are estimated, they are converted into MAVF risk scores as defined through our RAMP and GRC*."[185] The fact that PG&E is using a MAVF for its operational decisions begs the question of why the same approach should not be applied to the decision of whether to implement a mitigation to remove the need for power shutoff.

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[181] WSD-002; p. 20.
[182] Auditor Report; p. 28.
[183] Auditor Report; p. 30.
[184] PG&E WMP; p. 911.
[185] PG&E WMP; p. 914.

SCE performs a similar balancing between potential population impacts using Technosylva wildfire consequence modeling and epidemiological studies for power outage events.[186] SCE assumes *"$250 per customer, per de-energization event to quantify potential financial losses for the purpose of comparing PSPS risk to wildfire risk. The figure represents potential customer losses, such as lost revenue/income, food spoilage, cost of alternative accommodations, and equipment/property damage*."[187]

SDG&E's WiNGS-Ops model evaluates wildfire risks to facilitate PSPS decision-making. SDG&E's WiNGS-Planning product is used for prioritizing work in its service area. As SDG&E notes, "WiNGS-Planning and WiNGS-Ops are independent products that do not share outputs or dependencies."[188] However, SDG&E appears to foresee that WiNGS-Planning will incorporate PSPS as well: "*SDG&E has also launched the strategic undergrounding program and covered conductor program, which will become the preferred hardening strategies based on the WiNGS-Planning risk model to focus on both on wildfire risk reduction and mitigating PSPS impacts to customers.*"[189]

While all utilities are now quantifying PSPS consequences, to date their methodology has not been subject to public review or input, or been validated by either Energy Safety or the Commission. MGRA has urged the CPUC to take this up as an urgent topic in the RDF proceeding,[190] but so far there is no indication that it will do so. MGRA notes that numerous potential harms from power shutoff have been raised by stakeholders since de-energization as wildfire mitigation was first proposed in 2008, and many of these harms are not taken into account by the utility consequence models. Among these are risks specific to WUI areas during fire weather events that would not be included in historical outage data, such as risk from generators, cooking fires, house fires, inability to report or learn about fires because of communication failure, and delays in evacuation.[191]

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[186] SCE WMP; p. 523.
[187] SCE WMP; p. 524.
[188] THE PUBLIC ADVOCATES OFFICE DATA REQUEST: CALADVOCATES-SDGE-2022 WMP-07 SDG&E RESPONSE Date Received: February 24, 2022 Date Submitted: March 1, 2022; Response 1.
[189] SDG&E WMP; Attachment A: Long Term Vision Wildfire Mitigation Plan Long-Term Vision; p. 6.
[190] R.20-07-013; MUSSEY GRADE ROAD ALLIANCE PHASE II ROADMAP COMMENTS; March 8, 2022; pp. 2-3.
[191] R.18-12-005; MUSSEY GRADE ROAD ALLIANCE PHASE 2 TRACK 1 DE-ENERGIZATION PROPOSALS; September 16, 2019; p. 3.

Evaluation of PSPS as a mitigation rather than a harm and its comparisons to other mitigation is an urgent topic because utilities – particularly PG&E – are putting forward extremely expensive undergrounding and other hardening programs because of their effectiveness in eliminating both wildfire and PSPS.[192] At current undergrounding costs of $3 million to $5 million per mile[193] PG&E's proposed 10,000 mile program could potentially cost ratepayers $30-50 billion to mitigate 1/3 of its HFTD circuits, although the company claims (so far without substantial evidence) that it can substantially reduce these costs.

The Auditor Report suggests that cost of utility de-energization to date, based on SCE's methodology, totals $21 billion, $14 billion of which arises from PG&E's October 2019 shutoffs.[194] It is therefore not clear whether extremely expensive hardening programs might in the long run provide better public benefit than reliance on occasional shutoff. Even if they do initially, it is not clear how the point of diminishing returns could be determined, and if the IOUs are the correct entities to make this decision.

While rates and revenue are not the domain of Energy Safety, increasing energy safety costs money. It needs to be understood that both power shutoff and hardening programs are financially beneficial to utilities. Power shutoff shields utilities from liability. Hardening programs are capital projects, and utilities are permitted a rate of return on these investments. The "cost/benefit" for power shutoff versus hardening should not be maximization of utility profit but rather an optimization for public safety and costs. MGRA has argued for this determination to be led by regulators since 2009.[195] Major hardening projects are underway and more are proposed. It is essential that both the costs and benefits of power shutoff be quantitatively incorporated into the determination of whether these costs are reasonable.

192 PG&E WMP; p. 525.
193 SCE WMP; p. 661. SDG&E 2022 WMP Appendix: Effectiveness of Covered Conductors: Failure Mode Identification and Literature Review; Exponent Inc.; p. 29.
194 Auditor Report; p. 15.
195 CPUC D.09-09-030; pp. 30-31, 59-61. September, 2009.

Recommendation:

Energy Safety should drive a review of current utility methodologies for determining PSPS consequences, and should invite stakeholders to provide input. Energy Safety should then provide guidelines for consequence modeling in collaboration with the CPUC.

Urgency:

Immediate, since PG&E, SCE, and SDG&E expansions of their hardening programs are currently under consideration and the level of acceptable PSPS use needs to be incorporated.

Recommendation:

WSD's earlier determination to not allow an RSE to be used to justify PSPS should be modified and utilities requested to provide RSE justification for their choice of mitigation programs as compared to continued dependence on power shutoff.

Urgency:

Class B. This should be done as soon as a standardized methodology is available.

8.2. Protocols on Public Safety Power Shut-off

8.2.1. Enhanced Powerline Safety Settings (EPSS) and Fast-Trip

In response to the Dixie and Fly fire, PG&E: "*In July 2021, to address this dynamic climate challenge, we implemented the EPSS program on approximately 11,500 miles of distribution circuits, or 45 percent of the circuits in HFTD areas. With EPSS, we engineered changes to our electrical equipment settings so that if an object such as vegetation contacts a distribution line, power is automatically shut off within 1/10th of a second, reducing the potential for an ignition*."[196]

The result of this program was fairly immediate and dramatic, as seen in PG&E's Figure PG&E-4.3-1:

[196] PG&E WMP; p. 731.

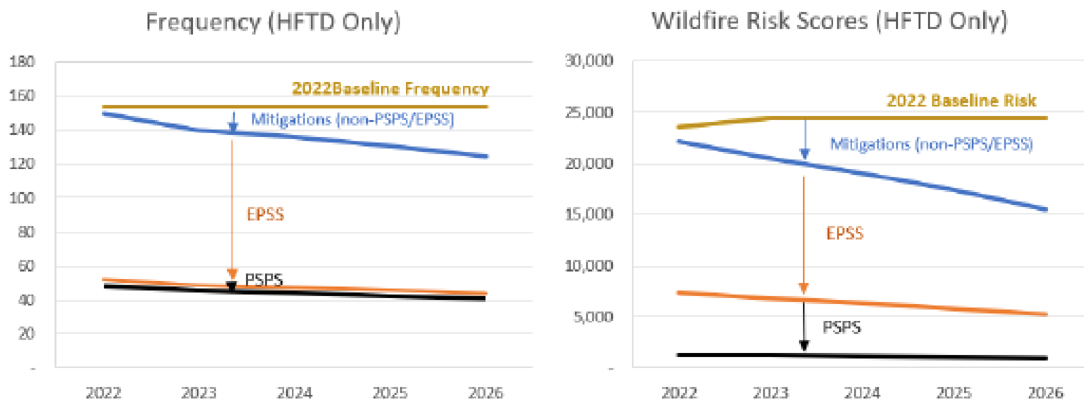

Figure 16 - Figure PG&E-4.3-1 showing how EPSS dramatically decreased ignition frequency and wildfire risk scores in the HFTD.[197]

PG&E intends to implement the EPSS program on the remainder of its HFTD in 2022.[198]

This program makes considerable sense from a technical standpoint. As shown in previous sections, during extreme weather conditions the probability of outages and ignitions rises dramatically. At the same time, the probability that an ignition will grow uncontrolled into a major fire also greatly increases. While there are many harmless faults and outages on utility electrical systems, the conditional probability that a fault occurring during one of these elevated risk periods either is arising from equipment damage or object contact is much higher, as is the risk that a fault from any source will progress into a serious wildfire. It therefore makes sense to temporarily shift tactics from an emphasis on reliability to an emphasis on wildfire prevention.

Unfortunately, there is not only the technical aspect to consider, but also the human element. Many of the harms associated with power shutoff are also present for EPSS, and in fact some are greatly aggravated because there is no ability to mitigate through prior notice. PG&E's roll-out of EPSS therefore was met with considerable irritation and controversy. As the Auditor Report notes: "*The three largest utilities have altered settings on their equipment, which resulted in hundreds of unplanned power outages with no advance notice to customers. However, unlike planned power shutoffs, the Energy Safety Office does not currently require utilities to identify in their mitigation plans the power lines that are frequently experiencing these unplanned outages*

[197] PG&E WMP; p. 84.
[198] PG&E WMP; p. 738.

and improvements to reduce their impact."[199]

"*From late July through early November 2021, its power-line settings program resulted in nearly 600 unplanned outages that affected more than 650,000 customers. These outages occurred with no advance notice, affected an average of more than 1,000 customers per outage, and averaged more than 17.5 hours per customer in duration. The CPUC indicates these outages are more than a matter of inconvenience—they are disruptive, and for customers who rely on electricity to maintain necessary life functions, they can be life-threatening. However, unlike a planned shutoff, customers and public safety partners receive no warning of these outages before their power is interrupted.*"[200]

As can be seen in the map below, these outages were widespread:

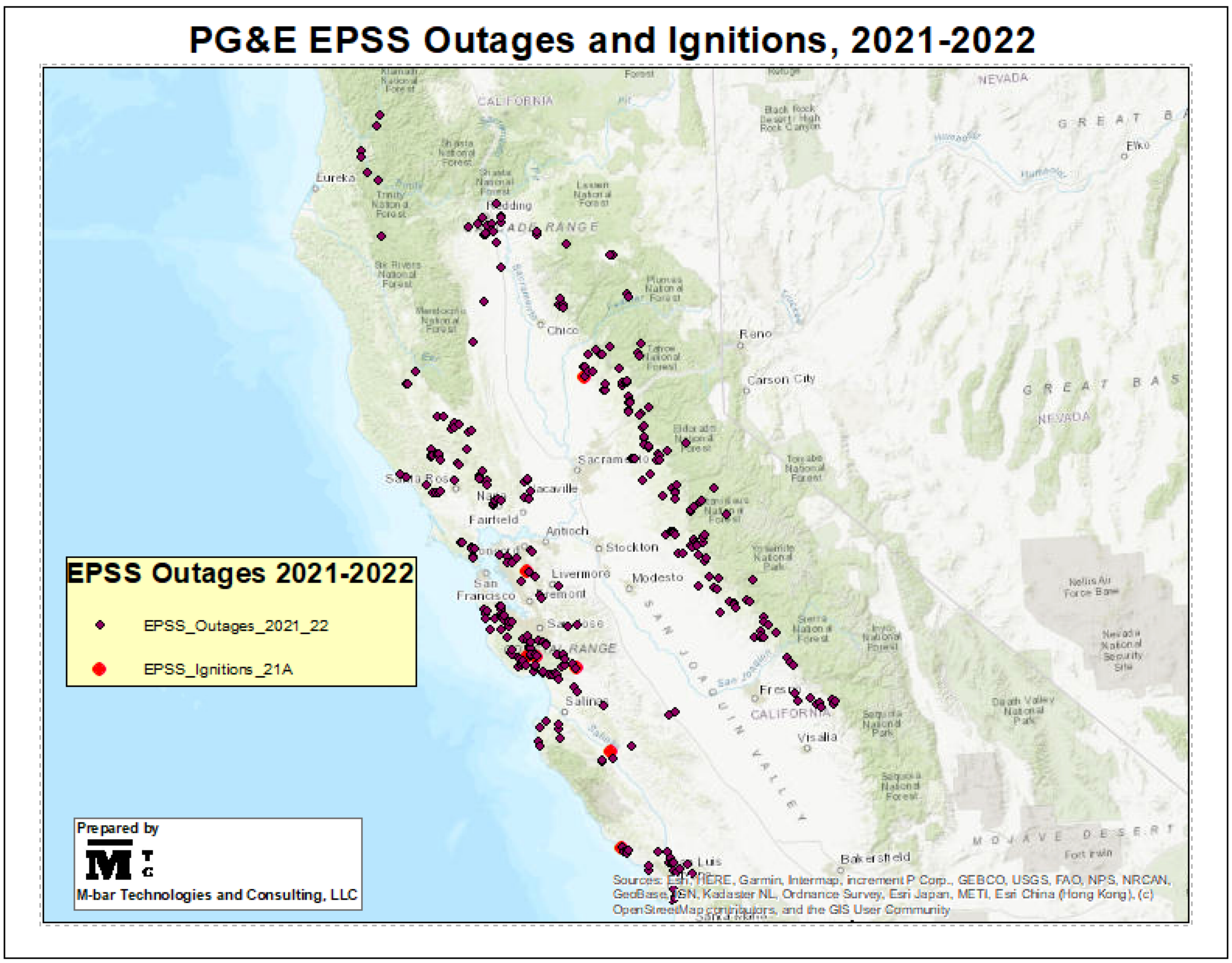

Figure 17 - Locations of circuit outages that are related to PG&E's EPSS program of lowering trip threshold criteria during enhanced fire danger. Ignitions that occurred on circuits with EPSS settings are shown in bright red.[201]

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[199] Auditor Report; p. 17.
[200] Auditor Report; p. 32.
[201] Appendix A; MGRA-PGEWMP22_DataRequest2-Q01.

As can be seen in Figure 17, the 11,800 miles of circuit to which the new settings were applied are scattered through the state. It is also shown that the application of EPSS is not a fool-proof wildfire mitigation. Even if circuits de-energize in 0.1 second, considerable energy can still be deposited under some circumstances, enough to cause an ignition. There were seven such instances in the PG&E service area in 2021. Six of the seven fires were less than 0.25 acres, and the remaining fire was less than 10 acres, as show below:

Index Number	Ignition Latitude	Ignition Longitude	HFTD	Suspected Initiating Event	Fire Size	Ignition Date	Ignition Time
1762	35.59422	-121.116	Tier 2	Vegetation	0.26-9.99 Acres	10/11/2021	13:48:00
1648	37.78679	-122.007	Tier 3	Contamination	<0.25 Acres	9/30/2021	09:12:00
1309	37.1163	-121.921	Tier 3	Vegetation	<0.25 Acres	8/27/2021	20:06:00
1258*	37.1152	-122.021	Tier 3	Contact - 3rd Party	<0.25 Acres	8/10/2021	21:01:00
1220	37.02188	-121.523	Non-HFTD	Equipment Failure	<3 meters of linear travel	8/8/2021	05:12:00
1190	36.35756	-121.208	Non-HFTD	Contamination	<0.25 Acres	8/5/2021	07:36:00
1154	39.31744	-121.403	Tier 2	Equipment Failure	<0.25 Acres	7/31/2021	06:15:00

Table 11 - Ignitions in the PG&E service area occurring on circuits on which EPSS had been enabled.[202]

As the Audit Report points out, some of the improvement in PG&E's PSPS statistics in 2021 may be attributable to customers being assigned uncontrolled outages via EPSS.

Other utilities are using fast trip settings as well, but it is not clear from their descriptions whether their programs are more or less aggressive than PG&E's and to what degree these have been implemented in the other utility service areas.[203]

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[202] Appendix A; MGRA-PGEWMP22_DataRequest2-Q02
[203] SDG&E WMP; p. 78. SCE WMP; p. 32, 292.

While EPSS and fast trip settings provide a clear reduction in wildfire risk, they cause significant customer impact since mitigation based on prior warning no longer helps customers subject to power loss. Also, while there is significant reporting required for every scheduled power shutoff event, no such reporting requirement exists for EPSS.

Recommendation:
OEIS should require that all de-energizations due to EPSS and fast trip settings be reported with the same level of detail as PSPS, including impacted customers, AFN populations, mitigating measures, total outage time, etc.
Urgency:
Class B – This should be put into place before the 2022 fire season.

Recommendation:
As part of the cost/benefit / RSE effort to quantify PSPS harm in a way that can be used for comparison with other mitigations, EPSS harms should be quantified and compared with PSPS. It may be that EPSS has a larger cost to the public because of its sudden onset, and this needs to be balance quantitatively against potential wildfire reduction benefits.
Urgency:
Class B – This should be implemented as soon as possible.

9. CONCLUSION

While there have been a number of advances in wildfire safety since the last Wildfire Mitigation Plan update, a number of new challenges have arisen as well. California is at the front line of climate change and the utility wildfire problem, and therefore the science, technology, operations, and regulatory practice in California are rapidly co-evolving. The Wildfire Mitigation Plans are therefore living documents, and it is not surprising that analysis of them reaches new conclusions every year.

The most noteworthy development this year is the proposal by utilities to massively scale up physical mitigation projects. If approved, these projects will be extremely costly, and it is up to regulators including Energy Safety to ensure that the proper balance is achieved between the cost of utility wildfires and the cost of mitigating them. The ability to make this determination depends on rigorous quantification of utility wildfire risk, which is a rapidly developing field. MGRA noted a number of issues with utility wildfire risk calculations in 2021, and Energy Safety directed utilities to address and clarify some of these issues. Utility efforts in this area were only partially successful, and several issues remain.

One key finding is that utilities still do not seem to have properly integrated the effect of weather on ignition probability into the risk ranking used in their planning. This is ironic, because utility operational risk estimates appear to be incorporating weather effects in a reasonable way. PG&E's enterprise risk model, in particular, has made a number of adjustments to incorporate weather-driven catastrophic risk events.

With the remaining uncertainty in utility risk calculations, it would be hasty to commit to massive capital expenditures that would have negative effects on the lives of Californians, especially those least able to afford the required rate increases. Additional work is also needed to quantify the impacts of power shutoff and fast trip settings so that the role of these mitigations can be correctly balanced against capital improvements and ratepayer impacts. Indeed, these comments argue for a recalibration of what is considered "wildfire risk" in California. At first, only the safety of those at risk of death or risk of wildfire were considered. Then, with the initiation of widespread power shutoff programs, the safety and well-being of those without power was also brought into scope. Going forward, we must also consider the impacts of wildfire smoke on the health of large swaths of the population, and, finally, consider the health and longevity impacts on low-income ratepayers of the massive rate increases needed to support wildfire mitigation projects. The definition of "public safety" needs to be broadened to incorporate all of these considerations.

Of the two main hardening strategies, covered conductor appears the compelling under most circumstances. Indeed, it seems that even the advocates of covered conductor may be overly conservative in claims regarding its effectiveness, as no ignitions or wires down have yet been observed in the SCE service area, which already has extensive deployment. Advanced, reasonably priced technologies such as REFCL may remove any remaining vulnerabilities and make covered conductor equivalent to undergrounding as a safety measure. Energy Safety should strongly encourage utility R&D projects of this type, including aggressive development plans for proven technologies.

This is not a complete review of the Wildfire Mitigation Plans, and we look forward to input from Cal Advocates, TURN, and Energy Safety itself to cover the many areas that had to be left out of scope for lack of time. Nevertheless, this review identifies a number of areas in which Californians would benefit from a stronger regulatory hand, as urged by the state Auditor. We hope that Energy Safety can make good use of these findings in its efforts to strengthen California's utility safety regulatory program.

Respectfully submitted this 11th day of April, 2022,

By: __/S/____***Joseph W. Mitchell, Ph.D.***____________________

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10. SUMMARY OF RECOMMENDATIONS

Recommendation*:* If procedurally and legally possible, OEIS should become a party to R.20-07-013. If this is not feasible, there will be numerous opportunities for OEIS to attend and participate in workshops and to provide informal comments.

Recommendation:
Utilities should adjust their enterprise risk modeling to correct for the bias introduced by using "worst" weather days in their consequence model. This may be done by applying a RFW filter (as PG&E has done) or by other corrections.
Urgency: Class A – Utilities and the Commission will be choosing between expensive mitigation strategies soon and need to accurately assess mitigation effectiveness.

Recommendation:
Utilities must adjust their per-circuit/per-segment risk modeling to correct for the bias introduced by using the "worst" weather days in their consequence model. This will require that risk drivers receive unique weightings. Utilities should attempt to apply this correctly over the landscape, since both drivers and weather conditions vary over the landscape.
Urgency: Class A – Utilities are carrying out expensive hardening programs and it is essential that these are carried out in the proper order.

Recommendation:
Utilities should investigate incorporating conditional probability per driver per consequence simulation, since this would allow current utility wind/outage models to be leveraged to provide the most accurate predictions.
Urgency: Class B – This approach might conflict with current utility analysis pipelines and machine learning algorithms, and would need further study and development**.**

Recommendation:
SDG&E should provide additional explanation of how it calculates its Wind Speed Adjustment Factor, and it should ensure that a specific adjustment is applied to different drivers. It should

consider using wind speeds used in the Consequence Model for its adjustments rather that maximum.

Urgency:

Class C: However, this calculation will have a strong bearing on SDG&E hardening programs, and should be completed prior to the initiation of major hardening efforts.

Recommendation:

Energy Safety should closely evaluate PG&E's WDRM v3 approach and ensure that it properly incorporates correlations between ignition probabilities and consequences for drivers having this correlation.

Urgency:

Class B: Once the model has been internally validated it should be reviewed by Energy Safety and stakeholders. No major hardening programs should go forward without proper prioritization.

Recommendation:

Energy Safety should ask utilities to provide additional information regarding Technosylva's building loss and fire suppression models.

Urgency:

Class B – After the models are introduced.

Recommendation:

Energy Safety should ask Technosylva to incorporate building age into its building loss model.

Urgency:

Class C

Recommendation:

Energy Safety should closely analyze PG&E's consequence model that incorporates VIIRS and Cal Fire data as well as Technosylva to determine whether it accurately predicts catastrophic wildfire consequences better than Technosylva alone.

Urgency:

Class B – Once PG&E's WDRM v3 has been finalized.

Recommendation:

OEIS should initiate a working group to explore the impact of wildfire smoke risk and solicit input from leading researchers in the field. This topic is currently scheduled to be taken up by the OEIS Risk Modeling Working Group, but only as one topic during a multi-topic discussion in July. More dedicated effort will be necessary.

Urgency:

Class B: Should be initiated soon after plan review.

Recommendation:

SDG&E's mechanism for calculating risk is in error, though in their favor they are the only utility to even attempt to estimate this risk. SDG&E should come up with an alternative method for calculating the "Acres burned" normalization using measured and calculated public health effects from wildfire and wildfire sizes, using a range of values for fatalities and hospitalizations supported by recent studies.

Urgency:

Class B: Should be updated in its quarterly report. It is also likely that a modified estimate will be provided as part of SDG&E's GRC filing.

Recommendation:

Utilities should include the potential for wildfire smoke exposure when estimating risks and benefits from power shutoff.

Urgency:

Class B: Should be described in the quarterly reports and operationalized before the peak of the fire season.

Recommendation:

Energy Safety should identify the installation of AQI sensors as a utility best practice and encourage utilities to initiate or expand programs.

Urgency:

Class C: Should be included in 2023 WMPs.

Recommendation:

Energy Safety should require that all utilities demonstrate that their enterprise risk models correctly calculate extreme wildfire losses with mathematically viable functions, and should note PG&E's

approach as a best practice. In cases where utilities uses an alternative function or method for calculating catastrophic wildfire losses, Energy Safety should require that the utility demonstrate that it is fully incorporating high end losses (of the magnitude of Camp fire and larger).

Urgency:

Class C, 2023 WMPs.

Recommendation:

Energy Safety should also validate that all utility enterprise risk models incorporate weather effects not only into their consequence models but also into the ignition probability component. PG&E's approach of tying its Catastrophic tranche to Red Flag Warnings should be further evaluated, since it introduces a correct correlation between weather-dependent risk drivers and worst weather days used in Technosylva calculations.

Urgency:

Class B for SCE and SDG&E, since their enterprise risk models do not demonstrate obvious weather dependencies. This is urgent because enterprise risk models will be used to evaluate high-cost mitigation programs currently under evaluation.

Class C for PG&E to more fully explain why its use of Red Flag Warnings as weather proxy is the optimal approach in its 2023 WMP.

Recommendation:

All utilities should use outages with conditional ignition probabilities, and also merge PSPS damage events into their risk event samples to avoid suppressing risk indicators from areas often subject to PSPS.

Urgency:

Class C – Next WMP. However, Energy Safety should warn utilities that PSPS bias should be removed from risk rankings prior to the initiation of major hardening programs.

Recommendation:

Energy Safety should find that wildfire risk geographic data cannot be considered critical infrastructure under federal law and should not be classified as confidential based on California Government Code 6255.

Recommendation:

Energy Safety should require that in addition to posting all data requests that utilities also be required to post all confidentiality declarations as part of the WMP review process.

Recommendation:

Energy Safety should create and publish an administrative process by which stakeholders can challenge and litigate confidentiality claims.

Recommendation:

Energy Safety should accelerate development of a public portal for GIS data, so that stakeholders do not have to request this data from utilities, so that utilities do not have to take extra effort to prepare special versions for stakeholders, and so that appropriate access restrictions can be automatically enforced.

Recommendation:

Energy Safety should require that all outages resulting for aggressive circuit breaker settings be logged either with a field in the outage table or as a separate GIS data set.

Urgency:

Class B for SDG&E and SCE. PG&E has already released this data via data request but standards should be put into place.

Recommendation:

Utilities should be required to determine whether the additional outages detected when EPSS or Fast Trip settings are in place provide any additional information regarding circuit vulnerabilities to extreme weather conditions or the state of circuit health.

Urgency:

Class B, Q2 or Q3 should add an additional analysis of EPSS/Fast Trip settings.

Recommendation:

Stakeholders should be provided periodic review and input into utility-centric OEIS working groups so that they are kept apprised of status and have the ability to ask questions.

Recommendation:
OEIS should immediately validate SCE's current data regarding outages, wires down, and ignitions, taking into account its pace of deployment, with an eye to seeing whether effectiveness rates on the order of 60-70% are reasonable or whether effectiveness should be ranked much higher.
Urgency: Class A. All utilities are moving forward with expensive capital projects with the assumption that covered conductor is "good but not that good". These assumptions inform much of their long-term strategy and their WMPs. For utilities to have adopted such conservative assumptions in light of experience at SCE and Pacificorp is concerning, and needs to be fully understood (or corrected) prior to plan approval.

Recommendations:
Energy Safety should recommend against any major roll-out of undergrounding as a long term solution until questions regarding effectiveness of alternatives such as covered conductor and REFCL have been evaluated, and proper risk/benefit of other alternatives such as PSPS and EPSS have been incorporated as well.
Urgency:
Class C: Only modest undergrounding is being done this year. However, Energy Safety should put utilities on notice that major undergrounding projects will need to be fully justified from a technical and economic standpoint if future plans are to be approved.

Recommendation:
Energy Safety should investigate whether incentives to support and complete capital projects, particularly undergrounding, are part of utility compensation packages.

Recommendation:
Energy Safety should request progress and final reports from SDG&E's third-party covered conductor tests.
Urgency: Class C – Next WMP.

Recommendation:
OEIS should begin a REFCL working group with a goal of identifying design configurations that would be most appropriate for California utilities, expanding potential pilot sites and goals, and

identifying and solving potential problems and pitfalls. OEIS and SCE should lead this group. The group should present bi-annually to stakeholders regarding progress.

Urgency:

Class B, to begin after WMP reviews.

Recommendation:

SDG&E, since it claims it has other technologies that may render REFCL unnecessary, should present these technologies in combination with covered conductor and compare them against REFCL in terms of both effectiveness and cost.

Urgency:

Class B, in one of the quarterly reports.

Recommendation:

SDG&E should either re-define its "at-risk" designation to represent the most hazardous tree species, and not use an arbitrary "top five" definition of trees with dissimilar risk characteristics, or come up with alternative or additional terms to denote tree species meriting special inspection but not necessarily implying additional risk.

Urgency:

Class C – 2023 WMP.

Recommendation:

Energy Safety should drive a review of current utility methodologies for determining PSPS consequences, and should invite stakeholders to provide input. Energy Safety should then provide guidelines for consequence modeling in collaboration with the CPUC.

Urgency:

Immediate, since PG&E, SCE, and SDG&E expansions of their hardening programs are currently under consideration.

Recommendation:

WSD's earlier determination to not allow an RSE to be used to justify PSPS should be modified and utilities requested to provide RSE justification for their choice of mitigation programs as compared to continued dependence on power shutoff.

Urgency:

Class B. This should be done as soon as a standardized methodology is available.

Recommendation:

OEIS should require that all de-energizations due to EPSS and fast trip settings be reported with the same level of detail as PSPS, including impacted customers, AFN populations, mitigating measures, total outage time, etc.

Urgency:

Class B – This should be put into place before the 2022 fire season.

Recommendation:

As part of the cost/benefit / RSE effort to quantify PSPS harm in a way that can be used for comparison with other mitigations, EPSS harms should be quantified and compared with PSPS. It may be that EPSS has a larger cost to the public because of its sudden nature, and this needs to be balance quantitatively against potential wildfire reduction benefits.

Urgency:

Class B – This should be implemented as soon as possible.

APPENDIX A - MGRA DATA REQUESTS

A-1 - PG&E Data Requests

PG&E – MGRA – Data Request Response 1

2022 Wildfire Mitigation Plans
PG&E
MGRA Data Request No. 1
February 7, 2022

GIS Data:

Please provide the non-confidential portions GIS data set provided to the Office of Energy Infrastructure Safety. This should be a complete and not incremental set, provided in geodatabase format. As per the WILDFIRE SAFETY DIVISION GEOGRAPHIC INFORMATION SYSTEM (GIS) DATA REPORTING STANDARD FOR CALIFORNIA ELECTRICAL CORPORATIONS – V2, February 4, 2021, please include and exclude all non-confidential data as per the following requests. Data should be current as of the WMP submission date.

Due date should be ten business days or concurrent with the release of the Wildfire Mitigation Plans, which ever comes later.

MGRA-1-1 Please provide for Asset Point data for Camera, Fuse, Support Structure, and Weather Station. Data for Connection Device, Lightning Arrester, Substation, Switchgear, Transformer Site, and Transformer Detail are optional. Customer Meter data is specifically excluded from this request for privacy reasons.

MGRA-1-2 Provide Asset Line data for Transmission Line (as permitted as non-confidential), Primary Distribution Line, and Secondary Distribution Line.

MGRA-1-3 Provide PSPS Event data. Include Event Log, Event Line, Event Polygon data. Please exclude customer meter data. Provide all PSPS Event Asset Damage data including photos.

MGRA-1-4 Provide Risk Event Point data, including Wire Down, Ignition, Transmission unplanned outage (as classified non-confidential), Distribution Unplanned Outage data, Risk Event Asset Log, and Risk Event Photo Log.

MGRA-1-5 Provide photo data for Ignition and Wire Down events.

MGRA-1-6 Under Initiatives, please provide Grid Hardening data, including Hardening Log, Hardening Point, and Hardening Line data. Inspection data is not requested at this time.

MGRA-1-7 Under Initiatives, please provide Other Initiative data for point, line, polygon features and the Other Initiative Log.

MGRA-1-8 Under Other Required Data, please provide Red Flag Warning Day polygon data.

PG&E – MGRA – Data Request Response 2

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q01		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q01		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: EPSS AND PSPS

QUESTION 01

Please provide a GIS file showing all EPSS-related outages and including an attribute for determined cause.

ANSWER 01

GIS File showing all EPSS-related outages are attached (WMP-Discovery2022_DR_MGRA_002-Q01Atch01).

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q02		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q02		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: EPSS AND PSPS

QUESTION 02

Please provide data for all ignitions that occurred while EPSS was active on a circuit, including size and attributed cause.

ANSWER 02

PG&E observed 7 CPUC reportable ignitions on EPSS protected primary overhead assets during EPSS enablement on limited circuits in our service territory. The first ignition was observed on 7/31/2021, four ignitions were observed in August, one in September, and one in October. The following table contains the ignition location latitude, ignition location longitude, fire size, and date and type stamp of these ignition events. Suspected initiating event has also been included.

Index Number	Ignition Latitude	Ignition Longitude	HFTD	Suspected Initiating Event	Fire Size	Ignition Date	Ignition Time
1762	35.59422	-121.116	Tier 2	Vegetation	0.26-9.99 Acres	10/11/2021	13:48:00
1648	37.78679	-122.007	Tier 3	Contamination	<0.25 Acres	9/30/2021	09:12:00
1309	37.1163	-121.921	Tier 3	Vegetation	<0.25 Acres	8/27/2021	20:06:00
1258*	37.1152	-122.021	Tier 3	Contact - 3rd Party	<0.25 Acres	8/10/2021	21:01:00
1220	37.02188	-121.523	Non-HFTD	Equipment Failure	<3 meters of linear travel	8/8/2021	05:12:00
1190	36.35756	-121.208	Non-HFTD	Contamination	<0.25 Acres	8/5/2021	07:36:00
1154	39.31744	-121.403	Tier 2	Equipment Failure	<0.25 Acres	7/31/2021	06:15:00

*PG&E is including ignition 1258 in this response. At the time of ignition, PG&E determined this ignition did not to meet reporting criteria due to eyewitness accounts to the fire size being less than 1-linear meter in size. In late February, PG&E received a fire incident report from the responding fire-suppression agency noting that the fire size did meet CPUC reporting criteria, conflicting with the prior determination. This ignition was previously excluded from analysis on the effectiveness of PG&E's 2021 EPSS program.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q03		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q03		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: EPSS AND PSPS

QUESTION 03

Is SmartMeter Partial Voltage Detection used for emergency de-energization?

ANSWER 03

PG&E does not currently use SmartMeter Partial Voltage Detection (PVD) as a sole trigger for emergency de-energization. Partial voltage data is used along with other information (e.g. device loading) to determine if emergency de-energization is warranted. In remaining cases, PG&E Control Centers dispatch a patrol to investigate upon receiving partial voltage alerts on the Distribution Management System application.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q04		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q04		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: EPSS AND PSPS

QUESTION 04

On p. 860, Figure PG&E 8.1-3, guideline categories are shown for Asset, Vegetation, and Consequence. Is the “Consequence” category the result of PG&E’s application of its “Black Swan” criteria, in which it shuts off power under conditions of high fire spread without regard to ignition probability?

ANSWER 04

The category “Consequence” in Figure PG&E 8.1-3 refers to Catastrophic Fire Behavior (CFB) locations that have concurrence of an increased probability for large fires and increased probability of wind-related ignitions on the distribution system. Additionally, the CFB criteria are used to identify locations that may have a lower probability of ignition but could result in fires that are not easily suppressed and have potentially high consequences. These locations are identified using fire spread simulations from Technosylva which are computerized simulations of wildfire behavior given an ignition at a location on a particular date. Consequences of fire spread simulations were not considered for PSPS in previous years and were included in 2021 PSPS decision making under the Catastrophic Fire Behavior.

In 2020 PG&E used “Black Swan” to account for high consequence, low probability (“black swan”) events. The inclusion of Black Swan Guidance allowed PG&E to identify lines that may show, for example, low wind-related outage probability but may experience conditions that have been present in some past, catastrophic fire incidents.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q05		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q05		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: EPSS AND PSPS

QUESTION 05

On p. 906, PG&E describes its decision-making process for PSPS. How does the existence of fires in or threatening the potential PSPS areas affect the decision to de-energize?

ANSWER 05

PG&E carefully reviews and considers the location of existing fires and where new fires are detected. PG&E uses the Satellite Fire Detection & Alerting System (FDAS), which uses data from six National Oceanic and Atmospheric Administration (NOAA)/ NASA satellites to detect fires, and other information compiled by PG&E's Hazard and Awareness Warning Center (HAWC) such as intel from field observers and intel directly from our public safety partners to consider the impact of fires in the PSPS areas. Once the presence of fires in the area are known, PG&E will receive direction from the local Authority Having Jurisdiction (AHJ) to de-energize the lines if requested. PG&E will also examine the direction of the forecasted winds to understand how the fire may spread over the period of concern and discuss any effects this may have on the PSPS event. If an active fire may require imminent community evacuations, we would consider how best to support those efforts in relation to PSPS decisions.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q06		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q06		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022]	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: RISK MODELING

QUESTION 06

On page 8, PG&E discusses “new modeling” for ignition risk. Please provide the description of what this “new modeling” consists of or provide and appropriate reference.

ANSWER 06

PG&E is in the process of updating its 2021 Wildfire Distribution Risk Model (WDRM) v2 to the 2022 WDRM v3. *See generally* 2022 WMP, pp. 128-129. The 2022 WDRM v3 extends the probability models to additional equipment failures such as Support Structures and Transformers. In addition, PG&E extended its ignition dataset from 2015 to 2019 ignitions, to include 2015 to 2020 outages, ignitions and observed PSPS damages. PG&E discusses the 2022 WDRM v3 in its 2022 WMP, Section 4.5.1 (b).

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q07		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q07		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: RISK MODELING

QUESTION 07

In Table PG&E-4.2-2; WILDFIRE RISK DRIVERS, the frequency of facility failures plus object contact in the HFTD is 60, compared to 74 for vegetation contact. Frequency of vegetation contact is 23% larger than the other two drivers. For the percentage of risk in the HFTD, equipment failures plus object contact represents 36.6% of the risk, while vegetation contact represents 59.3% of the risk. Frequency of vegetation contact is 62% larger than the other two drivers combined. How does PG&E account for this discrepancy?

ANSWER 07

PG&E notes that the statement in question, “Frequency of vegetation contact is 62% larger than the other two drivers combined” is incorrect and corrected as “Risk of vegetation contact is 62% larger than the other two drivers combined.”

Discrepancy in % frequency and % risk by drivers in Table PG&E-4.2-2 implies that the Consequence of a Risk Event (CoRE) value are different by drivers of a risk event. PG&E’s Bow Tie analysis that produced this table used different CoRE values by circuit segment as well as different Likelihood of Risk Event (LoRE) values by each driver by circuit segment. The circuit segment-level LoRE and CoRE values were then aggregated into the HFTD Distribution tranches in order to produce Table PG&E-4.2-2. Percent frequency by drivers and percent risk by drivers at the HFTD level will not be the same unless we have the same CoRE for all tranches in HFTD.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q08		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q08		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: RISK MODELING

QUESTION 08

On page 129, Figure PG&E-4.5.1-3, 2022 WDRM V3 COMPOSITE MODEL ARCHITECTURE, was the new WDRM V3 used in the GRC update provided in February?

ANSWER 08

No, the 2022 WDRM v3 model was not used to determine workplans described in the 2023 General Rate Case update provided in February.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q10		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q10		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:		Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: RISK MODELING

QUESTION 10

Provide a non-confidential version of documentation describing the IPW model.

ANSWER 10

PG&E does not have a non-confidential version of documentation for the IPW Model. However, the IPW model is described in detail in our 2022 WMP. Please see Section 4.5.1(g), pages 187 - 192, 418 - 419, and 896 - 897.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q11		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q11		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: RISK MODELING

QUESTION 11

On p. 189, PG&E states that the IPW model uses the Cat Boost Machine Learning model. What implementation of the Cat Boost Machine learning model was used for the IPW?

ANSWER 11

We utilized the CatBoost open-source library (v 0.25.1) on Python (v 3.8).

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q12		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q12		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: RISK MODELING

QUESTION 12

On p. 191, PG&E states that with its IPW model

> "Operational Meteorologists used the dashboard to evaluate model performance against key historical storm events, evaluating timing of weather onset compared to modeled outage probability increases, and relative magnitude of outage probabilities."

Please provide tabular and graphical analysis showing how the IPW finds that ignition probability increases versus wind speed for the five driver classes.

ANSWER 12

Please see attachments "WMP-Discovery2022_DR_MGRA_002-Q12Atch01" and "WMP-Discovery2022_DR_MGRA_002-Q12Atch02" for an image and tabular output extracted from the IPW Model exploratory dashboard. We selected data from one event from one node to provide. Note that the CSV file contains output from one 2 x 2 km grid cell in the node, while the image shows output from multiple 2 x 2 km grid cells in the node.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q13		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q13		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: HARDENING AND UNDERGROUNDING

QUESTION 13

On p. 265 PG&E describes its undergrounding efforts

> "including a small volume of previously hardened overhead lines that are being placed underground, and any other undergrounding work performed in HFTD or fire rebuild areas."

How many miles of previously hardened lines are being put underground and what is the motivation for this action?

ANSWER 13

Due to the unique nature of the Camp Fire, the need to restore power to customers who could be served promptly, and the commitment PG&E provided to the impacted community of Paradise post fire, the Butte County Rebuild Program is currently the only program in PG&E that is undergrounding previously hardened overhead. After the fire, PG&E installed approximately 30 miles of hardened primary overhead circuits (with covered conductor) to more quickly restore service to customers within the area PG&E committed to underground. By the end of the Butte County Rebuild Program, all of these hardened overhead lines will be undergrounded.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q14		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q14		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: HARDENING AND UNDERGROUNDING

QUESTION 14

Are the reviews of staff, management, or executives in any way tied to targets related to the successful completion of undergrounding projects?

ANSWER 14

PG&E objects to this request because the issue of annual performance reviews is not relevant to this proceeding.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q15		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q15		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: HARDENING AND UNDERGROUNDING

QUESTION 15

In attachment TN10634-0_20220225T144600_Section_71H_Atch01_WorkMaps, PG&E provides maps for Covered conductor installation, Undergrounding of Electric lines or Equipment, and System hardening including line removal. Please provide these maps as a GIS file.

ANSWER 15

PG&E objects to this request as unduly burdensome. Subject to and without waiving this objection, PG&E responds as follows: The maps provided in Section 7.1.H for covered conductor installation (Section 7.3.3.3), undergrounding of electric lines or equipment (Section 7.3.3.16), and distribution system hardening line removal (Section 7.3.3.17.1) reflect data provided in response to Remedy 21-14, including attachment 2022-02-25_PGE_2022_WMP-Update_R0_Section 4.6_Remedy 21-14_Atch01_Redacted_R1.xlsx.

As indicated on page 332 of the 2022 WMP, PG&E's system of record for planned work projects is SAP, which is not a GIS system. PG&E's GIS systems are maintained for normal operation and status and not for future work proposals. Therefore, requests to produce GIS layers in support of future workplans is an ad-hoc analysis that would require time and significant effort to develop. In addition, including early-stage planning materials into GIS has the potential to create inconsistency and errors among PG&E workstreams and lines of business that rely on GIS information for work planning purposes. Please see attachment 2022-02-25_PGE_2022_WMP-Update_R0_Section 4.6_Remedy 21-14_Atch01_Redacted_R1.xlsx, which constitutes the maximum quickly accessible GIS data points (i.e., Lat/Long of the starting points of the job) presently available for these projects.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q16		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q16		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: HARDENING AND UNDERGROUNDING

QUESTION 16

Please provide a non-confidential version of Data request response WMP-Discovery2022_DR_CalAdvocates_003-Q01Atch01CONF(T) regarding PG&E's hardening program.

ANSWER 16

Please find attached as "WMP-Discovery2022_DR_MGRA_002-Q16Atch01" the requested redacted file. Per instructions, the confidential information has been removed from this document.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q17		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q17		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: SITUATIONAL AWARENESS

QUESTION 17

On p. 319, PG&E states that it has

> "Developed a weather-station specific wind gust model, with particular emphasis on Diablo winds".

Please provide the documentation for this weather model.

ANSWER 17

After benchmarking with SDG&E and SCE, we used the same external expert to produce weather-station specific, machine learning wind gust models for approximately 200 weather stations in our territory. A list of these stations can be found in "WMP-Discovery2022_DR_MGRA_002-Q17Atch01". Below is a description on how each machine learning model was developed.

Observation data was retrieved for each candidate weather station that overlaps with the multidecadal historical weather model output period. For each station, the observation data was first quality controlled. This quality-controlled observation data is then matched to the hourly weather model output of the closest grid cell to each station. An initial comprehensive list of weather model variables is then evaluated to see which predictors have a significant relationship with the predictand (wind gust, in this case). Using Random Forest/XG Boost models across the entire data set period, we attain a unique predictor mixture which minimizes the machine learning model error (MAE, RMSE and BIAS). Finally, these optimized Random Forest/XG Boost models are tested for high-impact weather events not included in the training period. In the end, these models were operationalized to provide output given PG&E input weather forecast model data.

The model itself was developed by a third-party vendor retained by PG&E, ADS, and is proprietary. Therefore, PG&E does not possess any additional documentation describing the model.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q18		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q18		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: SITUATIONAL AWARENESS

QUESTION 18

On how many weather stations is 30 second weather observations collected? How long is the 30 second data maintained on the weather station? Is the 30 second weather data available to the public and are there any plans to make it so?

ANSWER 18

The current number of stations that PG&E can turn on the 30-second weather observations for is 1,030 (out of 1,318 total stations) as of March 24, 2022. This includes the entire PG&E network other than stations that must communicate via L-band satellite. Enabling 30-second weather observations on L-band satellite locations is detrimental to the battery in these stations as the communications are more power intensive versus stations that communicate via cellular modem. We are evaluating upgrading the battery and solar panels on these weather stations to extend the 30-second observation capability to the L-band satellite stations.

For a complete list of stations that have 30-second observations enabled, please see “WMP-Discovery2022_DR_MGRA_002-Q18Atch01".

When this feature is enabled, the 30-second observation data is maintained for 10 minutes on the datalogger (weather station).

The 30-second weather observation data is currently not available to the public and there are no plans at present to make the 30-second observation data available to the public. The existing 10-minute observations will continue to be made publicly available.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q19		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q19		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: SITUATIONAL AWARENESS

QUESTION 19

On p. 384 PG&E states that

> "The phase and magnitude of the Madden-Julian Oscillation was shown to be a potential predictor of upcoming Diablo wind events by both internal and external research.

Provide appropriate citations.

ANSWER 19

Below is link to an external study that looks at the Madden-Julian Oscillation relative to Diablo Winds:

https://ui.adsabs.harvard.edu/abs/2019AGUFM.A23J2945L/abstract.

Please also find an internal study that was performed on this topic titled: "WMP-Discovery2022_DR_MGRA_002-Q19Atch01".

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q20		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q20		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: DATA COLLECTION

QUESTION 20

On p. 765, PG&E states that its

> "EII team conducted audit of multiple work tracking databases to identify ignitions that had been missed in the past, increasing PG&E's reportable ignition record by 23 percent."

Please provide a complete set of the newly identified ignitions in GIS format.

ANSWER 20

Please see the attachment "WMP-Discovery2022_DR_MGRA_002-Q20Atch01" for data responsive to this request. Given the abbreviated timeframe, PG&E has provided this data in the format in which it is maintained in the usual course of business.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q21		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q21		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: DATA COLLECTION

QUESTION 21

Provide the EII “data dictionary/review guide for all collected [ignition] data points” with any confidential information removed.

ANSWER 21

PG&E’s Ignition Tracker Dictionary is provided as an attachment to this request, entitled “WMP-Discovery2022_DR_MGRA_002-Q21Atch01_Redacted.pdf. All confidential information has been removed.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q22		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q22		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: DATA COLLECTION

QUESTION 22

Provide the contents of TABLE PG&E-8.6-1 LIST OF FREQUENTLY DE-ENERGIZED CIRCUITS in Excel format.

ANSWER 22

See attachment “WMP-Discovery2022_DR_MGRA_002-Q22Atch01".

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q23		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q23		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: DATA COLLECTION

QUESTION 23

Please provide the 2022 reportable ignitions report, due to the CPUC on April 1, 2022. Due date for this data request is April 1, 2022.

ANSWER 23

PG&E will provide the 2022 reportable ignitions report when it is finalized and filed on April 1, 2022.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q24		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q24		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: NEW TECHNOLOGIES AND PILOTS

QUESTION 24

On p. 7.1.E-Atch1-21, the RSE for REFCL is given as 40. Please explain the factors that go into reaching this low estimate.

ANSWER 24

The factors that go into reaching the RSE estimate of 40 for REFCL are outlined in attachment WMP-Discovery2022_DR_CalAdvocates_013-Q11Atch01.xls submitted with PG&E's response to Cal Advocates' Data Request, Set 13, Question 11. The RSE is based on the program exposure, effectiveness of ignition frequency reduction, benefit length, and program cost as outlined in the 1-Program Exposure, 3-Eff - Freq Programs, 3-Eff - Freq Programs, and 2-Program Cost tabs of the attachment, respectively. The logic for the RSE calculation is outlined in the RSE Lite Tool Documentation in attachment 2022-02-25_PGE_2022_WMP-Update_R0_Section 7.3.a_Atch10.pdf submitted with the 2022 WMP.

PG&E has not calculated an RSE for the REFCL initiative 7.3.3.17.4. The RSE of 40 is unique to emerging technology projects and is not comparable to the RSEs for Section 7.3 initiatives generally. As mentioned in the response to WMP-Discovery2022_DR_CalAdvocates_013-Q11, further details on the assumptions for the estimated RSE score for the potential value of REFCL technology itself, if eventually proven and fully implemented, can be found in attachment 2022-02-25_PGE_2022_WMP-Update_R0_Section 7.1.E_Atch01.pdf submitted with the 2022 WMP. Please refer to the project titled "EPIC 3.15: Proactive Wires Down Mitigation Demonstration Project (Rapid Earth Fault Current Limiter)". In particular, the projects in Section 7.1.E assume ten years of deployment of the particular technology and an equal benefit life of ten years. We note that the RSE scores in this attachment for Section 7.1.E (New or Emerging Technologies) are also estimates intended to facilitate comparison among the new or emerging technology projects within Section 7.1.E only.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q25		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q25		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: NEW TECHNOLOGIES AND PILOTS

QUESTION 25

In the data request response WMP-Discovery2022_DR_CalAdvocates_013-Q11Atch01.xlsx, please verify the following interpretation: For a REFCL deployment, PG&E projects a $75M capex, plus $141M operating cost through 2026, constituting 14% of its 25,000 miles, and that the protection is 58% effective.

ANSWER 25

Yes, the interpretation is correct and represents the fully implemented state as discussed in attachment 2022-02-25_PGE_2022_WMP-Update_R0_Section 7.1.E_Atch01.pdf. Further clarification: 14% of the miles denote the percentage of miles that are covered by the installation in terms of effectiveness of the technology. The 58% effectiveness denotes the preliminary and estimated effectiveness of REFCL in reducing ignition frequency for the subdrivers listed in the tab 3-Eff - Freq Programs.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_002-Q26		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_002-Q26		
Request Date:	March 23, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest2
Date Sent:	March 28, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: VEGETATION MANAGEMENT

QUESTION 26

On p. 631 PG&E states that its Tree Assessment Tool (TAT) incorporates "local wind gust data". Is the local wind gust data specific to fire weather conditions (such as a Diablo corridor) or does it include winter storm conditions?

ANSWER 26

The windspeed data used to develop the TAT, which incorporates local wind gust data, is comprised of an average of the daily maximum windspeeds for all days from May to November 2006 – 2018. This data includes fire weather conditions and winter storm conditions that occurred from May to November 2006 – 2018. Conditions occurring outside of this timeframe are not included in the data.

PG&E – MGRA – Data Request Response 3-4

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_003-Q01		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_003-Q01		
Request Date:	March 28, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest3
Date Sent:	March 31, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: WILDFIRE RISK MODELING

QUESTION 01

Please explain technically how PG&E's WDRM applies a conditional probability or makes any other adjustment to account for the fact the Technosylva consequence model is run on "worst weather days", while the Probability of Ignition model analyzes all ignitions whether they are on worst weather days or not.

ANSWER 01

The 2021 Wildfire Distribution Risk Model (WDRM) v2 consequence model drew upon acres burned, structures impacted, flame length and rate of spread returned (with FL and ROS combined by Technosylva into a 1-5 Fire Behavior Index, called FBI) by Technosylva simulations, determining fire severity via thresholds of those values (i.e. large fire as greater than 300 acres) for every day of weather simulated. Each day's severity for each simulation location was assigned a consequence consistent with MAVF CoRE and the results were averaged over all simulation days to produce expected dangerous day consequence values for each simulation location.

The 2022 WDRM v3 consequence model draws upon 4 sources of data: the same physical outputs from 2021 updated simulations from Technosylva, satellite detected fires from VIIRS (infrared satellite), CalFire data on fire outcomes correlated to VIIRS fires (used to assign MAVF CoRE values), and daily estimates of the 1-5 scaled R-score produced for every 2x2km square in the territory on a daily basis by the models behind PSPS events. For the 2022 WDRM v3, fire severity for a given day is assessed for "destructive potential" vs. not, where destructive potential is assessed using Technosylva outputs of flame length and rate of spread (with threshold values that provide full recall of historically destructive fires) for historically worst weather <u>and</u> R-scores (4 and above) for all days in the June through November fire season. If either approach evaluates to destructive potential, the day/location is considered to have consequences consistent with the expectation value of MAVF CoRE assigned to fires from the VIIRS data set that also are flagged with destructive potential. The use of R-score allows for the marginalization of consequence values across the entire fire season, not just the worst weather days.

The 2022 WDRM v3 model now trains on outage data, producing P(outage) results with 100x100m resolution (and asset level predictions for support structures and transformers). These results provide fire season probabilities of outages occurring. These are multiplied through by the probability of an ignition given an outage, P(ignition|outage), to produce P(ignition) estimates. The P(ignition|outage) model is trained on all outage and event data using the actual conditions at the time/location of every outage/ignition event and is therefore based on site/day location fuel and wind conditions, among other variables, so its estimates are variable in space and time. As such, they answer the question "if there were an outage of this particular cause/equipment involved at this particular time/location, what are the odds that it would result in an ignition?".

The seasonal P(ignition) value are the result of marginalizing daily P(ignition|outage) values across days from historic fire seasons (i.e. based on daily weather and fuel conditions) to produce a seasonal value derived from daily estimates. In practice, marginalization, amounts to weighting the predictions for each day by the count of outages experience on that day, resulting in greater emphasis being placed on predictions from days that produced a higher count of outages. This calculation is performed separately for each "subset" of outages, so the weights used for vegetation caused outages, for example, are drawn from the historical count of vegetation outages.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_004-Q01		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_004-Q01		
Request Date:	April 1, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest4
Date Sent:	April 5, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: WILDFIRE RISK MODELING

In PG&E's response to MGRA Data Request 3, PG&E states that:

> ***For the 2022 WDRM v3, fire severity for a given day is assessed for "destructive potential" vs. not, where destructive potential is assessed using Technosylva outputs of flame length and rate of spread (with threshold values that provide full recall of historically destructive fires) for historically worst weather and Rscores (4 and above) for all days in the June through November fire season. If either approach evaluates to destructive potential, the day/location is considered to have consequences consistent with the expectation value of MAVF CoRE assigned to fires from the VIIRS data set that also are flagged with destructive potential.***

QUESTION 01

In the WDRM v3 model, has Cal Fire outcome data derived from VIIRS correlation now replaced the 8 hour Technosylva simulation?

ANSWER 01

No, it is used in tandem as described in the cited response.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_004-Q02		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_004-Q02		
Request Date:	April 1, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest4
Date Sent:	April 5, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: WILDFIRE RISK MODELING

In PG&E's response to MGRA Data Request 3, PG&E states that:

> ***For the 2022 WDRM v3, fire severity for a given day is assessed for "destructive potential" vs. not, where destructive potential is assessed using Technosylva outputs of flame length and rate of spread (with threshold values that provide full recall of historically destructive fires) for historically worst weather and Rscores (4 and above) for all days in the June through November fire season. If either approach evaluates to destructive potential, the day/location is considered to have consequences consistent with the expectation value of MAVF CoRE assigned to fires from the VIIRS data set that also are flagged with destructive potential.***

QUESTION 02

What is the remaining role of Technosylva simulation in the v3 model?

ANSWER 02

As described, the Flame Length and Rate of Spread values from the Technosylva model are used in the development of the Wildfire Consequence values.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_004-Q03		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_004-Q03		
Request Date:	April 1, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest4
Date Sent:	April 5, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: WILDFIRE RISK MODELING

In PG&E's response to MGRA Data Request 3, PG&E states that:

> ***For the 2022 WDRM v3, fire severity for a given day is assessed for "destructive potential" vs. not, where destructive potential is assessed using Technosylva outputs of flame length and rate of spread (with threshold values that provide full recall of historically destructive fires) for historically worst weather and Rscores (4 and above) for all days in the June through November fire season. If either approach evaluates to destructive potential, the day/location is considered to have consequences consistent with the expectation value of MAVF CoRE assigned to fires from the VIIRS data set that also are flagged with destructive potential.***

QUESTION 03

If the Technosylva outputs are linked to the VIIRS data, how is this linkage performed?

ANSWER 03

The Technosylva data is linked to the VIIRS data by the geospatial location of the fire in the VIIRS data set and the location of the Technosylva simulation.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_004-Q04		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_004-Q04		
Request Date:	April 1, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest4
Date Sent:	April 5, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: WILDFIRE RISK MODELING

In PG&E's response to MGRA Data Request 3, PG&E states that:

> ***For the 2022 WDRM v3, fire severity for a given day is assessed for "destructive potential" vs. not, where destructive potential is assessed using Technosylva outputs of flame length and rate of spread (with threshold values that provide full recall of historically destructive fires) for historically worst weather and Rscores (4 and above) for all days in the June through November fire season. If either approach evaluates to destructive potential, the day/location is considered to have consequences consistent with the expectation value of MAVF CoRE assigned to fires from the VIIRS data set that also are flagged with destructive potential.***

QUESTION 04

Specify how consequences are assigned from the VIIRS fires to the Cal Fire fire outcome data set. Is this assignment based on a specific mapping, on averages, or on a Monte Carlo.

ANSWER 04

The VIIRS sub-daily fire detections were combined with agency fire information via our partner Sonoma Technology, Inc (STI). This was done by mapping the date/time of fire detections to the date/time of fires in agency databases.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_004-Q05		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_004-Q05		
Request Date:	April 1, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest4
Date Sent:	April 5, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: WILDFIRE RISK MODELING

In PG&E's response to MGRA Data Request 3, PG&E states that:

> ***For the 2022 WDRM v3, fire severity for a given day is assessed for "destructive potential" vs. not, where destructive potential is assessed using Technosylva outputs of flame length and rate of spread (with threshold values that provide full recall of historically destructive fires) for historically worst weather and Rscores (4 and above) for all days in the June through November fire season. If either approach evaluates to destructive potential, the day/location is considered to have consequences consistent with the expectation value of MAVF CoRE assigned to fires from the VIIRS data set that also are flagged with destructive potential.***

QUESTION 05

PG&E states that: "The seasonal P(ignition) value are the result of marginalizing daily P(ignition|outage) values across days from historic fire seasons (i.e. based on daily weather and fuel conditions) to produce a seasonal value derived from daily estimates.

ANSWER 05

PG&E notes that this does not appear to be a separate question, but instead appears to be an introduction to Question 06.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2022
Data Response

PG&E Data Request No.:	MGRA_004-Q06		
PG&E File Name:	WMP-Discovery2022_DR_MGRA_004-Q06		
Request Date:	April 1, 2022	Requester DR No.:	MGRA-PGE-WMP22_DataRequest4
Date Sent:	April 5, 2022	Requesting Party:	Mussey Grade Road Alliance
PG&E Witness:		Requester:	Joseph Mitchell

SUBJECT: WILDFIRE RISK MODELING

In PG&E's response to MGRA Data Request 3, PG&E states that:

> ***For the 2022 WDRM v3, fire severity for a given day is assessed for "destructive potential" vs. not, where destructive potential is assessed using Technosylva outputs of flame length and rate of spread (with threshold values that provide full recall of historically destructive fires) for historically worst weather and Rscores (4 and above) for all days in the June through November fire season. If either approach evaluates to destructive potential, the day/location is considered to have consequences consistent with the expectation value of MAVF CoRE assigned to fires from the VIIRS data set that also are flagged with destructive potential.***

QUESTION 06

Is the seasonal P(ignition) multiplied by a seasonal estimate of consequence scores to obtain a seasonal risk score for each driver? Or is the daily (ignition|outage) multiplied by the daily consequence score, and the risk score averaged over season? If neither of these mechanisms explain risk scoring provide additional detail.

ANSWER 06

Yes, the fire season P(ignition) is multiplied by a season estimate of wildfire consequence to option the wildfire seasonal risk score for each driver at each location.

A-2 SCE Data Request Responses

SCE – MGRA – Data Request Response 1

Southern California Edison
2022-WMPs – 2022 Wildfire Mitigation Plan Updates

DATA REQUEST SET M G R A - S C E - 0 0 1

To: MGRA
Prepared by: David W Holder
Job Title: Sr. GIS Tech Spec
Received Date: 2/7/2022

Response Date: 2/17/2022

Question 01 - 08:
01. Please provide for Asset Point data for Camera, Fuse, Support Structure, and Weather Station. Data for Connection Device, Lightning Arrester, Substation,
Switchgear, Transformer Site, and Transformer Detail are optional. Customer Meter data is specifically excluded from this request for privacy reasons.

02. Provide Asset Line data for Transmission Line (as permitted as non-confidential), Primary Distribution Line, and Secondary Distribution Line.

03. Provide PSPS Event data. Include Event Log, Event Line, Event Polygon data.
Please exclude customer meter data. Provide all PSPS Event Asset Damage data including photos.

04. Provide Risk Event Point data, including Wire Down, Ignition, Transmission unplanned outage (as classified non-confidential), Distribution Unplanned Outage
data, Risk Event Asset Log, and Risk Event Photo Log.

05. Provide photo data for Ignition and Wire Down events.

06. Under Initiatives, please provide Grid Hardening data, including Hardening Log, Hardening Point, and Hardening Line data. Inspection data is not requested at this time.

07. Under Initiatives, please provide Other Initiative data for point, line, polygon features and the Other Initiative Log.

08. Under Other Required Data, please provide Red Flag Warning Day polygon data.

Response to Question 01 - 08:
SCE has provided the following data layers deemed non-confidential in the zipped geodatabase:

- SCE_Camera_2021_Q4
- SCE_WeatherStation_2021_Q4
- SCE_VegetationInspectionPoint_2021_Q4
- SCE_VegetationManagementProjectPoint_2021_Q4
- SCE_VegetationManagementProjectPolygon_2021_Q4
- SCE_AdministrativeArea_2021_Q4
- SCE_MajorWoodyStemExemptTreePoint_2021_Q4

- SCE_RedFlagWarningDayPolygon_2021_Q4
- SCE_PspsEventDamagePoint_2021_Q4
- SCE_DistributionVegetationCausedUnplannedOutage_2021_Q4
- SCE_PspsEventLog_2021_Q4
- SCE_VegetationInspectionLog_2021_Q4
- SCE_VegetationManagementProjectLog_2021_Q4

SCE – MGRA – Data Request Response 2

Southern California Edison
2022-WMPs – 2022 Wildfire Mitigation Plan Updates

DATA REQUEST SET M G R A - S C E - 0 0 2

To: MGRA
Prepared by: Ryan Stevenson
Job Title: Senior Advisor
Received Date: 3/7/2022

Response Date: 3/10/2022

Question 01:
Please provide copies of all received data requests and responses for all intervenors other than MGRA that are not already posted on SDG&E's website.

Response to Question 01:
Copies of all non-confidential data request responses can be found on SCE's WMP website (https://www.sce.com/safety/wild-fire-mitigation). To receive copies of confidential data request responses, SCE requires a NDA.

Southern California Edison
2022-WMPs – 2022 Wildfire Mitigation Plan Updates

DATA REQUEST SET M G R A - S C E - 0 0 2

To: MGRA
Prepared by: Krystyna R Bork
Job Title: Sr. Tech Spec
Received Date: 3/7/2022

Response Date: 3/15/2022

Question 02:
Please provide a GIS shapefile that shows OH distribution assets that have been 1) hardened with covered conductor 2) are planned for hardening in 2022, and 3) are untreated.

Response to Question 02:
The SCE_2021_CoveredConductor.gdb has been uploaded and includes feature classes for the OH distribution assets hardened with covered conductor in 2021, OH assets planned for hardening in 2022, and a feature class of untreated OH distribution assets. Please note that the feature class of untreated OH distribution assets may include OH assets planned for hardening in 2022.

Southern California Edison
2022-WMPs – 2022 Wildfire Mitigation Plan Updates

DATA REQUEST SET M G R A - S C E - 0 0 2

To: MGRA
Prepared by: Eric X Wang
Job Title: Senior Manager
Received Date: 3/7/2022

Response Date: 3/10/2022

Question 03:
Please provide a GIS shapefile that indicates "high consequence" segments of the distribution system. (p. 5)

Response to Question 03:
This response would require granular locational information on high consequence risk line segments within SCE's HFRA. The requested information is confidential and therefore cannot be provided without a NDA.

Southern California Edison
2022-WMPs – 2022 Wildfire Mitigation Plan Updates

DATA REQUEST SET M G R A - S C E - 0 0 2

To: MGRA
Prepared by: David W Holder
Job Title: Sr. Tech Spec
Received Date: 3/7/2022

Response Date: 3/10/2022

Question 04:
Provide the layer WMP_2022_4_5_2_Red_Flag_Warning_Frequency referenced on p. 102, if not already provided.

Response to Question 04:
The layer WMP_2022_4_5_2_Red_Flag_Warning_Frequency is in the zipped geodatabase file attachment MGRA_SCE_002_Q4.gdb.zip.

Southern California Edison
2022-WMPs – 2022 Wildfire Mitigation Plan Updates

DATA REQUEST SET M G R A - S C E - 0 0 2

To: MGRA
Prepared by: David W Holder
Job Title: Sr. Tech Spec
Received Date: 3/7/2022

Response Date: 3/10/2022

Question 05:
Provide the layer WMP_2022_4_5_2_High_Wind_Warning_Frequency referenced on p. 104, if not already provided.

Response to Question 05:
The layer WMP_2022_4_5_2_High_Wind_Warning_Frequency is in the zipped geodatabase file attachment MGRA_SCE_002_Q5.gdb.zip.

Southern California Edison
2022-WMPs – 2022 Wildfire Mitigation Plan Updates

DATA REQUEST SET M G R A - S C E - 0 0 2

To: MGRA
Prepared by: Michelle R Ochoa
Job Title: Legal Support Specialist
Received Date: 3/7/2022

Response Date: 3/8/2022

Question 06:
Provide table 4-18 (Wildfire and PSPS Risk Model Inventory) in Excel format.

Response to Question 06:
Please see the Excel attachment.

Southern California Edison
2022-WMPs – 2022 Wildfire Mitigation Plan Updates

DATA REQUEST SET M G R A - S C E - 0 0 2

To: MGRA
Prepared by: Kyle Ferree
Job Title: Advisor
Received Date: 3/7/2022

Response Date: 3/10/2022

Question 07:
Provide the analysis that shows that "2021 PSPS mitigation efforts likely reduced CMI by at least 45%, number of customers de-energized by 44%, and number of circuits de-energized by 33% from what they otherwise could have been" (p. 10).

Response to Question 07:
Please see the attached document for details of each event's backcast and the summarized totals for scope (customer interruptions), frequency (circuit de-energizations) and duration (customer minutes of interruption).

DATA REQUEST SET M G R A - S C E - 0 0 2

To: MGRA
Prepared by: David Michael Siuta
Job Title: Senior Advisor, Meteorology
Received Date: 3/7/2022

Response Date: 3/10/2022

Question 08:
Please provide analysis describing and supporting SCE's use of machine learning to enhance its weather station predictions, including verification statistics. (p. 30)

Response to Question 08:
Weather model forecasts are subject to error from imperfect initial conditions sources, incomplete representation of the underlying terrain, and scientific unknowns affecting small-scale meteorological processes. These sources of error can be random or systematic (repeatable) and are some of the primary limitations of weather model-based forecasts. To overcome these challenges, meteorologists can employ statistical methods such as machine learning (ML) to remove forecast biases from weather models resulting in improved forecasts when evaluated against observed values.

ML modeling is a statistical approach which trains a set of predictor variables against a known set of outcomes to result in a model that minimizes the error in the prediction. Once these models are trained, they are applied to future scenarios (forecasts) given the same predictors as input. For SCE, the predictors for the ML modeling are derived from SCE's in-house 2-KM deterministic WRF model. Table 1, below, is a comparative verification aggregated over six case studies between the 2-KM deterministic WRF model forecast and the ML model forecast at the 64 weather station point locations currently operational at SCE. The verification demonstrates the improvements the ML modeling approach provides over the 2-KM deterministic WRF model forecast with respect to the ability to differentiate between locations that will exceed set sustained wind speed or gust wind speed thresholds from those that will not exceed thresholds.

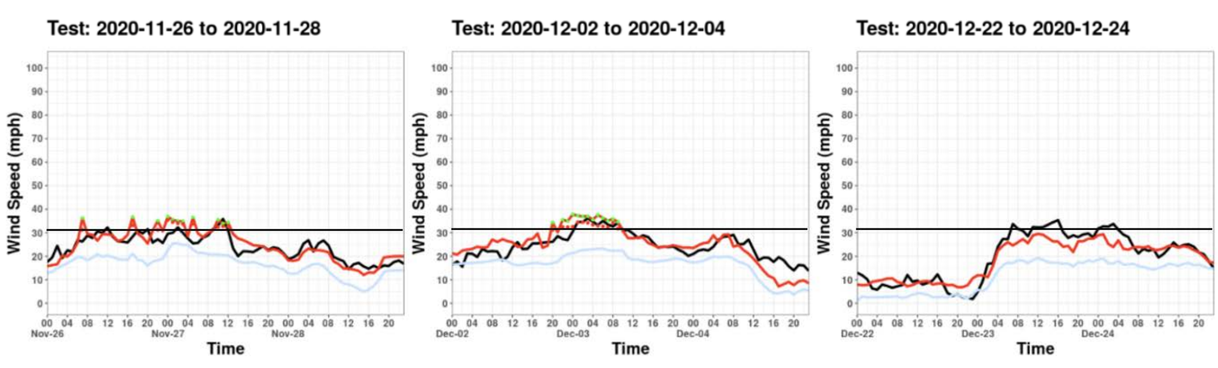
A forecast hit is a forecast and corresponding observation that exceeds a set threshold. A forecast miss occurs when an observed value exceeds the threshold, but the forecast does not. Finally, a false positive occurs when the forecast exceeds threshold, but the corresponding observed value remains below threshold. For this analysis, SCE used set thresholds of 31 MPH for the sustained wind speed and 46 MPH for the gust wind speed to determine the hit, miss, and false positive percentage. Over the test cases, the ML model improved the hit percentage for gust wind speeds by 33.5%, reduced misses by 33.5%, and reduced false positives by 8.7% (Table 1). For sustained winds, the hit percentage was improved by 49.8%, the miss percentage reduced by 49.8%, and false positives reduced by 29.7%.

Table 1: Hit, Miss, and False Positive Percentage statistics derived over six test cases prior to implementing the machine learning (ML) models at SCE. WRF represents the 2-KM deterministic WRF model forecast. Forecasts from both systems were derived at equivalent weather station point locations prior to performing the comparison. A total of 8,965 forecast-observation pairs were evaluated in the comparison.

Threshold	**46 MPH Gust**		**31 MPH Sustained**	
(n=8965)	**WRF**	**ML**	**WRF**	**ML**
Hit %	34.2	67.7	10.8	60.6
Miss %	65.8	32.3	89.2	39.4
False Positive (%)	44.1	35.4	65.8	36.1

Since the 2-KM deterministic WRF model is used as input into the ML model, the changes in verification scores between the two model sources provided in Table 1 can be interpreted directly as improvements gained by reducing bias in a weather model forecast. A more direct demonstration of this effect is provided in Figure 1, below, which compares the ML forecasts (red) and the 2-KM deterministic WRF model (blue) to the observations (black) at three separate case studies for the SCE Oat Mountain weather station location. In each case in Figure 1, the 2-KM deterministic WRF model forecast (blue) is consistently lower in magnitude than the ML forecast (red). The ML forecast (red) provides a closer fit to the observations (black). Additionally, the horizontal black line represents a threshold of 31 MPH sustained. In two of the three cases shown, the ML forecast correctly predicted winds to exceed the 31 MPH threshold, while in the third case, the ML forecast was much closer to the threshold than the raw weather model.

Figure 1: Forecast timeseries comparison at the SCE Oat Mountain weather station location for the machine learning forecast (red) and 2-KM deterministic WRF model (blue). Observations are provided in the black curve.



DATA REQUEST SET M G R A - S C E - 0 0 2

To: MGRA
Prepared by: Elim Li
Job Title: Senior Specialist
Received Date: 3/7/2022

Response Date: 3/10/2022

Question 09:
Please provide the analysis supporting the conclusion that fire resistant poles have an RSE of 3,725. (p. 72).

Response to Question 09:

SCE's general RSE calculation methodology can be found on page 69 of its 2022 WMP Update.

In summary, the calculation for the FR Poles RSE follows the steps below:

1. Use historical counts to forecast baseline (in absence of mitigations) CPUC ignition counts.
2. Gather data for the program (FR Poles):
    a. Cost forecast, factoring in costs from enabling activities
    b. Mitigation Effectiveness values (between 0-100%), denoting the effectiveness of reducing
        i. Risk driver frequency (which accounts for post-construction quality control findings), and
        ii. Consequence of events (0% overall, since FR Poles is not a consequence mitigation)
    c. Prospective units to be installed, and
    d. Years of useful life
3. Calibrate the WRRM to the forecast baseline 2022 CPUC ignition levels, converting probabilities to frequencies.
4. Estimate risk reduction on potential 2022 scope
    a. Since scope is not yet determined, filter for potential scope — high-fire locations that do not have covered conductor yet installed
    b. Use the risk buydown curve to mark the highest risk locations up to the number of units to be installed in 2022
    c. Calculate the risk reduction on those locations by applying the mitigation effectiveness to the particular asset's risk drivers and/or consequences and comparing the resulting risk with the baseline risk. The difference is the risk reduction.
5. Calculate the net present value (NPV) of the risk reduction by applying the years of useful life as the time horizon.

6. Calculate the RSE by dividing the NPV of risk reduction by the cost forecast.

The attached Excel spreadsheet contains the key data inputs used in the RSE calculation.

- "mitigation_units_FR_Poles":
  - (2a) 2022 costs, including enabling activity costs
  - (2c) 2022 count of prospective installations,
  - (2d) useful life
- "mit_eff_driver_FR_Poles":
  - (2bi) Mitigation effectiveness of reducing risk driver frequencies
- "mit_eff_conseq_FR_Poles":
  - (2bii) Mitigation effectiveness of reducing consequences of events

Further, if helpful, SCE can provide the R script that runs the modeling calculations, upon request.

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DATA REQUEST SET M G R A - S C E - 0 0 2

To: MGRA
Prepared by: Kyle Ferree
Job Title: Advisor
Received Date: 3/7/2022

Response Date: 3/10/2022

Question 10:
Please provide a version of Figure SCE 8-10 (p. 554) "Annual Circuit Hours Exceeding Control Points by Circuit Condition" that is normalized for the total number of circuit miles of hardened/not hardened circuit. (i.e. Circuit Hours per mile)

Response to Question 10:
SCE objects to Question 10 to the extent it seeks the creation of a new study, analysis, or presentation of data in a format that does not exist. Subject to and without waiving the foregoing objection, SCE responds as follows: Figure SCE 8-10 cannot be "normalized" by circuit condition because circuit condition has no bearing on the outcomes in the graph. The data labels for "not hardened" and "hardened" refer to the typical thresholds for those types of circuits and not the actual conditions of the circuit miles. The figure illustrates the frequency with which the entire population of SCE's HFRA circuits exceed the two controls points, regardless of the condition of a circuit, what the circuit's PSPS thresholds were, or if SCE called a PSPS event or not.

DATA REQUEST SET M G R A - S C E - 0 0 2

To: MGRA
Prepared by: Aja Clarke
Job Title: Senior Manager Technology Engagement
Received Date: 3/7/2022

Response Date: 3/9/2022

Question 11:
SCE states that it "actively disseminates findings from its research projects and policy recommendations through industry conferences and publishing the work in technical journals." (p. 80) Please provide a list of publications by SCE and its staff referenced in this statement.

Response to Question 11:
SCE publishes in multiple technical journals. From 2020 to the present date some of the publications are included below in the listed digital/print publications and conference proceedings. SCE staff can be found in the bylines.

- **CIGRE Canada Conference**
  - "Hardware-In-the-Loop Testing of Transient Ground Fault Detection Function for Wildfire Mitigation Applications" (Oct. 2020)
- **IEEE/PES (Institute of Electrical and Electronics Engineers' Power & Energy Society) Transmission and Distribution Conference and Exposition**
  - "12kV Covered Conductor Testing" (Oct. 2020)
  - "Study of End Point Voltage Measurements on Distribution Systems for Avoiding Open or Falling Conductors from Evolving to Ground Faults and Wildfire Ignitions" (Anticipated Apr. 2022)
- **IEEE PES Publications**
  - "Testing the Increased Sensitivity and Energy Reduction of a Ground Fault Neutralizer for Wildfire Mitigation" (Anticipated Jul. 2022)
- **IEEE Transactions on Power Delivery**
  - "Resonant Grounded Isolation Transformers to Prevent Ignitions From Powerline Faults" (Vol. 36, No. 4, Aug. 2021)
- **Jodie Lane National Conference**
  - "Ground Fault Neutralizers to Reduce Electrical Hazards from Single Phase-to-Ground Faults" (Nov. 2020)
- **NEMA (National Electrical Manufacturers Association) Magazine**
  - "Coming to America: The Ground Fault Neutralizer" (Vol. 26, No. 1, Jan/Feb. 2021)
- **SES & technologies ltd. Users Group Conference Proceedings**
  - "Balancing Charging Current on Three Wire Circuits with Capacitive Balancing Units Injecting Continuous Current into Grounding Electrodes" (Jun. 2021)

- **T&D World Magazine**
  - "Wildfire Mitigation: SCE's Approach to Isolating Ground Faults" (Aug. 2020)
  - "Heading Off Southern California Wildfires: Distribution Open Phase Detection" (Jan. 2022)
- **T&D World Wildfire & Risk Mitigation**
  - Webinar: *SCE's Approach to Isolating Ground Faults* (Dec. 2020)
- **The Western Protective Relay Conference**
  - "Rapid Ground Fault Detection in Compensated-Grounded Systems: Design and Testing" (Oct. 2020)
  - "A Proposed Scheme to Protect Transformer Bank and Arc Suppression Coil in Compensated-Grounded Distribution Systems" (Oct. 2021)
- **Western Energy Institute Conference**
  - "Wildfire Mitigation, Protection, and System Grounding Discussion" (Apr. 2021)

DATA REQUEST SET M G R A - S C E - 0 0 2

To: MGRA
Prepared by: Eric X Wang
Job Title: Senior Manager
Received Date: 3/7/2022

Response Date: 3/9/2022

Question 12:
SCE states that "it has sufficient quantities of data to draw correlations between wind speeds and wind-driven outages for a climate zone level" (p. 115). Please provide the analysis showing outage/wind correlations at the climate zone level.

Response to Question 12:
Please see zone level outage and wind speed correlation plots in zip file "Zone_Wind_And_Outage_Plots.zip."

Please note that SCE has only performed analysis on its HFRA circuits in those zones. No HFRA circuits are in zones 7 and 8, therefore no analysis was done for those two zones.

DATA REQUEST SET M G R A - S C E - 0 0 2

To: MGRA
Prepared by: Raymond Fugere
Job Title: Principal Manager
Received Date: 3/7/2022

Response Date: 3/9/2022

Question 13:
SCE states that "Fires that burn over 10,000 acres in the first 8 hours on average burn over 100,000 acres." (p. 214). Please provide the analysis that leads to this conclusion.

Response to Question 13:
SCE utilized the website www.simtable.com, which contains fire progression data of wildfires. SCE pulled all data of California fires between 2017 and 2020, and estimated the fire size at 8 hours using this. SCE then averaged the final fire size of fires that went over 10,000 acres within the first 8 hours. The excel file entitled "MGRA-SCE-002-Question13_Response.xlsx," contains the information used to support this statement. Column I entitled "Time" is the duration in days between the fire start date and time and the fire date and time closest to 8 hours recorded from the website. This was used to adjust the fire size to approximate the fire size at 8 hours.

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DATA REQUEST SET M G R A - S C E - 0 0 2

To: MGRA
Prepared by: Tom Rolinski
Job Title: Fire Scientist
Received Date: 3/7/2022

Response Date: 3/10/2022

Question 14:
Does the "Building Loss Factor" (p. 288) take into account building age?

Response to Question 14: No it does not.

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DATA REQUEST SET M G R A - S C E - 0 0 2

To: MGRA
Prepared by: Jesse Rorabaugh
Job Title: Senior Engineer
Received Date: 3/7/2022

Response Date: 3/9/2022

Question 15:
How many miles of its distribution system will be covered by the GFN (REFCL) installation on the Acton and Phelan substations in 2023? (p. 135)

Response to Question 15:
Ground Fault Neutralizers increase ground fault sensitivity and reduce energy release from ground faults across all the circuitry supplied by the bus where they are installed.

At Acton substation, the Ground Fault Neutralizer will operate on a total of 204 miles of circuitry. All of the circuitry is in HFRA and 157 miles are overhead.

At Phelan substation, the Ground Fault Neutralizer will operate on a total of 473 miles of circuitry. Of this circuitry, 389 miles is overhead and 140 miles of that is in HFRA.

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DATA REQUEST SET M G R A - S C E - 0 0 2

To: MGRA
Prepared by: Jesse Rorabaugh
Job Title: Senior Engineer
Received Date: 3/7/2022

Response Date: 3/9/2022

Question 16:
Can REFCL be retroactively applied to existing covered conductor circuits?

Response to Question 16:
REFCL and covered conductor are fully independent programs. Either program can be applied first. Circuits out of the Acton and Phelan substations have existing covered conductor and will have covered conductor work mostly complete before the Ground Fault Neutralizer is turned on. Currently, circuits out of the Neenach substation are mostly bare wire but some covered conductor has been installed since the Ground Fault Neutralizer has been installed.

DATA REQUEST SET M G R A - S C E - 0 0 2

To: MGRA
Prepared by: Stephen Augustine
Job Title: Engineer
Received Date: 3/7/2022

Response Date: 3/10/2022

Question 17:
SCE states that "Between October 2020 to end of 2021, SCE evaluated 10 instances where the EFD technology detected undesirable, degraded, or pre-failure system conditions where repairs have subsequently been completed." (p. 244)
Please provide a list of any other reported pre-failure system conditions on the circuits with EFD installed that were detected by visual inspection and not detected by EFD.

Response to Question 17:
SCE collected the inspection findings on the relevant circuits for the mentioned timeframe. The results were then filtered to remove inspection findings that were:

1. Repaired prior to EFD in-service dates or,
2. Not on the portion of circuitry monitored by EFD or,
3. Unrelated to EFD detection capabilities such as missing high voltage signs.

Based on descriptions from visual inspections, the following 8 pre-failure conditions were found during visual inspections and not detected or investigated as part of the EFD project. However, though investigation thresholds were not exceeded for these locations, the EFD sensors may have in fact detected these conditions. SCE will further review these 8 events for broader understanding and possible improvements in detection investigation processes.

Circuit Name	SCE District	Structure	Notification Voltage Class	Notification Type	Notification Component	Finding Source
APPALOUSA	WILDOMAR	OH-2207380E	Distribution Primary	Damaged/ Broken	Insulator	Overhead Detail Inspection
BENCH	REDLANDS	OH-2162152E	Distribution Primary	Damaged/ Broken	Cable/ Conductor	Overhead Detail Inspection
BLACKFOOT	MENIFEE	OH-1796623E	Distribution Primary	Damaged/ Broken	Cable/ Conductor	Overhead Detail Inspection

MENIFEE	MENIFEE	OH-215613S	Distribution Secondary	Vegetation/ Tree	Cable/ Conductor	Overhead Detail Inspection
OAKDALE	MENIFEE	OH-216488S	Distribution Primary	Damaged/ Broken	Insulator	Overhead Detail Inspection
RIVA	VENTURA	OH-1203743E	Distribution Primary	Damaged/ Broken	Cable/ Conductor	Overhead Detail Inspection
TRAUTWEIN	MENIFEE	OH-1594786E	Distribution Primary	Damaged/ Broken	Cable/ Conductor	Overhead Detail Inspection
TRAUTWEIN	MENIFEE	OH-2309846E	Distribution Secondary	Loose	Cable/ Conductor	Overhead Detail Inspection

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DATA REQUEST SET M G R A - S C E - 0 0 2

To: MGRA
Prepared by: Ignacio Sanchez
Job Title: Engineering Manager
Received Date: 3/7/2022

Response Date: 3/10/2022

Question 18:
Regarding the expansion of SCE's Hi-Z relay pilot (p. 245), as part of this pilot does SCE induce any failures to test performance of the relay or does the data collected consist only of actual faults in the field?

Response to Question 18:
SCE has not induced any failures to test performance on the Hi-Z element. However, SCE is in the process of setting up a testbed at one of its substations and will induce abnormal conditions on a circuit with Hi-Z relays installed. SCE is targeting performance of this test by the end of the second quarter in 2022. Further, the expansion of the SCE Hi-Z pilot will provide additional field data on abnormal circuit conditions to better determine the performance and security of the Hi-Z element.

SCE – MGRA – Data Request Response 3-4

Southern California Edison
2022-WMPs – 2022 Wildfire Mitigation Plan Updates

DATA REQUEST SET M G R A - S C E - 0 0 3

To: MGRA
Prepared by: Eric X Wang
Job Title: Sr. Manager
Received Date: 3/28/2022

Response Date: 3/30/2022

Question 01:
Please explain technically how SCE's planning risk model applies a conditional probability or makes any other adjustment to account for the fact the Technosylva consequence model is run on "worst weather days", while the Probability of Ignition model analyzes all ignitions whether they are on worst weather days or not.

Response to Question 01:

SCE's planning risk model is mainly used for long-term planning and grid-hardening purposes; therefore, it's important that the model can help prioritize work based on risk rankings with a consistent risk measurement.

SCE's risk model was developed in two separate steps: The Probability of Ignition (POI) part and the consequence of fire part. The POI model provides the probability that an ignition may start at a given location from SCE's line and/or equipment. The consequence model captures the potential outcome that a fire may cause if started from that location.

Technosylva consequence model is run on "worst weather days" to simulate possible worst outcomes that the fire may cause if a fire were to start from the simulated location. However, any fire has the potential to become large with significant impacts even during non "worst weather days".

The risk calculated using SCE's POI model and consequence model provides a consistent way to measure potential risks across SCE's HFRA, which can be used to help prioritize work based on risk rankings.

Southern California Edison
2022-WMPs – 2022 Wildfire Mitigation Plan Updates

DATA REQUEST SET M G R A - S C E - 0 0 3

To: MGRA
Prepared by: Eric X Wang
Job Title: Sr. Manager
Received Date: 3/28/2022

Response Date: 3/29/2022

Question 02:
Regarding SCE's response to MGRA-SCE-002-Q12

Please provide a GIS file showing SCE's fire risk zones used in the outage plots provided in response to the data requests.

Response to Question 02:

Please see file "MGRA-SCE-003_Q2_SCE_Fire_Zones.zip" showing SCE's fire risk zones.

DATA REQUEST SET M G R A - S C E - 0 0 3

To: MGRA
Prepared by: Eric X Wang
Job Title: Sr. Manager
Received Date: 3/28/2022

Response Date: 3/29/2022

Question 03:
Please provide a description of how the plots provided in the data response were created, including:
- What weather station was paired with each outage.?
- How was the baseline number of wind values for each wind measurement obtained in order to normalize against the number of outages?

Response to Question 03:

The weather data used in this analysis was not from weather stations due to the fact that SCE does not have enough weather stations historically to provide the granular data to support this analysis. Instead, SCE used Atmospheric Data Solutions (ADS) historical weather data that was created based on the Weather Research and Forecasting (WRF) model. The ADS historical weather data is generated hourly at a 2km*2km grid level. The ADS weather data was used to pair with each outage at the grid level.

For each wind-driven outage as identified in SCE's Outage Database and Reliability Metrics (ODRM) database, based on the location and time of the event, the corresponding wind data was processed using the ADS data based on the grid where the location was in and the time in which the event happened.

Southern California Edison
2022-WMPs – 2022 Wildfire Mitigation Plan Updates

DATA REQUEST SET M G R A - S C E - 0 0 3

To: MGRA
Prepared by: Eric X Wang
Job Title: Sr. Manager
Received Date: 3/28/2022

Response Date: 3/29/2022

Question 04:
Please provide a tabular list of the data displayed in the 12_Zone_Wind_And_Outage_Plots.

Response to Question 04:

Please see file “MGRA-SCE-003_Q4_Wind_Outage_Plot_Data.xlsx” for the detailed data that was used for the wind and outage plots. The file is organized by fire zones in different tabs.

A-3 SDG&E Data Requests

SDG&E – MGRA – Data Request Response 1

Date Received: February 07, 2022
Date Submitted: February 17, 2022

I. GENERAL OBJECTIONS

1. SDG&E objects generally to each request to the extent that it seeks information protected by the attorney-client privilege, the attorney work product doctrine, or any other applicable privilege or evidentiary doctrine. No information protected by such privileges will be knowingly disclosed.

2. SDG&E objects generally to each request that is overly broad and unduly burdensome. As part of this objection, SDG&E objects to discovery requests that seek "all documents" or "each and every document" and similarly worded requests on the grounds that such requests are unreasonably cumulative and duplicative, fail to identify with specificity the information or material sought, and create an unreasonable burden compared to the likelihood of such requests leading to the discovery of admissible evidence. Notwithstanding this objection, SDG&E will produce all relevant, non-privileged information not otherwise objected to that it is able to locate after reasonable inquiry.

3. SDG&E objects generally to each request to the extent that the request is vague, unintelligible, or fails to identify with sufficient particularity the information or documents requested and, thus, is not susceptible to response at this time.

4. SDG&E objects generally to each request that: (1) asks for a legal conclusion to be drawn or legal research to be conducted on the grounds that such requests are not designed to elicit facts and, thus, violate the principles underlying discovery; (2) requires SDG&E to do legal research or perform additional analyses to respond to the request; or (3) seeks access to counsel's legal research, analyses or theories.

5. SDG&E objects generally to each request to the extent it seeks information or documents that are not reasonably calculated to lead to the discovery of admissible evidence.

6. SDG&E objects generally to each request to the extent that it is unreasonably duplicative or cumulative of other requests.

7. SDG&E objects generally to each request to the extent that it would require SDG&E to search its files for matters of public record such as filings, testimony, transcripts, decisions, orders, reports or other information, whether available in the public domain or through FERC or CPUC sources.

8. SDG&E objects generally to each request to the extent that it seeks information or documents that are not in the possession, custody or control of SDG&E.

9. SDG&E objects generally to each request to the extent that the request would impose an undue burden on SDG&E by requiring it to perform studies, analyses or calculations or to create documents that do not currently exist.

10. SDG&E objects generally to each request that calls for information that contains trade secrets, is privileged or otherwise entitled to confidential protection by reference to statutory protection. SDG&E objects to providing such information absent an appropriate protective order.

II. EXPRESS RESERVATIONS

1. No response, objection, limitation or lack thereof, set forth in these responses and objections shall be deemed an admission or representation by SDG&E as to the existence or nonexistence of the requested information or that any such information is relevant or admissible.

2. SDG&E reserves the right to modify or supplement its responses and objections to each request, and the provision of any information pursuant to any request is not a waiver of that right.

3. SDG&E reserves the right to rely, at any time, upon subsequently discovered information.

4. These responses are made solely for the purpose of this proceeding and for no other purpose.

III. RESPONSES

GIS Data:
Please provide the non-confidential portions GIS data set provided to the Office of Energy Infrastructure Safety. This should be a complete and not incremental set, provided in geodatabase format. As per the WILDFIRE SAFETY DIVISION GEOGRAPHIC INFORMATION SYSTEM (GIS) DATA REPORTING STANDARD FOR CALIFORNIA ELECTRICAL CORPORATIONS – V2, February 4, 2021, please include and exclude all non-confidential data as per the following requests. Data should be current as of the WMP submission date.

QUESTION 1:

Please provide for Asset Point data for Camera, Fuse, Support Structure, and Weather Station. Data for Connection Device, Lightning Arrester, Substation, Switchgear, Transformer Site, and Transformer Detail are optional. Customer Meter data is specifically excluded from this request for privacy reasons.

OBJECTION:

SDG&E objects to this request on the grounds set forth in General Objection Nos. 2, 5, and 9. Subject to the foregoing objections, SDG&E responds as follows.

RESPONSE 1:

Response provided in “SDGE_2021_Q1_Q4_MGRA.gdb.zip.” Relevant information on availability of data included in “MGRADataRequestScope.xlsx.”

QUESTION 2:

Provide Asset Line data for Transmission Line (as permitted as non-confidential), Primary Distribution Line, and Secondary Distribution Line.

OBJECTION:

SDG&E objects to this request on the grounds set forth in General Objection Nos. 2, 5, and 9. Subject to the foregoing objections, SDG&E responds as follows.

RESPONSE 2:

Response provided in "SDGE_2021_Q1_Q4_MGRA.gdb.zip." Relevant information on availability of data included in "MGRADataRequestScope.xlsx."

QUESTION 3:

Provide PSPS Event data. Include Event Log, Event Line, Event Polygon data. Please exclude customer meter data. Provide all PSPS Event Asset Damage data including photos.

OBJECTION:

SDG&E objects to this request on the grounds set forth in General Objection Nos. 2, 5, and 9. Subject to the foregoing objections, SDG&E responds as follows.

RESPONSE 3:

Response provided in "SDGE_2021_Q1_Q4_MGRA.gdb.zip." Relevant information on availability of data included in "MGRADataRequestScope.xlsx."

QUESTION 4:

Provide Risk Event Point data, including Wire Down, Ignition, Transmission unplanned outage (as classified non-confidential), Distribution Unplanned Outage data, Risk Event Asset Log, and Risk Event Photo Log.

OBJECTION:

SDG&E objects to this request on the grounds set forth in General Objection Nos. 2, 5, and 9. Subject to the foregoing objections, SDG&E responds as follows.

RESPONSE 4:

Response provided in "SDGE_2021_Q1_Q4_MGRA.gdb.zip." Relevant information on availability of data included in "MGRADataRequestScope.xlsx."

QUESTION 5:

Provide photo data for Ignition and Wire Down events.

OBJECTION:

SDG&E objects to this request on the grounds set forth in General Objection Nos. 2, 5, and 9. Subject to the foregoing objections, SDG&E responds as follows.

RESPONSE 5:

Response provided in "SDGE_2021_Q1_Q4_MGRA.gdb.zip." Relevant information on availability of data included in "MGRADataRequestScope.xlsx."

Date Received: February 07, 2022
Date Submitted: February 17, 2022

QUESTION 6:

Under Initiatives, please provide Grid Hardening data, including Hardening Log, Hardening Point, and Hardening Line data. Inspection data is not requested at this time.

OBJECTION:

SDG&E objects to this request on the grounds set forth in General Objection Nos. 2, 5, and 9. Subject to the foregoing objections, SDG&E responds as follows.

RESPONSE 6:

Response provided in "SDGE_2021_Q1_Q4_MGRA.gdb.zip." Relevant information on availability of data included in "MGRADataRequestScope.xlsx."

QUESTION 7:

Under Initiatives, please provide Other Initiative data for point, line, polygon features and the Other Initiative Log.

OBJECTION:

SDG&E objects to this request on the grounds set forth in General Objection Nos. 2, 5, and 9. Subject to the foregoing objections, SDG&E responds as follows.

RESPONSE 7:

Response provided in "SDGE_2021_Q1_Q4_MGRA.gdb.zip." Relevant information on availability of data included in "MGRADataRequestScope.xlsx."

QUESTION 8:

Under Other Required Data, please provide Red Flag Warning Day polygon data.

OBJECTION:

SDG&E objects to this request on the grounds set forth in General Objection Nos. 2, 5, and 9. Subject to the foregoing objections, SDG&E responds as follows.

RESPONSE 8:

Response provided in "SDGE_2021_Q1_Q4_MGRA.gdb.zip." Relevant information on availability of data included in "MGRADataRequestScope.xlsx."

Date Received: February 07, 2022
Date Submitted: February 17, 2022

END OF REQUEST

SDG&E – MGRA – Data Request Response 2

MUSSEY GRADE ROAD ALLIANCE DATA REQUEST:
MGRA-SDGE-WMP22_DATAREQUEST2
SDG&E RESPONSE

Date Received: February 22, 2022
Date Submitted: February 24, 2022

GENERAL OBJECTIONS

1. SDG&E objects generally to each request to the extent that it seeks information protected by the attorney-client privilege, the attorney work product doctrine, or any other applicable privilege or evidentiary doctrine. No information protected by such privileges will be knowingly disclosed.

2. SDG&E objects generally to each request that is overly broad and unduly burdensome. As part of this objection, SDG&E objects to discovery requests that seek "all documents" or "each and every document" and similarly worded requests on the grounds that such requests are unreasonably cumulative and duplicative, fail to identify with specificity the information or material sought, and create an unreasonable burden compared to the likelihood of such requests leading to the discovery of admissible evidence. Notwithstanding this objection, SDG&E will produce all relevant, non-privileged information not otherwise objected to that it is able to locate after reasonable inquiry.

3. SDG&E objects generally to each request to the extent that the request is vague, unintelligible, or fails to identify with sufficient particularity the information or documents requested and, thus, is not susceptible to response at this time.

4. SDG&E objects generally to each request that: (1) asks for a legal conclusion to be drawn or legal research to be conducted on the grounds that such requests are not designed to elicit facts and, thus, violate the principles underlying discovery; (2) requires SDG&E to do legal research or perform additional analyses to respond to the request; or (3) seeks access to counsel's legal research, analyses or theories.

5. SDG&E objects generally to each request to the extent it seeks information or documents that are not reasonably calculated to lead to the discovery of admissible evidence.

6. SDG&E objects generally to each request to the extent that it is unreasonably duplicative or cumulative of other requests.

7. SDG&E objects generally to each request to the extent that it would require SDG&E to search its files for matters of public record such as filings, testimony, transcripts, decisions, orders, reports or other information, whether available in the public domain or through FERC or CPUC sources.

8. SDG&E objects generally to each request to the extent that it seeks information or documents that are not in the possession, custody or control of SDG&E.

9. SDG&E objects generally to each request to the extent that the request would impose an

undue burden on SDG&E by requiring it to perform studies, analyses or calculations or to create documents that do not currently exist.

10. SDG&E objects generally to each request that calls for information that contains trade secrets, is privileged or otherwise entitled to confidential protection by reference to statutory protection. SDG&E objects to providing such information absent an appropriate protective order.

II. EXPRESS RESERVATIONS

1. No response, objection, limitation or lack thereof, set forth in these responses and objections shall be deemed an admission or representation by SDG&E as to the existence or nonexistence of the requested information or that any such information is relevant or admissible.

2. SDG&E reserves the right to modify or supplement its responses and objections to each request, and the provision of any information pursuant to any request is not a waiver of that right.

3. SDG&E reserves the right to rely, at any time, upon subsequently discovered information.

4. These responses are made solely for the purpose of this proceeding and for no other purpose.

**MUSSEY GRADE ROAD ALLIANCE DATA REQUEST:
MGRA-SDGE-WMP22_DATAREQUEST2
SDG&E RESPONSE**

**Date Received: February 22, 2022
Date Submitted: February 24, 2022**

Process:

QUESTION 1

Please provide copies of all received data requests and responses for all intervenors other than MGRA that are not already posted on SDG&E's website.

RESPONSE 1

SDG&E objects to Question 1 on the grounds set forth in General Objections Nos. 5, 6, 7, and 10. Subject to the foregoing objections, SDG&E responds as follows:

Please see attachment "Response_1_CalAdvocates-SDGE-2022WMP-05". The excel attachment file associated with this data request will not be included as the information is Confidential.

MUSSEY GRADE ROAD ALLIANCE DATA REQUEST:
MGRA-SDGE-WMP22_DATAREQUEST2
SDG&E RESPONSE

Date Received: February 22, 2022
Date Submitted: February 24, 2022

SDG&E Situational Awareness: On page 2-3 of its Executive Summary, SDG&E states that it has upgraded 43 weather stations to provide readings every 30 seconds rather than every 10 minutes and furthermore that it is deploying AI prediction and AQI particulate sensors.

QUESTION 2

Please provide a list of the stations upgraded to provide 30 second data.

RESPONSE 2

215 of the 221 weather stations are able to provide 30 second data. The stations are:

Ammo Dump
Alpine
Archie Moore
Avocado
Anderson Valley
Border Field
Black Canyon
Blue Sky
Black Mountain Ranch
Buckman Springs
Barona
Bob Owens Canyon
Boulder Creek
Borrego
Barrett Junction
Barona Mesa
Buffalo Bump
Boulevard West
Blossom Valley
Bell Canyon
Carlsbad
Cuca Ranch
Calle De Vista
Country Estates
Cole Grade
Chihuahua Valley
Chollas Lake
Circle R
Creelman
Crestline
Cameron Corners
Cameron
Los Coches
Coronado Hills
Los Coyotes
Campo
Cristianitos
Carveacre
Crest
Corte Madera
Chula Vista
Cool Valley
Crestwood
Morena Dam
Descanso
Del Dios Highway
Del Dios South
Dehesa
Descanso Sub
Deerhorn Valley
Living Coast
De Luz Creek
De Luz Heights
De Luz Road
Deluz
Del Mar Heights
Dye Mountain
Dulzura
El Cajon
Elfin Forest
El Monte Road
Escondido
Eucalyptus Hills
East Warners
East Willows Rd
Fallbrook
Fruitvale
Gavilan Mountain
Goose Valley
Guatay
Guejito Ranch
Green Valley
Harmony Grove
Harbison Canyon
Hauser Mountain
Hodges Dam
Hellhole Canyon
Hideaway Lake
Hidden Meadows
Hoskings Ranch
Harrison Park
High Valley
Highland Valley West
Highland Valley
In Ko Pah
Imperial Valley
Iron Mountain Trail
Jamul
Julian
Japatul Valley Rd

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Keyes Creek
Laguna
Lawson Creek
Lake Cuyamaca
Linea del Cielo
Lucky Five Ranch
Lower Hellhole Canyon
La Jolla Heights
Lake Wohlford
Lilac
Loveland
Longs Gulch
La Posta
Lawson Valley
Maderas
Matics Field
Marion Canyon
Mesa Grande
Mussey Grade
Mataguay
San Miguel
Mt. Laguna
Lake Morena
Camp Elliot
Mt. Soledad
Mission Trails
Mission Valley North
Mt Woodson GC
National City
North Descanso
Nate Harrison Grade
North Miller Road
North Potrero
North Ramona
Narrows Sub
Oak Grove
Old Castle
Olivenhain
Otay Mesa Border
Ortega
Otay Mountain
Otay
Mt. Palomar
Pauma Valley
Pauma Creek
Pacific Crest Trail
Pine Hills
Pine Valley
Pauma
Paradise Mountain
Poomacha
Potrero
Pamo Valley
Poway
Pala Temecula
Peutz Valley
Pine Valley Creek
Palo Verde
Ramona
Rainbow Heights
Rainbow Valley
Rainbow Conservation Camp
Rincon Central
Ranchita
Rincon Res
Rancho Heights
Rincon
Rios Canyon
Rainbow
Rockwood
Rim of the Valley
Round Potrero
Rancho Penasquitos
Rancho Santa Fe
San Clemente Ridge
San Dieguito River
School House Canyon
Sherilton Valley
Sill Hill
San Marcos
Solana Beach
Simon Open Space
Spangler Peak
San Pasqual Valley
Sequan Truck Trail
Sunrise Hwy
Sunset Oaks
Sunshine Summit
Shockey Truck Trail
Santa Teresa Valley
San Vicente
Skye Valley
Sweetwater River
Sycamore Canyon
Santa Ysabel Ranch
Tavern
Tecolote Canyon
Tierra Del Sol
Talega
Turner Lake
Thundernut
Twins Oaks
Upper Daily Ranch
Valley Center Hilltop
Volcan Mountain
Viejas Grade
Valley Center High Point
Victoria
Vista
Viejas
Valley Center
Viejas Mtn Trail
West Alpine
Warners
Witch Creek
Wisecarver
West Descanso
Winterwarm
West Potrero
West Rancho Bernardo
White Star
West Santa Ysabel
West Wynola
Wynola
Santa Ysabel North

**Date Received: February 22, 2022
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QUESTION 3

Is the 30 second data available to the public or to intervenors, and if so how is it accessed?

RESPONSE 3

The 30 second data is not publicly available at this time.

**Date Received: February 22, 2022
Date Submitted: February 24, 2022**

QUESTION 4

How long is the 30 second data generally retained? Does SDG&E retain 30 second data for major windstorms?

RESPONSE 4

SDG&E objects to Question 4 on the grounds set forth in General Objections Nos. 3, 5, 6, 7, and 10. Subject to the foregoing objections, SDG&E responds as follows:

The 30 second data is not currently being retained at this time and is enabled only to support emergency operations. The data is archived at 10-minute intervals and it is used to make strategic decisions, mainly to ascertain if sporadic wind gusts are anomalous or persistent. The 10-minute data collected from these stations is retained indefinitely and is publicly available at: https://mesowest.utah.edu/

**Date Received: February 22, 2022
Date Submitted: February 24, 2022**

QUESTION 5

Provide a list of the weather stations which currently implement AI forecasting.

RESPONSE 5

Twice daily our supercomputers complete a circuit forecast using AI that provides the maximum gust and time for the next 4 days for each weather station. All 215 stations listed in question 2 are on the output file. However, 31 of those stations were installed since 2020 and have yet to accumulate enough historical data to train machine learning models, so the values listed on the circuit forecast are raw Weather Research and Forecasting (WRF) model output. SDG&E partners with the San Diego Super Computing Center to archive our meteorological data. The circuit forecast using AI forecasting is entitled "SDG&E Daily Weather Station Wind Gust Forecast" and can be found here: https://wifire-data.sdsc.edu/dataset?organization=sdge

The 30 stations yet to be trained with machine learning techniques are:

De Luz Heights (DLH)
Valley Center High Point (VHP)
North Miller Rd (NMR)
Thundernut (TNT)
Harmony Grove (HAG)
Del Dios South (DDS)
De Luz Creek (DLC)
De Luz Rd (DLR)
Cool Valley (CVY)
Matics Field (MAT)
Valley Center Hilltop (VCH)
Tavern (TAV)
Winterwarm (WIN)
Old Castle (OLD)
Longs Gulch (LOG)
Caballo Park (CAB)
Gavilan Mountain (GAV)
Morena Dam (DAM)
Simon Open Space (SOS)
Rainbow Conservation Camp (RCC)
Mt. Woodson Golf Club (MWG)
Rim of the Valley (ROV)
Calle De Vista (CDV)
North Ramona (NRA)
Hauser Mountain (HAU)
Bob Owen's Canyon (BOB)
Green Valley (GVY)
Pine Valley Creek (PVC)
Upper Daley Ranch (UDR)
Descanso (DCO)
Descanso Sub (DES)

**Date Received: February 22, 2022
Date Submitted: February 24, 2022**

QUESTION 6

Please provide data or analysis covering 2021 Santa Ana weather events quantifying the AI prediction error for all stations for which the system has been deployed.

RESPONSE 6

SDG&E objects to Question 6 on the grounds set forth in General Objections Nos. 2, 3, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

Per the response provided to Question 5 above, all AI forecasts for 2021 are available at the San Diego Super Computing Center archive created for SDG&E Meteorology and can be accessed here: https://wifire-data.sdsc.edu/dataset?organization=sdge

Additionally, all corresponding weather observations recorded every 10 minutes for 2021 from 221 SDG&E weather stations can be accessed here: https://mesowest.utah.edu/

SDG&E has not yet fully quantified the 2021 AI prediction error for all stations.

**Date Received: February 22, 2022
Date Submitted: February 24, 2022**

QUESTION 7

On page 90, SDG&E states that "To estimate weather conditions at the asset location, such as wind speed, methods such as closest proximity, linear interpolation, and manual mappings by Meteorology were explored." Please provide the results of this study.

RESPONSE 7

SDG&E objects to Question 7 on the grounds set forth in General Objections Nos. 2, 3, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

SDG&E has not conducted a formal study comparing the various methods for weather station to asset associations. For modeling, SDG&E generally uses the associations created by our meteorologist experts from our meteorology team (See Question 8). However, when associations did not exist (e.g., new or historical assets), then we used a closest proximity method.

**Date Received: February 22, 2022
Date Submitted: February 24, 2022**

QUESTION 8

Please provide the areas mapped to each weather station using the optimal method determined by SDG&E in GIS polygon format.

RESPONSE 8

SDG&E objects to Question 8 on the grounds set forth in General Objections Nos. 2, 3, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

See attached "Response_8_Vegetation_Risk_Index_(VRI).zip." SDG&E leverages meteorologic expertise as an optimal method for establishing the areas mapped to each weather station. SDG&E internally refers to these areas as Vegetation Risk Index (VRI) polygons.

**Date Received: February 22, 2022
Date Submitted: February 24, 2022**

QUESTION 9

Regarding satellite fire alerts received from the SDDC, what is the false positive rate?

RESPONSE 9

SDG&E objects to Question 9 on the grounds set forth in General Objections Nos. 2, 3, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

SDG&E has not performed a false positive analysis of the satellite fire alerts. Space based fire alerts originate from the Space Science and Engineering Center (SSEC) at the University of Wisconsin-Madison, a world-class archive of satellite data, receiving, archiving, and redistributing most geostationary weather satellite data produced globally. The SSEC sends the alert data to the San Diego Super Computing Center (SDSC) where they are archived and immediately sent to select SDG&E employees as an alert. The alert includes the location of the fire on the landscape, associated camera images in the area, and a rating of the fire confidence. SSEC, SDSC, and SDG&E have partnered to increase situational awareness of wildfire ignitions in the service territory.

The new series of Geostationary Operational Environmental Satellites (GOES) carry the Advanced Baseline Imager (ABI), a next-generation detector that allows fire detection and characterization at 2 km spatial resolution and temporal resolutions of five minutes and in some circumstances one minute or faster. The ABI Fire/Hot Spot Detection and Characterization (FHS) consists of four product outputs: metadata mask, fire radiative power (FRP), instantaneous fire temperature, and instantaneous fire size. The metadata mask assigns a flag to every earth-navigated pixel that indicates its disposition with respect to the FHS algorithm. It includes six fire categories:

- Processed fire: The highest fire confidence category, includes FRP, size, and temperature estimates
- Saturated fire: Also very high confidence fires, but the pixel was at instrument saturation so no properties could be determined
- Cloudy fire: A high confidence fire that appears to be partially obscured by cloud
- High possibility fire: A likely fire that did not meet the thresholds for the Processed category
- Medium possibility fire: Medium confidence fire category
- Low possibility fire: The lowest confidence class, a large number of false alarms are to be expected, also contains small and/or cooler fires

Each of the fire categories has a temporally filtered equivalent, which is triggered if fire was found within +/-1 pixel in the last 12 hours. Also included in the mask are flags that indicate why a pixel was excluded from consideration, including due to water, certain surface types, clouds, and bad data.

The FRP, size, and temperature fields represent the properties of a fire that would produce the same detected radiant energy for the pixel. Fires vary throughout their burn area in intensity, but the satellite measurement is a composite signal of the entire pixel. FRP, size, and temperature represent the composite properties of that pixel. A hypothetical fire with those properties would produce the same measured radiances. Due to this mixing of subpixel elements and diffraction in the sensor there are large error bars on these retrievals.

**Date Received: February 22, 2022
Date Submitted: February 24, 2022**

QUESTION 10

Has the AI smoke detection algorithm used by SDG&E webcams ever detected fires prior to the satellite alert? If so, provide a list of these events.

RESPONSE 10

SDG&E objects to Question 10 on the grounds set forth in General Objections Nos. 2, 3, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

AI smoke detection algorithm used by SDG&E webcams have detected fires prior to the satellite alert because smoke is often visible by the cameras before the fire can reach a threshold based on Fire Radiative Power, temperature, and size whereby sensors in space are triggered. SDG&E cannot provide a list of events because it doesn't track them. However, we have begun work to see if any synergy can be realized between the disparate systems and we have organized meetings between SSEC, SDSC, and AI Smoke Detection vendor.

Date Received: February 22, 2022
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QUESTION 11

Please provide a list of all wildfires detected in 2020 and 2021 by the satellite/AI smoke method, including 1) satellite detection time 2) cam AI detection confirmation time 3) location 4) fire name if applicable 5) latency (from actual fire start time) if known.

RESPONSE 11

SDG&E objects to Question 11 on the grounds set forth in General Objections Nos. 2, 5, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

SDG&E does not currently track and archive all wildfire activity detected by the satellite/AI smoke method. Fire Agencies do track and archive wildfire activity on significant wildfires in San Diego County. Satellite wildfire alerts and AI Smoke Detection Systems are complimentary systems used to prevent a fire from being missed.

All hotspot alerts detected by satellites can be accessed at the following link. https://wifire-data.sdsc.edu/dataset/sdge-goes-fire-detections

Date Received: February 22, 2022
Date Submitted: February 24, 2022

QUESTION 12

Provide a list of all existing particulate monitors and links to their public data.

RESPONSE 12

SDG&E objects to Question 12 on the grounds set forth in General Objections Nos. 2, 3, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

SDG&E does not currently have any operational air quality sensors, though in 2021, SDG&E completed sensor selection and purchased 6 Air Quality Index (AQI) sensors.

In 2022, SDG&E will place Air Quality Index (AQI) sensors at key locations and are planning to make the data publicly available.

**Date Received: February 22, 2022
Date Submitted: February 24, 2022**

QUESTION 13

Provide a list of all weather stations for which deployment of Air Quality Index (AQI) particulate sensors is planned in 2022.

RESPONSE 13

6 Air Quality Index (AQI) stations are currently planned to be installed by June 1 (they are in proximity but not co-located to weather stations):

AQ Station Name	Closest SDG&E Weather Station	Address
Kearny C&O	Camp Elliot	5488 Overland Ave. San Diego CA92123
Ramona C&O	North Ramona	110 14th St. Ramona, CA 92065
Eastern C&O	El Cajon	904 W Main St. El Cajon, CA 92020
Avocado Sub	Avocado	Behind 427 Industrial Way, Fallbrook 92028
Cameron Sub	Cameron Corners	1888 Buckman Springs Rd. Campo CA 91906
Valley Center Sub	Valley Center	14435 Vesper Rd. Valley Center, 92082

QUESTION 14

Does SDG&E have partners with whom it consults regarding siting, deployment, and analysis of its particulate monitors, and if so identify them.

RESPONSE 14

SDG&E objects to Question 14 on the grounds set forth in General Objections Nos. 2, 3, and 5. Subject to the foregoing objections, SDG&E responds as follows:

Western Weather Group Inc is supporting the deployment of AQ stations. We are also consulting with a vendor with established expertise in AQI systems. SDG&E has also reached out to the San Diego County Air Pollution Control District to collaborate on this effort.

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SDG&E in its description of its research program (Section 4.4.2) describes its findings regarding the effect of various mitigations.

QUESTION 15

Regarding SDG&E's study of the effectiveness of recloser protocols (Section 4.4.2.2), SDG&E studied the effect of disabling reclosing on ignition. How did SDG&E adjust the results from this study to adjust for the effect of PSPS events, which eliminate fault events.

RESPONSE 15

SDG&E objects to Question 15 on the grounds set forth in General Objections Nos. 2, 3, 5, and 9. Subject to the foregoing objections, SDG&E responds as follows:

SDG&E utilized five-year historical data to study the effectiveness of recloser protocols. This historical data was chosen because it already includes the effect of PSPS events that have occurred over this time period.

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SDG&E RESPONSE**

**Date Received: February 22, 2022
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<u>QUESTION 16</u>

Does the study mentioned in the previous question accurately predict what fraction of ignitions would be avoided in the absence of PSPS?

<u>RESPONSE 16</u>

SDG&E objects to Question 16 on the grounds set forth in General Objections Nos. 2, 3, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

The study utilizes historical information which includes the reduction of ignitions due to PSPS. Because it uses historical information, SDG&E is unable to speculate regarding the number of ignitions avoided if a PSPS had not occurred. Thus, SDG&E did not calculate what fraction of ignitions would be avoided by this mitigation in the absence of PSPS.

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QUESTION 17

If the answer to the previous question is no, what would be the result if SDG&E were to perform the calculation assuming absence of PSPS?

RESPONSE 17

SDG&E objects to Question 17 on the grounds set forth in General Objections Nos. 2, 3, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

SDG&E's methodology for these studies is to utilize historical information. The historical information includes PSPS periods where lines are de-energized and potential faults did not occur. Because it uses historical information, SDG&E is unable at this time to speculate regarding the number of ignitions avoided if a PSPS had not occurred. SDG&E does not have a methodology to re-calculate assuming those lines remained energized during PSPS.

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QUESTION 18

SDG&E also studies the effect of distribution hardening on overhead faults (Section 4.4.2.3), and observes a reduction from 13.5 events per 100 miles to 7.5 events per 100 miles correlated with hardening. Were PSPS periods removed from this sample, or was the bias from PSPS events (which will also preferentially reduce faults on hardened systems in higher fire risk districts) removed in some other fashion?

RESPONSE 18

SDG&E objects to Question 18 on the grounds set forth in General Objections Nos. 2, 3, 8 and 9. SDG&E further objects to the characterization of the study as having bias. Subject to the foregoing objections, SDG&E responds as follows

SDG&E utilized historical data to calculate the effect of distribution hardening on overhead faults. PSPS periods were not removed from this sample.

QUESTION 19

If the hardening study mentioned in the previous question did not account for biases introduced by PSPS, please recalculate the result with PSPS periods removed from the analysis.

RESPONSE 19

SDG&E objects to Question 19 on the grounds set forth in General Objections Nos. 2, 3, 5, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows

SDG&E's methodology for these studies is to utilize historical information. The historical information includes PSPS periods where lines are de-energized and potential faults did not occur. Because it uses historical information, SDG&E is currently unable to speculate regarding the number of ignitions avoided if a PSPS had not occurred. SDG&E does not have a methodology to re-calculate assuming those lines remained energized during PSPS.

QUESTION 20

In Section 4.4.2.5, SDG&E presents the results of an analysis of the effect of sensitive relay settings on ignition rates during red flag warning (RFW) events. RFW periods often result in PSPS, which removes high risk events from the sample. Describe whether SDG&E's analysis accounts for the effect of PSPS and if so how.

RESPONSE 20

SDG&E objects to Question 20 on the grounds set forth in General Objections Nos. 2, 3, 5, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

SDG&E utilized historical data to study the effectiveness of sensitive relay settings. This historical data was chosen because it already includes the effect of PSPS events that have occurred over this time period.

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QUESTION 21

If the analysis in the previous question does not account for potential bias introduced by PSPS, please provide an alternative "System Analysis" in which all areas subject to PSPS during the study period are removed from the analysis.

RESPONSE 21

SDG&E objects to Question 21 on the grounds set forth in General Objections Nos. 2, 3, 5, 8 and 9. SDG&E further objects to characterization of the study as biased. Subject to the foregoing objections, SDG&E responds as follows:

SDG&E's methodology for these studies is to utilize historical information. The historical information includes PSPS periods where lines are de-energized and potential faults did not occur. Because it uses historical information, SDG&E is currently unable to speculate regarding the number of ignitions avoided if a PSPS had not occurred. SDG&E does not have a methodology to re-calculate assuming those lines remained energized during PSPS.

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SDG&E RESPONSE

Date Received: February 22, 2022
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QUESTION 22

Regarding the Sensitivity Analysis Results presented in Table 4-15, please provide a breakdown of Total Outages by tree species for the 17.5 and 25 trim distances.

RESPONSE 22

SDG&E objects to Question 22 on the grounds set forth in General Objections Nos. 2, 3, 5, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows

SDG&E has discovered an error in the formula used to calculate the expected outages. The expected outages are corrected from the initial filing and are provided in the table below.

Adjust min line clearanc e	% of Records Change d	Predicted Outages by Model	Assumed true positive outage ratio	Expect ed Outage (T)	Non-Risk Trees Identified by Model	Assume False Negative Outage Rate	Expect ed Outage (F)	Total Outages	Differenc e
adjust <17.5 to 17.5	92%	235,561	1.92E-04	45	1,276,097	1.11E-05	14	59	(19)
adjust <25 to 25	98%	153,119	1.92E-04	29	1,358,539	1.11E-05	15	44	(34)

Total Outages (2017-2020) for 17.5' Trim Distance

Species	Total Outages
Eucalyptus	20
Palm-Fan	9.4
Pine	7.2
Oak	5.1
Sycamore	1.8
Palm-Feather	2
Pepper (California)	1.8
Willow	1.2
Tamarisk/Salt Cedar	0.8
Brush 5X5 Bamboo	0.7
Cypress	0.5

Pecan	0.5
Silk Oak	0.4
Palm-Date	0.3
Cottonwood	0.4
Ash	0.5
Acacia	0.3
Coral	0.2
Orchid	0.2
Century Plant	0.5
Jacaranda	0.3
Casuarina	0.1
Rubber	0.1
Cedar	0.2
Fir	0.1
Brush Very Fast 5x5	0.2
Deodara Cedar	0.1
Liquidambar	0.2
Elm	0.2
Avocado	0.7
Ailanthus	0.1
Brisbane Box	0.1
Brush Fast 5x5	0.1
Brush Med 5x5	0.2
Brush Slow 5x5	0.1
Camphor-Tree	0.1
Carrot Wood	0.1
Citrus	0.1
Eugenia	0.1
Ficus	0.2
Italian Cypress	0.2
Locust	0.1
Melaleuca	0.1
Mulberry	0.1
Olive	0.2
Other - Medium	0.1
Other - Slow	0.1
Pepper-Brazilian	0.3
Podocarpus	0.1

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Total Outages (2017-2020) for 25' Trim Distance

Species	Total Outages
Eucalyptus	13.9
Palm-Fan	8.4
Pine	4.7
Oak	4
Sycamore	1.3
Palm-Feather	1.3
Pepper (California)	1.2
Willow	0.7
Tamarisk/Salt Cedar	0.6
Brush 5X5 Bamboo	0.5
Cypress	0.3
Pecan	0.3
Silk Oak	0.3
Palm-Date	0.2
Cottonwood	0.2
Ash	0.4
Acacia	0.2
Coral	0.1
Orchid	0.1
Century Plant	0.5
Jacaranda	0.2
Casuarina	0.1
Rubber	0.1
Cedar	0.1
Fir	0.1
Brush Very Fast 5x5	0.2
Deodara Cedar	0.1
Liquidambar	0.2
Elm	0.2
Avocado	0.7
Ailanthus	0.1
Brisbane Box	0.1
Brush Fast 5x5	0.1
Brush Med 5x5	0.2

Brush Slow 5x5	0.1
Camphor-Tree	0.1
Carrot Wood	0.1
Citrus	0.1
Eugenia	0.1
Ficus	0.2
Italian Cypress	0.2
Locust	0.1
Melaleuca	0.1
Mulberry	0.1
Olive	0.2
Other - Medium	0.1
Other - Slow	0.1
Pepper-Brazilian	0.3
Podocarpus	0.1

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QUESTION 23

Regarding lab tests of covered conductors, what "additional studies will be performed to assess the effectiveness of covered conductor for various modes of failure" that have not been performed yet?

RESPONSE 23

SDG&E objects to Question 23 on the grounds set forth in General Objections Nos. 2, 3, 5, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows

SDG&E plans to have a third-party contractor to conduct an engineering analysis of the response of covered conductors to high wind. Specifically, the third-party contractor will conduct a computer-based simulation using finite element analysis (FEA) to understand the likelihood and effect of covered conductors clashing in a given wind speed. A similar analysis will be performed for bare conductors, allowing for a comparison of the likelihood of clashing for both bare and covered conductors. Ultimately, it is expected that the results from this study may help to inform the risk reduction associated with covered conductors.

SDG&E plans to have a third-party contractor perform accelerated aging studies on covered conductors to better understand the potential for time-dependent degradation of the polymeric conductor coating over time. Two specific metrics will be analyzed to simulate exposure to a California-like environment: the effect of long-term UV exposure and sustained heat. This accelerated aging will be designed to mimic a 40-year service life. Following accelerated aging exposure, samples will be subjected to tests designed to understand the potential for both mechanical degradation, as well as a reduction in dielectric strength.

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Modeling Methodology (Section 4.5)

QUESTION 24

Provide additional details and documentation of the conductor failure model, including the estimation of the feature importance for the variables included in the analysis.

RESPONSE 24

SDG&E objects to Question 24 on the grounds set forth in General Objections Nos. 2, 3, 5, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

The conductor failure model is a linear regression model (log-log), where the annual failure rate per unit length of wire is the dependent variable. To select the independent or explanatory variables (feature selection), we used a hybrid approach combining statistical values with SME feedback, where selected variables are required to have p-values less than 5 percent and approved by engineering experts.

SDG&E is currently reviewing the 2021 observations and plans to update this model in the future. In addition to updating the historical observations, SDG&E plans to revisit all the variables that did not show significance in the 2021 model.

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QUESTION 25

Provide additional detail and documentation regarding the Vegetation PoI/PoF models. Were wind gusts included in the Vegetation PoI/PoF model, and if not why not?

RESPONSE 25

SDG&E objects to Question 25 on the grounds set forth in General Objections Nos. 2, 3, 5, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

The Vegetation PoF model is a simple linear relationship with the number of trees in proximity with the asset, where “proximity” is determined by discretion of our Vegetation Management team (Powerworkz database). SDG&E explored using this data source in conjunction with asset information and historical weather conditions to incorporate wind gust as a predictor variable for vegetation PoF. SDG&E used methods like what was done for the conductor PoF model (See Question 24). While creating the model and reviewing preliminary results, it was concluded that additional analysis was needed to capture properly the relation between PoF and wind gust. Therefore, SDG&E opted not to include wind gust in the 2021 vegetation PoF model but continues to explore novel methods for including this variable in 2022.

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QUESTION 26

On p. 96, the WMP states that: "Tree-related outage during all adverse weather conditions were considered during model development, but the final VRI rating for a particular polygon was not filtered based on weather type. This may result in an overprediction of outage risk during a weather event." Should "overprediction" instead be "underprediction"? If the quote as stated is correct, please explain.

RESPONSE 26

SDG&E objects to Question 26 on the grounds set forth in General Objections Nos. 2, 3, and 5. Subject to the foregoing objections, SDG&E responds as follows:

The majority of weather-related outages occur during winter storms involving significant rainfall. When the VRI is used during Santa Ana events, the outage risk includes past outages that have occurred during heavy rainfall, thus overstating the risk during dry Santa Ana events.

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QUESTION 27

Why was a cubic polynomial chosen to represent the wind gust response function (p. 95)?

RESPONSE 27

SDG&E objects to Question 27 on the grounds set forth in General Objections Nos. 2, 3, and 5. Subject to the foregoing objections, SDG&E responds as follows:

SDG&E experimented with multiple polynomial functions, such as 2- and 4-degree polynomials, for estimating wind gust response and determined the cubic function to be the best fit for the 2021 models. In addition, the cubic function was found to be monotonic in the wind gust range of interest. These are decisions that will be revisited in 2022 model updates.

QUESTION 28

For the overhead conductor failure model, SDG&E's WMP states that "Areas with higher wind speeds influence this failure rate and would be further modified by the location of the asset in the models identified wind corridors" (p. 106). How were these wind corridors identified and quantified?

RESPONSE 28

SDG&E objects to Question 28 on the grounds set forth in General Objections Nos. 2, 3, and 5. Subject to the foregoing objections, SDG&E responds as follows

The wind corridors were created by SDG&E meteorologists to identify areas of high concern. The process to create the corridors started with peak wind gust data from SDG&E's 30-year Weather Research and Forecasting (WRF) model historical reanalysis dataset. The peak wind gust data was digitized as polygons across the service territory. Minor adjustments were subsequently made to the layer based on meteorological subject matter expertise. Knowledge gained from the SDG&E weather station network was then used to finalize the polygons.

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SDG&E RESPONSE**

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QUESTION 29

What is the methodology for applying the wind speed failure rate modification?

RESPONSE 29

SDG&E objects to Question 29 on the grounds set forth in General Objections Nos. 2, 3, and 5. Subject to the foregoing objections, SDG&E responds as follows:

The wind speed failure rate modification is applied as the wind factor calculation in the Wildfire Risk Reduction Model (WRRM) analysis. The following process comes from the Wildfire Risk Reduction Model FINAL REPORT created for SDG&E by Technosylva:

1. For each asset in the system, we added an attribute called WindFactor. This is attributed from the SDG&E provided FireWindGustPolygons and a look up table. There are 2 WindFactor datasets – one for poles & conductors, and one for everything else.
2. Import FireWindGustPolygons and Reproject to working coordinate system
3. Add field WindFactor to each asset feature class
4. Run a spatial join on each asset feature class with FireWindGustPolygons
5. Drop all new fields except Name and GustSpd
6. Calculate WindFactor according to look up table

WindFactor Look Up Table 10/16/2015		
Gust wind speed (mi/h)	POLES/ CONDUCTORS	ALL OTHER ASSETS
0-55	0.10	0.40
55-65	0.20	0.50
65-75	0.35	0.60
75-85	0.50	0.70
85-95	0.65	0.80
95-105	0.85	0.90
105-111	1.00	1.00

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QUESTION 30

Please provide any GIS data for identified wind corridors.

RESPONSE 30

SDG&E objects to Question 30 on the grounds set forth in General Objections Nos. 2, 3, 5, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

To create a robust 50-year wind gust potential map for the SDG&E service territory, SDG&E's Meteorology team took an approach of using the Weather Forecasting and Research (WRF) Atmospheric Model to recreate hourly weather conditions on a 3km grid for the last 30 years. This is possible through using government datasets to initialize WRF to create what is known as a reanalysis dataset. SDG&E chose to re-create 30 years of data for a couple different reasons: the first was that the data quality degrades beyond 30 years due to the lack of satellite data and second, 30 years was also very aggressive given the amount of computing power required. In 2012 and 2013 this reanalysis dataset took close to 1 million computing core hours to process on our company computing cluster.

Once the dataset was created, we were able to take the highest projected wind gusts for each point on the 3-km grid for each year going back to 1984. This provided a set of preliminary WRF model-derived values which were then further refined by applying bias corrections based upon actual physical measurements of wind speeds received from our SDG&E Weather Network. To achieve this, we took two years of data from every station in our weather network and compared it to the output from the WRF Model over the same two-year period. This enabled us to determine model biases for every grid cell on the map, which we were then able to apply to the entire 30-year dataset. Once we had the full 30 years of bias corrected data, we then needed to extend the 30 years of data to create a 50-year wind. This was achieved by determining the peak wind gusts for each year going back to 1984 and then applying a Generalized Extreme Value Probability Distribution Function (GEV PDF) to the data. This enabled our team to extend the 30-year wind to a 50-year wind for each grid cell in the map.

Once this step was complete, our Meteorology team was then able to conduct analysis on the map to make refinements based upon their subject matter expertise. Having an understanding of the model's tendencies resolving winds around certain terrain features, the meteorologists were able to refine details of the wind map to bring added value and accuracy to the final version which exists today. Features were created from isolines and the SDG&E electric service boundary. These isolines are edited versions of the version 1 isolines that were heads-up digitized at 1:50,000 or larger scale from a georeferenced marked up map. The original marked up map was created by photographing the physical map in several pieces, rectifying, and then mosaicking the images. These new isolines incorporate edits made to the existing isolines described above. The areas to be edited were identified by SDG&E meteorologists and marked

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up using a Touch Table displaying the version 1 isolines in Google Earth. The edit mark ups were done at various scales and levels of detail. These edit markups were then exported to KML and then imported into GIS for use as a template by GIS personnel to complete the update of version 2. Updated isolines were then turned into polygon features and attributed accordingly. See attached “Response_30” file.

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QUESTION 31

Is SDG&E's wildfire consequence model still using an 8-hour fire spread period for Technosylva simulations?

RESPONSE 31

Yes, SDG&E's wildfire consequence modeling still uses an 8-hour fire spread period as a simulation time for acquiring base data regarding Fire Size Potential and potential impacts.

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QUESTION 32

What is the definition of the Normalized Difference Vegetation Index (NDVI)?

RESPONSE 32

Normalized Difference Vegetation Index (NDVI) quantifies vegetation by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs). Healthy vegetation (rich with chlorophyll) reflects more near-infrared (NIR) and green light compared to other wavelengths, and absorbs more red and blue light. NDVI is a standardized way to measure healthy vegetation. When you have high NDVI values, you have healthier vegetation. When you have low NDVI, you have less or no vegetation. SDG&E utilizes NDVI values in the Fire Potential Index as a measure of grass health within the algorithm.

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QUESTION 33

Do the "urban encroachment" algorithms (p. 112) incorporate the variable of building age? If not, is there any plan to include this variable?

RESPONSE 33

SDG&E objects to Question 33 on the grounds set forth in General Objections Nos. 2, 3, 5, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

No, the algorithm does not include building age. While calibration is continually occurring, at this time there is no plan to include age as a variable. SDG&E instead has chosen to focus on building density and the surrounding fuel loading along with data from CALFIRE to update the variable as needed.

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QUESTION 34

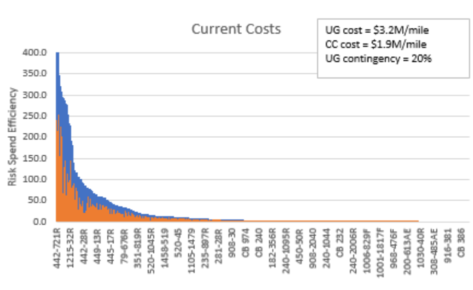
On page 128 of the WMP, SDG&E states that: "A sensitivity analysis is employed to validate the RSE and mitigation sections of the WiNGS-Planning model. In this analysis, constants, including cost per mile estimates and RSE thresholds, are adjusted to see how sensitive the mitigation recommendations are to different size variable adjustments." Please provide the results of this sensitivity analysis.

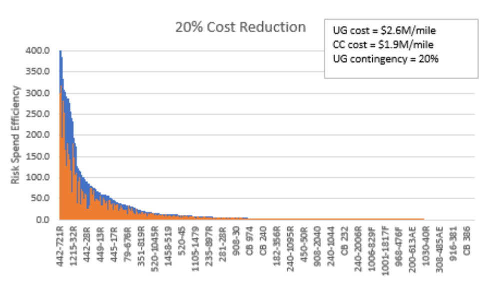
RESPONSE 34

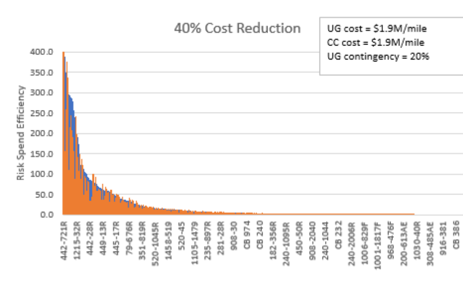
SDG&E objects to Question 34 on the grounds set forth in General Objections Nos. 2, 3, 5, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

To better understand the sensitivity around undergrounding cost estimates and RSE thresholds, various sensitivity analyses were pursued on several iterations of the WiNGS-Planning model to see the effect of changes to these variables within the model.

The below three figures show one such analysis, where the WF RSE values of undergrounding and covered conductor mitigations were assessed for the scope of segments within WiNGS-Planning. The analysis compared current undergrounding cost estimates (left figure) to a 20% cost reduction state (middle figure) and a 40% cost reduction state (right figure). The analysis was done to analyze anticipated cost reduction estimates projected for undergrounding mitigation and how that would affect the model outcome. As seen here, the WF RSE values for the undergrounding mitigation starts to converge to be comparable to the same metric for the covered conductor mitigation option, most notably so at the 40% undergrounding cost reduction state. These foreseeable future states of cost reduction for the undergrounding mitigation would see a resulting increase in the number of segments to be recommended for undergrounding mitigation as opposed to covered conductor, specifically an increase from 61 segments (current costs) to 100 segments (40% reduced cost) in this particular analysis, where applicable per construction feasibility and per the RSE threshold utilized to meet the cost and risk reduction objectives/constraints.







Sensitivity analysis was also done on the RSE threshold utilized within WiNGS-Planning to support prioritization and mitigation selection efforts of the model. One such sensitivity was run on the RSE threshold ranging it from 2 to 80, and the relevant resulting metrics, e.g. WF Risk Reduction and Total Portfolio Cost, were calculated accordingly. Objectives and constraints set around risk reduction goals and maximum portfolio costs can be targeted more accurately through the RSE threshold variability as a result of the analysis, in addition to better understanding the correlation between the RSE threshold constraint and the subsequent model outcomes.

RSE Threshold	WF Risk Reduction %	Portfolio Cost ($k)
2	98.8%	$11,228,760
4	97.2%	$8,882,119
6	95.5%	$7,416,811
8	94.0%	$6,382,780
10	92.5%	$5,669,208
12	91.9%	$5,488,839
14	90.8%	$5,091,759
16	88.9%	$4,489,017
18	87.9%	$4,235,468
20	86.4%	$3,955,696
22	84.7%	$3,602,218
24	82.8%	$3,186,817
26	81.1%	$2,879,965
28	80.0%	$2,681,103
30	78.8%	$2,454,169
32	78.4%	$2,383,835
34	78.0%	$2,344,535
36	77.5%	$2,307,325
38	76.3%	$2,145,969
40	75.7%	$2,109,465
42	75.0%	$2,056,914
44	74.8%	$2,036,353
46	74.2%	$1,974,861
48	73.1%	$1,892,842
50	72.0%	$1,816,470
52	71.4%	$1,779,606

54	71.0%	$1,753,546
56	70.9%	$1,740,338
58	70.0%	$1,671,192
60	69.1%	$1,621,423
62	68.3%	$1,572,519
64	68.1%	$1,565,583
66	67.4%	$1,537,914
68	66.4%	$1,478,398
70	66.4%	$1,478,220
72	64.7%	$1,365,542
74	63.2%	$1,293,508
76	62.0%	$1,253,332
78	60.9%	$1,210,579
80	60.8%	$1,208,858

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QUESTION 35

In the Wildfire Methodology section of Table 4-19, SDG&E states that its WiNGS-Ops analysis will estimate harm from wildfire smoke as "population impacted X smoke fatality fraction". Please provide description and documentation for how SDG&E will estimate the impacted population and the smoke fatality fraction.

RESPONSE 35

SDG&E objects to Question 35 on the grounds set forth in General Objections Nos. 2, 3, 5, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

SDG&E uses the Technosylva conditional impact consequence model to estimate population impacted for each potential risk event. Population impacted is a direct output of the Technosylva model. SDG&E estimates the "smoke fatality fraction", which is a quantification of additional significant injuries and fatalities resulting directly or indirectly from smoke, as a fraction of the population impacted. This fraction was determined by SME input. This fatality fraction will be revisited in 2022 model updates.

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SDG&E RESPONSE

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QUESTION 36

Provide any references or external partners used to develop SDG&E's smoke impact model.

RESPONSE 36

SDG&E objects to Question 36 on the grounds set forth in General Objections Nos. 2, 3, 5, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

The following references were reviewed when evaluating the smoke fatality fraction.

- https://www.publish.csiro.au/wf/fulltext/wf19091#R16
- https://ww2.arb.ca.gov/sites/default/files/2021-07/Camp_Fire_report_July2021.pdf
- https://ww2.arb.ca.gov/news/new-analysis-shows-spikes-metal-contaminants-including-lead-2018-camp-fire-wildfire-smoke
- https://www.sciencedirect.com/science/article/abs/pii/S0048969717320223?via%3Dihub

As noted in the previous response, this fatality fraction will be revisited in 2022 model updates.

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QUESTION 37

Describe whether and how smoke hospitalizations would be incorporated into SDG&E's smoke impact model.

RESPONSE 37

SDG&E objects to Question 37 on the grounds set forth in General Objections Nos. 2, 3, 5, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

Hospitalizations are indirectly considered as part of the estimation explained in Question 35. In future models, SDG&E will consider exploring the applicability of an explicit smoke-related hospitalization quantification for the purposes of PSPS decision-making.

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QUESTION 38

Please provide the geospatial map files used to create Figures 4-36 and 4-37 showing RFW and HWW days in file 2022_02_05_SDGE_2022_WMP Update_GIS Layer_452_2.zip if not already provided.

RESPONSE 38

See attached "Response_38_WMP_2022_7_3.gdb."

Vegetation Management

QUESTION 39

On p. 299, the WMP states that “Hazard tree trimming or removal is prioritized where necessary if failure is determined to be imminent.” Describe the conditions that would lead SDG&E arborists to classify a “strike potential” tree as being prone to imminent failure.

RESPONSE 39

SDG&E objects to Question 39 on the grounds set forth in General Objections Nos. 2, 3, and 5. Subject to the foregoing objections, SDG&E responds as follows

An imminent condition may be described as one where failure has started or is most likely to occur very soon. Observed conditions that might support the determination that a tree’s failure may be imminent and where work may be prioritized include, but are not limited to, one or more of the following:

- Dead or dying with shedding branches;
- Excessive or uncorrected lean that appears unsupported by counter-balancing weight from the tree’s crown or branches;
- Visible indicator of uplift in the root plate and/or and surrounding soil;
- Major cavity or cracking in trunk or branches that indicates the tree is unsound; or
- Storm-damaged tree.

PSPS

QUESTION 40

Please provide a version of the analysis of frequently de-energized circuits (pp. 369-373) containing the additional supplemental information:

a. Damage to circuits after inspection for each circuit/outage

b. De-energized customer-days for each circuit/outage

c. Total circuit length for each circuit

RESPONSE 40

SDG&E objects to Question 40 on the grounds set forth in General Objections Nos. 2, 3, 5, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows

See attached response titled "Response_40a-c_2022 WMP_MGRA_DR02."

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SDG&E RESPONSE

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10 Year Vision

QUESTION 41

What is the estimated effectiveness for a combination of SDG&E's falling conductor technology and covered conductor for all ignition risk drivers?

RESPONSE 41

SDG&E objects to Question 41 on the grounds set forth in General Objections Nos. 2, 3, 5, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

SDG&E has not quantified the effectiveness of combining Falling Conductor Protection (FCP) with Covered Conductor technologies, however we do recognize the inherent benefits provided by both technologies that should combine to further reduce wildfire risk.

SDG&E anticipates combining FCP with covered conductor technologies in a layered approach to mitigate overall risk. Covered conductor provides for a more robust and resilient overhead electric system and FCP will still be able to detect broken conductors on covered conductor circuit segments. So, if covered conductors failed causing an open phase condition, SDG&E expects FCP would provide adequate backup protection to de-energize the circuit segment before energized conductors could reach the ground.

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SDG&E RESPONSE

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QUESTION 42

In what scenarios would a combination of SDG&E's falling conductor technology and covered conductor still have significant residual ignition risk?

RESPONSE 42

SDG&E objects to Question 42 on the grounds set forth in General Objections Nos. 2, 3, 5, 8 and 9. Subject to the foregoing objections, SDG&E responds as follows:

It is possible for covered conductors to fall to the ground still intact without the conductor breaking. In these cases, falling conductor protection (FCP) would not detect a broken conductor or open phase condition and would not operate. The covered conductor that fell to the ground may still be a source of ignition because insulation over the conductor may be damaged and exposed. The risk of high impedance fault (HIF) events on covered conductor systems is higher due to the conductor insulation, so a combination of FCP and other Advanced Protection Technologies such as Sensitive Ground Fault (SGF) and Sensitive Relay Profile (SRP) may help to best prevent ignitions on our system.

The following risk drivers are known scenarios where a combination of FCP and covered conductor can still have residual ignition risk:

- Prolonged contact from object – vegetation, balloons, etc.
- Animal contact – animals chewing through insulation
- Equipment failure – lightning arrestor, switch, transformer, capacitor, fuse, connection device
- Wire-down without broken conductor – pole failure or crossarm failure which results in prolonged contact with the ground or other objects (pole/crossarm/vegetation) while conductor remains intact.

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SDG&E RESPONSE

Date Received: February 22, 2022
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Vegetation Management Impact Analysis

QUESTION 43

In the Machine Learning model used to estimate risk tree scores, please provide the "distribution of risk scores" (p. E-9) that were used to determine a threshold of 0.15 for "risk trees".

RESPONSE 43

SDG&E objects to Question 43 on the grounds set forth in General Objections Nos. 2, 3, and 5. Subject to the foregoing objections, SDG&E responds as follows

The threshold was established by returning as low a number of activity observations as possible but capturing a high percentage of true outage events. The testing dataset, 753,808 inspection or tree trimming observations from 2019 and 2020, represents two years of work activities on the inventory trees. As shown in distribution Figure 1 below, 22.5% (169,730) of observations have a probability score greater than 0.15. As shown in Figure 2 below, when the probability threshold is set at .15 on this testing dataset, the model captures 82% (32) of the true outages (2019-2020) by identifying 22.5% (169,730) of observations (2019-2020) as associated with trees that are more likely to cause an outage. These 169,730 observations represent 100,537 unique tree IDs.

Figure 1

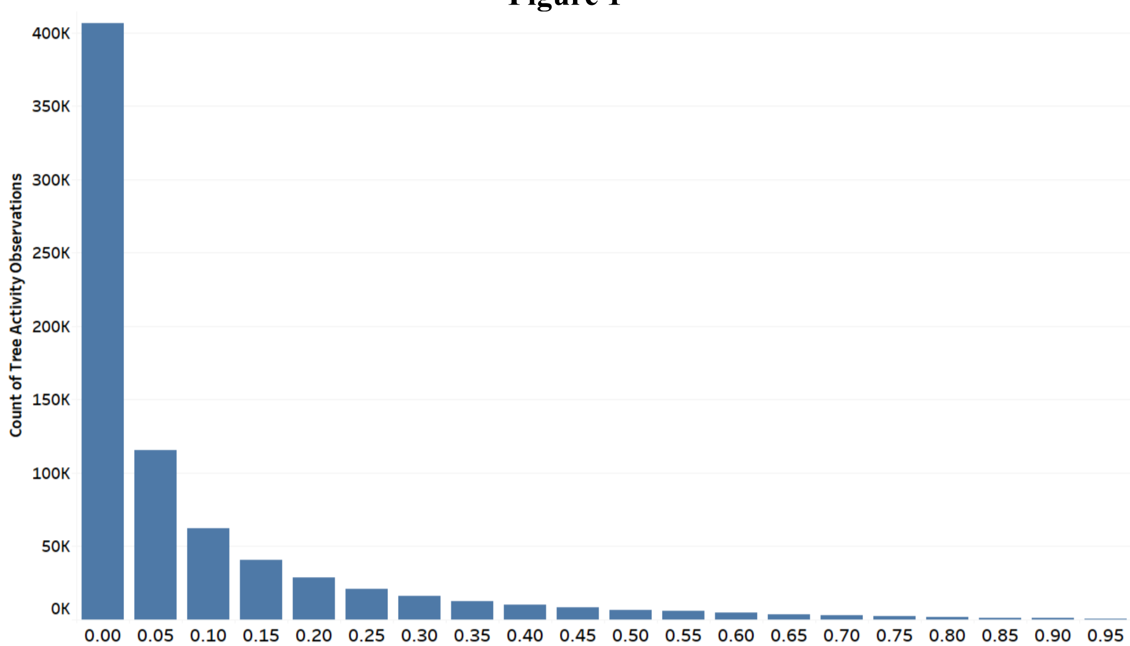

Figure 2: Testing Data (2019-2020) Outcome Performance (Risk Events)

	(Predicted) No Outage	(Predicted) Outage
(Actual) No Outage	584,071	169,698
(Actual) Outage	7	32

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Date Submitted: February 24, 2022**

QUESTION 44

Describe the qualitative considerations that led to the value .15 being chosen for the "risk tree" threshold.

RESPONSE 44

SDG&E objects to Question 44 on the grounds set forth in General Objections Nos. 2, 3, and 5. Subject to the foregoing objections, SDG&E responds as follows:

This preliminary study provided quantitative evidence that the increase in line clearance results in a decrease in risk events. For this study, the following qualitative considerations were applied:

The number of outages caused by inventory trees ranges from 15 to 37 per year (2010-2020), it is a minimal number compared to approximately 480,000 inventory trees in the database. Thus, the probability of an outage on an individual tree is low. To capture a greater number of true positive outcomes (actual outages), a low probability value 0.15 was used as the threshold. Again, the purpose of the model is not to predict the probability of all system wide vegetation outages. This model was used to evaluate the sensitivity and effectiveness of greater line clearance to outage reduction by computing the outage outcome with different line clearance values.

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END OF REQUEST

SDG&E – MGRA – Data Request Response 3-4

MUSSEY GRADE ROAD ALLIANCE DATA REQUEST:
MGRA-SDGE-WMP22_DATAREQUEST 3
SDG&E RESPONSE

Date Received: March 28, 2022
Date Submitted: March 30, 2022

GENERAL OBJECTIONS

1. SDG&E objects generally to each request to the extent that it seeks information protected by the attorney-client privilege, the attorney work product doctrine, or any other applicable privilege or evidentiary doctrine. No information protected by such privileges will be knowingly disclosed.

2. SDG&E objects generally to each request that is overly broad and unduly burdensome. As part of this objection, SDG&E objects to discovery requests that seek "all documents" or "each and every document" and similarly worded requests on the grounds that such requests are unreasonably cumulative and duplicative, fail to identify with specificity the information or material sought, and create an unreasonable burden compared to the likelihood of such requests leading to the discovery of admissible evidence. Notwithstanding this objection, SDG&E will produce all relevant, non-privileged information not otherwise objected to that it is able to locate after reasonable inquiry.

3. SDG&E objects generally to each request to the extent that the request is vague, unintelligible, or fails to identify with sufficient particularity the information or documents requested and, thus, is not susceptible to response at this time.

4. SDG&E objects generally to each request that: (1) asks for a legal conclusion to be drawn or legal research to be conducted on the grounds that such requests are not designed to elicit facts and, thus, violate the principles underlying discovery; (2) requires SDG&E to do legal research or perform additional analyses to respond to the request; or (3) seeks access to counsel's legal research, analyses or theories.

5. SDG&E objects generally to each request to the extent it seeks information or documents that are not reasonably calculated to lead to the discovery of admissible evidence.

6. SDG&E objects generally to each request to the extent that it is unreasonably duplicative or cumulative of other requests.

7. SDG&E objects generally to each request to the extent that it would require SDG&E to search its files for matters of public record such as filings, testimony, transcripts, decisions, orders, reports or other information, whether available in the public domain or through FERC or CPUC sources.

8. SDG&E objects generally to each request to the extent that it seeks information or documents that are not in the possession, custody or control of SDG&E.

9. SDG&E objects generally to each request to the extent that the request would impose an

undue burden on SDG&E by requiring it to perform studies, analyses or calculations or to create documents that do not currently exist.

10. SDG&E objects generally to each request that calls for information that contains trade secrets, is privileged or otherwise entitled to confidential protection by reference to statutory protection. SDG&E objects to providing such information absent an appropriate protective order.

II. EXPRESS RESERVATIONS

1. No response, objection, limitation or lack thereof, set forth in these responses and objections shall be deemed an admission or representation by SDG&E as to the existence or nonexistence of the requested information or that any such information is relevant or admissible.

2. SDG&E reserves the right to modify or supplement its responses and objections to each request, and the provision of any information pursuant to any request is not a waiver of that right.

3. SDG&E reserves the right to rely, at any time, upon subsequently discovered information.

4. These responses are made solely for the purpose of this proceeding and for no other purpose.

**MUSSEY GRADE ROAD ALLIANCE DATA REQUEST:
MGRA-SDGE-WMP22_DATAREQUEST 3
SDG&E RESPONSE**

**Date Received: March 28, 2022
Date Submitted: March 30, 2022**

QUESTION 1

Please explain technically how SDG&E's WiNGS-Planning model applies a conditional probability or makes any other adjustment to account for the fact the Technosylva consequence model is run on "worst weather days", while the Probability of Ignition model analyzes all ignitions whether they are on worst weather days or not.

RESPONSE 1

The WiNGS-Planning model characterizes the likelihood of a risk event (LoRE) for a wildfire utilizing available historical ignition data, to create a base annual ignition rate for a given circuit-segment portion of the system. To account for more precise circuit-segment risk profiles, adjustment elements associated to specific risk factors are applied to the base annual ignition rate at the circuit-segment level, which include risk factors such as vegetation, wind, conductor/pole age. For the wind risk factor adjustment element specifically, a 5-year historical max wind speed attribute is utilized for the adjustment to the ignition rate, the max being used in part to ensure the likelihood and consequence elements of the model employ aligned environmental conditions.

**Date Received: April 1, 2022
Date Submitted: April 5, 2022**

Wildfire Risk Modeling

In its response to MGRA Data Request 3 SDG&E stated that: The WiNGS-Planning model characterizes the likelihood of a risk event (LoRE)for a wildfire utilizing available historical ignition data, to create a base annual ignition rate for a given circuit-segment portion of the system. To account for more precise circuit-segment risk profiles, adjustment elements associated to specific risk factors are applied to the base annual ignition rate at the circuit segment level, which include risk factors such as vegetation, wind, conductor/pole age. For the wind risk factor adjustment element specifically, a 5- year historical max wind speed attribute is utilized for the adjustment to the ignition rate, the max being used in part to ensure the likelihood and consequence elements of the model employ aligned environmental conditions.

QUESTION 1

In the circuit-segment risk profiles, are the adjustments applied to specific risk factors applied to all ignitions equally or are they applied differently to different drivers? If the latter, how so?

RESPONSE 1

SDG&E objects to the Question on the grounds set forth in General Objections Nos. 2 and 3. Subject to the foregoing objections, SDG&E responds as follows:

The adjustments do not apply individually to specific ignition risk drivers in the current iteration of the WiNGS Planning model, but rather to the base calculated ignition rate for a given circuit-segment, which is estimated from the historical ignition counts across all risk drivers adjusted by the circuit-segment mileage of the given portion of the system being assessed. Current plans for updates to the wildfire likelihood methodology in WiNGS Planning include replacing the base ignition rate and adjustment factor elements with the circuit-segment outputs from the Probability of Ignition (PoI) models. The individual PoI models consist of specific asset and risk driver machine learning models, and therefore the update would constitute a more direct circuit-segment risk likelihood assessment based on individual risk drivers.

MUSSEY GRADE ROAD ALLIANCE DATA REQUEST:
MGRA-SDGE-WMP22_DATAREQUEST 4
SDG&E RESPONSE

Date Received: April 1, 2022
Date Submitted: April 5, 2022

QUESTION 2

What is the formula or algorithm by which the historical maximum wind speed is applied to the ignition rate?

RESPONSE 2

$$Norm.Ignition\ Rate\ Adj.by\ Wind_i = \frac{Base\ Ignition\ Rate_i * Wind\ Speed\ Adj.Factor_i * Total\ Ignition\ Rate}{Total\ UnNorm.Wind\ Adj.Ignition\ Rate}$$

Where,

$$Total\ Ignition\ Rate = \sum_{i=1}^{n}(Base\ Ignition\ Rate_i)$$

$Total\ UnNorm.Wind\ Adj.Ignition\ Rate = \sum_{i=1}^{n}(Base\ Ignition\ Rate_i * Wind\ Speed\ Adj.Factor_i)$

i = specific circuit-segment element

n = number of circuit-segment elements in scope

Wind Speed Adj. Factor = circuit-segment level adjustment factor calculated based on the historical Max Wind speed attribute, devised by internal Subject Matter Experts (SME) from Enterprise Risk Management (ERM) and Meteorology

Total Ignition Rate = annual rate based on historical counts across all ignition drivers associated to the scope of the model

Total UnNorm. Wind Adj. Ignition Rate = non-normalized adjusted annual rate based on the wind speed adjustment factor applied at the circuit-segment level

Note: Normalization of the ignition rates is achieved to ensure top-down alignment of the observed system level historical ignition rates with the more granular circuit-segment level ignition rates.

Date Received: April 1, 2022
Date Submitted: April 5, 2022

QUESTION 3

How has this approach been validated? Please provide any internal validation documents with any confidential data removed.

RESPONSE 3

SDG&E objects to the Question on the grounds set forth in General Objections Nos. 2, 3, and 5. Subject to the foregoing objections, SDG&E responds as follows:

The methodology of the current wildfire likelihood calculation of the risk analysis within WiNGS Planning has been constructed and quality checked by, and alongside, multiple internal teams, including Enterprise Risk Management, Wildfire Mitigation, and Meteorology, along with third party support provided by an external vendor to help formulate and construct the model framework. Current plans for WiNGS Planning includes detailing and initiating processes to implement a third-party review of the model, including, but not limited to, the wildfire likelihood portion of the calculation methodology.

A-4 Other Data Requests

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case Phase I
Application 21-06-021
Data Response

PG&E Data Request No.:	CalAdvocates_073-Q07		
PG&E File Name:	GRC-2023-PhI_DR_CalAdvocates_073-Q07		
Request Date:	September 16, 2021	Requester DR No.:	PubAdv-PG&E-073-MGN
Date Sent:	September 30, 2021	Requesting Party:	Public Advocates Office
PG&E Witness:	Sumeet Singh (subparts a, b)	Requester:	Miles Gordon

SUBJECT: PG&E'S REQUIREMENTS FOR A QUANTITATIVE PROGRAM EFFECTIVENESS APPROACH, IMPLEMENTATION OF NORTHSTAR CONSULTING GROUP'S RECOMMENDATIONS, INCORPORATION OF THE POWER LAW DISTRIBUTION INTO PG&E'S WILDFIRE RISK MODEL, INCORPORATION OF CLIMATE DATA INTO PG&E'S WILDFIRE RISK MODEL AND ASSOCIATED MITIGATION PROGRAM PROPOSALS AND PSPS DECISION-MAKING PROCESSES

QUESTION 07

Referring to PG&E's Workpapers for Exhibit PG&E-2, page WP-161, Line 416, PG&E states "PG&E has revisited the MAVF calculations based on intervenor feedback and will incorporate recommendations where appropriate, including use of a power law distribution for the wildfire risk and removing the cap on the scaling function."

a. Please describe how the power law distribution was used in PG&E's wildfire risk model. If PG&E specified a cutoff point for (or 'truncated') the power law function, please also provide the parameter(s) PG&E used and a justification for those parameter(s).

b. Using the matrix format provided below, please provide a comparison of the Likelihood of Risk Event (LoRE) and Consequence of Risk Event (CoRE) scores that PG&E generated for the wildfire risk **prior to <u>and</u> after** incorporation of the power law distribution and removing the cap on the scaling function, with columns for the prior and current LoRE and CoRE scores and the justification (including specific changes in input data) for changes that occurred.

Prior LoRE	Current LoRE	Justification for change	Prior CoRE	Current CoRE	Justification for change
<insert answer here>	<insert answer here>	<insert answer here>	<insert answer here>	<insert answer here>	<insert answer here>

c. Using the matrix format provided below, please detail any changes in Risk-Spend Efficiency (RSE) and Net Present Value (NPV) Risk Reduction for specific mitigations for the wildfire risk that occurred after incorporating the power law distribution and removing the cap on the scaling function. Include the mitigation, the prior and current RSE and NPV Risk Reduction values for the years 2021, 2022, 2023, 2024, 2025, and 2026 and the prior and current RSE and NPV Risk reduction totals for 2021-2026, as well as the justification (including specific changes in input data) for changes that occurred.

Sample matrix for each year (2021 to 2026):

Mitigation	Prior RSE	Current RSE	Justification for Change	Prior NPV Risk Reduction	Current NPV Risk Reduction	Justification for Change
<insert answer here>	<insert answer here>	<insert answer here>	<insert answer here>	<insert answer here>	<insert answer here>	<insert answer here>

ANSWER 07

a. Please see the attached whitepaper entitled ***Power Law Distribution*** (GRC-2023-PhI_DR_CalAdvocates_073_Q07Atch01). The whitepaper describes how PG&E has implemented the power law distribution in its update to the wildfire risk model. The *Power Law Distribution* whitepaper was submitted to the Safety Policy Division on September 3rd, 2021 in support of the Phase 1, Track 1 Technical Working Group discussions and the Risk OIR (R.20-07-013).

b. For the purpose of responding to this data request PG&E is defining "prior LoRE" and "prior CoRE" as the LoRE and CoRE for the wildfire risk model as shown in PG&E's 2020 RAMP Report post-Errata. PG&E is defining "current LoRE" and "current CoRE" as the LoRE and CoRE as shown in PG&E's 2023 GRC testimony.

	2020 RAMP Wildfire Risk Model LoRE	2023 GRC Opening Testimony LoRE	2020 RAMP Wildfire Risk Model CoRE	2023 GRC Opening Testimony CoRE	Justification for change
Entire transmission and distribution overhead system	Freq = 442 LoRE = 0.00447	Freq = 481 LoRE = 0.00482	57	48	1. See Power Law Distribution Whitepaper (Attachment GRC-2023-PhI_DR_CalAdvocates_073_Q07Atch01); 2. Dataset updates to include 2020 data that were not available at the time of 2020 RAMP Preparation; 3. See Updates to PG&E's 2020 RAMP Enterprise Risk Model in GRC testimony in page 3-21 ~3-24.
High fire threat districts only	Freq = 139 LoRE = 0.00548	Freq = 143 LoRE = 0.00563	168	153	

c. PG&E has requested an extension to respond to subpart c of this data request until October 6th, 2021 to incorporate errata impacting the 2023 GRC RSEs.

PACIFIC GAS AND ELECTRIC COMPANY
2023 General Rate Case Phase I
Application 21-06-021
Data Response

PG&E Data Request No.:	CalAdvocates_073-Q07		
PG&E File Name:	GRC-2023-PhI_DR_CalAdvocates_073-Q07		
Request Date:	September 16, 2021	Requester DR No.:	PubAdv-PG&E-073-MGN
Date Sent:	October 6, 2021	Requesting Party:	Public Advocates Office
PG&E Witness:	Sumeet Singh and Paul McGregor	Requester:	Miles Gordon

SUBJECT: **PG&E'S REQUIREMENTS FOR A QUANTITATIVE PROGRAM EFFECTIVENESS APPROACH, IMPLEMENTATION OF NORTHSTAR CONSULTING GROUP'S RECOMMENDATIONS, INCORPORATION OF THE POWER LAW DISTRIBUTION INTO PG&E'S WILDFIRE RISK MODEL, INCORPORATION OF CLIMATE DATA INTO PG&E'S WILDFIRE RISK MODEL AND ASSOCIATED MITIGATION PROGRAM PROPOSALS AND PSPS DECISION-MAKING PROCESSES**

QUESTION 07

Referring to PG&E's Workpapers for Exhibit PG&E-2, page WP-161, Line 416, PG&E states "PG&E has revisited the MAVF calculations based on intervenor feedback and will incorporate recommendations where appropriate, including use of a power law distribution for the wildfire risk and removing the cap on the scaling function."

a. Please describe how the power law distribution was used in PG&E's wildfire risk model. If PG&E specified a cutoff point for (or 'truncated') the power law function, please also provide the parameter(s) PG&E used and a justification for those parameter(s).

b. Using the matrix format provided below, please provide a comparison of the Likelihood of Risk Event (LoRE) and Consequence of Risk Event (CoRE) scores that PG&E generated for the wildfire risk **prior to <u>and</u> after** incorporation of the power law distribution and removing the cap on the scaling function, with columns for the prior and current LoRE and CoRE scores and the justification (including specific changes in input data) for changes that occurred.

Prior LoRE	Current LoRE	Justification for change	Prior CoRE	Current CoRE	Justification for change
<insert answer here>	<insert answer here>	<insert answer here>	<insert answer here>	<insert answer here>	<insert answer here>

c. Using the matrix format provided below, please detail any changes in Risk-Spend Efficiency (RSE) and Net Present Value (NPV) Risk Reduction for specific mitigations for the wildfire risk that occurred after incorporating the power law distribution and removing the cap on the scaling function. Include the mitigation, the prior and current RSE and NPV Risk Reduction values for the years 2021, 2022, 2023, 2024, 2025, and 2026 and the prior and current RSE and NPV Risk reduction totals for 2021-2026, as well as the justification (including specific changes in input data) for changes that occurred.

Sample matrix for each year (2021 to 2026):

Mitigation	Prior RSE	Current RSE	Justification for Change	Prior NPV Risk Reduction	Current NPV Risk Reduction	Justification for Change
<insert answer here>	<insert answer here>	<insert answer here>	<insert answer here>	<insert answer here>	<insert answer here>	<insert answer here>

ANSWER 07

PG&E provided responses to parts (a) and (b) on September 30, 2021.

c. PG&E assumes that the “Prior RSE” and “Prior NPV Risk Reduction” in this data request refers to the RSEs and NPV Risk Reduction included in PG&E’s 2020 RAMP Report. PG&E assumes that the “Current RSE” and “Current NPV Risk Reduction” in this data request refers to the updated 2023 GRC RSEs provided to parties on October 1, 2021 (see email from PG&E GRC PMT subject line: A.21-06-021 PG&E Corrected RSEs).

PG&E did not provide RSEs or NPV Risk Reduction for specific Wildfire mitigations by year (2021, 2022, etc.) in its 2020 RAMP Report. In the 2020 RAMP Report PG&E provided RSEs and NPV Risk Reduction for the periods 2020-2022 and 2023-2026. Therefore, PG&E cannot provide a year-by-year RSE or NPV Risk Reduction comparison.

Table 1 below shows the RSE and NPV Risk Reduction presented in PG&E’s 2020 RAMP Report for Wildfire Mitigations compared to the 2023 GRC corrected RSEs and NPV Risk Reduction for the period 2023 to 2026.[1] Table 1 includes those Wildfire mitigations that were included in both the 2020 RAMP Report and the 2023 GRC.

Changes in RSEs and NPV Risk Reduction between the 2020 RAMP Report and the 2023 GRC are due a combination of: changes in the Enterprise Multi-Value Attribute Framework (MAVF); changes in the Wildfire risk bow-tie structure; and, for certain mitigations, changes to risk model inputs (e.g. 2020 recorded costs and units of work completed, forecast cost, number of units of work forecast).

In the following paragraphs PG&E describes changes to the Enterprise MAVF and Wildfire bow-tie structure but does not repeat these changes in Table 1 below.

Changes to PG&E’s MAVF are described in Exhibit (PG&E-2), Chapter 1, Enterprise and Operational Risk Management Program, Section E(5). In summary, the changes to the MAVF include:

1 While the 2020 RAMP Report modeling workpapers included results for the period 2020-2022, PG&E’s 2023 GRC RSE input tool does not. Therefore, PG&E cannot provide a comparison for 2020-2022.

- RSE Methodology: In the 2020 RAMP Report, PG&E employed a portfolio view of risk reduction wherein PG&E calculated an individual RSE for each mitigation based on the portfolio risk reduction (from all of the mitigations in the risk mitigation portfolio) allocated to each mitigation. PG&E modified this approach and is now calculating an incremental risk reduction.
- Present Value of Revenue Requirements (PVRR): The RSEs presented in the GRC include a PVRR factor to convert capital dollars to NPV of a revenue requirement for each capital investment subject to cost-of-service ratemaking.
- Qualitative Methodology: PG&E is introducing a method for qualitatively assessing program effectiveness when no other data is available. Risk managers using the qualitative effectiveness model are required to develop a plan for converting program effectiveness to a quantitative approach.

Along with the changes described above, PG&E also made two additional changes to the MAVF:

- Removing the cap on the scaling function: In informal comments filed at the request of SPD on November 2nd, 2020, both TURN and MGRA recommended the removal of the cap on PG&E's scaling function. PG&E had originally followed the guidance of the Settlement Agreement D.18-12-014, which in pp 18, the 2018 S-MAP Revised Lexicon, described the Scaled Unit of an Attribute (which is the output of the scaling function) as: "a value that varies from 0 to 100", effectively imposing a cap of 100 on the scaling function. Based on the feedback above, PG&E adopted the recommendation of the parties to remove the cap. PG&E intends to follow up in subsequent Risk OIRs like R.20-07-013 to clarify the language of the Settlement Agreement so that caps are not interpreted as being required.
- Power Law/Pareto distributions: In response to SPD's recommendation to consider power-law distributions to model Wildfire risk consequences, PG&E reviewed its modeling of catastrophic safety consequences and adopted a power-law (aka Pareto Type 1) distribution, which belongs to a generalized family of distributions known as Pareto distributions. PG&E also revised its financial consequence modeling and adopted a Pareto Type 2 distribution.

Along with changes in the Enterprise MAVF, PG&E also changed the structure of the Wildfire risk bow-tie since filing the 2020 RAMP Report. The changes to the Wildfire bow-tie are described in Exhibit (PG&E-4), Chapter 3, Electric Operations Risk Management, Section D (2). In summary, the changes to the Wildfire bow-tie structure include:

- PG&E revised the tranches in the 2023 GRC Enterprise Risk Model for Wildfire. PG&E expanded its overall tranches from 8 to 40.
- PG&E made three key changes to its risk drivers since the 2020 RAMP Report. The 2023 GRC Enterprise Risk Model for Wildfire includes Operational Failure as a risk driver, using ignitions associated with PG&E workforce-caused outages. Second, PG&E updated the 2023 GRC Enterprise Risk Model for Wildfire drivers and sub-drivers to align with those presented in the 2021 WMP so that the information is consistent between the

two regulatory filings. Third, PG&E enhanced the substation drivers in the 2023 GRC Enterprise Risk Model for Wildfire.

- PG&E incorporated weather into its risk model. Weather and environmental conditions are included in the Wildfire Consequence Model from Technosylva fire simulations based on the worst weather days.
- PG&E is including more ignitions in its 2023 GRC Enterprise Risk Model for Wildfire than it included in the 2020 RAMP Report.
- PG&E incorporated power law into its consequence distribution.

PG&E also made changes to certain mitigation risk model inputs that impacted the RSE and NPV Risk Reduction. These input changes and the justification for those changes are described in Table 1 below.

In its estimation of costs from a "significant" fire, SDG&E uses a gamma distribution with a shape parameter (k) of 3 and a scale parameter (θ) of 0.8.
(See for example slide deck 2021 Risk Assessment Mitigation Phase (RAMP); Workshop: SDG&E Wildfire Risk; August 13, 2021 page 19.)

MGRA-4:
Provide the data that was used to obtain these fit parameters.

SDG&E Response MGRA-4:
The fit parameters SDG&E used was based on SDG&E's historical data, specifically the 2007 Witch Fire financial loss, and SME judgement. Based on these parameters, the financial loss is estimated to be $2.4 billion on average and around $5 billion dollars at the 95th percentile.

MUSSEY GRADE ROAD ALLIANCE DATA REQUEST
MGRA-DR-008
SDG&E/SOCALGAS 2021 RAMP REPORTS- A.21-05-011/014
DATE RECEIVED: OCTOBER 5, 2021
DATE RESPONDED: OCTOBER 19, 2021
PARTIAL

The following questions relate to 1) SDG&E's response to MGRA Data Request 7, 2) SDG&E's response to MGRA Data Request 3, Question 4, and 3) SDG&E's response to TURN Data Request 2, Question 1:

Question 1 (MGRA-52): For SDG&E's gamma function used to fit financial consequences, what is the median financial loss?

SDGE Response 1 (MGRA-52):

For a gamma (3, 0.8) distribution, the median (P50) value is $2.1 billion. This value is calculated using Python's SciPy library.

MUSSEY GRADE ROAD ALLIANCE DATA REQUEST
MGRA-DR-008
SDG&E/SOCALGAS 2021 RAMP REPORTS- A.21-05-011/014
DATE RECEIVED: OCTOBER 5, 2021
DATE RESPONDED: OCTOBER 19, 2021
PARTIAL

Question 2 (MGRA-53): For SDG&E's gamma function used to fit financial consequences, what is the 98% financial loss?

SDGE Response 02 (MGRA-53):

For a gamma (3, 0.8) distribution, the median (P98) value is $6.0 billion. This value is calculated using Python's SciPy library.

MUSSEY GRADE ROAD ALLIANCE DATA REQUEST
MGRA-DR-008
SDG&E/SOCALGAS 2021 RAMP REPORTS- A.21-05-011/014
DATE RECEIVED: OCTOBER 5, 2021
DATE RESPONDED: OCTOBER 19, 2021
PARTIAL

Question 3 (MGRA-54): For SDG&E's gamma function used to fit safety consequences, what are the median, average, and 95% and 98% fatality equivalents?

SDGE Response 3 (MGRA-54):

As reflected on slide 19 from the August 13, 2021, workshop, safety consequences were estimated by subject matter expert after interpretation of historical data. As such, SDG&E did not calculate fatality equivalents as part of its RAMP analyses. Also, as mentioned in SDG&E's RAMP Report,[1] SDG&E did not develop their Risk Quantification Framework to imply a statistical value of life, and SDG&E does not support its use for that purpose.

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[1] SCG/SDG&E-RAMP-E-20

MUSSEY GRADE ROAD ALLIANCE DATA REQUEST
MGRA-DR-008
SDG&E/SOCALGAS 2021 RAMP REPORTS- A.21-05-011/014
DATE RECEIVED: OCTOBER 5, 2021
DATE RESPONDED: OCTOBER 19, 2021
PARTIAL

Perform a sensitivity analysis replacing the gamma distribution used in financial and safety consequence models with a truncated power law distribution (power law distribution with an assumed maximum loss limit). See the attached PG&E power law analysis for guidance and reference. For maximum loss, use $50 B, and for shape/exponent use best fit or SME guidance.

Question 4 (MGRA-55): Calculate the median, average, 95% and 98% financial losses based on the power law distribution.

SDGE Response 4 (MGRA-55):

SDG&E performed the financial sensitivity analysis using data points resulting from a gamma (3, 0.8) distribution to fit a power law distribution. The results of this analysis are as follows:

P(50): $3.7 billion
P(95): $13.0 billion
P(98): $13.8 billion
Average: $4.6 billion

Values are calculated using Python's SciPy library.

MUSSEY GRADE ROAD ALLIANCE DATA REQUEST
MGRA-DR-008
SDG&E/SOCALGAS 2021 RAMP REPORTS- A.21-05-011/014
DATE RECEIVED: OCTOBER 5, 2021
DATE RESPONDED: OCTOBER 19, 2021
PARTIAL

Question 5 (MGRA-56): Calculate the median, average, 95% and 98% safety consequences in equivalent fatalities based on the power law distribution.

SDGE Response 5 (MGRA)-56:

SDG&E objects to this question under Rule 10.1 of the Commission's Rules of Practice and Procedure on the grounds that it seeks the creation of information that does not exist and that is neither relevant to the subject matter involved in the pending proceeding nor is reasonably calculated to lead to the discovery of admissible evidence. The question is out of scope as it asks SDG&E to perform a calculation unrelated to any analysis SDG&E performed as part of its RAMP Report. As discussed during workshops and as mentioned in SDG&E's RAMP Report,[2] SDG&E did not calculate or use equivalent fatality values as part of their RAMP analysis and do not support using the Multi Attribute Value Framework values for that purpose.

[2] SCG/SDG&E-RAMP-E-20

A-5 SCE Confidentiality Declarations

Southern California Edison
2022-WMPs – 2022-WMPs

DATA REQUEST SET M G R A - S C E - V e r b a l - 0 1

To: MGRA
Prepared by: Ryan Stevenson
Job Title: Senior Advisor
Received Date: 3/15/2022

Response Date: 3/16/2022

Question 01:
"Pursuant to a March 15, 2022 phone conversation with SCE, MGRA requested for SCE to submit all confidential declarations/certifications it has submitted related to its 2022 WMP Update."

Response to Question 01:
Please see the attached documents that include all the confidential declarations and applications/certifications sent to Cal Advocates and OEIS pertaining to the 2022 WMP Update.

DECLARATION OF ERIK TAKAYESU

VICE PRESIDENT OF ASSET STRATEGY AND PLANNING

REGARDING THE CONFIDENTIALITY OF CERTAIN DATA

I, Erik Takayesu, declare and state:

1. I am Vice President of Asset Strategy and Planning at Southern California Edison (SCE). As such, I am responsible for overseeing and reviewing SCE's confidential information being submitted herein to the California Public Utilities Commission. I am authorized to request confidential treatment via this declaration on behalf of SCE.

2. I am making this declaration in accordance with the instructions set forth in Decision 16-08-024 and Decision 17-09-023 of R. 14-11-001, which were issued August 25, 2016, and September 28, 2017, respectively, and govern the submission of confidential documents to the Commission.

3. I have personal knowledge of the facts and representations herein and, if called upon to testify, could and would do so, except for those facts expressly stated to be based upon information and belief, and as to those matters, I believe them to be true.

4. Listed below are the data for which SCE is seeking confidential protection and the basis for SCE's confidentiality request.

Location of Confidential Data	Pages (if available)	Description of Information that is Confidential	Basis for SCE's Confidentiality Claim
WMP_2022_7_1_F_Distribution_CONFIDENTIAL WMP_2022_7_1_F_Subtransmission_CONFIDENTIAL WMP_2022_7_1_F_Transmission_CONFIDENTIAL	All	GIS layer showing wildfire risk Asset Management and Inspections GIS layer 2022	*Critical Infrastructure Information* Gov't Code §§ 6254 (e), (k), (ab), 6255(a); 6 U.S.C. §§ 131(3), 6 CFR § 29.2(b); 6 U.S.C. § 133(a)(1)(E), 6 CFR § 29.8 (defining CII and restricting its disclosure) *Critical Electric Infrastructure*

Location of Confidential Data	Pages (if available)	Description of Information that is Confidential	Basis for SCE's Confidentiality Claim
			Information Pub. L. 114-94 (FAST Act - Critical Electric Infrastructure Security) Amended December 4, 2015 18 CFR §388.113(c); FERC Orders 630, 643, 649, 662, 683, and 702 (defining CEII); 68 Fed. Reg. 9862 (Dep't of Energy Mar. 3, 2003) (final rule) *Sensitive Security Information* 49 CFR §§1520.5, 1520.9 (defining SSI and restricting its disclosure)
System Operating Bulletin 322	pages 6-48	Operation of Subtransmission and Distribution Voltage Lines Traversing High Fire Areas	*Id.*
WMP_2022_4_5_2_AFN_Customer_Distribution_CONFIDENTIAL	All	AFN customer data, transmission & distribution lines and other relevant electrical equipment (e.g., substations	*Personally identifiable information or regulated entity customers protected by Gov't. Code Sec. 6524(c)* Gov't Code §6254(c) (PRA expressly protects "Personnel, medical, or similar files, the disclosure of which would constitute an unwarranted invasion of personal privacy"). 15 U.S.C. §§ 1681 et seq. Protected also under Gov't Code §§ 6254(a), (d), (k), 6254.7(d), 6255(a); Civil Code §§ 1798.21, 1798.80, 1798.81.5,

Location of Confidential Data	Pages (if available)	Description of Information that is Confidential	Basis for SCE's Confidentiality Claim
			1798.82, 1798.85 to 1798.89, 1798.90.1, 1798.98, 1798.99, 3426, 1798.3, 1798.24; Pub. Util. Code § 8380(d) (and associated CPUC Decisions D.11-07-056, D.12-08-045); Evid. Code § 1060; Cal. Const., art. I, § 1; and G.O. 77-M; Health Insurance Portability and Accountability Act of 1996 (HIPAA), 42 U.S.C. § 1320d-6; HITECH Act, American Recovery and Reinvestment Act of 2009, PL 111-5, Feb. 17, 2009, 123 Stat 115
WMP_2022_7_1_G_CC_System_Hardening_2022_CONFIDENTIAL WMP_2022_7_1_G_TUG_System_Hardening_2022_CONFIDENTIAL WMP_2022_7_1_G_CC_System_Hardening_2023_CONFIDENTIAL WMP_2022_7_1_G_TUG_System_Hardening_2023_CONFIDENTIAL WMP_2022_7_1_I_Transmission_Circuit_Patrol_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_Conductor_Sample_Target_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_Distribution_Infrared_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_Generation_Inspections_Asset_Management_CONFIDENTIAL	All	Grid Design and System Hardening mitigations GIS layer 2022, 2023, 2024	*Critical Infrastructure Information* Gov't Code §§ 6254 (e), (k), (ab), 6255(a); 6 U.S.C. §§ 131(3), 6 CFR § 29.2(b); 6 U.S.C. § 133(a)(1)(E), 6 CFR § 29.8 (defining CII and restricting its disclosure) *Critical Electric Infrastructure Information* Pub. L. 114-94 (FAST Act - Critical Electric Infrastructure Security) Amended December 4, 2015 18 CFR §388.113(c); FERC Orders 630, 643, 649, 662, 683, and 702 (defining CEII); 68 Fed. Reg. 9862 (Dep't of Energy Mar. 3, 2003) (final rule)

Location of Confidential Data	Pages (if available)	Description of Information that is Confidential	Basis for SCE's Confidentiality Claim
WMP_2022_7_1_I_Grid_Patrol_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_IRD_Distribtuion_Aerial_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_IRD_Distribution_Ground_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_IRD_Transmission_Aerial_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_IRD_Transmission_Ground_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_Line_Vue_Target_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_Splice_Target_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_Substation_Inspections_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_Transmission_Infrared_Asset_Management_CONFIDENTIAL			*Sensitive Security Information* 49 CFR §§1520.5, 1520.9 (defining SSI and restricting its disclosure)

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

Executed on February 17, 2022 at Cerritos, California.

/s/ Erik Takayesu________

Erik Takayesu
Vice President
Asset Strategy and Planning

SCE's 2022 Wildfire Mitigation Plan Update

Confidential Declaration of Erik Takayesu

Regarding the Confidentiality of Certain Data

I, Erik Takayesu, declare and state:

1. I am the Vice President, Asset Strategy & Planning at Southern California Edison Company (SCE). As such, I had responsibility for overseeing and reviewing SCE's response to Data Request Set CalAdvocates-SCE-2022WMP-01A, Question No. 2.

2. I am making this declaration in accordance with the instructions set forth in Decision 16-08-024 and Decision 17-09-023 of R. 14-11-001, which were issued August 25, 2016, and September 28, 2017, respectively, and govern the submission of confidential documents to the Commission.

3. I have personal knowledge of the facts and representations herein and, if called upon to testify, could and would do so, except for those facts expressly stated to be based upon information and belief, and as to those matters, I believe them to be true.

4. Listed below are the data for which SCE is seeking confidential protection and the basis for SCE's confidentiality request.

Location of Confidential Data	Pages	Description of Information that is Confidential	Basis for SCE's Confidentiality Claim
Geospatial data in SCE's Q4 2021 Quarterly Data Report being submitted to the Office of Energy Infrastructure Safety	All rows in the attached workbook entitled "SCE_Q42021_StatusReport_2.1.2022" where column L "Confidential? (Yes/No)" equals Yes; also, all rows in the tab entitled "PSPS Event" in the	This file contains information that can reveal vulnerabilities or gaps that could be taken advantage of by a party that intends to do harm to the grid or to the communities that SCE serves.	California Public Utilities Code Section 364(d). This section permits the Commission to withhold information from the public which could pose a security threat if disclosed. *See* 6 U.S.C. § 131(5); citations under CII and CEII: Protected under Gov't Code §§ 6254(e), 6255(a); 6 U.S.C. § 131(50; 68 Fed. Reg. 9857

Location of Confidential Data	Pages	Description of Information that is Confidential	Basis for SCE's Confidentiality Claim
	attached workbook entitled "SCE_Q42021_ StatusReport_11. 1.2021" where column M "Confidential? (Yes/No)" equals Yes		(Dep't of Energy Mar. 3, 2003) (final rule); Cal. Pub. Util. Code § 364(d). CEII 18 CFR §388.113(c); FERC Orders 630, 643, 649, 662, 683, and 702 (defining CEII); 68 Fed. Reg. 9862 (Dep't of Energy Mar. 3, 2003) (final rule) Critical Infrastructure Information Gov't Code §§ 6254 (e), (k), (ab), 6255(a); 6 U.S.C. §§ 131(3), 6 CFR § 29.2(b); 6 U.S.C. § 133(a)(1)(E), 6 CFR § 29.8 (defining CII and restricting its disclosure) Critical Electric Infrastructure Information Pub. L. 114-94 (FAST Act - Critical Electric Infrastructure Security) Amended December 4, 2015

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

Executed on February 1, 2022 at Cerritos, California.

/s/ Erik Takayesu__________________
Erik Takayesu
Vice President
Asset Strategy & Planning

Southern California Edison Company's Declaration of Confidential Designation Pursuant to the California Public Utilities Commission's Rules of Practice and Procedure

I, Erik Takayesu, declare and state:

1. I am Vice President of Asset Strategy and Planning at Southern California Edison (SCE)at Southern California Edison Company (SCE). As such, I am responsible for overseeing and reviewing SCE's confidential information being submitted herein to the California Public Utilities Commission. I am authorized to request confidential treatment via this declaration on behalf of SCE.

2. I am making this declaration in accordance with the instructions set forth in Decision 16-08-024 and Decision 17-09-023 of R. 14-11-001, which were issued August 25, 2016, and September 28, 2017, respectively, and govern the submission of confidential documents to the Commission.

3. I have personal knowledge of the facts and representations herein and, if called upon to testify, could and would do so, except for those facts expressly stated to be based upon information and belief, and as to those matters, I believe them to be true.

Listed below are the data for which SCE is seeking confidential protection and the basis for SCE's confidentiality request.

Location of Confidential Data	Pages (if available)	Description of Information that is Confidential	Basis for SCE's Confidentiality Claim
This data request response contains a zip folder named Cal Advocates-SCE-2022WMP-04_Confidential with the following confidential files: • WRRM_2021_06_AC_MAX_i.tif • WRRM_2021_06_AC_MAX_i.tif.ovr • WRRM_2021_06_AC_MAX_i.tif.vat.dbf • WRRM_2021_06_BU_MAX_i.tif		The wildfire risk modeling raster files contains ignition consequence results within SCE's High Fire Risk Area (HFRA) plus a 20-mile buffer adjacent to HFRA	The information meets the balancing test of California Government Code section 6255. It is in the public interest that the information not be disseminated publicly. Release of detailed asset and consequence of ignition data could make SCE's facilities vulnerable to attack and could be valuable information in planning an attack on critical infrastructure. Further, providing this information in addition to and in relation with Critical Facility information could further the consequences of such an attack. There is little to no benefit to making this information publicly available. Third, parties do not need this

• WRRM_2021_06_BU_MAX_i.tif.ovr • WRRM_2021_06_BU_MAX_i.tif.vat.dbf • WRRM_2021_06_POP_MAX_i.tif • WRRM_2021_06_POP_MAX_i.tif.ovr • WRRM_2021_06_POP_MAX_i.tif.vat.dbf			information to evaluate SCE's Wildfire Mitigation Plan. As such, the public interest in not disclosing this information far outweighs the public interest in disclosing it.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

Executed on February 25, 2022 at Cerritos, California.

/s/ Erik Takayesu_________________
Erik Takayesu
Vice President of Asset Strategy and Planning

Southern California Edison Company's Declaration of Confidential Designation Pursuant to the California Public Utilities Commission's Rules of Practice and Procedure

I, Erik Takayesu, declare and state:

1. I am Vice President of Asset Strategy and Planning at Southern California Edison Company (SCE). As such, I am responsible for overseeing and reviewing SCE's confidential information being submitted herein to the California Public Utilities Commission. I am authorized to request confidential treatment via this declaration on behalf of SCE.

2. I am making this declaration in accordance with the instructions set forth in Decision 16-08-024 and Decision 17-09-023 of R. 14-11-001, which were issued August 25, 2016, and September 28, 2017, respectively, and govern the submission of confidential documents to the Commission.

3. I have personal knowledge of the facts and representations herein and, if called upon to testify, could and would do so, except for those facts expressly stated to be based upon information and belief, and as to those matters, I believe them to be true.

4. Listed below are the data for which SCE is seeking confidential protection and the basis for SCE's confidentiality request.

Location of Confidential Data	Pages	Description of Information that is Confidential	Basis for SCE's Confidentiality Claim re Certification of Previously Designated
CalAdvocates_2022_WMP_04_007_Confidential	All	SCE current circuit grids/segment and associated risk scores	*Sensitive Security Information* 49 CFR §§1520.5, 1520.9 (defining SSI and restricting its disclosure)

I certify under penalty of perjury that the information contained in this certification is true, correct, and complete to the best of my knowledge.

Executed on February 25, 2022 at Cerritos, California.

/s/ Erik Takayesu________________
Erik Takayesu
Vice President of Asset Strategy and Planning

Southern California Edison Company's Declaration of Confidential Designation Pursuant to the California Public Utilities Commission's Rules of Practice and Procedure

I, Erik Takayesu, declare and state:

1. I am Vice President of Asset Strategy and Planning at Southern California Edison Company (SCE). As such, I am responsible for overseeing and reviewing SCE's confidential information being submitted herein to the California Public Utilities Commission. I am authorized to request confidential treatment via this declaration on behalf of SCE.

2. I am making this declaration in accordance with the instructions set forth in Decision 16-08-024 and Decision 17-09-023 of R. 14-11-001, which were issued August 25, 2016, and September 28, 2017, respectively, and govern the submission of confidential documents to the Commission.

3. I have personal knowledge of the facts and representations herein and, if called upon to testify, could and would do so, except for those facts expressly stated to be based upon information and belief, and as to those matters, I believe them to be true.

4. Listed below are the data for which SCE is seeking confidential protection and the basis for SCE's confidentiality request.

Location of Confidential Data	Pages	Description of Information that is Confidential	Basis for SCE's Confidentiality Claim re Certification of Previously Designated
CalAdvocates_2022_WMP_04_008_VM_Grids	All	GIS layer showing vegetation management grids and corresponding WRRM outputs	*Sensitive Security Information* 49 CFR §§1520.5, 1520.9 (defining SSI and restricting its disclosure)

I certify under penalty of perjury that the information contained in this certification is true, correct, and complete to the best of my knowledge.

Executed on February 25, 2022 at Cerritos, California.

/s/ Erik Takayesu________________
Erik Takayesu
Vice President of Asset Strategy and Planning

Southern California Edison Company's Application and Certification for Confidential Designation Pursuant to the Office of Energy Infrastructure Safety's Emergency Rules of Practice and Procedure

I, Erik Takayesu, declare and state:

1. I am the Vice President of Asset Strategy and Planning at Southern California Edison Company (SCE). As such, I had responsibility for overseeing and reviewing SCE's confidential materials being submitted to the Office of Energy Infrastructure Safety (OEIS). I am authorized to request confidential treatment via this application and certification on behalf of SCE.

2. I am making this declaration pursuant to California Code of Regulations Title 14, Division 17, Chapter 1, Article 1, § 29200(a) & 29200(d) and in accordance with the confidentiality bases set forth in California Public Utilities Commission Decision 16-08-024 and Decision 17-09-023 of R. 14-11-001, which were issued August 25, 2016 and September 28, 2017, respectively, and govern the submission of confidential documents. SCE discloses this information pursuant to these bases as confidential materials and has not disclosed the information publicly.

Application – Critical Energy Infrastructure Information

3. The data covered by these confidentiality bases as described in the following paragraphs is not customarily in the public domain.

4. The data should be kept confidential indefinitely because of the sensitive nature of the material.

5. To the best of my knowledge, the data labeled as GIS layers has not been voluntarily submitted to the Office of Emergency services as set forth in Government Code § 6254(ab).

6. The GIS layer data described below is not shared with the public. SCE treats all such feature class data as confidential, due to the risks posed to public safety should it be made public. These documents could assist potential malicious actors by

providing them details about SCE's operational details of electricity infrastructure. Such information could be exploited by those malicious actors for harmful purposes.

7. To the best of my knowledge, SCE's System Operating Bulleting (SOB 322) has not been voluntarily submitted to the Office of Emergency services as set forth in Government Code § 6254(ab).

8. SCE's System Operating Bulletin No. 322 is not shared with the public. SCE treats certain portions of this document as confidential, due to the risks posed to public safety should it be made public. The document could assist potential malicious actors by providing them details about SCE's operational response to electric system emergencies. That information could be exploited by those malicious actors for harmful purposes.

9. The SOB 322 information discusses vulnerabilities of a facility providing critical energy infrastructure. The release of the precise location, age, and other attributes of SCE's assets alongside the precise location of critical facilities may significantly increase safety risk to the public.

10. To the best of my knowledge, the SOB 322 data is not classified as protected critical infrastructure information by the Department of Energy or the Department of Homeland Security

11. Where applicable, SCE has designated confidentiality at the data field level even though it believes confidentiality designation should be applied at the feature class level. By themselves, these data points are not necessarily confidential but when aggregated the data becomes confidential because it presents information in a form that can be taken advantage of by individuals or groups of individuals with ill intentions.

12. The confidential information in this application has not been aggregated or masked because it does not appear practical to do so in light of the information requested. Links in the Standard Operating Bulletin to confidential information have been disabled. SCE is willing to discuss further the possibility of aggregating or masking the confidential material.

13. Listed below are the data for which SCE is seeking confidential protection and the basis for SCE's confidentiality request.

Location of Confidential Data	Pages	Description of Information that is Confidential	Basis for SCE's Confidentiality Claim of CEII
WMP_2022_7_1_F_Distribution_CONFIDENTIAL WMP_2022_7_1_F_Subtransmission_CONFIDENTIAL WMP_2022_7_1_F_Transmission_CONFIDENTIAL	ALL	GIS layer showing wildfire risk Grid Design and System Hardening mitigations GIS layer 2022, 2023, 2024 Asset Management and Inspections GIS layer 2022	*Critical Infrastructure Information* Gov't Code §§ 6254 (e), (k), (ab), 6255(a); 6 U.S.C. §§ 131(3), 6 CFR § 29.2(b); 6 U.S.C. § 133(a)(1)(E), 6 CFR § 29.8 (defining CII and restricting its disclosure) *Critical Electric Infrastructure Information* Pub. L. 114-94 (FAST Act - Critical Electric Infrastructure Security) Amended December 4, 2015 18 CFR §388.113(c); FERC Orders 630, 643, 649, 662, 683, and 702 (defining CEII); 68 Fed. Reg. 9862 (Dep't of Energy Mar. 3, 2003) (final rule) *Sensitive Security Information* 49 CFR §§1520.5, 1520.9 (defining SSI and restricting its disclosure)
System Operating Bulletin 322	pages 6-48	Operation of Subtransmission and Distribution Voltage Lines Traversing High Fire Areas	

Application – Non-Critical Energy Infrastructure Information

1. The data covered by these confidentiality bases as described in the following paragraph is not customarily in the public domain.

2. The data should be kept confidential indefinitely because of the sensitive nature of the material.

3. The data customer data and disclosure would result in violation of privacy laws and expose them to potential criminal activity.

4. SCE's access and functional needs customer data along with the accompanying information transmission & distribution lines and other relevant electrical equipment are not public. SCE treats all customer data as confidential due to the risks posed to their safety should it be made public.

5. The confidential information in this response has not been aggregated or masked because it does not appear practical to do so in light of the information requested. SCE is willing to discuss the possibility of aggregating or masking the confidential material.

6. Listed below are the data for which SCE is seeking confidential protection and the basis for SCE's confidentiality request.

Location of Confidential Data	Pages	Description of Information that is Confidential	Basis for SCE's Confidentiality Claim for Non-CEII
WMP_2022_4_5_2_AFN_Customer_Distribution_CONFIDENTIAL	ALL	AFN customer data, transmission & distribution lines and other relevant electrical equipment (e.g., substations	*Personally identifiable information or regulated entity customers protected by Gov't. Code Sec. 6524(c)* Gov't Code §6254(c) (PRA expressly protects "Personnel, medical, or similar files, the disclosure of which would constitute an unwarranted invasion of personal privacy"). 15 U.S.C. §§ 1681 et seq. Protected also under Gov't Code §§ 6254(a), (d), (k), 6254.7(d), 6255(a); Civil Code §§ 1798.21, 1798.80, 1798.81.5, 1798.82, 1798.85 to 1798.89, 1798.90.1, 1798.98, 1798.99, 3426, 1798.3, 1798.24; Pub. Util. Code § 8380(d) (and associated CPUC Decisions D.11-07-056, D.12-08-045); Evid. Code § 1060; Cal. Const., art. I, § 1; and G.O. 77-M; Health Insurance Portability and Accountability Act of 1996 (HIPAA), 42 U.S.C. § 1320d-6; HITECH Act, American Recovery and Reinvestment Act of 2009, PL 111-5, Feb. 17, 2009, 123 Stat 115

Certification re Previously Designated Information That Is Substantially Similar

1. I am seeking a confidential designation for information that is substantially similar to the previously submitted information and that all the facts and circumstances relevant to confidentiality remain unchanged.

2. To the best of my knowledge, the data labeled as "Grid Design and System Hardening mitigations GIS layer 2022, 2023, 2024" were submitted to the OEIS in SCE's 2021 Fourth Quarter AB 1054 Notification.

3. SCE's Grid Design and System Hardening mitigations are not shared with the public. SCE treats all feature class data as confidential, due to the risks posed to public safety should it be made public. These documents could assist potential malicious actors by providing them details about SCE's operational details of electricity infrastructure. Such information could be exploited by those malicious actors for harmful purposes.

4. Listed below are the data for which SCE is seeking confidential protection and the basis for SCE's confidentiality request.

Location of Confidential Data	**Pages**	**Description of Information that is Confidential**	**Basis for SCE's Confidentiality Claim re Certification of Previously Designated**
WMP_2022_7_1_G_CC_System_Hardening_2022_CONFIDENTIAL WMP_2022_7_1_G_TUG_System_Hardening_2022_CONFIDENTIAL WMP_2022_7_1_G_CC_System_Hardening_2023_CONFIDENTIAL WMP_2022_7_1_G_TUG_System_Hardening_2023_CONFIDENTIAL WMP_2022_7_1_I_Transmission_Circuit_Patrol_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_Conductor_Sample_Target_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_Distribution_Infrared_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_Generation_Inspections_Asset_Management_CONFIDENTIAL	All	Grid Design and System Hardening mitigations GIS layer 2022, 2023, 2024	*Critical Infrastructure Information* Gov't Code §§ 6254 (e), (k), (ab), 6255(a); 6 U.S.C. §§ 131(3), 6 CFR § 29.2(b); 6 U.S.C. § 133(a)(1)(E), 6 CFR § 29.8 (defining CII and restricting its disclosure) *Critical Electric Infrastructure Information* Pub. L. 114-94 (FAST Act - Critical Electric Infrastructure Security) Amended December 4, 2015 18 CFR §388.113(c); FERC Orders 630, 643, 649, 662, 683, and 702 (defining CEII); 68 Fed. Reg. 9862 (Dep't of Energy Mar. 3, 2003) (final rule) *Sensitive Security Information* 49 CFR §§1520.5, 1520.9 (defining SSI and restricting its disclosure)

WMP_2022_7_1_I_Grid_Patrol_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_IRD_Distribtuion_Aerial_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_IRD_Distribution_Ground_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_IRD_Transmission_Aerial_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_IRD_Transmission_Ground_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_Line_Vue_Target_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_Splice_Target_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_Substation_Inspections_Asset_Management_CONFIDENTIAL WMP_2022_7_1_I_Transmission_Infrared_Asset_Management_CONFIDENTIAL			

I certify under penalty of perjury that the information contained in this application for confidential designation is true, correct, and complete to the best of my knowledge.

Executed on February 17, 2022 at Cerritos, California.

/s/ Erik Takayesu________

Erik Takayesu
Vice President
Asset Strategy and Planning

Southern California Edison Company's Certification of Confidential Designation Pursuant to the Office of Energy Infrastructure Safety's Emergency Rules of Practice and Procedure

I, Erik Takayesu, declare and state:

1. I am the Vice President, Asset Strategy & Planning at Southern California Edison Company (SCE). As such, I had responsibility for overseeing and reviewing SCE's Q4 2021 Quarterly Data Report being submitted to the Office of Energy Infrastructure Safety (OEIS). I am authorized to request confidential treatment via this certification on behalf of SCE.

2. I am making this certification pursuant to California Code of Regulations Title 14, Division 17, Chapter 1, Article 1, § 29200(d). Consistent with that provision, I am "seeking a confidential designation for information that"… "is substantially similar to the previously submitted information and that all the facts and circumstances relevant to confidentiality remain unchanged."

3. Listed below are the data for which SCE is seeking confidential protection and the basis for SCE's confidentiality request. This information is substantially similar to geospatial data provided in SCE's Q3 2021 Quarterly Data Report.

Location of Confidential Data	Pages	Description of Information that is Confidential	Basis for SCE's Confidentiality Claim
Geospatial data in SCE's Q4 2021 Quarterly Data Report being submitted to the Office of Energy Infrastructure Safety	All rows in the attached workbook entitled "SCE_Q42021_ StatusReport_2.1 .2022" where column L "Confidential? (Yes/No)" equals Yes; also, all rows in the tab entitled "PSPS Event" in the	This file contains information that can reveal vulnerabilities or gaps that could be taken advantage of by a party that intends to do harm to the grid or to the communities that SCE serves.	California Public Utilities Code Section 364(d). This section permits the Commission to withhold information from the public which could pose a security threat if disclosed. *See* 6 U.S.C. § 131(5); citations under CII and CEII: Protected under Gov't Code §§ 6254(e), 6255(a); 6 U.S.C. § 131(50; 68 Fed. Reg. 9857

Location of Confidential Data	Pages	Description of Information that is Confidential	Basis for SCE's Confidentiality Claim
	attached workbook entitled "SCE_Q42021_ StatusReport_11. 1.2021" where column M "Confidential? (Yes/No)" equals Yes		(Dep't of Energy Mar. 3, 2003) (final rule); Cal. Pub. Util. Code § 364(d). CEII 18 CFR §388.113(c); FERC Orders 630, 643, 649, 662, 683, and 702 (defining CEII); 68 Fed. Reg. 9862 (Dep't of Energy Mar. 3, 2003) (final rule) Critical Infrastructure Information Gov't Code §§ 6254 (e), (k), (ab), 6255(a); 6 U.S.C. §§ 131(3), 6 CFR § 29.2(b); 6 U.S.C. § 133(a)(1)(E), 6 CFR § 29.8 (defining CII and restricting its disclosure) Critical Electric Infrastructure Information Pub. L. 114-94 (FAST Act - Critical Electric Infrastructure Security) Amended December 4, 2015

I certify under penalty of perjury that the information contained in this certification is true, correct, and complete to the best of my knowledge.

Executed on February 1, 2022 at Cerritos, California.

/s/ Erik Takayesu__________________
Erik Takayesu
Vice President
Asset Strategy & Planning

APPENDIX B – CPUC DOCUMENTS

APPENDIX B-1 A.21-05-011-014 - MGRA SDGE RAMP Informal Comments - Smoke Analsysis Excerpt

Joseph W. Mitchell, M-bar Technologies and Consulting, LLC.

Prepared for the Mussey Grade Road Alliance

October 22, 2022

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Application of San Diego Gas & Electric Company (U 902 M) to Submit Its 2021 Risk Assessment and Mitigation Phase Report	Application 21-05-011 (Filed May 17, 2021)
Application of Southern California Gas Company (U904G) to Submit Its 2021 Risk Assessment and Mitigation Phase Report.	Application 21-05-014 (Filed May 17, 2021)

MUSSEY GRADE ROAD ALLIANCE INFORMAL COMMENTS TO THE SAFETY POLICY DIVISION REGARDING SAN DIEGO GAS AND ELECTRIC COMPANY'S RAMP FILING

Diane Conklin, Spokesperson
Mussey Grade Road Alliance
P.O. Box 683
Ramona, CA 92065
Telephone: (760) 787-0794
Email: dj0conklin@earthlink.net

Dated: October 22, 2021

Excerpt

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1. INTRODUCTION

The Mussey Grade Road Alliance (MGRA or Alliance) submits these informal comments on the SDG&E 2021 RAMP filing[1] to the CPUC's Safety Policy Division (SPD) as per instructions.[2] These informal comments are prepared by Mussey Grade Road Alliance expert Joseph Mitchell.

In its Protest[3] and PHC Statement,[4] raised a number of issues that needed deeper examination in the RAMP proceeding, including:

- Adequate consideration of mitigation alternatives,
- Adequate disclosure of workpapers and sources, and the need for extensive discovery,
- Sensitivity of the SDG&E model to extreme values, and use of the gamma function rather than a power law function,
- Risks arising from power shutoff,
- Safety impacts from wildfire smoke, now incorporated into SDG&E's risk modeling,
- Statistical Value of Life equivalent to $100 million,
- Extreme wind as a cross-cutting factor,
- Lack of data quality estimations, and
- Tranches that depend on weather conditions,

MGRA has reviewed SDG&E's supplemental data and responses to intervenor data requests and has itself initiated eight data requests comprising over 50 questions.[5]

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[1] A.21-05-011; APPLICATION OF SAN DIEGO GAS & ELECTRIC COMPANY (U 902 M) TO SUBMIT ITS 2021 RISK ASSESSMENT AND MITIGATION PHASE REPORT; May 17, 2021, and A.21-05-014; APPLICATION OF SOUTHERN CALIFORNIA GAS COMPANY (U 904 G) TO SUBMIT ITS 2021 RISK ASSESSMENT AND MITIGATION PHASE REPORT; May 17, 2021. (RAMP)
[2] Email: Sempra RAMP Application Evaluation Deadline Extension Request; From: Benjamin.Turner@cpuc.ca.gov; September 17, 2021, 12:05 pm.
[3] A.21-05-011-14; MUSSEY GRADE ROAD ALLIANCE PROTEST ON SAN DIEGO GAS AND ELECTRIC COMPANY'S 2021 RAMP APPLICATION; June 9, 2021. (MGRA Protest)
[4] A.21-05-011-14; MUSSEY GRADE ROAD ALLIANCE PREHEARING CONFERENCE STATEMENT; July 7, 2021. (MGRA PHC Statement)
[5] SDG&E Data Request Responses to MGRA are included as Appendix A, as a separate document.

2. TECHNICAL ANALYSIS OF THE SDG&E RAMP

In this section, technical aspects of SDG&E's RAMP are examined in order to examine the extent to which SDG&E is correctly quantifying and prioritizing risks. Some of these issues were raised by MGRA in SDG&E's 2019 RAMP filing,[6] while others are based upon new information available in SDG&E's 2020 Wildfire Mitigation Plans, and MGRA participation in the PG&E RAMP (A.20-06-012) or the RDF/S-MAP proceeding (R.20-07-013). Suggestions regarding additional work that Staff should suggest that SDG&E incorporate into its GRC are included where appropriate.

2.1. Extreme Value Distributions and Power Laws

MGRA has been advocating for the use of power law distributions to describe extreme losses from wildfires based on numerous academic references.[7] MGRA urged SDG&E to examine the implications of a power law distribution in its protest.[8] SDG&E has been instead using a gamma distribution to describe extreme event behavior.[9] There is no theoretical basis for the use of the gamma function to fit wildfire loss distributions. While empirical fits (fits based on existing data rather than a hypothesis) can be reasonable for interpolation, their accuracy depends upon the availability of data for the initial fit. Using empirical fits for extrapolation beyond values seen in historical data is dangerous and likely to lead to inaccurate results.

MGRA found through data requests that SDG&E's gamma distribution function and its parameters were determined by a fit to a single data point.[10] SDG&E had purportedly also explored

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[6] I.19-11-010-1; MUSSEY GRADE ROAD ALLIANCE COMMENTS ON SDG&E'S 2019 RAMP FILING; April 6, 2020; p. 2. (MGRA 2019 RAMP Comments)

[7] MGRA White Paper, Wildfire Statistics and the Use of Power Laws for Power Line Fire Prevention, (MGRA White Paper) February 11, 2021 was attached as Appendix A to MGRA's Comments Regarding Development of Safety and Operational Metrics filed March 1, 2021, available as of August 23, 2021 at:
https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M368/K055/368055506.PDF.
Included as attachment to MGRA Protest.

[8] A.21-05-011-4; MUSSEY GRADE ROAD ALLIANCE PROTEST ON SAN DIEGO GAS AND ELECTRIC COMPANY'S 2021 RAMP APPLICATION; June 9, 2021; p. 19.

[9] Id.; p. 20.

[10] SDG&E Response to MGRA-DR-003, Question MGRA-4: "The fit parameters SDG&E used was based on SDG&E's historical data, specifically the 2007 Witch Fire financial loss, and SME judgement. Based on these parameters, the financial loss is estimated to be $2.4 billion on average and around $5 billion dollars at the 95th percentile."

using a power law for its fit, but was unable to find the supporting documentation reported by the SDG&E representative.[11] MGRA has therefore requested that SDG&E perform a sensitivity analysis using a power law distribution in its WiNGS model rather than a gamma function. The results of this analysis were not available in time for the preparation of these comments[12] and will be provided to SPD and the Commission when they have been received.

As MGRA has maintained in the RDF/SMAP proceeding and in PG&E's RAMP, the purpose of using a power law distribution is that it properly captures the probability of high consequence "tail" losses. While a utility might theoretically use a different function to describe losses, it is critical that the chosen probability distribution include a sufficient contribution from low-probability high-consequence events.

The probability distribution selected by SDG&E is the gamma distribution,[13] with a "shape parameter" *(k)* of 3 and "scale parameter" (θ) of 0.8.[14] SDG&E has calibrated its fit based on historical losses to have a median value of $2.1 billion.[15] Based on the selected distribution and parameters, SDG&E claims that 98% of its cumulative losses (P98) will be less than $6.0 billion.[16]

According to analysis by J. Mitchell in the MGRA White Paper and cited references, the cumulative statistical distribution of wildfire losses in California can be described by a power law with an exponent of -0.4 to -0.5.[17] One characteristic of power law distributions, however, is that they do not converge at large values. Deviations from power law behavior occur when the wildfires approach maximum feasible size for the landscape, so a maximum size needs to be chosen accordingly. A power law function that incorporates both high and low end cut-offs that has provided accurate fits to wildfire size distributions is:

$$y = C[(a+x)^{-\alpha} - (a+L)^{-\alpha}]$$

[11] SDG&E Response to MGRA-DR-006-Partial, MGRA-30. "While the representative stated his belief that some power law distribution may have been analyzed previously, SDG&E has conducted a reasonable inquiry but is unable to determine if it has responsive documents."
[12] SDG&E Response to MGRA-DR-008-Partial, MGRA-57.
[13] https://en.wikipedia.org/wiki/Gamma_distribution
[14] SDG&E Data Request Response MGRA-DR-003, Question MGRA-4.
[15] SDG&E Data Request Response MGRA-DR-008, Question MGRA-52.
[16] SDG&E Data Request Response MGRA-DR-008, Question MGRA-52.
[17] MGRA White Paper; pp. 5-8.

where a is the small size cutoff and L is the large size cutoff.[18]

In the table below, the gamma function chosen by SDG&E is compared against a power law with an exponent of -0.5. The scale of the two distributions is set to have the P50 point at $2.1 billion, as per SDG&E's SME judgement. A non-truncated power law is calculated, which does not converge, as well as a power law with a maximum loss set to $40 billion. Given the magnitude of known wildfire losses (specifically the Camp fire example), this may be sufficient for SDG&E's service area.

Wildfire Losses, $ Billions	Gamma (3,0.8)	Power Law (-0.5)	Power Law, $40 B Max
2.1	46.3814%	49.8813%	51.0296%
2.64	61.6927%	55.3316%	57.8912%
3.33	76.3285%	60.1893%	64.0067%
4.19	87.9305%	64.5187%	69.4570%
5.27	95.2107%	68.3772%	74.3147%
6.64	98.6246%	71.8162%	78.6440%
8.36	99.7388%	74.8811%	82.5026%
10.52	99.9707%	77.6128%	85.9415%
13.25	99.9983%	80.0474%	89.0065%
16.68	100.0000%	82.2172%	91.7382%
21.00	100.0000%	84.1511%	94.1728%
26.44	100.0000%	85.8746%	96.3426%
33.28	100.0000%	87.4107%	98.2764%
41.90	100.0000%	88.7798%	100.0000%

Table 1 - Probability of wildfire losses less than specified amount using gamma distribution (SDG&E), power law, and power law truncated at $40 billion (MGRA). The gamma function values were calculated using Microsoft Office Excel's GAMMA.DIST function, and match the P95 and P98 values reported by SDG&E in its data request responses.

[18] Moritz, M.A., Morais, M.E., Summerell, L.A., Carlson, J.M., Doyle, J., 2005. Wildfires, complexity, and highly optimized tolerance. Proceedings of the National Academy of Sciences 102, 17912–17917. https://doi.org/10.1073/pnas.0508985102

The calculation in the table above successfully reproduces SDG&E's P98 value of roughly $6 billion using the gamma distribution. As can be seen however, the behavior for larger losses is vastly different for the gamma and power law distributions. SDG&E's method, for instance, predicts that is virtually impossible for losses to occur that are greater than $10 billion (< 0.1% probability). Losses greater than $15 billion have less than a 0.0001% probability.

The truncated power law distribution, however, shows that losses greater than $15 billion have a 10% chance of occurring if the median loss is $2 billion. This is a difference of many orders of magnitude, and this will have a dramatic effect on wildfire risk calculations. As seen during the Camp fire as well, massive financial losses are often accompanied by numerous fatalities and injuries, so it is proper to use a power law to represent safety risks as well as financial losses.

In conclusion, it does not appear that a gamma function with the parameters chosen by SDG&E will adequately predict large losses. Instead, it predicts negligible probability of losses greater than $5 or $10 billion. SDG&E has provided no justification for its choice of a gamma function or the parameters it chose other than to say it was determined by an SME. Wildfire sizes, which will be related to losses, follow a power law and show a much higher probability of very large "tail" events. SDG&E should incorporate a power law distribution with an appropriate high-end cutoff for its service area in both its financial loss and safety risk calculations.

2.2. Risks from Wildfire Smoke

As MGRA noted in our protest,[19] SDG&E's incorporation of wildfire smoke as a safety risk is innovative and an overall positive development. However, the methodology SDG&E uses to calculate these impacts is incorrect, making a significant unit conversion error and being based upon outdated references. Alternative approaches that SDG&E might develop in its GRC are discussed. It will be shown that this is an area of active research and SDG&E should work with experts in the field to develop an optimal approach.

[19] MGRA Protest; pp. 11-13.

2.2.1. SDG&E's Wildfire Smoke Safety Impact Methodology

SDG&E now incorporates an "Acres Burned" contribution to its wildfire safety risk model, and it includes this as part of its safety attribute, with a weight of 0.0005 per acre burned, equivalent to one fatality or four severe injuries per 20,000 acres.[20] Wildfire has numerous impacts aside from the currently tracked attributes of deaths and injuries directly arising from the fire, and property lost. Prior to SDG&E's RAMP, no utility had incorporated deaths and injuries due to wildfire smoke[21] into its safety risk calculations. SDG&E correctly identifies wildfire smoke as a safety risk that can have negative health impacts on populations downwind of wildfires. SDG&E's estimate is based on emission of PM2.5[22] smoke in general pollution, but recent academic work has shown that fine particles emitted from wildfires are even more dangerous than particles arising from other sources.[23]

Additionally, even though no utility is currently incorporating environmental attributes into its multi-value attribute function (MAVF), area burned can serve as a proxy for this damage. While California landscapes are generally fire-adapted, fire that is too frequent or severe, or fire coupled with extended drought, may lead to permanent changes due to "type conversion" and loss of ecosystems and habitat.[24]

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[20] RAMP; p. C-15.

[21] In these comments, "wildfire smoke" injuries and fatalities are defined as injuries and morbidities resulting from downwind transport of wildfire smoke and exposure of populations at some distance from the fire. Technically, many direct fatalities from wildfire result from smoke inhalation (as opposed to burns), but these fatalities and injuries occur at the fire front and are included in casualty statistics associated with the wildfire.

[22] PM2.5 is used to described particulate emission smaller than 2.5 microns. These are generally believed to have the greatest impacts on human health, particularly pulmonary and cardiovascular health. See for example:
Xing, Y. F., Xu, Y. H., Shi, M. H. & Lian, Y. X. The impact of PM2.5 on the human respiratory system. J. Thorac. Dis. 8, E69 (2016), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4740125/ and
Pope, C. A. III & Dockery, D. W. Health effects of fine particulate air pollution: lines that connect. J. Air Waste Manag. Assoc. 56, 709–742 (2006)
https://www.tandfonline.com/doi/abs/10.1080/10473289.2006.10464485.

[23] Aguilera, R., Corringham, T., Gershunov, A., Benmarhnia, T., 2021. Wildfire smoke impacts respiratory health more than fine particles from other sources: observational evidence from Southern California. Nature Communications 12, 1493. https://doi.org/10.1038/s41467-021-21708-0

[24] Syphard, A.D., Brennan, T.J., Keeley, J.E., 2019. Drivers of chaparral type conversion to herbaceous vegetation in coastal Southern California. Diversity and Distributions 25, 90–101. https://doi.org/10.1111/ddi.12827

For its methodology, SDG&E uses three sources along with its internal data.[25] First, it uses Clinton et. al.'s[26] estimate that there were 17,400 metric tons of PM2.5 emissions from the 2003 Cedar fire. SDG&E then calculated the cost per metric ton of PM2.5 emissions using results from a European study from 2005 (AEA Study).[27] The results of this study were also summarized in the "Transportation Benefit-Cost Analysis" study, which provided SDG&E's baseline number of $63,339 (2007) per metric ton of PM2.5 emissions.[28] SDG&E then determines its cost per acre burned:

"*The formula is: 17,407.27 metric tons * 1.1 ton / metric ton * $63,339 per ton * 1.24 / 273,246 acres = $5503.8 per acre burned, which was rounded to $5,000 per acre burned.*

Based on 2021 RAMP MAVF, 1 fatality is equivalent to $100 million. So, 1 fatality is equivalent to 20,000 acres burned."[29]

It should be noted that SDG&E's safety impact is determined by financial impact. SDG&E takes the costs as determined by the AEA, which primarily looks at health impacts, and applies them to cost per acre. However, for the "fatality per acre burned" equivalency to be valid, however, SDG&E would need to use the same value of statistical life (VSL) that the AEA study does. They do not. In fact, the AEA study uses a VSL between €980,000 and €2,000,000 (2006 equivalent Euros) about $US 1-2 million (2021)[30]. This is a factor of 50-100 less than the value of $100 million used by SDG&E for VSL. As noted by intervenors,[31] the VSL used by federal agencies is $10 million. According to the values used by the AEA study, one fatality is equivalent to $1-2 M / $5000 per acre, or 200-400 acres per fatality, implying far more fatalities than the number used by SDG&E.

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[25] SDG&E response: THE UTILITY REFORM NETWORK DATA REQUEST TURN-DR-002 SDG&E/SOCALGAS 2021 RAMP REPORT – A.21-05-011/014; Question 12; July 14, 2021. SDG&E response: MGRA-DR-003 SDG&E/SOCALGAS 2021 RAMP REPORTS- A.21-05-011/014; September 10, 2021; Question 7.

[26] Nicholas E. Clinton, Peng Gong, Klaus Scott, "Quantification of pollutants emitted from very large wildland fires in Southern California, USA", 2006, doi:10.1016/j.atmosenv.2006.02.016.

[27] AEA Technology (2005), Damages Per Tonne Emission of PM2.5, NH3, SO2, NOx and VOCs From Each EU25 Member State, Clean Air for Europe Programme, European Commission (http://ec.europa.eu/index_en.htm).). (AEA Study)

[28] Transportation Benefit-Cost Analysis, http://bca.transportationeconomics.org/benefits/emissions/methodology

[29] SDG&E Response to MGRA-DR-003 Question 7.

[30] Accounting for inflation, one 2005 Euro is approximately equal to one 2021 US Dollar.

[31] MGRA Protest; p. 13.

2.2.2. Implications of SDG&E's Wildfire Smoke Results

As noted in the MGRA protest, SDG&E's addition of Acres Burned would have significant impacts if we look at the implication for some historical fires.[32]

Fire	Year	Fatalities	Injuries	Structures	Cost ($M)	Acres	Risk	Acres %	Fatl/Inj%	Cost%
Witch	2007	2	40	1711	1500	197990	1.78	16.7%	20.2%	63.1%
Kincade	2019	0	4	374	600	77758	0.60	19.5%	5.0%	75.4%
Laguna	1970	5		382	400	175425	0.71	36.9%	21.0%	42.1%
Thomas	2017	2		1063	2500	281893	2.36	17.9%	2.5%	79.5%
Camp	2018	85	17	18804	16700	153336	15.43	1.5%	17.3%	81.2%
Tubbs	2017	22		5636	5000	36807	4.47	1.2%	14.8%	84.0%
Butte	2015	2		921	450	70868	0.50	21.1%	11.9%	67.0%
Redwood Valley	2017	9	1	546	400	36523	0.63	8.7%	43.9%	47.4%
Dixie	2021	1		1329	1000	963276	2.22	64.9%	1.3%	33.7%

Table 2 - Comparison of major historical wildfires linked to utility infrastructure using weights and scales approximately derived from the weightings and scaling factors used in SDG&E's MAVF calculations. Relative contributions from direct fatalities/injuries from wildfire, acreage burned (which is a proxy for smoke fatalities and injuries), and financial impacts are shown in the last three columns. Additional details and assumptions can be found in footnote 32.

As can be seen, for larger fires the Acres Burned component can be a significant or even dominant component of the risk score. The Dixie fire, for instance (example added subsequent to MGRA's protest), has destroyed relatively few homes compared to other major fires, but burned a very large area. Using the method put forward by SDG&E, one would expect the major safety risk

[32] Table entries consist of the following: Most data was obtained from the CAL FIRE incident web page. Where costs were available from reliable public sources these were used. Otherwise, losses range between $500,000 and $ 2 million per structure destroyed in 2021 dollars, so $1 M per structure is used. Partial MAVF risk score is 0.6 * (fatalities + (0.25 * injuries) + (.00005 * acres))/20 + 0.15 * (cost / $200M) as per RAMP Report p. C-7. A variety of wildfires associated with electrical equipment has been included from the CAL FIRE "Top 20" lists for structures, fatalities, and acres burned. The Laguna fire was included because of its large size and smaller level of structure loss in order to demonstrate acreage contribution. It should be noted though, that population within the Laguna fire footprint has increased many-fold during the past 50 years, and a similar fire today would be far more destructive. Also, if fatalities for the subsequent mudslide are included for the Thomas fire, the relative contribution of Fatalities/Injuries would be much higher. Relative contributions of each risk component as a fraction are presented for comparative purposes.

from the Dixie fire to have been smoke. Of course, where fires occur relative to where people live is a critical consideration. Europe, where the AEA analysis was performed, is densely populated, so emissions are much more likely to affect population centers.

As mentioned previously, SDG&E makes a significant error in their assessment of acres per burned per fatality. The original "unit" used by the AEA analysis was fatalities, and then fatalities were converted into a monetary value. SDG&E converts this monetary value back into fatalities but uses a substantially larger number for the value of statistical life. SDG&E's conversion rate between these quantities is at least a factor of 50 different than that used by AEA. The table below is the same as Table 2, but corrects SDG&E's error. It maintains SDG&E's VSL of $100 M, but uses the European VSL of $2 M to assign number of fatalities per acre burned. This results in a conversion rate of .0025 (1 / 400 acres) rather than .00005 (1 / 20,000 acres).

Fire	Year	Fatalities	Injuries	Structures	Cost ($M)	Acres	Risk	Acres %	Fatl/Inj%	Cost%
Witch	2007	2	40	1711	1500	197990	16.33	90.9%	2.2%	6.9%
Kincade	2019	0	4	374	600	77758	6.31	92.4%	0.5%	7.1%
Laguna	1970	5		382	400	175425	13.61	96.7%	1.1%	2.2%
Thomas	2017	2		1063	2500	281893	23.08	91.6%	0.3%	8.1%
Camp	2018	85	17	18804	16700	153336	26.70	43.1%	10.0%	46.9%
Tubbs	2017	22		5636	5000	36807	7.17	38.5%	9.2%	52.3%
Butte	2015	2		921	450	70868	5.71	93.0%	1.1%	5.9%
Redwood Valley	2017	9	1	546	400	36523	3.32	82.6%	8.4%	9.0%
Dixie	2021	1		1329	1000	963276	73.03	98.9%	0.0%	1.0%

Table 3 - Comparison of major historical wildfires linked to utility infrastructure using weights and scales approximately derived from the weightings and scaling factors used in SDG&E's MAVF calculations. This is identical to Table 1, except that it corrects SDG&E's conversion error for VSL and replaces it with the AEA conversion. Effective number of fatalities per acre burned is .0025 rather than .00005.

As is evident in Table 3, when the European number for fatality per ton of emissions is used, the fractional contribution of safety risk from acres burned increases substantially, to over 90% for many major historical fires. Also noteworthy is the fact that the contribution of fatalities and injuries to the safety risk is much smaller, at 10% or less, even for major disasters such as the Camp fire.

Several intervenors, particularly TURN, have also raised the issue that SDG&E's VSL of $100 million is substantially greater than that used by the EPA and other federal agencies, which use a VSL of $10 million. If the federal VSL value and the AEA value for fatalities per acre burned are used for major historical fires, the following results are obtained:

Fire	Year	Fatalities	Injuries	Structures	Cost ($M)	Acres	Risk	Acres %	Fatl/Inj%	Cost%
Witch	2007	2	40	1711	1500	197990	2.65	56.1%	1.4%	42.5%
Kincade	2019	0	4	374	600	77758	1.04	56.3%	0.3%	43.4%
Laguna	1970	5		382	400	175425	1.63	80.7%	0.9%	18.4%
Thomas	2017	2		1063	2500	281893	4.00	52.9%	0.2%	46.9%
Camp	2018	85	17	18804	16700	153336	13.94	8.2%	1.9%	89.8%
Tubbs	2017	22		5636	5000	36807	4.09	6.7%	1.6%	91.6%
Butte	2015	2		921	450	70868	0.88	60.7%	0.7%	38.6%
Redwood Valley	2017	9	1	546	400	36523	0.60	45.5%	4.6%	49.9%
Dixie	2021	1		1329	1000	963276	7.98	90.6%	0.0%	9.4%

Table 4 - Comparison of major historical wildfires linked to utility infrastructure using weights and scales approximately derived from the weightings and scaling factors used in SDG&E's MAVF calculations. This is identical to Table 1 and 2, with fatalities per acre burned of 0.0025 and VSL of $10 M instead of $100 M.

Comparing Table 3 and Table 4, one can see that the relative contribution of the acres burned component is reduced, since the imputed cost of smoke fatalities is lessened. One can also see that the relative contribution of direct fire fatalities and injuries has become de minimis. This is a counterintuitive result and raises questions about basic MAVF assumptions and methodology.

2.2.3. Current Research on Wildfire Smoke Health Impacts

The impact of wildfire smoke on human health is a very active field of research, and new results are appearing frequently in the literature.[33] From this standpoint, using results from 2005 and 2006, as SDG&E has done in its estimate, is not a good practice. Significant work has been done in this field since SDG&E's reference were published, and more up-to-date results should be incorporated.

[33] See, along with cited references: O'Dell, K., Bilsback, K., Ford, B., Martenies, S.E., Magzamen, S., Fischer, E.V., Pierce, J.R., 2021. Estimated Mortality and Morbidity Attributable to Smoke Plumes in the United States: Not Just a Western US Problem. GeoHealth 5, e2021GH000457. (O'Dell et.al.) https://doi.org/10.1029/2021GH000457

More recent studies have employed a variety of methodologies to quantify health impacts from wildfire smoke. Recent results vary widely in their estimate of number of fatalities attributable to wildfire smoke annually in the US, with 95% confidence level ranges varying from 720[34] to 32,000, a factor of 40.

The issue of wildfire smoke health impacts is complicated. A common way to consider the issue is to find the concentration of pollutants from wildfires, particularly PM2.5 (particulate matter smaller than 2.5 microns), and to look for health effects in populations as a function of that concentration. These concentrations can be estimated from both ground measurement stations,[35] satellite data, or chemical transport models. Hospitalizations, emergency room visits, and excess mortality are among the variables measured. The result is commonly given as a fractional increase in excess health events per unit concentration of the pollutant (commonly expressed as $\mu g/m^3$ for PM2.5). Aguilera 2021[36], for instance, in their study of Southern California wildfires find that wildfire smoke increased the number of respiratory hospital admissions by 10% (95% CL from 3.5% to 16.5%) admissions per 100,000 individuals for every 10 $\mu g/m^3$ increase in PM2.5, whereas non-wildfire smoke increased admissions by only 0.76% per 10 $\mu g/m^3$ (95% CL from 0.42% to 1.1%).

2.2.4. Comparison of SDG&E Wildfire Smoke Results with Other Methods

The AEA study uses a model to directly link emissions to fatalities. It therefore implicitly assumes a distribution model for the pollutants, since in order for a fatality to occur it is necessary for someone to be downwind to breathe the emissions. If a tree burns in the forest and nobody breathes the smoke, then there will be no health impacts. However, the AEA model assumes populations are exposed, and that therefore fatalities will occur. This makes it over-simplistic for SDG&E's application, which is to determine fatalities specifically from wildfire. Calculating such a response in a realistic manner would require significantly more effort than SDG&E has put into

[34] Neumann, J.E., Amend, M., Anenberg, S., Kinney, P.L., Sarofim, M., Martinich, J., Lukens, J., Xu, J.-W., Roman, H., 2021. Estimating PM2.5-related premature mortality and morbidity associated with future wildfire emissions in the western US. Environ. Res. Lett. 16, 035019. https://doi.org/10.1088/1748-9326/abe82b

[35] See https://aqicn.org/

[36] Aguilera, R., Corringham, T., Gershunov, A., Benmarhnia, T., 2021. Wildfire smoke impacts respiratory health more than fine particles from other sources: observational evidence from Southern California. Nat Commun 12, 1493. https://doi.org/10.1038/s41467-021-21708-0

the calculation. Since SDG&E has presented a method in its RAMP, however, it would be useful to compare this calculation on an apples-to-apples basis with more current results in order to determine whether the SDG&E calculation is providing useful risk information.

Determining a "wildfire acres burned to fatalities" metric from current models would require a number of simplifying assumptions that may or may not be accurate. Also, as pointed out above, recent fatality estimates from wildfire smoke vary by over an order of magnitude, so the results of any calculations based on them must be viewed as highly uncertain. Nevertheless, comparison of models can be useful as a sanity check on SDG&E's method.

Firstly, a "corrected" value using SDG&E's method needs to be determined. As shown in the previous section, SDG&E erred by a factor of 50 by using the wrong Value of Statistical Life to convert from fatalities to monetary values, using its own value ($100M) rather than the value used by ASE ($2 M). Instead of 1 fatality per 20,000 acres burned, SDG&E should have calculated 1 fatality per 400 acres burned. While this may seem like it would yield an excessive estimate for fatalities, the results of Aguilera, et. al. imply that effects from wildfire should be even worse, since they find that wildfire smoke leads to ten times more hospital admissions than "normal" PM2.5 emissions. If this same effect were to carry over into fatalities, we would expect one fatality per 40 acres burned. Hence a 400,000 acre fire would, according to the SDG&E methodology, be equivalent to 1000 fatalities from smoke.

A cross check can be provided by the recent results of O'Dell et. al. These researchers estimate total US fatalities from wildfire smoke to be between 4,800 and 7,800, which is in the logarithmic center of the range from other researchers (720 to 32,000). Most usefully, O'Dell et. al. provide an estimate for California fatalities from wildfire smoke per year, at around 800.[37] The average annual number of acres burned in California between 2006 and 2018 (the duration of the O'Dell analysis) is 917,000. Naively taking the ratio, there have been approximately 1,150 acres burned for every wildfire smoke fatality. Even considering the wide range of results available in publications, SDG&E's value of 40 acres per fatality (corrected for error and scaled for wildfire smoke toxicity) is an extreme outlier, as is the (erroneous) value it uses in its RAMP of one fatality per 20,000 acres.

[37] O'Dell et. al.; p. 11, Figure 4.

A more difficult comparison is afforded by Liu, et. al.[38] This paper describes the health effects of smoke from the 2020 fire siege on residents of Washington state. Complicating this comparison is the fact that Washington was impacted by fires spread over three states: Washington (0.7 million acres), Oregon (0.9 million acres), and California (2.3 million acres). It should be assumed that health impacts were experienced by residents of all three states, but the study only looks at those in Washington. Liu et. al. observes an excess of 100 deaths from this wildfire episode in the state of Washington, with a population of 7.6 million. Scaling this number to the residents of Oregon (4.2 million), and Northern California (15.4 million), one would expect a total of 360 excess deaths in the entire region. With acres burned totaling 3.9 million acres, this would yield a ratio of one fatality per 10,900 acres burned. However, it should be noted that the smoke plumes from the 2020 fire siege extended across North America, indeed around the world, and health effects would likely not be limited to the states of origin.[39]

The estimates above are crude and for illustrative purposes only. A more accurate method should be used for risk calculations. Ideally, smoke plume calculations and population health impacts could be incorporated into fire spread modeling since these models already incorporate meteorological data. Additionally, the sensitivity of populations to specific concentration of PM2.5 pollutants is a well defined and studied value, whereas "fatalities per acres burned" is not.

2.2.5. Wildfire Smoke During Power Shutoff Periods

Another consideration that needs to be considered by utilities is the effect of wildfire smoke on power shutoff (PSPS). On one side of this issue, the compounded safety risk arising from wildfire smoke increases the value of all measures that can prevent utility wildfire ignition, including power shutoff. On the other side is the question whether and to what degree wildfire smoke effects will be exacerbated for people without electrical power, particularly if these events coincide with high temperatures.

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[38] Liu, Y., Austin, E., Xiang, J., Gould, T., Larson, T., Seto, E., 2021. Health Impact Assessment of the 2020 Washington State Wildfire Smoke Episode: Excess Health Burden Attributable to Increased PM2.5 Exposures and Potential Exposure Reductions. GeoHealth 5, e2020GH000359. https://doi.org/10.1029/2020GH000359

[39] Patel, K., October 20, 2021. Wildfire smoke harms more people in the eastern U.S. than West, study shows. Washington Post. Cites O'Dell, 2021. https://www.washingtonpost.com/weather/2021/10/20/wildfire-smoke-deaths-eastern-us/

Both wildfire smoke effects[40] and the risk of power shutoff are increased during periods of Santa Ana winds and National Weather Service Red Flag Warnings. Because these risks have the same driver, there is an increased chance that they will be coincident with each other, for instance when a utility determines to conduct a power shutoff during a period when large wildfires (which may be unrelated to utilities) are burning.

The US Environmental Protection Agency recommends that under periods of unhealthy air quality that people remain indoors and rely on air conditioning:

"*The most common advisory issued during a smoke episode is to stay indoors. The effectiveness of this strategy depends on how well the building limits smoke from coming indoors, and on efforts to minimize indoor pollution sources. Staying indoors will provide some protection from smoke, especially in a tightly closed, air-conditioned home in which the air conditioner recirculates indoor air. Generally, newer homes are "tighter" and keep ambient air pollution out more effectively than older homes.*

Staying inside with the doors and windows closed can reduce the entry of outdoor air into homes, in some cases by a third or more (Howard-Reed et al., 2002). Homes with central air conditioning generally recirculate indoor air, though some smoky outdoor air can still be drawn inside (e.g., when people enter or exit or when the central system can be set to bring in outdoor air). In homes without air conditioning, indoor concentrations of fine particles can approach 70–100% of the outdoor concentrations; however, it is more common that the indoor concentrations of fine particles that come from outdoors are 50% or less of outdoor concentrations when windows and doors are closed (Allen et al. 2012, Chen and Zhao 2011, Singer et al. 2016). In very leaky homes and buildings, outdoor particles can easily infiltrate the indoor air, so guidance to stay inside may offer little protection. In any home, if doors and windows are open, particle levels indoors and outdoors will be about the same."[41]

[40] Aguilera, et. al.
[41] EPA, n.d. Wildfire Smoke Guide Publications | AirNow.gov [WWW Document]. URL https://www.airnow.gov/wildfire-smoke-guide-publications (accessed 8.26.21); p. 18.

The EPA guidance states that air conditioning can appreciably reduce the concentrations of PM2.5, particularly if filters of rating MERV-10 or higher are used.[42] Supplemental electrostatic precipitators (ESPs) can also be installed to reduce PM2.5 concentrations for sensitive individuals. Low cost and effective DIY (do it yourself) air filtration units can even be fashioned by combining filters with a high MERV rating with house fans.[43] However, all of these methods for reducing exposure require electrical power. Under warm Santa Ana conditions, in the absence of air conditioning it may not be possible to safely keep the windows closed without risking health effects from high temperatures.

The MGRA expert has done a cursory examination of air quality data[44] near areas affected by power shutoff using utility PSPS data submitted to the CPUC, OEIS, and in response to data requests. So far (up to 2020), no obvious coincidences of areas experiencing simultaneous power shutoff and low air quality were observed. Hence, this remains a theoretical threat at this time, and it is unlikely that data currently exists to test this hypothesis.

Nevertheless, utilities, including SDG&E, should begin to consider the presence of wildfire smoke as an attribute that they factor into their determination of power shutoff thresholds. This should be considered a potential area of "coincident risks" that have the potential to increase the safety impact of power shutoff.

2.2.6. Wildfire Smoke Impact Conclusion

Notwithstanding the errors and inaccuracies in SDG&E's calculations, SDG&E deserves recognition for bringing the issue of wildfire smoke impact to the Commission's attention. Nobody else, neither the Commission nor intervenors nor other utilities have given wildfire smoke attention up to now. If we attempt to apply SDG&E's methodology for safety impacts of wildfire smoke using corrected assumptions and more recent references, it is apparent that wildfire smoke is the likely source of the greatest public safety risk from wildfires. Using O'Dell's estimate of 800 annual excess fatalities from wildfire smoke in California, that is equivalent to <u>***ten Camp fire death tolls per year, every year***</u>.

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[42] Id; p. 21.
[43] Liu et. al.
[44] https://aqicn.org/data-platform/register/

Wildfire smoke, however, is a silent killer, and inordinately affects those who are at risk from other sources. Zhou et. al.,[45] for example, calculate that smoke from the October 2020 fires caused an excess of 750 deaths from COVID-19 in California, Oregon, and Washington. These deaths lack the visceral drama of people being killed by flames, and we would not know about them at all except for the efforts of scientists to extract their stories from a mountain of data. The federal judge overseeing PG&E's probation, for instance, was sufficiently horrified by the story of a young family dying in their car during the Zogg fire to issue new demands and protocols for PG&E to follow.[46] What then should be the response to hundreds of deaths?

One of the problems SDG&E and other utilities have faced when balancing safety impacts from wildfire against costs are that "wildfires are expensive".[47] In other words, the number of fatalities directly attributable to wildfires tends to be low with respect to property damage. People usually can escape from approaching fires. Their houses cannot. To compensate for this preponderance of monetary damage, utilities have set a Value of Statistical Life of $100 million, ten times larger than the $10 million used by federal agencies. TURN and Cal Advocates have argued against using such a high value, that we should adopt a cost/benefit approach that more appropriately incorporates the need for affordable electricity. Adding in the massive contribution of wildfire smoke to potential risk, it may no longer be necessary for utilities to "artificially" inflate the VSL in order to introduce a large aversion to loss of human life. There is likely to be a very large equivalent monetary loss associated with the health effects of wildfire smoke, even if the standard federal VSL is used.

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[45] Zhou, X., Josey, K., Kamareddine, L., Caine, M.C., Liu, T., Mickley, L.J., Cooper, M., Dominici, F., n.d. Excess of COVID-19 cases and deaths due to fine particulate matter exposure during the 2020 wildfires in the United States. Science Advances 7, eabi8789. https://doi.org/10.1126/sciadv.abi8789

[46] United States of America vs. Pacific Gas and Electric Company; PG&E'S RESPONSE TO POSTHEARING ADDITIONAL REQUEST FOR RESPONSES; Judge: Hon. William Alsup; Case 3:14-cr-00175-WHA Document 1369-2 Filed 03/29/21 Page 24 of 90.

"But what's worse? Four people burning to death alive in the car? Start out alive and they get baked to death, the kind of death nobody should go through.

To me, there's a very clear answer to that. We don't want to sail too close to the wind. We want to err on the side of public safety, not on the side of public convenience."

[47] A.20-06-012; MUSSEY GRADE ROAD ALLIANCE COMMENTS ON THE PACIFIC GAS AND ELECTRIC COMPANY 2020 RISK ASSESSMENT AND MITIGATION PHASE REPORT AND THE SAFETY POLICY DIVISION STAFF EVALUATION REPORT; January 15, 2021; p. 8.

How to properly incorporate this loss, what values to use, and methodology, remain open questions. There is no question that SDG&E’s method and sources err in significant and probably irremediable ways. However, an initial look into the issue reveals that wildfire smoke will likely have the greatest contribution to wildfire safety risk. This problem cannot safely be ignored or put aside. The “correct” long term solution will likely come from modeling of simulated smoke plumes and calculating population impacts using carefully selected epidemiological data. This is likely too difficult for SDG&E to accomplish prior to its GRC, so interim methods similar to its current approach but with corrected calculations and sources may be acceptable. For the time being, estimates based on a “fatalities per acre burned” methodology using values from a range of recent studies will allow safety risk from wildfire smoke to be incorporated into MAVF calculations without undue delay or burden. Sensitivity analyses should use the full range of values currently considered plausible by the most recent academic work. Studies using hospitalizations rather than fatalities can also be used by considering a hospitalization a “serious injury”.[48]

The table below provides an illustrative example showing major historical power line fires. Based on the values and methodology in Table 2 through Table 4, relative MAVF contributions from safety (direct fatalities/injuries), acres burned (wildfire smoke fatalities/injuries), and financial contributions are shown for 1,000 acres per fatality (derived from O’Dell et. al. above) and 11,000 acres per fatality (derived from Liu et. al. above), using VSL of $10 million and $100 million.

Fire																	
	VSL	100				100				10				10			
	acre/ftl	11000				1000				11000				1000			
		Risk	Acres %	Fatl/Inj%	Cost%	Risk	Acres %	Fatl/Inj%	Cost%	Risk	Acres %	Fatl/Inj%	Cost%	Risk	Acres %	Fatl/Inj%	Cost%
Witch		2.02	26.7%	17.8%	55.6%	7.42	80.0%	4.8%	15.2%	1.21	4.4%	3.0%	92.6%	1.75	33.8%	2.1%	64.1%
Kincade		0.69	30.6%	4.3%	65.0%	2.81	82.9%	1.1%	16.0%	0.47	4.5%	0.6%	94.9%	0.69	34.0%	0.4%	65.6%
Laguna		0.93	51.5%	16.2%	32.3%	5.71	92.1%	2.6%	5.3%	0.36	13.2%	4.1%	82.7%	0.84	62.6%	1.8%	35.7%
Thomas		2.70	28.4%	2.2%	69.3%	10.39	81.4%	0.6%	18.0%	1.96	3.9%	0.3%	95.8%	2.73	31.0%	0.2%	68.8%
Camp		15.62	2.7%	17.1%	80.2%	19.80	23.2%	13.5%	63.2%	12.83	0.3%	2.1%	97.6%	13.25	3.5%	2.0%	94.5%
Tubbs		4.51	2.2%	14.6%	83.1%	5.51	20.0%	12.0%	68.0%	3.83	0.3%	1.7%	98.0%	3.93	2.8%	1.7%	95.5%
Butte		0.59	32.7%	10.2%	57.1%	2.52	84.2%	2.4%	13.4%	0.36	5.3%	1.7%	93.0%	0.56	38.2%	1.1%	60.7%
Redwood Valley		0.68	14.7%	41.0%	44.3%	1.67	65.5%	16.6%	17.9%	0.34	2.9%	8.2%	88.8%	0.44	25.1%	6.3%	68.6%
Dixie		3.41	77.1%	0.9%	22.0%	29.68	97.4%	0.1%	2.5%	1.02	25.9%	0.3%	73.8%	3.64	79.3%	0.1%	20.6%

Table 5 - Relative contributions of direct injuries/fatalities, smoke injuries/fatalities (Acres), and financial costs to losses from major historical power line fires using SDG&E's MAVF function. Uses acres/fatality derived from O'dell (100) and from Liu (11,000), and VSL of $100 M and $10 M. Details for each fire can be found in Table 2 through Table 4.

[48] In utility multi-attribute value functions, serious injuries are given ¼ the weight of a fatality.

More sophisticated and accurate approaches can be developed with expert scientific input as part of ongoing efforts by the CPUC and OEIS. As this issue affects all utilities and California residents, incorporation of wildfire smoke harm should be required for other utilities, and MGRA intends to raise this issue in the RDF/S-MAP Phase II proceeding and during OEIS risk modeling workshops.

What we have discovered, thanks to SDG&E's attempt to introduce wildfire smoke risk, is that we have been working on the wrong wildfire safety problem. Wildfire smoke blown downwind is responsible for killing and injuring far more Californians than those overrun by flame. The methodology used by SDG&E needs to be corrected prior to its GRC, and the Commission needs to ensure that this risk is properly incorporated by all utilities as they develop their RAMP filings and Wildfire Mitigation Plans.

Recommendations:

- The Commission should not accept SDG&E's current weighting of "Acres Burned" because it is based on erroneous calculations.
- SDG&E should consult with public health experts and academics in order to choose more appropriate references for public health effects from wildfire smoke.
- The correct long-term approach may be to include smoke plume effects along with fire spread simulations. SDG&E should inquire whether Technosylva or other vendors can incorporate plume spread along with population impacts.
- As an interim measure, SDG&E should compute "Fatalities per Acre Burned", using measured and calculated public health effects from wildfire and wildfire sizes, using a range of values for fatalities and hospitalizations supported by recent studies.
- The Commission should coordinate with OEIS to develop a common understanding of and modeling strategy for wildfire smoke risks.

safety deliberations. Staff should further probe issues where subject matter expertise is used in lieu of factual input.

MGRA thanks SPD staff for reviewing these comments and looks forward to providing feedback on Staff's report.

Submitted this 22nd day of October, 2021,

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Appendix B-2 RAMP Scenario Analysis Wind (MGRA)

Pacific Gas and Electric Company

Updated November 25, 2020

Power Law Distribution

September 3, 2021

Introduction

Many empirical studies find the relationships between frequencies and areas burned by wildfires are well represented by power law distributions over a wide range of wildfire sizes.[1] Under this power law relationship, a relative change in frequency is proportional to the relative change in areas burned. This property implies power law distributions can model losses from rare but catastrophic events that dominate total losses over a wide range of scale. Such losses are referred to as self-organized critical phenomena in an article about wildfires by Mitchell[2]. These empirical studies are consistent with an extreme value theorem[3], which states many distributions (in the limit of infinitely large thresholds) are well approximated by the Generalized Pareto Distribution, of which power law distributions are a special case.

This paper describes PG&E's current (as of writing) modeling of wildfire risk consequences with Pareto Distribution Type 1 (PD1) and Pareto Distribution Type 2 (PD2) distributions. Power law distributions are equivalent to PD1s, and PD1s are a special case of PD2s[4]. PD1s and PD2s are in turn special cases of the Generalized Pareto Distribution[5]. PG&E finds power law distributions (or, more specifically, PD1s and PD2s) better fit extreme data values than do lognormal distributions, but it also identifies challenges posed by adoption of power law distributions and areas for future development.

Background

In PG&E's 2020 Risk Assessment and Mitigation Phase Report, PG&E used lognormal distributions to model the financial consequences of the "Destructive" fires and the safety consequence of the "Catastrophic" fires.[6] In the CALFIRE dataset PG&E used to calibrate these distributions, there were 16 destructive fires and 11 catastrophic fires in northern California from 2015-2019. About two-thirds (68.75% = 11/16) of the destructive wildfires had fatalities.

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[1] For example, see Malamud, B.D., Morein, G., Turcotte, D.L., 1998. Forest Fires: An Example of Self-Organized Critical Behavior, Science 281, 1840–1842. https://doi.org/10.1126/science.281.5384.1840

[2] Joseph W. Mitchell, March 2005, WEEDS: Firebrand Defense for the "Typical Catastrophe", Wildfire Magazine

[3] Specifically, the Pickands–Balkema–de Haan theorem, which is sometimes referred to as the second theorem of extreme value theory,https://en.wikipedia.org/wiki/Pickands%E2%80%93Balkema%E2%80%93De_Haan_theorem

[4] Appendix A explains the equivalency between power law distributions and PD1s

[5] See Appendix B for more details on the relationship between Generalized Pareto Distribution and PD1s and PD2s.

[6] Destructive fires in this paper is defined as large fires (i.e., total acres burned are not less than 300 acers) destroying more than 100 structures, and catastrophic fires are defined as destructive fires with one or more lives lost.

In its informal comments on PG&E's Risk Assessment and Mitigation Phase Report, Mussey Grade Road Alliance suggested wildfire size and damage distributions are better described by power law distributions than by lognormal distributions, which potentially underestimate extreme events. In response, the California Public Utilities Commission's Safety Policy Division noted in its PG&E's 2020 Risk Assessment and Mitigation Phase Report evaluation that power law distributions may be a better mathematical model to characterize wildfire frequencies and consequences. The Safety Policy Division recommended PG&E revisit its wildfire modeling to determine whether it should replace its Risk Assessment and Mitigation Phase Report model distributions with power law distributions.

In response to Mussey Grade Road Alliance's feedback and Safety Policy Division 's recommendation, PG&E has expanded the list of available consequence distributions used to compute Consequence of Risk Event values (and, hence, the risk score values and the Risk Spend Efficiency values) to include PD1s and PD2s (see Appendix A).

PG&E evaluated PD1 and PD2 fits to its wildfire consequence data. This evaluation suggests PD1 and PD2 distributions were better fits than lognormal distributions for some of its wildfire risk model consequence distributions.

As a part of the ongoing Risk-Based Decision-Making Framework (Risk OIR, R.20-07-013) and at the request of the Safety Policy Division, PG&E committed to share its findings on applying power law distributions in modeling wildfire risk consequences. PG&E expects its findings to inform the proceeding and identify areas where further refinement and discussion on application of power law distributions may potentially be explored.

With this whitepaper, PG&E is sharing its application of power law distribution fitting and calibration in modeling wildfire risk consequences.

Power Law Distributions

The functional forms of power law distributions and PD1s are equivalent (see Appendix A).

The PD1 and PD2 cumulative distribution functions are, respectively,

(1) $F_{P1}(x) = 1 - \left(\frac{x}{\sigma_{P1}}\right)^{-(\alpha_{P1})} \quad where\ 0 < \sigma_{P1} \le \alpha_{P1},$

and

(2) $F_{P2}(x) = 1 - \left(1 + \frac{x-\mu_{P2}}{\sigma_{P2}}\right)^{-(\alpha_{P2})} \quad where\ \mu_{P2} \le x\ and\ 0 < \sigma_{P2},$

where μ is known as the location, σ is known as the scale, and α is known as the shape.

Note, when $\mu_{P2} = \sigma_{P2}$ is substituted into (2), (1) is recovered. That is, PD1s (therefore also power law) are a special case of PD2s.

PD2s offer additional flexibility when fitting data because they have an additional parameter, the scale parameter, σ. However, σ must be estimated, which introduces additional opportunity for error.

When the shape of a PD1 or PD2 (i.e., α_{P1} or α_{P2}) is less than 1, the mean is infinite unless truncation is applied. What an infinite mean implies is that the mean of the observed data will, on average, continue to increase without limit as more data is collected. Especially when modeling physical systems with physical boundaries or constraints, an infinite mean is unrealistic, so an upper truncation must be placed on the distribution when the shape of a PD1 or PD2 distribution is less than 1 to ensure a finite mean.

Data

Financial Consequence for destructive fires

From CALFIRE data of all 2015-2020 PG&E territory fires, 23 fires match PG&E's destructive criteria and were used to determine the best fit probability distribution for wildfire financial destructive consequences. The financial consequence for each destructive fire was estimated as the sum of property damage and fire suppression costs. Property damage cost was estimated as the number of structures destroyed multiplied by (the assumption of) $1M per structure. When PG&E could identify from a public source the suppression cost of a specific fire, it was used for that fire's suppression cost. Otherwise, the fire suppression cost of each destructive wildfire was estimated as the number of acres burned by that wildfire multiplied by (the assumption of) $1,175 per acre burned.

For example, for Camp Fire, 153,336 acres were burned, and 18,804 structures were destroyed, resulting in a financial consequence estimate of $18,984,169,800 (i.e., 153,336 * $1,175 + 18,804 * $1M). For August Complex Fire, there were 1,032,648 acres burned and 446 structures destroyed. The publicly available fire suppression cost was $115,511,218,[7] resulting in a financial consequence of $561,511,218 (i.e., $115,511,218 + 446 * $1M).

Safety Consequence for catastrophic fires

Out of 23 destructive wildfires described in the previous section, 14 had fatalities, ranging from 1 to 85. This subset of 14 data points was used to fit the probability distribution for the safety consequence in number of fatalities from a catastrophic wildfire.

[7] https://upload.wikimedia.org/wikipedia/commons/c/c9/2020_National_Large_Incident_YTD_Report.pdf

Analysis

Visual Investigation

Figure 1 below shows 2015-2020 PG&E territory wildfire consequence data. Figure 2 shows wildfire consequence data from a broader population of wildfires analyzed by Malamud et al.[8] Although the range of frequency values encompassed by the y-axes in Figure 1 and Figure 2 differ, both are such that data falling on a straight line indicate PD1 with a shape parameter equal to negative of the slope minus 1. For example, the first graph in Figure 1 with a slope of -1.3 indicates a shape parameter value of 0.3 (= -(-1.3) – 1).

The first graph in Figure 1, with x-axis values of acres burned, can be compared to the graphs in Figure 2, in which the x-axis values are also of area burned (in km^2). Note the slope of the data shown in the first graph in Figure 1 is close to the slopes of the data shown in Figure 2. That is, the distribution of PG&E's acres burned data compares well with the distributions of area burned data analyzed by Malamud et al. The middle and right-hand graphs in Figure 1 show, respectively, number of structures destroyed and the number of fatalities also fall on straight lines.

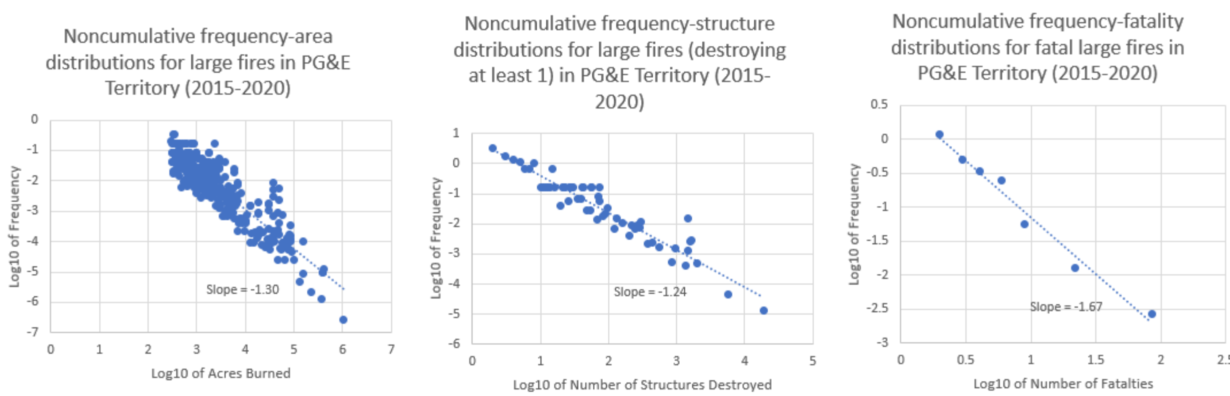

Figure 1 Noncumulative frequency-area, frequency-structure, and frequency-fatality graphs using large fire (greater than 300 acres) data in PG&E Territory (2015-2020).

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[8] Malamud, B.D., Morein, G., Turcotte, D.L., 1998. Forest Fires: An Example of Self-Organized Critical Behavior. Science 281, 1840–1842. https://doi.org/10.1126/science.281.5384.1840

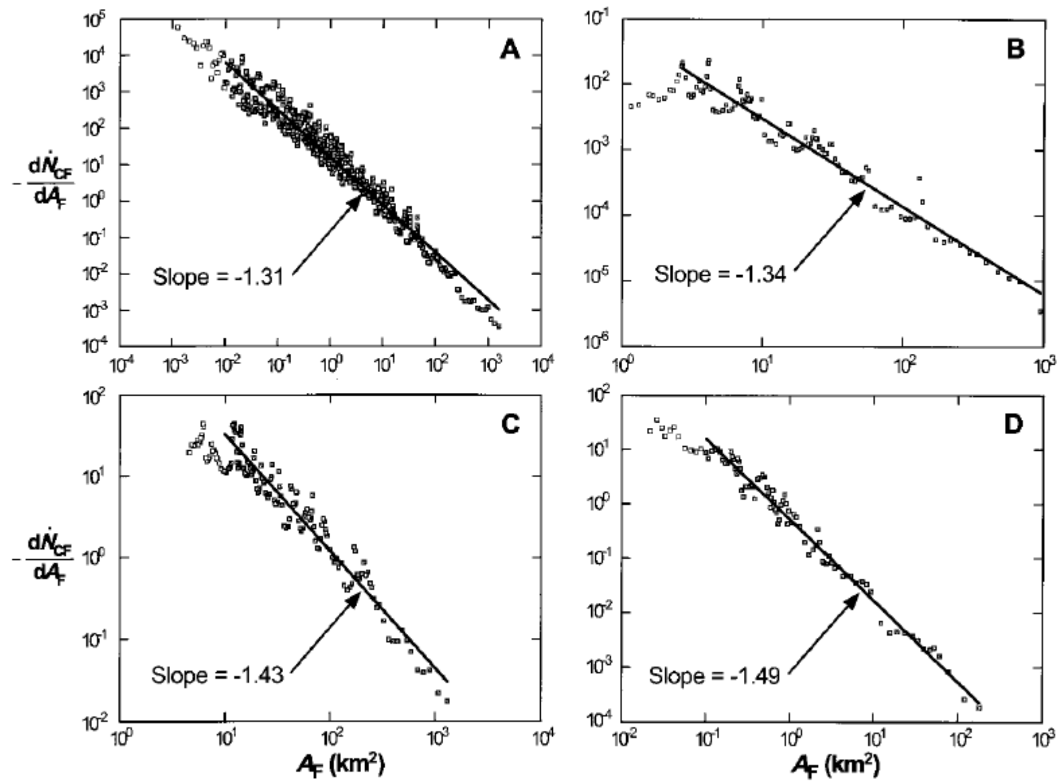

Fig. 2. Noncumulative frequency-area distributions for actual forest fires and wildfires in the United States and Australia: (**A**) 4284 fires on U.S. Fish and Wildlife Service lands (1986–1995) (*9*), (**B**) 120 fires in the western United States (1150–1960) (*10*), (**C**) 164 fires in Alaskan boreal forests (1990–1991) (*11*), and (**D**) 298 fires in the ACT (1926–1991) (*12*). For each data set, the noncumulative number of fires per year ($-d\dot{N}_{CF}/dA_F$) with area (A_F) is given as a function of A_F (*13*). In each case, a reasonably good correlation over many decades of A_F is obtained by using the power-law relation (Eq. 1) with $\alpha = 1.31$ to 1.49; $-\alpha$ is the slope of the best-fit line in log-log space and is shown for each data set.

Figure 2 Analysis done by Malamud et al.

Use of Power Law Distributions in PG&E's Wildfire Risk Modeling

Table **1** below is a summary of the Pareto distributions PG&E used in its wildfire risk modeling. These distributions are truncated for the following reason. The shape value for the untruncated PD1 fit to the wildfire catastrophic safety consequences was estimated to be less than 1. Untruncated PD1s (and untruncated PD2s) with shape values less than 1 have infinite mean. An infinite mean number of fatalities from a wildfire is unrealistic. To limit the PD1 fit's mean consequence, PG&E imposed an upper truncation value of 500 fatalities (equal to roughly 5 times the maximum data value of 85 fatalities). To be consistent, PG&E also imposed an upper truncation value of $100B (also equal to roughly 5 times the maximum data value) on the PD2 fit to the wildfire financial consequences. Different upper truncation values were analyzed (see Appendix C). Fitting of the data to untruncated lognormal distributions was also analyzed. Using truncated lognormal distributions to fit data is a potential area of future work.

Attribute	Outcome	Natural Unit	Distribution	Distribution Parameter Values			
				Shape	Location	Scale[(1)]	Upper Truncation
Financial	Destructive	$	Truncated PD2	2.8	$0.1B	$3B	$100B
Safety	Catastrophic	Fatalities[9]	Truncated PD1	0.78	1 fatality	1 fatality	500 fatalities

Table 1 **Summary of Pareto distributions used in PG&E's GRC Risk models**. [(1)] Scale parameter is set the same as location parameter for PD1.

The Parameter Estimation section below describes the procedure PG&E used to estimate PD1 (shape) and PD2 (shape and scale) parameters. The location values shown in Table 1 were set to be the theoretical minimum values for financial destructive ($100,352,500 = 300 acres burned x $1,175 per acre Cal FIRE suppression cost + 100 buildings destroyed x $1,000,000 / building destroyed) and the minimum value observed from the dataset (1 fatality) for safety catastrophic wildfires.

Figure 3**Error! Reference source not found.** shows the log–log graphs used to visually compare the untruncated lognormal, truncated PD1, and truncated PD2 fits to the data. Although visually comparing data to the curves that fit them can quickly reveal interesting data features such as clustering, outliers, etc., it is not sufficient to choose which distribution best fits the data. First, visual comparison is subjective. Second, which curve looks like it fits the data best may depend on how the data are graphed. For example, the linear–log graphs shown in Figure 4 are much more suggestive of the lognormal curves being the best fit to the data than are the log-log graph curves of Figure 3.

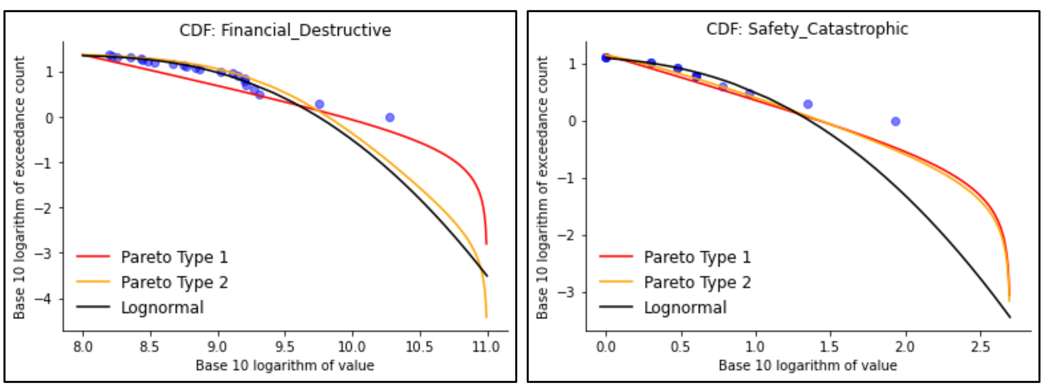

Figure 3 Wildfire data and truncated PD1, truncated PD2, and untruncated lognormal distribution fits. In both graphs, the logs of the ranks of the data are plotted against logs of their x values (dollars and fatalities). To illustrate what this means, consider the right most data point in the right graph. Its x value is 1.9, which is $\log_{10}$ (85), where 85 is the largest number of fatalities from the data. Its y value is 0, which is $\log_{10}$ (1), where 1 is the rank because 85 is the largest. Similarly, the penultimate right-hand point's x and y values are $\log_{10}$ (22) = 1.3 and $\log_{10}$ (2) = 0.3, which reflect the second largest fatalities value of 22. The survival or exceedance curves from the best fit truncated PD1, truncated PD2, and

[9] While Equivalent Fatalities, which include serious injuries as well as fatalities, are the Natural Unit used in PG&E's Multi-Attribute Value Function, this section describes the analysis based on fatality data and does not include the additional step of estimating Equivalent Fatalities from fatalities.

untruncated lognormal functions are also shown. Positive deviations of the data points from the theoretical values imply the function in question underestimates the likelihood of occurrence of the event. Consider, for example, the 85 fatalities event. The data point has a log rank of zero, while the corresponding point on the best fit lognormal curve has a log exceedance of approximately -1.0. This means the best fit lognormal function would underestimate the frequency of 85 fatalities events by approximately an order of magnitude.

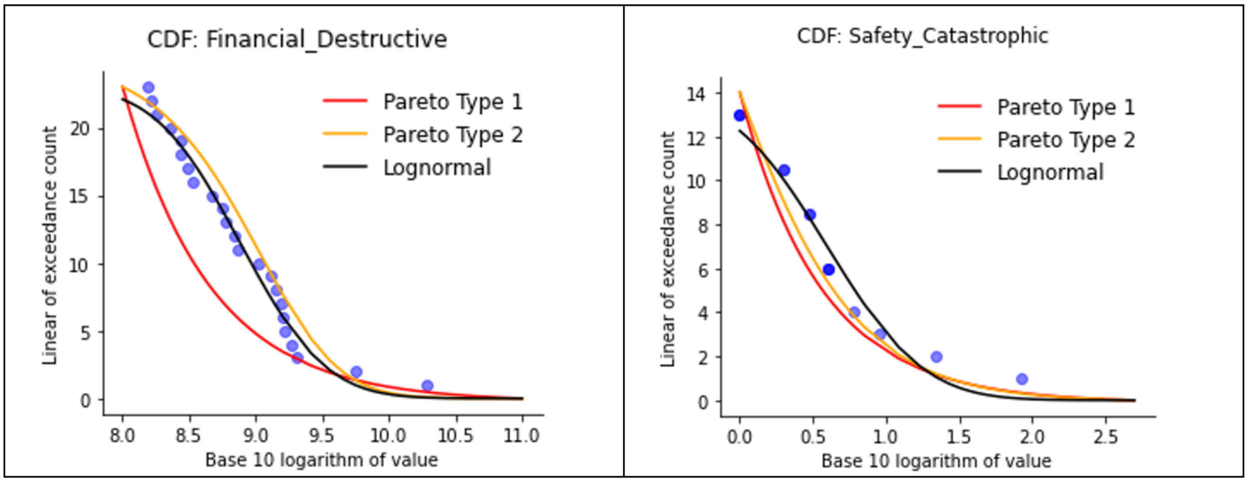

Figure 4 PD1, PD2 and lognormal distribution fit. In both graphs, the linear values of the ranks are plotted against logs of the x values (dollars and fatalities).

To supplement the visual comparison of curve fits to data, survival probabilities (also called exceedance probabilities) were also considered. The survival probabilities at different fatality consequence levels are shown in Table 2. This table shows the PD1 fit to the wildfire safety-catastrophic data has much greater survival probabilities at very high fatality values than does the lognormal fit and slightly greater survival probabilities at very high fatality values than does the PD2 fit.

Wildfire Safety Catastrophic Consequence (fatalities)	data	lognormal	PD1	PD2
>= 1	100%	88%	100%	100%
>= 5	29%	42%	28%	32%
>= 10	14%	22%	16%	18%
>= 50	7%	1.7%	4.0%	3.8%
>= 100	0%	0.3%	2.0%	1.8%
>= 200	0%	0.05%	0.83%	0.70%

Table 2 Survival probabilities (probabilities to exceed specified consequences).

PG&E also performed the Kolmogorov-Smirnov, mean squared error, Akaike information criterion, and Bayesian information criterion goodness-of-fit tests. For these tests, PG&E developed Python code which utilizes available Python packages including goodness-of-fit test functions. These available goodness-of-fit test functions are designed for non-truncated distributions; thus, these tests will not be exact for the truncated PD1 and PD2 that PG&E used. It is expected that a truncated distribution is a good fit to the data if the non-truncated distribution is a good fit because the upper truncation points are significantly greater than the highest-value data points.

With the caveat that the goodness-of-fit tests were for untruncated distributions, the best fit distributions as determined by the various tests are shown in Table 3 (details can be found in Appendix D). Where the test scores for two distributions are nearly equal, both distributions are shown.

	Kolmogorov-Smirnov	mean squared error	Akaike information criterion	Bayesian information criterion
Financial Destructive	PD2, lognormal	PD2, lognormal	PD2, lognormal	PD2, lognormal
Safety Catastrophic	PD1, lognormal	PD1, lognormal	PD1	PD1

Table 3 Best fit distributions for each goodness-of-fit test....

In the left graph of Figure3, truncated PD2 fits the data better than the untruncated lognormal distribution; and it fits nearly all but the highest value data point as well or better than PD1. For these (visual) reasons and because the truncated PD2 has a greater survival probability at very high values than does the untruncated lognormal, PD2 was chosen as the best fit distribution to the wildfire financial destructive consequence data.

In the right graph of Figure 3, the PD1 and PD2 curves are indistinguishable from one another and fit the data better than the lognormal curve. PD1 was chosen as the best fit to wildfire safety-catastrophic consequence data because PD1 has better Akaike information criterion and Bayesian information criterion goodness-of-fit test values than PD2 (see Table 3).

Parameter Estimations

As of current writing, PG&E estimated the shape parameter of the PD1 and the shape and scale parameter of the PD2 distributions using the Method of Moments. This method sets the free parameter(s) (the shape for PD1; the shape and scale for PD2) such that the moments of the theoretical distributions match empirical moments calculated from the data. Moreover, for both PD1 and PD2, PG&E calibrated the parameters to only match the first moment, i.e., the mean. This made the estimation procedure relatively straightforward to implement. While PG&E also investigated Maximum Likelihood estimation, it was not able to construct robust and stable numerical methods particularly for higher-order truncated Pareto distributions. The merits of developing PD1 and PD2 distributions centered on the historical mean is a subject for further discussion, but PG&E expects that this estimation method is acceptable in its risk quantification because of its non-linear Multi-Attribute Value Function, a tail focused risk measure. Using and developing different estimation methods should be an area of further investigation. The estimated parameters are shown in Table 1 above

Although the truncated PD1 looks to be the best fit distribution to the 2015-2020 PG&E territory catastrophic wildfire fatalities, PG&E finds the confidence interval of this distribution's shape value is very wide.[10] This finding is, perhaps, not surprising given there were only 14 such catastrophic wildfires.

From this shape value confidence interval, the wildfire catastrophic equivalent fatalities risk score, which was estimated as 7,700, was found to have a 95% confidence interval of 1,600 to 34,800. Appendix E describes the calculation of this confidence interval in detail.

Conclusion

Power law distributions intuitively fit the narrative of recent wildfire events in PG&E service territory. PG&E's analysis further suggests that they are acceptable distributions to adopt for wildfires consequences, but adopters should be prepared to address open, technical challenges when trying to fit these distributions to the datasets and specific conditions.

First and foremost, because the investigated events are tail events, by nature, the data is sparse. This results in uncertainties in estimated distribution-parameter values. Further, given this lack of data, the fitted wildfire power law distributions and, by extension, the resultant risk scores and risk spend efficiencies, can be expected to change as the distributions are re-estimated to reflect the latest wildfire data.

In adopting power law distributions for use in its wildfire models, PG&E had to develop new analyses and techniques, which remain to be validated and to have their downstream implications understood. PG&E did not calibrate upper truncation values but instead relied on a multiplier-of-historical-maxima approach based on judgement. If this approach is to be continued, more investigation and review will be required. Alternatively, approaches to jointly calibrate the shape and upper truncation values, or other calibration methods, can be investigated. PG&E used the Method of Moments to estimate power law distribution parameters. In the case of the truncated Pareto Type 1 distribution fit to the data, this meant estimating the shape value as that which makes the mean of the distribution equal to the mean of the data. Other calibration methods like Maximum Likelihood estimation were analyzed and rejected based on implementation difficulties, but PG&E feels further investigation is needed.

At the time of writing, PG&E is unaware of whether goodness-of-fit tests exists for *truncated* power law and *truncated* lognormal distributions. Most goodness-of-fit tests of untruncated power law and untruncated lognormal distribution fits to the data were inconclusive as to whether power law distributions or lognormal distributions describe the data better.

In conclusion, PG&E currently lacks the analytical tools to confirm or reject the hypothesis that truncated PD1 (truncated power law) and truncated PD2 distributions describe extreme-value

[10] The confidence intervals of other parameter estimates were not investigated; and their calculation is, potentially, an area for future work.

wildfire consequences significantly better than do other distributions - in particular, the truncated lognormal distribution. PG&E ultimately decided to use the power law distribution to describe some of its data based on a combination goodness-of-fit test results and because it assigns, consistent with historical frequencies, more weight to extremely high consequence events. However, the use of truncated PD1 and PD2 distributions currently introduces many complexities and trade-offs that are dependent on the data being studied and the limitations of the analytical methods. Hence, PG&E cannot currently recommend the adoption of the power law for *generalized* settings. PG&E will continue to investigate the appropriateness of the power law's use and better methods for calibrating the upper truncation and shape values.

Appendix

APPENDIX A Equivalence of Power Law and Pareto Type 1 Distributions

The power law probability density function ($f_{P-L}(x)$) and cumulative distribution function ($F_{P-L}(x)$) are

(3) $f_{P-L}(x) = \frac{\alpha_{P-L}-1}{x_{min,P-L}}\left(\frac{x}{x_{min,P-L}}\right)^{-(\alpha_{P-L})}$ $\quad where\ 1 < x_{min,P-L} \leq \alpha_{P-L},$

(4) $F_{P-L}(x) = 1 - \left(\frac{x}{x_{min,P-L}}\right)^{-(\alpha_{P-L}-1)}$ $\quad where\ 1 < x_{min,P-L} \leq \alpha_{P-L},$

where α_{P-L} is known as the power law exponent.

Similarly, the PD1 probability density function ($f_{PD1}(x)$) and cumulative distribution function ($F_{PD1}(x)$) are

(5) $f_{PD1}(x) = \frac{\alpha_{PD1}}{x_{min,PD1}}\left(\frac{x}{x_{min,PD1}}\right)^{-(\alpha_{PD1}+1)}$ $\quad where\ 0 < x_{min,PD1} \leq \alpha_{PD1},$

(6) $F_{PD1}(x) = 1 - \left(\frac{x}{x_{min,PD1}}\right)^{-(\alpha_{PD1})}$ $\quad where\ 0 < x_{min,PD1} \leq \alpha_{PD1},$

where α_{PD1} is known as the shape.

A comparison of (3) and (4) with (5)and (6) shows

(7) $\alpha_{P-L} = \alpha_{PD1} + 1,$

and

(8) $x_{min,P-L} = x_{min,PD1} + 1$

Note, there is no significant difference between the power law and PD1 $f(x)$ and $F(x)$. Power law distributions can be converted into PD1s with a change of variables. Specifically, substituting (7) and (8) into (3) and (4) gives (5) and (6).

In the standard notation for Pareto distributions, the PD1 and PD2 $f(x)$ and $F(x)$ are the following,

(9) $f_{PD1}(x) = \frac{\alpha_{PD1}}{\sigma_{PD1}}\left(\frac{x}{\sigma_{PD1}}\right)^{-(\alpha_{PD1}+1)}$ $\quad where\ 0 < \sigma_{PD1} < \alpha_{PD1},$

(10) $F_{PD1}(x) = 1 - \left(\frac{x}{\sigma_{PD1}}\right)^{-(\alpha_{PD1})}$ $\quad where\ 0 < \sigma_{PD1} \leq \alpha_{PD1},$

(11) $f_{PD2}(x) = \frac{-\alpha_{PD2}}{\sigma_{PD2}}\left(1 + \frac{x-\mu_{PD2}}{\sigma_{PD2}}\right)^{-(\alpha_{PD2}+1)}$ $\quad where\ 0 < x_{min,PD1} \leq \alpha_{PD1},$

(12) $F_{PD2}(x) = 1 - \left(1 + \frac{x-\mu_{PD2}}{\sigma_{PD2}}\right)^{-(\alpha_{PD2})}$ $\quad where\ \mu_{PD2} \leq x\ and\ 0 < \sigma_{PD2}.$

Here, μ is known as the location, σ is known as the scale, and α is known as the shape.

Note, when $\mu_{PD2} = \sigma_{PD2}$ and $PD2 = PD1$ are substituted into (11) and (12), (9) and (10) are recovered. That is, PD1 (and, therefore, also, power law distributions) are special cases of PD2.

PD2 has one more defining characteristic, μ, than does PD1. This means, as compared to PD1, there is more flexibility in defining PD2 when trying to match it to data, which is an advantage that also introduces more potential for error.

APPENDIX B General Pareto Distributions

PD1s and PD2s are special cases of the Generalized Pareto Distribution.

The Generalized Pareto Distribution has the following survival function[11],

$$(13)\quad \overline{F_{GPD}(x;\mu,\sigma,\xi)} = \left[1+\left(\frac{\xi(x-\mu)}{\sigma}\right)\right]^{-1/\xi} \qquad when\ \xi \neq 0,$$

$$= e^{-\frac{(x-\mu)}{\sigma}} \qquad when\ \xi = 0,$$

where $x \geq \mu$ when $\xi \geq 0$, $\mu \leq x \leq \mu - \frac{\sigma}{\xi}$ when $\xi < 0$, and μ, σ, and ξ are referred to as, respectively, the location, scale, and shape. The survival function is sometimes called the complementary cumulative distribution function and is equal to one minus the cumulative distribution function. In other words, $\overline{F}(x = a) = P(x > a)$.

Now,

$$(14)\quad \overline{F_{GPD}\left(x; x_{min}, \frac{x_{min}}{\alpha}, \frac{1}{\alpha}\right)} = \left[1+\left(\frac{\frac{1}{\alpha}(x-x_{min})}{\frac{x_{min}}{\alpha}}\right)\right]^{-\alpha} \qquad when\ \xi, \alpha > 0\ and\ where\ x \geq x_{min}$$

$$= \left[1+\left(\frac{(x-x_{min})}{x_{min}}\right)\right]^{-\alpha}$$

$$= \left[1+\frac{x}{x_{min}}-1\right]^{-\alpha}$$

$$= \left[\frac{x}{x_{min}}\right]^{-\alpha}$$

$$= \overline{F_{PD1}(x, x_{min}, \alpha)},$$

where $\overline{F_{PD1}(x, x_{min}, \alpha)}$ is the PD1 survival function with scale x_{min} and shape α.

Similarly,

[11] https://en.wikipedia.org/wiki/Generalized_Pareto_distribution

(15) $$\overline{F_{GPD}\left(x; x_{min}, \frac{\sigma}{\alpha}, \frac{1}{\alpha}\right)} = \left[1 + \left(\frac{\frac{1}{\alpha}(x - x_{min})}{\frac{\sigma}{\alpha}}\right)\right]^{-\alpha} \qquad when\ \xi, \alpha > 0\ and\ where\ x \geq x_{min}$$

$$= \left[1 + \left(\frac{(x - x_{min})}{\sigma}\right)\right]^{-\alpha}$$

$$= \overline{F_{PD2}(x; x_{min}, \sigma, \alpha)},$$

where $\overline{F_{PD2}(x; \mu, \sigma, \alpha)}$ is the PD2 survival function with location μ, scale σ, and shape α.

APPENDIX C Analysis of Different Upper Truncation Values

To explore where to set the appropriate upper truncation points, PG&E performed distribution fitting using various upper truncation points set as a series of multipliers (i.e., 1.5, 5, 10, 20, 50, 100) of the maximum values observed from the datasets. For example, Camp Fire has the largest financial consequence of $18,984,169,800 and fatality count of 85. Using a multiplier of 5 will set the upper truncation points to be $94,920,849,000 and 425 fatality respectively. PG&E further rounded up the upper truncation values as shown in Table C1.

Multiplier	**Financial Destructive**		**Safety Catastrophic**	
	Multiplier * Maximum	Truncation Value	Multiplier * Maximum	Truncation Value
1.5	28,476,254,700	30,000,000,000	128	200
5	94,920,849,000	100,000,000,000	425	500
10	189,841,698,000	190,000,000,000	850	900
20	379,683,396,000	380,000,000,000	1,700	1,700
50	949,208,490,000	950,000,000,000	4,250	4,300
100	1,898,416,980,000	1,900,000,000,000	8,500	8,500

Table C1 Roundup upper truncation points using various multipliers of the maximums.

Figure C1 depicts the fitting results for safety catastrophic PD1 curves at various upper truncation values against the observed data points and the untruncated lognormal curves.

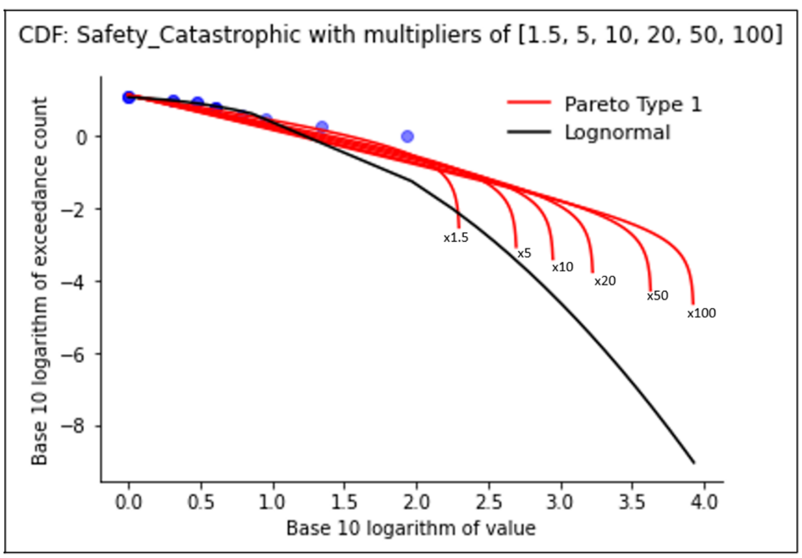

Figure C1 Truncated PD1 and untruncated lognormal distribution fits to wildfire safety consequence data.

Exceedance probabilities (or survival probabilities) at different consequence levels using various upper truncation points are shown in Table C2 below.

Safety Catastrophic	lognormal	P1D Multiplier 1.5	P1D Multiplier 5	P1D Multiplier 10	P1D Multiplier 20	P1D Multiplier 50	P1D Multiplier 100
>= 1	88%	100%	100%	100%	100%	100%	100%
>= 5	42%	33%	28%	26%	24%	22%	21%
>= 10	22%	20%	16%	14%	13%	12%	11%
>= 50	1.7%	4.9%	4.0%	3.5%	3.0%	2.6%	2.3%
>= 100	0.3%	1.9%	2.0%	1.8%	1.6%	1.3%	1.2%
>= 200	0.05%	0.00%	0.83%	0.86%	0.79%	0.68%	0.60%

Table C2 Survival probability (probability to exceed a specified safety consequence) when using each distribution with right truncation points set at various multipliers of the maximums observed from the datasets.

Figure C1 shows for multipliers greater than 10, there was virtually no difference between the curves except at values near the truncation values. The convexities (negative second derivatives) of the fitted Pareto curves appear to be higher (of greater magnitude) with lower multiplier and they seem to fit the data better. For example, the 1.5 multiplier curve closely tracks both the data and lognormal curve at low values. As the multiplier gets larger, the fitted curves flatten except near the truncation value.

PG&E considered that using a truncation point of 1.5 multiplier will clip the curve too sharply and will not account for extreme events well. This is also confirmed by Table C1. Using a 1.5 multiplier, the best fit distributions' exceedance probabilities of the extreme events (i.e., >=200 fatality) become zero (as these values are above the truncation values).

An interesting observation from Table C2 is that the exceedance probability peaks at multiplier 5 or 10 for extreme consequence levels (i.e., >=50 for Fatality Consequence). After the peak, the exceedance probability decreases as the multiplier increases.

In summary, PG&E finally considered a multiplier of 5 to strike the balance of not flattening the curve too much but also preserve the tail risk of extreme events.

APPENDIX D Goodness-of-Fit Tests

Kolmogorov-Smirnov (KS)

Notwithstanding that KS tests are invalid when distribution values such as shape are estimated[12], PG&E conducted 1-sample KS tests.

The null hypothesis (H_O) of a 1-sample KS test is that the data are sampled from the proposed distribution.

The alternative hypothesis (H_A) is that the data are not sampled from the proposed distribution.

The p-value is the probability that H_O is correct. That is, p-value = $P(H_O)$.

Note, either the H_O or H_A is true. It follows then that $P(H_O) + P(H_A) = 1$ and $P(H_A) = 1 - P(H_O)$.

If $P(H_O) < 5\%$ (which means $P(H_A) > 95\%$), then H_O is rejected, and H_A is accepted with more than 95% certainty.

If $P(H_O) > 95\%$ (which means $P(H_A) < 5\%$), then H_A is rejected, and H_O is accepted with more than 95% certainty.

If $5\% < P(H_O) < 95\%$ (which means $5\% < P(H_A) < 95\%$), then neither H_O nor H_A can be rejected with 95% certainty and neither can be accepted with 95% certainty. In this case, the KS test is statistically inconclusive.

The KS p-values are shown in Table D1 below. Blue highlights a p-value > 95%, which means H_O (the data come from the proposed distribution) is accepted with more than 95% certainty. Yellow highlights p-value < 5%, which means H_A (the data do not come from the proposed distribution) is accepted with 95% certainty. No highlight means the KS test is statistically inconclusive.

The Reliability Destructive p-values illustrate that the search for the best fit distribution should not stop as soon as a distribution is found with a KS p-value greater than 95%. Both the PD2 and lognormal p-values are more 95%. The certainty of the PD2 and lognormal data is shown in Figure D1; over the range of the data, these two distributions are nearly indistinguishable from one another.

[12] https://en.wikipedia.org/wiki/Kolmogorov%E2%80%93Smirnov_test

WF Data	KS p-value pareto 1	KS p-value pareto 2	KS p-value lognorm	KS p-value uniform
Reliability_NonSmall	8E-05	17.7%	77.0%	2E-57
Reliability_Destructive	6.4%	98.6%	99.8%	1E-08
Reliability_Large	4E-04	59.1%	90.5%	5E-24
Reliability_Small	3E-178	1E-15	5E-03	0E+00
Financial_NonSmall	3.9%	6E-04	4E-04	0E+00
Financial_Destructive	21.9%	90.1%	90.9%	7E-17
Financial_Large	3E-03	1E-03	2.1%	1E-173
Financial_Small	0E+00	0E+00	0E+00	0E+00
Safety_Destructive	47.7%	7.5%	49.7%	5E-09

Table D1

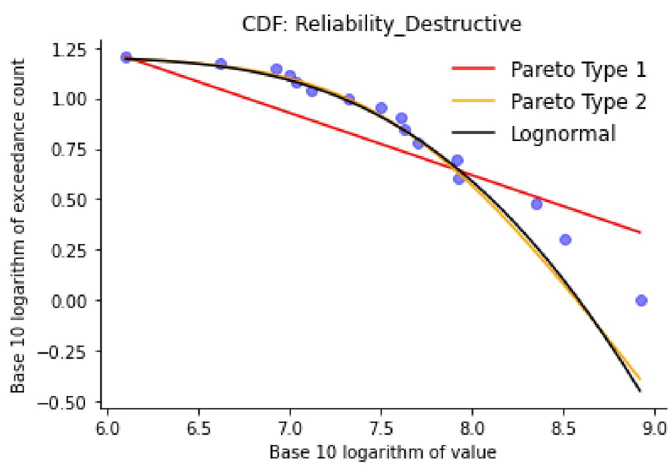

Figure D1

Table D2 below shows the same data as Table D1, but in Table D2, green highlights the highest p-value for a proposed distribution and red highlights the lowest.

WF Data	KS p-value pareto 1	KS p-value pareto 2	KS p-value lognorm	KS p-value uniform
Reliability_NonSmall	8E-05	17.7%	77.0%	2E-57
Reliability_Destructive	6.4%	98.6%	99.8%	1E-08
Reliability_Large	4E-04	59.1%	90.5%	5E-24
Reliability_Small	3E-178	1E-15	0.5%	0E+00
Financial_NonSmall	3.9%	6E-04	4E-04	0E+00
Financial_Destructive	21.9%	90.1%	90.9%	7E-17
Financial_Large	3E-03	1E-03	2.1%	1E-173
Financial_Small	0E+00	0E+00	0E+00	0E+00
Safety_Destructive	47.7%	7.5%	49.7%	5E-09

Table D2

Note that for the wildfire data with the largest risk score, Financial Destructive, the PD2 and lognormal p-values, which are the largest, are nearly identical, which is consistent with PG&E's choice of PD2. For the data with the second largest risk score, Safety Destructive, PD1 and lognormal p-values, which are the largest, are nearly identical, which is consistent with PG&E's choice of PD1.

Mean Squared Error (MSE) Test

PG&E computed the MSE between the empirical cumulative distribution function (CDF) (F_n) and the proposed distribution CDF (F). That is, PG&E calculated the values of MSE for each dataset and proposed distribution using the following formula:

$$\text{MSE} = \frac{1}{n}\sum_{i=1}^{n}[F_n(x_i) - F(x_i)]^2$$

MSE values are shown below in Table D3. Low values indicate a better fit. Blue highlights values < 0.01 and yellow highlights values > 0.1. Unlike the KS p-value, there is no MSE threshold value for accepting or rejecting a proposed distribution.

WF Data	MSE pareto 1	MSE pareto 2	MSE lognorm	MSE uniform
Reliability_NonSmall	0.024	0.004	0.001	0.295
Reliability_Destructive	0.018	0.003	0.002	0.207
Reliability_Large	0.028	0.003	0.001	0.206
Reliability_Small	0.048	0.003	0.000	0.316
Financial_NonSmall	0.002	0.001	0.004	0.324
Financial_Destructive	0.012	0.004	0.003	0.244
Financial_Large	0.003	0.004	0.003	0.242
Financial_Small	0.110	0.106	0.005	0.227
Safety_Destructive	0.007	0.030	0.007	0.237

Table D3

The MSE values are again shown in Table D4, but here green highlights the lowest MSE value for a proposed distribution and red highlights the highest.

WF Data	MSE pareto 1	MSE pareto 2	MSE lognorm	MSE uniform
Reliability_NonSmall	0.024	0.004	0.001	0.295
Reliability_Destructive	0.018	0.003	0.002	0.207
Reliability_Large	0.028	0.003	0.001	0.206
Reliability_Small	0.048	0.003	0.000	0.316
Financial_NonSmall	0.002	0.001	0.004	0.324
Financial_Destructive	0.012	0.004	0.003	0.244
Financial_Large	0.003	0.004	0.003	0.242
Financial_Small	0.110	0.106	0.005	0.227
Safety_Destructive	0.007	0.030	0.007	0.237

Table D4

Note, in Table D4, that for the wildfire data with the largest risk score, Financial Destructive, the PD1 and lognormal MSE values are identical, which is inconsistent with PG&E's choice of PD2. For the data with the second largest risk score, Safety Destructive, PD1 and lognormal are identical, which is consistent with PG&E's choice of PD1.

Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) Tests

The AIC for a given model is defined as

$$2k - 2\log(\hat{L}),$$

where k denotes the number of parameters in the model and $\hat{L}$ is the maximum value of the likelihood function for the model, i.e., $\hat{L}$ is the maximum likelihood estimate. The lower the AIC value is, the more likely the data come from the proposed distribution.

The BIC for a given model is defined as

$$k\log(n) - 2\log(\hat{L}),$$

where k denotes the number of parameters in the model, n denotes the number of observations in the dataset, and $\hat{L}$ denotes the maximum likelihood estimate. The lower the BIC value is, the more likely the data come from the proposed distribution.

The AIC and BIC test results are shown below in Tables D5 and D6, respectively. Excluding the uniform distribution values, green highlights the lowest AIC or BIC value for each distribution and red highlights the highest value. Note, the green and red highlighted cells in Tables D5 and D6 are almost exactly the same. Unlike the KS p-value, there is no AIC or BIC threshold value for accepting or rejecting a proposed distribution.

WF Data	AIC pareto 1	AIC pareto2	AIC lognorm	AIC uniform
Reliability_NonSmall	2,160	2,119	2,107	2,714
Reliability_Destructive	627	620	618	661
Reliability_Large	1,492	1,453	1,444	1,640
Reliability_Small	38,645	36,210	36,050	48,760
Financial_NonSmall	11,308	11,404	11,443	15,387
Financial_Destructive	1,024	1,017	1,017	1,092
Financial_Large	10,182	10,249	10,247	11,614
Financial_Small	33,413	35,144	37,960	46,346
Safety_Destructive	79	90	87	128

Table D5

WF Data	BIC pareto 1	BIC pareto2	BIC lognorm	BIC uniform
Reliability_NonSmall	2,164	2,125	2,111	2,719
Reliability_Destructive	629	622	620	663
Reliability_Large	1,496	1,458	1,448	1,644
Reliability_Small	38,656	36,226	36,060	48,771
Financial_NonSmall	11,316	11,415	11,450	15,395
Financial_Destructive	1,026	1,020	1,019	1,095
Financial_Large	10,190	10,260	10,255	11,622
Financial_Small	33,424	35,162	37,972	46,357
Safety_Destructive	81	92	89	129

Table D6

Note, in both Tables D5 and D6, that for the wildfire data with the largest risk score, Financial Destructive, PD2 and lognormal have virtually the same (lowest) values, which is consistent with PG&E’s choice of PD2. For the data with the second largest risk score, Safety Destructive, PD1 has the lowest values in both Tables D5 and D6, which is consistent with PG&E’s choice of PD1.

APPENDIX E Procedures of Calculating Confidence Interval

The following steps were followed to calculate the lower and upper bounds of the wildfire (wildfire) fatalities shape 95% confidence interval (the shape lower confidence interval (LCI) and upper confidence interval (UCI)). The Consequence of Risk Event value and risk score LCI and upper UCI were then calculated.

Step 1: Simulate 14 values (the number of wildfire fatalities data) from a PD1 distribution (The PD1 distribution) with lower and upper bounds of 1 fatality and 500 fatalities and an assumed shape value of 0.1.

Step 2: Use the Method of Moments (MOM) to estimate the shape value of The PD1 distribution fit to these 14 simulated values. Record these MOM estimated shape values.

Step 3: Repeat Steps 1 and 2 10,000 times.

Step 4: Average the rank 235 – 265 estimated shape values and record this as the 2.5% result for an assumed shape value of 0.1. Inspection of Table E1 below shows this value is -0.25.

Step 5: Average the rank 9,735 – 9,765 estimated shape values and record this as the 97.5% result for an assumed shape value of 0.1. Inspection of Table E1 below shows this value is 0.57.

Step 6: Repeat Steps 1-5 for assumed shape values of 0.2, 0.3, 0.4, …, 1.5, and 1.6.

Step 8: Set the LCI for each method equal to the lowest assumed shape value that produces a 97.5% shape value estimate (result) greater than the shape estimate based on the data (the Data Shape Estimate).

For example, from Table E2, the Data Shape Estimate is 0.78. In Table E1, the first 97.5% result greater than the Data Shape Estimate is the 0.88 result that is produced by assuming a shape value of 0.3. So, set the LCI to 0.3.

The thought here is that if the true shape value is 0.3, then there is a slightly greater than 2.5% chance 14 data will give a Data Shape Estimate as great or greater than the actual 0.78 Data Shape Estimate. Similarly, there is a slightly less than 2.5% chance if the true shape value is 0.2. Somewhere between a true shape value of 0.2 and 0.3 there is a 2.5% chance that 14 data will give a Data Shape Estimate as great or greater than the actual 0.78 Data Shape Estimate. Hence, the LCI is 0.3.

Step 9: Similarly, set the UCI equal to the greatest assumed shape value that produces a 2.5% result less than the Data Shape Estimate. As Table E1 shows, the UCI is 1.3.

As shown in Table E1, the simulations found the 95% confidence intervals for the MOM methods was 0.3 – 1.3.

Simulations assuming 100 data points rather than 14 found a similar risk score estimate with a 95% confidence interval of 3,800 to 13,800. That is, simulations indicate that had there been 100 data points instead of 14, 95% confidence interval of risk score would be about half of what it is.

SIMULATIONS RESULTS		
alpha	MOM	
	2.50%	97.50%
0.1	-0.25	0.57
0.2	-0.15	0.74
0.3	-0.05	0.88
0.4	0.04	1.04
0.5	0.12	1.23
0.6	0.20	1.40
0.7	0.27	1.56
0.8	0.34	1.72
0.9	0.39	1.93
1.0	0.48	2.07
1.1	0.59	2.27
1.2	0.66	2.56
1.3	0.75	2.75
1.4	0.84	3.00
1.5	0.92	3.33

Table E1

method	shape estimated from data
MOM	0.78

Table E2