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May 23, 2025 VIA ELECTRONIC FILING

Caroline Thomas Jacobs, Director
Office of Energy Infrastructure Safety
California Natural Resources Agency
Sacramento, CA 95814

RE: MUSSEY GRADE ROAD ALLIANCE COMMENTS ON THE 2025 UPDATE OF THE WILDFIRE MITIGATION PLANS OF PG&E

Dear Director Thomas Jacobs:

The Mussey Grade Road Alliance (MGRA or Alliance) files these comments pursuant to the February 24th Revised 2026-2028 Base Wildfire Mitigation Plan Update Schedule[1] provided by the Office of Energy Infrastructure Safety (OEIS or Energy Safety) which authorizes public comment for PG&E's Wildfire Mitigation Plan (WMP) by May 23, 2025.

The Mussey Grade Road Alliance is pleased to be able to continue to participate and provide substantive feedback on this update to the Large IOU Wildfire Mitigation Plans.

For any reader curious as to how the Mussey Grade Road Alliance, a grass-roots citizen-based organization located in Ramona, California has become involved in reviewing and improving utility power line fire safety in California over the last 17 years we would refer them to our last full description of our history and activities in the 2020 Wildfire Mitigation Plans.[2] MGRA has been involved in every WMP since their start, and in fact was the only intervenor providing comment on the "Fire Prevention Plans" early in the 2010's.

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[1] Docket 2026-2028-WMPs; Office of Energy Infrastructure Safety; 2026-2028 Wildfire Mitigation Plan Update Schedule; p. 2; TN15409_20250224T170637_Revised_20262028_Base_WMP_Schedule.pdf (2025 Updated Schedule)

[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) https://energysafety.ca.gov/wp-content/uploads/docs/misc/wmp/public-comments/mussey-grade-comments-2020-wmp.pdf

The Alliance comments are authored by the Alliance expert, Joseph W. Mitchell, Ph.D.[3] Many of the topics he raised in the previous years – 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 analysis this year based on new data provided by the utilities.

While utilities continue to refine their risk models under additional constraint and guidance by Energy Safety, MGRA continues to focus on the shortcomings of these models and their basic assumptions. Many of these issues remain the same as those MGRA has raised in the past, such as the effect of extreme winds on ignition risk, and to some extent OEIS has accommodated some of the MGRA inputs. However, this year's analysis uncovers an entirely new aspect of this relationship that might require that the foundations of the Machine Learning based outage probability models be questioned.

This WMP is also PG&E's last before it launches its 2026-2029 GRC cycle and additionally presents a ten-year undergrounding plan. Many of the issues it raises are designed to lay the groundwork for this major new set of activities and potentially major new capital projects. MGRA will be analyzing these areas with a critical eye, as it and other stakeholders have identified inherent preferences for undergrounding solutions.

PG&E's submission is of particular importance to MGRA. While not a resident of the PG&E service area, as the largest IOU PG&E wields a lot of influence, and technologies or policies adopted by PG&E often are adopted by the other IOUs, including our own SDG&E. These have included use of a power law to describe wildfire losses, an undergrounding-first attitude that has fundamentally changed mitigation philosophy since 2021, and as will be shown in these comments a "convex" risk attitude function that allows them to multiply their risk. MGRA has been involved in PG&E proceedings since 2019 for these reasons.

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

This is the first of the WMPs in which the timing is set so that MGRA cannot put its analysis for all utilities into the same document, which is unfortunate because comparison between utilities has always been a strong and unique aspect of MGRA's WMP Comments. There may still be some comparison done in the SDG&E or SCE WMP Comments, and we may also discuss them where appropriate in replies to utility supplemental filings needed to address issues.

We thank Energy Safety for the opportunity to provide these comments and in particular its staff who diligently work through the massive quantity of utility filings, data request responses, and stakeholder comments.

Respectfully submitted this 23rd day of May, 2025,

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On behalf of the Mussey Grade Road Alliance.

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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.[4]

1. INTRODUCTION AND SUMMARY

The Mussey Grade Road Alliance provides comment on the 2026-2028 Wildfire Mitigation Plan (WMP) for Pacific Gas and Electric Company (PG&E).[5]

Thanks to the more expansive and prescriptive guidance by OEIS the utility WMPs have become easier to review and process. For the sake of brevity, MGRA's comments do not address the many significant additions and improvements to PG&E's WMP and wildfire safety program. These MGRA comments concentrate on areas where improvements are needed, or where serious issues have arisen that merit Energy Safety attention and possibly intervention. As noted in the previous section, this document is the groundwork for the PG&E General Rate case (launched May 15, 2025) and soon-to-be-issued 10 year undergrounding plan. As PG&E will be shifting risk and revenues between those plans the WMPs form a valuable factual basis that will prove extremely valuable when examining PG&E's revenue requests.

1.1. Organization

Sections generally follow the numbering scheme laid out in Energy Safety guidelines.

MGRA is including utility data request responses as Appendix A of these comments. Even when we are not fully able to explore every issue that these cover in the comments, we hope that Energy Safety will review these responses from the utilities as well in order to inform its own evaluation.

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[4] M-bar Technologies and Consulting, LLC; http://www.mbartek.com; Email: jwmitchell@mbartek.com. Dr. Mitchell is also Secretary of the Mussey Grade Road Alliance.
[5] PG&E Wildfire Mitigation Plan R0; 2026-2028 | Volume 1 of 2; April 4, 2025.

An excerpt from MGRA's PG&E RAMP comments is attached as Appendix B. These comments explain in detail why PG&E's methodology for determining its "convex" risk avoidance attitude is not valid.

MGRA Workpapers can be found at:
https://github.com/jwmitchell/Workpapers/

Additional MGRA work, specifically that related to MGRA's weather analysis may be found at:
https://github.com/jwmitchell/mbar-weather

1.2. Comparison with 2025 PG&E WMP Update

MGRA made a number of recommendations as part of its comments on the 2025 WMP Update.[6] Some of these were acted upon by OEIS, either in its review of the WMP or in its comments on the utility quarterly report. Other recommendations may have been in one way or other implemented by utility actions. Some of MGRA's recommendations were not addressed but remain valid concerns. Some of MGRA's 2025 Update recommendations are summarized below:

Recommendation	**OEIS Action**	**Utility Action**	**Status**
Utilities should use field data and continue to develop their estimates of covered conductor effectiveness.	IOUs must continue CC effectiveness workstream and include in-field effectiveness.	PG&E does not calculate in-field effectiveness. PG&E lowers estimate of CC effectiveness.	MGRA evaluates PG&E CC effectiveness and finds consistency with SCE measured values, though small statistics. Section 8.2.2
MGRA recommended expanded data relating to EPSS.	PG&E-25U-06 modified.	PG&E is implementing.	Resolved.
MGRA recommended that PG&E use optimal combinations of mitigations as alternative to undergrounding.	Requires utilities to incorporate mitigation combinations (SPD-31,p. 24)	PG&E is using CC+EPSS +DCD and sometimes PSPS as alternative.	Resolved.

[6] MUSSEY GRADE ROAD ALLIANCE COMMENTS ON THE 2025 UPDATE OF THE WILDFIRE MITIGATION PLANS OF PG&E, SCE, AND SDG&E; May 7, 2024.

Utility risk models do not adequately represent correlation between ignition and spread due to extreme wind drivers.	Energy Safety now requires extreme scenario evaluation.	PG&E does not adopt Energy Safety requirement.	MGRA provides proof of wind/ignition link. Section 5.2.1.1. MGRA suggests framing for PG&E extreme event scenarios. Section 5.3.

Table 1 - MGRA recommendations made as part of the 2025 WMP Update review, Energy Safety and utility action on these topics, and current status.

1.3. Significant Findings in the 2026-2028 Wildfire Mitigation Plans

A number of significant issues were identified in PG&E's 2026-2028 WMP and will be addressed at length in the remainder of these comments. To summarize the most important of these issues identified in the MGRA review:

- PG&E's risk estimates are amplified by a "convex" risk attitude function. MGRA shows that the basis for its methodology are flawed and help to artificially improve the case for undergrounding.
- As in past WMPs, MGRA has found bias in the Machine Learning models used by utilities because they assume no coupling between probability and consequence due to wind effects. Independent analysis E3 also observed this issue. MGRA presents new evidence that large fires from powerlines are more highly correlated with windy conditions than large fires coming from other sources, implying that ignition models that ignore this effect may underestimate risk in windy areas.
- MGRA shows that the size and consequences (in terms of home loss) of large power line fires greatly exceeds those of other large wildfires.
- PG&E's "suppression" model produces results that contradict established research regarding is known about Wildland Urban Interface fires and needs to be re-worked. MGRA suggests breaking the problem into manageable pieces.
- PG&E's "egress" model isn't an egress model at all, and further work is necessary. Its observations regarding AFN populations are very important, however, and should be included as a component in consequence weighting.

- MGRA provides evidence that PG&E's "top tier" risk circuits seem to be observing the most damage during PSPS outages, mostly but not uniformly at high wind speeds.
- MGRA presents analysis showing that PSPS duration, frequency, and scope can be substantially increased if thresholds undergo moderate increases, say in conjunction with covered conductor.
- Recent utility data on advanced technologies such as downed conductor, ESD and Fast Circuit do not reveal cases in which these technologies failed to perform their function.
- PG&E ignores Energy Safety guidance requiring development of extreme risk scenarios. MGRA provides a possible framework for a PG&E response.
- MGRA demonstrates that PG&E is deploying a decision tree (as SDG&E had in its version of WiNGS-Planning used in its GRC) that allows undergrounding to be chosen without consideration of other alternatives based on arbitrary criteria established by PG&E.
- MGRA repeats its observation that based on SCE field data as of 2023 covered conductor is 85% effective at mitigating risk. An initial look at PG&E's 2024 field data, while low in statistics, is not inconsistent with this assertion.

2. RELATED ACTIVITY AT THE PUBLIC UTILITIES COMMISSION

2.1. A.24-05-008 – PG&E's 2024 RAMP Report

PG&E submitted its RAMP report as the first stage of its 2026-2028 Test Year GRC. MGRA and a number of other intervenors reviewed PG&E's submission, as did the Commission's Safety Policy Division (SPD). The SPD report[7] itself incorporates MGRA's "Informal Comments"[8]

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[7] A.24-05-008; December 2, 2024 Ruling, Attachment 2
EMAIL RULING GRANTING CAL ADVOCATES' REQUEST TO SET DECEMBER 4, 2024, DEADLINE FOR COMMENTS ON MOTION AND ENTERING SAFETY POLICY DIVISION REPORT INTO THE A.24-05-008 RECORD:
Safety Policy Division Evaluation Report on PG&E 2024 RAMP Application (A.)24-05-008; November 8, 2024; (SPD Report, PG&E 2024 RAMP)
https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M548/K361/548361466.PDF.

[8] SPD Report, PG&E 2024 RAMP; p. 309/407.
MUSSEY GRADE ROAD ALLIANCE INFORMAL COMMENTS TO THE SAFETY POLICY DIVISION REGARDING PACIFIC GAS AND ELECTRIC COMPANY'S RAMP FILING, REVISION 1; October 9, 2024. Revised October 11, 2024. (MGRA RAMP Comments)

which provide the primary technical analysis performed by MGRA in this proceeding. A number of the issues and analyses raised during the RAMP are continued into the PG&E WMP 2026-2028 filing.

One analysis examined the benefit of outage avoidance based on the Berkeley ICE model. MGRA examined the segments in PG&E's HFRA and the number of customers and their types, and the total CMI avoided for each type. The analysis found that according to PG&E's implementation of the Berkeley ICE model, the cost of CMI per customer is driven primarily by whether there are medium or large customers on circuit segments in question:

Customer Type	**Segments**	**Customers**	**CMI Total**
Medium and Large Business	1,805	5,972	$465,816
Small Business	3,410	39,260	$392,600
Residential	3,651	438,031	$26,282
Total	**4,143**	**465,816**	**$884,698**
On segments without M/L	2,338	142,109	$96,893
On segments without M/L/Small	733	7,925	$476

Table 2 - Breakdown of PG&E circuit segments crossing HFRA by customer type. Total number of segments with the customer type, number of customers, and total CMI per customer type are given. Number of customers on circuits without medium/large businesses, and with no businesses are shown in the last two rows.

This is understandable based on the ICE model, which weights medium and large business customers over 1,000 times more heavily than residential customers:

FIGURE 2-3
$/CMI USING ICE DEFAULT DATA AND PG&E-SPECIFIC DATA

	ICE Data (California)		PG&E Data	
Sector	Cost per CMI (2016$)	**Cost per CMI (2023$)**	Cost per CMI (2016$)	**Cost per CMI (2023$)**
Medium and Large C&I	$70.37	$89.34	$61.35	$77.89
Small C&I	$5.36	$6.81	$7.87	$9.99
Residential	$0.04	$0.06	$0.04	$0.06
All Customers	**$1.53**	**$1.94**	**$2.50**	**$3.17**

Table 3 -PG&E ICE calculations of cost per customer minute interruption (CMI) for medium and large businesses, and residential customers.[9]

The lesson to be drawn from this analysis, which was also raised in MGRA's 2025 WMP Comments, is that there was little sound economic justification based on reliability for using extreme hardening measures for reducing PSPS risk for the segments undergrounded by SDG&E and PG&E. In fact, as MGRA's 2025 WMP analysis showed, in many if not most cases it would be more economically viable to take residents off-grid and provide them with stand-alone solar and battery power than it would be to underground rural segments having sparse customers.[10]

MGRA also examined and provided critical analysis of PG&E's "market based" risk scaling methodology. This methodology has also been used in the 2026-2028 WMP,[11] and forms the basis of all enterprise risk estimates performed by PG&E. MGRA's criticism of this methodology is explained in detail in Section 5.1 and MGRA's full critique from the PG&E RAMP proceeding is provided as Appendix B to these comments. It is important to note that the CPUC, while allowing utility scaling functions to be used, requires that utilities provide linear risk scaling functions as a comparison,[12] a position for which MGRA was a strong advocate.

MGRA also performed analysis of PG&E EPSS and PSPS settings and presents these in Section 7, although they might have alternatively been placed in response to PG&E Section 8.7.1.

[9] Id.; p. 8; Cites:
RAMP; PG&E-2; p. 2-12.
A.24-05-008; APPLICATION OF PACIFIC GAS AND ELECTRIC COMPANY (U39M) TO SUBMIT ITS 2024 RISK ASSESSMENT AND MITIGATION PHASE (RAMP) REPORT; May 15, 2022.
[10] MGRA 2025 WMP Comments; pp. 27-39.
[11] PG&E WMP; p. 46.
[12] D.24-05-064; p. 98.

MGRA's analysis of EPSS versus PG&E's FPI calculation shows a good correlation between EPSS settings and fire danger, though it makes some suggestions for improvement. For PSPS, MGRA shows that PG&E could substantially decrease the impacts of PSPS in terms of extent, duration, and frequency by raising its PSPS wind threshold.

5. RISK METHODOLOGY AND ASSESSMENT

PG&E deploys essentially three types of risk models:

1) Enterprise risk models that can be used to estimate and compare the level of risk from all of PG&E's operations, including wildfire risk and reliability risk. It is used to assess the cost and effectiveness of entire mitigation programs. These models are developed in compliance with the CPUC's Risk-informed Decision-making Framework (RDF, Docket R.20-07-013)
2) A long term planning model that looks at risk across the landscape and allows PG&E to plan mitigations based on risk and cost. This looks at risks across the landscape based on historical weather, landscape, and fire data. And compares this to the history of risk events (ignitions, wires down, outages, and other damage) in those areas.
3) An operational model is similar to the planning model but uses live weather and vegetation conditions to model dynamic risk and inform PSPS and EPSS decision.

PG&E maintains independent models for transmission (WTRMv2) and distribution (WDRMv4). These comments will concern themselves primarily with the WDRM model. It also maintains separate risk models for PSPS and

PG&E was the first utility to put forward its RAMP after the CPUC's RDF process required that utilities begin to use Cost/Benefit analysis to inform their planning. PG&E deployed and used its newer WDRM v4 model in 2023 and now has a couple of years of experience with it. PG&E's modeling has grown in complexity and sophistication as it has refined its approach, dealt with obvious sources of bias and error, and expanded the types of risk that it considers in its models.

A considerable amount of effort and thought has gone into many of these models and their subcomponents, and it would be a joy to say that PG&E's models are converging on a methodology based on sound science and engineering. Unfortunately, we should not feel the joy yet. There are a number of fundamental misjudgments and even errors in the PG&E methodology for all of its sophistication, and these compromise the result. Some of these have been raised by MGRA before – particularly the bias introduced by the coupling of outage probability and fire spread during high wind events. MGRA has repeated this claim in its filing for years, however new data will be presented in these comments that strongly support the supposition that many power line fires are *caused* by wind, and that ML models that show wind as a minor causal attribute are in error.

PG&E has also introduced a number of "innovations" that are not ready for adoption into a rigorous wildfire model. The flaws in these new model components will be analyzed and remedial actions suggested.

5.1. Enterprise Risk and Risk Attitude

As mentioned previously, PG&E's risks are analyzed according to the RDF laid out by the CPUC. As part of the risk calculation, utilities are allowed to apply a "risk attitude" function to their risk calculations. PG&E in particular is an advocate of this approach. PG&E's claim is that there are uncertainties in the calculation and that therefore a more conservative and averse attitude toward extreme losses should be taken, and that furthermore this represents the attitude of the company itself and the ratepayers and residents in its area. This adjustment is not small. In fact, for in the catastrophic loss domain (which makes up the majority of utility wildfire risk), PG&E multiplies its risk values by a factor of 7.5 when doing its cost/benefit analysis.

It is important for Energy Safety to realize that this error amplification is occurring in some of PG&E's estimates and to clearly identify where this is occurring.

For example, PG&E's monetized risk analysis that it presented in its WMP and RAMP shows a residual risk after mitigation of $3.6 B after mitigation, or $6.6 B if PSPS and EPSS risks are included.

FIGURE PG&E-6.1.3.2-1:
2026 YEAR BASELINE
(WITH AND WITHOUT OPERATIONAL MITIGATION)

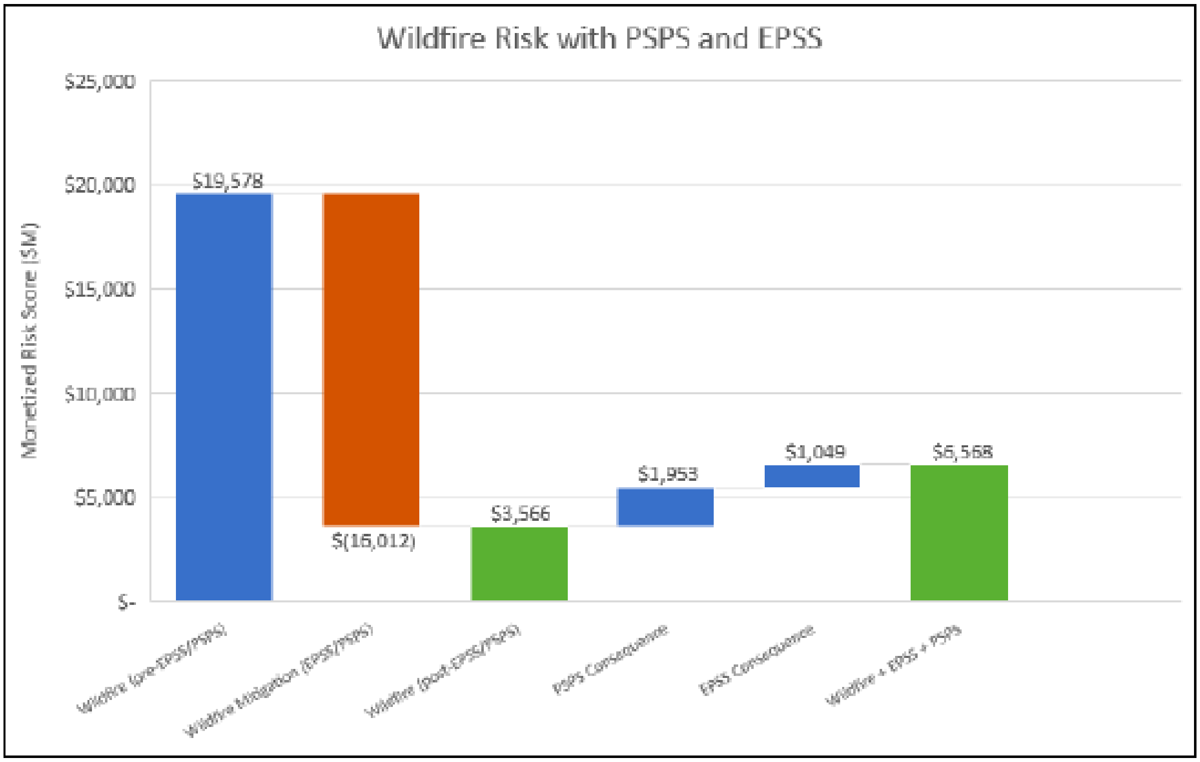

Figure 1 - PG&E's monetized risk estimate including PSPS and EPSS costs and risks. This graph uses PG&E's 'risk averse' scaling function.[13]

If a Risk-Neutral Scaling Function is used, PG&E’s Monetized Wildfire risk looks like this:

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[13] PG&E WMP; v.1; pp. 134-136.

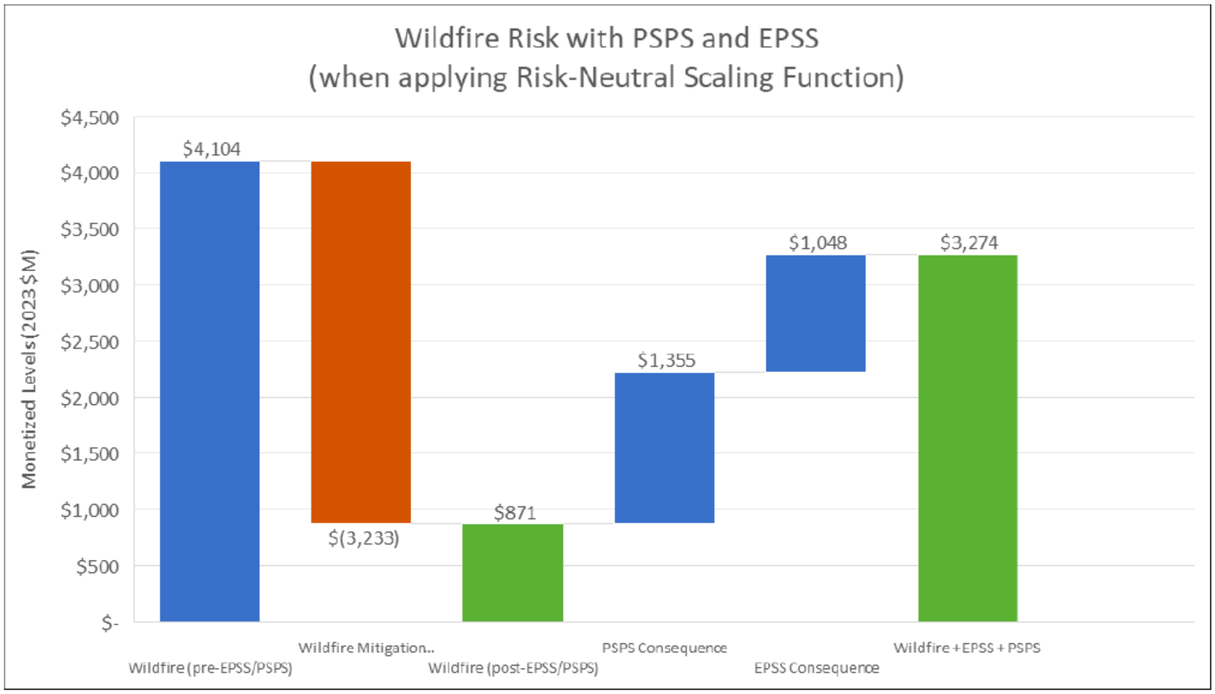

Figure 2 - PG&E's monetized wildfire risk estimates with a risk-neutral scaling function.[14]

Clearly, the residual wildfire risk using a "risk-neutral" function is significantly smaller – by a factor of four, making the combined residual risk roughly half of that using PG&E's 'risk averse' scaling, and in fact making reliability risk from PSPS and EPSS the dominant contributors to total wildfire risk.

PG&E explains its use of a scaling function thusly:

"*PG&E's approach, at its core, is to use available, objective data to determine the Risk-scaling function(s). Risk premiums from insurance and capital markets meet these criteria. These market prices encode preferences. As such, they can be used to develop empirically based Risk-Scaling Functions that will be more insightful and representative than any approach considered to date….*

Market theory tells us that the prices obtained from a perfect market maximize value to society. Of course, no market is perfectly competitive, complete, or truly representative of societal preferences, but there are established practices that can be employed within the market-based approach to account for shortcomings while still preserving its function of communicating societal

[14] PG&E Data Request Response WMP-Discovery2026-2028_DR_MGRA_003-Q007

values. Hence, Risk-Scaling Functions developed to be consistent with market prices would represent societal risk preferences, not those of the utility.

The Risk-Scaling Function is a bedrock component of PG&E's risk modeling, and is applied methodically across all risks, including PSPS and EPSS. Using the market-based approach above, separate Risk-Scaling Functions for reliability and safety are developed, which are then applied to the consequence distribution of PSPS and EPSS events to arrive at (Risk-Adjusted) CoRE values, per Row 24 of the RDF.46 Similarly, the post-mitigation CoRE values for PSPS and EPSS are determined by applying the Risk-Scaling Functions to the post-mitigated consequence distributions. In its Report on PG&E's 2024 RAMP Application, the CPUC SPD evaluated PG&E's Risk-Averse Risk Scaling Function and found that it was valid."[15]

There is a significant amount of misleading or inapplicable information packed into these statements. PG&E in fact had been advocating for a market-based approach in the RDF proceeding. MGRA's opinion on this proposal was initially neutral – the method would have to be evaluated once it was released. PG&E released its model in its RAMP filing and provided some detail on its methodology, and after it had done so MGRA conducted a deep analysis and came up with an extremely negative assessment of PG&E's approach. This is written up in some detail in MGRA's RAMP Comments, which are included as part of SPD's report on the PG&E RAMP.[16] For convenience, the relevant excerpt from MGRA's RAMP comments are being included as Appendix B to this filing.

To briefly summarize the issues with PG&E's approach:

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[15] PG&E WMP v1; pp. 130-131.

[16] A.24-05-008; December 2, 2024 Ruling, Attachment 2
EMAIL RULING GRANTING CAL ADVOCATES' REQUEST TO SET DECEMBER 4, 2024, DEADLINE FOR COMMENTS ON MOTION AND ENTERING SAFETY POLICY DIVISION REPORT INTO THE A.24-05-008 RECORD:
Safety Policy Division Evaluation Report on PG&E 2024 RAMP Application (A.)24-05-008; November 8, 2024; p. 309/407:
https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M548/K361/548361466.PDF
MUSSEY GRADE ROAD ALLIANCE INFORMAL COMMENTS TO THE SAFETY POLICY DIVISION REGARDING PACIFIC GAS AND ELECTRIC COMPANY'S RAMP FILING, REVISION 1; October 9, 2024. Revised October 11, 2024; pp. 322/407 – 332/407.

- PG&E claims that its risk adjustment is based upon a "market-based" estimate of risk. It isn't. PG&E's risk multiplier value derives from a CAT bond issued from a single vendor specific to its own business.
- Because the CAT bond vendor's methodology is proprietary, there is no way of validating whether its own methodology for determining risk for its own purposes is in any way relevant to the risk analysis performed by PG&E.
- Specifically, unless the CAT bond market is using the same truncated power law distribution that PG&E does for estimating enterprise risk, it is very likely that PG&E is "double counting" (in fact double multiplying) risk values that inherently incorporate significant "risk aversion".
- According to economic literature, risk premium traditionally is increased by 25-40% when uncertainty is incorporated. PG&E increases theirs by 650%. Even if uncertainty is amplified by the power law dependency, PG&E has done a sensitivity analysis with regard to its choice of power law truncation that would allow it to incorporate this as parametric uncertainty.
- A specific example from PG&E's RAMP illustrates one implication. PG&E intends to propose a $1 billion dollar program to underground service drops and secondary lines. Without PG&E's risk scaling, this program would have a CBR less than 1.0, i.e. would not provide estimated benefits in excess of its costs.

PG&E claims that the CPUC's Safety Policy Division (SPD) had found PG&E's risk scaling function satisfactory. It had. SPD is in error on this matter. While the Commission itself will not rule on this issue until after PG&E's GRC has been litigated, the ALJ in the proceeding recently issued the following guidance for the GRC proceeding:

"*MGRA commented that it found two potentially serious mistakes in the SPD Evaluation Report, those being (1) it erroneously found that PG&E's risk attitude model based on insurance products is valid, and (2) it accepted PG&E's covered conductor wildfire risk reduction efficiency of 65% NPV risk reduction…*

PG&E is directed to conduct a parallel risk evaluation using a risk-neutral, linear scaling function to establish a neutral baseline for GRC stakeholders to compare the impacts of its risk-averse scaling function on the selection decisions regarding risk mitigation. To comply with this *directive, PG&E must provide information for each risk evaluation and risk mitigation option as follows:*

• Provide parallel monetized levels of each attribute or attributes without applying its risk-averse Risk Attitude Function.

• Provide cost-benefit analysis (or benefit/ratios) without applying its risk-averse Risk Attitude Function."[17]

Recommendations:

MGRA urges Energy Safety to review the MGRA objections to PG&E's risk attitude function and to:

- Ensure that PG&E risk analyses including its scaling function are clearly labelled as such, and
- Require PG&E to use a risk-neutral scaling function in addition to its risk-averse scaling function when performing critical risk analyses.
- Request E3 to independently verify PG&E's approach to convex risk attitude functions.

5.2. Risk Analysis Framework

5.2.1. Likelihood of Ignition

PG&E has made a number of changes and improvements to its likelihood of ignition model, which consists of a P(o) (probability of outage) that is based on machine learning (ML) models, and a P(i|o), a conditional probability model based on Logistic Regression. PG&E has divided its risk drivers up into separate models and evaluated each separately. Their analysis is described in the supplemental document Distribution Event Probability Models Version 4 (DEPM 4).[18]

MGRA has criticized the ML approach in general in its annual WMP filings and in its filings at the CPUC. Briefly, utilities adopting the ML approach have been applying a simplistic

[17] A.24-05-008; ADMINISTRATIVE LAW JUDGE'S RULING TO PACIFIC GAS AND ELECTRIC COMPANY DIRECTING THE SERVICE OF ADDITIONAL INFORMATION AND OTHER REQUIREMENTS; April 22, 2025; pp. 5, 8.

[18] Distribution Event Probability Models Version 4; (DEPM v4); Documentation; March 12, 2025. (DEPM).

model in which the risk for a given event is equal to the product of the probability and consequence of the event. In fact, however, probability and consequence are not independent for some risk drivers. Extreme fire weather can cause outages due to wind, either from equipment failure or from vegetation or contact with other objects. If these outages cause ignition, the consequence can potentially be large because of the increased rate of fire spread under high wind conditions. The net result of this bias is that risk in areas prone to extreme fire weather will be suppressed compared to other areas, and that the overall risk of catastrophic wildfire (in lieu or PSPS) is larger overall than utility risk estimates indicate.[19] ML models utilized by the utilities look at annual aggregations of weather attributes, whereas the weather events that trigger catastrophic utility wildfires tend to occur during short time intervals.[20] This is true even of newer models used by PG&E, such as XGBoost: "*Some covariates, such as weather and other time-based variables, require derivation, as the data should represent the conditions under which known events have occurred. To support multi-year event datasets, the derivation typically requires statistical extracts of multi-year sequences of weather data*."[21]

Looking at PG&E's DEPM results for its risk drivers bears out this concern. The only driver in which an annualized wind speed variable is a significant contributor to ignition is that of Dynamic Protection Devices (DPD).[22] For Line Slap, daily maximum windspeed is also a substantial contributor, though it is less important than wet season precipitation. For wires down, wind speed is a minor feature (14th in importance), for other conductor issues it does not appear in the top 9 features. For support structures wind is not in the top 12 features, even though the text notes that "Structural support structure failures occur when the support structure experiences a physical failure to the pole or its crossarm(s) and are often triggered by wind events."[23] For branch contact from trees, wind speed is not in the top 12 contributing features. For tree fall-in, percent gusty summer day is the 8th most important feature but only a tiny contributor by overall contribution. Notably, "normalized historical wind direction strike potential" is a much stronger predictor of tree fall-in, implying that wind is causing trees to fall into lines, but none of the features is able to capture or quantify this fact. Summarizing: Judging from the feature importance

[19] WMPs-2022; MUSSEY GRADE ROAD ALLIANCE COMMENTS ON 2022 WILDFIRE MITIGATION PLANS OF PG&E, SCE, AND SDG&E; April 11, 2022; pp. 21-24 (MGRA 2022 WMP Comments);
[20] WMPs-2023-2025; MGRA WMP Comments; pp. 30-33.
[21] Supplemental Info: RaDA Modeling Algorithms and Methodologies; Version 1; Documentation; 03/12/2025; p.
[22] DEPM; pp. 19-77.
[23] Id.; p. 41.

generated by the ML models used by PG&E and SCE, wind is not a big deal with regard to igniting power line fires.

These numbers are quantified in the table below, based on PG&E's answer an MGRA data request,[24] using the contribution that any wind variable at all has towards explanatory power in the PG&E LM models:

submodel	SUM	SUM wind	Percent	Non-Wind	Pct Wind minus Baseline
capacitor bank	856	53.4	6.24%		4.41%
dpd	194	65.9	33.93%		32.10%
fuse	4547	107.1	2.36%	2.36%	0.53%
primary conductor - wire down	16374	853.9	5.21%		3.39%
primary conductor - line slap	2985	389.3	13.04%		11.22%
primary conductor - other	7798	378.8	4.86%		3.03%
support structure - equipment	12658	460.8	3.64%		1.81%
support structure - electrical	16082	712.9	4.43%		2.61%
Transformer - failure	50153	1644.7	3.28%		1.45%
Transformer - leaking	4155	132.7	3.19%	3.19%	1.37%
Switch	732	0.0	0.00%		-1.83%
voltage regulator	724	56.9	7.85%		6.02%
other_equipment_type	79	0.2	0.26%		-1.57%
secondary_conductor	100	1.6	1.59%		-0.24%
animal_bird	100	1.4	1.44%	1.44%	-0.39%
animal_squirrel	100	1.3	1.34%	1.34%	-0.49%
animal_other	100	7.2	7.22%		5.39%
third_party_vehicle	100	2.1	2.11%	2.11%	0.28%
third_party_balloon	100	3.3	3.30%		1.48%
third_party_other	100	0.5	0.53%	0.53%	-1.30%
vegetation_branch	100	1.8	1.81%		-0.01%
vegetation_trunk	100	3.8	3.82%		1.99%
vegetation_other	100	1.6	1.58%		-0.25%
			Mean Baseline	1.83%	

Table 4 - Contribution of annualized wind-related attributes to the total risk in each of the submodels. A "baseline" null value was determined using attributes known not to be wind-correlated, and these were subtracted. Color coding was

[24] WMP-Discovery2026-2028_DR_MGRA_003-Q006

applied to submodels having non-negligible contributions from annualized wind variables: green (>3%), tan (> 10 %), or red (>20%).[25]

As can be seen, only protection devices have a very clear contribution from wind variables, perhaps because they can only fail under conditions where wind is present, otherwise they will not be necessary or used. The only other submodel where wind variables are very significant is line slap. While line slap is a known problem under catastrophic fire weather, it is also caused by aeolian vibrations and ice formation and resultant "galloping".[26] Because this kind of motion is caused by continuous winds over longer periods, it would be more likely to be capture by the annualized wind variables used by the PG&E ML models.

As I have pointed out in filings with OEIS, and the CPUC, this is statistically and physically implausible given that nearly all catastrophic utility fires in California (with the exceptions of Butte and Dixie) have been wind-driven, and have had wind damage directly relating to their ignition. Previous WMP Comments have clearly shown that outages increase exponentially as a function of wind speed, confirming the earlier results of Mitchell 2013.[27] What is particularly noteworthy is that vegetation ignitions do not seem to have wind as a determinative variable at all. However, these have been responsible for a large number of the most destructive and deadly wildfire ignitions during wind storms (Rice, Cherokee, Adobe, Nuns, LaPorte, Norrbomm, Partrick, Lobo, Pocket, Zogg).[28] This clearly demonstrates that annualized weather data is incapable of identifying transient wind risk.

E3's latest analysis provides further support to the proposition that the utility ML models are potentially biased due to the fact they are not able to identify transient events. E3 consulted a broadly based Technical Advisory Committee (TAC) and noted:

"*Conversations with TAC members suggest that more closely linking probability of ignition and consequence may better-capture extreme wind's impact on wildfire ignition and spread. Extreme wind is a strong determinant of both the probability of ignition and consequences of*

[25] Workpaper WMP26/PGE/WMP-Discovery2026-2028_DR_MGRA_003-Q006Atch01-jwm.xlsx
[26] Pansini, A.J., 1991. Power Transmission and Distribution. The Fairmont Press, Lilburn, GA USA.; pp. 221-223.
[27] 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
[28] PG&E WMP v.1, pp. 35-37.

wildfire spread. Extreme winds are likely to cause equipment failures or vegetation obstructions that lead to arcing between conductors and vegetation, resulting in fire ignition. After the ignition, extreme winds exacerbate the spread of fire at a faster rate through a larger area. Crucially, the wind speed impacts both the probability of ignition and the consequence. PG&E's current modeling considers drivers of ignition and consequence separately. Other California IOUs such as SCE and SDG&E similarly separate their risk and consequence modeling. To capture the effect of extreme wind on both wildfire ignition risk and consequences, some TAC members strongly recommend a new methodology that incorporates a temporal element to capture the linkage between probability of ignition and consequence during extreme wind periods."[29]

It should be noted that PG&E's time aggregation used for its ML models also causes it to lack sensitivity to longer term climate effects such as drought:

"*PG&E evaluated variables related to drought as inputs to the vegetation models released with WDRM v4, which are machine learning (ML) models trained on historical failure & outage events. Specifically, the SPEI (Standard Precipitation Evapotranspiration Index) and CWD (Climatic Water Deficit) were evaluated. The inputs needed to be summarized over multiple years to fit the Maximum Entropy ML algorithm configuration requirements, which is a spatial model. The multi-year aggregation and correlation to other weather variables caused the drought-related variables to have little influence in the model*."[30]

This reinforces the suggestion of E3 and MGRA that PG&E adjust its model to be able to identify risks that are not visible in longer term time aggregations.

5.2.1.1. Winds cause power line fire ignitions

So far, these comments have merely repeated previous observations made by MGRA over the last several years (and in fact going back to 2008). The following analysis of PG&E data is new, and it suggests that wildfires originating from power lines are fundamentally *different* than fires originating from other sources, and that this difference is related to wind. Everyone accepts that wildfires are agnostic as to their origin: Once a fire starts its propagation will be determined only by

[29] E3 Review of PG&E's Wildfire Risk Model Version 4; July 2024. (E3 Review)
[30] WMP-Discovery2026-2028_DR_MGRA_003-Q003.

landscape and weather variables. Therefore, if there are differences in frequency between power line fires and other fires, this is evidence for a difference in the probability of ignition.

The following analysis looks at datasets provided to the Energy Division as part of PG&E's 2024 RAMP proceeding, specifically in file EO-WLDFR-7_CalFire Large+ Fires 2015-2022.xlsx. In this file, PG&E lists all of the "Red Book" fires that it includes in its consequence model.[31] These fires are used as a reference for fire behavior and prediction of losses. Included in the list are fires that are associated with powerlines, some of which are classified as "Electrical Power" by Cal Fire and some additional fires that were associated with electrical power by PG&E ('x_electrical_power_caused' field set to 'Yes').

This file was analyzed to determine the maximum wind gust speed within a specific radius (5 or 10 miles) of the fire ignition point within a one-hour window around the reported ignition time.[32] Maximum wind gust within a radius rather than nearest weather station was used to account for potential wind gust variations over local terrain.[33] The results from the 5 and 10 mile radii were usually comparable, but the 10 mile radius was more likely to contain samples whereas the 5 mile radius frequently had no weather stations, especially prior to the deployment of the PG&E mesonet. Data period analyzed was from 2015 to 2022, with the Mosquito and Sites fire added manually to the list because they were listed as potential power line fires by PG&E.[34] The results were binned by maximum local wind gust speed and compared. The hypothesis that the power line and non-power line fires come from the same statistical distribution was tested with chi-squared and log likelihood (G-test) methods. These results are shown below:

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[31] Wildfire Consequence Model Version 4; (WFC v4) Documentation; March 12, 2025; p. 12. (WFC)
[32] Methodology for weather analysis is found on the Readme tab of the file
EO-WLDFR-7_CalFire_2015-2022-jwm.xlsx
in Github repository Workpapers/WMP26/PGE.
Excel file was read by M-bar weather analysis utilities resident at:
https://github.com/jwmitchell/mbar-weather in the examples/WMP2026 folder.
[33] J.L. Coen, W. Schroeder, S. Conway, L. Tarnay, Computational modeling of extreme wildland fire events: a synthesis of scientific understanding with applications to forecasting, land management, and firefighter safety, Journal of Computational Science 45 (2020), 101152, https://doi.org/10.1016/j.jocs.2020.101152.
[34] PG&E WMP; p. 31.

Max Gust within 10 miles (mph)	PL Fires	Non-PL Fires	Chi2	Chi2 P	G-test	G-test P
0-10	5	50	1.816305	0.177754	2.085318	0.148721
10-20	16	130	2.481884	0.115164	2.724523	0.098818
20-30	16	86	2.02E-05	0.996411	2.02E-05	0.99641
30-40	10	25	4.378962	0.036385	3.689047	0.054771
40-50	5	8	5.087084	0.024105	3.92336	0.04762
>50	5	7	6.111498	0.013431	4.604326	0.031891
Total	57	279				

Table 5 - Cal Fire data used by PG&E for estimating consequences, including power-line related fires (PL), was analyzed to find the highest wind speed within 10 miles of the ignition point. This was binned and counted independently from both PL and non-PL fires. Number of large fires as a function of maximum windspeed shows a statistically different distribution for PL fires versus non-PL fires as measured by a chi-squared and log likelihood (G-test) metrics.

The data suggest that a greater proportion of large fires related to power lines have higher local wind speeds than those that are unrelated to power lines.[35] This relationship is statistically significant in wind gust speed bins above 30 mph ($P < 0.05$). This effect is more clearly evident if the cumulative distributions are plotted:

[35] Note that fires related to lightning ignitions were filtered from the sample because these might reasonably expected to have severe local weather. See methods.

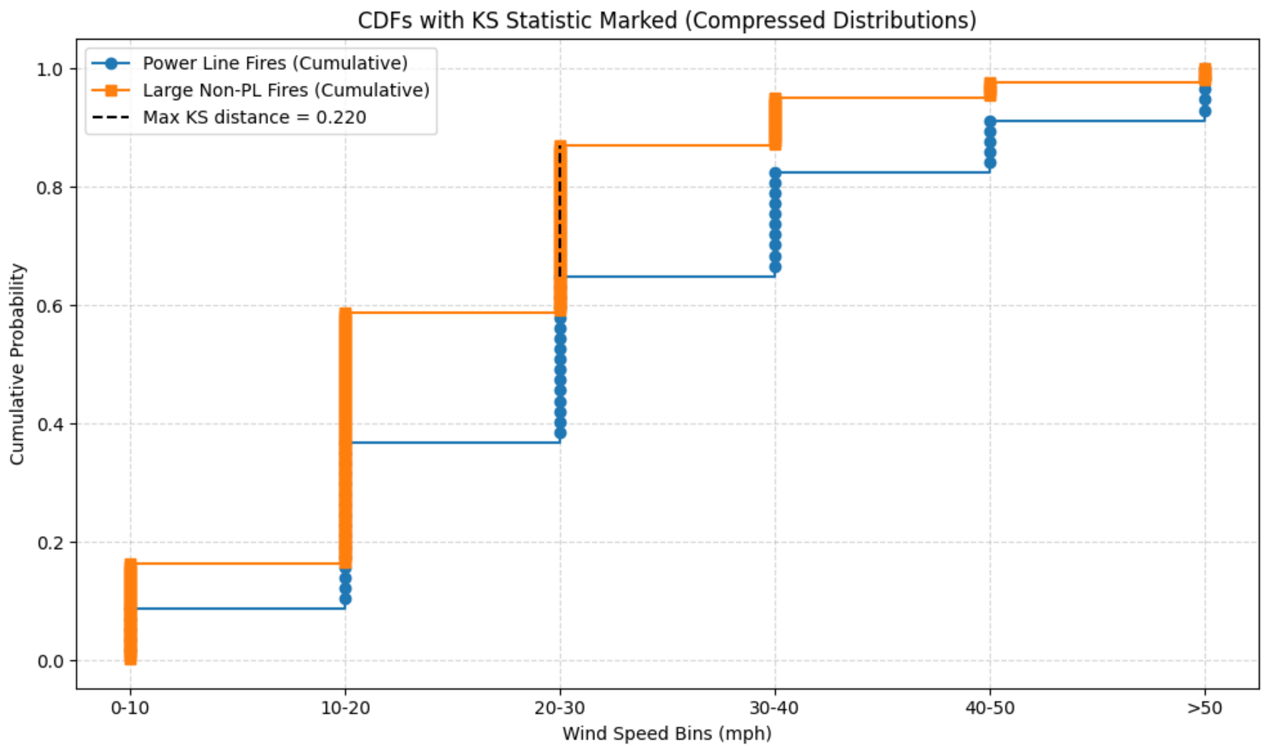

Figure 3 - Cumulative Distribution Function (CDF) as a function of maximum measured wind speed gust within 10 miles of wildfire ignition point. A Kolmogorov-Smirnov test was applied to compare the distributions and the maximum KS distance is shown**.**

This graph shows that the relative fraction of large non-PL fires ignite in areas where local winds are lower than the relative fraction of PL fires that ignite in lower speed areas. Hence power line related fires that become large and damaging are more likely to have ignited under high winds than other fires that become large and damaging. This suggests there is a causal connection between PL fire ignition and wind.

The difference between the two distributions was tested with a Kolmogorov-Smirnov (KS) metric and was shown to be statistically significant.

KS Statistic	KS p-value
0.220158	0.015723

Table 6 - Kolmogorov-Smirnov goodness of fit test comparing the hypothesis that the PL and non-PL wildfire frequencies arise from the same statistical distribution. The conclusion is that they do not, with a statistical significance of P=0.015.

It must be re-emphasized that of the attributes that contribute to PG&E's probability of outage model, wind effects play a minor role. Wind effects might contribute to the probability of ignition given an outage P(i|o),

In this sample power line related fires make up 17% of large fires. However in the highest wind gust speed bins (>40 mph) they make up 40% of large fires. It is hard to imagine an alternative coherent and self-consistent hypothesis explaining how this might be anything other than wind being an ignition driver for large power line fires.

An important thing to note about the sample is the relatively small window for significant power line wildfires to enter the sample: from 2015 to 2019, before PSPS was first applied on a broad scale drastically decreasing the number of outages and power line fires during high winds substantially . Even so, the contribution of PL related fires to the 2015-2022 sample is noticeable and leads to statistical anomalies.

5.2.1.2. Insensitivity of aggregated wind variables

It is difficult to currently assess the sensitivity of current metrics such as outages and ignitions to short-duration peak winds due to PSPS "blinding" of metrics. One remaining metric is the damage recorded during post-PSPS patrols. PG&E provided this data for 2024 in its response to Data Request 1 and 2. As will be shown in Section 7.1, the majority of this damage was associated with high wind gust speeds recorded by nearby weather stations.

PG&E's outage and ignition models use wind variables that are aggregated over long periods, at least a year. The implicit assumption is that "windy" areas – on the average - will be more likely to have outages and ignitions. As shown in Table 4, however, wind does not appear to be a significant predictor of outages and ignitions.

PG&E was asked to provide historical GIS data for its aggregated weather variables.[36] This data consist of point data, each point associated with the aggregated wind data for a given year. For this particular example, the variable 'pd_drymaxw' examines the mean percentage difference

[36] WMP-Discovery2026-2028_DR_MGRA_003-Q006.

between the maximum wind speed and the average wind speed during the dry fire season. The result is shown below. As can be seen, there are some general regional differences in "peakiness" of the average wind speed. For example, the southern Sierras generally have higher peaks above the average value, with the opposite being true in the northern Sierras.

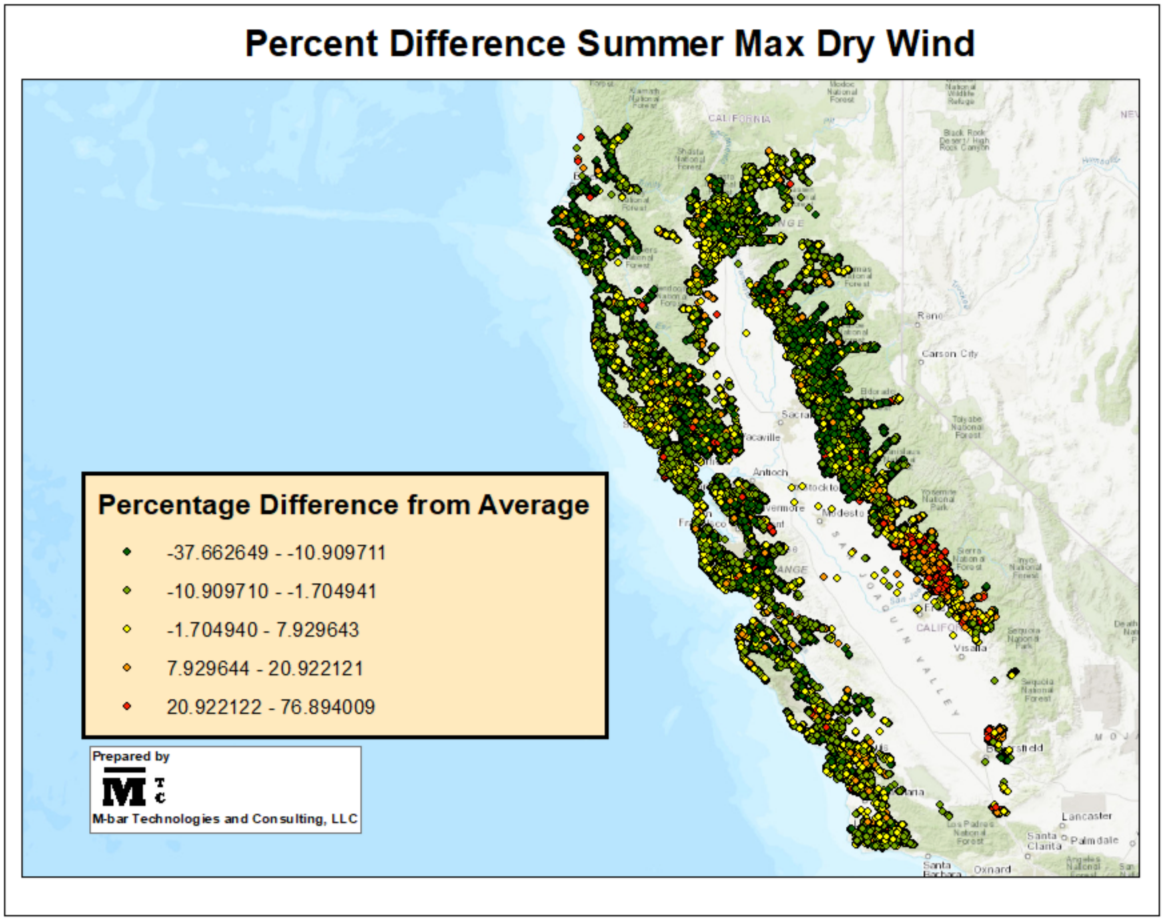

Figure 4 - PG&E calculated variable measuring the fraction by which maximum wind gust exceeds the average. Color coding is from green (lowest difference between maximum and average) and red (highest difference between maximum and average).

PG&E damage data was associated with these wind estimates to determine whether the PG&E variable was predictive in finding areas likely to undergo damage during high wind PSPS events. Points within 0.5 miles of the damage were aggregated into a table. 5015 separate wind estimate points fell within these boundaries, and the statistics associated with these events is shown in the table below.

Count	5015
Max %	38.1
Min %	-34.0
Average %	0.53
Standard Deviation	15.92
Standard Error	0.225

Table 7 - Summary statistics of percentage difference max dry wind variable within 0.5 miles of PSPS damage points.

As can be seen, while the average of 0.5% is slightly greater than zero, it is only slightly more than two sigma away from a null result. That, in addition to the fact that the standard deviation is 30 times larger than the average value renders this variable of little predictive value regarding PSPS damage. In other words, if you were to use the PG&E variable 'pd_drymaxw' which measures the deviation of the peak gust from the average gust during wildfire season as a predictor of PSPS damage, it would provide a correct result 1 in 60 times, otherwise it would produce a "coin flip" random result. Hourly wind values, on the other hand, were in most cases high within the 72 hours before the damage was reported.[37]

5.2.1.3. Implications of missing wind impacts

If utility wind models are not able to correctly identify short-duration spatial wind dependencies, then utility risks that are particularly dependent on wind, such as equipment damage and vegetation contact with conductors will be underestimated in certain regions. Because of "PSPS bias", ignitions and outages will not be reported in windy regions during the time of highest wildfire risk. Because such regions will accumulate fewer risk events, their risk rating may be lowered over the longer term, potentially meaning that they may not be chosen for de-energization during a future fire weather period even though the risk is still present.

Recommendations:

- Energy Safety should request that PG&E investigate mechanisms that allow data that changes over time to be incorporated into its ML models, or alternatively investigate non-ML models that identify risks with a temporal dimension, either short term (such

[37] Section 7.1.

as wind) or long term (such as drought and climate), or that other adjustments such as weighting for wind speed be put into the calculation.

5.2.2. Consequence of Wildfire Risk Event

PG&E's supplemental document Wildfire Consequence Model Version 4 (WFC) provides detail about the significant changes that led it to abandon use of the Technosylva fire spread model alone to predict consequence (such as was done with SCE's MARS model and its switch to IWMS) and use Technosylva fire spread predictions as an input along with historical satellite (VIIRS) data. PG&E has also expanded its simulations from 8 hours to 24 hours, a recommendation that MGRA has been suggesting for some time.

PG&E also has in its most recent model included a "Dry Wind Condition (DWC)" status for its consequence model to better differentiate conditions associated with extreme losses.[38] Dry Wind Conditions, destructive potential, and HFRA are combined to determine a "Base Consequence" MAVf score.

PG&E's base consequence score is then combined with suppression and egress models to provide a final consequence score:

[38] WFC; p. 14.

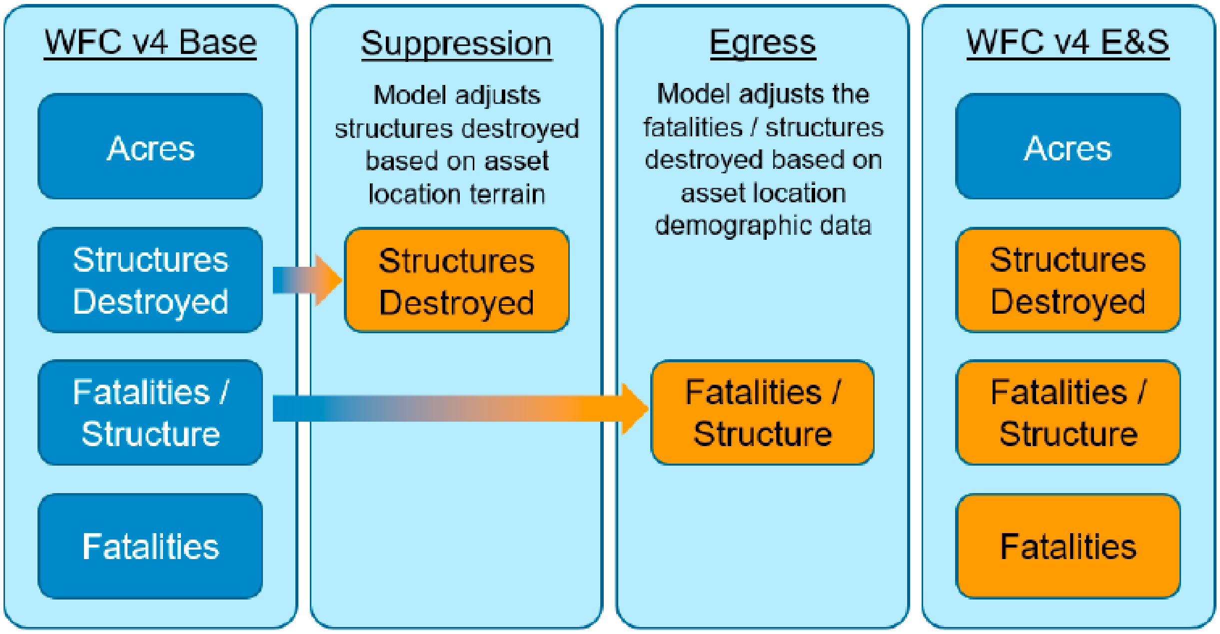

Figure 4 - Wildfire Consequence v4 Model Architecture

Figure 5 - PG&E wildfire consequence model architecture

5.2.2.1. Simulation increase from 8 to 24 hours

Technosylva fire spread modeling is used as an input to PG&E's "Predictive Destructive" condition analysis. In its most recent analysis, PG&E expanded the simulated burn time from 8 hours to 24 hours. The advantages of expanding the burn time are evident from the comparison of historic fires to the Technosylva simulations:

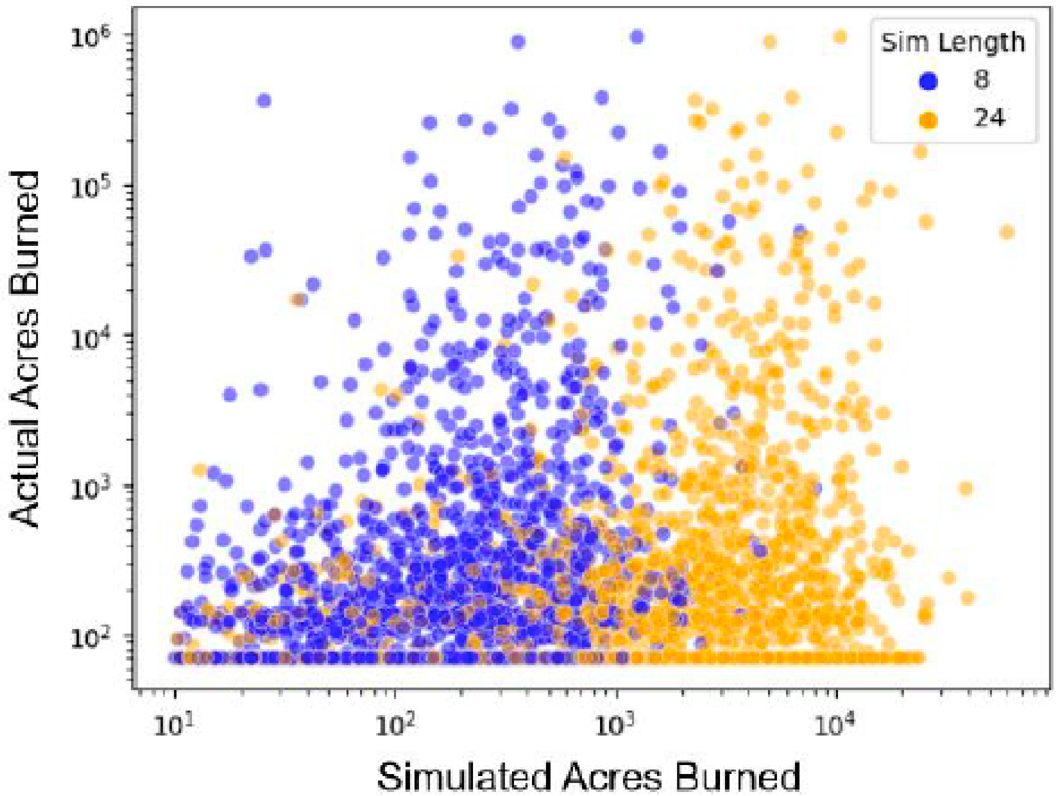

Figure 6 - 8-hr & 24-hr Fire Simulations (log-log scale)

Figure 6 – This figure "presents a log-log plot of the historical fire simulation pairs with 8-hr results in blue and 24-hr results in orange". Note the cutoff at around 1,000 acres for 8 hour simulations, and how 24 hour simulations allow more realistic catastrophic fire sizes to be obtained.[39]

Note the cutoff at around 1,000 acres for 8 hour simulations. This strongly vindicates MGRA's historical claim that an 8 hour simulation was not sufficient to fully represent catastrophic fires which make up the majority of power line fire losses.

Also noteworthy is the low correlation between Technosylva simulations and actual fire sizes for individual wildfires. PG&E notes: "The initial Pearson R correlation results for the 8-hr and 24-hr simulations were very low, only 0.0637 and 0.0795, respectively. Applying a logarithmic transform to the data improved the correlation results for the 8-hr and 24-hr simulations to 0.198 and 0.208, respectively. PG&E plots a "binned logarithmic transform" that aggregates the varying consequence values and shows that averaged over many fires the predicted and measured wildfire

[39] WFC; p. 13.

sizes do correlate, particularly if the 24 hour burn time is used. 8 hour simulations significantly underpredict actual burn size.

This "binned logarithmic transform" is plotted in PG&E's Figure 7:

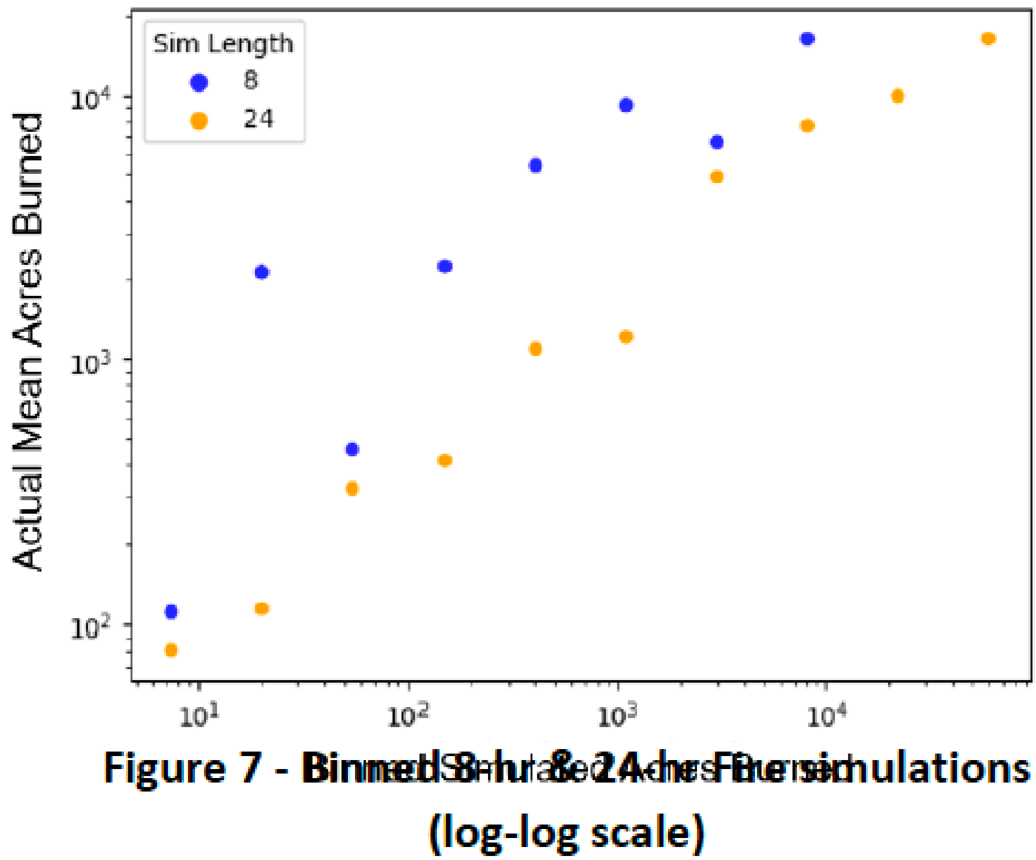

Figure 7 - "Binned logarithmic transform" data for aggregations of fires. Technosylva simulation size is x axis, actual acres burned on the y. Garbling is in original.[40]

PG&E states that: "*In the end, 24-hr wildfire simulations were chosen to develop the WFC v4 model due to the smoother relationship between simulated and actual burn sizes. However, the overall impact to relative consequence values was minimal*." PG&E does not directly use the per-fire calculated Technosylva fire size but instead calculates a "Predicted Destructive (PD)" score, that "*combines results from PG&E Meteorology's Fire Potential Index R-score (FPI-R) and Technosylva's fire simulation results for Flame Length and Rate of Spread indices.*"[41]

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[40] WFC; p. 13.
[41] WFC; p. 15

5.2.2.2. Power line fire consequences compared to other large fires

In addition to examining the wind dependence of power line fires and non-power line fires and showing these two different populations of wildfire have statistically different wind dependence, the MGRA analysis[42] compares consequences of power line fires with those of other CAL FIRE Large fires used by PG&E for its consequence reference data. This data is shown below, both as a function of local wind speeds and as aggregate for powerline fires (PL) and non-powerline fires (NPL):

Max Gust within 10 miles (mph)	PL Fires	NPL Fires	PL Acres per Fire	NPL Acres per Fire	PL Structures per Fire	NPL Structures per Fire	PL Acre / Structure	NPL Acre / Structure
0-10	5	50	947	23236	43	14	22.2	1669.3
10-20	16	130	12322	10930	72	47	171.0	232.1
20-30	16	86	75373	13512	263	14	286.5	994.9
30-40	10	25	17149	3966	596	2	28.8	2609.0
40-50	5	8	44742	55358	4032	228	11.1	242.4
>50	5	7	74183	4581	289	2	257.0	2466.8
Total	57	279	38,140	14,122	581	34	65.6	411.1

Table 8 - Power line fires and Cal Fire Large non power line fires compared for sizes and number of structures destroyed, as a function of maximum local wind speed.

One caveat when displaying loss statistics is that both acreage burned and number of structures loss display power law distributions, which means that large variation within bins is expected. Therefore normal statistical tools (standard deviation, standard error, or goodness of fit) should not be applied. However general trends may be noted.

First it appears that on the average, power line fires are larger than other fires classified as "large". The difference does not seem to have an obvious dependence on local wind speed.

A much more dramatic effect is the much higher numbers of structures lost in power line fires than in fires from other causes – more than a factor of 10. One might hypothesize that the

[42] EO-WLDFR-7_CalFire_2015-2022-jwm-v3; Tab Stat_6 Fixed. Data was assembled from Pivot table using PL and non-PL filters.

reason for this would be that in general power line equipment is closer to population centers, so that power line fires are more likely to impact settled WUI areas than are fires further out in the wilderness. This is of particular concern if a utility were to draw its structure loss and loss of life models from historical Cal Fire data, since this will underrepresent powerline wildfire structure losses.

It is not clear from PG&E's showing whether losses from "remote" fires are used to determine PG&E's structure loss estimate or acreage loss estimates. If so, these effects should be corrected. Fire spread simulations using PG&E infrastructure as ignition point would not be expected to have this bias and could be used to correct it if it indeed exists, as would specific structure loss models using wildfire spread simulations.

5.2.2.3. Suppression Model

OEIS has required that utilities attempt to account for suppression in their consequence modeling. Suppression is a difficult topic, and was discussed in some depth in the Wildfire Risk Modeling Group.[43] The reason suppression is so hard to account for is that it means a number of different things:

- Initial attack – Many fires are stopped before they reach the threshold of destructiveness (<100 acres). Success of initial attack can be a function of many things. Mitchell 2009 demonstrated that wind speed was one aspect affecting initial attack success,[44] but other factors affect the rapidity of fire growth as well, and these are reflected in variables such as Fire Potential Index.
- Perimeter control – After a wildfire is established, firefighting practice is to establish lines of control and suppression around the perimeter of the wildfire. If successful,

[43] For example March 20, 2024 and May 10, 2024 meetings.
[44] Mitchell, J.W., 2009. Power lines and catastrophic wildland fire in southern California, in: Proceedings of the 11th International Conference on Fire and Materials. Interscience Communications, pp. 225–238.

this changes the shape and trajectory of the wildfire and reduces overall area burned.[45,46]

- Structure protection – Firefighters will protect structures that are threatened by wildfire if they have access to them, the structure is defendable, and if they can do so safely. During catastrophic wildfires it is likely that many or most structures that are threatened will have no direct firefighter protection due to lack of resources or due to firefighter safety concerns.

Modeling these factors is extremely challenging, particularly because the details of every wildfire will be different and influenced by contingent circumstances, for instance if firefighting resources are stretched due to a fire siege, specific decisions about where to deploy firefighting resources, neighborhood topologies and ease of protecting structures, etc.

Nevertheless, PG&E decided to give a fire suppression metric a go. They decided to go only with the end product "structures destroyed" as their end metric, and then use this method to make an adjustment to the overall consequence. They explain their thought thusly:

"*The crucial development activity for creating a wildfire suppression impact model was the determination to use buildings survival fraction from historical fires as a proxy value for suppression effectiveness.*

The primary objective for fighting a wildfire is to protect life and property, with an emphasis on saving lives. Unfortunately, it is difficult to obtain precise data on the successful protection of lives for a given wildfire. However, public egress impact model development, discussed in Section 0, has established that there is a consistent relationship between lives lost and the number of buildings destroyed by a wildfire. Therefore, success at protecting buildings, in terms of the fraction of buildings undamaged after a wildfire, will also imply success at protecting lives."[47]

PG&E assumed the following model for determining structure loss:

"*After evaluation, a binomial regression algorithm was selected to model historical wildfire*

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[45] Reimer, J., Thompson, D.K., Povak, N., 2019. Measuring Initial Attack Suppression Effectiveness through Burn Probability. Fire 2, 60. https://doi.org/10.3390/fire2040060

[46] US Forest Service, 2020. Aerial Firefighting Use and Effectiveness (AFUE) [WWW Document]. US Forest Service. URL https://www.fs.usda.gov/managing-land/fire/aviation/afue (accessed 5.3.25). PDF: https://www.fs.usda.gov/sites/default/files/2020-08/08242020_afue_final_report.pdf

[47] WFC; p. 19.

outcomes. The model took the form of:

$$Log\ Odds\ of\ (Fractional\ Structure\ Loss) \cong a * TDI + b * WS + c * LFM + intercept$$”

Unfortunately this approach is scientifically erroneous, and it renders the current PG&E methodology for incorporating “suppression” unusable and in fact dangerous.

The “TDI” variable, which is provided by Technosylva, represents a “Terrain Difficulty Index”. This is a combinatory variable that is proprietary and is therefore not transparent, i.e. comparisons of the effectiveness of this variable do not appear to be publicly available.[48] It is not clear what TDI actually measures, and Technosylva is not disclosing this information. PG&E cites to no authority or publication in which the TDI variable is discussed or compared to other potential metrics. In order for such an estimate to be used in risk calculations, which impact both public safety and ratepayer costs, PG&E and Technosylva should demonstrate either through refereed publication or through audit by OEIS itself or a third party such as E3 that the methodology is useful and valid.

Nevertheless, there is no doubt that terrain difficulty will be related to wildfire suppression – particularly the problem of initial attach and later perimeter control. The WS refers to wind gust speed, and the LFM variable refers to live fuel moisture. There is little doubt that all of these variables will have some effect on the ability of firefighters to conduct initial attack, manage fire perimeters, and access homes. However none of these features describe homes, neighborhoods, building characteristics, etc., which have been inconvertibly shown to affect home loss rates. PG&E justify the basis of its model as follows:

“*However, given the sensitivity of outcomes to weather and fire behavior extremes, where extreme fire behavior can overwhelm even the best firefighting resources and landscape and building measures, the modeling team did not feel it would be appropriate to report lower consequence, and therefore discourage mitigation, in locations with expected destructive fire behavior but potentially favorable structure spacing or characteristics.*

As a practical matter, the vast majority of the building stock is untouched by fire building codes and we expect all Wildland Urban Interface (WUI) communities in CA (and beyond) to have structures with characteristics favorable to ignition.”[49]

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[48] WMP-Discovery2026-2028_DR_MGRA_006-Q003.

[49] WMP-Discovery2026-2028_DR_MGRA_006-Q005Supp01.

There is an extensive literature devoted to the science of home loss in wildfire and the role of various factors in that loss. For instance, housing arrangement and location,[50] home structural characteristics (materials and features),[51,52] defensible space and the vegetation around the structure,[53] age of neighborhoods and application of fire codes, among many others. Firefighting suppression of structural fires is problematic, as one review points out: "*In large WUI fires, the fire department cannot be relied upon to provide full extinguishment because many buildings burn down due to firebrand ignition tens of hours after the main fire line has passed. Firebrands and other smoldering debris slowly transition to flaming from innocuous sources that are difficult to identify, while the main fire front threatens new homes and communities miles away. Firebrands can also be transported several kilometers ahead of the front depending on atmospheric conditions, resulting in a large area affected by either firebrands, spot fires, or the main fireline. No firefighting crew has sufficient resources to cover such a large area*."[54] This is well known to MGRA members and residents personally – during the 2003 and 2007 wildfire storms our area was without any significant firefighter support. This is because our area is *dangerous* – it is single egress and supports extreme fire behavior. At one time local firefighters referred to the canopy road as the "Tunnel of Death". Firefighters properly avoid such areas under extreme fire conditions. Homeowners know this (or learn it the hard way) and make their own preparations.

The problem with the PG&E suppression model statistically is that it does not take any of these variables into account, variables that have been shown in many statistical studies to be correlated with home loss, but instead constrains its model to fit three variables related only to terrain and potential wildfire conditions (wind and fuel moisture). It presented the following erroneous plots in its WFC:

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[50] Syphard, A.D., Keeley, J.E., Massada, A.B., Brennan, T.J., Radeloff, V.C., 2012. Housing Arrangement and Location Determine the Likelihood of Housing Loss Due to Wildfire. PLOS ONE 7, e33954. https://doi.org/10.1371/journal.pone.0033954.
[51] 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
[52] Mitchell, J.W., Patashnik, O., 2006. Firebrand protection as the key design element for structure survival during catastrophic wildland fires, in: Fire & Materials '07. Presented at the Fire & Materials '07, San Francisco, pp. 940–943.
[53] Syphard, A.D., Brennan, T.J., Keeley, J.E., 2014. The role of defensible space for residential structure protection during wildfires. International Journal of Wildland Fire 23, 1165–1175.
[54] Caton, S.E., Hakes, R.S., Gorham, D.J., Zhou, A., Gollner, M.J., 2017. Review of pathways for building fire spread in the wildland urban interface part I: exposure conditions. Fire technology 53, 429–473.

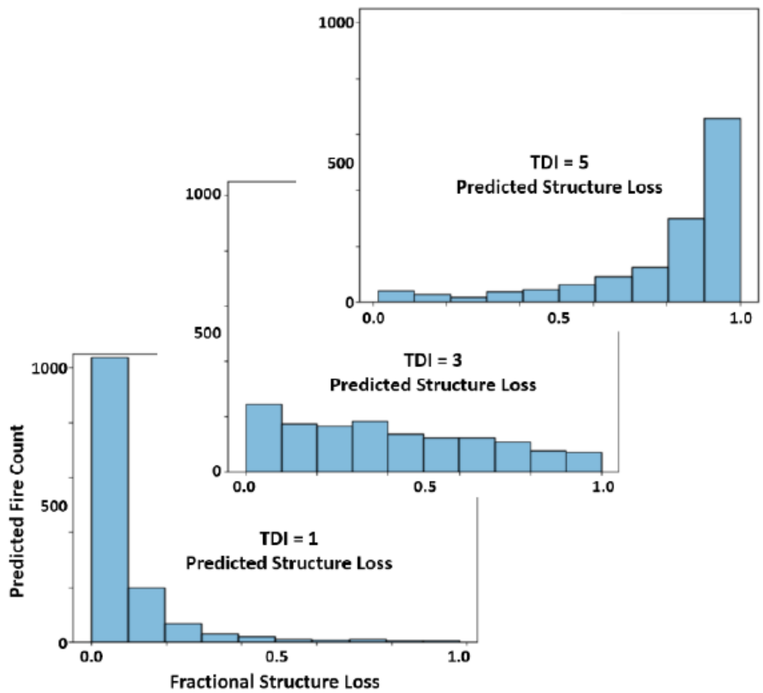

Figure 8 - PG&E's suppression model index presented in its WFC. PG&E has acknowledged this is erroneous, with its updated values shown in Table 9.

PG&E found that the data shown in its WCM Figure 10 was erroneous and based on an incomplete version of the v4 model. PG&E provided corrected data in response to an MGRA data request:

loss fraction	**historical**	**tdi_1**	**tdi_3**	**tdi_5**
0.0-0. 1	3494	5264	439	0
0.1-0. 2	888	33	3332	6
0.2-0. 3	440	2	1327	111
0.3-0. 4	245	0	160	251
0.4-0. 5	149	0	35	931
0.5-0. 6	62	0	4	2165
0.6-0. 7	18	0	2	1485
0.7-0. 8	3	0	0	300
0.8-0.9	0	0	0	47
0.9-1.0	0	0	0	3

Table 9 - Corrected PG&E estimation of the TDI value versus fractional home loss.[55]

The distributions shown in the table are very different than those shown in Figure 10. Most significantly, note that for TDI=5, there is not a peak near 100% home loss but rather than the

[55] WMP-Discovery2026-2028_DR_MGRA_006-Q005Supp01.

50-70% range, which is consistent with academic studies of WUI fire loss rates in remote areas. It has been well observed that in wildland interface communities prior to the application of fire codes the home losses in rural communities within a fire permitter without significant firefighter intervention were 50-70%, which is roughly consistent with Table 9.[56,57]

However these loss rates can vary widely depending on the neighborhood type and configuration. For example, the recent Eaton fire transitioned from a wildland-interface to a wildland-urban conflagration with house-to-house ignition. There was no issue with terrain difficulty in the Altadena and Pasadena neighborhoods. This would imply a classification of TDI~1, and that the probability of major loss was negligible. However, in fact losses ranged close to 100% in many portions of the city. The inverse example is the development of Rancho Cielo in the community of Rancho Santa Fe in San Diego. While in an inaccessible location (TDI unknown, but in a hilly area with complete shrubland exposure, limited egress, and winding roads) this development of over 200 homes directly built into the wildland urban interface with exposure to nearly all homes, it survived a direct hit from the 2007 Witch fire with ***zero*** home losses, due to stringent construction and vegetation management standards.[58]

Another problem with PG&E's model is that for low TDI, loss fraction is proposed to be small *regardless of the severity of wildfire-related conditions*. In other words, very little variation in the fit is explained by the fuel and wind variables, and TDI is effectively the only predictive variable in their fit. PG&E needs to present an analysis showing the goodness of the model fit (such as R-squared) as well as the degree of variation explained by each variable (such as partial R-squared).

PG&E's oversimplification of the suppression problem has consequences, literally, as they show in their buy-down curves:[59]

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[56] Chen, K., McAneney, J., 2004. Quantifying bushfire penetration into urban areas in Australia. Geophysical Research Letters 31, 2004GL020244. https://doi.org/10.1029/2004GL020244
[57] Mitchell, J.W., 2006. Wind-enabled ember dousing. Fire Safety Journal 41, 444–458. https://doi.org/10.1016/j.firesaf.2006.04.002
[58] Mega Fires: The Case for Mitigation, 2008. IBHS; MEGA FIRES: The Case for Mitigation The Witch Creek Wildfire, October 21 – 31, 2007. https://ibhs.org/wp-content/uploads/member_docs/Mega-Fires-The-Case-for-Mitigation_IBHS.pdf
[59] WFC; p. 32.

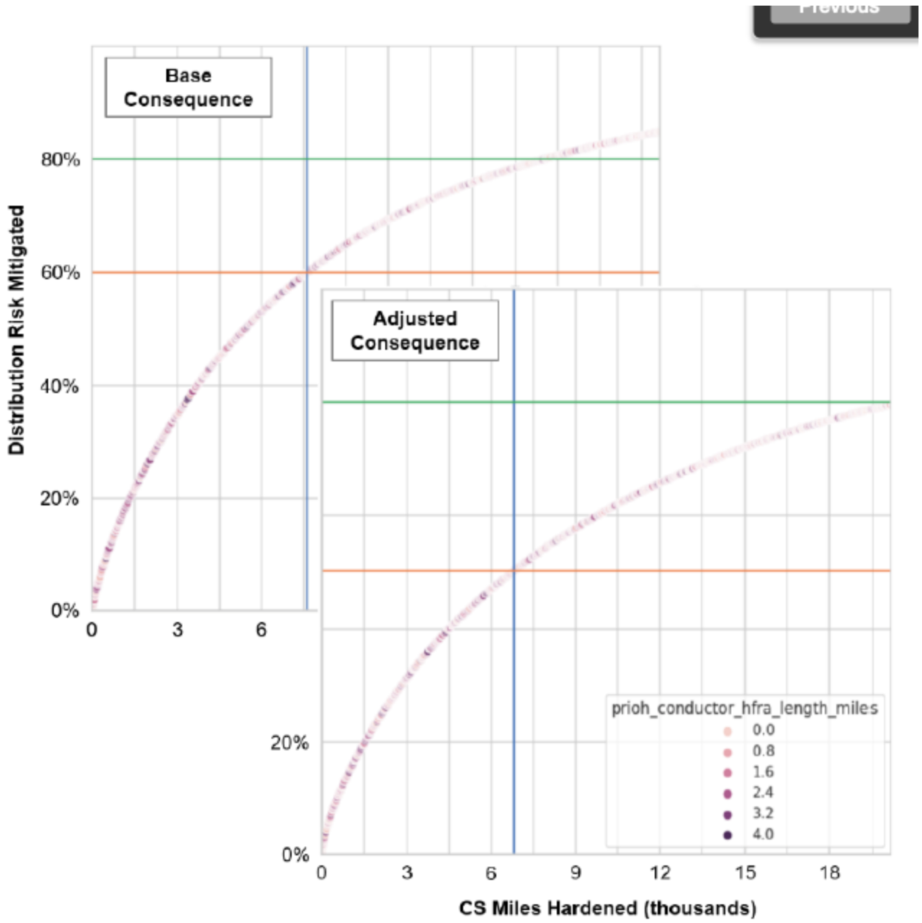

Figure 20 - System Hardening Risk Buydown

Figure 9 - PG&E risk buy down curve taking into account the weighting that would be applied due to its suppression model and egress model. Suppression model is expected to dominate the curve, since it greatly expands risk into remote areas.[60]

PG&E explains that: "*The significance of the flattened curve is that it will take more miles of mitigated risk to achieve reduction targets. The base consequence curve estimates that it will take about 7,500 miles of work to mitigate 60% of wildfire risk, whereas the adjusted consequence curve estimates that it will require 10,000 miles of work to mitigate the same amount of risk...*"[61]

So this leaves PG&E, OEIS, and the CPUC some combination of two choices:

- Maintain the same risk tolerance and mitigate an additional 2,500 miles of conductor, costing potentially $7.5 B if this is done through undergrounding, or

[60] Id.
[61] Id.

- Accept a higher level of risk and shift mitigation efforts out to remote areas with high TDIs and sparser populations where home losses are expected to be higher according to their model, and away from more populated areas with more potential for ignition near homes but easier firefighter access.

This would be a Hobbesian bargain if the PG&E suppression model were reasonable. But it isn't, which leads to the third option:

- Require PG&E to revise its suppression model.

The main problem with PG&E tries to lump too many pieces into "suppression" and therefore conflates its results. The suppression model can be most easily addressed (and it is never "easy") by dividing it into three component parts:[62]

Initial Attack:

Study which variables determine the probability that a fire can be kept under a threshold (30 acres-100 acres), and use these for weighting not of the consequence but of the ***ignition probability***.

Under this scheme

$P(wf) = P(o)P(i|o)P(wf|i)$

Where wf = "Wildfire", i.e. "significant wildfire", and

P(wf|i) is the probability of a significant wildfire given a wildfire ignition, i.e. the probability that a fire ignites and initial attack fails.

MGRA plans to present an analysis of one example using ignition data and FPI in the PG&E service area, but is still attempting to get the proper data. If this is not possible prior to comment deadline this analysis will be presented in the SCE or in the SDG&E WMP comments, along with FPI-equivalent variables for the local service areas if possible. A simpler example of a similar analysis that determined a relationship between initial attack success rate and wind speed was Mitchell 2009.

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[62] MGRA's representative suggested the approach of addressing initial attack as a separate suppression phase and linking it to ignition probability rather than consequence during the 5/10/23 Risk Modeling Working Group meeting.

A number of variables may influence initial attack success rate, not only FPI and wind speed, but others that may be captured in the Terrain Difficulty Index. Ideally, a multivariate analysis, either regression or machine learning-based, should be performed to allow prediction of initial attack success.

This is suggested as a first step because it is relatively simple and sufficient data already exists to perform the analysis – ignition data from Cal Fire, FPI data from utilities, and TDI from Technosylva (or equivalent variables). It would provide an immediate benefit by providing information that can be used to optimize EPSS and PSPS thresholds, thereby improving reliability and reducing wildfire risks. Technosylva has also communicated to PG&E that it is planning to publish data supporting the premise that fire behavior conditions affect the success of initial attack.[63]

Perimeter Control:

Once the fire has evaded initial attack it will grow. This growth can be modelled with fire spread software, and it can also be monitored by satellite. The open question is how much influence firefighting has on the perimeter of the fire and how it affects any deviations from its expected growth. When the real and modelled perimeters differ, is it due to the model limitations or due to human intervention? This is a difficult problem and further research needs to be conducted. OEIS should support further utility investigation into this area, but any attempt to include it in parametric estimations of wildfire consequences for risk estimation purposes need to be fully analyzed and vetted by the regulators, stakeholders, and third party analysts. It may be that TDI or other similar variables may be predictive in this area but that should be demonstrated.

WUI Home Loss and Resilience:

As has been discussed previously, there is considerable documentation and scientific literature on the vulnerability of neighborhoods and homes, and this information is potentially useful for determining wildfire consequences. How to parameterize this into usable information is an unsolved problem, as PG&E notes in its data request response. The insurance industry may be of

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[63] WMP-Discovery2026-2028_DR_MGRA_006-Q003.

help in this area, because they have their own means of weighting home risk in order to determine insurability and required premiums.

PG&E's concerns about "favoring" some neighborhoods or towns because of home characteristics, such as age, is probably not an ethical problem. The social equity impact of any such favoritism is likely positive rather than negative: in general rich people can and do own more fire-resilient homes than poor people, who may live closer together, in older housing, and not be able to easily afford retrofitting measures. Hence, less affluent neighborhoods would be likely to be rated as higher risk and receive additional weighting in allocation of mitigation resources. On the other side, homes that defend themselves and are unlikely to burn present fewer potential consequences. This "auto-suppression" effect should not be ignored.

Firefighter access is also an issue, and maybe TDI describes this in urban interface areas as well as out in the wildlands, but this should be demonstrated quantitatively before accepting any TDI-based adjustments to consequence to adjust for home loss.

Recommendations:

- The TDI model should be explained prior to use and its efficacy and accuracy verified by academic reference and external audit, either by OEIS or a third party such as E3.
- PG&E's suppression model should not be accepted in its present form because it conflates important variables and ignores the relationship between neighborhood and density and home type and age and wildfire risk, and potentially leads to either higher cost or the unjustified shift of risk from remote rural to more populated WUI areas.
- PG&E should be required to provide additional statistical information about its regression models (suppression and egress), which show 1) how much of the observed variation is explained by the model (such as R-squared or adjusted R-squared), 2) residual plots, and 3) an analysis of how much of the variation is explained by each variable (such as partial R-squared).
- Any risk estimates that have been performed using PG&E's suppression model should be repeated without that model.
- Energy Safety should continue to support the development of a suppression model.

- The first step in the development of a suppression model is the inclusion of an initial attack success probability in the probability component of risk.
- Further work should be conducted to study the relationship of TDI or other variables to the growth of fires deviating from predicted models before incorporating these variables as adjustments to consequence.
- Additional analysis should be performed on the weighting of community and neighborhood characteristics, possibly including firefighter availability and access, before assigning consequence values.

5.2.2.4. Egress

PG&E also presents an "egress model" in its Wildfire Consequence Model v4. This is in fact not an "egress" model at all, but an observation that fatalities in wildfire catastrophes tend to be skewed towards older, vulnerable, and AFN populations. PG&E's observation is valuable and should be given weight. But it isn't actually "egress".

PG&E explained its decision:

"*The feasibility of capturing public egress complexities in a model is limited by the usually sparse and often complete lack of availability of data relating each of the factors to actual wildfire outcomes. After considerable research, the Public Egress Impact model was developed to predict the ratio of the number of fatalities that will occur per number of buildings burned as a proxy for egress effectiveness…*

The historical wildfire egress outcome general model structure that was explored for developing the wildfire egress impact model took the form of: $Log\ Odds\ of\ (Fatality\ Fraction) \cong f(Road\ Miles\ per\ Capita, Mobility)$*…*

With only 170 wildfires available for the training data set, only a limited number of variables could be used for any given model evaluation to prevent regression model overfit. Covariate selection was strongly influenced by exploratory analysis of historical fires such as Tubbs, Nunns, and Camp…."

"*Potential road congestion, which is often suggested as a covariate by subject matter experts such as firefighters and wildfire analysts, was also rejected as a variable mostly due to lack usable information pertinent to modeling. A road availability proxy value available from Technosylva was tested but resulted in unstable regressions with poor covariate significance. While* *there may be a relationship between road congestion and wildfire fatalities, a means to successfully model the relationship eluded the development for this version of Egress impact modeling*."[64]

PG&E's attempt to find a solid scientific and statistical basis for an egress model is commendable, and as it states there is very little solid data available that allows a model to be developed. However PG&E's conclusion based on its analysis of the Camp fire needs to be questioned:

"*86% of the Camp fire victims were found in buildings and the overwhelming majority in people in vehicles, 99.98%, reached safety. Roadway egress obstructions did not substantially contribute to fatalities during the largest fire evacuation in California history.*"[65]

The fact that only 9 victims were found in or near their car does not mean that egress was not an issue. PG&E notes that severe gridlock was an issue and that there were 23 burnover events. This misses the deeper question of why 73 victims remained in their homes and why 5 victims fled on foot. If any of these people, in their last half hour, had been offered a safe, speedy evacuation in an emergency vehicle or helicopter, would they have chosen it? Evacuation of Paradise and the surrounding towns entailed driving into or through a major wildfire, and it may not have been clear to residents what the best survival choice was. For those that have not seen it, the Frontline documentary "Fire in Paradise" provides firsthand footage of the experience.[66] Even if as PG&E states many victims had mobility issues, these people would have been evacuated had sufficient time and resources been available. Like wildfire smoke, egress is an issue that is hard to quantify but has serious and undeniable impacts. Further effort in quantification and prevention is required, even if these turn out to be relative estimates, rankings, or highly uncertain.

PG&E instead pivots to the observation that 67 of the 85 victims were age 64 or above.[67] When asked to provide the equivalent age distribution of the evacuation PG&E provided the following 2010 Census for Paradise:

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[64] WCM; pp. 23-25.
[65] Id.
[66] Fire in Paradise; FRONTLINE; July 6, 2021.
https://www.pbs.org/wgbh/frontline/documentary/fire-in-paradise/
https://m.youtube.com/watch%3Fv%3DF3OX1PR2SCM
[67] WCM; p. 24.

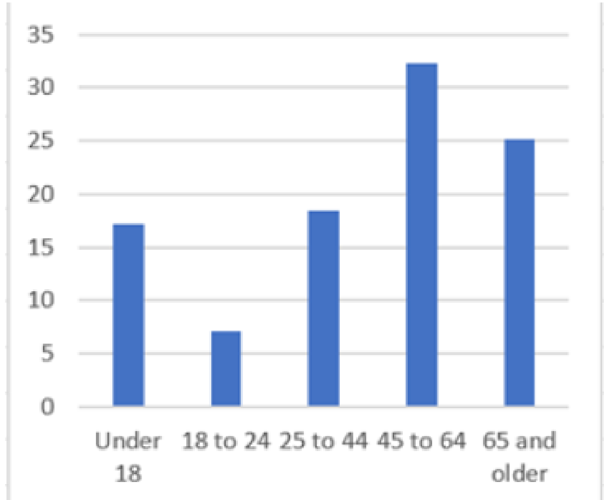

Figure 10 – PG&E in response to WMP-Discovery2026-2028_DR_MGRA_006-Q009 stated "we did consult the 2010 census results for Paradise: The age distribution was 4,501 people (17.2%) under the age of 18, 1,858 people (7.1%) aged 18 to 24, 4,822 people (18.4%) aged 25 to 44, 8,466 people (32.3%) aged 45 to 64, and 6,571 people (25.1%) who were 65 years of age or older. The median age was 50.2 years. The median age for the victims of the Camp fire is 72 years."

The median age for fire victims was 20 years older than the median age of the population. As PG&E elsewhere noted, many victims had mobility issues.

This trend is by no means restricted to the Camp fire. The Sonoma fires of 2017 shared a similar trend, with an average age of victims in the late 70s.[68]

PG&E has made a key observation, and its proposal to incorporate AFN and age considerations in its consequence model has substantial merit. While this cannot be necessarily lumped under "egress" it is predictive in its own right and should be incorporated in consequence calculations and thereby area prioritizations for mitigation. As far as overall impacts to enterprise risk, this should be a "neutral" adjustment. Unfortunately, the fatality statistics used to calculate risk already incorporate an excess of elderly and AFN population. However, in the determination of local risk, areas with higher relative elderly AFN populations may be seen as having a greater safety risk than places with lower elderly and AFN populations, and mitigations and prioritization should be shifted appropriately.

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[68] Tchekmediyian, A., Bermudez, E., October 17, 2017. California firestorm takes deadly toll on elderly; average age of victims identified so far is 79. Los Angeles Times. https://www.latimes.com/local/lanow/la-me-ln-norcal-fires-elderly-20171012-story.html

Finally PG&E's statistical model is a regression model:

$$Fractional\ Fatalities \cong a * AFN + b * WS + intercept$$

Once again, it lacks the appropriate safeguards to show how much of the variation is explained by the variables PG&E has chosen. PG&E needs to supply statistics to show how much of the variation is explained by the model, residual plots, and how much variation is explained by each variable.

Recommendation:

- PG&E should be required to continue work on developing an egress metric to identify communities at risk.
- PG&E's AFN metric should be operationalized and used to identify communities at risk and reweight segment consequences accordingly.
- PG&E should be required to provide additional statistical information about its regression models (suppression and egress), which show 1) how much of the observed variation is explained by the model (such as R-squared or adjusted R-squared), 2) residual plots, and 3) an analysis of how much of the variation is explained by each variable (such as partial R-squared).

5.2.2.5. Wildfire smoke health effects

Historically SDG&E was the only utility that attempted to do a correction for smoke effects and their impact on public health (incorrectly), but is no longer doing so. Discussions in the Wildfire Risk Working Group did not help, and while all stakeholders acknowledge the importance of wildfire smoke health effects – it likely is the largest cause of health impacts and premature deaths from wildfire – the technical problem is difficult enough that there is widespread desire to defer this issue and to slough it off onto another agency if possible.[69] Accordingly, none of the 2025 IOU WMP updates refers to wildfire smoke at all. MGRA has provided substantial evidence that wildfire smoke effects are likely the largest harm done by utility wildfires, larger even that direct casualties.[70] OEIS through the RMWG has de-emphasized the importance of this issue because it is

[69] WMPs-2023-2025; MGRA WMP Comments; p. 125.
[70] MUSSEY GRADE ROAD ALLIANCE COMMENTS ON 2022 WILDFIRE MITIGATION PLANS OF PG&E, SCE, AND SDG&E; April 11, 2022; pp. 47-50. (MGRA 2022 WMP Comments)

hard to solve correctly and requires external resourcing. E3, however, in its review of PG&E's risk model agrees with the importance of wildfire smoke modeling and urges that some form of it be incorporated:

"*E3 recommends that PG&E, in collaboration with the State and other IOUs, consider a simple, standardized statewide approach to model the consequences of smoke from utility-caused wildfires. Because smoke is a complex, computationally expensive consequence to model, standardizing a simple statewide modeling approach would prove beneficial to all utilities and State agencies considering the health consequences of wildfire smoke….*

If smoke were to be incorporated in the consequence score, careful consideration would need to be given to how this might impact the geospatial distribution of consequence. For example, the consequences related to smoke would likely be more concentrated in highly populated areas. The consequence score is main driver of the risk tranche assignment for circuit segments (e.g. only circuit segments in the top two quintiles of consequence are considered to be in the top eight risk tranches)."[71]

Recommendation:

- Energy Safety should initiate a process is underway that will build the infrastructure needed for utilities to incorporate wildfire smoke risk estimates into their consequence models. Currently no such effort is underway, and no other California or federal organization has the mandate to focus on outputs that are relevant to the power line wildfire smoke problem. These should be developed under Energy Safety leadership, through coordination with other agencies.

5.3. Design Basis Scenarios

The "Design Basis Scenarios" instruction provided by Energy Safety is extensive and detailed. According to OEIS:

"*The design scenarios identified must be based on the unique wildfire risk and reliability risk characteristics of the electrical corporation's service territory and achieve the primary goal and stated plan objectives of its WMP. The design scenarios must represent statistically relevant weather and*

[71] E3 Report; pp. 57-58.

vegetative conditions throughout the service territory."[72] These scenarios include 1) wind conditions of increasing severity as timescale increases, 2) weather conditions including climate effects, and 3) vegetation conditions both current and projected. Energy Safety requests that the utility provide narrative discussion of how it will address scenarios as they arise.

However, PG&E does not comply with the basic requirement or goal of design scenarios at all. For the case of Extreme Event / High Uncertainty scenarios PG&E simply refuses to comply with guidance:

"*The framework presented by Energy Safety in the WMP guidelines presents a different paradigm for the risk modeling that could be conducted for a range of potential future scenarios. PG&E's risk modeling framework accounts for all scenarios in a single predictive model that is represented by the historical data sets used in model development. As a result, some conditions considered by the extreme scenarios outlined by Energy Safety may not be represented in the historical data.*"[73]

Here PG&E entirely misses the point. It is precisely because future extreme events *may* be ahistorical and not represented in event histories that other methodologies – statistical or scenario-based, must be applied to ensure future safety. PG&E therefore refuses to complete the required exercise:

"*PG&E is not completing Table 5-3 above as we do not directly account for extreme event scenarios as articulated in the WMP Guidelines in risk modeling. PG&E's Company Emergency Response Plan (CERP) includes a plan to address an event where an extreme scenario wildfire risk is realized coincident with other risk events. The purpose of the CERP is to assist PG&E personnel with safe, efficient, and coordinated response to an emergency incident affecting gas or electric generation, distribution, storage, and/or transmission systems within the PG&E service territory or the people who work in these systems*."[74]

For MGRA in particular, this brings a feeling of painful *déjà vu*. The original proposal made by MGRA in 2009 for Fire Protection Plans were for *contingency* plans – plans for what the utility

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[72] PG&E WMP; p. 84.
[73] PG&E WMP; p. 86.
[74] PG&E WMP; p. 90.

would do in the case of an extreme fire weather event.[75] PG&E opposed this proposal, in fact using exactly the same argument that it is making 15 years later: "*Contingency planning is something that any responsible company is already currently doing in a variety of areas. Finally, GO 166 already covers planning for major emergencies, disasters and power outages. The rule is not needed*."[76] After the disasters of the 2017 power line firestorm, the Camp fire, the Kincade fire, the Zogg fire, and the Dixie fire, PG&E's original attitude has been shown to be utterly wrong, but here it is again, making the same point: We have an emergency plan – we don't need this.

Current utility operational and hardening have made in the aftermath of the 2017 and 2018 disasters have made the system significantly more resilient to extreme events. PSPS, for example, can be employed regardless of the severity of the risk event with equivalent effectiveness. Consequently it isn't clear that "tail risk" on the weather and climate side necessarily leads to additional "tail risk" to the public. However, it still is beneficial to work through the contingencies of major events to ensure that all implications of those events can be properly managed if they occur. Some examples are given below, and OEIS may use these and possibly others to provide more detailed guidance as to what it expects from utilities in this section:

5.3.1. Extreme 50+ year fire wind event

An extreme 50+ year fire wind event would be potentially characterized by:

- Record-breaking wind gusts, sometimes in areas not typically affected by high winds
- Long duration of high winds, potentially many days.
- Potential for uncharacteristic or unstable weather behavior, including rapid changes in local weather conditions.

Primary utility response to such an event would be:

- Normal operation in areas where full path is undergrounded, however with greater potential for secondary line ignitions.
- General long-duration PSPS active throughout large portions of the service area.

[75] R.08-11-005; MUSSEY GRADE ROAD ALLIANCE PROPOSED PHASE 2 RULES; December 16, 2009.
[76] R.08-11-005; OPENING BRIEF OF PACIFIC GAS AND ELECTRIC COMPANY (U39E) ON PHASE 2 JOINT PARTIES' WORKSHOP REPORT FOR WORKSHOPS HELD JANUARY – JUNE 2010; September 3, 2010.

Potential complications of such an event would be:

- Increased vulnerability to failures in circuit control systems due to the sheer number being affected.
- Areas requiring de-energization that may not have been fully sectionalized.
- Rapid changes in local weather conditions challenging operational response times.
- Extensive damage to above-ground electrical infrastructure potentially requiring mutual aid assistance.
- Long duration outages affecting the population in general, as well as critical facilities and AFN populations, potentially extending beyond current contingency plans.
- Increased dangers of sparking during re-energization and resulting wildfires.

Energy safety should require PG&E to analyze these and other potential risks that it may itself propose, and then for each of these list the measures that PG&E would take to mitigate each of those risks.

5.3.2. Extended extreme drought exacerbated by climate change

It is also foreseeable that an extended drought, such as those California has suffered in the past decades but even more severe, may occur under climate change. In these circumstances, PG&E would face the following exacerbated risks:

- Increased tree mortality causing a greater rate of tree fall-in and vegetation contact on overhead lines.[77]
- Much greater vapor pressure deficits and dangerously low vegetation moisture for extended periods, leading to higher FPIs and extended EPSS enablement.

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[77] PG&E WMP; p. 24 ,and
WMP-Discovery2026-2028_DR_MGRA_003-Q003, cites:
Lessons from California's 2012–2016 Drought. Jay Lund, Josue Medellin-Azuara, John Durand and Kathleen Stone. J. Water Resour. Plann. Manage., 2018:
"*Perhaps the greatest impact of California's drought was the death of 1020 million forest trees, which depend on soil moisture accumulated in the wet season for growth during the spring and summer*."

- Greater potential for fuel-driven rather than wind-driven catastrophic wildfires, meaning that ignition drivers unrelated to wind may make up a greater proportion of severe power line fires.
- Greater potential for extended PSPS even in the absence of extreme winds.
- Greater potential for an extreme weather "fire siege" consisting of multiple simultaneous large wildfires (such as Southern California October 2003, Southern California October 2007, Bay and Northern California 2017, Los Angeles 2025). Even in the case that power line fires are prevented, there is the potential for multiple catastrophic large fires simultaneously threatening multiple transmission assets and significantly damaging distribution assets in affected areas.

Energy safety should require PG&E to analyze these and other potential risks that it may itself propose, and then for each of these list the measures that PG&E would take to mitigate each of those risks.

7. PUBLIC SAFETY POWER SHUTOFF (PSPS AND EPSS)

It is clear from PG&E's wildfire mitigation strategy that a considerable portion of its success in reducing wildfire risk arises from judicious employment of both PSPS and EPSS.[78] PG&E estimates that covered conductor, EPSS+DCD, and PSPS can reduce wildfire risk by 97%.[79] Particularly if neutral risk scaling is used (as should be appropriate), PSPS and EPSS risks remain the largest contributors to public risk, larger than the residual wildfire risk.[80] Hence, being able to reduce PSPS risk and EPSS risk in a cost-effective manner without increasing wildfire risk would be a great benefit. Last year's MGRA WMP comments showed that for PG&E and SDG&E undergrounding projects to date, the reduced PSPS/EPSS risk was insignificant compared to the substantial costs of undergrounding, introducing the notion that it would be most cost efficient in many if not most cases to provide remote rural residence with the capacity to go off grid rather than spend the money on undergrounding projects.[81]

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[78] See Figure 1.
[79] PG&E WMP TABLE PG&E-6.1.3-1; p. 126.
[80] See Figure 2.
[81] MGRA 2025 WMP Update Comments; pp. 29-39.

Recently, the independent HAAS group working out of Berkeley performed an independent analysis of PG&E's wildfire issue and found that dynamic EPSS was an economically more efficient way to reduce risk than vegetation management or hardening.[82]

It is essential to understand, particularly as we move into the SB 884 long term underground planning projects, that while improving reliability and preventing unnecessary power loss is a public good, the power of PSPS and EPSS (particularly with DCD which partially addresses the tree fall-in vulnerability of covered conductor) cannot be easily and cheaply dispensed with. Raising shutoff thresholds on hardened systems, as will be shown below, can go a long way to reducing the scope, duration, and frequency of PSPS events. Monitoring effectiveness using post-event damage surveys as a probe provides feedback as to where these changes can be made safely. PG&E application of PSPS in 2024 appears to have overall be prudent and reasonable, and suggestions are made below as to how to further prudently reduce impacts without resorting to the crude and expensive tool of undergrounding.

7.1. Recent PSPS Effectiveness

One way to gauge the effectiveness of PSPS is whether it prevented risk events or damage to energized lines that might have resulted in a wildfire. In 2024, PG&E deployed PSPS in Q3 and Q4, but only reported damage events in Q4.

These events were analyzed and are shown below. Damage/risk events are color coded by PG&E's rated risk tier (Top 5%, Top 5-10%, Top 10-15%, and Bottom 80%). The numeric values show the maximum wind speed measured by any weather station within 5 miles of the damage within 72 hours of the damage report.[83]

[82] Warner, C., Callaway, D., Fowlie, M., n.d. Dynamic Grid Management Technologies Reduce Wildfire Adaptation Costs in the Electric Power Sector (No. WP-347R). https://haas.berkeley.edu/wp-content/uploads/WP347.pdf

[83] See supplemental file PGE_2024_PSPS_Damage.xlsx, Tab PGE24WIND. Wind analysis was performed using the M-bar Technologies and Consulting, LLC wind analysis suite. (Github – Wind).

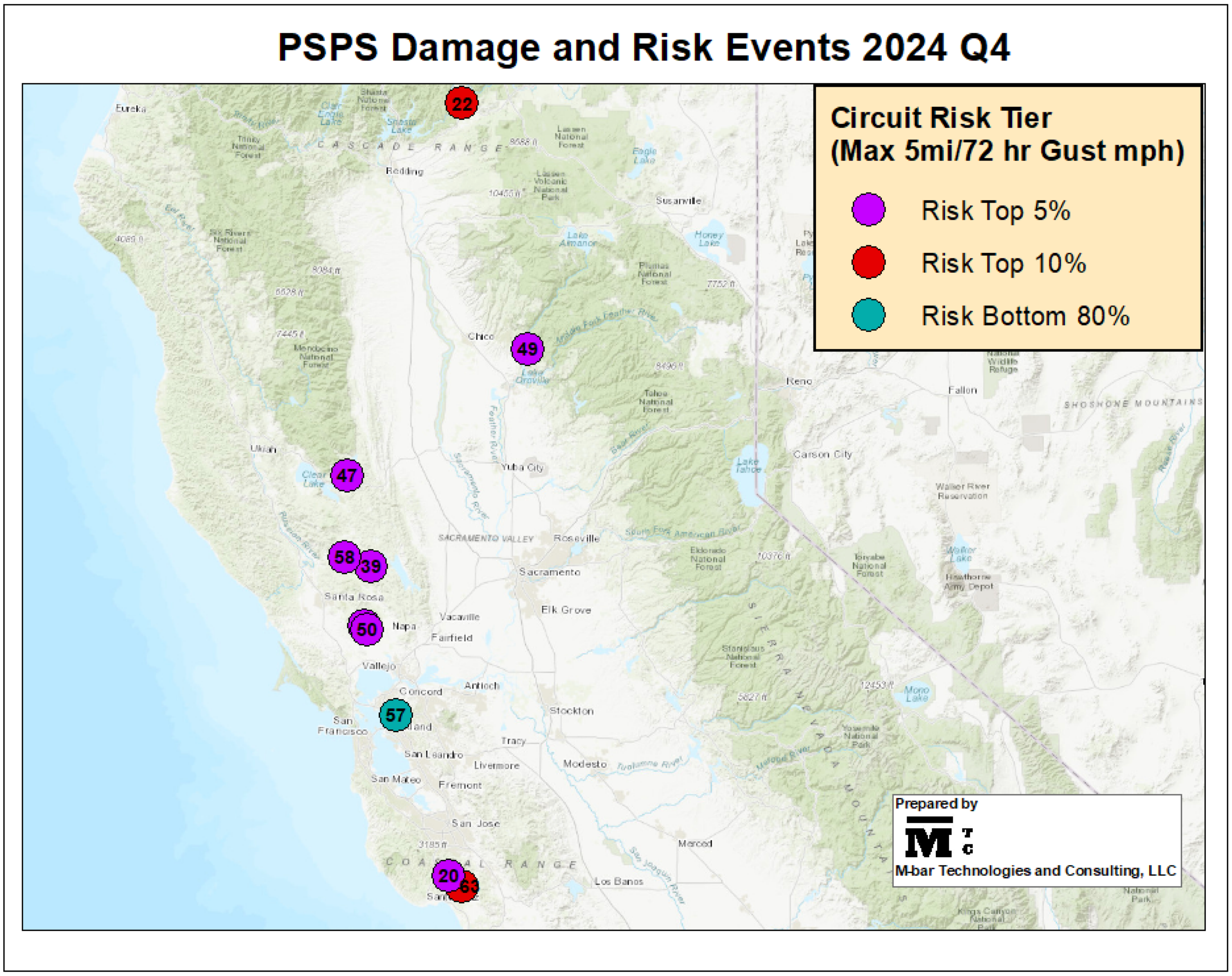

Figure 11 - PG&E risk and damage events identified in post-PSPS inspections. Event circuit risk tier is identified by color coding. The numeric values are the maximum wind gust speed in mph recorded by ground weather stations within five miles of the event in the 72 hour period prior to the damage report

All of the events except two occurred during significant wind gusts (above 25 mph), but only one occurred with nearby winds exceeding 60 mph. Structural damage should not be occurring at such wind speeds as per GO 95, though it is possible that vegetation damage might occur at lower wind speeds.

We can also examine the mileage of lined de-energized and compare them to PG&E's purported risk. PG&E provided records for de-energized lines in Q3 and Q4.[84] Looking at the more extensive record from Q4, the lines were compared to PG&E's "TopX%" and "Bottom 80%" risk tier lines.[85] While the match was not always optimal, since these GIS data sets used different line

[84] WMP-Discovery2026-2028_DR_MGRA_001-Q003 was analyzed as GIS data.
[85] Found in Supporting documents WDRMv4 Circuit Segment Risk Levels- Top 10-15_.shp

segments, it was still possible to assess what fraction of de-energized line in PG&E's risk area corresponded to PG&E risk classifications:

Fraction of Q4 De-energized Line by Risk Tier.

	Length ft	Length mi	
Top 5	2212328.06	419.001527	35.6%
Top 10	1360131.87	257.600733	21.9%
Top 15	1475794.61	279.506555	23.7%
Bottom 80	1173368.62	222.228905	18.9%
	Total	1178.33772	

Table 10 - De-energized line in Q4, classified approximately as to PG&E's WDRM v4 risk ranking. This did not correspond 1:1 to its de-energized segments. We note that there appears to be a missing classifier "Top15-20%".[86]

While these may be only approximate values due to different mechanisms for producing the GIS files, they do show that the top 81% of the de-energized line lay in the top 20% risk tiers. This and the fact that all but one of its PSPS damage events lay within its top 20% risk tiers implies that PG&E is doing a reasonable job of restricting its PSPS to areas that are most likely to have damage or risk events during fire weather. Nevertheless a number of improvements could be made:

Recommendations:

- PG&E should identify which PSPS Damage events could have been addressed by covered conductor and consider application of covered conductor with higher wind thresholds on those and similar segments.
- For damage events occurring where winds are gusting above GO 95 thresholds, undergrounding should be considered for segments in those areas.
- For segments subject to frequent PSPS but with 1) moderate wildfire risk and 2) relatively low numbers of customers in general, AFN customers, and businesses, PG&E should be allowed to offer incentives for customers to choose off grid solutions.

7.2. EPSS vs. PG&E Fire Potential Index (PG&E RAMP)

As part of the PG&E 2024 RAMP proceeding MGRA issued data requests in order explore the local weather conditions in the vicinity of an outage when an EPSS event occurred in order to

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[86] Workpaper PSPSEventLine_Q4, Tab "Sums".

see if an opportunity exists to make EPSS targeting more precise using local data. PG&E responded with datasets describing outage data between 2021 and 2024, which MGRA analyzed. This analysis is fully described in MGRA's Comments found in the SPD RAMP Comments.[87]

PG&E provided outage and weather data for a large number of EPSS events, as well as FPI values. Number of EPSS events versus FPI level is shown below:

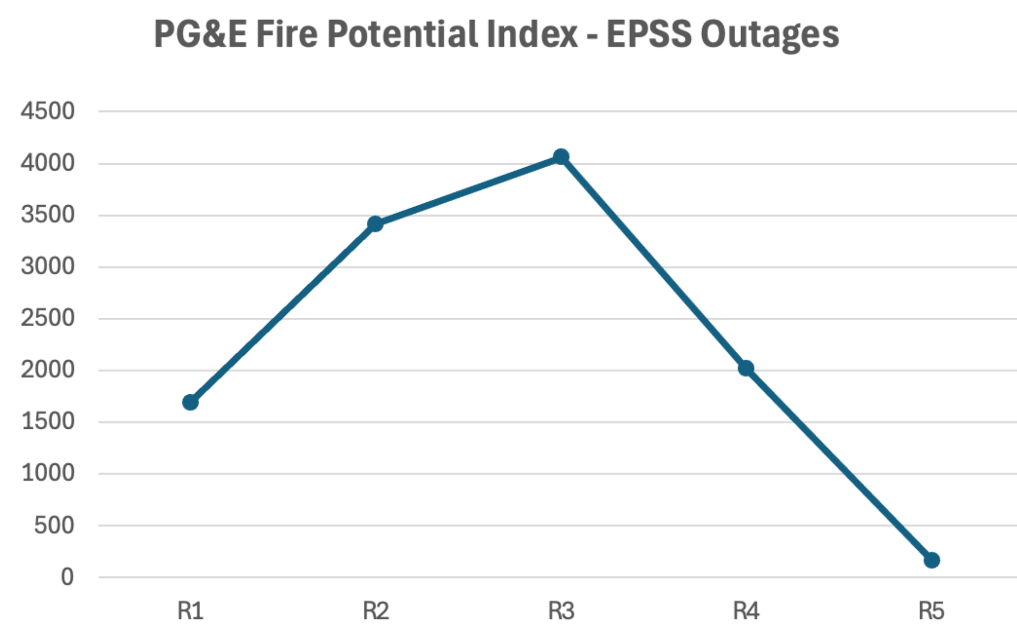

Figure 12 - PG&E outages associated with EPSS settings and the PG&E Fire Potential Index (FPI) associated with those settings. Data is from 1/29/2022 to 12/27/2023.

The figure above shows the distribution of outages occurring with EPSS settings active, binned into the FPI setting for the circuit experiencing the outage. The peak number of outages occur during R3 conditions, and there may be several factors contributing to that. First, R1 and R2 conditions do not always result in EPSS enablement, whereas R3 always do. A second potential contributing factor is that the weather associated with the FPI level may in fact be causing the outage.

MGRA tested the hypothesis of whether local weather data could be used to optimize EPSS settings, since the FPI thresholds used by PG&E to enable EPSS are determined from WRF data. To do this comparison, MGRA prepared an ad-hoc "weather metric" from local weather data provided

[87] MGRA Informal Comments; pp. 40-46 (SPD Comments pp. 350-356)

by PG&E including temperature, humidity, and wind gust speed. This was compared to FPI and the result is shown below:

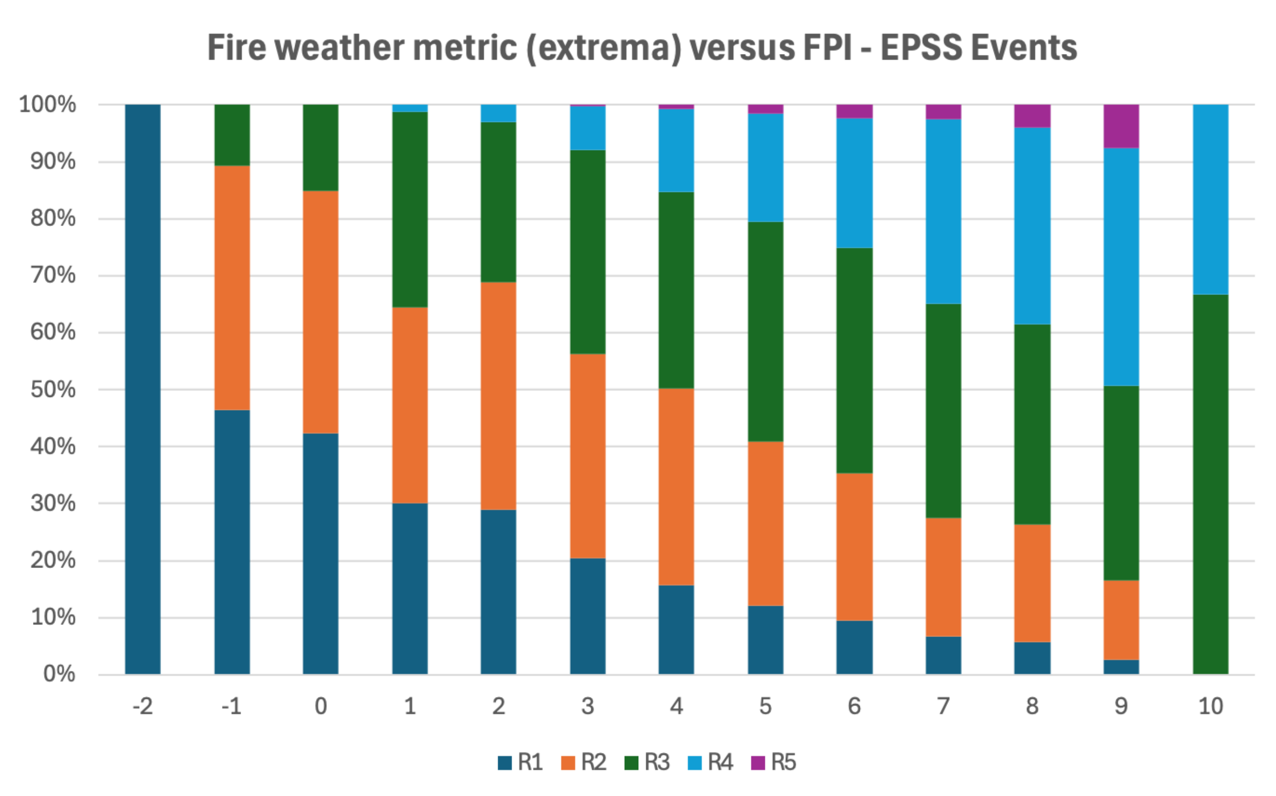

Figure 13 - For each value of MGRA's fire weather metric, the fraction of events classified by FPI ranking is shown.

There is a clear correlation between ad-hoc fire weather metric calculated by MGRA and the FPI ranking, despite the fact that the MGRA weather metric does not take into account fuel moisture, vegetation, or fire history as FPI does. This shows that the local conditions, at least the most severe local conditions, correlate reasonably with PG&E's climatology-based weather model and that other contributions to FPI such as fuel moisture and vegetation do not overwhelm the FPI metric. For reference a RH of 15%, temperature of 85 degrees F, and wind gust of 18 mph would be a weather metric value of 6. However, it can be seen that there are still a significant number of cases where the local weather is quite moderate but an FPI of R3 or higher is still in place. Hence it may be possible to optimize EPSS settings using local weather data.

Recommendations:

- Either WRF wind speed predictions or real-time weather conditions and fuel moisture should be taken into account for FPI=R3 in the same manner that they are for R1 and R2 to ensure that EPSS is not being enabled under conditions not likely to support significant wildfire growth.

- PG&E should study the feasibility of a data model incorporating FPI and live weather and fuel data to come up with an optimized threshold for EPSS settings.

7.3. PSPS and Shutoff Thresholds

As part of the PG&E RAMP analysis, MGRA requested that PG&E do a wind exceedance study over all PG&E weather station history, measuring the number of measurements that exceed four thresholds: 58 mph, 65 mph, 70 mph, and 84 mph. PG&E responded with the file RAMP-2024_DR_MGRA_001-Q005Atch01.xlsm, which was analyzed and posted as an MGRA RAMP workpaper as RAMP-2024_DR_MGRA_001-Q005Atch01-Wind-jwm.xlsm. Result of the analysis summarized over all of PG&E's weather stations is presented in the table below:

Number of Stations	Gust Threshold (mph)	Annual Count
	58	199
	65	101
	70	59
	84	14
Measurements above threshold		**Total Count above threshold**
	58	20382
	65	6972
	70	3021
	84	409

Table 11 - Effect of wind gust threshold on number of PG&E weather stations exceeding threshold more than once yearly and total number of measurements over threshold.[88]

[88] MGRA RAMP Comments; DR Response RAMP-2024_DR_MGRA_001-Q005.
Workpaper RAMP-2024_DR_MGRA_001-Q005Atch01-Wind-jwm.xlsm, found in RAMP workpapers: https://github.com/jwmitchell/Workpapers/tree/main/PGERAMP24
Description of analysis:
PG&E's raw data was modified by adding a calculated start year column (Tab MGRADR1_Q005). Data was selectively copied to the Gust Rates Tab using several criteria: 1) wind gust data only (this is more accurate than "average" wind speed for PG&E weather station design) 2) data starting in 2019 and ending in 2023 (2018 and 2024 data sets do not represent an entire year). Columns were added to sum the number of exceedances over all years, and also to calculate the mean number of gust exceedances annually. If the

The "Count" data represents the number of stations exceeding threshold annually, and is a proxy for the geographical "extent" of the PSPS events. It is interesting to note that only 199 stations out of PG&E's >1,500 annually exceed a 58 mph wind gust, implying that high wind risk is a localized problem. Raising the threshold to 65 mph would drop the number of stations to 100, reducing the number of stations (and by proxy area) affected by half. Only half again of these stations experience wind gusts of over 70 mph annually, implying that annual PSPS would only be necessary on a small fraction of circuits. Circuits regularly experiencing conditions of excessive wind are good candidates for undergrounding and should be given priority.

The total count above threshold measures the number of 10 minute measurements observed across the PG&E service area in HFTD Threat Districts 2 and 3 above threshold for all stations over the entire history. This proxy is influenced by the frequency, extent, and duration of extreme weather conditions. It shows a somewhat steeper drop off with rising threshold than does the count proxy, showing a 3X reduction between 58 and 65 mph and a 8X reduction between 70 and 84 mph. The 6,000 exceedance measurements (representing 1,000 station-hours) over 58 mph is small considering that PG&E claims to have analyzed 300 million weather station measurements (50 million station-hours) in order to produce its data set.[89] This indicates that conditions meriting PSPS constitute a small fraction of the overall PG&E service area over geography and time.

Recommendations:

- When modeling PSPS consequences using backcasting for covered conductor alternative mitigations in its GRC, PG&E should include the effect of an increased PSPS wind speed threshold.
- PG&E should present data with its GRC using its analysis of post-PSPS patrol damage and risk reports to determine the residual risk for covered conductor if wind speed thresholds were to be incrementally raised to 65 mph.

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number of annual exceedances was 1.0 or greater, a "CountYr" column was set to 1. A number of weather stations reported only 1 exceedance event in their history, and this event exceeded 84 mph. This was flagged as an error condition and these stations were not used in the summary. A pivot table was constructed on Tab "Tables" and the summaries presented in the table were performed.

[89] Op. Cite.

8. GRID DESIGN AND SYSTEM HARDENING

8.2. Covered Conductor and Undergrounding

8.2.1. Covered Conductor and Undergrounding Decision Tree

As part of its decision-making process for determining the appropriate combination of covered conductor versus undergrounding, PG&E employs a decision tree, a portion of which is shown below:

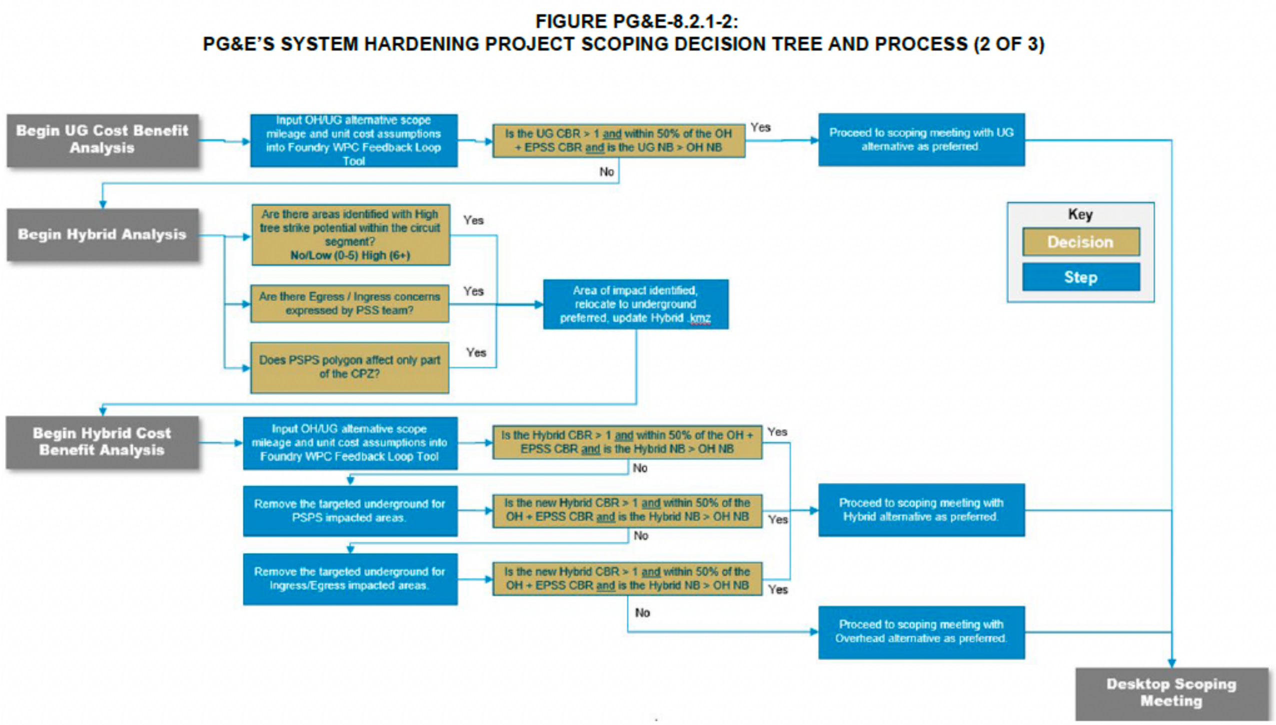

Figure 14 - Portion of PG&E's decision tree for hardening decisions, showing its undergrounding cost benefit analysis. Default conditions for undergrounding are shown in the third box.

In the third box the condition is applied "Is the UG CBR > 1 and within 50% of the OH + EPSS CBR and the UG NB > OH NB?" This sets a "default to underground" condition if the cost benefit ratio for undergrounding is within 50% of the cost benefit ratio of the cost benefit ratio for overhead and EPSS CBR.

Nowhere in the WMP does PG&E explain how this 50% value was determined. TURN's Data Request TURN_002_Q10 probes PG&E's motivation for this threshold. PG&E's response implies that this is not a quantitative value:

"*The 50% threshold is a discretionary value intended to ensure that CBR remains a key consideration, while also allowing for the engineering team to weigh the full range of benefits, including mitigation of tree strike risks, reliability risks created by operational mitigations, and ingress/egress considerations, which are often not fully quantified in CBR or risk calculations. In these cases, the CBR must also be greater than 1, indicating the benefits of the mitigation outweigh its costs*."

This reply is somewhat misleading. What the decision box in the figure actually implies is that the engineering team input and evaluation of other risks will only occur if the 50% CBR criterion is *not* met. If it is met, then default is undergrounding. PG&E's response actually means that undergrounding may still be chosen on a discretionary basis if the CBR for undergrounding is significantly *less than* 50% of the covered conductor + EPSS solution.

It is also important to point out that PG&E's alternative includes EPSS but not PSPS. If it did, CBR would be significantly more attractive for the overhead solution, particularly if PSPS shutoff criteria could be eased in conjunction with covered conductor hardening, as suggested by the MGRA data presented in Section 7.3.

Finally, while costs are not within the OEIS purview, ensuring that risks are mitigated in a cost-effective manner will ensure that an optimal rate of risk reduction will occur. It is important to emphasize that the CBR used by PG&E as its threshold is to a large extent arbitrary because it is determined by its convex risk attitude function, as explained in Section 5.1. While this does not greatly affect the difference between overhead and underground hardening, it does affect the threshold of whether the mitigation is cost effective at all, i.e. the CBR > 1.

For these reasons, any CBR ratio threshold should be quantitatively justified, with the justification for undergrounding requiring a positive case to be made for special circumstances such as tree strike or egress issues.

Recommendations*:*

- Decision trees should specify quantitative justifications for applying a mitigation with a CBR that is less than the mitigation with the optimal CBR.

- Criteria for fundamental cost effectiveness (CBR > 1) should apply a neutral risk scaling function.
- Optimal overhead hardening should include all operational mitigations, including EPSS and PSPS.

8.2.2. Covered Conductor Effectiveness

PG&E, which has installed minimal covered conductor compared with the comparably sized Edison, grossly underestimates the effectiveness of covered conductor in the reduction of wildfire ignition risk. PG&E bases its calculations largely on internal SME estimates and ignores 1) joint studies performed in conjunction with other utilities and 2) data accumulated by Edison field experience, which has been made available to it for years. PG&E makes no secret of its ambition to underground over 10,000 miles of conductor. Undergrounding is extremely effective as a wildfire mitigation, and if universal would also eliminate PSPS risk and reliability impacts. It is also extremely profitable to utilities, which are awarded ~10% additional revenue on capital projects. Undergrounding is, however, slow to roll out not only for technical reasons but because its extreme cost limits the amount of undergrounding that customers can bear. Rather than allowing undergrounding to be fairly judged against its major competitor (covered conductor plus operational measures), PG&E not only introduces a decision tree that favors undergrounding, discussed in the previous section, but brazenly puts its thumb on the scales and understates the effectiveness of covered conductor.

8.2.2.1. PG&E Underestimates Some Covered Conductor Driver Effectiveness

In Table PG&E-8.2.1-4[90] PG&E lists various wildfire risk drivers and then provides its estimate for the effectiveness of covered conductor plus EPSS plus downed conductor detection, as well as for undergrounding. It provides ratings of All (100%), Very High (90-99%), High (70-89%), Medium High (60-69%), Medium (40-59%) for each driver.[91]

The ratings it states for the covered conductor combination for various drivers are much lower than estimated by any other utility for covered conductor alone.

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[90] PG&E WMP pp. 193-194.
[91] PG&E WMP; pp. 191-192.

For example, as part of its GRC SCE provided detailed estimations of covered conductor wildfire ignition mitigation effectiveness in its workpapers.[92] SCE claims to have obtained these estimates from laboratory testing conducted by Exponent and Kinetics as part of its activity in the "Joint IOU Covered Conductor Working Group",[93] an effort in which PG&E was also a participant.

Claimed wildfire ignition reduction efficiency by SCE (CC alone) and PG&E (CC+EPSS+DCD) are compared in the table below:

Ignition Driver	PG&E (CC+EPSS+DCD)	SCE (CC only)
Crossarm failure	70-89%	50%
Pole Damage	70-89%	0%
Vegetation Contact	70-89%	71%
Animal	70-89%	65%
Balloon	70-89%	99%
Vehicle	70-89%	82%
Other Contact	40-59%	77-81%
Wire-to-Wire Contact	90-99%[94]	99%

Table 12 - Ignition reduction effectiveness estimates for different drivers from PG&E (covered conductor + EPSS + downed conductor detection) and SCE (covered conductor alone).

PG&E is underestimates the efficiency of covered conductor in performing its basic function of preventing contact with charged conductor for some drivers, particularly balloons and "Other Contact". With regard to more catastrophic damage, such as vehicle collisions, crossarm failures,

[92] CPUC Docket A.23-05-010; DIRECT TESTIMONY OF THE MUSSEY GRADE ROAD ALLIANCE SOUTHERN CALIFORNIA EDISON COMPANY 2025 GENERAL RATE CASE; ERRATA 2A – CLEAN; pp. 64-66. Dated: February 29, 2024.
https://docs.cpuc.ca.gov/PublishedDocs/SupDoc/A2305010/7338/531383951.pdf
Updated: May 13, 2024, July 13, 2024. Cites:
DR Response TURN-SCE-007-Q1b-Revised; WP SCE-04 Vol. 05 Pt. 1 - WCCP-UGRSE_Amended.
[93] Id; Cites:
CPUC Docket A.23-05-010; SCE Testimony SCE-04 Vol. 05 Pt. 2A; p. 40-42.
https://docs.cpuc.ca.gov/PublishedDocs/SupDoc/A2305010/7193/528555370.pdf
[94] This value was mis-reported as "medium" in the original WMP. PG&E will issue an errata changing it to "Very High". WMP-Discovery2026-2028_DR_MGRA_005-Q003.

and pole failures, PG&E's estimates imply that its EPSS and DCD settings will reduce the residual risk, making its estimates more compatible with the SCE estimates.

Nevertheless, OEIS should not accept estimates that are far outside what has been developed by joint utility efforts without actual supporting evidence that the efficiencies are really that low.

Recommendations:

- Energy Safety should not accept PG&E's Table 8.2.1-4 estimates for wildfire risk reduction without additional supporting evidence that its estimates are superior to those already reported in previous filings.
- Energy safety should require any other calculation in the WMP that is based on PG&E's estimation of covered conductor efficiency to be revised using PG&E's updated values that are sufficiently supported by evidence, instead those based on the Joint IOU Covered Conductor Working Group or field data from SCE.

8.2.2.2. SCE field data implies a higher covered conductor efficiency

MGRA provided its analysis of SCE's ignition data for both covered conductor and unhardened overhead lines in its 2025 WMP Update comments.[95] It is planned to repeat this analysis with additional 2024 data during the current WMP cycle. However, the MGRA analysis and conclusion bear repeating, since it implies that the efficiency of covered conductor in reducing ignitions is much higher than even SCE claims, and certainly higher than PG&E claims. This has significant implications for utility undergrounding programs. The following table shows SCE's covered conductor program through 2023:

[95] MGRA 2025 WMP Update Comments; pp. 21-23.

	2019	2020	2021	2022	2023*
Bare Wire (BW) Miles	9,263	8,466	7,040	5,684	4,484
CC installed miles	372	1,354	2,857	4,269	5,469
Total	9,635	9,820	9,897	9,953	9,953
BW Weight of mi/yr	0.2651	0.2423	0.2015	0.1627	0.1283
CC Weight of mi/yr	0.0260	0.0945	0.1995	0.2981	0.3819
*2023 covered conductor miles of 1200 are approximate					

Table 13 - SCE has been the only major IOU to make a major investment in covered conductor. This allows strong statistical inferences to be made from its field data.

"*With so much covered conductor deployed for several years in the SCE service area, it is possible to draw conclusions regarding its effectiveness in reducing outages, wire downs, and ignitions.*

SCE's estimates are approximately equal to its observed reduction in outages on fully covered conductor segments, as reported in the Joint Covered Conductor Report, in which it demonstrated that fully covered circuits reduce 69% of the faults.[96]

Examination of wires down also shows a reduction in fully covered conductor segments in that are somewhat smaller than SME estimates:

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[96] SDG&E 2022 WMP; CC Appendix: 2022 WMP Update Progress Report Effectiveness of Covered Conductor; p. 25 (p. 590/699).

	2019	2020	2021	2022	2023		Total or Wtd Avg
Bare Wire Downs	218	166	162	121	189		856
Covered Conductor Wire Downs	2	2	19	29	76		128
BW Wire Downs / mile-yr	0.023534	0.019608	0.023011	0.021288	0.04215		0.024501
CC Wire Downs / mile-yr	0.005376	0.001477	0.00665	0.006793	0.013897		0.008938
BW / CC	4.377416	13.27451	3.460182	3.133715	3.033127		2.741268
Reduction %	77.2%	92.5%	71.1%	68.1%	67.0%		63.5%
Expected CC Wires Down	8.754831	26.54902	65.74347	90.87773	230.5176		422.4427

Table 14 - Wires down for bare wire and covered conductor circuits for the period 2019 to 2023.[97]

Examination of the ignition rates as covered conductor has been deployed, however gives surprising results:

	2019	2020	2021	2022	2023		Total or Wtd Avg
Bare Wire Reportable Ignitions	37	49	46	36	15		183
Covered Conductor Reportable Ignitions	0	1	2	5	3		11
BW Ignitions / mile-yr	0.003994	0.005788	0.006534	0.006334	0.003345		0.005238
CC Ignitions / mile-yr	0	0.000739	0.0007	0.001171	0.000549		0.000768
BW / CC		7.836759	9.333949	5.4076	6.09835		6.8194
Reduction %		87.2%	89.3%	81.5%	83.6%		85.3%
Expected CC ignitions	1.485912	7.836759	18.6679	27.038	18.29505		73.32362

Table 15 - Reportable ignitions on bare wire and covered conductor circuits for the period 2019 to 2023.[98]

There is a relative reduction in ignitions of 85% between covered conductor versus bare wire in the SCE field data. This is roughly a factor of 2 more than SCE SME predictions (0.85^2.0 = 0.72). In fact, given the observed number of events it is possible to put a 95% confidence level at 75.3% reduction, thus excluding the hypothesis that the observed number of ignitions is the result of a statistical fluctuation consistent with SCE's 72% prediction."[99]

A similar analysis was done for PG&E 2024 ignition data, but due to its extremely slow roll-out of covered conductor, this is not nearly as statistically significant. With that limitation noted, it is consistent with the higher covered conductor efficiencies derived from SCE data:

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[97] Workpapers WMP25; Workpapers 2-1.a-f_MGRA-SCE-002_Q2-CCUG-WD-Ign-jwm.xlsx, Tab WireDowns.
[98] Id; Tab Ignitions.
[99] There were 11 ignitions observed on covered conductor segments, with 73.3 predicted based on the bare wire ignition rate. Assuming Poisson statistics, the single-tail 95% confidence interval was calculated using the Excel formula CHISQ.INV.RT(0.05,2*(D15+1))/2, where D15=11. This gives an upper limit of 18.2 events, and 18.2/73.3 = 75.3%. See:
Workpapers WMP25: MGRA Workpaper 2-1.a-f_MGRA-SCE-002_Q2-CCUG-WD-Ign-jwm.xlsx, Tab 'CL Stats'.

Wire type	Ignitions	Feet	Miles	Ign/Mile
ALL				
bare	475	414994902	78597.5193	0.00604345
insulated	48	154277811	29219.2824	0.00164275
covered	2	8045007	1523.67557	0.00131262
HFTD2				
bare	58	85018055	16101.9044	0.00360206
insulated	2	11977176	2268.40455	0.00088168
covered	1	3697017	700.192614	0.00142818
HFTD3				
bare	23	30827591	5838.5589	0.00393933
insulated	0	5324275	1008.38542	0
covered	0	3416580	647.079545	0
HFTD				
bare	81	115845646	21940.4633	0.00369181
insulated	2	17301451	3276.78996	0.00061035
covered	1	7113597	1347.27216	0.00074224

Table 16 – PG&E provided GIS data as per MGRA data requests 1 & 2. This was analyzed as described in Workpaper Mbar_PGE_Ign_CCvBare.xlsx. Ignition locations were classified by PG&E, as were conductor types. PG&E classified conductor as "bare", "insulated" (tree wire), and "covered". Significantly lower ignition rates were observed on insulated and covered conductor, both generally and in the HFTD.

Only one covered conductor ignition was observed in the HFTD (HFTD2). Based on deployed conductor, this is a per-mile rate of about 20% that of bare wire, though uncertainties are large due to the small statistics. This is closer to the claimed SCE and MGRA rates than to PG&E's claimed rates of ignition reduction.

Due to limited PG&E statistics, and without any evidence indicating otherwise, it would be prudent for OEIS to adopt the values determined from the SCE data analysis as the actual ignition reduction efficiency for covered conductor.

Recommendations:

- In lieu of statistically significant or representative field data, SCE field data should be considered representative of covered conductor deployments. PG&E should be required to recalculate its wildfire reduction estimates using the ignition reduction effectiveness determined by SCE field data in its comparative analyses that include covered conductor, in addition to any reasonable local adjustments due to tree fall-in and PG&E-specific technologies such as EPSS and DCD.

8.7. Advanced Technologies

8.7.1. EPSS + SGF

PG&E continues to push the boundaries of EPSS and with the introduction of Sensitive Ground Fault (SGF), it has changed its settings to trip with the detection of 5 amperes within five seconds. While this does not achieve the performance of REFCL (as low as 1 ampere[100]), it is a substantial improvement and can substantially reduce the risk of ignition during high fire hazard periods.[101]

PG&E reported five ignition events that might have been mitigated by SGF in 2024. It has not yet determined if there are reliability impacts due to SGF.[102]

Recommendations:

- For the purposes of ideal risk calculations, PG&E's standard CC+EPSS+DCD portfolio should include SGF if it is not included already.
- OEIS should require that PG&E monitor EPSS outages in order to determine whether excess outages arise from SGF settings and make a showing in its next WMP update.

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[100] PG&E WMP; p. 336.
[101] PG&E WMP; pp. 326-327.
[102] WMP-Discovery2026-2028_DR_MGRA_003-Q009.

Respectfully submitted this 23th day of May, 2025,

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

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14. RECOMMENDATION SUMMARY

Recommendations:

- MGRA urges Energy Safety to review the MGRA objections to PG&E's risk attitude function and to:
    - Ensure that PG&E risk analyses including its scaling function are clearly labelled as such, and
    - Require PG&E to use a risk-neutral scaling function in addition to its risk-averse scaling function when performing critical risk analyses.
    - Request E3 to independently verify PG&E's approach to convex risk attitude functions.
- Energy Safety should request that PG&E investigate mechanisms that allow data that changes over time or shows short term variations to be incorporated into its ML models, or alternatively investigate non-ML models that identify risks with a temporal dimension, either short term (such as wind) or long term (such as drought and climate), or that other adjustments such as weighting for wind speed be put into the calculation.
- PG&E's suppression model should not be accepted in its present form because it conflates important variables and ignores the relationship between neighborhood and density and home type and age and wildfire risk, and potentially leads to either higher cost or the unjustified shift of risk from remote rural to more populated WUI areas.

- Any risk estimates that have been performed using PG&E's suppression model should be repeated without that model.
- Energy Safety should continue to support the development of a suppression model.
- The first step in the development of a suppression model is the inclusion of an initial attack success probability in the probability component of risk.
- Further work should be conducted to study the relationship of TDI or other related variables to the growth of fires deviating from predicted models before incorporating these variables as adjustments to consequence.
- Additional analysis should be performed on the weighting of community and neighborhood characteristics, possibly including firefighter availability and access, before assigning consequence values.
- PG&E should be required to continue work on developing an egress metric to identify communities at risk.
- PG&E's AFN metric should be operationalized and used to identify communities at risk and reweight segment consequences accordingly.
- PG&E should be required to provide additional statistical information about its regression models (suppression and egress), which show 1) how much of the observed variation is explained by the model (such as R-squared or adjusted R-squared), 2) residual plots, and 3) an analysis of how much of the variation is explained by each variable (such as partial R-squared).
- Energy Safety should initiate a process is underway that will build the infrastructure needed for utilities to incorporate wildfire smoke risk estimates into their consequence models. Currently no such effort is underway, and no other California or federal organization has the mandate to focus on outputs that are relevant to the power line wildfire smoke problem. These should be developed under Energy Safety leadership, through coordination with other agencies.
- Decision trees should specify quantitative justifications for applying a mitigation with a CBR that is less than the mitigation with the optimal CBR.
- Criteria for fundamental cost effectiveness (CBR > 1) should apply a neutral risk scaling function.
- Optimal overhead hardening should include all operational mitigations, including EPSS and PSPS.

- Energy Safety should not accept PG&E's Table 8.2.1-4 estimates for wildfire risk reduction without additional supporting evidence that its estimates are superior to those already reported in previous filings.
- Energy safety should require any other calculation in the WMP that is based on PG&E's estimation of covered conductor efficiency to be revised using PG&E's updated values that are sufficiently supported by evidence, instead those based on the Joint IOU Covered Conductor Working Group or field data from SCE.
- In lieu of statistically significant or representative field data, SCE field data should be considered representative of covered conductor deployments. PG&E should be required to recalculate its wildfire reduction estimates using the ignition reduction effectiveness determined by SCE field data in its comparative analyses that include covered conductor, in addition to any reasonable local adjustments due to tree fall-in and PG&E-specific technologies such as EPSS and DCD.
- For the purposes of ideal risk calculations, PG&E's standard CC+EPSS+DCD portfolio should include SGF if it is not included already.
- OEIS should require that PG&E monitor EPSS outages in order to determine whether excess outages arise from SGF settings and make a showing in its next WMP update.

APPENDIX A - MGRA DATA REQUESTS

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_001-Q001
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_001-Q001
Request Date:	March 18, 2025
Requester DR No.:	MGRA Data Request No. 1
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 25, 2025

QUESTION 001

Please provide for Asset Point data for Camera, Fuse, Support Structure, and Weather Station.

GENERAL LIMITATIONS ON DATA PROVIDED IN RESPONSE TO THIS REQUEST

In response to requests 1 through 6 of this set of data requests, due to the high volume of records in each of our quarterly submissions (anywhere between 10-16 million records), individual record review for confidential data is not feasible nor practical. The feature classes and related tables included in the submission are not static and change each quarter. Similarly, the Office of Energy Infrastructure Safety (Energy Safety) often revises its Data Guidelines introducing and removing various data points, consolidating feature classes, changing field names, updating definitions, and renaming fields. Such revisions make it difficult to create a consistent, non-confidential GDB version. Energy Safety does not have a non-confidential GDB submission. The submission Energy Safety receives is confidential.

To create a non-confidential file for MGRA, PG&E attempts to apply logic to the feature classes to strike known confidential fields, data types, or entire datasets across the entire GDB. However, confidential data could still have been provided inadvertently. PG&E respectfully requests that MGRA use this data for internal purposes only and restrict access to a need-to-know basis.

Additionally, the interconnected aspect of feature classes data and geospatial representation of the data creates complexities in identifying the confidentiality of individual records and introduces additional risk for error. As such, PG&E may designate additional data points confidential at a later point in time should more confidentiality considerations become known.

ANSWER 001

In response to this request, PG&E is providing Camera and Weather Station data, as delivered in our 2024 Quarterly OEIS GIS Data Guidelines Submissions. PG&E is also providing non-confidential data from the Support Structure feature class. PG&E is not providing data for the Fuse feature class as this data is confidential critical energy infrastructure information (CEII).

Please see attachment *"WMP-Discovery2026-2028_DR_MGRA_001-Q001Atch01.zip"* for the data provided in response to this data request.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_001-Q002
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_001-Q002
Request Date:	March 18, 2025
Requester DR No.:	MGRA Data Request No. 1
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 25, 2025

QUESTION 002

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

ANSWER 002

In response to this request, PG&E is providing non-confidential data for the Primary and Secondary Distribution Line Feature Classes, as delivered in our 2024 OEIS GIS Data Guidelines Submissions. Please see *"WMP-Discovery2026-2028_DR_MGRA_001-Q001Atch01.zip".* PG&E is not providing the Transmission Line feature class because it is confidential CEII. PG&E refers MGRA to review externally available datasets. Specifically, the California Energy Commission's (CEC) "California Electric Transmission Lines" dataset.[1]

[1] Please see https://cecgis-caenergy.opendata.arcgis.com/ for the CEC's transmission data mappings.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_001-Q003
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_001-Q003
Request Date:	March 18, 2025
Requester DR No.:	MGRA Data Request No. 1
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 25, 2025

QUESTION 003

Provide PSPS Event data. Include Event Log, Event Line, Event Polygon data. Please exclude customer meter data. Provide all PSPS Event Asset Damage data. Data should include time, duration.

ANSWER 003

In response to this request, PG&E is providing non-confidential data for the PSPS Event Line, PSPS Event Log, PSPS Event Polygon, PSPS Event Conductor Damage Detail, PSPS Event Damage Point, and PSPS Event Support Structure Damage Detail feature Classes, as delivered in our 2024 OEIS GIS Data Guidelines Submissions. Please see *"WMP-Discovery2026-2028_DR_MGRA_001-Q001Atch01.zip".* Please note, PSPS events took place during Q3 and Q4 2024 only.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_001-Q004
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_001-Q004
Request Date:	March 18, 2025
Requester DR No.:	MGRA Data Request No. 1
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 25, 2025

QUESTION 004

Provide Risk Event Point data, including Wire Down, Ignition, Transmission unplanned outage (as classified non-confidential), Distribution Unplanned Outage data, Distribution Vegetation Caused Unplanned Outage, Risk Event Asset Log. Attributes should include location, time, and cause information.

ANSWER 004

In response to this request, PG&E is providing non-confidential data for the Wire Down, Ignition, and Unplanned Outage feature classes, as delivered in our 2024 OEIS GIS Data Guidelines Submissions. Please see *"WMP-Discovery2026-2028_DR_MGRA_001-Q001Atch01.zip".* The Office of Energy Infrastructure Safety changed their schemas in version 3.0 of the Data Guidelines released December 14, 2022, to no longer include Transmission Unplanned Outage, Distribution Unplanned Outage, Distribution Vegetation Caused Unplanned Outage, and Risk Event Asset Log feature classes, but rather consolidated these previous outage feature classes into a single Unplanned Outage feature class[1]. PG&E adopts and reports out against the required Data Guidelines as required to by Energy Safety. Please note, we have included the requested cause data in the referenced attachment.

[1] The Office of Energy and Infrastructure Safety's Guideline revisions can be found here: https://energysafety.ca.gov/who-we-are/department-organization/data-analytics-division/

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_001-Q005
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_001-Q005
Request Date:	March 18, 2025
Requester DR No.:	MGRA Data Request No. 1
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 25, 2025

QUESTION 005

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

ANSWER 005

In response to this request, PG&E is providing non-confidential data for the Grid Hardening Point and Grid Hardening Line feature classes, as delivered in our 2024 OEIS GIS Data Guidelines Submissions. Please see *"WMP-Discovery2026-2028_DR_MGRA_001-Q001Atch01.zip".* The Office of Energy Infrastructure and Safety changed their schema for version 3.0 of the Data Guidelines (released December 14, 2022) which removed the Grid Hardening Log feature class.[1] PG&E adopts and reports out against the required Data Guidelines as required to by Energy Safety.

[1] The Office of Energy Infrastructure Safety's Guideline revisions can be found here: https://energysafety.ca.gov/who-we-are/department-organization/data-analytics-division/

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_001-Q006
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_001-Q006
Request Date:	March 18, 2025
Requester DR No.:	MGRA Data Request No. 1
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 25, 2025

QUESTION 006

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

ANSWER 006

In response to this request, PG&E is providing the Red Flag Warning Day polygon feature class, as delivered in our 2024 OEIS GIS Data Guidelines Submissions. Please see *"WMP-Discovery2026-2028_DR_MGRA_001-Q001Atch01.zip".* Please see RedFlagWarningIssueDateTime field for the dates and the start time. Please note, duration is not a field included in Energy Safety's schema found in the Data Guidelines.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_001-Q007
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_001-Q007
Request Date:	March 18, 2025
Requester DR No.:	MGRA Data Request No. 1
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 25, 2025

QUESTION 007

Please provide a layer indicating calculated circuit-level risk using the methodology presented in the WMP.

a. If independent probability and consequence layers exist, please provide these independently as well.

ANSWER 007

The method described in our WMP to aggregate model results is conducted to produce a circuit segment level risk value, but it is not used to produce a circuit level risk value. However, the geospatial representation of circuit segments that would be provided in response to this data request involves the identification of critical energy infrastructure information (CEII), which we are required by law to maintain as confidential and cannot produce without the requesting party agreeing to protect the information through a non-disclosure agreement.

In an effort to reach a middle ground on this issue, in previous years, in response to this request, we provided the requesting party with risk information at the circuit segment level in Excel format that does not include geospatial information. Please see attachment "*WMP-Discovery2026-2028_DR_MGRA_001-Q007Atch01.xlsx*" for that same information as it relates to our current WMP.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_001-Q008
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_001-Q008
Request Date:	March 18, 2025
Requester DR No.:	MGRA Data Request No. 1
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 25, 2025

QUESTION 008

If PG&E maintains that providing specific data in response to the above requests would violate confidentiality as it has asserted it please provide a justification for each of the asserted violations. Likewise, if requested data cannot be provided for other reasons please provide justifications. Please expedite response to this data request to the extent required by applicable OEIS process documents.

ANSWER 008

Each individual response in this request identifies information that is being excluded on confidentiality grounds, if any, and the reason for the exclusion. CEII is defined as follows, in accordance with the definition created by the Federal government:

> CEII is specific engineering, vulnerability, or detailed design information about proposed or existing critical infrastructure (physical or virtual) that:
>
> 1. Relates details about the production, generation, transmission, or distribution of energy;
> 2. Could be useful to a person planning an attack on critical infrastructure;
> 3. Is exempt from mandatory disclosure under the Freedom of Information Act; and
> 4. Gives strategic information beyond the location of the critical infrastructure.[1]

[1] *See* https://www.ferc.gov/ceii.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_002-Q001
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_002-Q001
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 2
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 16, 2025

SUBJECT: GIS DATA

As per the meet and confer between representatives of MGRA and PG&E held on April 2, 2024, PG&E has proposed late delivery of the GIS data requested by MGRA in Data Request 1. PG&E has offered to provided tabular data representing some of the requested information in an expedited manner. Accordingly, MGRA requests the following to be provided in Excel spreadsheet form including latitude and longitude, and including all attributes that are in the geodatabase for the particular data type.

QUESTION 001

Weather station metadata valid as of Q4 of 2024.

Answer 001

In response to this request, PG&E is providing the Weather Station Feature Class as delivered in the 4Q 2024 OEIS GIS Data Standard Submission. Please see the file "*WMP-Discovery2026-2028_DR_MGRA_002-Q001Atch01.xlsx*."

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_002-Q001Supp01
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_002-Q001Supp01
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 2
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 16, 2025 Supp01: April 18, 2025

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QUESTION 001

Weather station metadata valid as of Q4 of 2024.

Answer 001 Supplemental 01

Please see "*WMP-Discovery2026-2028_DR_MGRA_002-Q001Supp01Atch01.xlsx"* in which PG&E has included requested lat/long information.

Answer 001

In response to this request, PG&E is providing the Weather Station Feature Class as delivered in the 4Q 2024 OEIS GIS Data Standard Submission. Please see the file "*WMP-Discovery2026-2028_DR_MGRA_002-Q001Atch01.xlsx*."

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_002-Q002
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_002-Q002
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 2
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 16, 2025

SUBJECT: GIS DATA

As per the meet and confer between representatives of MGRA and PG&E held on April 2, 2024, PG&E has proposed late delivery of the GIS data requested by MGRA in Data Request 1. PG&E has offered to provided tabular data representing some of the requested information in an expedited manner. Accordingly, MGRA requests the following to be provided in Excel spreadsheet form including latitude and longitude, and including all attributes that are in the geodatabase for the particular data type.

QUESTION 002

PSPS event damage event reports obtained from post-event patrols, including cause for all quarters of 2024.

Answer 002

In response to this request, PG&E is providing non-confidential data for the PSPS Event Damage Feature Classes, as delivered in 2024. Please note that PG&E did not have PSPS events during each quarter nor is every table applicable for relevant damages. For example, there were no support structure or other asset damages, so there are no data to report in the *PspsEventSuppportStructureDamageDetail* or *PspsEventOtherAssetDamageDetail* to report. Attached, please see the responsive files and associated explanations for when PG&E had relevant data to report each quarter for 2024:

- *"WMP-Discovery2026-2028_DR_MGRA_002-Q002Atch01.xlsx"*
  - PG&E only provided data in this Feature Class for 4Q 2024.
- *"WMP-Discovery2026-2028_DR_MGRA_002-Q002Atch02.xlsx"*
  - PG&E only provided data in this Feature Class for 4Q 2024.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_002-Q002Supp01
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_002-Q002Supp01
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 2
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 16, 2025 Supp01: April 18, 2025

SUBJECT: GIS DATA

As per the meet and confer between representatives of MGRA and PG&E held on April 2, 2024, PG&E has proposed late delivery of the GIS data requested by MGRA in Data Request 1. PG&E has offered to provided tabular data representing some of the requested information in an expedited manner. Accordingly, MGRA requests the following to be provided in Excel spreadsheet form including latitude and longitude, and including all attributes that are in the geodatabase for the particular data type.

QUESTION 002

PSPS event damage event reports obtained from post-event patrols, including cause for all quarters of 2024.

Answer 002 Supplemental 01

Please see the attachments listed below in which PG&E has included the requested lat/long information. Please note that a third file responsive to this question was inadvertently omitted from our initial response and is included here.

- "*WMP-Discovery2026-2028_DR_MGRA_002-Q002Supp01Atch01.xlsx*"
- "*WMP-Discovery2026-2028_DR_MGRA_002-Q002Supp01Atch02.xlsx*"
- "*WMP-Discovery2026-2028_DR_MGRA_002-Q002Supp01Atch03.xlsx*"

Answer 002

In response to this request, PG&E is providing non-confidential data for the PSPS Event Damage Feature Classes, as delivered in 2024. Please note that PG&E did not have PSPS events during each quarter nor is every table applicable for relevant damages. For example, there were no support structure or other asset damages, so there are no data to report in the *PspsEventSuppportStructureDamageDetail* or

PspsEventOtherAssetDamageDetail to report. Attached, please see the responsive files and associated explanations for when PG&E had relevant data to report each quarter for 2024:

- *"WMP-Discovery2026-2028_DR_MGRA_002-Q002Atch01.xlsx"*
  - PG&E only provided data in this Feature Class for 4Q 2024.
- *"WMP-Discovery2026-2028_DR_MGRA_002-Q002Atch02.xlsx"*
  - PG&E only provided data in this Feature Class for 4Q 2024.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_002-Q003
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_002-Q003
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 2
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 16, 2025

SUBJECT: GIS DATA

As per the meet and confer between representatives of MGRA and PG&E held on April 2, 2024, PG&E has proposed late delivery of the GIS data requested by MGRA in Data Request 1. PG&E has offered to provided tabular data representing some of the requested information in an expedited manner. Accordingly, MGRA requests the following to be provided in Excel spreadsheet form including latitude and longitude, and including all attributes that are in the geodatabase for the particular data type.

QUESTION 003

Unplanned outage data, including cause for all four quarters of 2023 and 2024.

a. If possible should include whether the outage occurred on a covered conductor segment

Answer 003

In response to this request, PG&E is providing non-confidential data for the Unplanned Outage Feature Class for all 8 quarters requested from 2023 and 2024, as delivered in the OEIS GIS Data Standard Submissions for each quarter. Please see "*WMP-Discovery2026-2028_DR_MGRA_002-Q003Atch01.xlsx.*"

a. The provided Feature Classes are not structured to include data on covered conductor segmentation, and thus PG&E is presently unable to provide this requested data. When the non-confidential GDBs are created, as requested by MGRA in MGRA-PGE-WMP26_DataRequest1, MGRA will be able to identify line classifications and make spatial inferences through the Primary Distribution Line feature class.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_002-Q003Supp01
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_002-Q003Supp01
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 2
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 16, 2025 Supp01: April 18, 2025

SUBJECT: GIS DATA

As per the meet and confer between representatives of MGRA and PG&E held on April 2, 2024, PG&E has proposed late delivery of the GIS data requested by MGRA in Data Request 1. PG&E has offered to provided tabular data representing some of the requested information in an expedited manner. Accordingly, MGRA requests the following to be provided in Excel spreadsheet form including latitude and longitude, and including all attributes that are in the geodatabase for the particular data type.

QUESTION 003

Unplanned outage data, including cause for all four quarters of 2023 and 2024.

a. If possible should include whether the outage occurred on a covered conductor segment

Answer 003 Supplemental 01

Please see "*WMP-Discovery2026-2028_DR_MGRA_002-Q003Supp01Atch01.xlsx*", in which PG&E has included the requested lat/long information.

Answer 003

In response to this request, PG&E is providing non-confidential data for the Unplanned Outage Feature Class for all 8 quarters requested from 2023 and 2024, as delivered in the OEIS GIS Data Standard Submissions for each quarter. Please see "*WMP-Discovery2026-2028_DR_MGRA_002-Q003Atch01.xlsx.*"

a. The provided Feature Classes are not structured to include data on covered conductor segmentation, and thus PG&E is presently unable to provide this requested data. When the non-confidential GDBs are created, as requested by MGRA in MGRA-PGE-WMP26_DataRequest1, MGRA will be able to identify line classifications and make spatial inferences through the Primary Distribution Line feature class.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_002-Q004
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_002-Q004
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 2
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 16, 2025

SUBJECT: GIS DATA

As per the meet and confer between representatives of MGRA and PG&E held on April 2, 2024, PG&E has proposed late delivery of the GIS data requested by MGRA in Data Request 1. PG&E has offered to provided tabular data representing some of the requested information in an expedited manner. Accordingly, MGRA requests the following to be provided in Excel spreadsheet form including latitude and longitude, and including all attributes that are in the geodatabase for the particular data type.

QUESTION 004

Wire down data for all four quarters of 2023 and 2024. Include cause and any associated outage identifier.

a. If possible should include whether the outage occurred on a covered conductor segment.

Answer 004

In response to this request, PG&E is providing non-confidential data for the Wire Down Feature Class, as delivered in the 8 quarters requested in 2023 and 2024. Please see the file “*WMP-Discovery2026-2028_DR_MGRA_002-Q004Atch01.xlsx”*.

a. The provided Feature Classes are not structured to include data on covered conductor segmentation, and thus PG&E is presently unable to provide this requested data. When the non-confidential GDBs are created, as requested by MGRA in MGRA-PGE-WMP26_DataRequest1, MGRA will be able to identify line classifications and make spatial inferences through the Primary Distribution Line feature class.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_002-Q004Supp01
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_002-Q004Supp01
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 2
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 16, 2025 Supp01: April 18, 2025

SUBJECT: GIS DATA

As per the meet and confer between representatives of MGRA and PG&E held on April 2, 2024, PG&E has proposed late delivery of the GIS data requested by MGRA in Data Request 1. PG&E has offered to provided tabular data representing some of the requested information in an expedited manner. Accordingly, MGRA requests the following to be provided in Excel spreadsheet form including latitude and longitude, and including all attributes that are in the geodatabase for the particular data type.

QUESTION 004

Wire down data for all four quarters of 2023 and 2024. Include cause and any associated outage identifier.

a. If possible should include whether the outage occurred on a covered conductor segment.

Answer 004 Supplemental 01

Please see "*WMP-Discovery2026-2028_DR_MGRA_002-Q004Supp01Atch01.xlsx*", in which PG&E has included the requested lat/long information.

Answer 004

In response to this request, PG&E is providing non-confidential data for the Wire Down Feature Class, as delivered in the 8 quarters requested in 2023 and 2024. Please see the file "*WMP-Discovery2026-2028_DR_MGRA_002-Q004Atch01.xlsx*".

a. The provided Feature Classes are not structured to include data on covered conductor segmentation, and thus PG&E is presently unable to provide this requested data. When the non-confidential GDBs are created, as requested by

MGRA in MGRA-PGE-WMP26_DataRequest1, MGRA will be able to identify line classifications and make spatial inferences through the Primary Distribution Line feature class.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_002-Q005
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_002-Q005
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 2
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 16, 2025

SUBJECT: GIS DATA

As per the meet and confer between representatives of MGRA and PG&E held on April 2, 2024, PG&E has proposed late delivery of the GIS data requested by MGRA in Data Request 1. PG&E has offered to provided tabular data representing some of the requested information in an expedited manner. Accordingly, MGRA requests the following to be provided in Excel spreadsheet form including latitude and longitude, and including all attributes that are in the geodatabase for the particular data type.

QUESTION 005

Ignition data for all four quarters of 2023 and 2024.

a. Should include cause and any associated outage identifier.

b. If possible should include whether the ignition occurred on a covered conductor segment

Answer 005

In response to this request, PG&E is providing non-confidential data for the Ignition Feature Class, as delivered in the 8 quarters requested in 2023 and 2024. Please see "*WMP-Discovery2026-2028_DR_MGRA_002-Q005Atch01.xlsx".*

a. The provided Feature Classes include the columns *SuspectedInitiatedCause* and *OutageID* which are responsive to this question.

b. The provided Feature Classes are not structured to include data on covered conductor segmentation, and thus PG&E is presently unable to provide this requested data. When the non-confidential GDBs are created, as requested by MGRA in MGRA-PGE-WMP26_DataRequest1, MGRA will be able to identify line classifications and make spatial inferences through the Primary Distribution Line feature class.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_002-Q005Supp01
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_002-Q005Supp01
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 2
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 16, 2025 Supp01: April 18, 2025

SUBJECT: GIS DATA

As per the meet and confer between representatives of MGRA and PG&E held on April 2, 2024, PG&E has proposed late delivery of the GIS data requested by MGRA in Data Request 1. PG&E has offered to provided tabular data representing some of the requested information in an expedited manner. Accordingly, MGRA requests the following to be provided in Excel spreadsheet form including latitude and longitude, and including all attributes that are in the geodatabase for the particular data type.

QUESTION 005

Ignition data for all four quarters of 2023 and 2024.

a. Should include cause and any associated outage identifier.

b. If possible should include whether the ignition occurred on a covered conductor segment

Answer 005 Supplemental 01

Please see "*WMP-Discovery2026-2028_DR_MGRA_002-Q005Supp01Atch01.xlsx*", in which PG&E has included the requested lat/long information.

Answer 005

In response to this request, PG&E is providing non-confidential data for the Ignition Feature Class, as delivered in the 8 quarters requested in 2023 and 2024. Please see "*WMP-Discovery2026-2028_DR_MGRA_002-Q005Atch01.xlsx*".

a. The provided Feature Classes include the columns *SuspectedInitiatedCause* and *OutageID* which are responsive to this question.

b. The provided Feature Classes are not structured to include data on covered conductor segmentation, and thus PG&E is presently unable to provide this requested data. When the non-confidential GDBs are created, as requested by MGRA in MGRA-PGE-WMP26_DataRequest1, MGRA will be able to identify line classifications and make spatial inferences through the Primary Distribution Line feature class.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_003-Q002
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_003-Q002
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 3
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 16, 2025

SUBJECT: RISK DRIVERS AND CLIMATOLOGICAL EFFECTS

QUESTION 002

Some of the risk drivers in Table 3-1 (pp. 20-21) show wind as a Climatological risk factor. Please provide a technical explanation as to why wind is a factor for the following Risk Sub-Drivers. Also provide data supporting this association:

a. Capacitor Bank
b. Fuse
c. Lightning Arrestor
d. Transformer
e. Balloon
f. Contamination

Answer 002

Wind increases the failure risk of overhead electrical utility equipment through both direct mechanical loading and indirect environmental effects. High wind speeds exert dynamic lateral forces on pole-mounted components such as capacitor banks, fuses, lightning arrestors, and transformers, especially those with large surface areas. Wind-driven lateral forces can induce structural oscillations, accelerate fatigue, or cause displacement at the pole top – conditions that can accelerate structural degradation over time. Wind loading on conductors can also introduce tension imbalances and galloping, which can increase mechanical stress at connection points, bushings, and supporting structures. ASCE Manual No. 74 provides guidance for evaluating wind load impacts on transmission and distribution infrastructure.

Wind also indirectly increases failure risk by driving foreign objects and vegetation into energized equipment. Vegetation clearance and line routing standards address the fact that high winds can cause branches or debris to contact components like fuses or arrestors, initiating phase-to-ground faults or electrical arcing. Mylar (metalized) balloons, which are highly conductive, can cause short circuits or flashovers (faults) when blown into energized overhead electrical equipment. Additionally, because devices like capacitor banks and transformers may have exposed energized-terminals and bushings, they can be vulnerable to mylar balloon-induced faults.

Furthermore, wind contributes to the accumulation and activation of surface contamination – a known driver of insulation failure in overhead systems. Contamination refers to the buildup of debris or pollutants such as dust, salt, or industrial particulates on equipment and insulators. Under dry conditions, these materials typically cause no electrical or mechanical issues; however, wind combined with moisture (ex. fog or mist) can convert these deposits into conductive films. This can result in surface tracking or flashovers (faults), especially across insulators and bushings connected to transformers, capacitor banks, and lightning arrestors. IEEE Std 1313.2 and IEC 60815 provide methodologies to identify contamination and creepage distances to mitigate such failures.

While the technical explanation (above) describes well-established engineering mechanisms, PG&E does not currently have asset-specific failure data that directly correlates wind conditions with elevated equipment failure rates or ignition rates for capacitor banks, fuses, lightning arrestors, transformers, or balloons. However, wind is a key component of PG&E’s Fire Potential Index (FPI), which is used extensively to inform the execution of key mitigations like PSPS and EPSS.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_003-Q003
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_003-Q003
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 3
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 22, 2025

SUBJECT: RISK DRIVERS AND CLIMATOLOGICAL EFFECTS

QUESTION 003

On p. 24, PG&E states that "*These exceptional temperatures, in turn, impact the relative humidity of the atmosphere, increasing the occurrence of vapor pressure deficit that is also linked to more severe fires. These conditions also pose a health risk to vegetation, increasing the potential for branch or tree failures impacting our assets and creating potential sources of wildfire ignition*."

a. What evidence does PG&E have that demonstrates how drought conditions relate to branch and tree failures?

b. Has PG&E analyzed the relationship between drought variables and vegetation outage rates? If so please provide the results.

c. If it has not done so, is it planning to do so and what would be the timeline? If it is not planning to do so what is the justification?

Answer 003

a. PG&E's statement on page 24 of its WMP references a peer-reviewed article that offers strong scientific support for the mechanism of drought impact on tree aridity and stress. Specifically, it details how rising temperatures and increased vapor pressure deficit reduce vegetation moisture content and increase plant stress and flammability. The scientific rationale for linking drought conditions to tree mortality and failures is well established in the literature. For example, the article "Lesson from California's 2012-2016 Drought"[1] confirms this link stating:

1 *Lessons from California's 2012–2016 Drought*. Jay Lund, Josue Medellin-Azuara, John Durand and Kathleen Stone. J. Water Resour. Plann. Manage., 2018

"Perhaps the greatest impact of California's drought was the death of 1020 million forest trees, which depend on soil moisture accumulated in the wet season for growth during the spring and summer."

Though not PG&E-specific evidence, these peer-reviewed articles underscore how drought conditions severely compromise tree health.

b. PG&E evaluated variables related to drought as inputs to the vegetation models released with WDRM v4, which are machine learning (ML) models trained on historical failure & outage events. Specifically, the SPEI (Standard Precipitation Evapotranspiration Index) and CWD (Climatic Water Deficit) were evaluated. The inputs needed to be summarized over multiple years to fit the Maximum Entropy ML algorithm configuration requirements, which is a spatial model. The multi-year aggregation and correlation to other weather variables caused the drought-related variables to have little influence in the model. These features are described in more detail in Section 3.5.2.3 in the Distribution Event Probability Models, Version 4 documentation available at Community Wildfire Safety Program.

c. PG&E is continuing to evaluate whether inputs related to vegetation health, like soil moisture, can be incorporated into the vegetation models. If successful, the enhanced vegetation models would be released with Wildfire Distribution Risk Model (WDRM) v5.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_003-Q004
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_003-Q004
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 3
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 22, 2025

SUBJECT: RISK MODELS

QUESTION 004

Provide technical description and available documentation for the Suppression Access model used in the WFC v4 Consequence model, along with data and analysis used to support the Suppression Access model.

Answer 004

Please refer to sections 2.4.2 and 4.1 in the Wildfire Consequence model version 4 documentation for details on the Suppression model, available at Community Wildfire Safety Program.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_003-Q005
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_003-Q005
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 3
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 22, 2025

SUBJECT: RISK MODELS

QUESTION 005

Provide technical description and available documentation for the Public Egress model used in the WFC v4 Consequence model, along with data and analysis used to support the Public Egress model.

Answer 005

Please refer to sections 2.4.3 and 4.2 in the Wildfire Consequence model version 4 documentation for details on the Public Egress model, available at Community Wildfire Safety Program.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_003-Q006
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_003-Q006
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 3
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	May 5, 2025

SUBJECT: RISK MODELS

QUESTION 006

Regarding the WDRM v4 ignition probability model:

a. Are the covariates calculated for each geographic location in the machine learning models such as Random Forest calculated as one value per geographic location? Or are they calculated per year?

b. Please provide tabular data supporting each of the "Feature Importance" figures in the Distribution Event Probability Models v4 documentation.

c. If there is a single value for feature/attributes at each location, or if these are calculated on a coarse time scale (annually), then please provide GIS data for the following feature/attributes for the HFTD+HFRA areas of the PG&E service area:

   i. Average wildfire season daily max windspeed
   ii. Percent difference from average wildfire season daily max windspeed
   iii. Average wildfire season relative humidity
   iv. Average wildfire season vapor pressure deficit
   v. Percent gusty summer day

Answer 006

a. Covariate calculation for the models depends on the algorithm used. The algorithm used for each model is documented in the Distribution Event Probability Model, version 4, documentation. In general, covariates are calculated as follows:

   - MaxEnt spatial models: the weather variables are aggregated over multiple years to identify the average mean, maximum, or minimum seasonal values.
   - XGBoost asset models: Both the average values described above, and yearly values are used. The yearly values are calculated as the percent difference

between that year and the average year. This measurement helps avoid correlation between the average and yearly values.

b. The feature importance scores are listed in a tabular format in "*WMP-Discovery2026-2028_DR_MGRA_003-Q006Atch01.xlsx*" for the models described in the Distribution Event Probability Model, version 4, documentation. The feature importance methods are described in more detail in Section 3.2 of the RaDA Algorithms and Methodologies, Version 1, documentation.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_003-Q007
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_003-Q007
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 3
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 22, 2025

SUBJECT: COVERED CONDUCTOR PROGRAM:

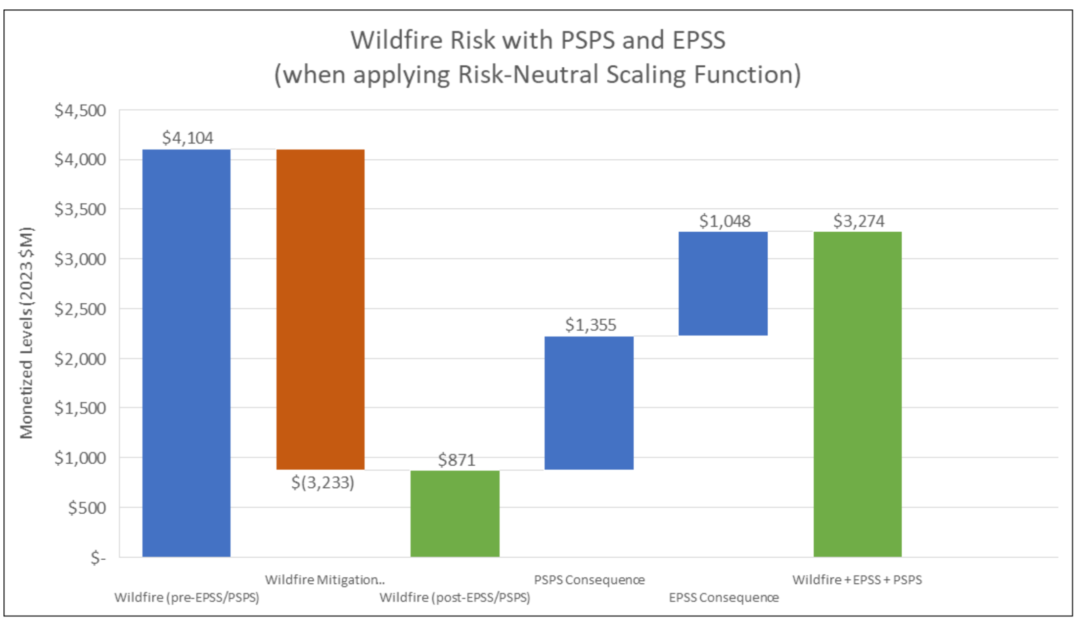
QUESTION 007

Regarding Figure PG&E-6.1.3.2-1 (2026 Year Baseline) representing system-wide wildfire risk, do the values shown in the figure include PG&E's risk scaling function?

a. If the answer is 'yes', please provide a figure showing the same values without the scaling function (a neutral risk attitude).

Answer 007

Yes, the values shown in Figure PG&E-6.1.3.2-1 (2026 Year Baseline) includes PG&E's risk scaling function. Please see the figure below which shows the same values without the scaling function (a neutral risk attitude).



PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_003-Q006Supp01
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_003-Q006Supp01
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 3
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	May 5, 2025 Supp01: May 6, 2025

SUBJECT: RISK MODELS

QUESTION 006

Regarding the WDRM v4 ignition probability model:

a. Are the covariates calculated for each geographic location in the machine learning models such as Random Forest calculated as one value per geographic location? Or are they calculated per year?

b. Please provide tabular data supporting each of the “Feature Importance” figures in the Distribution Event Probability Models v4 documentation.

c. If there is a single value for feature/attributes at each location, or if these are calculated on a coarse time scale (annually), then please provide GIS data for the following feature/attributes for the HFTD+HFRA areas of the PG&E service area:

   i. Average wildfire season daily max windspeed

   ii. Percent difference from average wildfire season daily max windspeed

   iii. Average wildfire season relative humidity

   iv. Average wildfire season vapor pressure deficit

   v. Percent gusty summer day

Answer 006 Supplemental 01

c. The requested geospatial data is provided in the following formats. Each dataset was exported using EPSG:4326.

   - A shapefile is provided in the “*WMP-Discovery2026-2028_DR_MGRA_003-Q006Supp01Atch01.zip*” for the following data inputs. Each row represents a distribution support structure related to WDRM v4 and the associated multi-year average values.

i. Average wildfire season daily max windspeed
ii. Average wildfire season relative humidity
iii. Average wildfire season vapor pressure deficit

- A shapefile is provided in the Attachment "*WMP-Discovery2026-2028_DR_MGRA_003-Q006Supp01Atch02.zip*" for the following data input. Each row represents a year of input data for a distribution support structure related to WDRM v4.

  i. Percent difference from average wildfire season daily max windspeed

- A geotiff raster file in the Attachment "*WMP-Discovery2026-2028_DR_MGRA_003-Q006Supp01Atch03.tif*" for the following data input. The raster file contains one band of data and is clipped to PG&E's service territory.

  i. Percent gusty summer day

Answer 006

a. Covariate calculation for the models depends on the algorithm used. The algorithm used for each model is documented in the Distribution Event Probability Model, version 4, documentation. In general, covariates are calculated as follows:

- MaxEnt spatial models: the weather variables are aggregated over multiple years to identify the average mean, maximum, or minimum seasonal values.
- XGBoost asset models: Both the average values described above, and yearly values are used. The yearly values are calculated as the percent difference between that year and the average year. This measurement helps avoid correlation between the average and yearly values.

b. The feature importance scores are listed in a tabular format in "*WMP-Discovery2026-2028_DR_MGRA_003-Q006Atch01.xlsx*" for the models described in the Distribution Event Probability Model, version 4, documentation. The feature importance methods are described in more detail in Section 3.2 of the RaDA Algorithms and Methodologies, Version 1, documentation.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_003-Q008
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_003-Q008
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 3
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 22, 2025

SUBJECT: COVERED CONDUCTOR PROGRAM:

QUESTION 008

Figure 6-1 (p. 149) shows PG&E's fractional risk reduction on a yearly basis from 2023 to 2033. Using available data and methodology, please provide an equivalent risk reduction curve showing the fractional change of PG&E's overall service territory wildfire risk between 2017 and 2024.

Answer 008

PG&E did not start estimating wildfire risk reduction until 2023 with the 2023-2025 WMP cycle. The risk reduction calculations require temporal and spatial alignment across a model version, circuit segments, and work plans. Currently, historical circuit segment datasets have only been prepared with a WDRM model release (earliest full-territory dataset is with WDRM v3). The earliest year that we have a WDRM model, respective circuit segment data, and associated work plans is in 2023.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_003-Q009
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_003-Q009
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 3
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 16, 2025

SUBJECT: ADVANCED TECHNOLOGIES

QUESTION 009

PG&E states that "*In 2023, there were observed ignitions that occurred during EPSS protection that were lower than the detectable thresholds of DCD. It was identified that a lower SGF pickup could have interrupted the events sooner, potentially preventing the ignition (DCD not present). In 2024, we revised SGF trip floor settings criteria and device reprogramming planned for increased detection of high-impedance faults to 5 amperage faults within 5 seconds*."

a. Assuming that these ignitions are listed in the GIS and tabular data provided to MGRA by PG&E, indicate which of these ignitions were the high impedance faults that could potentially be detected by lower trip settings.

b. What is the estimated increase in outage rate that would be caused by lowering the SGF trip floor setting to 5 amperes within 5 seconds?

Answer 009

a. Ignitions 20230693, 20230823, 20230912, 20231073, and 20231074 were the high-impedance faults that could potentially be interrupted sooner by lower SGF trip settings from 2023.

b. As PG&E has just started to deploy the revised settings thresholds at the end of 2024 EPSS season, it is not possible to accurately estimate any negative reliability impact. While these changes are not expected to significantly contribute to negative reliability, there is not sufficient data to provide outage rate impacts at this time. PG&E will continue to monitor reliability system performance with SGF as settings are enabled in the 2025 EPSS season.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_003-Q010
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_003-Q010
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 3
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 16, 2025

SUBJECT: WEATHER AND CLIMATE

QUESTION 010

On p. 458 PG&E writes that: "*a paper on chaos and weather prediction from the European Centre for Medium-Range Weather states that: A requirement for skillful predictions is that numerical models can accurately simulate the dominant atmospheric phenomena. The fact that the description of some physical processes has only a certain degree of accuracy, and the fact that numerical models simulate only processes with certain spatial and temporal, is the second source of forecast errors. Computer resources contribute to limit the complexity and the resolution of numerical models and assimilation—since, to be useful, numerical predictions must be produced in a reasonable amount of time. These two sources of forecast errors cause weather forecasts to deteriorate with forecast time.*"

a. Provide a citation for this paper.

Answer 010

Please see "*WMP-Discovery2026-2028_DR_MGRA_003-Q010Atch01.pdf*," and citation below:

> Buizza, Roberto. "Chaos and weather prediction January 2000." *European Centre for medium-range weather meteorological training course lecture series ECMWF* (2002).

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_003-Q011
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_003-Q011
Request Date:	April 11, 2025
Requester DR No.:	MGRA Data Request No. 3
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 16, 2025

SUBJECT: UTILITY DATA

QUESTION 011

Please provide tabular data in Excel spreadsheet format containing the data in the following tables:

a. TABLE 4-3: FREQUENTLY DE-ENERGIZED CIRCUITS (CONTINUED)

b. TABLE 5-5: SUMMARY OF TOP-RISK CIRCUITS, SEGMENTS, OR SPANS

c. TABLE 6-1: PG&E PRIORITIZED AREAS BASED ON OVERALL UTILITY RISK

d. Table 6-4 - TABLE 6-4: SUMMARY OF RISK REDUCTION FOR TOP RISK

Answer 011

Please see "*WMP-Discovery2026-2028_DR_MGRA_003-Q011Atch01.xlsx*" for all tables in PG&E's 2026-2028 WMP in Excel spreadsheet format.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_005-Q001
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_005-Q001
Request Date:	April 25, 2025
Requester DR No.:	MGRA Data Request No. 5
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	May 13, 2025

SUBJECT: WMP-Discovery 2026-2028_DR_OEIS_001-Q022

QUESTION 001

For the three technologies listed in PG&E's response to the OEIS data request EFD, DFA, Gridscope), please provide a per-year estimate of the deployment of these devices for 2026, 2027, and 2028 in the HFRA+HFTD:

a. The number of devices to be deployed.

b. The miles of overhead conductor to be monitored by these technologies in the HFTD in miles.

c. The fractional coverage of the overhead conductor system.

d. The estimated cumulative risk reduction due to the deployment of that technology.

ANSWER 001

a. PG&E plans to deploy 180 EFD devices/year and 15 DFA devices/year during 2026-2028 WMP period. PG&E is still in the deployment strategy development phase for Gridscope devices.

b. EFD devices planned for deployment in 2026 will monitor approximately 467 primary overhead miles of HFTD conductor. DFA devices planned for deployment in 2026 will monitor approximately 1,616 primary overhead miles of HFTD conductor. Deployment results in 2027 and 2028 are expected to be comparable to 2026.

c. The approximately 467 miles of primary overhead conductor HFTD miles on the circuits planned for deployment of EFD devices in 2026 account for 1.9% of all primary overhead conductor HFTD miles in PG&E service territory. The 1,616 miles of primary overhead conductor HFTD miles on the circuits planned for deployment of DFA devices in 2026 account for 6.4% of all primary overhead conductor HFTD miles in PG&E service territory. Deployments results in 2027 and 2028 are expected to be comparable to 2026.

d. Like asset inspections, sensors provide eyes-on-risk, detecting conditions that could create a wildfire or public safety risk. Actual risk reduction is accomplished when identified conditions are addressed by maintenance.

- EFD – 2.52% EOR per year.
- DFA – 9.92% EOR per year.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_005-Q002
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_005-Q002
Request Date:	April 25, 2025
Requester DR No.:	MGRA Data Request No. 5
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 30, 2025

Suppression

QUESTION 002

During a meeting of the Risk Mitigation Working Group, I recall one of the PG&E team stating that they had looked at the CalFire ignition database to determine whether weather local conditions affected the probability of successful initial attack.

a. Did PG&E ever perform an analysis similar to that described?
   a) If the answer is yes, please provide the results.
b. Is the PG&E FPI model available through a public interface? i.e., If a latitude, longitude, and time is provided can a corresponding FPI value be retrieved?
c. If the answer to b) is no, what is the approximate volume of PG&E's FPI history, could it potentially be exported, and how much time (days) and effort (person-hours) would it require?
d. As PG&E's FPI algorithm has changed over time, has PG&E segregated historical periods with different FPI approaches? Or has it re-run its history with the most recent FPI version?

ANSWER 002

a. PG&E did not perform a study that evaluated if local weather conditions affected the probability of successful initial attack. We did perform a study briefly discussed during a recent Risk Mitigation Working Group meeting that evaluated classes of the FPI model. This did show that most buildings damaged/destroyed occur during the first 24 hours from the initial fire detection. See the table below.

	% of Total Buildings Damaged				Buildings Damaged per 10,000 Acres			
FPI Class Actual	**Small**	**Large**	**Critical**	**Catastrophic**	**Small**	**Moderate**	**Critical**	**Catastrophic**
Initial Detect	0.0%	0.8%	4.6%	30.8%	2	6	78	683

Initial Burning Period (0+ to 24+ hours)	**0.0%**	**1.2%**	**3.7%**	**31.1%**	**0**	**19**	**36**	**392**
Second Burning Period (24+ to 72+ hours)	**0.0%**	**0.0%**	**3.4%**	**8.0%**	**0**	**1**	**26**	**69**
Third Burning Period (3+ to 7+ days)	**0.0%**	**0.2%**	**4.4%**	**2.6%**	**0**	**3**	**19**	**29**
Extended Burning Period (More than 7+ days)	**0.0%**	**0.0%**	**1.0%**	**8.2%**	**0**	**0**	**2**	**34**

b. While the PG&E FPI is not available through a public interface, daily FPI 5.0 ratings by Fire Index Area (FIA) back to 2008 are provided in "*WMP-Discovery2026-2028_DR_MGRA_005-Q002Atch01.*" This allows for a daily FPI 5.0 FIA rating to be retrieved with a latitude, longitude and date.

c. N/A

d. PG&E both retains the FPI ratings that were forecast using the operational FPI model at the time and re-runs a FPI historical dataset via hindcast (using the weather/fuels climatology) using the latest model in production. See attachment associated with part B.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_005-Q003
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_005-Q003
Request Date:	April 25, 2025
Requester DR No.:	MGRA Data Request No. 5
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	April 30, 2025

Covered Conductor

QUESTION 003

In Table PG&E-8.2.1-4: COVERED CONDUCTOR AND UNDERGOUNDING IMPACTS ON THE LIKELIHOOD OF IGNITION, PG&E'S analysis of Wire-to-Wire contact lists the effectiveness of Covered Conductor as medium it reducing this risk source, whereas other parties rank this as a high effectiveness.

a. Please justify why wire-to-wire contact is only reduced to a medium outage prevention.

b. Please provide examples in which wire to wire contact between covered conductors. resulted in an outage and under what conditions.

ANSWER 003

a. The referenced line item in table PG&E-8.2.1-4 was mislabeled as wire-to-wire contact. This driver should have been labeled: *Equipment / facility failure - Secondary damage or failure*. This update will be reflected in a forthcoming non-substantive errata targeted for May 16, 2025. PG&E's qualitative assessment of the effectiveness of covered conductor for wire-to-wire contact is rated as *Very High*.

b. PG&E does not track covered conductor outages vs bare wire outages and does not have examples of wire-to-wire contact readily available.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_006-Q001
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_006-Q001
Request Date:	May 5, 2025
Requester DR No.:	MGRA-PGE-WMP26_DataRequest6
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	May 8, 2025

QUESTION 001

Please provide all information available on the following risk events, including detailed cause information, lessons learned, the type of conductor or equipment involved in particular whether the segment had been converted to covered conductor.

a. On 8/3/2024, at 6:14 am, an ignition was reported related to PG&E infrastructure at latitude 39.0932719 longitude -121.308724

b. On 11/8/2024, at 11:42 AM, a post PSPS inspection revealed a damage event at latitude 37.102827 and longitude -121.900178.

ANSWER 001

a. PG&E confirmed with MGRA that this question intends to refer to an ignition on August 23, 2024, not August 3, 2024. Please see "*WMP-Discovery2026-2028_DR_MGRA_006-Q001Atch01.xlsx*" for information regarding the ignition.

b. Please see "*WMP-Discovery2026-2028_DR_MGRA_006-Q001Atch02.xlsx*" for information regarding this PSPS damage event. Please note that PG&E does not collect information regarding the type of conductor during PSPS patrols.

Executive Summary

On 08/23/2024 at 0614 hours, a PG&E Troubleshooter was dispatched to the LINCOLN 1104, a 12kV distribution Circuit on 4N/O 9711 MC COURTNEY RD, Placer County in response to a Fire report. Initial analysis indicates that the Utility work operation was the cause of the ignition. It has been determined that a balloon came into contact with distribution line on August 22 around 2338 hours, the control center received abnormal alarms from Line Recloser (LR) 997576 and LR 51756 which protect the Lincoln 1104 circuit. Distribution troubleshooter was dispatched to inspect the line. Due to the nighttime darkness and the similarity in color between the rose gold balloon and the steel pole, it was difficult to identify the cause. Following standard procedure, the control center manually reenergized the line, which ignited the grass below and caused the ignition. While no PG&E assets were damaged, a tag was created to inspect the conductor for any damage and determine if any repairs are required. The ensuing fire was between 10-20 acres and suppressed by California Fire Department. This incident caused a power outage affecting 113 customers. This incident location occurred within aTire2 HFTD, R3 FPI, and HFRA zone. Enhanced powerline safety

PSPS Event Date	Circuit Name	County	Structure Identifier	Tier 2/3 or Non-HFTD
11/5/24	Los Gatos 1107	Santa Cruz	100520160	Tier 3

Damage/Hazard	Type of Damage/Hazard	Description of Damage/Hazard	Lat/Long
Damage	Vegetation	Broken Pole	37.102827, -121.900178

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_006-Q002
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_006-Q002
Request Date:	May 5, 2025
Requester DR No.:	MGRA-PGE-WMP26_DataRequest6
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	May 12, 2025

QUESTION 002

With reference to PG&E's Wildfire Consequence model v4 documentation, Sections 4.1, 4.2, and 4.3 please provide substantive answers to OEIS_001-Q025 c. and d.

ANSWER 002

c. As documented in Section 4.1, the covariates used in the suppression model, which predicts the survival fraction of structures involved in a fire, are Terrain Difficulty Index (TDI), live fuel moisture, and wind speed. Among these, only TDI relates to "access".

d. As documented in Section 4.2, the covariates used in the egress model are Access and Functional Needs (AFN) and wind speed.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_006-Q003
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_006-Q003
Request Date:	May 5, 2025
Requester DR No.:	MGRA-PGE-WMP26_DataRequest6
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	May 12, 2025

QUESTION 003

WFC v4 Section 4.1.3.1 states that "The TDI is composite index from 1 to 5 that uses local topography and other factors to determine speed and ease of access from public roads and fire line feasibility for service territory equipment asset locations."

a. List all "other factors" that are included other than local topography.

b. What are the topographic variables that are included in TDI?

c. How are the topographic and other variables combined and weighted to compose the TDI?

d. What metrics were used to validate that the TDI accurately "determine[s] speed and ease of access from public roads and fire line feasibility for service territory equipment asset locations"?

e. Please provide this validation.

ANSWER 003

a. The Terrain Difficulty Index (TDI) is a proprietary, quantitative measure developed by Technosylva that is designed to assess how challenging it may be to contain a wildfire, particularly during initial attack operations. It reflects terrain-related factors that influence suppression efforts and the complexity of fuel conditions. TDI supports wildfire response planning by combining multiple indicators into a single, interpretable score. Given the proprietary nature of this information, Technosylva would not disclose the information without a non-disclosure agreement. Please let us know if you would like to meet and confer to discuss this request further.

b. Technosylva proprietary inputs and sub-indices relate to suppression and the complexity of fuel conditions. Given the proprietary nature of this information, Technosylva would not disclose the information without a non-disclosure agreement. Please let us know if you would like to meet and confer to discuss this request further.

c. The set of sub-indices to calculate the final TDI is Technosylva proprietary within their operational and planning tools. Given the proprietary nature of this information, Technosylva would not disclose the information without a non-disclosure agreement. Please let us know if you would like to meet and confer to discuss this request further.

d. Preliminary validation has shown that higher TDI, FBI (Fire Behavior Index), and IAA values correlate with lower initial attack success rates, helping agencies and utilities better anticipate when a fire may exceed available suppression capabilities.

e. The methodology described in subpart (d) above is currently undergoing peer review and is expected to be published soon in the *International Journal of Wildland Fire.*

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_006-Q004
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_006-Q004
Request Date:	May 5, 2025
Requester DR No.:	MGRA-PGE-WMP26_DataRequest6
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	May 12, 2025

QUESTION 004

With regard to WFC v4 Table 9:

a. Table 9 presents an abridged summary of the model regression results. Please provide the full model regression results.

b. P value is shown to be 0 (or less than 0.00005) in Table 9. What is the meaning of this P value? Does this imply a perfect fit?

c. In the regression, how many variables were used to fit how many bins of data?

d. Please also provide the validation that was done to quantify the explanatory value of TDI and other variables

ANSWER 004

a. Please see the table below for the requested results.

Generalized Linear Model Regression Results

	coef	std err	z	P>|z|	[0.025	0.975]
Intercept	-3.3012	0.021	-159.431	0.000	-3.342	-3.261
tdi	0.9263	0.002	508.681	0.000	0.923	0.930
lfm_chamise_1km	-0.0207	0.000	-74.746	0.000	-0.021	-0.020
ws_mph_300m	0.0266	0.000	245.897	0.000	0.026	0.027

b. We are reporting standard regression model P-values for coefficients as computed by the machine learning python package “statsmodels”. In regression modeling, the P-value for a coefficient quantifies the probability that the Null Hypothesis (that the true value of the coefficient is zero) is true. Small P-values indicate that the coefficient in question is statistically significant (i.e. very unlikely to actually be zero). Small P-values confirm covariance between the explanatory variables and the variable being modeled but do not directly relate to “perfect fit”.

c. Three variables and a constant term were used to fit structure loss outcomes from 5,299 fires. It is unclear what “bins of data” would refer to in this context.

d. The regression model results table provides diagnostics for the statistical significance of the model coefficients. The worked examples in Section 4.1 also provide a sanity check on the range of possible model predictions in a real-world setting.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_006-Q005
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_006-Q005
Request Date:	May 5, 2025
Requester DR No.:	MGRA-PGE-WMP26_DataRequest6
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	May 12, 2025

QUESTION 005

In Section 4.1.2.1 PG&E's model asserts that

$Structure\ Loss\ Fraction \cong f(Fuels, Terrain, Weather)$

The literature on structure loss in wildfire is extensive and lists a number of variables that have been shown to correlate with structure loss. These include housing materials, age of neighborhood, density of neighborhood and separation of houses, proximity of vegetation to the structure, enclosed eves and vents, and others.

a. How does PG&E's structure loss model incorporate other variables that are implicit to the structures, maintained landscapes, and neighborhoods?

b. Please provide the numerical values that went into Figures 9 and 10.

c. Figure 10 implies that for TDI=1 that the probability of structure is very small (counts for loss < 0.3 >> loss > 0.3), and that for TDI=5 probability of structure loss is very large (counts for loss > 0.7 >> loss < 0.7). Does this imply that PG&E's model assumes that home survival fraction is primarily dependent on the availability of firefighting resources? If so, what justification (analysis or citations) does it provide for this assertion?

ANSWER 005

a. The structure loss fraction model is focused on fire behavior, not community vulnerability. The empirical data on structure losses from historical fires used to train the model is, by definition, inclusive of a wide range of conditions in the built environment. However, given the sensitivity of outcomes to weather and fire behavior extremes, where extreme fire behavior can overwhelm even the best firefighting resources and landscape and building measures, the modeling team did not feel it would be appropriate to report lower consequence, and therefore discourage mitigation, in locations with expected destructive fire behavior but potentially favorable structure spacing or characteristics.

   As a practical matter, the vast majority of the building stock is untouched by fire building codes and we expect all Wildland Urban Interface (WUI) communities in CA (and beyond) to have structures with characteristics favorable to ignition. We also note that we have consulted experts in the fire research community and have not identified reliable sources of data on housing materials, landscaping vegetation, roof conditions, etc. that cover PG&E's territory. We have found that the literature on structure loss (likely consistent with research referenced in the question) is primarily focused on explaining the survival of specific structures after specific fires, where such data is gathered locally and after the fact – and therefore not suitable to our purposes. The relative vulnerability of specific communities to fire is a topic of ongoing research and model development both inside PG&E and in the wider wildfire modeling community.

b. As discussed during a call with MGRA on May 8, 2025, we anticipate responding to this question on May 14, 2025.

c. The suppression model is a regression model that quantifies correlations between the survival fraction of structures and the TDI, fuel moisture, and wind speed covariates from the fire footprint. The model provides the best statistical fit to the training data; it does not make assumptions. The model fit indicates that all three major covariates are statistically significant, with the value of the coefficients multiplied by the underlying covariate values determining the size of the contribution to the predicted structure loss for each fire. The TDI coefficient values is larger than the wind speed and fuel moisture coefficients, but TDI values range from 1 to 5, wind speeds range from 0 to 90+ mph, and fuel moisture is mainly between 60 and 150, so the magnitude of relative contributions from TDI vs. wind speed vs. fuel moisture will vary by fire without consistently being dominated by TDI. We assume the contribution from TDI relates to the fact that fires that are harder to reach, further from roads, and in more rugged terrain are more likely to escape "initial attack" becoming more established and more likely to spread further in the process. Also presumably related to TDI, surrounding slopes can also aid fire spread as fire prefers to burn uphill.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_006-Q005Supp01
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_006-Q005Supp01
Request Date:	May 5, 2025
Requester DR No.:	MGRA-PGE-WMP26_DataRequest6
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	May 12, 2025 Supp01: May 14, 2025

QUESTION 005

In Section 4.1.2.1 PG&E's model asserts that

$Structure\ Loss\ Fraction \cong f(Fuels, Terrain, Weather)$

The literature on structure loss in wildfire is extensive and lists a number of variables that have been shown to correlate with structure loss. These include housing materials, age of neighborhood, density of neighborhood and separation of houses, proximity of vegetation to the structure, enclosed eves and vents, and others.

a. How does PG&E's structure loss model incorporate other variables that are implicit to the structures, maintained landscapes, and neighborhoods?

b. Please provide the numerical values that went into Figures 9 and 10.

c. Figure 10 implies that for TDI=1 that the probability of structure is very small (counts for loss < 0.3 >> loss > 0.3), and that for TDI=5 probability of structure loss is very large (counts for loss > 0.7 >> loss < 0.7). Does this imply that PG&E's model assumes that home survival fraction is primarily dependent on the availability of firefighting resources? If so, what justification (analysis or citations) does it provide for this assertion?

ANSWER 005 SUPPLEMENTAL 01

b. The calculations in the section of documentation that includes Figures 9 and 10 were included as examples from a development version of the model, notably before weights were added to emphasize model fit against fires with more buildings in their footprints compared to those with fewer buildings, and fit using an earlier version of the fires data set. For these reasons, the data highlighted in the documentation example was not aligned with the values used in the v4 release. The number of fires in the deciles of predicted loss fraction consistent with the v4 model are provided in the table below:

loss fraction	historical	tdi_1	tdi_3	tdi_5
0.0-0. 1	3494	5264	439	0
0.1-0. 2	888	33	3332	6
0.2-0. 3	440	2	1327	111
0.3-0. 4	245	0	160	251
0.4-0. 5	149	0	35	931
0.5-0. 6	62	0	4	2165
0.6-0. 7	18	0	2	1485
0.7-0. 8	3	0	0	300
0.8-0.9	0	0	0	47
0.9-1.0	0	0	0	3

ANSWER 005

a. The structure loss fraction model is focused on fire behavior, not community vulnerability. The empirical data on structure losses from historical fires used to train the model is, by definition, inclusive of a wide range of conditions in the built environment. However, given the sensitivity of outcomes to weather and fire behavior extremes, where extreme fire behavior can overwhelm even the best firefighting resources and landscape and building measures, the modeling team did not feel it would be appropriate to report lower consequence, and therefore discourage mitigation, in locations with expected destructive fire behavior but potentially favorable structure spacing or characteristics.

   As a practical matter, the vast majority of the building stock is untouched by fire building codes and we expect all Wildland Urban Interface (WUI) communities in CA (and beyond) to have structures with characteristics favorable to ignition. We also note that we have consulted experts in the fire research community and have not identified reliable sources of data on housing materials, landscaping vegetation, roof conditions, etc. that cover PG&E's territory. We have found that the literature on structure loss (likely consistent with research referenced in the question) is primarily focused on explaining the survival of specific structures after specific fires, where such data is gathered locally and after the fact – and therefore not suitable to our purposes. The relative vulnerability of specific communities to fire is a topic of ongoing research and model development both inside PG&E and in the wider wildfire modeling community.

b. As discussed during a call with MGRA on May 8, 2025, we anticipate responding to this question on May 14, 2025.

c. The suppression model is a regression model that quantifies correlations between the survival fraction of structures and the TDI, fuel moisture, and wind speed covariates from the fire footprint. The model provides the best statistical fit to the training data; it does not make assumptions. The model fit indicates that all three major covariates are statistically significant, with the value of the coefficients multiplied by the underlying covariate values determining the size of the contribution to the predicted structure loss for each fire. The TDI coefficient values is larger than the wind speed and fuel moisture coefficients, but TDI values range from 1 to 5, wind speeds range from 0 to 90+ mph, and fuel moisture is mainly between 60 and 150, so the magnitude of relative contributions from TDI vs. wind speed vs. fuel moisture will vary by fire without consistently being dominated by TDI. We assume the contribution from TDI relates to the fact that fires that are harder to reach, further from roads, and in more rugged terrain are more likely to escape “initial attack” becoming more established and more likely to spread further in the process. Also presumably related to TDI, surrounding slopes can also aid fire spread as fire prefers to burn uphill.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_006-Q006
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_006-Q006
Request Date:	May 5, 2025
Requester DR No.:	MGRA-PGE-WMP26_DataRequest6
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	May 12, 2025

QUESTION 006

The analysis provided estimated TDI values for the Dixie fire. Please provide a TDI for other major fires as well including:

a. Eaton (2025)

b. Palisades (2025)

c. Lahaina (2023)

ANSWER 006

TDI data was licensed from Technosylva for PG&E’s service territory and is proprietary. We do not have access to TDI values for any of the requested fire locations, all of which were outside of PG&E’s service territory. We observe that the primary suppression-relevant characteristic shared by those fires was their rate of spread, supported by extremely dangerous fuel and wind conditions.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_006-Q007
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_006-Q007
Request Date:	May 5, 2025
Requester DR No.:	MGRA-PGE-WMP26_DataRequest6
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	May 12, 2025

QUESTION 007

Was PG&E's suppression model developed internally or by a third party vendor, and if the latter which vendor.

ANSWER 007

PG&E's suppression model is a regression model that was developed internally. As discussed in the previous responses in this set of data requests, the TDI covariate was developed by and licensed from Technosylva.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_006-Q008
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_006-Q008
Request Date:	May 5, 2025
Requester DR No.:	MGRA-PGE-WMP26_DataRequest6
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	May 12, 2025

QUESTION 008

With regard to Table 12

a. Please provide the full model regression results.

b. P value is shown to be 0 (or less than 0.00005) in Table 12. What is the meaning of this P value? Does this imply a perfect fit?

c. In the regression, how many variables were used to fit how many bins of data?

d. Please also provide the validation that was done to quantify the explanatory value of AFN and other variables.

ANSWER 008

a. The calculations in the section of documentation were included as examples and were not aligned with the values used in the v4 release. The results in the table below, and the discussion that follows, are based on the model fit with coefficients aligned with the released v4 model.

```
                 Generalized Linear Model Regression Results
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
Intercept     -7.2095      0.224    -32.156      0.000      -7.649      -6.770
afn_10km_pct   3.0006      0.453      6.621      0.000       2.112       3.889
ws_mph_300m    0.0133      0.002      6.607      0.000       0.009       0.017
==============================================================================
```

b. We are reporting standard regression model P-values for coefficients as computed by the well-known machine learning python package “statsmodels”. In regression modeling, the P-value for a coefficient quantifies the probability that the Null Hypothesis (that the true value of the coefficient is zero) is true. Small P-values indicate that the coefficient in question is statistically significant (i.e. very unlikely to actually be zero). Small P-values confirm covariance between the explanatory variables and the variable being modeled but do not directly relate to “perfect fit”.

c. The regression uses two variables and an intercept to fit 170 fire outcomes involving fatalities. It is unclear what “bins of data” would refer to in this context.

d. The regression model results table provides diagnostics for the statistical significance of the model coefficients. The worked examples in Section 4.2 also provide a sanity check on the range of possible model predictions in a real-world setting.

PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigations Plans Discovery 2026-2028
Data Response

PG&E Data Request No.:	MGRA_006-Q009
PG&E File Name:	WMP-Discovery2026-2028_DR_MGRA_006-Q009
Request Date:	May 5, 2025
Requester DR No.:	MGRA-PGE-WMP26_DataRequest6
Requesting Party:	Mussey Grade Road Alliance
Requester:	Joseph Mitchell
Date Sent:	May 12, 2025

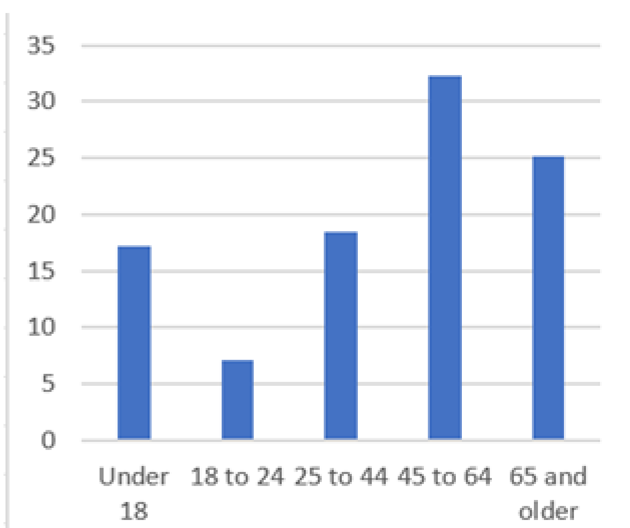
QUESTION 009

In Section 4.2.3, PG&E advances the hypothesis that AFN fraction is a predictor of fatalities, using the Camp fire as an example with high statistics.

a. Figure 12 shows an age distribution for the Camp fire fatalities. Please provide an equivalent age distribution graph for the 50,000 people who evacuated from the Camp fire.

ANSWER 009

a. We are not aware of a survey of evacuees but we did consult the 2010 census results for Paradise: The age distribution was 4,501 people (17.2%) under the age of 18, 1,858 people (7.1%) aged 18 to 24, 4,822 people (18.4%) aged 25 to 44, 8,466 people (32.3%) aged 45 to 64, and 6,571 people (25.1%) who were 65 years of age or older. The median age was 50.2 years. The median age for the victims of the Camp fire is 72 years. Those numbers in a histogram look like the figure below, which depicts the percentage of the population on the y-axis and age-groups on the x-axis.



APPENDIX B – EXCERPT FROM MGRA 2024 PG&E RAMP COMMENTS

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Application of Pacific Gas and Electric Company (U 39 M) to Submit Its 2024 Risk Assessment and Mitigation Phase Report	Application 24-05-008 (filed May 15, 2024)

MUSSEY GRADE ROAD ALLIANCE INFORMAL COMMENTS TO THE SAFETY POLICY DIVISION REGARDING PACIFIC GAS AND ELECTRIC COMPANY'S RAMP FILING

REVISION 1

Diane Conklin, Spokesperson
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Email: dj0conklin@earthlink.net

Dated: October 9, 2024
Revised: October 11, 2024

2.2.2. Reliability and the ICE Calculator

As PG&E explains in its RAMP:

"*The RDF Proceeding Phase II Decision requires each IOU to use the most current version of the Lawrence Berkeley National Laboratory Interruption Cost Estimate (ICE) Calculator to determine a standard dollar valuation of electric reliability risk for the Reliability Attribute.*

As shown in Figure 2-1, the main output section of the ICE Calculator produces results for three customer classes – Medium and Large Commercial and Industrial (C&I),30 Small C&I, and Residential – as well as the average results for all customer classes, weighted by the number of customers in each class…

The ICE Calculator categorizes Medium and Large C&I as customers with annual electricity usage exceeding 50,000 kWh."[16]

PG&E calculated imputed costs per Customer Minutes of Interruption (CMI) using ICE and PG&E-specific inputs, as shown in the table below.

FIGURE 2-3
$/CMI USING ICE DEFAULT DATA AND PG&E-SPECIFIC DATA

	ICE Data (California)		PG&E Data	
Sector	Cost per CMI (2016$)	**Cost per CMI (2023$)**	Cost per CMI (2016$)	**Cost per CMI (2023$)**
Medium and Large C&I	$70.37	$89.34	$61.35	$77.89
Small C&I	$5.36	$6.81	$7.87	$9.99
Residential	$0.04	$0.06	$0.04	$0.06
All Customers	**$1.53**	**$1.94**	**$2.50**	**$3.17**

Figure 1 - PG&E ICE calculations of cost per customer minute interruption (CMI) for medium and large businesses, small businesses, and residential customers.[17]

What is remarkable about this estimate compared with historical utility estimates of PSPS consequences is the fact that reliability costs are overwhelmingly dominated by medium and large business outages. Unfortunately, the "recent" version of the ICE model, ICE 1.0 was released in 2016 and does not include important factors like backup generation.[18] The utilities are collaborating

[16] RAMP; PG&E-2; p. 2-12.
[17] Id.; p. 1-16
[18] RAMP; PG&E-4; p. 2-57.

in ICE 2.0 model development, and this will include results of a backup generation survey, but the new model is not planned for use in PG&E analysis until Q1 2027.[19] This also means that PSPS risks that are currently not informed by wildfire-related risks. MGRA has made filings in a number of CPUC proceedings stating the case that current utility PSPS risk models insufficiently capture a number of elements, such as loss of communication, traffic impacts, potential for fire starts due to generator and cooking fires, and other impacts, elements that IOU analyses lack.[20] PG&E's PSPS safety risk estimate is based only on historical disasters and does not account for these factors.[21] When PG&E compares PSPS reliability risk to PSPS safety risk using its cost/benefit analysis, its estimates for reliability risk are 100 times larger than safety risks.[22] Consequently, the story of "PSPS risk reduction" is almost wholly the story of preventing risk to large businesses. To compensate for this,

"*PG&E already prioritizes some of its investments by customer types on a non-economic basis, and introducing Tranche-specific, economically-based values of Reliability from ICE could lead to unforeseen impacts. For example, in determining tranche-level impact of PSPS, customers that provide critical services like hospitals and fire stations were given a higher weighting than others based on a weighting scheme that balances myriad considerations which was comprehensively analyzed and reviewed by stakeholders*."[23]

During workshops, SPD inquired why PG&E chose to use the average $3.17/CMI rather than finer granularity.[24] PG&E provided plausible answers, portions of which are cited above. However, examination of the segment-level structure of PSPS risk shows variations that are leading to significant misallocation of resources if expensive mitigation such as undergrounding is deployed.

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[19] DR Response RAMP-2024_DR_MGRA_001-Q010.
[20] Examples are MGRA 2022 WMP Comments; pp. 85-86;
R.20-07-013; MUSSEY GRADE ROAD ALLIANCE ADDITIONAL COMMENTS REGARDING DEVELOPMENT OF SAFETY AND OPERATIONAL METRICS; March 1, 2021; pp. 1-2.
[21] RAMP; PG&E-2; p. 2-8.
[22] RAMP; PG&E-4; p. 1-6. Figure 1-2 shows PSPS total risk as 3,655 and Figure 1-3 shows PSPS safety risk as 44.
[23] RAMP; PG&E-4; p. 2-57.
[24] Id.

MGRA Data Request MGRA-01, Question 6 addressed the question of how customer types are distributed across circuit segments, and PG&E's response can be seen in RAMP-2024_DR_MGRA_001-Q006 and attached Excel spreadsheet. MGRA's request erroneously requested data for PG&E's HFRA when it intended to request PG&E's HFRA+HFTD. Nevertheless, data for PG&E's HFRA should be representative of its customer distribution with the caveat that medium and large business customers may be more likely to be found in the periphery of PG&E's HFTD, which is largely rural. MGRA is also issuing another data request to PG&E for the HFRA+HFTD data, and we would invite SPD to monitor its response. The MGRA analysis of the HFRA data calculates a number of metrics and can be found in workpaper RAMP-2024_DR_MGRA_001-Q006Atch01-CMI-jwm.xlsx.

The total number of circuit segments provided was 4,143, with a total of 415,816 customers, and estimated CMI total of $884,698, which works out to an average $2.13 CMI per customer versus the $3.17 per customer used for PG&E's tranche estimates, reflecting a higher ratio of non-business customers than in the PG&E customer pool as a whole.

Results are broken down into customer types in the table below:

Customer Type	**Segments**	**Customers**	**CMI Total**
Medium and Large Business	1,805	5,972	$465,816
Small Business	3,410	39,260	$392,600
Residential	3,651	438,031	$26,282
Total	**4,143**	**465,816**	**$884,698**
On segments without M/L	2,338	142,109	$96,893
On segments without M/L/Small	733	7,925	$476

Table 1 - Breakdown of PG&E circuit segments crossing HFRA by customer type. Total number of segments with the customer type, number of customers, and total CMI per customer type are given. Number of customers on circuits without medium/large businesses, and with no businesses are shown in the last two rows.

One would expect that the overall cost of mitigation will scale with the number of circuits mitigated, and that the benefits will scale with CMI avoided. Safety benefits will generally scale with number of customers, but critical infrastructure will also factor in in ways that are not accounted for in the tallies above. 1,805 circuits, 44% of the total, with 5,972 medium and large business customers are responsible for 53% of the total CMI costs. 142,109 customers, 30% of the total, live on the 2,338 segments without large businesses, but are responsible for only $96,893 (11%) of CMI costs, reflecting an average per customer CMI of $0.68. Similar results for small businesses were obtained but very few customers live on circuit segments without small business.

The analysis shows that circuits that have no medium or large businesses have a much lower benefit from avoided outages both in aggregate and per customer than circuits with medium or large businesses. Therefore, when selecting circuits for undergrounding mitigation for the purposes of mitigation, from a risk reduction standpoint it would make sense to restrict the selection to:

- Circuits segments required for medium and large businesses,
- Circuits segments required for critical infrastructure lacking adequate backup capacity, and
- Circuits segments required for many residential customers.

Circuit segments not meeting these criteria may still be given priority for mitigation based on their wildfire risk, but using other measures such as covered conductor + DCD/EPSS which is far more cost effective.

These are common-sense restrictions and if applied as a pre-screen would greatly improve the post-mitigation cost/benefit ratio. One might ask, because these are common-sense measures, whether PG&E is already applying them. We have the data from PG&E's underground program to date and its planned undergrounding program through 2025, and the answer is definitively "***no***". The analysis supporting this conclusion is found in Section 3.2.2.

Recommendations:

- Underground mitigation should be prioritized over overhead mitigation (covered conductor) only when specific criteria are met:
    - The circuit segment provides services for medium and large businesses, large numbers of residential customers, or critical infrastructure without adequate backup generation, and is significantly affected by PSPS and/or EPSS.

  - The circuit segment is in an area with high safety hazard due to extreme winds, high tree fall-in probability, or where ingress and egress from populated areas in the event of wildfire would be compromised.
- PG&E should provide number of customers served and CMI per circuit segment and aggregated over its proposal in its HFTD+HFRA areas along with its GRC filing.

2.2.3. Risk Scaling

PG&E has adopted a novel method for risk scaling, adopting a "Risk Premium Multiplier" to create a risk-averse attitude in its scaling function. It defines three ranges for its risk scaling function: Routine, Elevated, and Catastrophic, where "Catastrophic" is defined as losses over $1 billion, while the Elevated range describes losses between $100 million and $1 billion.[25]

These multipliers were shown during PG&E's workshops:

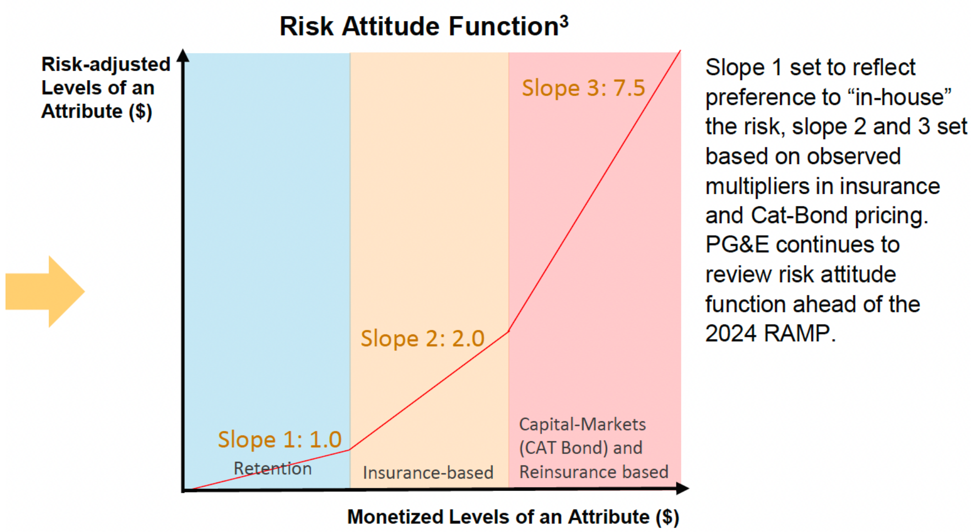

Figure 2 - PG&E's risk multipliers for different levels of consequence. Categories are Retention (<$100m), Insurance-based ($100m-$1b), and Catastrophic (>$1b).[26]

As seen in Figure 2, PG&E's risk function uses a multiplier for each attribute level. PG&E's method for obtaining its Catastrophic multiplier "*is to use available, objective data to determine the Risk Scaling Function(s). Risk Premiums/Prices from Insurance and Capital Markets meet these*

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[25] RAMP; PG&E-2; p. 2-26.
[26] A.24-05-008; PG&E 2024 Risk Assessment and Mitigation Phase Workshop #1; February 7, 2024.

criteria because they are for products from independent entities that mitigate the same underlying risk presented in this Report such as wildfires, Loss of Containment (LOC) on gas pipelines, cyber-attacks, etc."[27]

2.2.3.1. CAT bonds as a risk attitude proxy

What PG&E uses for "objective data" (as opposed to the detailed analysis it has done to quantify its geographical vegetation data, ignition data, fire data, customer data, etc.) is data from the reinsurance market in the form of catastrophic (CAT) bonds.[28] Its justification for doing so is that "*Market theory tells us that the prices obtained from a perfect market maximize value to society. Of course, no market is perfectly competitive, complete, or truly representative of societal preferences—for instance, in addressing ESJ concerns—but there are established practices that can be employed within the market-based approach to account for shortcomings while still preserving its function of communicating societal values. Markets are often used to determine the fair value of goods and services, but whether one should obtain the said goods or services is dependent on individual circumstances. Hence, market data… can be used, in part, to determine the value of mitigations, and whether to fund such programs is part of the IOU's General Rate Case process, and should include budget considerations, overall priorities, risk tolerance and other factors*."[29]

This justification merits skepticism. The efficient market hypothesis defines "*a market to be 'informationally efficient' if prices always incorporate all available information*."[30] The assumption that CAT bond prices efficiently reflect risk, and do so better than PG&E itself, is only correct if the insurance companies have more complete information regarding wildfire consequences directly applicable to PG&E's circuits than PG&E itself does. Once consequence of this assumption, if it is true, is that CAT bond prices would align well with each other. PG&E lists the CAT bond prices it used to obtain its estimate:

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[27] RAMP; PG&E-2; p. 2-20.
[28] RAMP; PG&E-2; p. 2-23.
[29] Id; p. 2-21.
[30] Chen, J., Kelly, R.C., Kvilhaug, S., 2022. Informationally Efficient Market: Meaning, Hypothesis, Criticism [WWW Document]. Investopedia. URL https://www.investopedia.com/terms/i/informationallyefficientmarket.asp (accessed 10.8.24). See also: Grossman, S.J., Stiglitz, J.E., 1980. On the Impossibility of Informationally Efficient Markets. The American Economic Review 70, 393–408. https://www.jstor.org/stable/1805228

TABLE 2-9
CAT BOND DATA SUMMARY

Line No.	Issue	Risk	Date	Attachment	Coverage	Premium Multiplier
1	PG&E Cat Phoenix Re	Wildfire	Aug 2018	$1.25b	$200m	7.5
2	Sempra SD Re Ltd (series 2018-1)	Wildfire	Oct 2018	$1.326b	$125m	19
3	Sempra SD Re Ltd (series 2020-1)	Wildfire	Jul 2020	$1b	$90m	5-4 - 6.4
4	LA DWP Power Protective RE Ltd (series 2021-1)	Wildfire	Dec 2020	$125m	$50m	15 - 18
5	Sempra SD Re Ltd (series 2021-1) class B	Wildfire	Oct 2021	$1.2b	$135m	5 – 6
6	LA DWP Power Protective Re Ltd (series 2021-1)	Wildfire	Oct 2021	$125m	$30m	20 - 23
7	PoleStar Re Ltd (series 2024-1)	Cyber	Dec 2023	N/A	$140m	10.3
8	Matterhorn Re Ltd (Series 2023-1)	Cyber	Dec 2023	N/A	$50m	7.0
9	East Lan Re VII Ltd (Series 2024-1)	Cyber	Dec 2023	N/A	$150m	6.7
10	Long Walk Reinsurance Ltd (Series 2024-1)	Cyber	Nov 2023	N/A	$75m	5

Table 2 - CAT bond premium prices used by PG&E to estimate its Catastrophic Level risk multiplier.[31]

As can be seen, CAT bond prices for wildfire risk show significant variation, with premium multipliers ranging from 5 to 23. PG&E would appear to have based its own multiplier on the estimate of only one insurer – the aptly named Phoenix Reinsurance – with a premium multiplier value of 7.5. The lack of agreement on the range of reinsurance estimates is a red flag that insurers have very different methods for assessing risk, and not all of these can be "right". MGRA raised its point during the workshops: "*MGRA questioned whether markets can account for risk better than IOUs themselves, since IOUs presumably have more information about their service territories, assets and operating conditions. MGRA reasons that if market participants do not possess as much information and expertise as the IOUs, then the prices would not be an accurate reflection of risk.*

PG&E cannot comment on the level of knowledge that market participants possess but notes they have access to at least as much information as regulators and intervenors do, from PG&E's RAMP, GRC and WMP filings."[32]

This admission is noteworthy, and shows the implicit assumption PG&E makes in trusting its own risk estimate to Phoenix Reinsurance:

- That the company has an ignition probability algorithm that either uses PG&E's own results or calculates its own in a more accurate way than PG&E's,

[31] Op. Cite; p. 2-25.
[32] RAMP; PG&E-2; p. 2-61.

- That the company also performs a consequence analysis that incorporates a truncated power law distribution as PG&E's does, or uses PG&E's calculation, and
- That the company runs wildfire simulations superior to those of PG&E, incorporating PG&E's own highly customized vegetation modeling based on field observations, or uses PG&E's own calculation.

PG&E provides no evidence that any of these conditions are met, in fact it says it admits it does not know anything about how Phoenix Reinsurance calculates its premium. So the CAT bond price is a magical black box, lacking all transparency, into which PG&E can project anything it wishes. PG&E argues that this is the market, risk management is how these reinsurers make their money, so we should trust that they know their business. There is reason to be skeptical of this view.

As noted previously, the market requires knowledge, and detailed knowledge of risk is very difficult to get, as the Commission and intervenors have watched PG&E struggle over many years to build a defendable risk management framework, dedicating tremendous expense and many thousands of hours of person-time. PG&E has presented no evidence that Phoenix Re has done this. Furthermore, as MGRA discussed in depth in a filing ten years ago, when there is a small probability of loss during the tenure of an employee or manager at a company, the personal interest of the manager or employee deviates from the long-term interest of the company. Therefore, it is improper for PG&E to make the implicit assumption that the risk estimation made by a third party is superior to its own even if calculating risk is central to that party's business.

Finally, there is also the assumption in PG&E's model that the risk attitude of the insurer reflects the risk attitude of PG&E ratepayers and residents of wildfire-prone areas. This is not the case. There are areas of common interest between the insurer and ratepayer/residents: neither wants property or life losses from major wildfires. However, interests significantly diverge in a number of areas:

- Ratepayers care about the cost of their electric bill, very much so. Insurers do not.
- Residents care whether their power is reliable. No utility is being sued over reliability issues, and it is not clear whether a CAT bond issuer would be liable even if they were. It's reasonable to conclude that insurers don't care about reliability.

- People can be harmed by wildfire smoke quite far from the source. However, nobody to my knowledge has ever sued a utility over health effects of inhaling smoke from a wildfire the utility ignited. It's reasonable to conclude that insurers don't care about wildfire smoke.

2.2.3.2. Power law risk distribution versus CAT bonds

Unless the reinsurer is using PG&E's consequence model or its results, it is highly unlikely that it is modeling losses with a truncated power law, an innovation that originated with work by MGRA and tested, adopted and owned by PG&E with the encouragement of SPD. If indeed the reinsurer is not using a truncated power law model, then by using the insurer's model and its own, PG&E is double-counting the effect of extreme wildfires. Actually, it is much worse than double-counting: in double-counting things are being added together that shouldn't. In the PG&E's "market[of one]-based" risk calculation numbers are being multiplied together that shouldn't be. A truncated power law is an inherently and naturally very risk-averse function, with the great majority of risk coming from the extreme end of the model near the cutoff.[33] Hence: "*There is no explicit necessity to inject a risk scaling function in order to incorporate uncertainty properly*."[34] To apply an external multiplier on top of a truncated power-law is likely to grossly overestimate maximum risk. In this case, the consequence cut-off was set by PG&E after a sensitivity analysis to be approximately 5X the losses due to the Camp fire.[35] These were approximately $20 billion, and so the cut-off is approximately $100 billion. It is not likely that we reach this level of loss, because maximum area that can burn is reaching its limit with modern fires, thus causing a deviation from power law distribution. Nevertheless, applying a multiplier of 7.5 as PG&E does creates a potential loss of $750 billion, 37.5X the losses of the Camp fire, which strains all credulity.

PG&E claims that modification of its risk calculation is necessary to incorporate uncertainty. PG&E is correct in this claim, and MGRA's previous suggestion in R.20-07-013 was to use a

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[33] R.20-07-013; MGRA Tail Risk Whitepaper; TAIL RISK AND EVENT STATISTICS FOR UTILITY PLANNING; August 1, 2022; pp. 20-24.
[34] R.20-07-013; MUSSEY GRADE ROAD ALLIANCE REPLY TO PARTY COMMENTS ON WORKSHOP 4 AND RISK SCALING; November 13, 2023; p. 8 (MGRA RDF Workshop 4 Reply)
[35] Pacific Gas and Electric Company; "Power Law Distribution"; September 3, 2021. (PG&E Whitepaper) Available at: https://data.mendeley.com/public-files/datasets/8nds4cx88k/files/c0178e67-92fc-4ab3-9ea7-7fdcdf3b4556/file_downloaded

Monte Carlo methodology to incorporate this uncertainty.[36] Additionally, the question of how much risk premium is introduced by uncertainty has been well studied,[37] and has been estimated to be 25-40%, far from the 750% introduced by PG&E. In the same proceeding PG&E makes a detailed and seemingly plausible argument against this proposed approach based on the Central Limit Theorem.[38] PG&E cites Nassim Taleb in their correct assertion that calculations of means and estimation of uncertainty have no value for Pareto (power law) distributions, because the total consequences over time diverge as the variable (wildfire size in our case) gets larger and larger.[39]

PG&E's core argument against the MGRA position is that using a Monte Carlo method will not address *epistemic* uncertainty, i.e. the unknown unknows.[40] "The market" that PG&E assumes is an efficient risk calculator puts a 25-40% additional premium on all risk, including epistemic risk. There is only one uncertainty capable of driving much larger variations, and that is variation on a power law cut-off point.

PG&E uses a ***truncated*** power distribution, and this makes all the difference. The mean is calculable and does not diverge. What about the uncertainty? PG&E's risk calculation is very dependent on the cut-off value, since most of the risk occurs near that value. For Pareto distributions, Taleb warns that we should "fuhgetaboudit" when it comes to mean or standard deviation.[41] This warning would also apply to uncertainty, and the 25-40% discussed by Kunreuther et. al. likely applies to uncertainties with normal distributions and not to Pareto distributions. This would be a serious issue if PG&E had not already done a sensitivity analysis of the cut-off.

PG&E's analysis described in the PG&E Whitepaper describes how the cut-off value was determined, and the risk was studied as a function of the cut-off value. It concludes: "*In summary,*

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[36] Op. Cite.
[37] Kunreuther, Howard and Erwann O. Michel-Kerjan with Neil A. Doherty ... [et al.]; At war with the weather: managing large-scale risks in a new era of catastrophe; 2009; pp. 129-133.
[38] R.20-07-013; OPENING COMMENTS OF PACIFIC GAS AND ELECTRIC COMPANY ON WORKSHOP #4; November 6, 2023; pp. 4-10.
[39] *Statistical Consequences of Fat Tails: Real World Preasymptotics, Epistemology, and Applications (The Technical Incerto Collection), Nassim Nicholas Taleb, STEM Academic Press, 2023*; p. 149. https://arxiv.org/abs/2001.10488
[40] R.20-07-020 OPENING COMMENTS OF PACIFIC GAS AND ELECTRIC COMPANY ON PROPOSED PHASE 3 DECISION; May 16, 2024; pp. 11-13. (PG&E RDF Phase 3 Comments)
[41] Op. Cite; pp. 27-28.

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."[42] MGRA's suggestion of a Monte Carlo method to incorporate uncertainty would be to apply a lognormal variation around the mean value of cutoff, with a width determined by SMEs, either fundamentally as an input to PG&E's Monte Carlo or as a scaling factor applied afterwards. This would incorporate uncertainties in a transparent manner that is defensible in the real world.

PG&E's argues against such an approach, noting that the Method of Moments it used for its sensitivity analysis is frowned upon by Taleb for Pareto distributions.[43] This depends on what exactly we mean by "cut-off parameter". If this is a fit value, and this appears to be how PG&E implemented it, then Taleb's admonition applies. "Cut-off" value, however, is supposed to represent a "worst case" wildfire, where basically all available connected landscape burns. During the RDF proceeding, SCE presented comparisons of 8 and 24 hour simulations (arguing that 8 hour is sufficient, which MGRA opposed), and their geospatial model clearly showed that in many if most cases very large fires are already running up against physical boundaries: built and developed environments, agricultural lands, the ocean and other water features.[44] By jumping to 5X the maximum historical visible loss, and with simulations showing that it is hard to find scenarios at much larger levels the value that PG&E picked by fit is a plausible maximum upper bound. Of course the uncertainty of this bound can be tested with PG&E's sensitivity analysis data, using the method suggested by MGRA. This reframing is consistent with Taleb's guidance, described in his book The Black Swan:

"*… we do not realize the consequences of the rare event.*

What is the implication here? Even if you agree with a given forecast you have to worry about the real possibility of significant divergence from it… I would go even further and, …state that it is the lower bound of estimates (i.e. the worst case) that matters when engaging in a policy — the worst case is far more consequential than the forecast itself. This is particularly true if the bad scenario is not acceptable."[45]

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[42] p. 16.
[43] PG&E RDF Phase 3 Comments; p. 12. Cites:
Taleb 2022; p. 34.
[44] MGRA Tail Risk Whitepaper; pp. 35-36.
[45] Taleb, Nassim Nicholas. The Black Swan - The Impact of the Highly Improbable. Second edition. New York: Random House, 2010; pp. 161-162.

In the current case, the "worst-case" – based upon physical limitations – is used as input for the cut-off parameter. We have additional knowledge: that wildfires smaller than worst-case follow a power law distribution that has been measured and parameterized. Uncertainty in worst-case can be tested using the method described.

No other uncertainty other than cut-off is likely to affect the output at the order of magnitude level, except one: wildfire smoke.

2.2.3.3. Wildfire smoke, again

Uncertainty due to wildfire smoke risk is a unidirectional dependency. PG&E's wildfire safety risk estimate is too low because it ignores wildfire smoke safety and health risks. MGRA has analyzed and discussed this risk extensively in its filings, and it has been reviewed in an OEIS workshop, but inclusion of wildfire smoke risk into OEIS or CPUC processes has been determined to be a "hard problem" and tabled by both organizations. MGRA filings have argued that regardless of the fact that a "good" model of wildfire smoke exposure is beyond current capabilities, that the approximation introduced by SDG&E using more up-to-date references would be "less wrong" than ignoring what is almost certainly a very substantial source of risk. The approximate approach yields a correction of one fatality per 1,000 to 10,000 acres burned.[46]

2.2.3.4. Perverse incentive

Finally, bias that PG&E might have regarding its choice of risk calculation methodology should be discussed. As has been previously mentioned, PG&E can maximize its profit by choosing the most expensive capital mitigation. Much of the rest of these comments relate to choice of mitigation to reduce wildfire risk. However, the introduction of the cost/benefit ratio (CBR, and more properly benefit/cost ratio) introduces a precondition for a mitigation. In order to have a reasonable argument for mitigation, CBR must be greater than 1.0. According to PG&E's proposal, CBR for undergrounding is 13.[47] If the cost is inflated by a factor of 7.5 (as would be all

[46] MUSSEY GRADE ROAD ALLIANCE COMMENTS ON 2022 WILDFIRE MITIGATION PLANS OF PG&E, SCE, AND SDG&E; April 11, 2022; pp. 47-50. (MGRA 2022 WMP Comments)
[47] DR Response RAMP-2024_DR_SPD_015-Q001, refers to:
MGRA Workpaper RAMP-2024_DR_SPD_015-Q001_804549Atch01_804550-Secondaries-jwm.xlsx

other mitigations), then CBR is reduced to 1.7. The argument for using an undergrounding mitigation in preference to other mitigations that have higher CBR, as PG&E does, is severely compromised by this rescaling, as individual circuits will be more likely to have undergrounding CBR less than 1.0.

PG&E's proposal gets even weaker. In this GRC cycle, PG&E proposes substantial mileage of secondary lines and service drops. SPD Data Request 15 Q1 addressed this issue and PG&E responded with a file published as an MGRA workpaper called MGRA Workpaper RAMP-2024_DR_SPD_015-Q001_804549Atch01_804550-Secondaries-jwm.xlsx.[48] PG&E's CBR for secondary lines is 9.4, and if this is reduced by 7.5X the CBR hovers over 1.0 at 1.3. However, PG&E's CBR estimate for service drops is only 2.4, and if rescaled this would be only 0.3 – far below the breakeven CBR of 1.0. Therefore, it is only the risk rescaling by PG&E's risk-averse multiplier that makes this effort viable, in the sense it is in the public interest. PG&E's proposed service drop program cost is $750 million. The cost for secondaries is $135 million. Nearly $1 billion in capital costs (almost $100 million in profit for PG&E) is totally dependent on PG&E's risk scaling function. There is a strong perverse incentive for PG&E to try to amplify its wildfire risk.

2.2.3.5. Risk scaling conclusion

The original MGRA position regarding PG&E's "market based" CAT bond proposal was skeptical but open to seeing what PG&E's proposal entailed.[49] Having now examined PG&E's RAMP filing and data request responses, it is necessary to reach the conclusion that PG&E has not provided sufficient information supporting its proposal, and that information which it has provided tends to discredit its proposal. PG&E's new risk scaling function has a number of critical flaws:

- The wildfire CAT bond market is extremely small and its risk premium estimates vary substantially,

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Note: PG&E RAMP tables and data request responses list two different CBR values for undergrounding, one ~8 and another ~13. This was late-discovered in the analysis, and SPD should apply whichever that it has determined is the value currently supported by PG&E. PG&E doubtless will clarify in its comments as well.

[48] Id.

[49] MGRA RDF Workshop 4 Reply; p. 5.

- The “market” for wildfire CAT bonds is extremely illiquid and likely to lack information, explaining some of this variability,
- PG&E appears to be basing its risk scaling function on only one CAT bond,
- Neither PG&E, the Commission nor any stakeholder has visibility into how risk premium is determined by the reinsurer,
- Unless the reinsurer is using PG&E’s risk estimates as the basis of its risk premium, it is extremely unlikely that its risk estimation is anywhere near that developed by PG&E, and therefore it may be no more than an educated guess,
- Unless the re-insurer is using a Pareto risk distribution for wildfire, a bespoke approach that does not seem to be yet in use outside of PG&E and SDG&E, or unless PG&E itself has abandoned the Pareto approach to consequence modeling, the use of a risk multiplier to amplify the predicted wildfire risk is entirely inappropriate and would lead to estimated losses up to $750 billion. (Reminder, that is indeed a ‘b’.)
- Classical estimates for uncertainty premium range from 25-40%, whereas PG&E’s uncertainty premium is 650%.
- Even allowing for the fact that an uncertainty premium for a Pareto distribution should be significantly higher than classical estimates, PG&E has a transparent way to estimate this premium using the sensitivity analysis it performed for its consequence cap, currently set to 5X the losses of the Camp fire.
- PG&E has a significant perverse incentive to amplify risk, because it is proposing a nearly $1 billion undergrounding program for secondary and service drops that would not meet the criterion of a favorable CBR.

PG&E’s new risk averse scaling approach is patently inferior to its existing risk calculation, which was developed over many years at great effort and expense, and thoroughly vetted by stakeholders. For PG&E to arbitrarily multiply its risk by a number that neither it nor stakeholders understands undoes much of that work and compromises the goal of creating a CBR, which is intended to calculate risk in terms of cost. PG&E needs to incorporate uncertainty, but it can do so using the sensitivity analysis it has already done for cut-off threshold.

Intervenors, particularly TURN, have been pushing for linear risk scaling, and to at least have a reference with linear risk scaling to compare to any new model. The Commission, so far, has not been ready to intercede on this issue. However, given the state of PG&E’s new risk scaling it is imperative that the Commission ensure that there is a transparent model available for comparison and potentially for use.

Recommendations:

- PG&E's GRC application should not be considered unless it includes calculation of CBR assuming linear risk scaling.
- PG&E's GRC application should not be considered unless it provides additional information supporting its use of the Phoenix Reinsurance bond and showing that the risk premium of this bond is based on quality risk analysis that is as good as or better than PG&E's risk analysis. This showing must indicate whether the CAT bond is using a Pareto distribution for wildfire loss estimates, and whether PG&E itself continues to use its Pareto based consequence model.
- PG&E should incorporate uncertainty into its risk calculation through a mechanism other than the CAT bond. The suggested mechanism is to use the function derived from PG&E's consequence cap analysis to provide the basis for a Monte Carlo varying around the 5X Camp fire value using a lognormal distribution with deviation suggested by SMEs.
- PG&E should adopt SDG&E's methodology for approximating wildfire smoke impacts, and use current references which have an imputed risk per acre burned of between 1,000 and 11,000.

3. ELECTRICAL OPERATIONS – WILDFIRE, PSPS, AND EPSS

3.1. Assumptions – Covered Conductor versus Undergrounding

Covered conductor has been extensively deployed by Southern California Edison, and has led to an extremely rapid and significant drop in wildfire risk, as shown in the figure below.