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Docket: 2021-WMPs e-filing

RE: MUSSEY GRADE ROAD ALLIANCE COMMENTS ON THE 2021 WILDFIRE MITIGATION PLAN Q3 QUARTERLY REPORTS OF SDG&E, PG&E, AND SCE

Dear Office of Energy Safety Infrastructure,

The Mussey Grade Road Alliance (MGRA or Alliance) files these comments on the third quarter 2021 reports of SCE,[1] SDG&E,[2] and PG&E[3] pursuant to the WSD Guidance letter of July 17, 2020,[4] which authorized public comment within 14 days of their mailing for Remedial Compliance Plans (RCPs) and Quarterly Reports (QRs).

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[1]Southern California Edison Company's Wildfire Mitigation Plan Progress Report Pursuant to Resolution WSD-020 (SCE Report); Southern California Edison Company's Quarterly Notification Pursuant to Public Utilities Code Section 8389(e)(7) Regarding the Implementation of Its Approved Wildfire Mitigation Plan and Its Safety Culture Assessment and Safety Recommendations (SCE QN); Update Change Order Report (SCE UCOR); SCE Table 12 update TN10430-2_20211101T165709_SCE_Q3_2021 (SCE Table Update); and SCE Q2 2021 QIU (SCE QIU); November 1, 2021.
[2] San Diego Gas & Electric 2021 WMP Action Statement – Supplemental (SDGE WMP-AS); QUARTERLY NOTIFICATION TO THE OFFICE OF ENERGY INFRASTRUCTURE SAFETY REGARDING SDG&E'S IMPLEMENTATION OF ITS WILDFIRE MITIGATOIN [sic] PLAN, PURSUANT TO PUBLIC UTILITIES CODE SECTION 8389(e)(7) (SDG&E QN); and TN10431_20211102T133927_2021QIU_11_1_2021 (SDG&E QIU); November 1, 2021.
[3] PACIFIC GAS AND ELECTRIC COMPANY QUARTERLY REPORT ON 2020 WILDFIRE MITIGATION PLAN FOR THIRD QUARTER 2021 (PG&E QR); 2021 Wildfire Mitigation Plan – Change Orders for 2021 Wildfire Mitigation Plan (Docket #2021-WMPs) (PG&E CO); PACIFIC GAS AND ELECTRIC COMPANY'S SUBMISSION OF 2021 WILDFIRE MITIGATION PROGRESS REPORT (PG&E WMP-PR); and TN10411_20211101T104657_PGE's_Quarterly_Initiative_Update_for_Third_Quarter_2021 (PG&E QIU); November 1, 2021.
[4] Guidance on the Remedial Compliance Plan & Quarterly Report Process Set Forth in Resolution WSD-002; Caroline Thomas Jacobs; July 17, 2020.

The following Alliance comments were prepared by MGRA's expert witness, Joseph W. Mitchell, Ph.D.

1. UTILITY COLLABORATION

MGRA is pleased to see that utilities have begun to collaborate on a number of issues, including vegetation clearance,[5] PSPS consequences,[6] and risk modeling.[7] IOUs will also be collaborating on RSE approaches.[8] MGRA has consistently been a proponent of fostering a unified approach to utility wildfire prevention.[9] Wildfire does not respect service area boundaries. And while there are climactic and geographic differences between ecological firescapes, how these are divided between utility service areas is arbitrary. Collaboration provides two primary benefits to ratepayers and residents: First, it helps to identify best practices so that they can be used across the state, guaranteeing that all California residents equal access to safe power. Secondly, it reduces development costs and the costs of false starts and non-optimal choices, and these savings can be passed on to ratepayers.

Energy Safety has attended some of these joint meetings, for example the vegetation clearance study meetings.[10] It would also be beneficial for members of the public to attend some of these meetings, particularly those who might have the ability to provide technical input and ask relevant questions. While it is efficient for IOUs to work directly together, there is a concern that they may concentrate on approaches that benefit utilities over ratepayers. It should be possible for the public to learn about utility approaches and provide feedback before they become *faits accomplis*.

In the cases where technically qualified members of the public have been specifically invited to attend, for instance the OEIS-sponsored wildfire risk modeling working group, this is not as much of a concern. However, SDG&E has itself raised a concern regarding the Wildfire Risk Modeling Working Group that: "*The electrical corporations designing and implementing the*

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[5] PG&E WMP-PR; p. 82; SDG&E WMP-AS; p. 13.
[6] PG&E WMP-PR; p. 10.
[7] PG&E WMP-PR; p. 99.
[8] Id.
[9] See for example WMP-21; Appendix A; p. 12.
[10] PG&E WMP-PR; p. 82.

models should have the opportunity to first discuss and learn together about risk modeling before the qualified parties provide additional input on the models. There are concerns that the working groups will not be as effective if other qualified parties are involved in each meeting, as models continue through the development and discussion process."[11] SDG&E proposes that "*the qualified members join every other working group session, so in total one two-hour working group a month*."[12]

SDG&E's proposal to limit attendance by non-utility experts is flawed both technically and from a policy standpoint. The SDG&E proposal makes several technical mistakes that would render their proposal unworkable:

- The proposed meetings are every three weeks. Limiting non-utility attendance to every other meeting would mean that these team members would attend every six weeks, not every month.
- While meeting duration is not finalized, it was MGRA's expert's recollection that meetings would be three hours.
- Topics have been tentatively pre-assigned to meetings. Adopting SDG&E's proposal would mean that non-utility attendees would be excluded from discussions of certain topics.

From a policy standpoint, the idea that non-utility experts should be excluded from discussions runs counter to OEIS's intent for the working group. While there may well be value in having utilities share approaches to wildfire problems in a non-public setting, there is nothing that prevents them from doing so on their own time. As it is, the tentative schedule proposed by Energy Safety crowds many complex and technical topics into a short time frame, and it will be challenging to achieve the proposed goals of the group. Further curtailing the length of the meetings by limiting the attendance of non-utility experts would prevent critical topics from being adequately discussed.

Energy Safety should ensure that utility working groups are adequately transparent. In working groups for which there currently is no public involvement or input, such as vegetation management, OEIS should organize quarterly or bi-annual public workshops during which the

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[11] Docket # Risk-Model-Group; SDG&E Comments on Energy Safety Risk Modeling Workshop; November 8, 2021; p. 2

[12] Id.

public can ask questions and make comments. These should be dedicated events outside of the annual WMP review period, which is already too short. For meetings that have public input, such as the Wildfire Risk Modeling Workshops, Energy Safety should ensure that access by qualified non-utility experts is encouraged.

Recommendations:

- Joint utility working groups organized by OEIS that don't currently allow public attendance should hold quarterly or biannual public workshops during which results of the working group can be presented and members of the public can ask questions.
- Joint utility working groups organized by OEIS that do currently allow public attendance should continue to do so. Utilities that wish to share information prior to the working group meeting are free to organize appropriate side-bar meetings with each other.

2. USAGE OF WIND VARIABLES IN RISK ESTIMATES AND PLANNING

MGRA's comments on the 2021 WMPs comprehensively addressed the issue of how utilities are using wind speed to calculate ignition probabilities and thereby circuit risks.[13] MGRA demonstrated that there is overwhelming evidence that high winds are correlated with outages and ignitions. MGRA's input was incorporated into several Issues found by Energy Safety its WMP reviews:

> *PG&E-21-04:*
> *Issue title: PG&E does not adequately justify the wind speed inputs it uses in its Probability of Ignition models.*
> *Issue description: PG&E's Outage Producing Winds model finds a correlation between equipment failure and high wind speed. Despite the correlation, PG&E does not use peak wind speed as part of its input data set for its Equipment Probability of Ignition models. Instead, PG&E uses average wind speed. PG&E provides justification for its rationale in its Revision Notice Response, however inconsistencies remain between PG&E's approach and that of its peer utilities that use peak or near-peak wind speeds as part of their Wildfire Risk Modeling input data sets.*[14]

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[13] MUSSEY GRADE ROAD ALLIANCE COMMENTS ON 2021 WILDFIRE MITIGATION PLANS OF PG&E, SCE, AND SDG&E; March 29, 2021; pp. 14-39.
[14] WMP-021; Appendix A; p. 45.

SCE-21-11, Unclear how SCE's ignition models account for correlations in wind speeds, ignitions, and consequence.
Despite an observed correlation between some ignition causes and high wind speed, SCE states that it "does not have enough wind- driven outage data at the circuit level to make determinations about correlations between wind speeds and outage rates." It is unclear how SCE accounts for this correlation between wind speed and ignitions in its probability of ignition models. [15]

Utilities have provided extensive responses to the issues identified by Energy Safety, and these responses are addressed below. In summary, the IOUs' new machine learning analyses continue to ignore critical predictive information regarding "fire weather" data, and therefore there is likely additional room for improvement in these models. Approaches that may be enable the incorporation of this data are suggested. Future changes in utility models will likely result in additional re-ordering of utility remediation priority lists.

2.1. PG&E Response to PG&E-21-04

PG&E states: "To be clear, we agree that peak wind speeds are a key contributor to failures, ignitions, and wildfires. However, peak wind speed data sets are not predictive in the current Probability of Ignition Models."[16] This response begs the question: **How can a "key contributor" be "not predictive"**? Doesn't this throw doubt on the results of the models? For explanation, PG&E refers to its Revised WMP.

In its Revised WMP, PG&E explains its use of weather data:
*For weather covariates, we are interested in the more proximate environmental causes of failures (like wind and gusts) and factors that influence ignition viability and spread (like ground cover, fuel moisture, and wind). However, we are evaluating these on the timescale of entire fire seasons, so covariates **must reflect temporal aggregation**, capturing the typical or extreme values of each or some cumulative count or "exposure" to*

[15] WSD-020; Appendix A; App-15.
[16] PG&E Report; p. 8.

dangerous conditions across the season(s).[17] (Bold face underline added.)

The decision to capture weather variables as aggregates underlies the problem with IOU approaches to incorporating wind as an ignition source. Extreme weather events are rare, and averaging them over longer periods of moderate weather can wash out the signal so that it is invisible. Which scenario is more likely to result in an ignition: 500 hours of 1 mph wind gusts or 5 hours of 100 mph wind gusts? An "aggregated" linear averaging approach would view these two scenarios as equivalent. It should be remembered that "aggregation" is a method for *throwing data away*. There is nothing inherently wrong with throwing data away – in fact the art of scientific analysis is the art of extracting elusive information from massive amounts of data in a manner that does not bias the result. The relatively new domain of *data science* (comprising machine learning - ML, and AI) differs from traditional scientific methods by demanding *more* rather than *less* pre-processed data and using advanced algorithms to optimize predictions based on all available information. Using more information often allows ML and AI to significantly outperform traditional statistical approaches. Nevertheless, all methods including ML and AI suffer from the fundamental constraint of all computational science: garbage in, garbage out.

The results of PG&E's analysis using aggregated weather data are shown below.

[17] PG&E Revised WMP; p. 163.

TABLE PG&E-REVISION NOTICE-4.5-2: VEGETATION PROBABILITY OF IGNITION – COVARIATES

Rank	Model Feature	Feature description	Units	Permutation Importance (%)
1	tree-height-max	Satellite derived tree height estimates – highest tree per-raster pixel	m	26.1
2	100-hour-fuels-avg	standard fire modeling metric of fuel dryness for fuels about 1-3" in diameter, mean over season	%	24.1
3	vapor-pressure-deficit-avg	vapor pressure deficit, mean over season	kPa	21.6
4	gusty-summer-day-pct	The percentage of days with sustained hourly wind speeds over 20 mph	%	6
5	HFTD	High Fire Threat District (2 or 3)		4.2
6	precipitation-avg	Seasonal daily average precipitation	mm	3.1
7	Impervious	NLCD imperviousness product - represent urban impervious surfaces as a percentage of developed surface	%	2.8
8	specific-humidity-avg	Seasonal average specific humidity	kg/kg	2.4
9	burn-index-avg	National Fire Danger Rating System (USNFDRS) Burning Index (BI)		2.3
10	wind-max	Annual 99th percentile hourly wind speed at 10m	m/s	1.9
11	temperature-avg	Average of daily maximum temperature in Kelvin	K	1.6
12	windy-summer-day-pct	The percentage of days with sustained hourly wind speeds over 15 mph	%	1
13	local-topography	The topographic position index (TPI) extracted from the USGS national elevation dataset		0.8
14	tree-height-avg	Satellite derived tree height estimates – average per-raster pixel	m	0.8
15	1000-hour-fuels-avg	standard fire modeling metric of fuel dryness for fuels about 3-8" in diameter, mean over season		0.6
16	energy-release-avg	USNFDRS Energy Release Component (ERC)		0.4

Table 1 - PG&E's revised Table 4.5-2, showing the relative contributions of covariates in its ignition probability analysis for vegetation-related ignitions, ranked from most significant to least.[18]

[18] PG&E Revised WMP; p. 164.

TABLE PG&E-REVISION NOTICE-4.5-3: EQUIPMENT PROBABILITY OF IGNITION - COVARIATES

Rank	Model Feature	Feature Description	Units	Permutation Importance
1	Unburnable	non-burnable area	%	30.8
2	precipitation_ave	daily precipitation, mean	mm	29.8
3	conductor_material_acsr	conductor material: ACSR	%	9.7
4	estimated_age	estimated conductor age	years	8.9
5	tree_height_max	max tree height	m	4.3
6	splice_record_exists	Reliability Program splice	%	4.3
7	vapor_pressure deficit_ave	vapor pressure deficit, mean	kPa	4.0
8	conductor_size_2	conductor size: 2	%	3.4
9	conductor_size_4	conductor size: 4	%	1.6
10	100_hour_fuels_ave	100-hour fuel moisture, mean	%	1.1
11	max_temperature_ave	max temperature, mean	K	1.0
12	wind_ave	wind speed, mean	m/s	0.9
13	local_topography	TPI	%	0.2
14	conductor_size_6	conductor size: 6	%	0.1
15	conductor_material_al	conductor material: Al	%	~0
16	conductor_material_cu	conductor material: Cu	%	~0
17	coastal	coastal	%	~0
18	specific_humidity_ave	specific humidity, mean	%	~0

Table 2 - PG&E's revised Table 4.5-3, showing the relative contributions of covariates in its ignition probability analysis of equipment-related ignitions, ranked from most significant to least.[19]

The results in the above tables can be briefly summarized. While there are many covariate model features, many of these arise from common or similar drivers. For instance, covariates precipitation_ave, vapor_pressure_deficit_ave, fuel moistures covariates, and low humidity arise from and are correlated with "drought". Features relating to conductor materials, age, and splices would be expected to correlate to and arise from "outdated equipment". For PG&E's vegetation-related ignitions, most predictive features primarily come from "drought" and "tree height". For PG&E's equipment-related ignitions, its most predictive features come from "drought" and "outdated equipment". In neither case does wind rank as a significant feature.

How can this be if wind is a "key contributor" to ignitions? As mentioned previously, MGRA provided significant evidence in its WMP comments that ignitions are strongly correlated with wind. Part of the evidence presented was PG&E's own OPW (Outage Producing Wind) model results, which show a super-linear dependence of outage rates on wind speed. An additional demonstration of the wind speed dependence of outages is shown in PG&E's report on its study of RF and ECCVM fault detection, released in response to Energy Safety Issue PG&E-21-07.

[19] PG&E Revised WMP; p. 164.

Figure 18. Wind Speed/Wind Gust Timeseries Data for Weather Stations with ECCVM Events

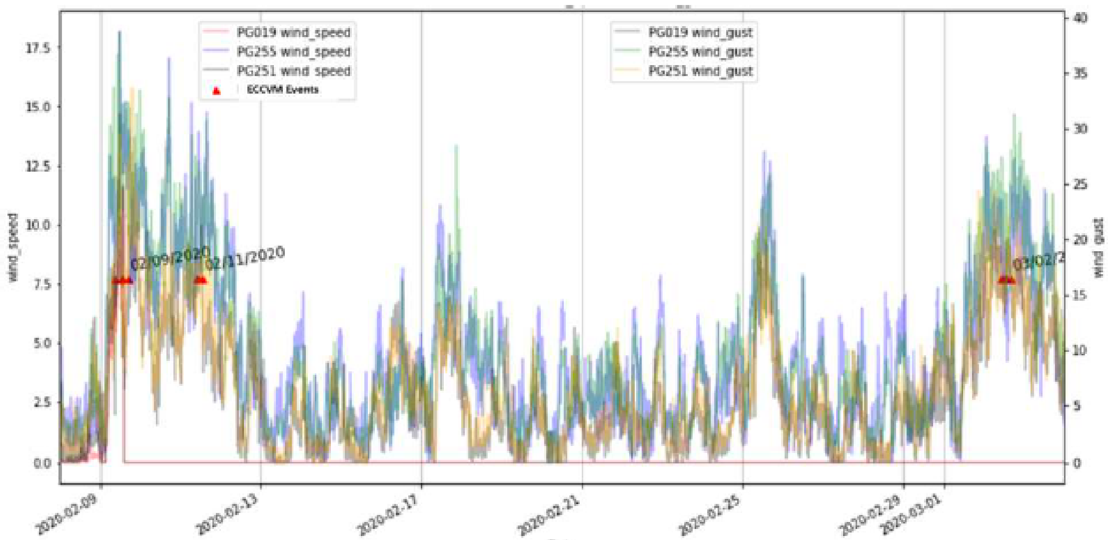

Figure 1 - PG&E wind speed measurements correlated to fault events detected with its prototype ECCVM (Event Classification through Current and Voltage Monitoring) technology.[20]

PG&E's study, released as part of an EPIC research program, describes PG&E's use of Event Classification through Current and Voltage Monitoring, a technology originally developed at Texas A&M university.[21] The ECCVM technology can detect incipient fault conditions. Figure 1 demonstrates an intermittent condition that arises during wind gusts. In this case, the detection led to "a section of circuit in which there appeared to have been phase conductors slapping together, probably caused by wind. A spacer was added to this circuit and no additional faults have recurred."[22]

In order to clarify why winds do not play a larger role in PG&E's POI model, PG&E's Revised WMP explains that: "*The annual ignition probability model assesses* ***spatial*** *differences in ignition likelihoods rather than* ***temporal*** *ones and treats all ignitions equally, with downstream consequences for each ignition calculated using fire simulations whose input weather is drawn from more than 400 of the worst fire weather days in the last 30 years*."[23] (bold emphasis PG&E). PG&E's oversight in this case that probability of ignition has ***<u>both spatial and temporal</u>***

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[20] PG&E Response; EPIC 2.34 Predictive Risk Identification with Radio Frequency (RF) Added to Line Sensors Reference; Name EPIC 2.34 RF Sensors; November 12, 2020; p. 48.
[21] Texas Wildfire Mitigation Project;
https://wildfiremitigation.tees.tamus.edu/
Downloaded 11/11/2021.
[22] Op. Cite.
[23] PG&E Revised WMP; p. 165.

dependencies. In other words, there may be areas of the PG&E service areas that are particularly susceptible to high winds during fire weather conditions, and PG&E's analysis method has no mechanism for identifying these if the spatial distribution is different from that of other ignitions.

PG&E argues that the wind-related ignition events are in fact incorporated into its analysis, but they are overwhelmed by other ignition sources: "*If there are a similar number of wind events in similar locations over time, the model is already accounting for wind impacts on annual ignitions. However, most ignitions are not caused by wind at all and 95 percent of outages do not occur during NE wind event days*."[24] As MGRA noted in its WMP Comments, "most ignitions" are harmless, most ignitions causing catastrophic fires *were* caused by wind during NE wind event days. The greater number of non-wind ignitions will tend to dilute geographic dependency.

Comparing PG&E's two quotes listed above reveals a fundamental error in its methodology:

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

PG&E is therefore calculating risk based on consequences resulting from conditions that are unlikely to exist when the risk events occur. This will result in an overprediction of risk for events unrelated to wind, an overprediction that overwhelms the estimated risk from wind-related events. If the geographic distributions of wind-related and unrelated events are different, then PG&E's model will overweight areas where catastrophic wildfire risk may not be as great.

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

In one sense, this problem is an outgrowth of limitations of the MAVF model, problems that MGRA raised while MAVF was under consideration during the S-MAP proceeding.[25] The MAVF

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24 Id.; p. 166.
25 CPUC; A.15-05-002-5; REPLY OF THE MUSSEY GRADE ROAD ALLIANCE (MGRA) TO PARTY COMMENTS ON THE INTERVENOR SMAP WHITE PAPER; February 26, 2016; p. 6.

methodology assumes that for any given risk event type, the probabilities and consequences are independent, allowing risk to be determined by summation over the products of probability and consequence for individual risk events. For the case where probability and consequence are strongly correlated, as they are for wildfire ignition, this simple relationship does not hold. As will be explained in a subsequent section, this problem may be at least approximately addressed by appropriate tranching of risk types.

In its Q3 Report, PG&E explains that part of the problem is the difficulty of the calculation: "*The key challenge is that it is difficult to predict the peak wind speed in a location in the next year. Moreover, it is not just predicting the peak wind speed but the probability that a wind speed will occur that will exceed the strength of trees and assets in a given location*."[26] PG&E's assertion is correct. Nevertheless, this is the key problem that utility Probability of Ignition models need to solve:

The goal of utility probability of ignition models is to determine the correct spatio-temporal distribution of the probability of ignition of potentially catastrophic wildfires resulting from their equipment.

Potential remedies will be addressed in a subsequent section.

2.2. Southern California Edison Probability of Ignition

SCE also addresses the probability of ignition in its Q3 Report in response to OEIS Issue SCE-21-11, which states:

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

In response, SCE provides additional support for the premise that wind can drive an increase in ignition probability:

[26] PG&E Report; p. 9.

While sufficient data did not exist on all circuits, there was sufficient data on many circuits which has allowed SCE to observe statistically significant correlations for 10% of circuits for which there was available data." This was determined based on a study SCE performed in late 2018, when SCE tested the circuit-level wind speeds and wind-driven outage correlations in order to perform circuit-by-circuit analysis. In some cases, for example for circuits located in non-windy areas, there were limited recorded wind-caused outages over the past five years.[27]

For its weather data, "SCE's POI model uses 20 years of historical weather data consisting of hourly Atmospheric Data Solutions (ADS) weather model data (e.g., wind speed, wind direction, temperature, dew point, etc.,) to capture the impacts from weather conditions on potential faults and ignitions."[28] This is all very promising so far, but SCE provides some additional detail that raises concern:

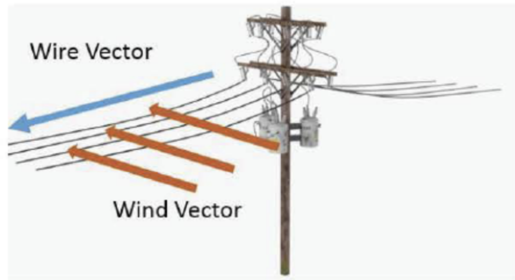
The variables used in the POI models include minimum/maximum/mean/standard deviation of the historical wind/gust speeds at each pole and segment level.[29]

In other words, SCE is using ***aggregated*** weather variables, just as PG&E does. Their POI model may therefore be subject to the same problems as PG&E's, which overpredicts risk from non-wind events due to its use of "worst weather days" consequence modeling.

SCE's analysis has an additional feature that might be expected to improve its predictive power:

SCE leverages the same dataset in conjunction with SCE's pole-loading software program to calculate the cumulative downforce to SCE's lines including both wind speeds and wind directions as well as the relative wind direction to SCE's power lines. An example is illustrated in the figure below:

[27] SCE Report; p. 40.
[28] SCE Report; p. 39.
[29] Id.



The downforce is calculated as:

$$Downforce = \|\vec{A}^{wire} \times \vec{w}^{wind}\|$$

Figure 2 - SCE illustration of its "downforce" calculation, which estimates the magnitude of the wind force perpendicular to the conductor.[30]

> *where the magnitude and direction correspond to the wind speed and direction, and conductor length and direction, respectively. The cross product was chosen because it is maximal when the vectors are orthogonal to each other and minimal when parallel. By including these variables in the POI model, the machine learning model takes the contributions from wind speeds and wind directions, as well as downforces, into account and then correlates the spark-causing outages to these input variables*.[31]

Including a "downforce" variable makes sense from a physics and engineering standpoint, but in combination with aforementioned variable aggregation their approach raises some concerns. Specifically, the wind speed and direction at a location is not constant but instead varies over time. Therefore, the greatest contribution to time-averaged "downforce" may come from winds that are from a different direction than the average. In mathematical terms:

$$\overline{Downforce} = \frac{\int_0^{t_0} \|\vec{A}^{wire} \times \vec{w}(t)^{wind}\| \, dt}{t_0} \neq \|\vec{A}^{wire} \times \overline{\vec{w}}^{wind}\|$$

In plain English, the average downforce over time is *not* the same as the downforce due to the average wind. In the simplest example, say that the circuit segment is aligned in the direction of the prevailing wind. The "average" wind is parallel to the conductor, so if the wind blew only in this direction the average downforce would be zero. In reality, the "average" wind direction is an average over many different wind directions at different times, with the "average" direction being

[30] Id.
[31] Id.

the most typical. But because the wind pressure on the conductor is positive definite (always greater than zero), variations from parallel will always contribute positively to the average downforce.

Note that SCE has not provided enough information to indicate whether its downforce calculation correctly averages downforce over time or whether it uses its aggregated wind variable. However, if it is using mean wind speed and direction in its downforce calculations that would be incorrect. Instead, SCE should be calculating downforce for every moment in time and averaging that value. Energy Safety which method SCE is using.

2.3. Effect of PSPS on POI

A point that MGRA has repeatedly raised ever since power shutoff became a common utility practice is that it biases outage and ignition data, since areas subject to PSPS will not have wind-related outages and ignitions. This bias will tend to increase risk estimates in areas outside of PSPS boundaries and reduce risk estimates within PSPS boundaries – a potentially dangerous outcome.

As a remedy, MGRA has been advocating the incorporation of PSPS damage data into utility risk estimates. There has been some progress in this area.

PG&E, for instance, is in the process of incorporating 2020 PSPS damage events into its Outage Producing Wind (OPW) model.[32] However, the OPW is only used for operational purposes, and is not used for risk estimation for hardening: "*The OPW Model is one of three key inputs into PG&E's analysis to inform Public Safety Power Shutoff (PSPS). The OPW Model forecasts the probability of unplanned outages associated with wind events occurring in PG&E's service area at an hour-by-hour temporal granularity for PSPS planning and decision-making purposes*."[33]

PSPS damage data should not be limited to operational purposes, but also be used by all IOUs in risk modeling for the purpose of determining areas to harden and where PSPS-specific mitigation might prove most beneficial.

[32] PG&E QIU; Row 30.
[33] CPUC; A.21-06-021; PG&E Response to MGRA DR 2, Q6; GRC-2023-PhI_DR_MGRA_002-Q06

2.4. Resolving Probability of Ignition Issues Due to Omission of Hourly Wind Data

MGRA's WMP Comments make clear the evidence that the worst catastrophic utility wildfires are ignited during high-wind conditions, and that high winds are also contributing if not primary causes of these ignitions. No utility disputes that high winds cause damage that can lead to catastrophic fires. In fact, all of them regularly de-energize areas forecasted to be subject to high winds, low humidity, and low fuel moisture.

Nevertheless, high winds do not rank heavily in PG&E's POI model due to its aggregation of weather data, and SCE's model may be similar in this regard since it also uses aggregated weather data. Methods using aggregated weather data will be ineffective at identifying any areas where high fire winds may be prevalent. Consequently, much-needed mitigation to reduce ignition risk and mitigate PSPS harms may go to less appropriate locations.

Utility argument that all ignitions should be considered potentially significant (which is what their POI models assume) has some merit. If ignitions occur randomly in time (a Poisson process) then occasionally one of these ignitions will overlap in space and time with an area experiencing severe fire weather and dangerous fuel conditions, and a catastrophic fire will occur. This is not theoretical, it has happened, with some examples being the Butte and now the Dixie fire. There is no dispute that this type of fire lends itself to the current machine learning models.

On the other hand, most of the destructive historical wildfires in California can be traced to a wind-related ignition: Camp, Tubbs, Thomas, Witch/Guejito, Rice, Woolsey, and Kincade. Models should be able to determine where this kind of outage and ignition is more likely to occur under the Santa Ana / Diablo wind conditions typical of this kind of fire, so that these areas can be favored for appropriate mitigation. The fact that current models do not have a mechanism to incorporate this dependency is a major shortcoming.

The raw hourly weather data contains the information necessary to quantify ignition risk as a function of local wind speed. However, incorporating this data into the machine learning models currently in use is challenging. Another approach is needed. Some ideas are listed below.

2.4.1. Develop a ML/AI model that incorporates hourly weather data

The current ML models being used (Random Forest and Maximum Entropy) do best with a limited number of discrete variables. IOU data teams choose to use aggregated weather variables for this reason. The amount of raw weather data available is very large, and this makes incorporating it a impractical with the current models. Data science teams may be able to suggest alternative approaches that would enable incorporation of the raw weather data.

2.4.2. Score ignitions based on consequences

Wind-related ignitions tend to happen during extreme fire weather and therefore have worse consequences. It may be that some of these ignitions share characteristics that are predictive of bad outcomes, specifically location and weather. Such an approach faces two major hurdles, however. First, this approach breaks the MAVF contract of independence between probability and consequence. This may be okay, since in reality probability and consequence are ***not*** independent for weather-related fires. More daunting is the paucity of available data: there just are not that many truly catastrophic fires to train machine learning models.

2.4.3. Weather-related MAVF tranch(es)

A simple approach was suggested by MGRA in the "MGRA Whitepaper" presented in the CPUC RAMP proceeding and included as Appendix B in the 2021 MGRA WMP Comments. This approach would separate wildfire risk into tranches characterized by weather severity. While the MGRA Whitepaper suggested multiple tranches, a good first step would be to separate risk from random ignitions and risk from externally driven ignitions into two tranches. Ignitions and outages not related to fire weather and wind would be analyzed in one tranche, while ignitions, outages, and PSPS damage arising from fire weather winds would be captured in the other. The advantage of this approach is that it should lend itself to the same tools and methodologies that are currently used for utility risk models. Weather variables could still be aggregated, but would be specific to each tranche.

In order to normalize the two tranches with each other, it is necessary to have a model for the frequency of fire weather events per year. There is abundant data to support such a model.

Because the “fire weather” tranche represents events occurring during fire weather conditions, minimal normalization should be necessary to use it with the Technosylva “400 worst days” consequence calculation. The “random ignition” tranche, on the other hand, will need to have its risk estimates multiplied by the probability that a random ignition occurs during “400 worst days” conditions. Because this is likely to be a small fraction, one should anticipate that the relative contribution of random ignition events to the risk score will substantially decrease. In fact, if IOUs are not performing any such normalization now, we should expect overall wildfire risk scores to significantly decrease with respect to other system risks once this correction is put into place.

PG&E states that it looks forward to further discussions of its POI modeling: “We look forward to participating in the Working Group established by Remedy PG&E-21-02 to further discuss how wind speeds are reflected in risk modeling.”[34] Hopefully these workshops will provide an adequate forum for discussion of these modeling issues. If significant remediation of models turns out to be required, additional sidebar workshops may be appropriate.

Recommendations:

- If utilities are not normalizing wildfire probability with the probability that random ignitions occur during “400 worst day” consequence conditions, they should do so immediately.
- Consideration should be given to dividing risk event data into “fire weather” related events and “random” event tranches for MAVF calculations as well as circuit risk rankings.
- Risk workshops (and potentially sidecar workshops) should discuss methods to address how to differently handle weather-driven ignitions versus random ignitions.
- Energy Safety should verify that SCE is calculating its “downforce” variable based on incremental weather data and then aggregating the result, rather than calculating it from aggregated wind speed and direction.

[34] PG&E Report; p. 9.

3. SDG&E VEGETATION MANAGEMENT

As a result of issues raised by MGRA over the last review periods year, SDG&E was required to address Issue SDGE-21-06 “Quantitative Analysis of “at-risk” Species. SDG&E has done so and presented its results in its Q3 report. MGRA’s concern was that many tree species had been lumped into the “at-risk” category, even though the likelihood that a tree of each type would cause an outage varied broadly between “at-risk” species.

In its response, SDG&E explains that its “at-risk” designation is made “to facilitate targeted inspections of these species to better identify if they require enhanced clearances and/or removal.” It emphasizes that “simply because a tree has been identified as “at risk” does not mean that it will be trimmed to an enhanced clearance.”[35] SDG&E’s “at-risk” designation is based solely on total number of ignitions, not on the relative risk from each tree. This is illustrated in its figure for outages versus tree population:

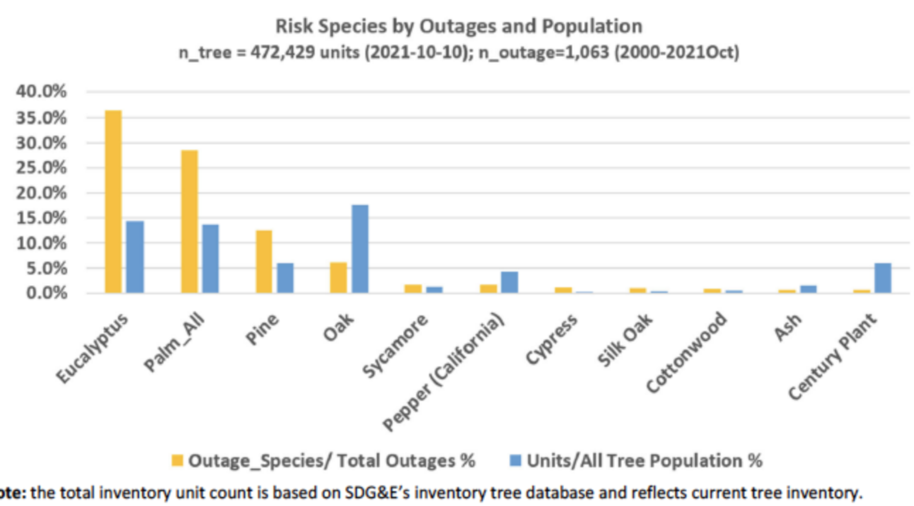


Figure 3 - SDG&E graph of total outages (yellow bars) and tree population (blue bars).[36]

As can be seen, certain species, like eucalyptus and palm, are over-represented in outages with respect to their population, while oaks are responsible for relatively fewer outages.

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[35] SDG&E WMP-AS; p. 17.
[36] Id; p. 18.

MGRA quantified this relationship in its WMP Comments.[37] SDG&E has reviewed and corrected MGRA's result, explaining that "In MGRA's analysis, tree units trimmed represent only a portion of the total inventory units of the species. This explains the discrepancies between the two studies. The revised, corrected 'Average Inventory Per Year' in Chart 6.2 compared to the 'Average Inventory' in MGRA Chart 6.3 explains differences in the relative average outages per 1000 inventory trees."[38] The result of this discrepancy is that MGRA's "Outages per 1000 trees per year" are higher than SDG&E's "Avg. Outages Per 1000 Inventory Units Per Year".

SDG&E provides its modified version of the MGRA table below:

Chart 6.2: 2000-2020 Risk Species Statistics and Threshold[21]

No.	Name	Average Inventory Per Year (Unit)	Average Trees Trimmed Per Year (Unit)	Average Outages Per Year	Total Outages	% of Total Outages	Avg. Outages Per 1000 Inventory Units Per Year
1	Eucalyptus	80,636	44,193	18.10	380	36.2%	0.22
2	Palm	33,592	17,206	14.29	300	28.6%	0.43
3	Pine	30,697	10,407	6.29	132	12.6%	0.20
4	Oak	69,290	17,704	3.10	65	6.2%	0.04
5	Sycamore	5,904	2,815	0.76	17	1.6%	0.13
6	Pepper (California)	16,996	7,491	0.81	16	1.5%	0.05
7	Cypress	1,476	425	0.52	11	1.0%	0.35
8	Silk Oak	2,351	1,450	0.43	9	0.9%	0.18
9	Cottonwood	3,913	1,792	0.43	9	0.9%	0.11
10	Century Plant	11,002	317	0.33	7	0.7%	0.03
11	Ash	7,562	4,309	0.33	7	0.7%	0.04
12	Avocado	24,238	10,947	0.29	6	0.6%	0.01
13	Tamarisk/Salt Cedar	2,059	1,244	0.29	6	0.6%	0.14
14	Willow	13,937	8,128	0.29	6	0.6%	0.02
23	Ficus	3,605	1,395	0.14	3	0.3%	0.04

Table 3 - SDG&E's list of risk species ranked by total number of outages and showing the number of outages per 1000 trees in the inventory.

Using the number of outages per inventory rather than trees trimmed results in a lower number of outages per 1,000 trees, and this varies between species because not all species were trimmed at the same rate. Comparing the SDG&E and MGRA results, however, shows that while there are significant differences for some minor contributors, the overall ranking for the five "at risk" species is the same using both the MGRA and SDG&E data.

[37] MGRA 2021 WMP Comments; p. 40.
[38] SDG&E WMP-AS; p. 19.

	Name	Avg. Outages Per l000lnventory Units Per Year	MGRA Outages Per 1000 Trims	Ratio MGRA/ SDGE	SDGE At-Risk Rank	MGRA At-Risk Rank
1	Eucalyptus	0.22	0.53	2.41	3	3
2	Palm	0.43	1.11	2.59	1	1
3	Pine	0.20	0.70	3.52	2	2
4	Oak	0.04	0.19	4.77	5	5
5	Sycamore	0.13	0.36	2.74	4	4
6	Pepper (California)	0.05	0.11	2.22		
7	Cypress	0.35	1.42	4.06		
8	Silk Oak	0.18	0.28	1.56		
9	Cottonwood	0.11	0.37	3.36		
10	Century Plant	0.03	1.25	41.67		
11	Ash	0.04	0.13	3.25		
12	Avocado	0.01	0.06	6.00		
13	Tamarisk/Salt Cedar	0.14	0.30	2.14		
14	Willow	0.02	0.05	2.50		
23	Ficus	0.04	0.32	8.00		

Table 4 - Comparison of MGRA and SDG&E estimates per 1000 trees. SDG&E numbers are lower because they use the entire inventory. While some species show a larger discrepancy (century plant, ficus, avocado), the relative rankings of the five at-risk species are identical in each analysis.

MGRA and SDG&E's analysis reach identical conclusions regarding the five "at-risk" species. We note that SDG&E's decision to designate these species as "at-risk" leads can lead to confusion, as when the first yearly Independent Evaluator report on SDG&E's WMP raised the issue that SDG&E was trimming too many eucalyptus and palm trees. MGRA took issue with the Independent Evaluator's assessment in the audit report and supported SDG&E's emphasis on these species.[39]

While MGRA does not take issue with the general approach and prioritization that SDG&E has put into practice regarding its "at-risk" species, we still find it problematic that this designation is applied to species of significantly different relative risk. The term also has a pejorative implication, since it implies that a tree of a given species innately presents a hazard. SDG&E should consider replacing this designation with a more accurate and less worrisome classification, for example "enhanced inspection."

[39] Docket: 2021-IE; MUSSEY GRADE ROAD ALLIANCE COMMENTS ON THE INDEPENDENT EVALUATOR REPORTS OF SDG&E, PG&E, AND SCE; August 3, 2021; pp. 5-6.

Recommendation:

- SDG&E should replace its "at-risk" species classification with a term that more accurately represents the purpose of this classification, for example "enhanced inspection".

4. COVERED CONDUCTOR, UNDERGROUNDING, PILOTS, AND MOON SHOTS

Since 2017, extreme fire weather conditions and record drought have become yearly occurrences, leading to record-breaking catastrophic fires and outage events. While IOUs have been using power shutoff as a stopgap measure, this is not acceptable in the long term to either regulators or the public. Long term plans as evidenced in the PG&E and SDG&E RAMP filing show a slow steady decrease in wildfire risk over time, but nothing that indicates the problem will soon be under control. Nevertheless, utilities are rolling out, or planning to roll out, massive infrastructure projects. SCE is all-in on covered conductor, while PG&E is planning a massive undergrounding program to bury 10k of the 25k miles of conductor it maintains in the HFTD. Simultaneously, utilities are investigating a slew of advanced technology projects, some of which show promise but may be moot for underground circuits. Putting all of this into context, the question that Energy Safety and IOUs should be asking is: "*How can we most quickly and efficiently eliminate the risk of wildfire and power shutoff?*"

4.1. Undergrounding

As mentioned in our previous comments on quarterly reports, PG&E has announced that it plans to propose a "moon shot" program to underground 10,000 of the 25,000 miles of distribution line in its service territory.[40] This has raised concerns among CPUC staff and intervenors involved in PG&E's GRC proceeding.

Edison, with its commitment to covered conductor, issues a scathing assessment of undergrounding in its Change Order Report, stating that:
"*undergrounding remains a considerably more lengthy and costly mitigation than other approaches*

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[40] PG&E Will Bury 10,000 Miles of Power Lines So They Don't Spark Wildfires; Associated Press; July 21, 2021. (NPR)
https://www.npr.org/2021/07/21/1019058925/utility-bury-power-lines-wildfires-california

to mitigating overhead bare conductor risk. In addition to lengthy deployment time and comparatively high unit costs, undergrounding can also require more miles to be installed than what is required for an overhead route, for example to bypass rocky terrain or sloping areas, or obtain easements. For targeted undergrounding in 2021, this will result in an average of approximately 20 percent more miles of undergrounding per project than was previously required by the overhead circuitry. Given the relative ease of terrain in 2021, this average could be much higher for more difficult terrain in the future."[41]

In a section titled "PG&E's Undergrounding Announcement Threatens to Render All Technology Programs Moot", MGRA's comments on utility Q2 reports observes that "*this switch in prioritization and strategy, if it were to occur, undoes the efforts taken over the past decade by the CPUC and OEIS to mandate cost-effective wildfire safety measures through the S-MAP/RDF/RAMP process and the Wildfire Mitigation Plans. Undergrounding, while an effective method of eliminating wildfire risk, has generally be acknowledged as one of the least cost-effective ways of approaching the problem. Adoption of this strategy by PG&E will likely lead to similar approaches by the other utilities, particularly if the possibility of accessing taxpayer funds is added to the mix. There is a real danger that other mitigation methods that are more cost effective or that are based on promising but not yet fully available technology…*"[42]

PG&E, on the contrary, asserts that: "*We do not believe that our 10,000 miles of undergrounding proposal will impact any research or technologies that are under review. We will continue to evaluate and, where appropriate, use these technologies*."[43] It has a similar position regarding hardening: "*PG&E's decision to underground 10,000 miles of its electric system will not have an immediate impact on the decision-making framework for system hardening because we are currently in the initial stages of program development*."[44] It strains credulity that a program of the magnitude PG&E is planning to propose (which may be over $30 billion) will not affect potentially redundant risk reduction approaches.

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[41] SCE WMP-COR; p. 3.
[42] Docket 2021-WMPs; MUSSEY GRADE ROAD ALLIANCE COMMENTS ON THE 2021 WILDFIRE MITIGATION PLAN Q2 QUARTERLY REPORTS OF SDG&E, PG&E, AND SCE; August 16, 2021; p.3.
[43] PG&E Report; p. 45.
[44] Id.; p. 43.

Energy safety should ensure that alternatives to undergrounding projects are adequately investigated by utilities so that equally effective solutions can be developed if they exist. These solutions may consist of a combination of hardening and advanced technologies.

4.2. Covered Conductor

As noted in Section 1, the OEIS has requested that utilities collaborate on a common review of covered conductor. This is essential due to the extreme difference between utilities in their approaches to covered conductor installation and their claimed costs from it. SCE's covered conductor installation is well underway with at least 1,000 miles (and possibly up to 1,400 miles) scheduled for 2021.[45] IOUs however, have limited expectations for the effectiveness of covered conductor. For example, here are the risk buy-down curve from SCE as a function of cumulative miles:

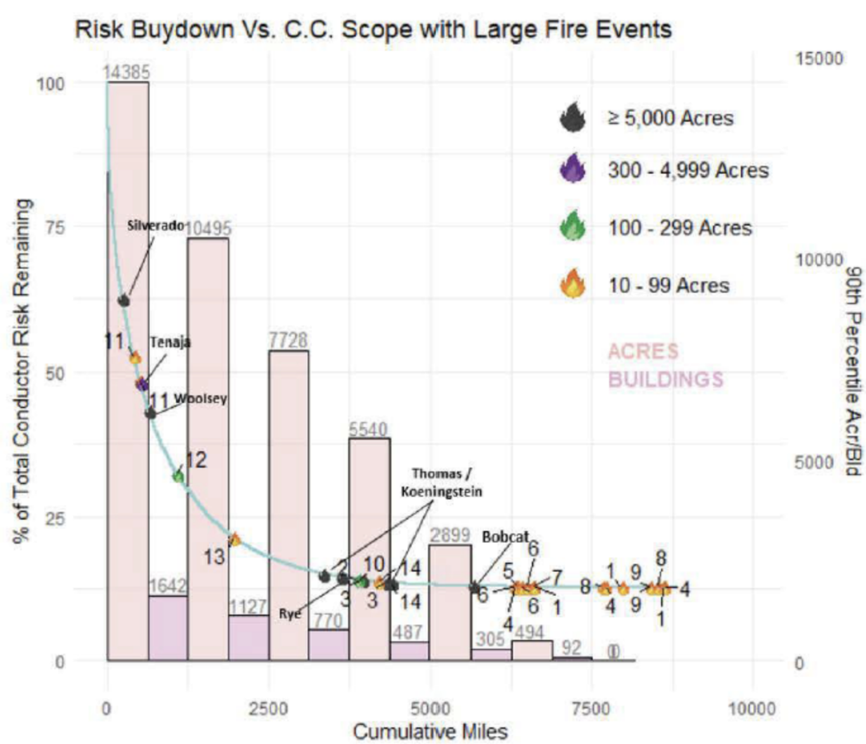

Figure 4 - SCE risk buy-down curve showing segments responsible for major fires attributed by CAL FIRE to utility ignitions.[46]

[45] SCE QIU; Row 17.
[46] SCE Report; p. 16.

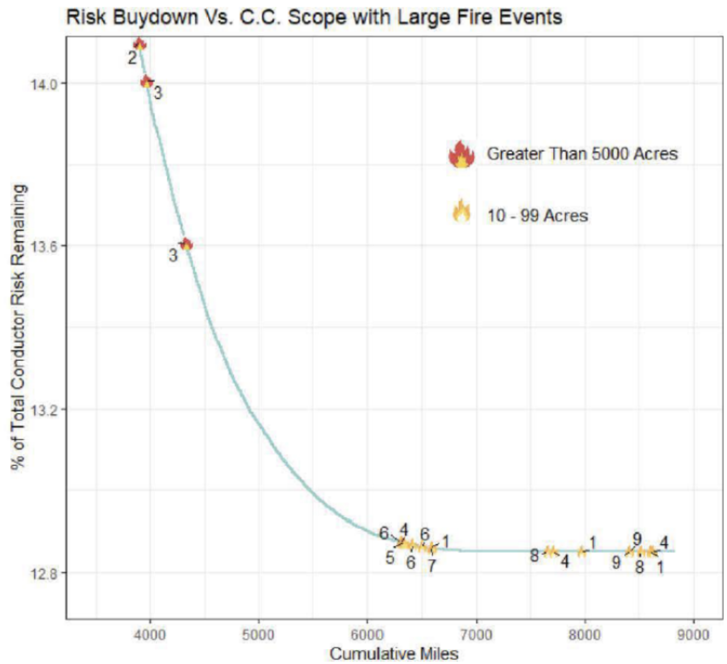

Figure 5 - Cost buy-down curve for cumulative miles larger than 3000. This graph shows SCE's projected maximum risk buy-down for covered conductor.

As can be seen, SCE projects that its covered conductor efforts will reach a point of diminishing returns after 2500 miles or so have been deployed, and that residual risk of 12.8% or so will remain regardless of covered conductor installation.

For its part, SDG&E's WMP and RAMP have projected a roughly equivalent RSE for covered conductor and undergrounding, owing to its higher costs for covered conductor installation.[47] This differs from the 2018 comparison performed by SCE and provided as an appendix to the Q3 updates:

[47] In response to MGRA data requests in SDG&E's RAMP proceeding, for instance, SDG&E did an alternative analysis in which its proposed hardening projects – which rely heavily on undergrounding as opposed to covered conductor, were to use covered conductor instead. SDG&E's results showed that an undergrounding-heavy mix of mitigations was superior to a covered conductor solution as far as RSE.

Mitigation Option	Relative Mitigation Effectiveness Factor	Cost per Mile ($ million)	Mitigation-Cost Ratio
Re-conductor - Bare	0.15	0.30	0.50
Re-conductor - Covered	0.60	0.43	1.40
Underground Conversion	1.00	3.00	0.33

Table 5 - SCE's 2018 analysis of covered conductor versus undergrounding and reconductoring, demonstrating a very high risk/spend efficiency.[48]

Energy Safety has required utilities to work together to resolve the discrepancies between utilities for the value of covered conductor compared to other potential mitigations. OEIS should ensure that these discussions are fruitful and drive to a common agreement as to the effectiveness and value of covered conductor as opposed to other mitigations.

4.3. REFCL Fail and Other Advanced Technologies

The most disappointing result of the Q3 reports is PG&E's failure to successfully implement the REFCL technology:

"*Commissioning of currently installed REFCL system is 90% complete. The current REFCL pilot project at Calistoga experienced unsuccessful technology integration and implementation to date.*

o There have been component failures during the commissioning and testing phase of the project.

o A detailed investigation is needed to determine why these failures have occurred and fully understand how to prevent reoccurrence.

While we have encountered challenges with successfully implementing the REFCL technology, we remain on track to have final results based on this pilot by September 1, 2021."[49]

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[48] SCE Report; p. 97.
[49] PG&E QIU; Row 69.

The reason that this technology failure is so disappointing is that REFCL, were it to operate properly, would prevent ignitions from scenarios that utilities claim might still occur with covered conductor, such as auto accidents and tree fall-ins. Energy Safety should carefully review PG&E's REFCL report to ensure that the pilot failure is well understood and that there are no potential remedies that might enable this technology to be used.

Should REFCL deployment prove to be infeasible, there are other technologies currently under investigation by the IOUs that may complement covered conductor or other mitigations. Among technologies that should be examined are PG&E's ECCVM and RF sensors, SDG&E's falling conductor technology, and SCE's MADEC. OEIS should request that IOUs assemble "underground equivalent" solutions, potentially consisting of multiple hardening and technology components. The goal would be to ascertain if there are solutions to the wildfire problem that can be deployed within a reasonable timeframe and at reasonable cost, as an alternative to PG&E's CEO's call for an undergrounding "moon shot" potentially costing tens of billions of dollars and still covering only a fraction of PG&E's HFTD area.[50]

Recommendations:

- Energy Safety should ensure that the covered conductor working group comes to consensus on how to quantify the effectiveness of covered conductor and understand the cost and RSE differences between utilities.
- Energy Safety should carefully review PG&E's REFCL report to ensure that the pilot failure is well understood and that there are no potential remedies that might enable this technology to be used.
- OEIS should request that utilities should investigate whether "underground equivalent" wildfire solutions can be constructed, potentially incorporating multiple hardening and technology mitigations.

[50] PG&E Aims to Curb Wildfire Risk by Burying Many Power Lines; Ivan Penn; New York Times; July 21, 2021.
https://www.nytimes.com/2021/07/21/business/energy-environment/pge-undergroundpowerlineswildfires.html

5. CONCLUSION

MGRA appreciates the opportunity to provide feedback to the Office of Energy Infrastructure Safety and OEIS's incorporation of MGRA WMP comments into its Wildfire Mitigation Plan reviews. Many of the issues raised by OEIS are now being addressed and reported in the Q3 utility updates. The methodologies used by IOUs to calculate ignition probability and risk, however, still raise considerable concern, and MGRA looks forward to addressing these issues during the OEIS-facilitated risk workshops.

Respectfully submitted this 15th day of November, 2021,

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