Diane Conklin
Spokesperson
Mussey Grade Road Alliance
PO Box 683
Ramona, CA 92065

March 29, 2021 VIA ELECTRONIC MAIL

Ms. Caroline Thomas Jacobs
Director, Wildfire Safety Division
California Public Utilities Commission
505 Van Ness Avenue
San Francisco, CA 94102

Transmittal to: wildfiresafetydivision@cpuc.ca.gov, CALFIREUtilityFireMitigationUnit@fire.ca.gov, and R.18-10-007 service list

RE: MUSSEY GRADE ROAD ALLIANCE COMMENTS ON 2021 WILDFIRE MITIGATION PLANS OF PG&E, SCE, AND SDG&E

Dear Director Thomas Jacobs:

The Mussey Grade Road Alliance (MGRA or Alliance) serves these comments pursuant to Resolution WSD-011,[1] which authorizes public comment on the 2021 Wildfire Mitigation Plans (WMPs) of the three major investor-owned utilities (IOUs) by March 17, 2021, and the Wildfire Safety Division's (WSD's) approval of the Joint Stakeholders' request for an extension setting a due date of March 29, 2021.[2]

The Alliance is once again pleased to have the opportunity to provide feedback on California utilities' wildfire mitigation plans. The history of the Mussey Grade Road Alliance, a grass-roots citizen-based organization located in Ramona, California, and its 15 year efforts to improve power line fire safety in California are described in MGRA's comments on the 2020 Wildfire Mitigation Plans.[3] As we stated then, we were the first party to call for wildfire prevention

---

[1] Resolution implementing the requirements of Public Utilities Code Sections 8389(d)(1), (2) and (4), related to catastrophic wildfire caused by electrical corporations subject to the Commission's regulatory authority; November 30, 2020; p. 9. (WSD-011)
[2] Letter from Lucy Morgans; Wildfire Safety Division; Re: Joint Stakeholder Request for Extension of Time to Provide 2021; Wildfire Mitigation Plan Comments; March 1, 2021.
[3] 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)

plans in 2009.[4] We were strongly opposed by the utilities in this successful rulemaking initiative and the resulting plans seemed to be an afterthought by the IOUs, submitted and forgotten. Before the Alliance could address this problem, a series of catastrophic fires occurred in Northern California resulting in dozens of deaths. Only after the legislature created the present law did the newly named Wildfire Mitigation Plans become the basis for IOU wildfire management.

The current plans are immensely more sophisticated than the early feeble attempts by the IOUs to check the box. The current stakes, though, are also much higher. The approval of the WMPs by the Wildfire Safety Division (WSD) and the CPUC now confers a "Safety Certification" that allows utilities to tap into ratepayer funds to cover damages from the fires they cause. The Certification also and crucially shifts the burden of proof to ratepayers to prove that there is "substantial doubt" that a utility complied with its plan, and that this failure caused the fire. This arrangement assigns the responsibility to the Wildfire Safety Division to ensure on behalf of the people of California that these plans are comprehensive and accurate, that they will actually reduce fire risks, and that the utilities do what they say they are going to do in these plans to ensure fire safety. Any gaps could result in mass deaths, huge property losses and widespread environmental destruction, the burden of which according to present law will be placed on the backs of Californians as well as utilities.

The job of critiquing and approving the WMPs has become harder over the past year as these so-called "updates" have mushroomed into immense documents. To its credit, WSD issued completely new guidance and templates regarding WMP format and content, leading to more detailed WMPs. Utilities have responded quarterly to deficiency reports issued by the WSD, providing additional detail regarding their programs. WSD now also requires utilities to provide detailed geospatial data on a regular basis. While these changes have improved the completeness and quality of the WMPs, the documents alone are now over 2,000 pages, not counting at least another 1,000 pages of supplemental files, data tables, and data request responses. Much of this material is highly technical.

As a result, there are several topics which are rife with data and material requiring analysis and review that are simply left unaddressed in these comments. We respectfully request that the

[4] D.12-01-032; pp. 45-55.

WSD allow a more thorough public review in of WMPs by granting additional time in future reviews and continue to pursue some of the topics we and others critiquing these plans raise in our comments. WSD does neither stakeholders nor itself any good by shortening review periods to less than the maximum allowable by the statute.[5]

MGRA's comments once again are authored by the Alliance expert, Joseph W. Mitchell, Ph.D.[6] In the analyses presented in these comments, he demonstrates that some of the new initiatives being undertaken by utilities have foundational problems that can put Californians at *greater* risk, and suggests ways that these initiatives can be put back on track. One area of great concern is the use of power shutoff. We are seeing climate change play out as wildfires become more intense year after year. 2020 was the worst year for wildfires on record in California with over 4 million acres burned.[7] Utility wildfires played a smaller role in the loss of life and homes than in previous years (the deadly Zogg fire being an exception[8]), but that is mostly because utilities have aggressively deployed power shutoff as their mitigation tool of choice. Shutting off electricity causes immense harm to and imposes risks and expenses on everyone who uses the power – cities, counties, businesses and homes, and should be a measure of last resort. It isn't. One crucial change that the Alliance expert recommends is making the utility infrastructure safer in order to enable utilities to operate safely under known local conditions so that the blunt hammer of power shutoff isn't used for every nail and in the process shifting the impacts onto utility customers. In a word this is wrong.

Our expert's analysis uncovers several serious issues in the 2021 WMPs. The most serious have to do with utility risk calculations. A general problem that affects all of the three major IOUs arises from improper use of the Technosylva wildfire modeling tool, which they all now use. Simulated fires used by the utilities in their modeling are substantially smaller than the catastrophic

---

[5] The original deadline of March 17, 2021 was extended to March 29th by WSD's March 1st letter granting an extension to stakeholders. In 2020, the deadline was April 4, 2020. WSD can, at its discretion, allow additional time for review. Public Utilities Code § 8386.3(a) states in part: "The Wildfire Safety Division shall approve or deny each wildfire mitigation plan and update submitted by an electrical corporation within three months of its submission, unless the division makes a written determination, which shall include reasons supporting the determination, that the three-month deadline cannot be met."

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

[7] Cal Fire: https://www.fire.ca.gov/incidents/2020; downloaded 3/21/2021.

[8] The Zogg fire burned 50,000 acres and resulted in four deaths. https://www.fire.ca.gov/incidents/2020/9/27/zogg-fire/

fires responsible for most harm, and this will tend to skew predicted risk toward circuits nearest to population centers and away from remote, windy back country areas where the most catastrophic fires are likely to start. This requires urgent verification and review by WSD and the utilities.

PG&E also has its own serious issue with its ignition model, which is based upon ignition data and makes the faulty finding that ignitions are independent of wind conditions, a preposterous outcome. PG&E has completely reordered its mitigation priorities based upon its ignition and fire spread models, which the Alliance analysis asserts to be in error. Additionally, PG&E's risk/spend efficiency calculations fail to break down mitigation measures such as covered conductor, undergrounding, and wire hardening into separate options or programs, making it impossible to gauge the effectiveness of each of these separate safety strategies, and flaunting the guidance it has been given by WSD to provide greater granularity and clarity in its risk and spending calculations. These issues are grave and require remediation prior to any approval of PG&E's Wildfire Mitigation Plan.

This is the last set of Wildfire Mitigation Plans that the Wildfire Safety Division will oversee under the California Public Utilities Commission. The Alliance has been pleased with the transparency, dedication, and openness to public input that WSD has displayed in its nascent phase. We trust that it will endeavor to continue these trends as it moves to the California Natural Resources Agency. The Alliance has in the past raised concerns that the role of stakeholders and the public was not well-defined in WSD's foundational legislation, and those concerns remain going forward despite WSD management's many actions to allay them. The Wildfire Safety Division and its successor the Office of Energy Infrastructure Safety have tremendous responsibilities not only as guardians of public safety but as guardians of the public purse, since their determination affects ratepayers, and must ensure that safety certifications are not granted lightly and that utilities are held to a much higher safety standard than they have been in the past. In order to do this, WSD/OEIS will need to incorporate public input and therefore will need to develop formal mechanisms for public participation and support for such participation to guarantee stakeholder rights and due process.

The Alliance looks forward to providing future input to WSD's mission as it moves into its next phase.

Respectfully submitted this 29th day of March, 2021,

By: __/S/____ ***Diane Conklin***____________________

Diane Conklin
Spokesperson
Mussey Grade Road Alliance
P.O. Box 683
Ramona, CA 92065
(760) 787 – 0794 T
(760) 788 – 5479 F
dj0conklin@earthlink.net

TABLE OF CONTENTS

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.[9]

1. INTRODUCTION

1.1. Overview, Organization, and Summary

The Mussey Grade Road Alliance provides comment this year on the Wildfire Mitigation Plans (WMPs) for Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), and San Diego Gas and Electric Company (SDG&E). For the sake of comparison between utilities, all comments are provided in one document that primarily uses the structure laid out in the templates approved in Resolution WSD-011. Also, any section that has no MGRA comment has been removed and renumbered so that topics correspond to the WSD templates. An exception is this introductory section, which covers issues not covered in the template. Every section has one or more accompanying recommendations, usually for utility improvements or actions, but also often for WSD improvements to the WMP process or templates. A recommended urgency is also given, usually immediate (plan approval contingent), within quarterly updates, or in the next major revision. Comment regarding the February 26th WMP updates is also included.

It is important to note that the 2021 WMPs from the major IOUs are over double the length of their 2020 predecessors. They contain 2000 pages of text in the reports alone, and are accompanied by Fourth Quarter 2020 reports, updates, and numerous data files. This growth in the size of the WMPs results from a variety of sources: more comprehensive and detailed templates from WSD, accumulated responses to deficiencies noted in the 2020 WMPs and in quarterly reports, and overall expansion and maturing of the utility wildfire prevention programs. It is not feasible for MGRA or any other member of the public to delve into every aspect of the WMPs. The topics selected by MGRA are a function of not only their perceived importance but also of our technical capabilities and interests.

---

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

MGRA explored a number of topics for which the information provided in the 2021 filings was insufficient or unclear, and issued a number of data requests to the utilities. These are included under Appendix A of these comments. The CPUC also conducted a number of wildfire-related proceedings in 2020 and 2021, some of which produced filings and data of direct relevance to the 2021 WMP reviews. Key filings from these proceedings are contained under Appendix B of this report.

1.2. Comparison with 2020 WMPs

MGRA made a number of recommendations as part of its 2020 WMP filing. Many of these were acted upon by WSD, either in its own comments on the WMP or in its comments on the utility quarterly report. Other recommendations were in one way or other implemented or obviated by utility actions. Some of MGRA's recommendations were not addressed but remain valid concerns in the 2021 WMP reports. In the table below these two categories of recommendations are summarized.

Recommendation	WSD Action	Utility Action	Status
Workshops for templates and utility issues	Held workshops	Implemented	Complete
PG&E should report ignitions, not wildfires	None	Still reports wildfires	Still active[10]
Supplement data with a wind metric	Requires NWS HWW metric	Reporting of HWW wire-days	Still needs 1) better metric 2) risk events vs HWW and RFW
PG&E MAVF function flawed. Other utilities lack detail.	Guidance-3	PG&E RAMP, Quarterly Reports,	RAMP data presented as appendix. New S-MAP, WMP-21; Further WMP-21 review
PSPS customer harm not incorporated into RSE	RSE use for PSPS forbidden by WSD-03	PG&E RAMP has w/wo PSPS.	Utilities developing PSPS harm methods. May be discussed in S-MAP. Active for WMP-21.

[10] PG&E provided false information to TURN regarding this issue. In Data Request Response PG&E WildfireMitigationPlans_DR_TURN_015-Q01, PG&E states that "No parties objected to PG&E's definition of wildfire in Table 2 of its 2020 WMP." This is false. MGRA strongly objected in its 2020 WMP Comments.

Common FPI approach between utilities	None	None	Open
Satellite detection validation	None	None	Active for WMP-21
SDG&E steel pole validation	None	Justification vs wrap in WMP-21	Closed
Egress issues and wooden poles	None	PG&E developing guidelines	Open
SDG&E insufficient justification for 25' trim	SDGE-13, SDGE-14	Utilities met to discuss at-risk species	Active for WMP-21
SDG&E slow rollout of covered conductor	Continue pilot	Successful pilot, will become default hardening	Active for WMP-21
More granular and complete breakdown for programs	Guidance-6	More programs included in WMP-21	Active for WMP-21
WSD should request S-MAP initiation	None	CPUC initiates new S-MAP	Active in R.20-07-013
Significant difference between PG&E & SCE weather models covering same area	None	None	Active for WMP-21
Utilities should include outage-producing winds in risk models and ranking and be transparent with ranking criteria	None	New risk and risk ranking models for all utilities. PG&E's OPW improved but ignition model does not include peak winds.	Active for WMP-21
Improve the maturity model to eliminate inappropriate and incorrect questions	Model is to be stable for 3 years	Electronic provision of questionnaire, not available to public	Active for WMP-21

Table 1 - MGRA recommendations made as part of the 2020 WMP review, WSD and utility action on these topics, and current status.

1.3. Significant Findings in the 2021 WMPs

There has been significant progress made in the quality and breadth of utility WMP submissions since last year, due largely to guidance provided by WSD in its review and subsequent monitoring of quarterly reports, the adoption of new reporting templates, and the adoption of a new geospatial data standard. For their part, the utilities themselves are learning from their data and expanding their wildfire prevention and risk management divisions.

Meanwhile, the California Public Utilities Commission has not been idle on the wildfire issue and a number of proceedings have produced information that is highly relevant to the review of the 2021 WMPs. The review phase of PG&E's RAMP proceeding has been completed and SDG&E is preparing to launch its own RAMP proceeding. A new S-MAP proceeding, now called Risk-Based Decision-Making Framework (RDF), has started and is re-examining basic assumptions about wildfire losses and the proper construction and use of the MAVF (Multi-Atribute Value Function). The 2020 California fire season, as noted in the WMPs, was in many aspects the worst on record. While utility-ignited fires did not rank highly in destructive fires, as they did in 2017 and 2018, this is largely because the IOUs resorted to their primary mitigation of power shutoff, or "PSPS". Information from these shutoffs can also be used to inform and cross-check claims in the 2021 WMPs. MGRA has included data and analysis from Commission proceedings where appropriate in its 2021 WMP analysis, and provides relevant filings as appendices to these comments.

One of the most notable changes in the utility approach to estimating wildfire risk was a move to adopt machine learning or AI analysis techniques as opposed to the standard statistical approaches used in the 2019 and 2020 WMPs. All utilities are moving in this direction and it is largely a positive step, as these methodologies are becoming ubiquitous in science and engineering because of the improvements they bring to predictive capabilities. One apparent success of this migration is PG&E's outage producing winds (OPW) model, which now shows a super-linear dependency of outage rates on wind speeds much as SDG&E's data has been shown to exhibit in past analyses. Machine learning models, however, are not a panacea and exhibit the same limitations that all software models face: they need to be provided proper inputs to give correct outputs ("garbage in / garbage out" in the software engineering vernacular). The analysis presented in these comments demonstrates that PG&E's ignition probability model, in particular, makes some dubious assumptions and produces a result that strongly conflicts with data and analysis from numerous sources: specifically, it concludes that ignition probability is not wind dependent, or at the least that winds during fire weather events have no predictable geographic dependency. PG&E appears confident in its claim, and so it's necessary for these comments to go to some lengths to refute PG&E's assertion, and number of arguments are brough to bear – from forensics to outage wind dependencies, and clear evidence of wind speed dependencies for PG&E and SCE ignitions. Error in PG&E's ignition model is indeed highly impactful because PG&E has completely changed its mitigation priorities based on the new model.

Another major change since 2020 was the adoption of the Technosylva fire spread model by all three major utilities. Adoption of a common model is a great aid to transparency, and the use of fire spread modeling to estimate consequences is a valid and useful technique. All three major IOUs run into a significant issue with this modeling, however: the fires being simulated are smaller than typical "catastrophic" wildfires that cause damage. One reason is that the duration of the simulation is limited to 8 hours, a choice made by all three major IOUs. The net effect of smaller simulated fires is to artificially shift the calculated risk towards utility infrastructure proximate to population centers, and to downplay the risk of ignitions in remote areas that grow into major fires before descending as a broad front into wildland urban interface areas. These modeling assumptions need to be re-examined, as could potentially lead to a shifting of mitigation resources away from the areas of highest risk.

In general, IOU estimation of risk remains opaque and difficult to compare between IOUs. Comparison was attempted in the MGRA 2020 WMP Comments, with some general conclusions being possible. With the 2021 IOU risk estimates, it is nearly impossible to do a meaningful comparison between utilities. While WSD increased the granularity of the utility programs, all three IOUs have responded to this requirement in different ways, leaving different inputs empty and interpreting others differently. Further direction from WSD is needed in this area.

With regard to power shutoff versus mitigation, SCE and PG&E are moving toward a model that prioritizes mitigations that reduce the need for power shutoff. This is appropriate. An analysis prepared for MGRA at the behest of the Safety Policy Division regarding the implications of power law fire size distributions is attached in Appendix B. This document proposes that circuits be classified with regard to risk tiers based upon the severity of weather event for which equipment in that risk tier can be safely operated. Implications of power law statistics are that losses are driven by the "worst of the worst" weather events. De-energization provides mitigation for such events, but de-energization causes great public harm. Hence optimal hardening and other mitigation should be directed at reducing the harm from power shutoff.

With regard to metrics, ignition and outage data are now dubious as risk proxies because of the effect of power shutoff, which eliminates both ignitions and outages. Alternative risk metrics need to be developed, including outages outside of fire weather windows, particularly during high wind events, and also damage reports from post-event patrols after de-energization events. The power of this kind of metric is demonstrated for SCE, which alone of all IOUs provides wind speed data for its de-energized circuits. Results are surprising, with significant damage occurring at wind gust speeds less than 50 mph, clearly demonstrating the need for remediation.

1.4. Supplemental Data and Methods

Some of the results presented in these comments was the product of scientific and statistical analysis performed using software such as Microsoft Excel and Python. The analysis methods themselves are discussed but not fully disclosed in this document. In order to provide transparency into the data and methods, all software and spreadsheets have been published on the GitHub website at the location:

https://github.com/jwmitchell/mbar-weather

Data and software are available for public use under the Gnu General Public License version 3.0.

There are several sections of this git repository:

- The top level directory contains general information and (incomplete) documentation, and python modules for weather data analysis using the Synoptic API.[11]
- The /examples directory contains the python programs and input/output data for the SCE and PG&E ignition analysis described in this document.
- The /supplemental/wmp21 directory contains Excel spreadsheets. Mostly, these are spreadsheets originally produced by PG&E, SCE, and SDG&E plus additional analysis.

[11] http://synoptic.com Note that the API token found in some files has been revoked.

Should any additional information be required regarding any of these files please contact MGRA or send inquiries to jwmitchell@mbartek.com.

4. LESSONS LEARNED AND RISK TRENDS

4.3. Change in Ignition Probability Drivers

4.3.1. High Winds Cause Catastrophic Wildfire Ignitions

It has generally been understood, even before the modern era of utility wildfire prevention began with the 2007 Southern California Fire Storm, that the causal link between utility equipment damage due to high winds and the role these winds play in catastrophic fire growth makes utility wildfires particularly dangerous. The 2001 version of the Power Line Fire Prevention Field Guide makes the following prescient observation:

"*The potential exists that power line caused fires will become conflagrations during the long, hot and dry fire season commonly experienced in California. The very same weather conditions that contribute to power line faults also lead and contribute to the rapid spread of wildfire. The most critical of these weather factors is high wind, which is commonly accompanied by high temperatures and low humidity.*

High, gusty winds may cause vegetation to sway into power lines, break off limbs or fall into power lines. High winds may also create vibrations in power lines that lead to stress failures or cause loose connections to separate. Arcing usually accompanies such faults. Automatic reclosers re-energizing the line into the fault may cause repeated arcing and increase the probability of igniting vegetation."[12]

It is therefore shocking that to this day, and particularly in regard to the 2021 Wildfire Mitigation Plans, that this principle is being challenged, and in fact dismissed. Specifically, PG&E's Wildfire Distribution Risk Model finds that wind speed is a poor predictor of ignitions. For example, in response to WSD's question in PGE-13 which asks it for its "analysis on the correlation between wind speed and wire down events", PG&E responds that: "Wind speed is one of many variables that influences failures and wire down events. However, wind speed alone is not the only

---

[12] OSFM, CDF, USFS, PG&E, SC Edison, SDG&E; Power Line Fire Prevention Field Guide; Mar 27, 2001

factor that needs to be considered in wire down events. When developing the 2021 Wildfire Distribution Risk Model, wind speed was considered as a variable impacting ignition, and it was determined, as can be seen in the output below, that average wind speed… has a marginal effect on the probability of ignition."[13] In a data request response to MGRA, PG&E explains that their Distribution Risk Model "is a model trained to predict where ignitions are more likely to occur over the next year and not when they will occur… As long as there are a similar number of wind events in similar locations over time, the model is already accounting for wind impacts on annual ignitions. However, the majority of ignitions are not caused by wind as 95% of outages do not occur during NE wind days."[14]

Likewise, during the February 22nd WMP technical workshops Southern California Edison's Joseph Goizueta commented that SCE had not observed correlation between wind speeds and outage rates, though upon review SCE has stated that "SCE does not have enough-wind driven outage data at the circuit level to make determinations about correlations between wind speeds and outage rates."[15]

What is being put forward is effectively an alternative model of catastrophic power line wildfire ignition. In the model without wind-driven ignitions, ignitions occur at a certain rate. Should an ignition happen to occur during critical fire weather in a location subject to rapid fire growth, it is much more likely to blow up into a major fire. So, this argument would go, by lowering the overall ignition rate, particularly where ignitions occur more often, we can lower the probability of catastrophic wildfires.

Major wildfires that are not directly sparked by wind do happen. The Butte fire is one example. As tragic as the losses are from such fires, they are nothing compared to the loss of life and disruption due to wind-sparked fires such as the Camp, Nuns, Atlas, Witch, and Thomas fires. The evidence that wind increases ignition probability is in fact overwhelming, and comes from a wide variety of sources, including:

- Forensic analysis
- Academic data analysis

---

[13] PG&E WMP; p. 203.
[14] Appendix A: PG&E Data Request Response DR_MGRA_010-Q06.
[15] Appendix A: SCE Data Request Response MGRA-SCE-006-Q005.

- Utility data analysis
- Application of physics and statistics

4.3.1.1. Forensic analysis of wildfires

Wind is mentioned as a cause in fire agency investigations for most of the most destructive utility fires in California. Some examples:

Thomas fire:

"'A high wind event caused the power lines to come into contact with each other, creating an electrical arc,' the Ventura County Fire Department said in a press statement Wednesday. 'The electrical arc deposited hot, burning or molten material onto the ground, in a receptive fuel bed, causing the fire. The common term for this situation is called 'line slap,' and the power line in question is owned by Southern California Edison.'"[16]

Nuns fire:

"This means that the combination of branch foliage weight and wind dynamics combined to create pressure that was simply too great for the branch to maintain."[17]

Camp fire:

"Working with meteorologist Kris Kuyper, Mr. McGormley and his team created a wind load model of the Feather River canyon, enabling them to calculate that the wear on the broken C hook from Tower 27/222, as well as the most worn C hook from Tower 24/199, was consistent with approximately **97 years of rotational body on body wear**."[18]

Witch fire:

"While flying the fire scene he observed arcing coming from the power lines. He observed a line of bluish colored flashes, going with the wind. As he flew, he was able to focus on these flashes on two separate occasions. He described them as looking like tracers and flashes which would catch his eye. He described them as unusual and shooting down wind."[19]

---

[16] Los Angeles Times; Southern California Edison power lines sparked deadly Thomas fire, investigators find; Joseph Serna; March 13, 2019.

[17] CALIFORNIA PUBLIC UTILITIES COMMISSION; Safety and Enforcement Division; Electric Safety and Reliability Branch; Incident Investigation Report; April 30, 2019; Incident E20171016-01; p. 31. (Nuns Fire Report)

[18] Butte County District Attorney; THE CAMP FIRE PUBLIC REPORT; A SUMMARY OF THE CAMP FIRE INVESTIGATION; June 16, 2020; p. 22.

[19] California Department of Forestry and Fire Protection; INVESTIGATION REPORT; Incident 07-CA-MVU-10432; p. 17. (Witch Fire Report)

4.3.1.2. Fire size and loss statistics

An indirect indication that winds cause power line fire ignitions is the fact that power line ignited wildfires tend to be more destructive than what would be expected from their relative frequency. This relationship has been observed for a long time, even prior to the October 2007 fires.[20] Recent (through 2016) CAL FIRE data puts the overall fraction of California ignitions due to power lines at roughly 8-9%.[21] Including the 2020 fires, CAL FIRE now claims that power line fires made up 3 of the top 20 largest wildfires, 4 of the top 20 most deadly wildfires, and 8 of the top 20 most destructive wildfires in terms of home loss.[22] The probability of 8 out of 20 fires power line fires being the most destructive is roughly 6E-06.[23] Even if the weaker statistical results from the largest fire sets and most deadly fire sets are included as separate observations, statistical significance is still approximately 1 in 100,000.

Another statistical anomaly that supports wind-caused ignitions is that the number of power line fires are over-represented compared to their regular frequency[24] during wind-driven "fire storms" or "fire sieges". One interesting comparison is between the 2003 Southern California Fire siege and the 2007 Southern California Fire siege. Both of these fire weather events were associated with approximately 20 major fires. In 2003, none of the major fires were caused by power lines. In 2007, 9 of the fires were caused by power lines. With power line fires accounting for less than 10% of ignitions, it is almost impossible that these two samples are created by the same drivers. The causal difference between these events is that peak winds were roughly 80% higher in 2007 than in

---

[20] A.06-08-10; OPENING BRIEF OF THE MUSSEY GRADE ROAD ALLIANCE ON PHASE I ISSUES OF THE SUNRISE POWERLINK TRANSMISSION PROJECT; November 9, 2007.

[21] R.18-12-005; MUSSEY GRADE ROAD ALLIANCE COMMENTS ON PROPOSED DECISION ADOPTING DE-ENERGIZATION GUIDELINES; May 16, 2019; p. 4.

[22] https://www.fire.ca.gov/media/4jandlhh/top20_acres.pdf
https://www.fire.ca.gov/media/t1rdhizr/top20_destruction.pdf
https://www.fire.ca.gov/media/lbfd0m2f/top20_deadliest.pdf
Downloaded March 7, 2021.
Note that the five major lighting complexes that occurred in 2020, triggered by dozens of lightning strikes, now dominate fire size statistics.

[23] Calculated as a one-tail chi-squared distribution with a Yates adjustment for small bin statistics.

[24] Less than 10% of wildfires in California are associated with power lines. D.19-05-042; p. 3.

2003.[25] Likewise, during the October 2017 Northern California Fire Siege, there were 21 major fires and electrical equipment was associated with 16 ignitions, including all five of the fires responsible for fatalities.[26] This effect has also been seen in Australia, with power lines accounting for 5 of 11 of the major "Black Saturday" fires and 4 out of 8 of the "Ash Wednesday" fires.[27]

The implications of this result is that it is extraordinarily unlikely that power line fires "just happen" to ignite under fire weather conditions. A causal relationship between extreme fire weather conditions and the ignitions is implied, though the nature of this causal relationship needs to be inferred.

4.3.1.3. Academic work on wildfire ignitions

Most of the academic work suggesting a causal relationship between winds and power line fire ignitions provides indirect evidence, specifically noting that power line fires are more destructive that what would be expected from their relative frequency.[28] Academic works directly related to the causal relationship between wildfire ignition and wind are Mitchell 2009,[29] which addresses a number of the physical mechanisms responsible for power line fire ignitions, and Mitchell 2013, [30] which shows outage versus wind speed dependency for SDG&E data. This dependency is shown in the figure below:

---

[25] Mitchell, J.W., 2013. Power line failures and catastrophic wildfires under extreme weather conditions. Engineering Failure Analysis, Special issue on ICEFA V- Part 1 35, 726–735. https://doi.org/10.1016/j.engfailanal.2013.07.006 (Mitchell 2013).
[26] California Public Utilities Commission; Safety and Enforcement Division; Report on October 2017 Fire Siege; October 2017 Wildfires in Northern California; June 13, 2019.
[27] 2009 Victorian Bushfires Royal Commission Final Report. Government Printer for the State of Victoria. PP. No. 332, Session 2006 – 10, ISBN 978-0-9807408-4-4, July 2010. v.2, pp. 148-150.
[28] Miller, C., Plucinski, M., Sullivan, A., Stephenson, A., Huston, C., Charman, K., Prakash, M., Dunstall, S., 2017. Electrically caused wildfires in Victoria, Australia are over-represented when fire danger is elevated. Landscape and Urban Planning 167, 267–274. https://doi.org/10.1016/j.landurbplan.2017.06.016
Syphard, A.D., Keeley, J.E., 2015. Location, timing and extent of wildfire vary by cause of ignition. Int. J. Wildland Fire 24, 37–47. https://doi.org/10.1071/WF14024
[29] Mitchell, J.W., 2009. Power lines and catastrophic wildland fire in southern California, in: Proceedings of the 11th International Conference on Fire and Materials., pp. 225–238. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.469.2877&rep=rep1&type=pdf
[30]

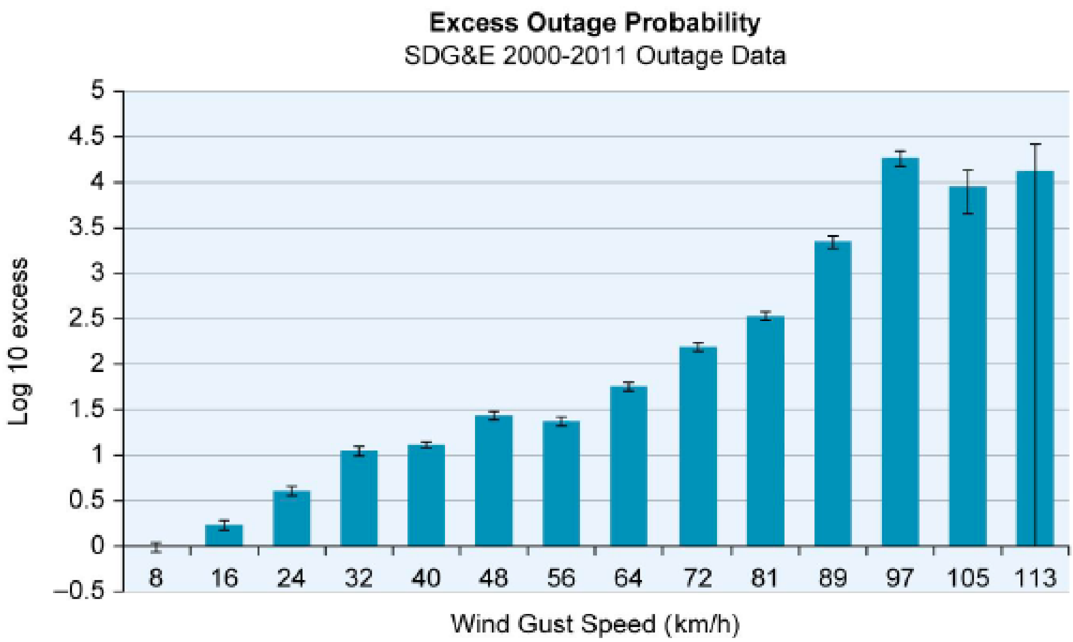

Figure 1 - Excess outage probability as a function of wind speed obtained by normalizing SDG&E outage data with historical Mesowest weather station data. For each outage, a wind speed was determined at the nearest appropriate weather station for the circuit having the outage. Historical data for each of these weather stations was analyzed to determine what fraction of time the wind speed exceeded the speed at which the outage occurred. Data were then normalized against a baseline wind speed of 8 km/hr, giving the number of outages per unit time at a particular wind speed at that location compared to number of outages that would be expected during calm weather. The vertical scale is logarithmic. Data show a ten-fold increase in outage rate for every 15-20 mph increase in wind gust speed. Reproduced from Mitchell 2013.

With a ten-fold increase in outage rate for every 15-20 mph increase in wind gust speed, this graph demonstrates the extreme sensitivity of utility infrastructure (and surrounding objects) to wind speed. Mitchell 2009 posits three mechanisms that explain a super-linear dependency on wind speed:

1. Wind pressure varies as the square of velocity.
2. Fatigue in metals would be expected to vary as the third to fourth power of wind speed.
3. Engineering and maintenance to tolerance would introduce an inverse Weibull (exponential) dependency in the area of thresholds.

It remains an inference, however that ignitions will likewise have this strong dependency on wind. As confirmed in all WMPs, outages and faults often have associated arcing and energy release that can cause fires. Hence the use of outages as a proxy for ignitions is a reasonable choice, and in fact SCE uses outages as an input for its ignition probability model.[31]

4.3.1.4. Utility outage and ignition data

Despite any current claims questioning the relationship of outages or ignitions to wind, some utilities have produced data an analysis showing that outage and even ignition rates increase with wind. If one still questions whether this relationship holds, one can examine the *reductio ad absurdum* thought experiment of postulating what would happen to a utility system that was experiencing winds of 150 mph. This relationship has actually been measured for hurricanes. We present an analysis for Florida Power and Light[32] below:

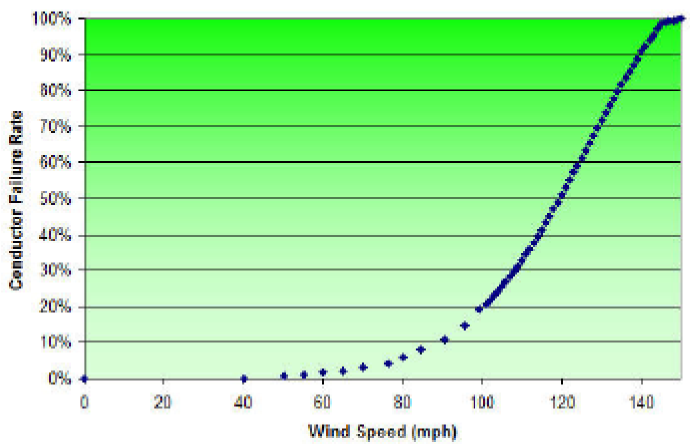

Figure 5-2. Florida Power & Light Span Failure Rate Data

Figure 2 - FPL/Quanta Span Failure Rate - reprinted by permission.

As can be seen, at some point the failure rate for any system must reach 100% asymptotically as the stress on that system goes far beyond its design tolerances. So "wind causes failures" is not really in question. A more apt question is what severity of wind causes failures? What is the behavior of such a curve in the low wind region, and at what point does wind-driven damage become appreciable?

---

[31] SCE 2021 WMP; p. 85.

[32] Quanta Technology, "Undergrounding Assessment Phase 3 Final Report: Ex Ante Cost and Benefit Modeling." Prepared for the Florida Electric Utilities and submitted to the Florida Public Service Commission per order PSC-06-0351-PAA-EI. Contacts: Le Xu, Richard Brown. May 21st, 2008.

The issue that makes these questions hard to answer is that there are many sources of outages and ignitions that are not wind related, and these make up the bulk of the utility data. Extracting a wind-dependent signal from this data can be challenging, particularly when wind information may not be well-known in the area of the fault, or the fault location itself might not have been pinpointed. As shown in the previous section, SDG&E's data was adequate for doing such an analysis. SCE claims that its attempts to find a wind signal have failed. PG&E on the other hand has produced an Outage Producing Wind (OPW) model based on a machine learning algorithm, and this model clearly shows wind dependency of outage data.

PG&E presents output from its OPW analysis in FIGURE PG&E-4.2-8: SNAPSHOT OF OPW DASHBOARD. This figure is not legible, but MGRA obtained a better scan of it from PG&E.[33] Some highlights are captured below:

Figure 3 - Header of Figure PG&E-4.2-8 OPW Model. Shows the symbology used for outage cause (when attributed), and shows that the plot is showing outage probability versus sustained wind speed. The maximum scale shown in the graph is 0.001**.** Note that the title is incorrect: it should be "OPWp vs Sustained Wind Speed (mph)".

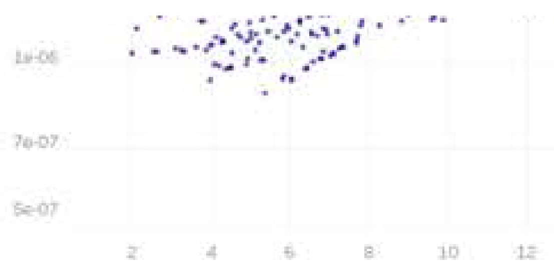

Figure 4 - Lower left of Figure PG&E-4.2-8 OPW Model. The horizontal axis has a 0 mph intercept, and vertical axis, which is logarithmic, shows a minimum probability value of 5e-07**.**

Figure 5 - Lower center and right of Figure PG&E-4.2-8 OPW Model. The horizontal axis shows a maximum sustained wind speed of 44 mph.

[33] WildfireMitigationPlans_DR_MGRA_010-Q18_Atch01.pdf

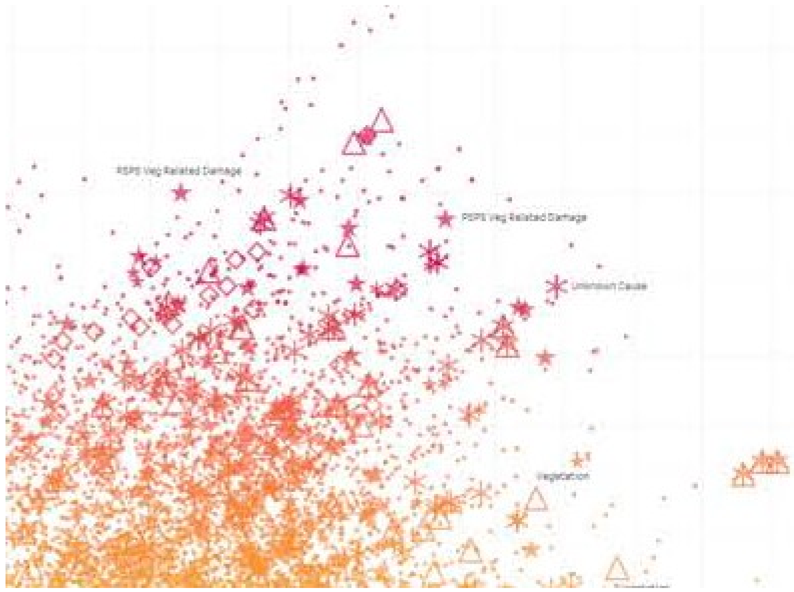

Figure 6 - High wind data and damage attributions for Figure PG&E-4.2-8 OPW Model. While captions are still illegible, symbology can be seen in the previous figure. Equipment damage, vegetation damage, and PSPS damage can be seen to be major contributors.

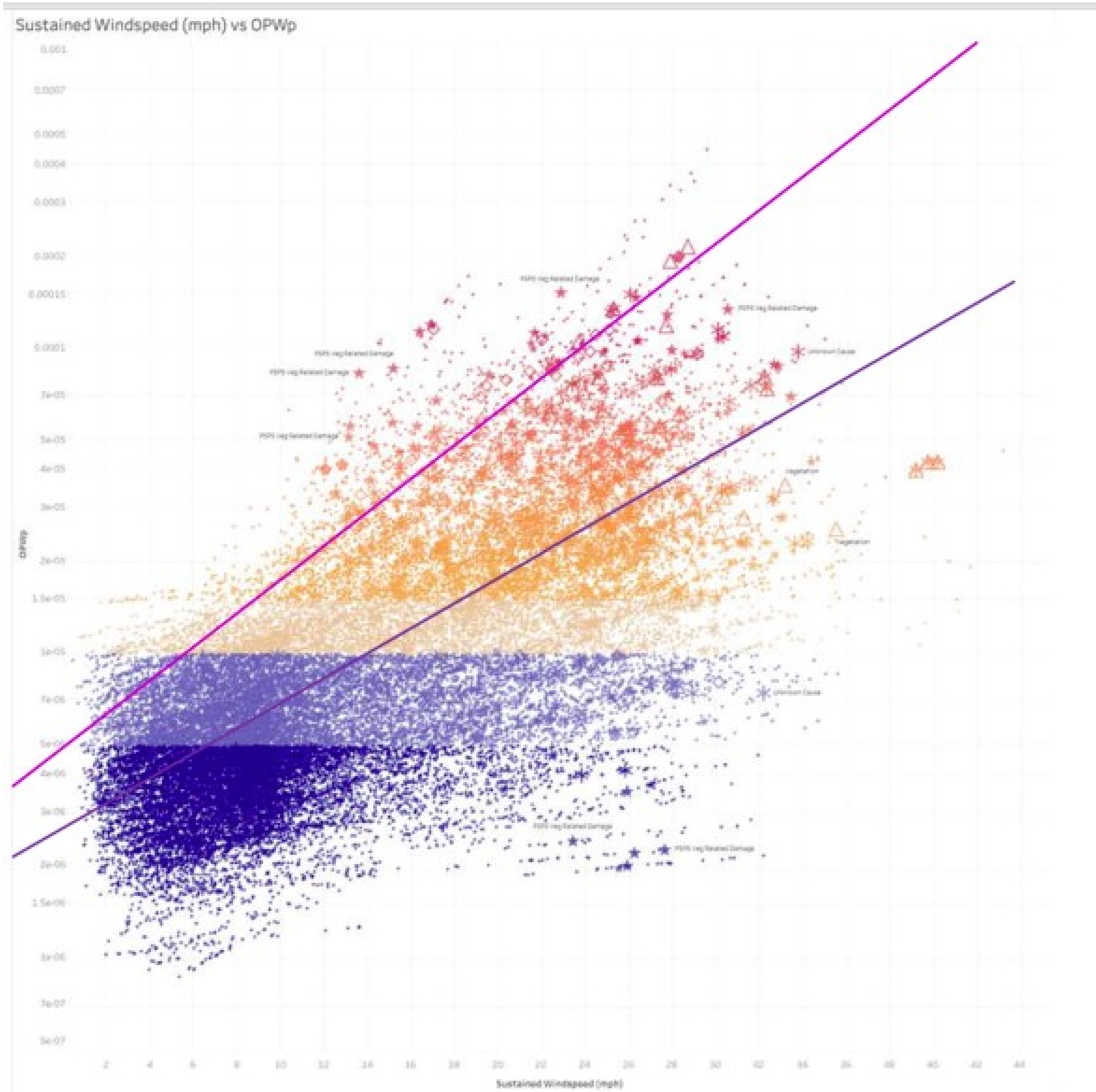

Figure 7 - Excerpt from Figure PG&E-4.2-8 OPW Model. Lines have been added as guides to the eye (not a numerical fit), one showing "typical" wind dependency and one showing "high end" wind dependency**.** The “typical” dependency slope has a 0 mph intercept at 3e-06 and reaches a maximum of 0.00016 at 44 mph. The “high end” wind dependency has a 0 mph intercept at 5e-06 and reaches a maximum of .001 at 42 mph.

PG&E’s OPW Model “forecasts the probability of unplanned outages associated with wind events occurring in PG&E’s service area. The output of the OPW Model is a measure of the probability of an outage in specific parts of PG&E’s service territory based on forecasted wind speed,” and is described in some detail on pp. 75-77 of PG&E’s WMP. PG&E’s meteorologists evaluated model performance “against key historical storm events by evaluating the timing of weather onset compared to modeled outage probability increases, and relative magnitude of outage probabilities against actual outage data,” using an OPW dashboard, an example screenshot of which is shown in figure PG&E-4.2-8.[34] Excerpts from this figure (at a higher resolution), are shown in Figure 3 through Figure 7. Key elements of this figure are:

- The figure displays calculated probability of an outage for a given wind speed for actual outage data.
- Probability is plotted on a logarithmic scale extending from 5e-07 to 1e-03.
- Sustained wind speed is plotted from 0 to 44 mph.
- Real outage types are plotted as symbols and include equipment damage and vegetation.

The data show that outage probability has a strong dependency on wind speed, increasing by orders of magnitude in the wind speed range studied. While it may be true that: "Wind speed is one of many variables that influences failures and wire down events," no other variable will show an order-of-magnitude increase under conditions conducive to the growth of catastrophic wildfires.

To capture this dependency, two lines have been drawn in Figure 7. One of these roughly bisects the distribution, while the other describes events which show a "stronger" wind dependency than the norm (though not as strong as some data indicates). The shallower curve shows a factor of 17 increase in the range from 10 mph to 40 mph. The steeper curve shows a factor of 47 increase over the same wind speed range. Comparing this to the data from Mitchell 2013 shown in Figure 1, and converting Mitchell 2013's gust wind speed to sustained wind using a gust factor of 1.6, Mitchell 2013 shows an increase of a factor of 32 for a 20 mph increase in sustained winds. These are compared directly in the table below, showing the relative increase in outage probability for a 10 mph increase in sustained winds:

Data Source	**Outage probability increase per 10 mph sustained wind speed.**
OPW – Mid	5.7
OPW – High	15.7
Mitchell 2013	16

Table 2 - Increase in outage probability per 10 mph increase in sustained wind speed based on mid and high range dependencies of PG&E's Outage Producing Wind (OPW) model, and for SDG&E data presented in Mitchell 2013.

---

[34] Id.; p. 77.

PG&E's OPW model and data supporting it are reasonably consistent with Mitchell 2013, though Mitchell 2013 data lies at the high end of the range of data in PG&E's OPW data set. Most importantly, both data sets exhibit an exponential dependency of outage probability on wind speed.

PG&E also independently analyzes wires down data and incorporates meteorological conditions into the analysis. According to Table PG&E-4.6-4 on p. 199, it classifies events as "Blue Sky Day", "Grey Sky/Storm", or "Major Event Day", and presents yearly data between 2017 and 2020. PG&E defines "Grey Sky/Storm" days as days with northeast winds, northwest winds and winter storms. The "Wires Down/Day" metric it calculates shows that wires down rates are significantly higher on storm days, and much higher still on major event days. Averaging over the four years presented, the results are as follows:

Weather classification	**Wires Down/Day 2017-2020**	**Relative to Blue Sky**
Blue Sky	1.65	1.0
Grey Sky / Storm	3.9	2.4
Major Event	18.1	11.0

Table 3 - Data from PG&E Table PG&E-4.6-4 showing distribution wires down due to equipment (conductor and splice failures) averaged over annual values from 2017 to 2020. The third column gives the relative frequency of wires down compared to "blue sky" days.

PG&E's data clearly shows that wires down rates due to equipment rise significantly on storm days and on major event days, further illustrating the dependency of outage rates on wind.

Ignitions arise from outages that create arcing, but whether an ignition occurs "may depend on the presence of other factors such as weather and fuels".[35] Both SCE and SDG&E analyze fire history data to obtain probability of ignition for outages. SDG&E presented the results of a five year study of ignition rates on p. 59 of its WMP:

[35] Appendix A; SCE Response to MGRA Data Request 6, Question 6.

	Ignition Rate			
Location	Normal	Elevated	Extreme	ALL
Non-HFTD	1.17%	2.91%	0.00%	1.46%
Tier 2	2.20%	5.07%	10.34%	3.37%
Tier 3	1.62%	4.31%	10.00%	2.74%
HFTD (Tier 2 + Tier 3)	1.92%	4.69%	10.20%	3.07%
System	1.42%	3.91%	6.10%	2.09%

Table 4 - SDG&E ignition rate study results from p. 59 of its WMP. The table shows the fraction of faults leading to wildfire ignition under normal, elevated, and extreme weather conditions in different high fire threat districts within its service area.

Direct evidence for elevated ignition rates due to wind conditions is difficult to obtain because wind-induced wildfire ignitions are a small fraction of overall ignitions, even though they are much likelier to have serious consequences. Nevertheless, direct evidence of wind-induced wildfire ignitions was obtained by an analysis by PG&E and MGRA done as part of PG&E's R.20-06-012 RAMP proceeding, and also in a similar analysis of SCE ignition data performed as part of this WMP review and presented later in this section.

As per the D.18-12-014 Settlement Agreement,[36] IOUs are required to perform alternative MAVF analyses at the request of intervenors. MGRA opted to have PG&E determine whether high winds were a factor in its risk events (specifically ignition events), particularly those leading to catastrophic losses. It requested the following analysis parameters:

> "Wind gust speed can be based on meteorological modeling or weather station data, though this should be done in a consistent way for the entire model run.
>
> - If meteorological analysis uses continuous rather than gust wind speed, use a gust factor of 1.6.
> - The tranches can be applied to the HFTD only.
> - Each wind speed category should be separated into RFW / non-RFW tranches.
> - Sub-driver (cause) information should be recorded for each incident. It is expected that certain ignition causes will show wind dependency (equipment failure, vegetation contact) and some will not (3rd party contractor, animals).
> - Mitigation analyses should be done for each tranche.

[36] D.18-12-014; Attachment A; SETTLEMENT AGREEMENT AMONG PACIFIC GAS AND ELECTRIC COMPANY, SOUTHERN CALIFORNIA EDISION COMPANY, SOUTHERN CALIFORNIA GAS COMPANY, SAN DIEGO GAS & ELECTRIC COMPANY, THE UTILITY REFORM NETWORK, ENERGY PRODUCERS AND USERS COALITION, INDICATED SHIPPERS, AND THE OFFICE OF RATEPAYER ADVOCATES.

The four wind speed categories that MGRA proposes are:

- Maximum wind gusts (MWG) within 3 miles < 25 mph
- 25 mph <= MWG < 40 mph
- 40 mph <= MWG < 55 mph
- MWG >= 55 mph"[37]

PG&E responded with an analysis attached as Appendix B-2 of this document. PG&E's data analysis found that there was a significantly larger probability of a large fire occurring when the wind speed was in excess of 25 mph. As MGRA predicted, drivers for the ignitions differed at higher wind speeds as well, with the relative likelihood of ignition by external agent (animal, balloon, vehicle) dropping significantly with respect to ignitions from vegetation and equipment failure. PG&E also found that of seven catastrophic fires it analyzed, six had wind gusts over 25 mph at the time of ignition (the Butte fire being the sole exception).

MGRA did a parallel analysis of PG&E's ignition data. PG&E used its POMMS weather model to calculate local wind speeds. MGRA instead used weather station data near the ignition points.[38] Rather than using nearest weather station, as was done in Mitchell 2013, the MGRA analysis instead searched all weather stations within 8 miles of the ignition for the highest wind gust value within 1 hour of the ignition. The motivation for this algorithm is the recent work of Coen, et. al. that shows that peak winds can show significant variation over short times scales and small geographic areas.[39] If strong gusts are occurring in highly localized areas, it is more likely to sample them if more station data is included, even if station data of varying quality is included. The 8 mile radius was chosen over a 4 mile radius because a significant number of ignitions had no weather stations within 4 miles. MGRA performed this analysis as a cross-check on PG&E, which turned out to be important as the initial PG&E analysis contained an error.

---

[37] A.20-06-012; MUSSEY GRADE ROAD ALLIANCE COMMENTS ON THE PACIFIC GAS AND ELECTRIC COMPANY 2020 RISK ASSESSMENT AND MITIGATION PHASE REPORT AND THE SAFETY POLICY DIVISION STAFF EVALUATION REPORT; January 15, 2021; p. 20. (MGRA RAMP Comments)

[38] MGRA's data was based on the publicly available weather station data at http://synoptic.com. Data and software used for the analysis can be found at http://github.com/jwmitchell/mbar-weather

[39] Coen, J.L., Schroeder, W., Conway, S., Tarnay, L., 2020. 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, 101152. https://doi.org/10.1016/j.jocs.2020.101152 (Coen, et. al., 2020)

The overall results of the MGRA and PG&E results were similar but contain some significant differences.

	POMMS (PG&E)						**Measured (MGRA)**					
Gust (mph)	**Veg**		**Equip**		**Agent**		**Veg**		**Equip**		**Agent**	
< 25mph	241	92.3%	146	94.8%	123	98.4%	229	87.7%	139	90.3%	122	97.6%
25-40mph	19	7.3%	7	4.5%	2	1.6%	22	8.4%	13	8.4%	2	1.6%
40-55mph	1	0.4%	1	0.6%		0.0%	6	2.3%	2	1.3%	1	0.8%
55mph+							4	1.5%				
Total	261		154		125		261		154		125	

Table 5 - Fraction of ignitions from vegetation, PG&E equipment, and external agents (balloons, animals, vehicles, 3rd party). Predicted PG&E and measured MGRA wind gust data are shown.

As can be seen, the relative contribution of ignitions from external agents drops from about ¼ of ignitions under low wind conditions to only 7% under higher wind conditions, a result that is similar for both PG&E & MGRA wind gust models. This is due to the fact that high wind conditions make up only a small fraction of the history, and there is no causal relationship between agent-caused ignitions and winds. This represents a roughly 4-fold increase in ignition probabilities for non-agent ignition sources for wind speeds greater than 25 mph.

For vegetation and equipment-related ignitions, however, the results of the two analyses are different. PG&E finds that equipment related failures make up roughly ¼ of ignitions under low and high wind conditions, whereas the MGRA analysis of measure data shows the relative fraction increase from ¼ to 0.3, indicating that equipment is if anything even more sensitive to wind effects than vegetation. MGRA analysis shows a greater propensity for ignition under high wind conditions for both vegetation (13.2% MGRA vs 7.7% PG&E) and equipment (9.7% MGRA vs. 5.0% PG&E).

While the fact that agent-caused ignition sources are suppressed compared to equipment and vegetation related ignition sources implies that wind is a causal agent in ignition risk, it does not fully quantify this dependency. In order to study this problem, further analysis of PG&Es ignition data set was done to compare ignition conditions against baseline weather conditions. To create baseline weather conditions for the ignition points, a Monte Carlo was used to create synthetic ignition data. The steps in the analysis were:

- An ignition point was randomly selected out of PG&E's ignition history data set.
- A random time between January 1, 2015 and December 31, 2019 was selected.
- Maximum weather station wind speed within one hour and within 8 miles was collected at the randomly selected ignition point at the randomly selected time.
- 2500 synthetic ignitions were analyzed.
- Wind speeds were classified into bins of < 25 mph, 25-40 mph, 40-55 mph, and > 55 mph.
- Statistical differences were analyzed between the Monte Carlo data wind speeds and the PG&E ignition data wind speeds.

	Ignitions versus wind speed			
Wind Speed	**Monte Carlo**	**Fraction**	**PG&E Ignition**	**Fraction**
< 25mph	2294	94%	526	92%
25-40mph	116	4.8%	36	6.3%
40-55mph	13	0.5%	9	1.6%
55mph+	5	0.2%	1	0.2%
No data	72		1	
Total	**2500**		**573**	

Table 6 - Ignitions versus wind speed for real (PG&E ignition) and synthetic Monte Carlo data that was generated at random real ignition points at random times in the five year data window. Data is sorted into wind gust speed bins, which represent the maximum wind gust speed measured at any weather station with recorded wind gust data within 8 miles of the ignition point and within a one hour window of the ignition. The "No data" bin had no weather station data within 8 miles of the ignition point at the time of the event within the 1 hour event window**.**

While the excess of ignitions for real data at higher wind speeds is not dramatic, it is statistically significant with a p = 0.01 using both a chi-squared and one-tailed z test. In particular, above 40 mph 10 ignition events are observed where only 4 would have been expected from the baseline ignition rate. Some additional observations regarding this result:

- Areas where ignitions occur could potentially be windier than other areas of the service area, and if so this would suppress any excess over the baseline weather condition. This could be tested by randomly selecting points along utility circuits in the HFTD rather than known ignition points.
- Selecting peak wind speed in the area rather than at nearest weather station is likely to produce a higher baseline reading than nearest weather station or averaging of weather stations. Ideally, an "optimal" value should be selected based on characteristics of the geographic location.

- It is important to note that while only 8% of PG&E ignitions occurred with nearby weather stations reading wind gusts of over 25 mph, 6 of 7 catastrophic fires analyzed by PG&E (7 of 8 if the Kincade fire is included) started under these conditions, and all of these fires had causes related to wind.
- PG&E started using de-energization to prevent wildfires in 2018, and more generally in 2019. Since ignitions cannot occur during the high wind conditions associated with de-energization, ignitions are effectively suppressed under high wind conditions for over 20% of the sample.

A similar analysis was performed on ignition data from SCE provided to MGRA via data request, as will be described in Section 9. This data was subjected to the same analysis as the PG&E ignition data, namely:

- Weather station data was scanned from publicly available sources to determine the maximum wind gust speed measured within 8 miles of the ignition point within 1 hour of the ignition.
- A Monte Carlo simulation was run for 1,500 data points at randomly selected ignition locations and using a randomly selected time between January 1, 2015 and December 31, 2020. This selected the maximum wind gust speed at any weather station within 8 miles of the random ignition point within 1 hour of the randomly selected time.

The ignition data was also classified as to general cause: Agent (animal, vehicle, balloon, 3rd party, vandalism), vegetation, equipment, unknown, or under investigation (ignition not confirmed by SCE and subject to litigation/investigation).

SCE Ignitions 2015-20 Wind Gust	**Agent**	**Equipment**	**Investigation**	**Unknown**	**Vegetation**	**Total**
< 25mph	46	33	6	10	7	102
25-40mph	11	11	6	2	1	31
40-55mph			3	1	1	5
55mph+		2	5	1		8
Total	**57**	**46**	**20**	**14**	**9**	**146**

Table 7 - SCE ignitions, 2015-2020, by wind speed and cause. "Agents" are animal, vehicle, balloon, 3rd party, and vandalism. "Investigation" ignitions are not confirmed by SCE but being investigated or litigated. Wind speed was highest wind gust measured at any publicly available weather station within 8 miles of the ignition point within a 1 hour window of the ignition.

It is notable that no ignitions attributed to "agents" occurred at wind speeds over 40 mph, which would be expected because there should be no causal relationship between external agents and wind speed. The category with the largest contribution at high wind speeds is "Investigation", which is also not surprising since wildfires ignitions under high wind speeds are more likely to spread and become damaging fires.

The Monte Carlo data shows "ambient" wind conditions at the ignition points, and allows a comparison with the wind conditions for actual ignitions.

Wind Gust	Random Sample	Fraction
< 25mph	1253	0.8353
25-40mph	197	0.1128
40-55mph	32	0.0206
55mph+	6	0.0040
No data	12	
Grand Total	**1500**	

Wind Gust	Expected	Observed
< 25mph	121.9587	102
>25 mph	20.05492	44

Table 8 - SCE ignition data 2015-2020 compared with a Monte Carlo simulation using randomly selected ignition points and times. The Monte Carlo data is used to predict an expected number of ignitions above and below 25 mph wind gust speed. This is compared with the observed number of ignitions in the SCE data.

As can be seen, there is a significant excess of ignitions occurring at wind speeds above 25 mph, with 20 ignitions expected from the Monte Carlo simulation and 44 being observed in the actual data. The probability that this value is due to a statistical fluctuation is 1.7×10^{-8}.[40]

The excess at wind speeds greater than 55 mph is dramatic, as shown in the figure below.

[40] Using Microsoft Excel CHISQ.TEST function.

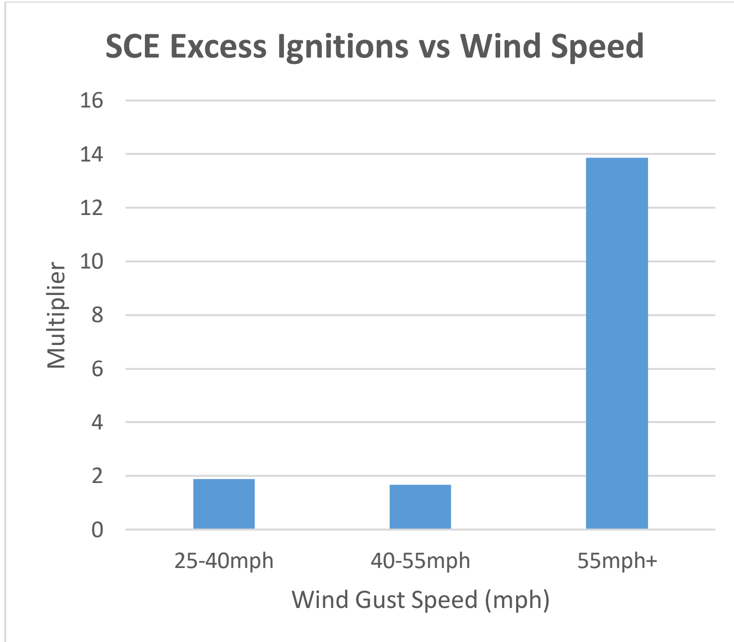

Figure 8 - Excess ignitions above ambient wind speed for SCE 2015-2020 ignition data as compared against Monte Carlo data using the same ignition locations. The "multiplier" is determined by dividing measured ignitions by expected ignitions in each bin.

The point of this discussion is to demonstrate that utility-ignited wildfires are to a great extent a problem of wind, at the fault and ignition level and not merely a fire consequence problem. PG&E's new Ignition Probability Model errs in not adequately accounting for wind. The next section describes the specific errors in PG&E's model and how these might be corrected.

4.3.2. Errors in the PG&E Ignition Probability Model

Since the 2020 WMPs (and since the filing of their RAMP), PG&E has adopted a new ignition probability model that utilizes a new statistical analysis technique that it claims will more accurately characterize ignition risks. Called a "maximum entropy" model, (MaxEnt as it is referred to in the PG&E treatment) this type of model optimizes available information (and uncertainty) to make an optimum decision based on available data. Originally based on Shannon information entropy,[41] the method was developed by Jaynes in 1957[42], and by the early 1960s was in use by geographers and ecologists. PG&E has selected a machine learning algorithm that uses maximum entropy as a classifier, or prediction model. PG&E claims that this has greatly improved its risk

[41] Shannon, C.E., 1948. A mathematical theory of communication. The Bell System Technical Journal 27, 379–423. https://doi.org/10.1002/j.1538-7305.1948.tb01338.x
[42] Jaynes, E.T., 1957. Information theory and statistical mechanics. Physical review 106, 620.

rankings, and has now completely re-ranked both its hardening and EVM programs based upon this new data.

Review of the assumptions and processes PG&E incorporated into its machine learning model, however, reveals several errors that can potentially lead to incorrect ignition probability information and therefore mis-ranking of circuit risk and miscalculation of MAVF scores. Specifically these are:

- PG&E does not incorporate wind associated with ignitions as an explanatory variable (model covariate), or peak wind value at the time of ignition, but rather annual average wind speed. Catastrophic fires generally do not start under "average" conditions.
- PGE uses 2016-2018 as the training set for its model and 2019 for its test set. PG&E began using PSPS as its go-to wildfire mitigation tool in 2019, which leads to significant bias in the data due to the fact that the data set no longer contains samples containing potentially catastrophic conditions.
- In fact, use of ignitions or outages is no longer a good risk indicator after PSPS comes into play, since the data set is "blinded" to risk conditions.

The implications of these errors are that if there are geographic areas particularly prone to Diablo fire-winds, which happen only a few (at most) days per year, these will not be identified by PG&E's model. Regarding the use of 2019 data as a test set, PG&E actually identifies the bias without realizing its cause, noting that "the spatial pattern and other characteristics of 2019 vegetation-caused ignitions deviated slightly from 2015-2018."[43] Use of ignitions and outages as risk indicators going forward will no longer be viable if the utility is using PSPS, which effectively removes all data representing the highest risk.

4.3.2.1. Use of annual averages for weather covariates

In response to an MGRA data request, PG&E justifies its use of average wind speed versus peak wind speed or wind speed at time of ignition: "*As a planning model, the 2021 Wildfire Distribution Risk Model provides insights used to develop annual mitigation plans. It is a model*

[43] PG&E Data Request Response WildfireMitigationPlans_DR_CalAdvocates_041-Q03.

trained to predict where ignitions are more likely to occur over the next year and not when they will occur. This is different than an operational model that would be used for a PSPS event where the likelihood of ignition for a forecasted weather pattern is the objective. For an operational model, peak weather values play a significant role in developing predictions. However, when modeling all ignitions over longer periods of time, prevailing wind speeds and directions play a different role. As long as there are a similar number of wind events in similar locations over time, the model is already accounting for wind impacts on annual ignitions. However, the majority of ignitions are not caused by wind as 95% of outages do not occur during NE wind days."[44]

There are several assumptions that are implicit in PG&E's description:

- The location of ignition events is not correlated with the time of their occurrence.
- The goal of wildfire mitigation plans is to reduce the number of ignitions.
- Ignitions that start catastrophic fires are identical in all characteristics to ignitions that cause no damage.

These assumptions and the approach they support are flawed. The goal of utilities is to eliminate the potential for catastrophic wildfire. If all ignitions could be eliminated, this would certainly prevent catastrophic wildfires. However, if the 1% of ignitions that lead to catastrophic fires could be prevented this would prevent over 95% of wildfire losses. So, in prioritizing mitigation work, utilities should be prioritizing the prevention of catastrophic fires, rather than trying to prevent the greatest number of ignitions. The goal of a data science approach to this problem ***should*** be to identify which if any environmental and physical characteristics are the best predictors of ***catastrophic*** wildfires. In order to make this determination, a correct set of correlate variables needs to be selected.

As detailed in the previous section, ignitions that are most likely to trigger catastrophic wildfires occur during periods of high wind gusts and low relative humidity. These sometimes violent weather conditions are relatively brief. Hence, they would not be expected to contribute appreciably to annual averages. Whether areas in the PG&E service area that are subject to strong foehn winds with adiabatic drying (such as Diablo winds) have higher or lower average annual wind speed or relative humidity is, to my knowledge, unknown. An assertion that the average annual and

[44] Data Request Response PG&E WildfireMitigationPlans_DR_MGRA_010-Q06.

extreme weather values have identical geographical distributions would need to be proven, and does not seem intuitively obvious.

It might be expected that 99% annual peak winds would provide a better description of weather conditions likely to cause catastrophic fire, but in fact PG&E evaluated this possibility and "the 'wind max' variable was removed from the input variables as it did not contribute performance gain during out of sample testing…", a result that they found surprising enough that it was "questioned by our modeling team."[45] PG&E provides an explanation as to why this is so: "Prevailing wind metrics over the course of the fire season are only weakly predictive of ignitions. This is because: (1) over 90% of reportable ignitions do not occur during unusual wind conditions; (2) prevailing winds shape vegetation settlement and structure -Red Flag Warning ignitions are due to anomalous conditions, not prevailing conditions and the low-risk coasts and low-veg high mountains see the highest prevailing winds; and (3) the danger associated with wind is most closely correlated with fire intensity and spread and therefore quantified by consequence data (as distinct from ignitions)."[46]

While PG&E's explanation is clear and succinct, it is flawed in several ways:

- While 90% of reportable ignitions don't occur under unusual wind conditions, over 90% of catastrophic power line wildfire ignitions do;
- Fire weather influences plant distributions as well. Areas subject to frequent or severe fire weather are also more likely to have frequent fires, meaning that the landscape will be more likely to have fire-adapted vegetation; and
- If PG&E's assertion that ignition probability is unrelated to weather conditions were true, then the fraction of major fires resulting from power lines would be the same as the overall fraction of wildfires of all sizes resulting from power lines. This is not the case.

PG&E's puts forward a plausible argument as to why annual weather data fails to show an ignition correlation. Indeed, Red Flag Warning conditions are "anomalous" and they are not well represented by either mean or 99th percentile wind speed data. The correct approach, however, would be to derive a variable that captures Red Flag Warning effects (specifically strong,

---

45 Data Request Response PG&E WildfireMitigationPlans_DR_MGRA_011-Q33.
46 Id.

directional winds accompanied by low humidity) rather than remove wind entirely from the analysis.

It should also be observed that ignitions and outages during extreme wind events are likely to have distinctly different causes (and hence mitigations) than ignitions and outages occurring outside of high wind periods. This is distinctly shown by the PG&E and MGRA analysis of PG&E ignition data in the previous section, which shows that agent-caused ignitions (balloons, 3rd party, vehicles) are four times less likely relative to equipment and vegetation caused ignition when the wind is gusting over 25 mph. Post-fire reviews by the CPUC and fire agencies, some examples of which are given in Section 4.3.1.1, also describe wind-specific failure modes. One obvious example is line slap (Thomas fire, Witch fire), which only occurs under windy conditions.

Finally, with regard to PG&E's observation that "*95% of outages do not occur during NE wind days*", it is also true that over 95% of wildfire damage due to utility fires is due to ignitions that occur on NE wind days. This means that if a means can be determined to identify potential outages that are more likely to occur on NE wind days, mitigation to prevent these ignitions would be 20 times more efficient than a shotgun approach does not prioritize based on appropriate drivers.

As a result of this error, PG&E's ignition model will not capture increased ignition risk in geographic areas that are particularly subject to high winds during red flag warning events. This error needs to be corrected.

The MGRA whitepaper prepared for the SMAP/RDF proceeding at the request of the Safety Policy Division[47] suggests that risk modeling should be based upon weather severity tiers, which would allow circuits to be classified as "safe" for operation as a function of weather severity level, with weather severity impacting both the ignition probability and consequence. The current PG&E approach is adequate for determining ignition probabilities in the "base tier" but is flawed when used for higher severity wind events. It should be possible to address higher severity wind tiers through a separate or corrected ignition probability model.

---

[47] Appendix B-1: WILDFIRE STATISTICS AND THE USE OF POWER LAWS; Joseph W. Mitchell, M-bar Technologies and Consulting, LLC; Prepared for the Mussey Grade Road Alliance; Proceeding R.20-07-013; February 11, 2021 (MGRA Whitepaper)

4.3.2.2. Bias introduced by de-energization

MGRA has long warned that use of de-energization will compromise the use of outage and especially ignition data as risk proxies.[48] The reason is obvious: when the power is off, outages and ignitions don't occur, so it is not possible to track frequency and location of these events. Ignoring this bias is potentially harmful. Risk events that are in the data set will be more likely to be outside of the areas subject to PSPS, which are in fact the most hazardous areas. Hence, naïve use of ignitions or outages as a risk proxy will lead to mitigation strategies that emphasize areas outside the most dangerous areas – an undesirable outcome. As alternatives, MGRA has suggested the use of outage data from wind events outside of fire danger windows and also for the use of damage data collected during post-PSPS event patrols.

PG&E has begun to incorporate PSPS damage into its Outage Producing Wind model[49] and its Transmission Operability Assessment (OA) Model.[50] These are positive steps that will help to address de-energization bias. PG&E should also incorporate PSPS damage into its Wildfire Distribution Risk Model if it is not doing so already.

4.3.2.3. Bias in years after 2018

Even if PG&E incorporates PSPS damage or wind-induced outages outside of fire risk windows into its machine learning model, it will still be faced with the problem that fire risk data after 2018 will potentially have a significantly different spatial, temporal, and causal dependency profiles than data prior to 2018. As described in the previous section, in years after 2018 ignition risk will show an apparent shift toward areas and times not affected by PSPS. With this in mind, it is particularly concerning that the PG&E machine learning analysis breaks out the year 2019 as the year used for validation. Unsurprisingly, PG&E finds that the spatial distribution for ignition risk differs in 2019 from its 2015-2018 distribution.[51]

---

[48] R.18-10-007; MUSSEY GRADE ROAD ALLIANCE SUPPLEMENTAL COMMENTS ON PHASE 2; September 6, 2019.
[49] PG&E WMP; p. 281.
[50] Id. p. 138.
[51] PG&E Data Request Response WildfireMitigationPlans_DR_CalAdvocates_041-Q03.

In the short term, PG&E can reduce this bias by aggregating all data and selecting training and test populations by random selection. SCE used this approach for its own WRRM machine learning model.[52] However, in the longer term, PG&E (and in fact all utilities) are faced with the problem of how to assess risk in areas where de-energization is a frequent mitigation. Even if post-PSPS damage is included as a "ignition-equivalent" event, there will be some uncertainty as to what the calibration between these events and actual ignition events is. This will require further study on the part of the WSD and utility data science teams.

4.3.2.4. Urgency and resolution of PG&E model issues

PG&E has completely changed its risk model and is using its machine learning model to prioritize its mitigation work. This has substantially changed the order in which circuits are prioritized for mitigation.[53] If there are indeed issues with the model that PG&E is using, this has direct impacts on public safety and requires urgent attention. PG&E's modeling has been checked through internal review and they have "currently contracted Energy and Environmental Economics, Inc. to perform a review and validation of the modeling methodology, code, model results and application to be completed in the spring 2021."[54] The concern is not that PG&E's selection of model is incorrect, but rather that its choice of explanatory variables was not suited to identifying the source of catastrophic fires, and that it has not compensated for the biases introduced by the introduction of PSPS in 2018. PG&E's model is not able to adequately account for ignitions occurring during the "anomalous conditions" that have been associated with the majority of California home losses and fatalities because these are rare events that will be lost in the overall statistics unless appropriate variables can be identified to detect them.

These problems should be addressed prior to the 2021 mitigation program. Recommendations for resolving these problems within PG&E's current analysis framework are listed below.

Recommendation:

[52] SCE WMP; p. 407.
[53] Data Request Response PG&E WildfireMitigationPlans_DR_WSD_010-Q06.
[54] PG&E WMP; p. 139.

PG&E should not use annual averages wind speed and relative humidity as covariate variables as these would be expected to have little predictive power for catastrophic fire ignition. Preferably wind gust speed at time and location of ignition should be used, or a variable identifying strong directional gusts under low humidity conditions.

Urgency:

Class A: Prior to approval. PG&E is planning to re-prioritize mitigations for 2021 using its analysis.

Recommendation:

PG&E should incorporate PSPS damage data into its ignition data sample to compensate for loss of ignition data due to PSPS. PG&E should calibrate ignition probabilities from PSPS damage data based on damage using historical outage and ignition data.

Urgency:

Class A: Prior to approval. PG&E is planning to re-prioritize mitigations for 2021 using its analysis.

Recommendation:

After incorporating PSPS damage data into its ignition sample, PG&E should divide its ignition data into learning and testing samples based on randomized sampling and not calendar years.

Urgency:

Class A: Prior to approval. PG&E is planning to re-prioritize mitigations for 2021 using its analysis.

Recommendation:

WSD should require PG&E to recalculate its risk rankings to incorporate peak winds and PSPS damage, and to account for the bias in data collection caused by the introduction of PSPS in 2018.

Urgency:

Class A: Prior to approval. PG&E is planning to re-prioritize its mitigation program in 2021 and by failing to account for enhanced catastrophic fire ignition probabilities due to wind and by failing to incorporate data from areas subject to PSPS there is a significant chance that calculated risk rankings will not represent actual catastrophic fire risk.

4.4. Research Proposals and Findings

4.4.1. SDG&E Research on Enhanced Vegetation Management

SDG&E provides the results of its Enhanced Vegetation Management program. MGRA has expressed concern regarding this program in the past and its choice of "High Risk Species", which for SDG&E are "Eucalyptus, Oak, Palm, Pine, and Sycamore, the species that rank in the top five as far as risk event contribution and account for over 80% of all vegetation related risk events."[55]

In its 2020 Q3 comments on SDG&E's program, MGRA pointed out that SDG&E's high risk species do not necessarily represent the greatest risk *per tree.*[56] As seen in the table below, trees representing the greatest risk per tree are palm, cypress, and century plant, with pine and eucalyptus also presenting an elevated risk. Sycamore presents a more modest risk per tree, while oaks a relatively low risk per tree.

Species	Average Inventory	Average Outages per year	Total Outages	% of total outages	Outages per 1000 trees per year
Eucalyptus	48116	25.50	459	41.90%	0.53
Palm	11223	12.50	225	20.50%	1.11
Pine	11509	8.11	146	13.30%	0.70
Oak	19510	3.72	67	6.10%	0.19
Sycamore	3118	1.11	20	1.80%	0.36
Pepper (California)	8462	0.94	17	1.60%	0.11
Cottonwood	1931	0.72	13	1.20%	0.37
Avocado	11838	0.72	13	1.20%	0.06
Cypress	473	0.67	12	1.10%	1.42
Ash	4706	0.61	11	1.00%	0.13
Century Plant	401	0.50	9	0.80%	1.25
Ficus	1587	0.50	9	0.80%	0.32
Willow	9099	0.50	9	0.80%	0.05
Silk Oak	1578	0.44	8	0.70%	0.28
Tamarisk/Salt Cedar	1310	0.39	7	0.60%	0.30

Table 9 - Copied from MGRA Q3 Comments (Footnote 56). Recalculation of SDG&E Table 24. Columns have been added for total number of outages and for outages per 1000 trees per year. Only plants causing more than 6 outages in the 18 year study period are included. Color coding is based upon number of outages per year per 1,000 trees: Red: >1.00, Yellow: 0.5 to 1.0, No color, 0.3 to 0.5, and Green, < 0.3.

In response, WSD has requested that the utilities arrive at a common approach to the definition of high risk species. SDG&E explains that "all three IOUs met weekly beginning on January 6, 2021 for the purpose of developing a unified plan and aligned strategies that include definitions, methodologies, timelines, data standards and assumptions. This joint plan will be

[55] SDG&E WMP; p. 70.
[56] MUSSEY GRADE ROAD ALLIANCE COMMENTS ON 2020 WILDFIRE MITIGATION PLAN Q3 QUARTERLY REPORT OF SDG&E, PG&E, AND SCE; September 30, 2020; pp. 5-7. (MGRA Q3 Comments)

provided in a WMP Supplemental Filing on February 26, 2021."[57] However, such a joint plan, if it yet exists, does not appear to have been served along with the February 26, 2020 Supplemental Filings, nor does it appear on any of the IOU websites. WSD should ensure that this work is completed and that it is subject to public comment.

MGRA's past concerns with SDG&E's aggressive trim program have been that it needs to show that the reduced wildfire risk justifies the substantial harm it can do to healthy native species. Indeed, looking at SDG&E's data between 2002 and 2020, showed that 0.4 risk events per year occurred for trim distances of 15-20 feet (5% of total risk events), and it detected no risk events at all for trims greater than 20 feet. SDG&E's tree trimming data show that it 5% of the trees in its inventory are trimmed to greater than 20 feet, and 8.5% to greater than 15 feet.

The most drastic vegetation management approach is tree removal. It should be apparent from tree removal data what priority utilities give to treating their "at risk" species. MGRA therefore requested that all utilities provide tree removal data for 2018 through 2020, providing species, reason, and distance of the tree from utility equipment.[58] SDG&E came closest to fully complying with this request, with limited justification data but providing full distance data. Their results are summarized in the table below:

Distance	Century Plant	Cottonwood	Cypress	Eucalyptus	Oak	Other	Palm	Pepper-CA	Pine	Sycamore	Grand Total
0.0 to 2.0 ft			4	85	16	110	621	6	15		862
2.1 to 4.0 ft		1	6	113	14	117	659	28	34	3	987
4.1 to 5.9 ft	1	22	5	303	36	233	1080	57	140	5	1900
6.0 to 7.9 ft	1	16	13	633	105	449	1275	116	217	11	2882
8.0 to 9.9 ft		16	11	1203	81	487	1175	132	149	26	3329
10.0 to 11.9 ft	3	19	7	1689	45	776	1298	82	122	22	4107
12.0 to 14.9 ft	2	14	2	1070	27	253	630	12	57	10	2083
15.0 to 19.9 ft	3	7		595	25	198	673	6	43	4	1565
20.0 to 30.0 ft	11	6		687	23	282	956	13	70	3	2056
30.1 to 40.0 ft	8	9		304	10	95	370	14	28	3	842
40.1 to 50.0 ft	2			66	1	20	63	1	13	1	167
50.1 to 60.0 ft	1	2		135	2	43	68	2	5		259
60.1 to 80.0 ft	2			148	8	85	67	3	10		326
80.1 to 100.0 ft	2	1		159	6	75	70	7	20	1	342
100.1 ft +	2	25	13	1498	78	508	1429	115	218	23	3960
Grand Total	**38**	**138**	**61**	**8688**	**477**	**3731**	**10434**	**594**	**1141**	**112**	**25667**
> 15 feet	31	50	13	3592	153	1306	3696	161	407	35	9517
> 15 feet %	81.6	36.2	21.3	41.3	32.1	35.0	35.4	27.1	35.7	31.3	37.1
Total %	0.15	0.54	0.24	33.85	1.86	14.54	40.65	2.31	4.45	0.44	100.00

[57] SDG&E WMP; p. 73.
[58] Appendix A: Data Request Responses MGRA-SDGE-04 Response 11; SCE response to MGRA Data Request SCE No. 6, MGRA-28; PG&E WildfireMitigationPlans_DR_MGRA_011-Q28.

Table 10 - SDG&E tree removals from 2018 to 2020, by species type and distance between the plant and utility equipment. Some species representing a small number of removals are not shown in the table for clarity (ex. silk oak, ficus). Some categories, such as palm, are aggregated from a number of related species.

As can be seen in the table, the "at-risk" non-native species eucalyptus and palm make up 74% of SDG&E tree removals. "Other" species, from a long list of mostly non-native domestic trees make up another 14.5% of removals. Of the at-risk native species, oaks make up only 1.9% of removals and sycamores (a less common tree, but associated with the 2007 Rice fire), make up 0.45% of removals. Pines (both domestic and native) represent 4.5% of removals.

So, while SDG&E lists eucalyptus, pine, oak, sycamore, and palm as "at-risk" species, in fact their most aggressive removals primarily target palm and eucalyptus. This is appropriate, and consistent with the analysis shown in Table 9 and its determination that eucalyptus, palm, and pine are the most hazardous trees in terms of outage probability per tree. Similar data should be provided supplementing SDG&E's tables in the same format as Table 10 showing trim distance.

Recommendation:

Utilities should be required to complete and circulate common definitions, methodologies, timelines, data standards and assumptions regarding "at-risk" species and criteria for EVM, and to circulate it for public comment.

Urgency:

Class B. Prior to the first quarterly update.

Recommendation:

Utilities should be required to show trim distance and number of removals as a function of tree species.

Urgency:

Class B. Should be done in a quarterly update.

4.5. Model and Metric Calculation Methodologies

4.5.1. Wildfire power law statistics and their implications for risk modeling

As part of the S-MAP proceeding, MGRA has been advocating for the use of power law statistics for wildfire consequence modeling. As a result, MGRA was invited to present a white paper on the justification for and use of power law statistics for S-MAP Technical Working Group 1. The analysis performed for MGRA makes several finding of direct relevance to the current wildfire mitigation plans. Therefore, MGRA's white paper is attached to these comments as Appendix B-2.[59]

To summarize the key points of the MGRA whitepaper, utility wildfire frequency is driven both by the frequency of extreme weather events and their severity, while wildfire size and potential harm is driven by severity of weather events. The size of wildfires has long been understood both theoretically and observationally to follow a "power law" distribution of the form $y = Cx^{-\alpha}$.[60] Such a relationship indicates what is known as a "fat-tailed" distribution, for which contributions from large events will dominate overall consequences. For an exponent of less than 1.0, which is the case for California wildfires, the contribution from large events is so overwhelming that it is not possible to predict a correct mean value from historical events. In other words, the worst fire is always in the future.[61] Deviations from this behavior occur when a maximum size of the available landscape is reached. Statistics are poor, but for California fires this may be for a fire scale of roughly 500,000 acres.

---

[59] Appendix B-2; R.20-07-013; WILDFIRE STATISTICS AND THE USE OF POWER LAWS FOR POWER LINE FIRE PREVENTION FINAL: FEBRUARY 11, 2021. Joseph W. Mitchell, Ph.D.; M-bar Technologies and Consulting, LLC; Prepared for the Mussey Grade Road Alliance. (MGRA whitepaper)

[60] For example see:
Malamud, B.D., Morein, G., Turcotte, D.L., 1998. Forest Fires: An Example of Self-Organized Critical Behavior. Science 281, 1840–1842. https://doi.org/10.1126/science.281.5384.1840
Turcotte, D.L., Malamud, B.D., Guzzetti, F., Reichenbach, P., 2002. Self-organization, the cascade model, and natural hazards. PNAS 99, 2530–2537. https://doi.org/10.1073/pnas.012582199
Drossel, B., Schwabl, F., 1992. Self-organized critical forest-fire model. Phys. Rev. Lett. 69, 1629–1632. https://doi.org/10.1103/PhysRevLett.69.1629
Moritz, M.A., Morais, M.E., Summerell, L.A., Carlson, J.M., Doyle, J., 2005. Wildfires, complexity, and highly optimized tolerance. Proceedings of the National Academy of Sciences 102, 17912–17917. https://doi.org/10.1073/pnas.0508985102

[61] For those of us living with or dealing with California wildfires over the past two decades, the implications of this mathematical relationship have been repeatedly demonstrated.

Power law relationships are often demonstrated by plotting data on a log-log plot, with the x axis being the logarithm of the fire size and the y axis being the number of fires or cumulative number of fires. This is shown in Figure below, which contains CAL FIRE fire perimeter data. The plot on the left is all fires without power line fires and the plot on the right contains only wildfires attributed to power lines.

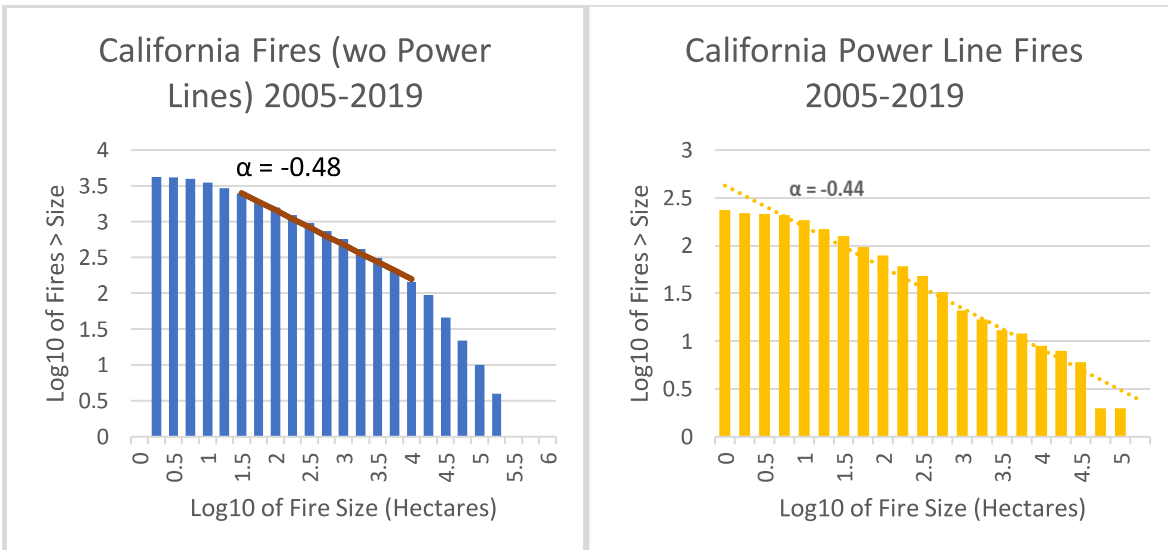

Figure 9 - CAL FIRE perimeter data for wildfires attributed to power line ignitions, shown as cumulative distributions plotted on log-log axes. 2007 and 2017 fire attributions are corrected with CAL FIRE and CPUC assessments. The trendlines are a guide to the eye, rather than a best fit and shows how power line exponents would appear. These are extreme fat-tailed distributions. Deviations from power law behavior appear above 30,000 acres (without power lines) and 80,000 acres for power line fires. Maximum scale may be 500,000 acres, with large uncertainty.

The MGRA whitepaper recommends that utilities address this problem through division of risk events into tranches based on weather severity. Weather is a driver of ignitions, it leads to greater fire sizes, and it also drives risk from PSPS events. There is a baseline as well of ignitions and potentially large (though not necessarily catastrophic) wildfires that are not driven by severe weather events. For severe weather events, utilities use power shutoff as an effective mitigation, though one that generates significant customer inconvenience, harm, and risk.

This is illustrated below:

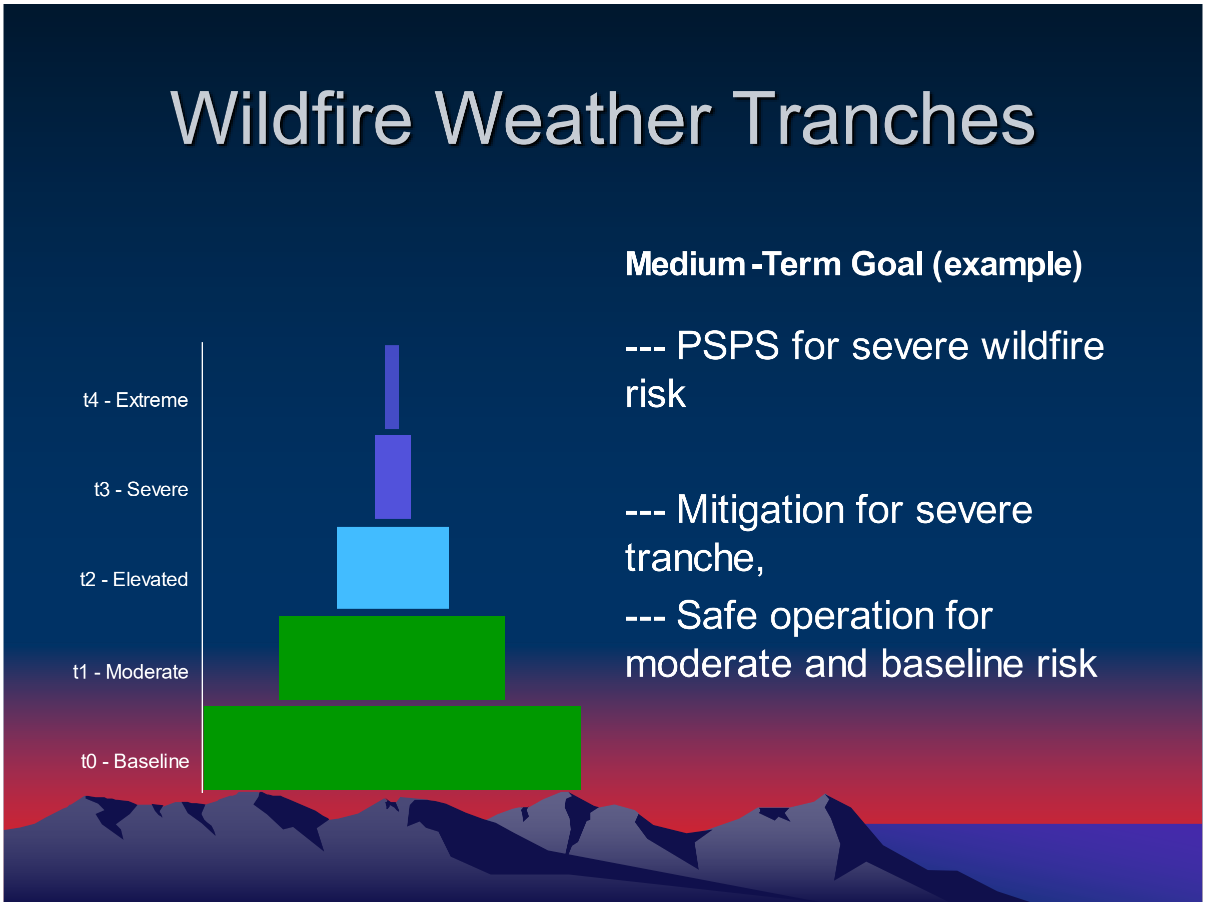

Figure 10 - Example of a risk analysis for a utility that is able to operate safely under moderate fire weather conditions. It evaluates and undertakes mitigations that would let it operate under elevated fire weather conditions. PSPS remains a last resort for severe and extreme fire weather conditions.

The whitepaper's position can be summarized: "***The purpose of utility wildfire mitigation is to raise the fire weather severity limits at which utility equipment can be safely operated.***" The primary goal is to reduce the potential for catastrophic fires that burn tens of thousands of acres, hundreds or thousands of homes, and result in many fatalities. These are the fires that cause the greatest harm to Californians. They are readily prevented by power shutoff, but this in itself is quite harmful. By shifting mitigation goals to reduce the need for power shutoff, utilities can address this harm as well. In fact, IOUs are already moving in this direction.[62] This is good and should be encouraged.

---

[62] For example, SCE's WMP on p. 340: "SCE had previously prioritized covered conductor installation primarily based on ignition risk reduction analysis. We are transitioning to using PSPS risk as a criterion when installing covered conductor, thereby targeting select areas of the grid expected to be frequently impacted by PSPS."

There are a number of ways that the statistical nature of catastrophic wildfire events influences the way that they should be thought of, and this has direct implications for the Wildfire Mitigation Plans and their interpretation:

- In retrospect, the definition of "catastrophic" wildfire adopted in WSD's Vision Statement[63] was in error. The most pressing and clear danger is that future utility wildfires may be even more destructive than those that we have already experienced. With the reservation of the term "catastrophic" we no longer have a linguistic means to differentiate between these massively destructive fires and a smaller fire that kills one person. While elimination of all lethal wildfires is a fine aspirational goal, prevention of wildfires that can kill hundreds is an absolute mandate, and the strategy and tactics to achieve these two goals can be quite different.
- Utility hardening prioritization and determination of PSPS thresholds and extent both depend upon consequence modeling. All major IOUs now use the Technosylva platform for their consequence modeling. In order to model realistic losses, it is essential that the fire spread modeling mirror historical fire losses in its wildfire size distribution. However, all utilities limit the size of wildfires generated with this model by limiting duration of fire spread. This will artificially elevate perceived risk from ignition points closer to population centers. This is discussed in more detail in Section 4.1.
- While catastrophic fires (in the catastrophic sense) can be prevented through de-energization, it is essential that de-energization be conducted at the right place and the right time. There are examples of fires causes as secondary consequences of de-energization, as well as fires that started in energized areas proximate to PSPS events in location and time. This re-emphasizes the need for full validation of utility weather forecasting.
- The greatest uncertainty (and therefore greatest risk) comes from the high end of the fire size spectrum, because the ultimate potential size of wildfires is not well known. Utilities and WSD must therefore make conservative assumptions about the potential for extremely large fires.

---

[63] WSD Strategic Roadmap; Appendix 2: Utility Wildfire Mitigation Vision and Objectives; p. 4.
"The criteria are:
Public Safety: Directly causes one or more deaths
Property: Damages or destroys over 500 structures
Natural resources: Burns over 140,000 acres of land."

- In order to understand what constitutes reasonable spending to buy down PSPS risk, we need to have a well-defined model for how PSPS risk is calculated. Utilities have made an initial attempt at this in their 2021 WMPs, but standards need to be in place. Development of these standards should occur as part of the S-MAP proceeding R.20-07-013.
- Attempts to calculate risk for extreme tail events are fraught with uncertainties that render risk/spend efficiency calculations imprecise and potentially dangerous. Heuristic methods to eliminate tail risk are recommended in the MGRA white paper and in reference articles on this kind of risk.[64] PG&E's "Black Swan" filter[65] for PSPS determinations conceptually falls into this category. However, by de-energizing customers during extreme risk periods it places them into greater peril and needs to be examined with some scrutiny. This is discussed in more depth in Section 8.1.4.

Recommendation:

WSD should re-define "catastrophic" in its vision statement so as to describe the potential for many casualties. Alternatively, it should define a new term to describe high-casualty wildfires.

Urgency:

Next revision of the WSD Strategic Roadmap.

Recommendation:

Utilities and WSD should validate that the wildfire size distribution produced by Technosylva in the run periods defined by the IOUs adequately reproduces the wildfire size distribution of real fires. This can be demonstrated with a log-log plot of cumulative fires versus the fire size.

Urgency:

---

[64] Taleb, N.N., 2020. Statistical Consequences of Fat Tails: Real World Preasymptotics, Epistemology, and Applications. STEM Academic Press.; p. 204: "do not push outliers under the rug, rather build everything around them. In other words, just like the FAA and the FDA who deal with safety by focusing on catastrophe avoidance, we will throw away the ordinary under the rug and retain extremes as the sole sound approach to risk management."
Danner, C., Schulman, P., 2019. Rethinking risk assessment for public utility safety regulation. Risk analysis 39, 1044–1059: "*manage from possibility, and not simply probability. Uncertainty concerning consequences leads HROs* [High Reliability Organizations] *to manage against worst-case scenarios. Uncertainty about both likelihoods and consequences leads them to cease operations in precursor zones, and stress emergency response preparations and the promotion of resilience*."

[65] PG&E WMP; p. 880.

Class B. Can be generated by the next quarterly report.

Recommendation:

The WSD should validate that weather forecasting models run by the utilities are consistent and correct in approach and have been validated against utility data.

Urgency:

Class B. Should be in scope for workshops / working groups in 2021.

Recommendation:

Utility risk spending prioritization will largely be determined by models developed as part of the Risk-Informed Development Framework (RDF or SMAP 2) currently underway under the auspices of R.20-07-013. As this affects wildfire safety, the Wildfires Safety Division should have a party or advisory role in this proceeding.

Urgency:

Phase 1 of SMAP 2 is currently underway and Phase 2 will be initiated in the next few months. WSD should begin participation as soon as possible in order to provide additional guidance for wildfire prevention priorities.

4.5.2. Fire consequence modeling and catastrophic risks

From the previous section the importance of properly estimating wildfire sizes and consequences is critical to estimating risk. There is a world of difference between the "typical wildfire" and the "wildfire a typical house sees before it burns down". In other words, pick out a random California wildfire from any database, and pick out a random home (or life) lost to wildfire and look at the fire that took it:

Typical California Wildfire	**Wildfire Taking Typical Home or Life**
Less than 100 acres	Tens of thousands of acres
Quickly controlled by fire services	Little to no control of fire growth
Low to moderate spread	Extreme fire spread rate
Many firefighters per mile of fireline	Few firefighters per mile of fireline
Low to moderate winds	High winds with firebrand showers and long range ember transport

Aggressive attack and suppression	Defensive asset protection, perimeter control, opportunistic structure protection, rescue
Reasonable number of firefighters per threatened structure	Vastly more threatened structures than firefighters
Probably not a power line fire	Probably a power line fire

Table 11 - The differences between a random California fire and the fire that destroyed a randomly selected home or life, based on historical Cal Fire data (perimeter or CAIRS for fires, Top 20 Acres/Deadliest/Destructive for fires causing harm.

The mandate of the Wildfire Safety Division and CPUC is first and foremost to protect lives, property, and the environment from electrical fires – hence their mandate is to reduce fires of the type in the right-hand column, the most destructive fires. One could argue by that reducing the number of fires in the left column the number of fires in the right will likewise be reduced. While that might be true in principle, it ignores the fact that the drivers of wildfires in the right and left columns, weather and ignition causes, can be very different, and determine whether a wildfire in the left column becomes instead a fire in the right column. Prevention of catastrophic fires and calculation of the risk that they present require qualitative and quantitative understanding and modeling of the drivers that are most likely to lead to catastrophic fire ignition and spread.

If utilities are going to correctly model risk, they must correctly model consequences. The consequences determining overall California fire losses have been from catastrophic fires. Hence utility consequence models must properly account for these catastrophic fires.

Unfortunately, IOU fire models do not properly incorporate catastrophic losses, and this introduces biases into their risk modeling, especially as regards geographic distribution of risk.

All three major utilities now use the Technosylva wildfire simulation software to generate computer simulations of wildfire and its impact on communities. SDG&E states that "Technosylva aggregated 69 million wildfire computer simulations to build a geospatial layer of wildfire vulnerability over the SDG&E electric distribution overhead assets. This layer combined with the assets expected failure and ignition rates were used to assign a wildfire risk score."[66] PG&E: "Ignition probability models, in conjunction with the wildfire consequence modeling from Technosylva, is used to determine and identify wildfire risk at specific grid locations within the

[66] SDG&E WMP; p. 76.

HFTD Tiers 3 and 2. Since wildfire risk is not uniform across HFTDs, these models produce information that can also be used to identify which locations should be prioritized for specific initiatives and wildfire mitigations."[67] SCE: "In late 2020, SCE transitioned from using the Reax ignition consequence model to Technosylva, which resulted in some reprioritization of the circuit segments."[68]

Simulating potential fire losses given certain fire spread conditions (weather and fuels) as a function of geographic position is a valuable technique for understanding risks due to utility infrastructure, and helps with both the prioritization of mitigation measures and the operational task of selecting what circuits and segments should be subject to power shutoff. There is an assumption underlying this strategy: ***<u>In order for a wildfire simulation to accurately simulate risk, it must accurately represent the wildfires that cause harm.</u>*** The wildfire simulations run by the major IOUs fail to do this adequately.

The problem with the utility approach is not with the simulation itself, but with the limitations that are put on it. PG&E limits its typical fire spread modeling to 8 hours after ignition by default,[69] though it can go longer, as does SCE[70] and SDG&E.[71]

PG&E provided some of the output received from the Technosylva runs in its file 2021WMP_ClassB_Action-PGE-15_Atch01.xlsx, representing 8 hour data runs.[72] PG&E ran multiple Technosylva runs with different weather and fuel conditions for each geographic point, and presents both a mean and maximum fire size, in acres.

PG&E's Technosylva data was taken and further analyzed to produce Figure 11. These figures display the fire size distributions in 2021WMP_ClassB_Action-PGE-15_Atch01.xlsx in a manner comparable to Figure 9, which shows the cumulative wildfire size distribution for California wildfires. As seen below, the Technosylva wildfire size distributions are dissimilar to the power law dependency seen in Figure 9.

[67] PG&E WMP; p. 379.
[68] SCE WMP; p. 212.
[69] Appendix A: PG&E Data Request Responses WildfireMitigationPlans_DR_MGRA_012-Q36 through Q41.
[70] Appendix A: SCE Data Request Responses MGRA-SCE-008 Responses 1 through 6.
[71] Appendix A: SDG&E Data Request Responses MGRA-SDGE-06 Responses 1 through 5.
[72] PG&E WMP; pp. 66-67.

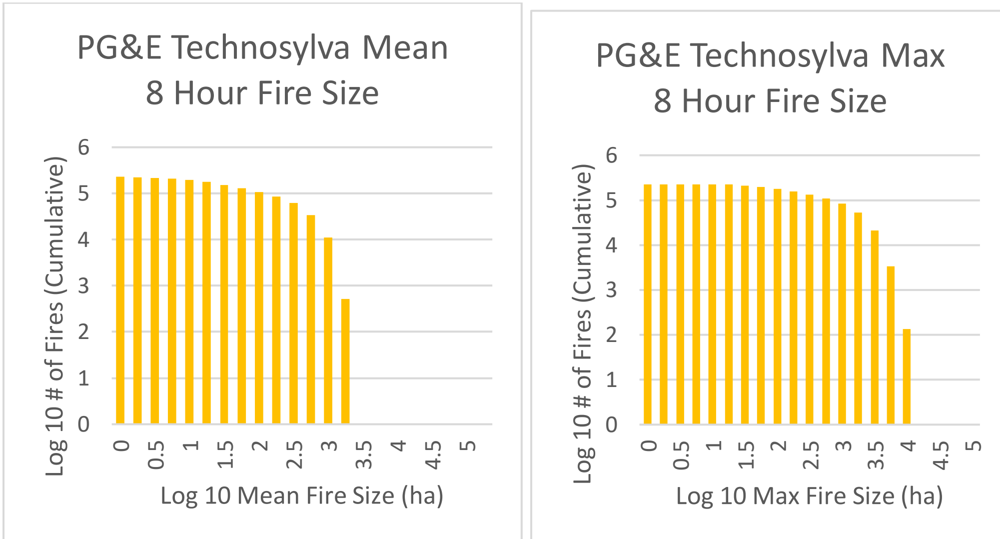

Figure 11 - Cumulative number of simulated wildfires greater than a given fire size threshold. This log-log plot is meant for comparison to Figure 9 showing the power law dependency of wildfire areas in California. As can be seen, the set of simulated fires amplifies the number of fires in intermediate ranges (with respect to small fires) and then cuts off abruptly. The left chart indicates mean fire sizes of simulations for specific geographic data points and the right indicates the maximum size of simulations for specific geographic data points. Overall, fires over 10,000 acres are very rare (< 1% of even the maxima) for 8 hour simulations. Fire sizes are in hectares (ha, 2.7 acres) to be directly comparable to the California fire sizes.

Rather than dropping off with a power law dependency, which would be seen as a constant slope, the log of the number of maximum fire sizes and means remains roughly constant as a function of size up to several hundred acres, then drops precipitously. The PG&E 8 hour simulation data also shows that the Technosylva calculations will rarely produce fires over 10,000 acres (3,700 ha) within 8 hours, even when "worst case" spread conditions are selected. The largest wildfire simulated by any PG&E Technosylva run in a set of 9 million simulations was 31,015 acres.[73]

In order to simulate actual risk, simulated wildfire size distributions that are similar to real wildfire size distributions should be used. Imposing size limitations on fire sizes will result in serious inaccuracies in risk assessments. For circuit risk ranking, for instance, using smaller fire sizes will imply that circuits most proximate to population centers will have a higher risk score. In fact, with many catastrophic fires the most damage is done at some distance from the point of origin as winds drive fires out of remote areas and into the wildland urban interface.

For example, the 2007 Witch fire perimeter in the SDG&E service territory is shown below, including the population centers that it affected. Superimposed on this fire perimeter is an oval

[73] Appendix A: PG&E Data Request Responses WildfireMitigationPlans_DR_MGRA_012-Q37.

approximately 10,000 acres in area, near the maximum typical value produced by PG&E's 8 hour simulation.

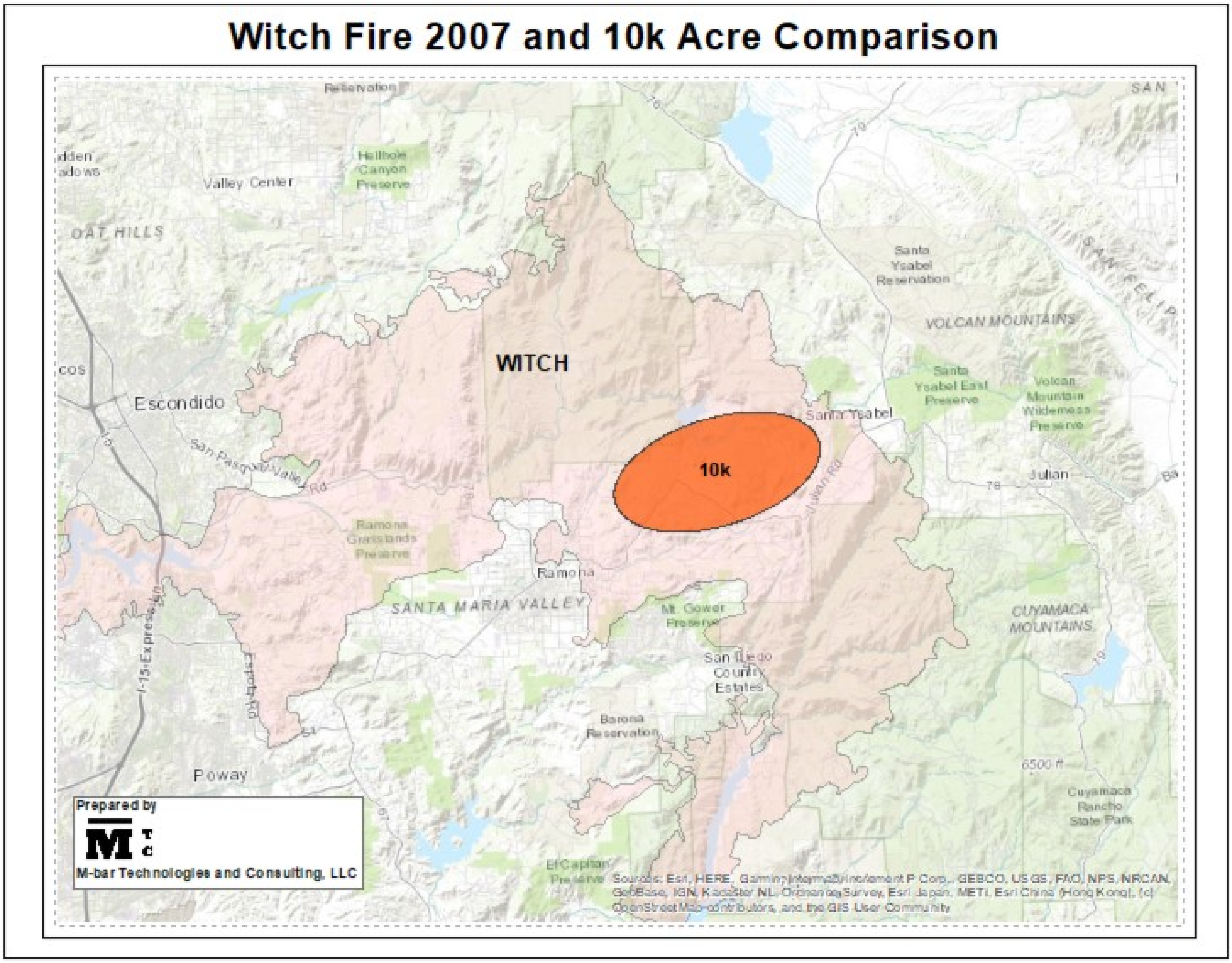

Figure 12 - The 2007 Witch fire perimeter in the SDG&E service area is shown with a 10,000 acre oval near the point of origin. The population centers of Poway, Ramona, and Escondido were heavily impacted by the Witch fire but would not be shown as threatened by a 10,000 acre fire at the same point of origin.

The Witch fire started near the area denoted as Santa Ysabel in the figure, grew to 200,000 acres, destroyed 1,650 homes, and was responsible for two deaths, impacting the communities of Poway, Ramona, and Escondido. Significant impacts and losses occurred after the first eight hours after ignition had passed.[74] An oval approximately 10,000 acres in size has been drawn with one end near the point of origin to depict how a simulation with a maximum size of 10,000 acres would evaluate the fire risk. As can be seen, no population centers would be shown as impacted in the

[74] Maranghides, A., Mell, W.E., 2009. A Case Study of a Community Affected by the Witch and Guejito Fires (No. NIST TN 1635). National Institute of Standards and Technology.

simulation. The circuit related to the origin would therefore likely be given a lower risk score than equivalent circuit closer to population centers, even if it had less potential for unlimited fire growth.

In some cases, losses occur within the first eight hours of ignition, such as the Tubbs fire.[75] In the case of the Camp fire most losses and fatalities occurred within the first eight hours, but losses continued after the 8 hour window has passed.[76] A Technosylva analysis of simulated fires from damage occurring during de-energization was conducted at the request of the Commission. These analyses were for 24 hours, and simulated damages occurred well after 8 hours, and for some losses were still occurring even after 24 hours.[77] For the purposes of safety risk assessment, the greatest danger appears to be in the initial period before effective notification and safe evacuation can occur. For the purposes of financial risk assessment, the entire period during which structures may be at risk should be evaluated.

What this exercise is intended to show is that accurate calculation of fire risks and risk rankings requires accurate simulation of fire sizes. Incorporating larger wildfires into the sample will tend to distribute perceived risk more evenly into areas farther from population centers but more subject to severe fire weather, where catastrophic fires can gestate before exploding into the wildland urban interface.

Using fire simulations for power shutoff raises similar concerns. Currently, only SDG&E utilizes fire spread modeling for gauging which circuits to de-energize.[78] If the risk from a circuit being considered for power shutoff is being evaluated, fire spread from an ignition due to that circuit should be run for the forecasted duration of the severe weather event. Shorter durations will again tend to weight the calculated risk closer to developed areas than it should properly be.

---

[75] Watkins, D., Griggs, T., Lee, J.C., Park, H., Singhvi, A., Wallace, T., Ward, J., 2017. How California's Most Destructive Wildfire Spread, Hour by Hour. The New York Times. https://www.nytimes.com/interactive/2017/10/21/us/california-fire-damage-map.html; Downloaded 3/26/2021

[76] Maranghides, A., Link, E.D., Brown, C.U., Mell, W., Hawks, S., Wilson, M., Brewer, W., Vihnanek, R., Walton, W.D., 2021. A Case Study of the Camp Fire - Fire Progression Timeline (Technical Note (NIST TN) No. 2135);

[77] California Public Utilities Commission; Public Meeting on Technosylva 2019 PSPS Wildfire Risk Analysis Results; Friday March 26, 2021.

[78] Appendix A: SDG&E Data Request Responses MGRA-SDGE-06 Response 3, SCE Data Request Responses MGRA-SCE-008 Response 4 and 5, PG&E Data Request Response WildfireMitigationPlans_DR_MGRA_012-Q39.

SDG&E expressed concerns regarding longer fire simulations, noting that "24 hour simulations are rarely performed as it would be extremely unusual for a fire to burn for 24 hours without some amount of suppressive action. In the instances that SDG&E has run the model for 24 hours, the acres impacted are highly dependent upon the weather conditions."[79] Indeed, whether suppressive action itself has an effect is also weather dependent, with fire services often requiring a break in the fire weather to gain the upper hand.[80] It would also be expected that inaccuracies and uncertainties in model results will grow with time, as these are non-linear systems. However, this is still preferable to ignoring a potentially dangerous bias in the data that would focus utility efforts more toward where people live rather than toward where the danger to those people will be coming from.

Recommendation:

The Wildfire Safety Division should sponsor workshops and/or working groups to analyze assumptions regarding Technosylva model inputs in order to ensure that simulations are equivalent to power line fire events. Alternatively, WSD could request that the Commission sponsor this activity as part of R.18-12-005 or R.20-07-013.

Urgency:

Class B: To the extent that these calculations affect circuit risk rankings, this is a moderately urgent issue.

Recommendation:

For analysis used for MAVF or for circuit risk ranking, fire modeling simulations should run for the projected length of the typical hazard events leading to catastrophic losses. For example, "SCE uses 41 weather scenarios across a 20-year historical climatology in the consequence component of its WRRM,"[81] while SDG&E "focused on the maximum consequence for each distribution segment, which represents the worst case weather and vegetation."[82] The duration of the wildfire spread simulations should match the weather scenarios used.

Urgency:

---

[79] Appendix A: Data Request Response MGRA-SDGE-03 Response 9.

[80] Finney, M., Grenfell, I.C., McHugh, C.W., 2009. Modeling Containment of Large Wildfires Using Generalized Linear Mixed-Model Analysis. Forest Science 55, 249–255. https://doi.org/10.1093/forestscience/55.3.249 https://academic.oup.com/forestscience/article-pdf/55/3/249/22545803/forestscience0249.pdf

[81] SCE WMP; p. 190.

[82] Data Request Response MGRA-SDGE-05 – Response 3.

Class B: To the extent that these calculations affect circuit risk rankings, this is a moderately urgent issue.

Recommendation:

To provide validation that the Technosylva fire simulations match actual California fire data, utilities should be required to provide cumulative fire size plots such as shown in Figure 9 and Figure 11 for their Technosylva model runs.

Urgency:

Class B: To the extent that these calculations affect circuit risk rankings, this is a moderately urgent issue.

Recommendation:

If Technosylva fire spread simulations are being used to model PSPS events to determine circuits at risk, the duration of the model run should match the duration of the forecasted fire weather event.

Urgency:

Class A: This should be put into place immediately so that is active prior to the 2021 PSPS season. Curtailing fire spread model runs will artificially move risk to circuits proximate to population centers and away from more remote circuits that may present a greater danger of catastrophic fire ignition.

4.5.3. Integration of risk events with RFW and HWW metrics

The latest templates request that utilities provide metrics that allow risk events to be normalized for the level of environmental hazard experienced during the year. The required metrics are "Red Flag Warning overhead circuit mile days", and "High Wind Warning overhead circuit mile days". These are based on National Weather Service Red Flag Warning (RFW)[83] and High Wind Warning (HWW) designations, and the "overhead circuit mile days" represents the time exposure of utility overhead equipment to these conditions.

---

[83] PG&E observes that: "Many NWS offices have developed their own RFW criteria and most offices consider wind speed when issuing an RFW. Some NWS offices consider wind gusts over 35 mph, while others utilize a minimum sustained wind from 15-25 mph, while others use a matrix approach dependent on the combination of RH and wind speed." PG&E WMP; p. 73. Hence this criteria may not be uniform across utilities or geographic regions.

MGRA in its 2020 WMP comments had urged that WSD adopt high wind criteria in order to classify risk events, so that the "resiliency" of utility infrastructure to high winds could be tracked over time.[84] WSD, for its part, added the "High Wind Warning overhead mile days" in order to apply a commonly defined metric that could be used by all utilities. The HWW is a binary on/off metric showing larger geographic areas where wind gusts in excess of 58 mph are anticipated.[85] It is therefore not ideal, but can still potentially show utility infrastructure sensitivity for high winds.

In order for these metrics to be fully utilized, it is necessary to have utility risk events – ignitions, outages, and wires down – classified as to whether they occurred during these risk periods. Ideally, this should be presented as additional summary data in non-GIS data tables 1-12. An example format would be:

#	Outcome metric name	2015									
		HFTD Tier 2					HFTD Tier 3				
		Total	RFW	HWW	HWW&RFW	HWW&^RFW	Total	RFW	HWW	RFW&HWW	HWW&^RFW
1.a.	Number of all events with probability of ignition, including wires down, contacts with objects, line slap, events with evidence of heat generation, and other events that cause sparking or have the potential to cause ignition										
1.b.	Number of wires down (total)										
1.c.	Number of outage events not caused by contact with vegetation (total)										
1.d.	Number of outage events caused by contact with vegetation (total)										
7.c.ii.	Number of ignitions										

Table 12 - Example format for table to collect summary data on risk events during National Weather Service Red Flag Warnings (RFW) and High Wind Warnings (HWW). Additionally, entries for the intersection of these (HWW&RFW) are important to differentiate whether the weather event causing the failure occurred in or outside of fire weather. It's compliment (HWW&^RFW), showing high wind warnings and not red flag warning, is redundant and can be removed from the table. Event data for number of risk events, wires down, outage events, and ignitions are shown. Separate entries for events caused by vegetation are suggested, as would be events known to be caused by equipment (not shown). Data is divided into HFTD tiers. Only the year 2015 is shown in the example, but the table should cover the entire reporting period.

SCE, PG&E, and SDG&E were presented with this table and asked to populate it with historical data. SCE and PG&E claimed that this was burdensome and was a new analysis, and that they did not have the means to calculate whether events occurred within the HWW and RFW time windows and geographic boundaries because they had not yet converted event data into the required GIS format (see Section 10.2 for further discussion of completeness of utility GIS data).[86] MGRA

[84] MGRA 2020 WMP Comments; pp. 10-12.
[85] SCE Data Request Response CalAdvocates-SCE-2021WMP-08; Question 005.
[86] Appendix A: PG&E Data Request Response WildfireMitigationPlans_DR_MGRA_009-Q01 to Q05, SCE Data Request MGRA Data Request No. 3; Questions MGRA-7 through MGRA-11 (no response).

agreed to allow PG&E and SCE to provide raw outage and ignition data with geographic location information in the form of excel spreadsheets. This data will be analyzed by MGRA to produce the requested information, though this will not be completed in time for inclusion in stakeholder comments. SDG&E, on the other hand, performed all of the requested analysis and provided the results in an Excel file.[87] SDG&E was also asked to provide annual High Wind Warning data in circuit-mile-days divided into HFTD tiers.[88] This data is summarized in the table below:

Outcome metric name	**2015-2020 HFTD Tier 2&3**				
	Total	RFW	HWW	HWW&RFW	HWW&^RFW
Number of all events with probability of ignition	2572	108	27	5	22
Number of wires down (total)	264	6	6	0	6
Number of outage events not caused by contact with vegetation (total)	2499	102	12	1	11
Number of outage events caused by contact with vegetation (total)	73	6	15	4	11
Number of ignitions	100	10	8	5	3
RFW/Circuit mile days		284,660.3			
HWW/Circuit mile days			164,547.5		
RFW %		3.7			
HWW %			2.1		
EXPECTED events with probability of ignition		96.31	55.20		
EXPECTED Number of wires down (total)		10.50	5.84		
EXPECTED Number of outage events not caused by contact with vegetation (total)		93.10	53.34		
EXPECTED Number of outage events caused by contact with vegetation (total)		3.21	1.86		
EXPECTED Number of ignitions		3.70	2.08		

Table 13 - SDG&E outage data for 2015-2020 normalized by Red Flag Warning (RFW) and High Wind Warning (HWW) conditions. Measured values for risk events, wires down, outages w/wo vegetation, and ignitions are shown. Expected values were calculated using fraction of time under RFW and HWW conditions multiplied by total events. An excess of ignitions and vegetation-related outages is seen during RFW and HWW. The deficit in number of observed outage events during HWW is not understood.

[87] Data Request Response MGRA-SDGE-03; Questions 1-5.
[88] Data Request Response MGRA-SDGE-05; Question 2.

Observations:

Between 2015 and 2020, SDG&E's HFTD Tier 2 and Tier 3 experienced Red Flag Warning Conditions roughly 3.7% of the time and High Wind Warning conditions 2.1% of the time. No apparent excess of risk events, wires-down events, or non-vegetation related outages was observed under RFW/HWW conditions. An excess was observed in the number of vegetation outage events for both RFW (6 events observed, 3.2 expected) and HWW (15 observed, 1.9 expected), with the smaller excess for RFW possibly due to the effect of PSPS. An excess was also observed in the number of ignitions under RFW conditions (10 observed, 3.7 expected) and HWW conditions (8 observed, 2.1 expected), further supporting the assertion that ignitions are wind-related. It is surprising that even with its aggressive targeted PSPS program and lack of catastrophic fires since 2008 that SDG&E still exhibits excess ignitions during Red Flag Warning days. The deficit observed for the number of risk events under high wind warnings (27 observed, 55 expected) is anomalous and not understood, particularly since the number of events expected and observed under red flag warnings are in reasonable agreement.

The anomalous deficit in HWW risk events and non-vegetation related outages raises questions regarding the quality of the outage data that should be further explored. Other variables seem to show consistency between RFW and HWW, with HWW showing slightly larger excesses that might be explained by de-energization during Red Flag Warnings. This data shows that in principle High Wind Warning data can be used to normalize risk metrics and provide a resilience metric that supplements the Red Flag Warning data because it is less subject to power shutoff biases. It should be re-emphasized that SDG&E's data was analyzed because they were able to rapidly provide it, demonstrating a greater mastery of their metrics than either PG&E or SCE.

Recommendation:

All IOUs should be required to provide risk metrics ("near miss", outages, wires down, ignitions) divided into HFTD tiers and classified as to whether they occurred during RFW or HWW conditions, in the format shown in Table 12. This allows true normalization of risk metrics against the environmental stresses being experienced by their infrastructure. For full normalization, total number of circuit-mile-days for both RFW and HWW should be provided divided into HFTD tiers.

Urgency:

Class B. All utilities have this data, and it is straightforward for them to analyze it. This analysis provides a critical normalization that allows risk metrics to be associated with system resilience.

Recommendation:

The method by which potential ignition events are classified should be more closely examined, particularly by SDG&E, to discover the apparent deficit of risk events during HWW days.

Urgency:

Class B. If there are any issues with how the potential ignition metric itself is obtained, these should be identified and resolved prior to the next major review cycle.

5. DIRECTIONAL VISION FOR WMP

5.1. Goal of the Wildfire Mitigation Plan

In general, the utility Wildfire Mitigation Plan goals are insufficiently ambitious and focus on small improvements. For example, PG&E's goal that it claims "is shared across WSD and all utilities: Documented reductions in the number of ignitions caused by utility actions or equipment and minimization of the societal consequences (with specific consideration to the impact on Access and Functional Needs populations and marginalized communities) of both wildfires and the mitigations employed to reduce them, including PSPS."[89]

As shown in the previous sections, the primary risk to Californians is from the ignition of ***catastrophic*** fires. Most utility ignitions cause no harm. Utility efforts should instead be focused on "utility actions or equipment *leading to catastrophic wildfire ignition...*". This is a potentially achievable and greatly beneficial goal. Incremental improvements in reducing the number of ignitions will *never* succeed in protecting Californians. Mitigations should be focused on ignitions that have external drivers and that are likely to occur under the worst possible conditions. The emphasis should be on patching the boat, not draining the lake.

Recommendation:

[89] PG&E WMP; p. 218.

Guidance should be set for the utilities that they should emphasize strategies, tactics and mitigations that target the reduction of ignitions likely to lead to catastrophic fires with potential for mass casualties and extensive financial losses.

Urgency:

Class C: This should be done in the 2022 WMP revisions.

7. MITIGATION INITIATIVES

7.3. Detailed Wildfire Mitigation Programs

7.3.1. Risk assessment and mapping

7.3.1.1. Coupling of ignition and fire spread models

As noted in Section 4.5.2, the fire spread modeling performed by the IOUs in order to determine risk does not reproduce the fire sizes typically responsible for losses of life and property. Running these simulations for a longer time is recommended. Another key element in producing realistic risk assessments is to tie the conditions responsible for ignition to the conditions responsible for fire spread. None of the utilities currently do this. PG&E claims that wind is not predictive of ignition, an assertion that was refuted in Section 4.3.1. SCE attempts to "account for a wide range of historical weather scenarios", and therefore "uses 41 weather scenarios across a 20-year historical climatology in the consequence component of its WRRM."[90] SDG&E comes closest to this approach: "*The current version of WiNGS, which is used for prioritizing and scoping projects, considers weather and fuel in two places:*

(1) The consequence values of potential wildfires that were calculated by Technosylva contained weather and fuel scenarios. The worst case of fire spread that was derived from those scenarios was used as an input in WiNGS.

(2) The likelihood of a wildfire was modified to account for the highest recent wind gust measured on each segment. Together, these inputs help shape the overall wildfire risk calculations on each segment."[91]

So, while SDG&E does incorporate recent peak winds in its probability of ignition model, it does not directly tie the same winds to the Technosylva inputs for its simulation. Instead, SDG&E

[90] SCE WMP; p. 190.

[91] Appendix A: Data Request Response MGRA-SDGE-06 Response 3.

selects the “worst case” from multiple fire spread simulations. It is likely that the “worst case” fire spread would be accompanied by high wind conditions, so the net effect may well be the same as specifically selecting severe fire weather inputs to the consequence model. However, this is not the most efficient means to determine catastrophic fire risks, and as noted earlier the duration of the calculation terminates at 8 hours.

As described in the MGRA White Paper in Appendix B-1, an approach that might more closely simulate real risk would be to divide the risk calculations into two components. The first component describes “ambient” ignitions and weather conditions. Most ignitions have nothing to do with the weather. However, if an igntion occurs during fire weather conditions there is still the potential for a serious fire, such as was seen during the Butte fire. The potential for this type of non-wind related fire growth is tied to dead fuel moisture and relative humidity, as explained in PG&E’s WMP:[92]

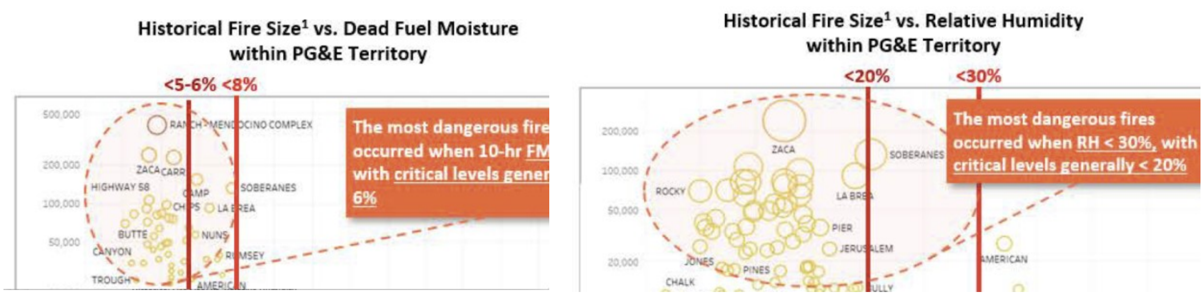

Figure 13 - Detail of PG&E FIGURE PG&E-4.2-6: AGENCY TRAINING MATERIALS AND PG&E VALIDATION, showing the dead fuel moisture and relative humidity conditions for the most catastrophic fires in PG&E's service territory**.**

For ignitions that are driven by weather conditions, however, the prior condition of severe fire weather should be assumed, and not merely be incidental. Calculating the wind-driven component of fire risk means that assumptions about the frequency, duration, and intensity of weather events need to be model inputs. The same weather parameters would then be used to derive both the contingent ignition probability and also as input to fire spread modeling to determine consequences.

---

[92] PG&E WMP; p. 73; with a legible version being provided in Appendix A: PG&E Data Request Response WildfireMitigationPlans_DR_MGRA_010-Q17_Atch01

A complete and correct risk wildfire risk model needs to capture both of these components: an "ambient" fire threat arising from random ignitions and the fact that fire conditions can extend through much of the year, and a "weather-driven" component that captures the conditions under which the vast majority of California's utility fire losses occur, during which there is an increased probability of ignition coupled to the capacity for rapid and extended fire spread. Models that decouple ignition and wildfire spread, and that curtail fire spread durations, will lead to incorrect results with risk being artificially moved towards population centers and away from remote areas subject to severe weather conditions where megafires are likely to ignite and spread into broad swathes of the wildland urban interface.

Recommendation:

WSD should start a working group to study ignition and fire spread modeling to ensure that the utilities are using accurate models for risk assessment. Alternatively, it should request that the Commission conduct such workshops as part of the SMAP/RDF (R.20-06-12 proceeding), and then attend these workshops either as a party or as a technical consultant.

Urgency:

Class B: It is likely that the current models are not properly capturing and distributing wildfire risk.

7.3.2. Situational awareness and forecasting

7.3.2.1. Satellite wildfire detection

PG&E's satellite fire detection pilot program was described in its 2020 WMP,[93] and it has continued with deployment of its satellite early warning as described in its 2020 WMP.[94] SCE is also currently evaluating PG&E's system.[95] PG&E claims that "Satellite technology has matured to a point where data from geostationary and polar orbiting satellite data can be utilized to monitor fires in near-real time."[96] In MGRA's 2020 WMP comments we probed whether PG&E's system was able to effectively provide first-alert warnings that preceded reporting from other sources, noting: "While PG&E's program may be of value, both for early detection and for real time fire

[93] PG&E 2020 WMP; p. 11.
[94] PG&E WMP; p. 416.
[95] SCE WMP; p. 181.
[96] PG&E 2020 WMP; p. 11.

perimeter mapping, this has not yet been demonstrated through the response it made to WSD's question. In particular, it raises the question of how many of the 2,800 incidents were actual wildfires, and of these how many of these were detected promptly by PG&E's analysis of the GOES data."[97]

Unfortunately, PG&E still is not able to verify what its false alarm rate is for wildfires, or what added value its satellite programs provide for initial alerts. Each of the polar orbit satellites it uses for detailed infrared mapping make only two daily overhead passes for points in the PG&E territory,[98] so only geosynchronous GOES data is available for "near real time" alerts. Even after over a year of operation, "PG&E is unable to provide a fraction of alerts that are 'false alarms'. PG&E does not track the number of alerts which turn up to be false."[99] This is a dangerous attitude to take towards false alarms, since it increases the likelihood that its subscribers will simply ignore alerts. SCE takes a similarly blithe attitude toward alert verification, noting in its response to WSD Class B Deficiency SCE-8:

"2) Provide the quantitative pass/fail criteria used to determine the performance of individual pilot programs.

…If any fire is detected early using these imaging technologies, this project would be considered a success."[100]

This is not a reasonable response. In order for alerts to be effective, the "signal to noise" ratio should be substantial enough that valuable first responder time and attention is not wasted, or worse, that alerts are not ignored because they have a low probability of being valid. Even assuming the best case, that satellite sensitivity and wildfire detection algorithms have improved to the point that these signals are superior to or competitive with other means of detection, if PG&E wants to provide these warnings as a service it should make efforts to improve the quality of the alerts, and this effort requires having a metric for alert quality.

Recommendation:

---

[97] MGRA 2020 WMP Comments; pp. 25-26.
[98] Appendix A: PG&E Data Request ResponseWildfireMitigationPlans_DR_MGRA_010-Q09
[99] Id.
[100] Southern California Edison's 2021 Wildfire Mitigation Plan Update Supplemental Filing – CORRECTED; February 26, 2021; p. 344. (SCE WMP Update)

PG&E should develop a metric for satellite alert quality to ensure that alerts being sent to first responders are of high quality, and should take efforts to improve its alert algorithms according to this metric. It could, for instance, compare its satellite alerts against data from its wildfire detection cameras to validate which of these systems is able to first detect incipient wildfires.

Urgency:

Class C. PG&E should be required to provide validation of its satellite detection system prior to the next WMP update.

7.3.3. Grid design and system hardening

7.3.3.1. Covered conductor

It is important that WSD determine the value of hardening through the use of covered conductor. SCE is in the process of upgrading substantial portions of its system, while SDG&E and PG&E are extremely slow in their covered conductor R&D and roll-out. Either covered conductor is an excellent mitigation for utility wildfire problems, in which case PG&E and SDG&E are laggards, or it is not, in which case SCE is spending a lot of money that it should not. As will be shown in Section 7.3.4, the approach of different utilities towards calculation of risk/spend efficiency is so different that judging the value of covered conductor through RSE is dubious. SDG&E remains more reticent regarding covered conductor, estimating that it would have 0% efficiency in preventing ignition from vehicle collision,[101] while SCE relates an anecdotal story of covered conductor preventing ignition as a result of a vehicle collision.[102]

It may be that SCE's infrastructure requires more significant rebuilding than SDG&E's, which has had a hardening program in place for over a decade, which it initiated in the aftermath of the 2007 power line firestorm. SCE also sets very low thresholds for de-energization (Section 8.1.1), sees a large number of wind-associated ignitions (Section 4.3.1.4), and is prone to wind damage at wind speeds substantially lower than 56 mph (Section 8.1.5). Taken together, these factors suggest that SCE is aware that it has a serious problem and is deploying covered conductor to attempt to address it. Why PG&E has not reached a similar conclusion regarding the value of covered conductor is unclear. There have been numerous workshops, reports, plans, and comments

[101] Appendix A: Response to Data Request MGRA-SDGE-04, Response 16.
[102] SCE WMP; p. 212.

on this issue. The Wildfire Safety Division should take a more active role in helping to clarify why the utility approaches are so different, and whether there are guidelines that should be applied prior to the expenditure of very substantial amounts on infrastructure upgrades.

Recommendation:

The WSD should gather additional information regarding utility covered conductor programs to try to determine actual risk/spend efficiencies relative to other mitigation measures, and should ascertain whether IOUs are correctly assessing the costs and benefits of covered conductor.

Urgency:

Class B: The proper role of covered conductor as a mitigation measure should be better understood prior to the next WMP revision cycle.

7.3.8. Resource allocation methodology

MGRA's 2020 WMP Comments provided a comparison of risk-spend efficiency calculations across different utilities.[103] This exercise is repeated here for the 2021 WMPs, using the data available in Table 12 of the IOU supplemental data filings. The 2021 analysis uses only the RSE specified for High Fire Threat District Tier 2 and Tier 3, since this is where the bulk of the catastrophic fire threat lies. In the case where RSE is different for Tier 2 and Tier 3, the average of the two is used. The new templates introduced in December 2020 added considerably more detail at the program level. Each of the three major IOUs each adapted to this new template in its own way. None of the utilities calculated an RSE for every initiative, and the utilities all made different choices as to which initiatives were to be included in their RSE calculations. For comparability, the analysis below looks primarily at the program level. In the case where multiple initiatives were in a program and had calculated RSEs, a program RSE was calculated based on the RSE for each initiative weighted by the fraction of the initiative's contribution to the overall cost of the program (CAPEX + OPEX) for 2020 and 2021.

In the MGRA 2020 WMP comments, two tables were presented: the first contained the raw RSE values and the second table contained RSEs normalized to the SDG&E hardening program.

[103] MGRA 2020 WMP Comments; pp. 38-43.

Unfortunately, this same approach could not be applied to the 2021 RSE scores, as seen in the table below:

Initiative	Activity	RSEs (spending wtd) SDG&E	SCE	PG&E
7.3.1	Risk modeling			573.87
7.3.2.1	Weather modeling & measurement			257.11
7.3.2	Fault monitoring and sensors	122.84	3606.29	6638.75
7.3.3.3	Covered conductor installation	59.75	3852.66	6.05
7.3.3.8	PSPS Grid Improvements	202.63	255.10	NA
7.3.3.16	Undergrounding	59.40	397.15	6.05
7.3.3.17	Hardening	45.37	NA	6.05
7.3.3.17.4	REFCL	NA	NA	104
7.3.4	Asset Inspections	123.49	1474.79	141.06
7.3.5	Vegetation Management	164.85	390.14	3869.15
7.3.6.5	PSPS	93.44	147.84	NA

Table 14 - Risk / spend efficiency for risk mitigation programs of SDG&E, SCE, and PG&E. RSEs are for Tier 2 and Tier 3 of the HFTD. In the cases where there were multiple initiatives in each program, the RSE for each initiative was weighted by the overall cost (CAPEX+OPEX) of the initiative for 2020 and 2021 as a fraction of the total cost of the program for 2020 and 2021.

The table above would seem to suggest that the three major California IOUs are operating on different planets. The lack of comparability between the three utilities fundamentally calls into question the implementation of the current risk-based decision making framework. For example, while SDG&E finds roughly equal (within a factor of two) efficiencies for spending on vegetation management and asset inspections, SCE finds asset inspections 5X times more efficient than vegetation management,[104] PG&E finds vegetation management 25X more efficient than asset inspection. This is a variation of a factor of 125. While there are no doubt some differences between PG&E's and SCE's vegetation management problems and equipment, it is not conceivable that differences of this magnitude should be seen. Which of the approaches is "correct"?

Problems with the PG&E risk evaluation methodology applied during its 2020 RAMP filing is that 1) PG&E applies a cap to its maximum losses which are much lower than high-end losses seen in catastrophic wildfires, and 2) PG&E compensates for the artificial risk reduction this causes

[104] This is partly because the vegetation management section of SCE's Table 12 is sparsely populated, with some major initiatives (in terms of cost) lacking an RSE. This lowers the weighted RSE substantially. Individual initiative RSEs are higher.

by adopting a non-linear scale.[105] As a result, the meaning of PG&E's risk estimates are unclear and do not correspond to actual risk. MGRA has recommended that PG&E eliminate loss caps, properly incorporate high-end losses to risk calculations, and use a linear scale.[106]

RSEs help to determine how much money is spent on initiatives, and are intended to allow intervenors and the Commission to quantitatively compare programs in a "transparent" fashion. The chasms between utility results suggest that this transparency is an illusion – it is false precision. Fundamentally, these choices affect whether people get to live their lives safely or not, and how much they pay for their utility bills. We are fortunate that WSD has begun to formalize the comparison of utilities in a manner that highlights these glaring differences, particularly with the SMAP/RDF proceeding (R.20-07-013) now in progress. This data will be a valuable addition to that proceeding.

While the RSE results in Table 12 are questionable, we still present below some of their implications and corresponding recommendations in the hope that WSD will probe more deeply into utility risk calculations over the coming year.

- PG&E has made a stab at evaluating the RSE for difficult-to-evaluate programs such as wildfire risk modeling and weather modeling. The WSD should examine PG&E's assumptions and if these turn out to be reasonable they should require SCE and SDG&E to apply similar calculations for their own risk and weather modeling programs.
- PG&E also sees an extremely high RSE for fault monitoring, driven particularly by its SmartMeter™ Partial Voltage Detection initiative. WSD should examine whether this program or a similar one could be deployed by the other utilities.
- PG&E bundles its undergrounding, hardening, and covered conductor initiatives into one program because it decides which to deploy on an opportunistic basis.[107] The

[105] Data Request Response PG&E WildfireMitigationPlans_DR_CalAdvocates_042-Q01; WildfireMitigationPlans_DR_CalAdvocates_042-Q02.
[106] R.20-06-012; MUSSEY GRADE ROAD ALLIANCE COMMENTS ON THE PACIFIC GAS AND ELECTRIC COMPANY 2020 RISK ASSESSMENT AND MITIGATION PHASE REPORT AND THE SAFETY POLICY DIVISION STAFF EVALUATION REPORT; January 15, 2021.
[107] Data Request Response PG&E WildfireMitigationPlans_DR_CalAdvocates_046-Q02.

RSE for this program, in any case, is very low – at least a factor of 20 lower than any of their other programs.

- PG&E's RSE estimate for its Rapid Earth Fault Current Limiter (REFCL) provided in Table 12 was in error, and it has provided the corrected value as 128.[108]
- SCE finds the RSE for covered conductor to be 10X larger than for undergrounding, whereas SDG&E finds the RSE for these two approaches to be roughly the same.
- PG&E's RSE estimate for the value of vegetation management is an outlier and likely relies on a significantly different assumptions.
- The IOU estimates for PSPS RSE are not based on common assumptions and have not been validated by the CPUC, WSD, or any stakeholder. SCE, for instance, identifies a low cost of $250 per customer per event.[109]

Recommendation:

While it is useful for WSD to have broken down Section 7 of the WMP Template (and thereby Table 12) into programs and initiatives, utility responses are sparse and overlap poorly. While WSD intends that all programs and initiatives should have an RSE, utilities are nowhere near reaching that goal. It would be helpful for WSD to prioritize common programs that must immediately have an RSE (for example wire hardening, undergrounding, covered conductor, etc.), and to require utilities to immediately provide this information.

Urgency:

Class A. The second phase of the SMAP proceeding is underway and it is essential that any fundamental problems in its basic construction and premises be identified immediately so that they can be resolved within the framework of this proceeding.

Recommendation:

The WSD should become a party to the SMAP 2/RDF proceeding R.20-07-013 or participate in that proceeding in an advisory role.

Urgency:

[108] Appendix A: PG&E Data Request Response WildfireMitigationPlans_DR_MGRA_010-Q12

[109] SCE WMP; p. 59.

NA. However, the second phase of the RDF proceeding will be initiated within the next few months and WSD expertise and input would be helpful and would help to align WSD's WMP requirements and those of the Commission.

Recommendation:

WSD should examine PG&E's assumptions regarding risk and weather modeling programs and if they are reasonable they should require SCE and SDG&E to conduct similar calculations.

Urgency:

Class B. If PG&E's assumptions are not reasonable they should be required to correct them in quarterly reports. If they are reasonable SCE and SDG&E should be required to supplement their Table 12 reports using similar methods.

Recommendation:

WSD should examine PG&E's SmartMeter™ program to validate its extremely high RSE and should request that SCE and SDG&E explain whether and how such a program could be deployed in their areas.

Urgency:

Class C. Monitoring seems to be an area of potentially good return on investment and WSD should request a more detailed showing during the next WMP update.

Recommendation:

PG&E should be required to provide separate RSEs for hardening technologies and techniques such as overhead hardening, undergrounding, and covered conductor. While its description of its distribution hardening program is detailed,[110] it does not provide RSEs for the various technologies and strategies it plans to use as part of this program.

Urgency:

Class A. WSD has repeatedly asked for a finer-grained breakdown of PG&E hardening programs. Nevertheless, PG&E provides only an aggregate RSE score. In the light of the fact that the RSE reported by PG&E is so low, it is urgent that PG&E justify its current strategy.

Recommendation:

---

[110] PG&E WMP; p. 548-563.

WSD should more closely examine the assumptions of the covered conductor and undergrounding assumptions made by SDG&E and SCE, since these vary in relative value by a factor of ten, and it is unlikely that both approaches can be valid.

Urgency:

Class B. WSD should require SDG&E and SCE to use valid assumptions and common approaches to calculating the RSE values for covered conductor and undergrounding.

Recommendation:

WSD should more closely examine the assumptions made by PG&E regarding how RSE is calculated for its vegetation management programs and compare this to the approach of SDG&E and SCE. While it is a given that PG&E has many more trees adjacent to its lines, the relative value that it attributes to its vegetation management program compared to its other programs cannot be squared with the lower values reported by other utilities.

Urgency:

Class B. WSD should examine the assumptions and approaches used by PG&E versus SCE and SDG&E to calculate the RSEs for their vegetation management programs and require that calculations be performed using common assumptions.

Recommendation:

In their risk estimations, utilities should use uncapped losses, incorporate high-end losses to properly weight the contribution of catastrophic events, and use linear scales to properly represent all risks.

Urgency:

Class B. This is important for PG&E and SDG&E GRC and RAMP phases that are getting underway.

Recommendation:

Utilities should have the methodology used for estimating PSPS RSE reviewed. WSD can perform this analysis, or it can be conducted by the CPUC under proceedings R.20-07-013 (SMAP/RDF) or R.18-12-005 (PSPS). WSD should not accept the utility PSPS RSE values at this time.

Urgency:

Class C. The analysis or the costs and risks from de-energization should be led by either the CPUC or WSD.

8. PUBLIC SAFETY POWER SHUTOFF (PSPS)

8.1. Directional Vision for Necessity of PSPS

As in the 2020 Wildfire Mitigation Plans, none of the three major IOUs has a directional vision to eliminate public impacts from power shutoff as a long term goal, either through alternative or improved technologies or through providing alternative sources of power. IOUs discuss "reducing the number of customers impacted",[111] to de-energize "less often",[112] and to "reduce the scope of PSPS events".[113] PG&E's WMP is particularly scanty when referring to long term plans.

Recommendation:
Utility directional vision for PSPS should envision how the impacts of power shutoff on the public might be eliminated.
Urgency:
Class C. WSD should provide clear guidance as to what it expects from utility "directional vision".

8.1.1. Shift to hardening as a mitigation against power shutoff

Both PG&E and SCE have expressed an intention to prioritize circuit hardening that reduces the impacts of power shutoff. "PG&E's strategy for 2021 is to target our mitigations to the locations that are most likely to be impacted by PSPS events while also focusing towards the suite of activities that will enable continued PSPS scope reduction in the long-term,"[114] a strategy shared by SCE.[115] This is appropriate. If power shutoff is used as a primary mitigation measure, as it seems to be, then hardening circuits that are going to be de-energized anyway would not seem to be the best use of resources. It is better, as suggested in Section 4.5.2, to certify circuits for operation under specific weather conditions in order to minimize public harm due to de-energization.

---

[111] SDG&E WMP; p. 353.
[112] SCE WMP; p. 343.
[113] Op. Cite.
[114] PG&E WMP; p. 849.
[115] SCE WMP p. 340.

Along this line, it is of concern that according to PG&E's "Black Swan" criteria, "under extreme weather conditions it is still possible that even circuits and customers that have been identified as 'fully mitigated' from PSPS events may still need to be de-energized."[116] SCE has also made statements that it would de-energize line based on fire spread conditions and not on ignition potential: "SCE sets thresholds based on SCE's risk-informed assessment of the potential for a large or catastrophic wildfire should an ignition occur under the conditions presented."[117] If this is correctly stated, then SCE shuts off power regardless of the ignition potential.

In order to justify such a strategy, it should be demonstrated that:

- The "ambient" ignition rate, i.e. the ignition rate without wind-related drivers, is such that it is not improbable that ignitions will occur in the threatened area during the risk period,
- That the ambient ignition rate is a non-negligible fraction other likely ignition sources, and
- That there is a potential for catastrophic fire growth (in the catastrophic sense, with the potential for multiple casualties and billions of dollars of property damage).

It needs to be determined to what degree there is potential for catastrophic fire growth *without* substantial winds, i.e. a fuel-driven convective fire, that can cause WUI losses at the high end of the scale, and what sort of precursor conditions of relative humidity and fuel moisture (see Figure 13) would accompany any such event.

If on the other hand high winds are effectively necessary to trigger the "Black Swan" criteria, then the concept of "fully mitigated from PSPS events" simply needs to be redefined according to the "tiering" concept of Section 4.5.2. Rather than calling a circuit "mitigated", it is better to classify it "safe up to X weather event intensity". This sets reasonable expectations and allows full operational flexibility to deal with extreme weather events.

Recommendation:

WSD should investigate the use of de-energization for mitigation against catastrophic fire growth potential alone (without respect to ignition potential) and ensure that utilities are not simply

[116] PG&E WMP; p. 853.

[117] SCE PSPS Post Event Report – November 29 to December 4, 2020; December 21, 2020. p. 24.

deploying de-energization as a liability-reducing measure. WSD should obtain additional information from the IOUs regarding the degree to which wind-driven ignition potential is weighted in their shutoff criteria as opposed to fire spread potential, and ensure that any criteria based on fire spread potential alone represents a plausible risk.

Urgency:

Class B. This should be examined as soon as possible, since severe fire potential may develop early this year due to drought conditions.

8.1.2. Validation of utility forecasts

When planning for an executing a power shutoff event, all IOUs rely heavily on in-house weather modeling. These operation of and assumptions going into these weather models are opaque, and it is not clear how accurate the results of the models are, what their limitations are, or how they have been validated. MGRA has requested that forecast estimates be provided on a per-circuit basis for the post-event shutoff reports.

Impacts of inaccurate weather models can be severe:

- Customers outside of the danger areas may be subject to unnecessary power outages.
- Customers outside of the danger areas may receive unnecessary warnings.
- Power may be shut off too early or too late.
- Power may be left on in a danger area, possibly leading to wildfire.

Several severe wildfires associated with utility equipment and occurring proximate to a PSPS event were:

Fire	**Date**	**Utility**
Camp	November 8, 2018	PG&E
Kincade	October 23, 2019	PG&E
Zogg	September 27, 2020	PG&E
Silverado	October 26, 2020	SCE
Cornell	December 7, 2020	SCE

Table 15 - Fires with alleged involvement of utility equipment occurring proximate to a period when PSPS was being conducted.

The WSD should validate utility weather models. MGRA performed an analysis comparing utility weather models during the 2020 Wildfire Mitigation Plan (WMP) evaluation. This analysis performed an apples-to-apples comparison in geographic areas where PG&E and SCE weather modeling overlapped. The analysis a drastic difference between SCE and PG&E weather models along the edges of the Central Valley and surrounding Sierra foothills, as shown in the figure below:[118]

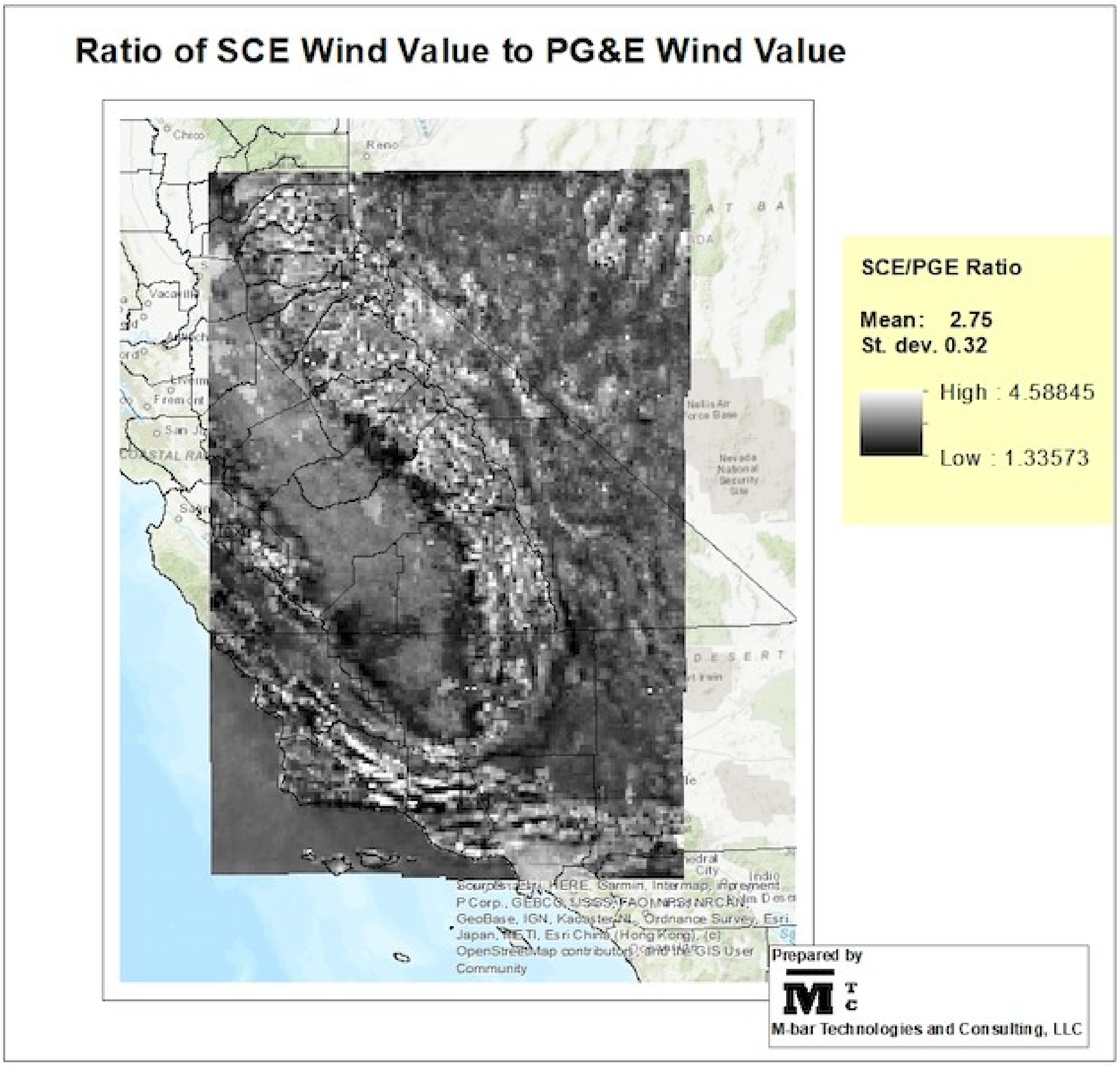

Figure 14 - Ratio of SCE and PG&E 99th percentile wind values, analyzed for MGRA's 2020 WMP Comments. Areas that are light or dark indicate significant differences between the models. Areas where models predict similar behavior

---

[118] MGRA 2020 WMP Comments; MUSSEY GRADE ROAD ALLIANCE COMMENTS ON 2020 WILDFIRE MITIGATION PLANS OF SDG&E, PG&E, SCE; April 7, 2020; pp. 53-54.

are indicated by even grey or checkerboard shading. Overall normalization (mean ratio between models) has not been addressed and does not represent a predicted ratio of wind speeds.

Despite this issue being raised in 2020, and despite utilities' expressing willingness to discuss weather modeling assumptions, SCE and PG&E took no action to examine the cause for these differences.[119] PG&E suggests that "Model domain overlap occurs because the domain of a weather model must extend beyond the area of concern due to a phenomenon known as edge effects, where model accuracy is lower at the edges of the weather model field. If the area of discrepancy is located near the edge of one of the weather models, edge effects could be partially responsible for this discrepancy. Also, while the same base model is utilized by both utilities, the WRF Model contains a significant number of parameter and physics options and variables which are determined by the end user."[120] "Edge effects", however, would be expected to have a geographic dependency, with a gradient extending away from the boundary of the two utility service areas. Instead, the figure displays a topographic dependency, with certain feature types exhibiting different wind characteristics.

PG&E has refused to release a public version of its internal documentation validating its weather forecasting model. There is no valid reason why this information would contain trade secrets or sensitive infrastructure information, or affect any "competitive advantage". WSD should request and release this information to the public.[121]

Recommendation:

WSD should direct the utilities to compare and validate wind forecast models to ensure optimal choices are being made that affect power shutoff forecasts.

Urgency:

Class B. WSD should organize workshops or working groups to address utility weather modeling.

Recommendation:

WSD should require public release of PG&E's internal validation of its weather forecasting model.

Urgency:

Class A. This information should be available to validate 2021 WMPs.

[119] Appendix A: Data Request Response MGRA-SCE-007 Response 3.

[120] Appendix A: Data Request Response WildfireMitigationPlans_DR_MGRA_010-Q10.

[121] Data Request Response PG&E WildfireMitigationPlans_DR_CalAdvocates_052-Q01.

8.1.3. SCE directional vision for PSPS versus practice

As mentioned earlier, SCE states that it has a goal of targeting mitigation towards reduction in the number of customers affected by PSPS. It is working to exclude circuits that pose a low risk: "SCE's circuit exception process entails a detailed periodic review of circuits and circuit-segments located in HFRA to identify those with sufficiently low wildfire risk based on the latest information to warrant removal from future PSPS scope altogether."[122] It also targets hardening programs that isolate segments with covered conductor. These are positive steps.

However, SCE also applies an aggressively low threshold for PSPS, turning off power for National Weather Service High Wind Advisories (31 mph sustained and 46 mph wind gust) for bare conductor segments. [123] As noted repeatedly in post PSPS comments by both MGRA and the Acton Town Council, SCE often applies even more extreme thresholds, cutting off power at wind gust speeds of 32 mph or less. For example, during a January 2021 PSPS event, SCE de-energized the Shovel circuit at wind gust speeds of 31.5 mph.[124] There are numerous other instances of low thresholds being applied in PSPS events.

The original decision allowing power shutoff under limited and extreme circumstances was D.09-09-030, which set a wind gust threshold of 56 mph – which is the utility interpretation of the GO 95 wind loading standard. ESRB-8 expanded this allowance to include for wind-borne vegetation, which can become a problem at wind speeds lower than the GO 95 standard. Acton Town Council has complained, however, that these lower wind thresholds are applied even in desert areas without significant vegetation near the lines.[125] Acton Town Council conducted discovery on SCE as part of the R.18-12-005 proceeding, and found that one reason its area is subject to low threshold de-energization is that SCE has classified a large number of spans as "High P2" (subject to failure in 6-12 months) due to span length or other issues.[126]

---

[122] SCE WMP; p. 343.
[123] SCE WMP; p. 341.
[124] Letter to Director Palmer, SED; The Acton Town Council Comments on the Southern California Edison's Post-Event Report dated February 4, 2021. Reference: SCE De-energization Events of January 12-21, 2021; March 1, 2021; p. 11. (ATC February 4 Comments)
[125] Id.; p. 16.
[126] Id; pp. 30-32.

These actions suggest that portions of SCE's infrastructure are not GO 95 compliant. SCE can avoid the fines, penalties, and civil litigation that could accompany a failure of this infrastructure by simply turning off the power when it is under any appreciable stress. MGRA has called for the Commission to open an investigation of SCE to see whether it is complying with GO 95, ESRB-8 and other Commission regulations or simply using power shutoff as a way to limit its civil liability.[127]

Recommendation:

The WSD should examine cases of de-energization at low wind speed thresholds to determine whether these are being used to mask unreported defects. WSD should ensure that defects limiting safe operation of utility infrastructure under known local conditions are given a high priority.

Urgency:

Class B. Issues of low de-energization threshold should be identified and resolved prior to next fall's Santa Ana / Diablo season.

8.1.4. SDG&E use of 30 second weather station data

SDG&E has upgraded the majority of its weather stations to enable collection of weather data every 30 seconds rather than every 10 minutes, which was the previous standard. They explain that this "*provides more real-time and detailed situational awareness, and also helps reduce PSPS impacts. Because the 30 second data flows are enabled as adverse conditions arise, the near real-time monitoring of wind gusts helps provide decision-makers with information on the frequency of stronger gusts that are not reflected in the usual 10-minute observations. For instance, if a weather station has several consecutive 30 second reads at or above any defined threshold, that would increase the probability that a PSPS event would occur because consistent high winds are being reported. However, if the 30 second reads show one brief gust above that same threshold, followed by several observations of much weaker winds, it would indicate that conditions are not quite as severe. This was the case during SDG&E's December 2020 Red Flag Warning events, where more than 6,000 customers accounts were not deenergized during the December 2-4 event and around 20,000 customer accounts were not deenergized during the December 7-9 event*."[128]

---

[127] Letter to Director Palmer, SED; MGRA Response to November and December 2020 Shutoff events by SCE and SDG&E; January 4, 2021; pp. 6-10.

[128] SDG&E WMP; p. 351.

While SDG&E's use of improved technologies and capabilities to reduce power shutoff risks to the public is admirable, in this particular case there is a concern that should be raised based on recent atmospheric science research. Specifically, the results of Coen et. al. 2018 show that peak winds during Santa Ana and Diablo wind events often arrive in regular bursts, with a periodicity of several minutes.[129] Under these circumstances, SDG&E's modified alerts might provide a false sense of security. A ten minute data collection window would be likely to capture one or more of the bursts, so subsequent ten minute windows show elevated wind speed. With 30 second sampling of data, a brief wind gust may be followed by a number of data samples with lower wind speeds, which might be flagged by SDG&E's new alerting system as an "all clear". Repeated gusts followed by lulls might be missed by the SDG&E's technique as described in its WMP. In fact, periodic gusts might be even more dangerous to utility equipment than constant winds, since material fatigue is a function of repeated stress and relaxation cycles. Mitchell 2009 demonstrates how intermittent winds can increase the probability of failure due to metal fatigue by a factor of wind speed to the 3rd to 4th power.

SDG&E can avoid this potential danger while still benefitting from the added diagnostic power of 30 second data by changing its alerting algorithm to watch for repeated wind gusts. For instance, it could have a "pre-alert" triggered by a 30 second reading over threshold, which would go to "full alert" if there is another gust above threshold in the next 15 minutes. This would still be superior to triggering on either a single 10 minute signal above threshold (which could lead to aggressive shutoff) or double 10 minute signal above threshold (which could expose infrastructure to up to 20 minutes of dangerous winds).

Recommendation:

SDG&E should ensure that its use of 30 second weather station data to provide alerts for PSPS accounts for and triggers alerts for potential periodic wind gusts with a period greater than a few minutes.

Urgency:

Class B. Needs to be evaluated and implemented prior to the upcoming fire season.

---

[129] Coen, J.L., Schroeder, W., Quayle, B., 2018. The Generation and Forecast of Extreme Winds during the Origin and Progression of the 2017 Tubbs Fire. Atmosphere 9, 462. https://doi.org/10.3390/atmos9120462.

8.1.5. Potential expansion of PG&E de-energization scope

As PG&E states in its Supplemental Filing, it is "assessing how to incorporate the presence of known, high-risk vegetation conditions adjacent to powerlines into PSPS decision making. This assessment may result in PG&E executing PSPS in 2021 for powerlines where high priority vegetation tags have been identified, including on lines that may not have met the 2020 PSPS event criteria."[130] PG&E does not mention that this is in response to a request from Judge Alsup, who is overseeing PG&E's probation, in response to the 2020 Zogg fire, which was responsible for four deaths.[131] The California Public Utilities Commission has filed an amicus letter opposing Judge Alsup's proposal to require PG&E to lower its thresholds for power shutoff.[132] In this letter, excerpts from MGRA filings as well as those of other intervenors were used to support the CPUC's opposition to this proposal. Expansion of shutoff criteria without evaluation of the harm or benefits is opposite to the direction that MGRA, the CPUC, WSD, and the Wildfire Safety Advisory Board have taken.

Recommendation:

The Wildfire Safety Division and Wildfire Safety Advisory Board should support the position taken by the CPUC opposing the lowering of PG&E's shutoff threshold and the expansion of PG&E's shutoff without full evaluation of the impacts of such a move.

Urgency:

Immediate. Judge Alsup is expected to make a ruling within the next few weeks.

8.1.6. Importance of utility damage data as a metric

With the increasing utilization of de-energization as a mitigation measure, the usefulness of outage and ignition data as a metric is substantially decreased. During fire weather, no ignition or

[130] PACIFIC GAS AND ELECTRIC COMPANY SUPPLEMENTAL FILING ADDRESSING REMEDIAL COMPLIANCE PLAN AND FIRST QUARTERLY REPORT ACTION ITEMS FEBRUARY 26, 2021; p. 11.

[131] NBC Bay Area; "State Pushes Back on Judge's Plan to Expand PG&E Shutoffs"; Jaxon Van Derbeken; February 19, 2021. https://www.nbcbayarea.com/investigations/state-pushes-back-on-judges-plan-to-expand-pge-shutoffs/2472917/

[132] UNITED STATES DISTRICT COURT FOR THE NORTHERN DISTRICT OF CALIFORNIA; SAN FRANCISCO DIVISION; Case No. 14-cr-00175-WHA; CPUC MOTION FOR LEAVE TO FILE AMICUS LETTER; February 19, 2021.

outage data is collected in affected areas because the power is turned off. While this is actually the goal of de-energization, it makes it more difficult to tell whether power shutoff was reasonable or whether utility infrastructure is withstanding known local conditions. Outage and ignition metrics should be supplemented by utility damage data that is collected in post shutoff surveys prior to re-energization of lines.

For example, damage events reported by SCE in its service area during the November and December 2020 shutoff periods are shown below:

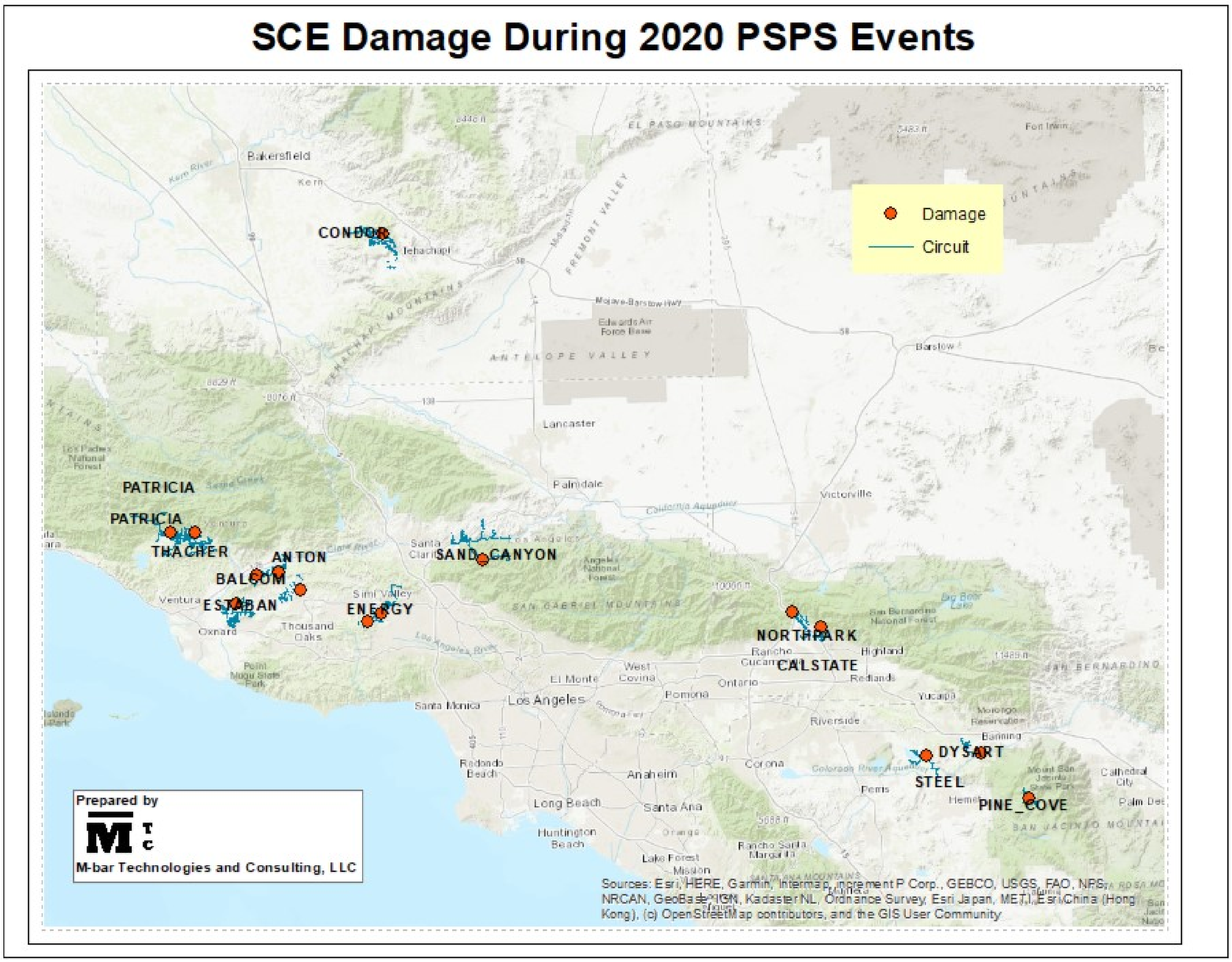

Figure 15 - Damage during 2020 PSPS events reported to WSD by SCE. The name of the circuit is indicated.

Of all the utilities, only SCE calculates an estimated wind speed for each circuit based on its best estimate of the most appropriate weather station. Additional information regarding cause was provided in response to an MGRA data request.[133]

---

[133] Data Request Response MGRA-SCE-005 Response 1 and associated .gdb file. Wind speeds are from: SCE PSPS Post Event Report – November 24 to November 28, 2020; December 11, 2020.

Date	Circuit	Wind Gust	Damage
11/24/2020	Condor	41.9	connector
11/29/2020	Anton	40.1	crossarm
11/29/2020	Balcom	34.7	tree contact
11/29/2020	Dysart	47.8	crossarm
11/29/2020	Energy	48.1	crossarm
11/29/2020	Energy	48.1	transformer lead
11/29/2020	Estaban	42.1	tree contact
11/29/2020	Northpark	43.1	tree contact
12/4/2020	Balcom	46.6	tree contact
12/4/2020	Patricia	45.1	tree contact
12/4/2020	Pine_Cove	47.2	crossarm
12/4/2020	Pine_Cove	47.2	arrestors
12/4/2020	Sand_Canyon	50.9	insulator
12/4/2020	Thacher	45.3	pole
12/16/2020	Calstate	50.9	insulator
12/16/2020	Steel	46.9	conductor

Table 16 – SCE infrastructure damage that occurred during 2020 PSPS events. This includes the date that the damage was discovered, the name of the circuit, self-reported wind speed data for the most relevant weather station near that circuit, and the nature of the damage.

It should be noted that in none of these cases of damage did wind gust speeds exceed the claimed design loading of 56 mph, thus suggesting that equipment may not be meeting the GO 95 standard. It should be additionally noted that this is self-reported data, and its value as a measurement of the resilience of utility infrastructure needs to be weighed against value in GO 95 compliance enforcement. In any case, there was insufficient time to analyze SDG&E and PG&E damage data to come up with equivalent wind speed measurements, or to validate the SCE wind speed estimates.

PG&E intends to incorporate de-energization damage reports into its future machine learning models.[134]

Recommendation:

SCE PSPS Post Event Report – November 29 to December 4, 2020; December 21, 2020.
SCE PSPS Post Event Report – December 4 to December 14, 2020; December 29, 2020.
SCE PSPS Post Event Report – December 16 to December 24, 2020; January 11, 2021.

[134] Data Request Response PG&E WildfireMitigationPlans_DR_WSD_010-Q06.

Utilities should be required to provide forecasted and measured wind speed data as well as cause information for all reported damage events.

Urgency:

Class B: Data should be provided retroactively for 2020 and 2019. Complete 2021 data should be provided prior to the 2022 WMPs.

Recommendation:

Utilities should incorporate damage data into their risk calculations in the same manner as outage and ignition data. WSD should hold workshops to help determine a technically correct approach to doing so.

Urgency:

Class B: Standard ignition and outage data becomes more irrelevant as metrics as PSPS becomes more prevalent as a mitigation.

Recommendation:

In cases where damage is occurring regularly in areas where winds do not exceed 56 mph, WSD should investigate and require that a remediation program be developed.

Urgency:

Class B: While areas that are de-energized are not subject to ignitions, the potential for widespread damage at low wind speeds leads utilities to set shutoff thresholds at excessively low value, thus causing public harm.

9. UTILITY WILDFIRE MITIGATION MATURITY MODEL SURVEY

The following section addresses the answers that PG&E, SCE, and SDG&E provided for the Utility Wildfire Mitigation Maturity Model survey (Maturity Survey). One gap in the current process is that the Wildfire Safety Division has made its annual Maturity Survey an electronic filing process. Utilities have provided page printouts from this survey in supplemental data, but these are poorly formatted and basically unusable. Additionally, there is no requirement that utilities explain how they arrived at any year-to-year changes in their self-assessments.

To compensate for these gaps, utilities were asked to provide a table containing a list of their maturity survey items that had changed and to provide a justification for each change. These are attached in Appendix A-4 under "Utility Wildfire Mitigation Maturity Model Survey".

A brief summary of the results from the three utilities is shown in the table below.

Utility	Capabilities Upgraded 2021	Capabilities Downgraded 2021	Capabilities Upgraded Future	Capabilities Downgraded Future
SDG&E	14	3	14	5
PG&E	44	3	17	2
SCE	44	1	34	3

Table 17 - Summary of the SDG&E, PG&E, and SCE Utility Wildfire Mitigation Maturity Survey for 2021 and comparison with 2020. This table provides a count of the capabilities that have been upgraded and downgraded according to the utility self-assessments. Upgrades and downgrades for future capabilities (2022) are also provided.

It is important to emphasize that these results are utility self-assessments and can be subject to pressures from sources both external (attention from WSD and the public) and internal (whether improvements are tied to compensation). For this reason, it is critical that these results be audited not only for internal consistency and adherence to WSD's definitions, but also across utilities to ensure that utility responses mean the same thing for all utilities.

From the results in the table, it is clear that both PG&E and SCE claim to have made significant progress from last year. Where these two utilities differ is their future outlook: SCE claims that it will achieve even more by 2022, while PG&E's future outlook for improvement is more muted and comparable to that of SDG&E. SDG&E started from a higher level of maturity, so it is perhaps not surprising that it tallies fewer improvements since last year. SDG&E is also more apt to reassess its capabilities and what WSD's definitions means. Its larger number of downgrades represents re-calibration rather than slippage in maturity capability.

Recommendation:

The WSD should require utilities to provide tabular data from their Utility Wildfire Mitigation Maturity Model Surveys that shows any changes to current or future maturity when compared to the assessment from the previous year.

Urgency:

Class C. Utilities have provided the data in Appendix A. They should continue providing this information in future WMP updates.

Recommendation:

If they are not already doing so, WSD audits of UWMMS responses should compare audit results between utilities to ensure that survey questions are interpreted in a common way.

Urgency:

Class C. This should be part of the audit process for 2021.

Recommendation:

As noted in MGRA's 2020 WMP, the current survey has numerous inefficiencies and inaccuracies, and should be corrected. WSD should begin the process of optimizing the survey so that inaccuracies are corrected, new and more appropriate data collected, and so that there is a clear mapping and transition from the current survey to future surveys.

Urgency:

Class C. This process should begin this year so that it can be initiated in 2022.

10. GIS DATA

As part of the new templates and data collection process, WSD-011 requires utilities to provide geospatial data in a format laid out in WSD's geospatial data template.[135] It is clear from the language of WSD-011 that WSD and the Commission intend that both WSD and stakeholders be given access to this information:

WSD-011; Attachment 2.1; p. 1 – "Accordingly, the WSD will consider these four key elements for the 2021 WMP Update submission and review process:

1.) Frontload data collection. This would extend the timeframe for WSD and stakeholder review of relevant utility data in advance of the WMP submission and review period, in addition to reducing the need for follow-up data requests. This means some data is collected prior to the annual WMP through Quarterly Reports..."

---

[135] Draft Wildfire Safety Division (WSD) Geographic Information System (GIS) Data Reporting Requirements and Schema for California Electrical Corporations; ISSUED BY CALIFORNIA PUBLIC UTILITIES COMMISSION (CPUC); August 21, 2020. (GIS Template)

10.1. Confidentiality of GIS Data

One issue that delayed timely issuance of all requested GIS data is that utilities had not prepared to release non-confidential versions of data to stakeholders. MGRA therefore conceded to receive non-confidential versions of some GIS data after the release of the WMPs.[136] SCE made the most formal complaint regarding release of confidential data and only released four tables in its initial release: overhead primary distribution lines, overhead secondary distribution lines, cameras, and weather stations. After discussions and filtering of sensitive data, it later released ignition, outage, and PSPS damage data. While MGRA supports IOU efforts to protect critical infrastructure, some of the concerns raised by SCE seem implausible. For example, SCE is concerned that "knowledge of the location of specific SCE assets in areas with historical high fire weather could make them vulnerable to attack during the worst possible time."[137] It is unlikely that a bad actor bent on causing ignitions during historical high fire weather could find no targets more vulnerable than SCE infrastructure for their actions. Nevertheless, WSD will need to weigh legitimate concerns regarding sensitive infrastructure against the public's right to scrutinize utility activities. SCE states that it is "working towards identifying confidentiality at the field level for its next Quarterly Report submission",[138] and this is a good first step. WSD should work with utilities and stakeholders as it develops a data portal to ensure that public access to non-sensitive utility data is enabled. In the meantime, WSD should require all utilities to issue non-confidential data on their websites as part of their quarterly updates.

Recommendation:

The WSD should work with utilities and stakeholders to identify which elements of its GIS templates are confidential and which can be released to the public. Utilities should be required to release public GIS data along with quarterly updates.

Urgency:

Class B. This should be in place prior to the next release of utility data to WSD.

---

[136] Appendix A – PG&E MGRA Data Request Response 1&2; SCE MGRA Data Request Response 1&2; SDG&E MGRA Data Request Response 1&2.
[137] Appendix A – SCE MGRA Data Request Response 1 – Question 1.
[138] Id.

10.2. Completeness of GIS Historical Event Data

The Wildfire Safety Division's GIS Template was originally put forward in an operational draft form in August 2020, and it was formally adopted as a requirement in WSD-011 at the end of November 2020. Based on data provided to MGRA through its initial data requests, MGRA has found that the event data being provided by SCE and SDG&E to the WSD, for instance wires down, risk events, ignitions, outages, and PSPS damage has only been provided starting in the last quarter of 2020, even though summary data provided in Tables 1-12 show utility tallies of event data going back to 2015. SDG&E was able to fully comply with MGRA's request and provided historical event data. Historical data is necessary to analyze trends. Therefore, the data provided to date from SCE and PG&E is inadequate to do this trend analysis. PG&E and SCE did provide historical data to MGRA in tabular form in response to later data requests, but these are not in the GIS data format required by WSD.

Recommendation:
The WSD should require all utilities to provide historical event data back to 2015 in the format specified in its GIS Template so that it can analyze trend data and verify utility claims. Utilities should be required to make non-confidential portions of this data available to stakeholders.
Urgency:
Class B. Utilities have this data but not in the required format. They have already created a process to generate WSD-compliant GIS data, so requiring conversion of their historical data should not prove to be an onerous burden.

10.3. Initial Analysis of Utility GIS Data

While stakeholders now have access to some of the non-confidential utility GIS data, much of it is incomplete (only going back three months), and it has taken some time to receive the remainder in a form that can be analyzed. This has left stakeholders insufficient time for a full analysis. Nevertheless, at least one relevant issue will be explored here, and further supplemental analysis may be performed over the next year and provided in response to utility quarterly reports and potentially in the context of CPUC proceedings.

10.3.1. SCE ignition data

MGRA was the original proponent of utility ignition data collection,[139] and this was finally achieved after long effort and negotiation.[140] Official ignition data collection under CPUC auspices was begun in 2015. One important point of compromise in the original negotiations was that utilities were allowed to withhold any ignition data for any event that they contested was an utility-caused ignition or that was under criminal investigation or civil litigation, in order to preserve their right against self-incrimination. This was viewed as acceptable by proponents of data collection because wildfires causing significant harm are almost always in the public record and the data is available to public agencies and researchers. Stakeholders should always be aware that the utility ignition data set is incomplete (as are the Cal Fire records) and these need to be amended to include additional ignitions that utilities omitted from the set reported to SED. Likewise, Cal Fire cause attributions provided in their public records (perimeter data), also requires manual updates.

PG&E augmented its own ignition data listing with major wildfires in the data analysis it performed with MGRA as part of its RAMP.[141] SCE was requested by MGRA to provide a list of wildfires it had not provided to SED and SCE reported 24 fires were under active investigation and had not been reported.[142] Using a combination of data sources,[143] twenty of these wildfires were assembled into a combined ignition data set, augmenting the list of 2015-2019 ignitions provided in response to a TURN data request.[144] These are displayed in the figure below:

---

[139] D.12-01-032; pp. 128-135.
[140] D.14-02-015.
[141] Appendix B-2; MGRA RAMP Comments.
[142] Appendix A; SCE Data Request Response MGRA-SCE-004; Question 002.
[143] Data sources were used to determine location, ignition time, agency having jurisdiction, and fire size. Data sources were:
Cal Fire's date-based incident website: https://www.fire.ca.gov/incidents/2019/10/31 (example shows incidents occurring on October 31, 2019).
California State Geoportal California Fire Perimeters geodatabase: https://gis.data.ca.gov/datasets/e3802d2abf8741a187e73a9db49d68fe_0
CAIRS/NFIRS database, received from Cal Fire May 8, 2020.
Local news reporting at the time of the incident was used to determine ignition times in a few cases, since some ignitions occurred in jurisdictions not reporting to CAIRS/NFIRS.
[144] Data Request Response TURN-SCE-001; Question 001. c Amended and attached file "2015-2020 CPUC Reportable Igintions.xlsx".

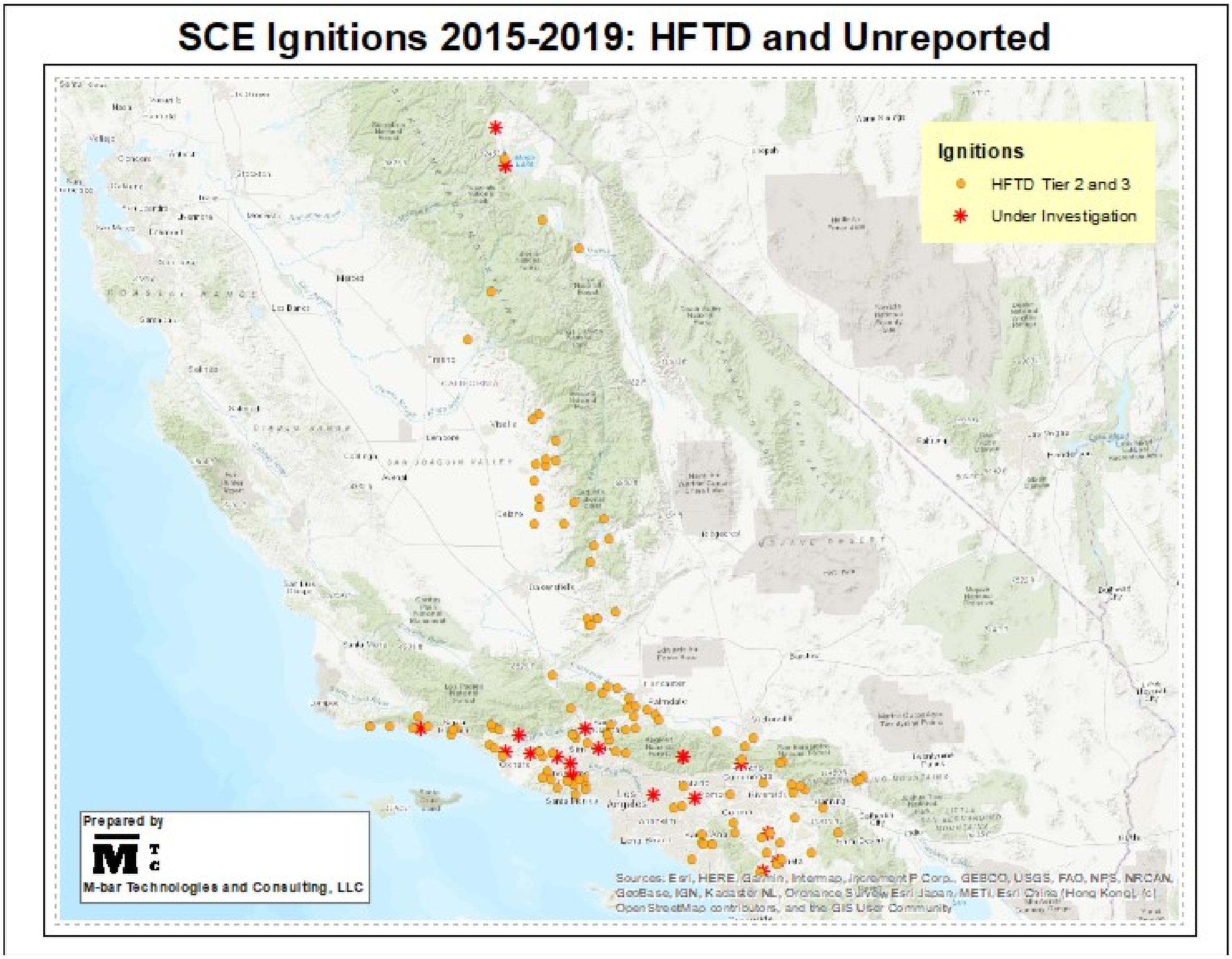

Figure 16 - Ignitions in the SCE service territory 2015-2019. CPUC reportable ignitions in Tier 2 and Tier 3 of the High Fire Threat District are indicated by orange circles. Additional ignitions withheld from the CPUC data set because they are under investigation (and potentially contested) are indicated by red asterisks.

As might be expected, the fires under investigation are larger, deadlier, and more destructive than the standard ignitions reported to the CPUC by SCE, as shown in the figure below:

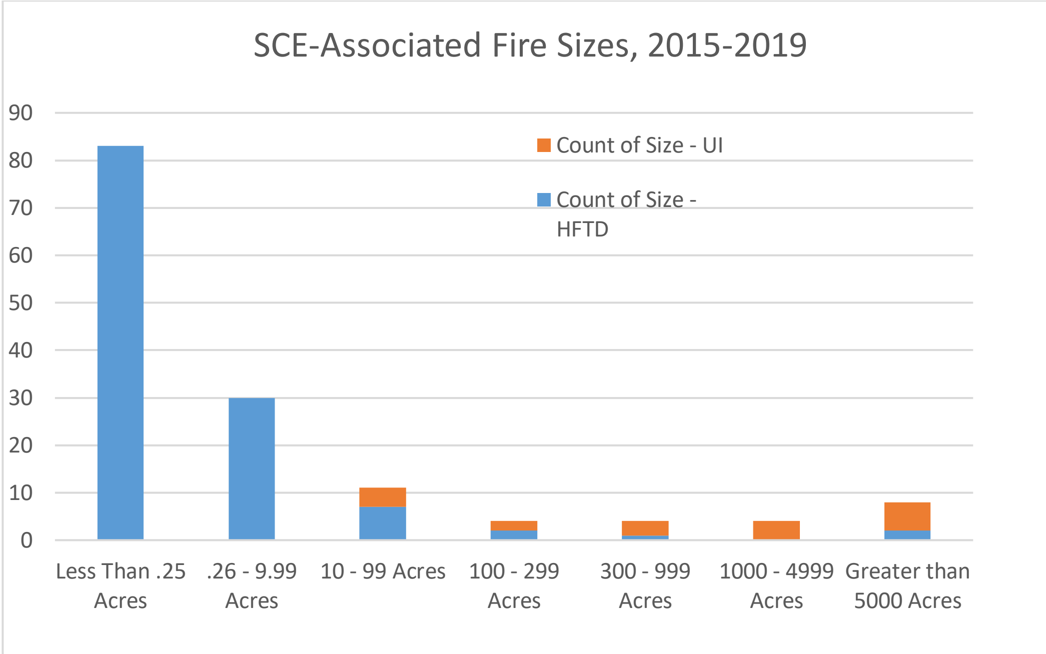

Figure 17 - SCE related fire sizes, 2015-2019. The blue bars are from the ignition data set reported to the CPUC that lie in Tier 2 and Tier 3 of the High Fire Threat District. The orange bars represent the wildfires with alleged SCE involvement that are under investigation (UI).

This chart clearly shows that the majority of major fires over 100 acres are investigated and thus subject to withholding from the CPUC-reported data set. This emphasizes the importance of amending any ignition data set prior to analysis with data not included in CPUC reporting. Fires with alleged SCE involvement and currently under investigation for which publicly available data could be found are:

Name	Date	Size
VAN DYKE	2/6/15	300 - 999 Acres
CABIN	8/14/15	1000 - 4999 Acres
EDISON	5/12/16	10 - 99 Acres
ERSKINE	6/23/16	Greater than 5000 Acres
MARINA	6/24/16	300 - 999 Acres
RYE	12/5/17	1000 - 4999 Acres
ELLIS	10/18/17	Unknown
THOMAS	12/4/17	Greater than 5000 Acres
RYE	12/5/17	Greater than 5000 Acres
MEYERS	12/5/17	10 - 99 Acres
LIBERTY	12/7/17	300 - 999 Acres
HOLIDAY	7/6/18	100 - 299 Acres
WOOLSEY	11/8/18	Greater than 5000 Acres
STAR	7/28/19	100 - 299 Acres
TENAJA	9/4/19	1000 - 4999 Acres
SADDLE RIDGE	10/10/19	Greater than 5000 Acres

OAK	10/28/19	10 - 99 Acres
EASY	10/30/19	1000 - 4999 Acres
MUREAU	10/30/19	10 - 99 Acres
MARIA	10/31/19	Greater than 5000 Acres

Table 18 - Wildfires with alleged SCE involvement currently under investigation and not reported in the CPUC reportable ignitions data set. Fire size data is from Cal Fire incident website or Cal Fire perimeter GIS data.

SCE's data was also analyzed to determine the dependence of ignition probability on wind speed. The results are shown at the end of Section 4.3.1.4, and demonstrate that there is a strong dependency of ignition probability on wind speed. They also show that of the 20 wildfires under investigation for which data is available, 12 had wind speeds over 25 mph within 8 mi of the ignition point with 5 having wind speeds over 55 mph.

Recommendation:

While WSD may have access to confidential ignition data regarding ignitions that IOUs do not provide in their CPUC ignition data reports, stakeholders and members of the public do not. IOUs should report all wildfires for which investigation is underway, including the wildfire name and its start date. Fire name and start date will allow stakeholders and researchers to obtain data from public sources without compromising utility due process rights.

Urgency:

Class B. This is not burdensome and should be included in the first quarterly update and in each annual plan update thereafter.

11. SUMMARY OF RECOMMENDATIONS

Recommendation:

PG&E should not use annual averages wind speed and relative humidity as covariate variables as these would be expected to have little predictive power for catastrophic fire ignition. Preferably wind gust speed at time and location of ignition should be used, or a variable identifying strong directional gusts under low humidity conditions.

Urgency:

Class A: Prior to approval. PG&E is planning to re-prioritize mitigations for 2021 using its analysis.

Recommendation:

PG&E should incorporate PSPS damage data into its ignition data sample to compensate for loss of ignition data due to PSPS. PG&E should calibrate ignition probabilities from PSPS damage data based on damage using historical outage and ignition data.

Urgency:

Class A: Prior to approval. PG&E is planning to re-prioritize mitigations for 2021 using its analysis.

Recommendation:

After incorporating PSPS damage data into its ignition sample, PG&E should divide its ignition data into learning and testing samples based on randomized sampling and not calendar years.

Urgency:

Class A: Prior to approval. PG&E is planning to re-prioritize mitigations for 2021 using its analysis.

Recommendation:

WSD should require PG&E to recalculate its risk rankings to incorporate peak winds and PSPS damage, and to account for the bias in data collection caused by the introduction of PSPS in 2018.

Urgency:

Class A: Prior to approval. PG&E is planning to re-prioritize its mitigation program in 2021 and by failing to account for enhanced catastrophic fire ignition probabilities due to wind and by failing to incorporate data from areas subject to PSPS there is a significant chance that calculated risk rankings will not represent actual catastrophic fire risk.

Recommendation:

Utilities should be required to complete and circulate common definitions, methodologies, timelines, data standards and assumptions regarding "at-risk" species and criteria for EVM, and to circulate it for public comment.

Urgency:

Class B. Prior to the first quarterly update.

Recommendation:

Utilities should be required to show trim distance and number of removals as a function of tree species.

Urgency:

Class B. Should be done in a quarterly update.

Recommendation:

WSD should re-define "catastrophic" in its vision statement so as to describe the potential for many casualties. Alternatively, it should define a new term to describe high-casualty wildfires.

Urgency:

Next revision of the WSD Strategic Roadmap.

Recommendation:

Utilities and WSD should validate that the wildfire size distribution produced by Technosylva in the run periods defined by the IOUs adequately reproduces the wildfire size distribution of real fires. This can be demonstrated with a log-log plot of cumulative fires versus the fire size.

Urgency:

Class B. Can be generated by the next quarterly report.

Recommendation:

The WSD should validate that weather forecasting models run by the utilities are consistent and correct in approach and have been validated against utility data.

Urgency:

Should be in scope for workshops / working groups in 2021.

Recommendation:

Utility risk spending prioritization will largely be determined by models developed as part of the Risk-Informed Development Framework (RDF or SMAP 2) currently underway under the auspices of R.20-07-013. As this affects wildfire safety, the Wildfires Safety Division should have a party or advisory role in this proceeding.

Urgency:

Phase 1 of SMAP 2 is currently underway and Phase 2 will be initiated in the next few months. WSD should begin participation as soon as possible in order to provide additional guidance for wildfire prevention priorities.

Recommendation:

The Wildfire Safety Division should sponsor workshops and/or working groups to analyze assumptions regarding Technosylva model inputs in order to ensure that simulations are equivalent to power line fire events. Alternatively WSD could request that the Commission sponsor this activity as part of R.18-12-005 or R.20-07-013.

Urgency:

Class B: To the extent that these calculations affect circuit risk rankings, this is a moderately urgent issue

Recommendation:

For analysis used for MAVF or for circuit risk ranking, fire modeling simulations should run for the projected length of the typical hazard events leading to catastrophic losses. For example, "SCE uses 41 weather scenarios across a 20-year historical climatology in the consequence component of its WRRM,"[145] while SDG&E "focused on the maximum consequence for each distribution segment, which represents the worst case weather and vegetation."[146] The duration of the wildfire spread simulations should match the weather scenarios used.

Urgency:

Class B: To the extent that these calculations affect circuit risk rankings, this is a moderately urgent issue.

Recommendation:

To provide validation that the Technosylva fire simulations match actual California fire data, utilities should be required to provide cumulative fire size plots such as shown in Figure 9 and Figure 11 for their Technosylva model runs.

Urgency:

Class B: To the extent that these calculations affect circuit risk rankings, this is a moderately urgent issue.

Recommendation:

If Technosylva fire spread simulations are being used to model PSPS events to determine circuits at risk, the duration of the model run should match the duration of the forecasted fire weather event.

Urgency:

Class A: This should be put into place immediately so that is active prior to the 2021 PSPS season. Curtailing fire spread model runs will artificially move risk to circuits proximate to population centers and away from more remote circuits that may present a greater danger of catastrophic fire ignition.

---

[145] SCE WMP; p. 190.

[146] Data Request Response MGRA-SDGE-05 – Response 3.

Recommendation:

All IOUs should be required to provide risk metrics ("near miss", outages, wires down, ignitions) divided into HFTD tiers and classified as to whether they occurred during RFW or HWW conditions. This allows true normalization of risk metrics against the environmental stresses being experienced by their infrastructure. For full normalization, total number of circuit-mile-days for both RFW and HWW should be provided divided into HFTD tiers.

Urgency:

Class B. All utilities have this data, and it is straightforward for them to analyze it. This analysis provides a critical normalization that allows risk metrics to be associated with system resilience.

Recommendation:

The method by which potential ignition events are classified should be more closely examined, particularly by SDG&E, to discover the apparent deficit of risk events during HWW days.

Urgency:

Class B. If there are any issues with how the potential ignition metric itself is obtained, these should be identified and resolved prior to the next major review cycle.

Recommendation:

Guidance should be set for the utilities that they should emphasize strategies, tactics and mitigations that target the reduction of ignitions likely to lead to catastrophic fires with potential for mass casualties and extensive financial losses.

Urgency:

Class C: This should be done in the 2022 WMP revisions.

Recommendation:

WSD should start a working group to study ignition and fire spread modeling to ensure that the utilities are using accurate models for risk assessment. Alternatively, it should request that the Commission conduct such workshops as part of the SMAP/RDF (R.20-06-12 proceeding), and then attend these workshops either as a party or as a technical consultant.

Urgency:

Class B: It is likely that the current models are not properly capturing and distributing wildfire risk.

Recommendation:

PG&E should develop a metric for satellite alert quality to ensure that alerts being sent to first responders are of high quality, and should take efforts to improve its alert algorithms according to this metric. It could, for instance, compare its satellite alerts against data from its wildfire detection cameras to validate which of these systems is able to first detect incipient wildfires.

Urgency:

Class C. PG&E should be required to provide validation of its satellite detection system prior to the next WMP update.

Recommendation:

The WSD should gather additional information regarding utility covered conductor programs to try to determine actual risk/spend efficiencies relative to other mitigation measures, and should ascertain whether IOUs are correctly assessing the costs and benefits of covered conductor.

Urgency:

Class B: The proper role of covered conductor as a mitigation measure should be better understood prior to the next WMP revision cycle.

Recommendation:

While it is useful for WSD to have broken down Section 7 of the WMP Template (and thereby Table 12) into programs and initiatives, utility responses are sparse and overlap poorly. While WSD intends that all programs and initiatives should have an RSE, utilities are nowhere near reaching that goal. It would be helpful for WSD to prioritize common programs that must immediately have an RSE (for example wire hardening, undergrounding, covered conductor, etc.), and to require utilities to immediately provide this information.

Urgency:

Class A. The second phase of the SMAP proceeding is underway and it is essential that any fundamental problems in its basic construction and premises be identified immediately so that they can be resolved within the framework of this proceeding.

Recommendation:

The WSD should become a party to the SMAP 2/RDF proceeding R.20-07-013 or participate in that proceeding in an advisory role.

Urgency:

NA. However, the second phase of the RDF proceeding will be initiated within the next few months and WSD expertise and input would be helpful and would help to align WSD's WMP requirements and those of the Commission.

Recommendation:

WSD should examine PG&E's assumptions regarding risk and weather modeling programs and if they are reasonable they should require SCE and SDG&E to conduct similar calculations.

Urgency:

Class B. If PG&E's assumptions are not reasonable they should be required to correct them in quarterly reports. If they are reasonable SCE and SDG&E should be required to supplement their Table 12 reports using similar methods.

Recommendation:

WSD should examine PG&E's SmartMeter™ program to validate its extremely high RSE and should request that SCE and SDG&E explain whether and how such a program could be deployed in their areas.

Urgency:

Class C. Monitoring seems to be an area of potentially good return on investment and WSD should request a more detailed showing during the next WMP update.

Recommendation:

PG&E should be required to provide separate RSEs for hardening technologies and techniques such as overhead hardening, undergrounding, and covered conductor. While its description of its distribution hardening program is detailed,[147] it does not provide RSEs for the various technologies and strategies it plans to use as part of this program.

Urgency:

Class A. WSD has repeatedly asked for a finer-grained breakdown of PG&E hardening programs. Nevertheless, PG&E provides only an aggregate RSE score. In the light of the fact that the RSE reported by PG&E is so low, it is urgent that PG&E justify its current strategy.

Recommendation:

---

[147] PG&E WMP; p. 548-563.

WSD should more closely examine the assumptions of the covered conductor and undergrounding assumptions made by SDG&E and SCE, since these vary in relative value by a factor of ten, and it is unlikely that both approaches can be valid.

Urgency:

Class B. WSD should require SDG&E and SCE to use valid assumptions and common approaches to calculating the RSE values for covered conductor and undergrounding.

Recommendation:

WSD should more closely examine the assumptions made by PG&E regarding how RSE is calculated for its vegetation management programs and compare this to the approach of SDG&E and SCE. While it is a given that PG&E has many more trees adjacent to its lines, the relative value that it attributes to its vegetation management program compared to its other programs cannot be squared with the lower values reported by other utilities.

Urgency:

Class B. WSD should examine the assumptions and approaches used by PG&E versus SCE and SDG&E to calculate the RSEs for their vegetation management programs and require that calculations be performed using common assumptions.

Recommendation:

In their risk estimations, utilities should use uncapped losses, incorporate high-end losses to properly weight the contribution of catastrophic events, and use linear scales to properly represent all risks.

Urgency:

Class B. This is important for PG&E and SDG&E GRC and RAMP phases that are getting underway.

Recommendation:

Utilities should have the methodology used for estimating PSPS RSE reviewed. WSD can perform this analysis, or it can be conducted by the CPUC under proceedings R.20-07-013 (SMAP/RDF) or R.18-12-005 (PSPS). WSD should not accept the utility PSPS RSE values at this time.

Urgency:

Class C. The analysis or the costs and risks from de-energization should be led by either the CPUC or WSD.

Recommendation:

Utility directional vision for PSPS should envision how the impacts of power shutoff on the public might be eliminated.

Urgency:

Class C. WSD should provide clear guidance as to what it expects from utility “directional vision”.

Recommendation:

WSD should investigate the use of de-energization for mitigation against catastrophic fire growth potential alone (without respect to ignition potential) and ensure that utilities are not simply deploying de-energization as a liability-reducing measure. WSD should obtain additional information from the IOUs regarding the degree to which wind-driven ignition potential is weighted in their shutoff criteria as opposed to fire spread potential, and ensure that any criteria based on fire spread potential alone represents a plausible risk.

Urgency:

Class B. This should be examined as soon as possible, since severe fire potential may develop early this year due to drought conditions.

Recommendation:

WSD should direct the utilities to compare and validate wind forecast models to ensure optimal choices are being made that affect power shutoff forecasts.

Urgency:

Class B. WSD should organize workshops or working groups to address utility weather modeling.

Recommendation:

WSD should require public release of PG&E’s internal validation of its weather forecasting model.

Urgency:

Class A. This information should be available to validate 2021 WMPs.

Recommendation:

The WSD should examine cases of de-energization at low wind speed thresholds to determine whether these are being used to mask unreported defects. WSD should ensure that defects limiting safe operation of utility infrastructure under known local conditions are given a high priority.

Urgency:

Class B. Issues of low de-energization threshold should be identified and resolved prior to next fall's Santa Ana / Diablo season.

Recommendation:

SDG&E should ensure that its use of 30 second weather station data to provide alerts for PSPS accounts for and triggers alerts for potential periodic wind gusts with a period greater than a few minutes.

Urgency:

Class B. Needs to be evaluated and implemented prior to the upcoming fire season.

Recommendation:

Utilities should be required to provide forecasted and measured wind speed data as well as cause information for all reported damage events.

Urgency:

Class B: Data should be provided retroactively for 2020 and 2019. Complete 2021 data should be provided prior to the 2022 WMPs.

Recommendation:

The Wildfire Safety Division and Wildfire Safety Advisory Board should support the position taken by the CPUC opposing the lowering of PG&E's shutoff threshold and the expansion of PG&E's shutoff without full evaluation of the impacts of such a move.

Urgency:

Immediate. Judge Alsup is expected to make a ruling within the next few weeks.

Recommendation:

Utilities should incorporate damage data into their risk calculations in the same manner as outage and ignition data. WSD should hold workshops to help determine a technically correct approach to doing so.

Urgency:

Class B: Standard ignition and outage data becomes more irrelevant as metrics as PSPS becomes more prevalent as a mitigation.

Recommendation:

In cases where damage is occurring regularly in areas where winds do not exceed 56 mph, WSD should investigate and require that a remediation program be developed.

Urgency:

Class B: While areas that are de-energized are not subject to ignitions, the potential for widespread damage at low wind speeds leads utilities to set shutoff thresholds at excessively low value, thus causing public harm.

Recommendation:

The WSD should require utilities to provide tabular data from their Utility Wildfire Mitigation Maturity Model Surveys that shows any changes to current or future maturity when compared to the assessment from the previous year.

Urgency:

Class C. Utilities have provided the data in Appendix A. They should continue providing this information in future WMP updates.

Recommendation:

If they are not already doing so, WSD audits of UWMMS responses should compare audit results between utilities to ensure that survey questions are interpreted in a common way.

Urgency:

Class C. This should be part of the audit process for 2021.

Recommendation:

As noted in MGRA's 2020 WMP, the current survey has numerous inefficiencies and inaccuracies, and should be corrected. WSD should begin the process of optimizing the survey so that inaccuracies are corrected, new and more appropriate data collected, and so that there is a clear mapping and transition from the current survey to future surveys.

Urgency:

Class C. This process should begin this year so that it can be initiated in 2022.

Recommendation:

The WSD should work with utilities and stakeholders to identify which elements of its GIS templates are confidential and which can be released to the public. Utilities should be required to release public GIS data along with quarterly updates.

Urgency:

Class B. This should be in place prior to the next release of utility data to WSD.

Recommendation:

The WSD should require all utilities to provide historical event data back to 2015 in the format specified in its GIS Template so that it can analyze trend data and verify utility claims. Utilities should be required to make non-confidential portions of this data available to stakeholders.

Urgency:

Class B. Utilities have this data but not in the required format. They have already created a process to generate WSD-compliant GIS data, so requiring conversion of their historical data should not prove to be an onerous burden.

Recommendation:

While WSD may have access to confidential ignition data regarding ignitions that IOUs do not provide in their CPUC ignition data reports, stakeholders and members of the public do not. IOUs should report all wildfires for which investigation is underway, including the wildfire name and its start date. Fire name and start date will allow stakeholders and researchers to obtain data from public sources without compromising utility due process rights.

Urgency:

Class B. This is not burdensome and should be included in the first quarterly update and in each annual plan update thereafter.