BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

Application Of Southern California Edison Company (U 338-E) For Authority To Increase Its Authorized Revenues For Electric Service In 2025, Among Other Things, And To Reflect That Increase In Rates.	Application A.23-05-010 (Filed May 12, 2023)

DIRECT TESTIMONY OF THE MUSSEY GRADE ROAD ALLIANCE

SOUTHERN CALIFORNIA EDISON COMPANY 2025 GENERAL RATE CASE

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INTRODUCTION

Q. Please state your name, address, company and qualifications.

A. My name is Dr. Joseph W. Mitchell. My business address is 19412 Kimball Valley Road, Ramona, CA 92065. I am the owner of M-bar Technologies and Consulting, LLC in Ramona, CA. I have been an expert witness at the CPUC since 2007 on issues of wildfire. I have a Ph. D. in physics, and have been working in the area of wildland fire since 2002, and utility power line fires since 2007. I have several publications in this field. My full qualifications are provided in Appendix A of this testimony.

Q. On whose behalf are you submitting this testimony?

A. I am submitting this testimony on behalf of the Mussey Grade Road Alliance (MGRA or Alliance).

Q. What is the purpose of your testimony?

A. The focus of this testimony is to examine issues relating to wildfire that are discussed in the documents supporting 2025 General Rate Case Application (Application)[1] , including its testimony, revised testimony, and data request responses. SCE's GRC will be specifically reviewed to ascertain whether it properly incorporates feedback from the CPUC's Safety Policy Division and parties that SCE received during its Risk Assessment and Mitigation Phase (RAMP) proceeding.[2] This testimony also analyzes additional issues related to wildfire, including SCE's recent shift from its

[1] A.23-05-010; TEST YEAR 2025 GENERAL RATE CASE APPLICATION OF SOUTHERN CALIFORNIA EDISON COMPANY (U 338-E); May 12, 2023. (Application)
[2] A.20-06-013; APPLICATION OF SOUTHERN CALIFORNIA EDISON COMPANY (U 338-E) REGARDING 2022 RISK ASSESSMENT MITIGATION PHASE (RAMP); May 13, 2022. (RAMP)

extensive and successful covered conductor program (WCCP or CC) to undergrounding (TUG or Targeted Undergrounding) as a primary wildfire mitigation and the potential impact of this shift on ratepayers. SCE's new strategy is based on its Integrated Wildfire Mitigation Strategy (IWMS), a consequence-only analysis framework.

Q. What is your interest in this proceeding?

A. I have been involved as an expert for the Mussey Grade Road Alliance in the area of wildfire since 2007. The Mussey Grade Road Alliance, established in 1999, is a grass-roots citizen-based organization located in Ramona, California, which is in the SDG&E service area. MGRA has been actively involved in activities related to utility wildfire risk at the CPUC since 2006 when SDG&E submitted its Sunrise Powerlink transmission line application (A.06-08-010). MGRA has since demonstrated a deep commitment to the issue of wildfire safety in California, a commitment arising from its own experience in the 2003 Cedar fire, when two-thirds of homes in the area were lost. On behalf of MGRA, I have provided expert comment, testimony, and briefing in numerous proceedings before the Commission, including those having to do with wildfire rulemaking (R.08-10-005, R.15-05-006), wildfire mitigation plans (R.18-10-007), power shutoff (A.08-12-021, R.18-12-005, I.19-11-013), risk assessment S-MAP, RDF, and RAMP proceedings for SDG&E, SCE and PG&E (R.13-11-006, A.15-02-005-7, I.16-10-015, A.20-06-012, R.20-07-013, A.21-05-011, A.22-05-013), GRCs for SDG&E and PG&E (A.14-11-005-6, A.21-06-021), and responsibility for wildfire costs (A.09-08-020, A.15-09-010). I have also offered expert comment on behalf or MGRA in analysis of annual utility Wildfire Mitigation Plans (WMPs) from 2019 to 2023 under the auspices of the Commission and the Office of Energy Infrastructure Safety (OEIS or Energy Safety).

MGRA is an organization of ratepayers and residents of a wildfire-prone area that advocates for wildfire risk reduction through cost-effective mitigation programs. MGRA was the first to propose a cost/benefit analysis as a mechanism to determine power shutoff thresholds.[3] MGRA been actively involved in the S-MAP, which required utilities to incorporate a risk/spend efficiency (RSE) into their mitigation decisions, and more recently in its successor Risk-Based Decision-Making Framework (RDF) proceeding which formally requires a cost/benefit analysis be incorporated into utility decision-making.[4] MGRA actively participated in SCE's RAMP proceeding and provided feedback through informal comments that were incorporated into the Safety Policy Divisions SCE RAMP report,[5] as well as MGRA comments[6] and MGRA reply comments[7] on SCE's RAMP and the SPD Report. MGRA raised a number of technical concerns with SCE's wildfire risk estimation methodology. MGRA identified a number of of shortcomings with SCE's MARS methodology that it uses to rank its circuit segment risk and decide appropriate mitigations. Other utilities make similar mistakes in their risk estimations, and it is of interest to MGRA to ensure that scientific and transparent methods are used to determine risk and mitigation prioritization across California.

One of the issues of greatest interest and concern to MGRA is SCE's introduction of its IWMS framework for prioritizing mitigations. This framework steps away from the Commission's stated goal of having utilities a quantifiable risk-based framework for assessing risks and mitigations, and instead adopts a "consequence-only" classification model that defaults to undergrounding as a preferred mitigation. If the Commission finds this acceptable, other California utilities will also feel free to adopt the same or similar approaches, putting undergrounding (and its costs) under the sole control of utilities.

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[3] D.09-09-030; pp. 55;
A.08-12-021; MGRA Opening Comments; Appendix A; Mitchell, Joseph W; M-bar Technologies and Consulting, LLC for the Mussey Grade Road Alliance; "WHEN TO TURN OFF THE POWER? COST/BENEFIT OUTLINE FOR PROACTIVE DEENERGIZATION"; March 27, 2009

[4] D.22-12-027; p. 2.

[5] A.20-05-013; Safety Policy Division Staff Evaluation Report on the Southern California Edison Company's 2022 Risk Assessment and Mitigation Phase (RAMP) Application; November 11, 2022 (SPD Report)

[6] A.22-05-013; MUSSEY GRADE ROAD ALLIANCE COMMENTS ON SOUTHERN CALIFORINA EDISON COMPANY'S RAMP FILING AND THE SAFETY POLICY DIVISION REPORT; December 9, 2022. (MGRA RAMP Comments)

[7] A.22-05-013; MUSSEY GRADE ROAD ALLIANCE REPLY TO COMMENTS ON SOUTHERN CALIFORNIA EDISON COMPANY'S RAMP FILING AND THE SAFETY POLICY DIVISION REPORT; January 4, 2023. (MGRA RAMP Reply)

When PG&E first announced its ten year, 10,000 mile undergrounding project in 2021, I stated that "*Undergrounding is the most expensive mitigation strategy per mile, and the declaration of the solution without examination of the alternative[s] effectively negates seven years of effort at the Commission to formulate methods for risk-based decision-making. If PG&E succeeds in implementing its undergrounding plan, it must be anticipated that other utilities around the state will adopt similar strategies. Even if PG&E's plan fails or is rejected, it will have a chilling effect on other wildfire mitigation efforts*."[8]

As predicted, PG&E's proposal initiated a seismic shift in the approach to risk taken by the major California utilities. SDG&E cut back the proposed spending on covered conductor in its GRC from $435 million to $207 million.[9] SDG&E further projected spending $1.7 billion on wildfire mitigation capital projects between 2025 and 2027, primarily on undergrounding.[10]

This testimony will show that SCE has also taken a dramatic turn, ramping down its extensive and highly successful covered conductor program in 2025 to 2026 and replacing it with a far more modest yet more expensive "Targeted Undergrounding" program (TUG),[11] using its IWMS framework as a basis for this transition.

Concerns about undergrounding costs are statewide. Since my analysis of the 2022 Wildfire Mitigation Plans showed how even "modest" annual rate increases of a

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[8] A.21-06-021; Prehearing Conference Transcript; August 30, 2021; p. 60.
[9] A.22-05-015/6; Exh. SDG&E-13; PREPARED DIRECT TESTIMONY OF JONATHAN T. WOLDEMARIAM (WILDFIRE MITIGATION AND VEGETATION MANAGEMENT); May 2022; Table JW-39; p. JTW-106, and
Exh. SDG&E-13-2R; SECOND REVISED PREPARED DIRECT TESTIMONY OF JONATHAN T. WOLDEMARIAM (WILDFIRE MITIGATION AND VEGETATION MANAGEMENT); October 2022; Table JW-39; pp. JTW-106-7.
[10] Id.; Table JW-74; p. JTW-170.
[11] A.23-05-010; Exhibit No.: SCE-04 Vol. 05 Pt. 2A; Witnesses: R. Fugere, A. Swisher; 2025 General Rate Case; Wildfire Management; Part 2 Amended: Grid Hardening; Table I-3; p. 10. Table I-10; p. 31. (SCE-04 Vol. 05 Pt. 2A).

few hundred dollars per year, when applied to a large enough population, could lead to impacts on public health that are larger than potential safety risks from wildfire and PSPS, due to the steep dependency of life expectancy on income in the US.[12] This will also be explored in this testimony.

In the late summer of 2022, Senate Bill 884, which provides for an expedited review of 10 year utility undergrounding plans, was passed into law,[13] further tilting the balance in favor of undergrounding. For those focused on cost efficient mitigation of utility wildfire risk, this raised additional concerns, particularly since SCE's application is making new and dramatic changes in its risk policy that are at odds with directives from the Commission regarding risk-based wildfire mitigation.[14]

While many of MGRA's CPUC and OEIS contributions apply to utilities in general, some have been more focused on SCE. For example, SCE's extensive covered conductor program has placed thousands of miles of covered conductor into service in HFTD areas, and as such is the perfect testbed for determining the effectiveness of this mitigation. This information is critical to other utilities determining to what degree covered conductor should be a part of their hardening programs. MGRA has analyzed this data and found that SCE's covered conductor program appears to be significantly more effective at reducing wildfire ignitions than the 72% effectiveness stated by Edison. This finding may be applicable to all California utilities, and could promise additional savings to SCE ratepayers if it leads to lower cost covered conductor being used in the stead of undergrounding.

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[12] OEIS Docket 2022-WMPs; MUSSEY GRADE ROAD ALLIANCE COMMENTS ON 2022 WILDFIRE MITIGATION PLANS OF PG&E, SCE, AND SDG&E; pp. 58-60. (MGRA 2022 WMP Comments)

[13] McGuire, 2022. SB-884 Electricity: expedited utility distribution infrastructure undergrounding program; California Public Utilities Code Section 8385. https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220SB884

[14] D.16-08-018; p. 179 – "According to D.14-12-025, beginning February 1, 2015, the risk-based decision-making framework shall apply to all future GRC application filings of PG&E, SDG&E, SoCalGas, and SCE."

While the Mussey Grade corridor is not within the SCE service area, it is in the wildland-urban interface and in 2007 was surrounded by utility-ignited wildfires. Additionally, many in this area also struggle to pay their utility bills. Determining how to effectively mitigate wildfire in a way that controls costs has been an interest of MGRA since it began intervening at the Commission. MGRA has made substantive contributions to a number of state-wide wildfire proceedings involving SCE. The decision in the SCE rate case is likely to set precedent for future rate cases and for utility SB 884 undergrounding plans. It is MGRA's intent that this work will benefit not only SCE ratepayers and residents but will provide valuable input to future RAMP, GRC and RDF proceedings and to SB 884 applications from other utilities.

Q. What are the limitations of your testimony?

A. I am a physicist who has been working on wildfire in general since 2003 and the utility wildfire problem in particular since 2007. I am neither an electrical engineer nor a power engineer. Statements made in this testimony regarding specific utility systems or mitigations are based on 1) statements made by SCE and other utilities 2) documentation and data provided by SCE, 3) physical analysis of specific situations 4) my established expertise resulting from the study of utility wildfires, 5) statistics and 6) logical or deductive consistency.

This testimony will rely primarily on the testimony and comment provided by SCE in its RAMP and GRC applications, as well as its responses to data requests issued by MGRA and other intervenors. Textual responses to MGRA data requests in this proceeding are attached as Appendix B of this testimony. Information from other Commission proceedings and Wildfire Mitigation Plan reviews are also incorporated when appropriate. MGRA's testimony is primarily technical in nature and related to the area of wildfire risk.

SUMMARY OF MGRA TESTIMONY

Q. What is the scope of the MGRA testimony?

A. The Mussey Grade Road Alliance presents testimony related to wildfire risks and wildfire prevention programs proposed by SCE in its general rate case application. The testimony will cover the following areas:

- Whether SCE adequately incorporated feedback from the Safety Policy Division and parties including MGRA that it received in the course of its RAMP proceeding,
- An analysis of risk management policy issues raised by SCE's submission,
- An assessment of SCE's MARS risk analysis and whether it is adequate to support SCE's proposed revenue request.
- An assessment of SCE's IWMS framework, both from a technical standpoint and from a policy standpoint,
- An evaluation extensive covered conductor program,
- An evaluation of advanced technologies being deployed by SCE,
- A comparison of undergrounding, covered conductor, and advanced technology mitigations, especially REFCL,
- A comparison of combined scenarios that will show that SCE is capable of providing equivalent or greater risk reduction than its current plan calls for at substantially reduced cost.
- An analysis showing impacts of increased rates on the health and safety of the poorest and most vulnerable population.

SCE'S RISK ASSESSMENT AND MITIGATION PHASE (RAMP)

SCE's RAMP application was submitted in May 2022.[15] Intervenors conducted scenario analysis and other analyses on SCE's RAMP filing, and submitted informal comments to SPD in October 2022. These submissions were analyzed and incorporated into the SPD Report. MGRA and other parties filed comments on both the RAMP filing and SPD's report in December 2022, and reply comments in January 2023.[16] The incorporation SPD and MGRA RAMP recommendations into the GRC was discussed in exhibit SCE-04-05-01 (pp. 48-53). SCE contested a number of SPD and MGRA recommendations.

Q. What issues did MGRA identify during the evaluation of SCE's RAMP application?

A. A number of significant issues were raised by MGRA in its RAMP informal and formal comments:

- The use by utilities of an eight hour limit for Technosylva wildfire spread simulations will bias the risk model, since this imposes a roughly 60,000 acre limit on the size of the wildfire.[17] However, the wildfires responsible for the most catastrophic damage can grow much larger than this and are responsible for the majority of wildfire losses in California and elsewhere.[18] The resulting bias will underestimate total wildfire losses, and geographically will artificially amplify risk in areas closer to the ignition point.

[15] A.20-05-013; APPLICATION OF SOUTHERN CALIFORNIA EDISON COMPANY (U 338-E) REGARDING 2022 RISK ASSESSMENT MITIGATION PHASE (RAMP); May 13, 2022. (RAMP)
[16] A.20-05-013; MUSSEY GRADE ROAD ALLIANCE REPLY TO COMMENTS ON SOUTHERN CALIFORNIA EDISON COMPANY'S RAMP FILING AND THE SAFETY POLICY DIVISION REPORT; January 4, 2023. (MGRA RAMP Reply)
[17] MGRA RAMP Comments; p. 4.
[18] MGRA RAMP Comments; p. 6.

- Based on analysis of SCE field data, the effectiveness of SCE's covered conductor program in preventing wildfire ignitions appeared to be significantly better than the 72% estimated by SCE's subject matter experts (SMEs).[19]
- MGRA has repeatedly raised the issue that PSPS prevents the collection of an unbiased data sample for risk modeling, since high-risk ignitions and outages will not occur in PSPS areas, making these areas appear safer than they actually are. MGRA has urged utilities to use PSPS damage events as proxies, but so far only PG&E has done so.[20]
- SDG&E proposed using a number of fatalities per acres burned to represent wildfire smoke health hazards. MGRA urged SCE to adopt the approximate methodology used by SDG&E, with a fatalities-to-acres proportionality. Using SCE's MARS methodology and numbers obtained from recent academic studies, MGRA showed that smoke may become the predominant safety risk if more than 1,600 acres burn.[21]
- MGRA continued to raise issues with SCE's probability of ignition (POI) analysis, which is based on a machine learning algorithm using a "random forest" classifier. While such algorithms are useful in a number of domains, the issue with SCE's specific application is that all weather variables are aggregated by year, so that extreme weather events are mixed in with a much larger sample. MGRA has shown that this underpredicts the wind-related ignitions that contribute to the vast majority of utility wildfire losses.[22]
- The method that SCE uses to combine risk and consequences, which uses a ensemble of "worst case weather days", has a tendency to amplify risk drivers that are *not* correlated with extreme weather (such as vehicles, animals, balloons, and 3rd party contact).[23]

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[19] MGRA RAMP Comments; pp. 6-7.
[20] Id; p. 7.
[21] Id.; pp. 7-9..
[22] Id; pp. 9-12.
[23] Id; pp. 12-14.

Q. Did the Safety Policy Division adopt any of MGRA's recommendations or positions aligning with MGRA?

A. Yes. SPD adopted some of MGRA's recommendations, specifically:

"High-level critical observations that apply to the 2022 SCE RAMP:

3. High implied Value of Statistical Life (VSL).

5. Lack of transparency related to models using machine learning techniques.

Wildfire Risk (Chapter 4):

2. Low cost-efficiency of wildfire covered conductor (WCCP) and targeted undergrounding (TUG) mitigation programs.

3. Lacking justification for the late addition of TUG circuit segments.

5. Not all risk factors, such as egress, included in RSE calculations.

6. Wind dependency is missing in SCE's ignition models.

7. Catastrophic losses are inadequately modeled.

8. Risk model does not include the health and safety consequences of wildfire smoke.

9. The risk reduction from the covered conductor mitigation program is likely under-valued in the risk modeling.[24]

Q. What were SCE's responses to MGRA and SPD's RAMP recommendations?

A. SCE responded to SPD and MGRA's recommendation in its Reply Comments:[25]

- "*SCE takes issue with the SPD Report's recommendation that SCE's resources could be deployed more efficiently to 'buy down' 85% of the ignition risk associated with its infrastructure in its WCCP and TUG proposals by spending 40% of the money SCE proposes to invest in grid hardening mitigations.' SCE states that 'SPD's conclusion fundamentally*

[24] SPD Report; p. 4.

[25] A.22-05-013; SOUTHERN CALIFORNIA EDISON COMPANY'S (U 338-E) OPENING COMMENTS ON SAFETY POLICY DIVISION'S EVALUATION REPORT ON SCE'S 2022 RAMP REPORT; December 9, 2022. (SCE RAMP Comments)

misses the point…' because of 'the dangers of the logical fallacy of conflating the concepts of relative and absolute risk.'"[26]

- SCE defends its IWMS modeling approach with its lack of RSE scoring or ranking. MGRA's Reply Comments note that "*The Commission is careful to provide latitude to utilities, acknowledging that risk analysis is complex and that some important considerations may not be quantifiable. However, SCE (and PG&E, in its GRC proceeding) bend this latitude to the breaking point by not incorporating RSE into planning in any visible or comprehensible way*."[27]
- SCE raised numerous objections to the inclusion of a wildfire smoke component to risk analysis, some of them legitimate (i.e. there is no verified and accepted method for including smoke risk), while others attempted to disperse responsibility for wildfire smoke damage and identify alternative responsible parties.[28]
- SCE objected to SPD's suggestion that SCE adopt a Value of Statistical Life value closer to the Department of Transportation value of $11.8 million dollars. It states that: "*It is challenging to see how drastically lowering the implicit value of a life, based on a general figure provided in a different context, would be beneficial to the safety of our customers and the communities we serve*."[29]

Q. What was SCE's response in the GRC to MGRA's suggestion that it use PSPS damage events as a proxy for ignition data to eliminate PSPS bias?

A. "*SCE is not using PSPS damage reports in its probability of ignition models because those reports are biased in two directions: first, the existence of damage does not mean an ignition would have occurred (over-indexing), and second, the absence of*

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[26] MGRA Reply Comments; p. 2, cites:
SCE RAMP Comments; p. 8.
[27] MGRA RAMP Reply Comments; p. 5.
[28] Id.; p. 6
[29] SCE RAMP Comments; p. 23.

damage does not mean an ignition would not have occurred in the absence of PSPS (under-indexing). SCE notes that damage discovered following PSPS events is valuable information that SCE considers in system hardening and PSPS threshold decisions even though the data does not have sufficient fidelity to be used in its models."[30]

Q. Is SCE's objection to incorporating PSPS damage events in its risk model reasonable?

A. It is reasonable to incorporate data or a model that has a high degree of uncertainty if it has been shown that the effect of *not* incorporating the data or model will lead to a larger error than could be introduced by including it. PSPS bias is relatively straightforward to understand. MARS risk modeling uses historical outage or ignition data. PSPS eliminates outages and ignitions in the areas in which it is in effect. Therefore, areas with frequent PSPS will appear to be "safer", since there are no ignitions or outages during extreme weather events, and thus less apt to be mitigated. This is a potentially serious flaw, and any attempt to correct it (even if not perfect) is preferable to ignoring it.

SCE, however, does recognize that "*damage discovered following PSPS events is valuable information that SCE considers in system hardening and PSPS threshold decisions."* SCE's designation of "extreme wind locations" in its IWMS may be the mechanism that it uses to incorporate this information, and may compensate for PSPS bias. This will be discussed in more detail in the section on IWMS.

Q. How did SCE respond in its GRC to MGRA's and SPD's suggestion that it should incorporate field data into its estimate of covered conductor effectiveness?

A. SCE states that it is incorporating such data and has increased the predicted value for covered conductor effectiveness in its GRC: "*SCE's mitigation effective values for covered conductor reflect SCE's fault and wire-down data as well as laboratory testing performed in 2022. SCE is also leading the Joint IOU Covered Conductor Effectiveness*

[30] SCE-04 Vol. 05 Pt. 1A; p. 56.

Working Group and the utilities continue to make progress on the objectives. Progress on these efforts is described in Appendix F of SCE's 2023 – 2025 WMP, which can be found on SCE's website… The primary lessons learned resulting from the study thus far has been the increase in effectiveness of covered conductor as compared to earlier assumptions, which SCE has incorporated into its risk analysis for this GRC."[31]

Q. Did SCE increase its estimated effectiveness of covered conductor correctly?

A. It appears that SCE's higher estimate for covered conductor effectiveness (72%) was based primarily on third party testing.[32] In the section on covered conductor (p. 62) this testimony will show that the reduction in wildfire ignitions seen in field data is significantly higher than 72%.

Q. Did SCE include an alternative mitigation that used REFCL and other advanced technologies in combination with covered conductor?

A. While I have been unable to find a direct estimate of REFCL + CC costs and effectiveness in the testimony, SCE has provided such estimates in data request responses, both during the WMP phase and in the data request responses associated with the current proceeding.[33] Additionally, SCE discusses CC+REFCL as a mitigation under IWMS, to be used in cases in which undergrounding is implausible: "*For example, mountainous regions with winding rights-of-way and rocky soil may not be conducive to undergrounding. In those situations, SCE would examine alternatives such as covered conductor paired with REFCL.*"[34]

The effectiveness of REFCL and other advanced technology solutions in combination with covered conductor will be covered in the section on p. 74.

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[31] SCE-04 Vol. 05 Pt. 1A; p. 55.
[32] SCE-04 Vol. 05 Pt. 2A; p. 39.
[33] For example DR Response PubAdv-SCE-075-MGN-Q02.
[34] SCE-04 Vol. 05 Pt. 1A; p. 48.

Q. In summary, did SCE incorporate RAMP suggestions from MGRA and SPD into its GRC?

A. SCE offered numerous objections to MGRA and SPD input both in its RAMP Comments and in its GRC coverage, rejecting input on potential biases in its risk analysis. Accordingly, these biases remain in SCE's MARS risk analysis. However, in certain ways SCE's IWMS framework, if implemented, would compensate for some of these biases, though IWMS itself should not be considered a risk analysis because it lacks a probability component. The issues raised by deviation from the risk framework adopted by the Commission are addressed in the following section. The subsequent sections (pp. 24 and 41) will deal with technical aspects of SCE's MARS risk analysis bias and the IWMS framework respectively.

SCE'S RISK MANAGEMENT AND POLICY

Q. Did SCE adopt any major changes to its approach to risk management and risk management policy in this GRC cycle?

A. Yes. SCE's use of its IWMS framework to prioritize mitigations is a departure from the risk-based decision-making framework adopted by the Commission. IWMS mitigations are based only on consequence, rather than risk. Accompanying its use of IWMS, SCE has also adopted a zero-tolerance policy for catastrophic wildfire potential in combination of an "as low as reasonably practicable" approach to risk reduction. Consequently, SCE has made undergrounding the default mitigation for circuit segments meeting criteria that SCE defines according to its own risk tolerance policy. The fact that undergrounding is the most expensive mitigation, and that SCE earns a return on equity of 10% on capital improvements,[35] creates a condition of perverse incentive in which SCE obtains a monetary benefit from choosing higher-costing capital mitigations. The Commission will need to determine whether it is appropriate for utilities to set risk tolerance standards when their own interest is not identical to the public interest.

[35] D. 22-12-031; p. 52.

IWMS and Risk-based Decision-Making

Q. Does IWMS conform to the Commissions Risk-based Decision-Making Framework (RDF)?

A. No, IWMS cannot be considered a risk analysis, and therefore does not conform to the Commission's definition of risk-based decision-making.

As SCE defines it: "*The IWMS Risk Framework defines three risk tranches within SCE's HFRA based on potential consequences should an ignition occur at a specific utility asset location. This analysis includes elements such as potential egress constraints and CEFC. The IWMS Risk Framework is anchored on wildfire consequence should an ignition occur and does not adjust consequences based on the probability of ignition. SCE takes this approach because probability of ignition changes over time due to many variables such as age, loading, etc. Furthermore, in some locations the consequences of an ignition that leads to a wildfire may be so extreme that it is prudent to mitigate ignition risk regardless of probability*."[36]

The definition of risk in terms of the CPUC S-MAP Settlement Agreement[37] is:

Risk = Probability of Risk Event X Consequences of Risk Event[38]

Under this definition, IWMS is not a "Risk Framework", because it has no probability component. IWMS looks at potential consequences for a given geographic

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[36] SCE-04 Vol. 05 Pt. 1A; p. 16.
[37] D.18-12-014; Appendix A; p. A-3. (Settlement Agreement)
[38] D.22-12-027 Appendix A, A-5:
"The potential for the occurrence of an event that would be desirable to avoid, often expressed in terms of a combination of various Outcomes of an adverse event and their associated Probabilities."

location, using a decision tree[39] to sort events into categories based on threshold characteristics that SCE defines.

Q. Do the IWMS consequence categories that SCE defines have merit?

A. SCE's consequence categories address areas and circumstances that are inadequately addressed by SCE's MARS risk model, and therefore have merit. Areas that are fire-prone and ingress/egress constrained, communities that would be at risk soon after an ignition, high-wind areas, and areas where an ignition could lead to an extremely large wildfire need to be addressed and should be given priority for mitigation. However, these considerations could be equally addressed by a standard risk modeling approach.

Q. Is it ever justifiable to dispense with the probability calculation and proceed directly to consequence and mitigation?

A. Determining a complete understanding of the physical system in such a way that probabilistic estimates of behavior can be made is the ideal and "correct" way to compute risk and its potential mitigations. While subject matter expertise can be and is trusted for many things, there are limitations to the imagination when dealing with purportedly once-in-a-lifetime events that might make preparations inadequate (and for examples we can simply look back to the power line fire storms of 2007 in Southern California and 2017/2018 in Northern California). Additionally, not all SMEs can be counted on to have the same training, background, knowledge, or opinion.

In some cases, incorporating probabilistic elements is very difficult or comes with a large measure of uncertainty. In particular, SCE has made no attempt to model the fat-tailed wildfire loss distribution as a truncated power law, as SDG&E and PG&E have done.[40] Also, its MARS risk calculations has many biases and shortcomings as will be

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[39] SCE-04 Vol. 05 Pt. 1A; p. 22.
[40] R.20-07-013; Mussey Grade Road Alliance; TAIL RISK AND EVENT STATISTICS FOR UTILITY PLANNING; August 1, 2023.

discussed in the MARS section (p. 24). Rather than put additional effort into identifying the uncertainties and improving its quantification, SCE instead applied SME expertise and identified categories that need mitigation, and simply proposes to fix them, thus bypassing the entire question of how to correctly do a risk calculation for a tricky problem.

There is some philosophical and statistical justification for such an approach, particularly for fat-tailed distributions (like wildfire) for which uncertainties are large (they are). Mathematical statistician Nassim Nicholas Taleb suggests in such circumstances that: "*Once we know something is fat-tailed, we can use heuristics to see how an exposure there reacts to random events: how much is a given unit harmed by them. It is vastly more effective to focus on being insulated from the harm of random events than try to figure them out in the required details (as we saw the inferential errors under thick tails are huge). So it is more solid, much wiser, more ethical, and more effective to focus on detection heuristics and policies rather than fabricate statistical properties*."[41]

So while there may be some logical foundation to SCE's approach, there remain a number of sticky points that do not entirely fit into this framework.

- First, the statistical distribution of wildfire losses has been studied for years and is relatively well-known and modellable.[42]
- Second, by walking away from quantification, it becomes impossible to compare different heuristic categories. How does one value an egress-limited neighborhood over a mountain range prone to burn hundreds of thousands of acres under the right ignition conditions? Sure, the problem disappears if you "just fix everything", but due to resource constraints and

[41] Nassim Nicholas Taleb; STATISTICAL CONSEQUENCES OF FAT TAILS - Real World Preasymptotics, Epistemology, and Applications Papers and Commentary; STEM Academic Press; The Technical Incerto Collection; 2020; p. 63.
[42] Op. Cite.

time prioritization will be necessary and not everything will get fixed, at least not all at once.

- Finally, the resource constraints themselves may be deadly, since loss of income among the lowest income tier can have effects on life span, as shown in the section on Affordability (p. 99). In recent discussions in the RDF proceeding R.20-07-013, it was noted that a full remediation of the utility wildfire problem in California through undergrounding would cost very approximately $100 billion, whereas SDG&E had recently calculated that California's recent utility wildfire losses were $30 billion.[43]

One criteria Taleb also makes clear as a prerequisite to his statement quoted above is that "*we first need to make a distinction between mediocristan and Extremistan, two separate domains that about never overlap with one another. If we fail to make that distinction, we don't have any valid analysis.*"[44] By "mediocristan" he means the world of normal statistics, whereas by "Extremistan" he means the world of tail-risk statistics. What is clear about the complex world of utility wildfire and risk is that both of these types of statistics are intertwined. "Extreme" tail risk statistics apply to wildfire losses, extreme weather conditions follow extreme value statistics (though not power law), with unknown worst-case conditions particularly under the assumption of climate change. Power shutoff harm and harm from unbridled utility rate increases follow "normal" statistics but on such a massive scale that they can be compared to historical wildfire losses. There is no clean way to solve this problem. The goal should be to attempt to be the "least wrong", and make assumptions that globally result in the "least harm". This means using all available information, incorporating and estimating uncertainties and flaws rather than overlooking them, and doing quantitative comparisons to the extent possible so that the interest of no stakeholder is overlooked.

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[43] R.20-07-013; SOUTHERN CALIFORNIA GAS COMPANY'S (U 904 G) AND SAN DIEGO GAS & ELECTRIC COMPANY'S (U 902 M) PHASE 3, WORKSHOP 6 TAIL RISK PROPOSAL; December 12, 2023; p. 4.
[44] Taleb; p. 63.

So while it is preferable to have SCE's risks calculated as risks, and not dealt with as special cases, it is understandable why SCE might decide in some cases that it is simpler to "just solve the problem" rather than worry about probabilities. However, SCE's proposal as to ***how*** the problem should be solved further complicates the mix and creates additional policy problems.

Risk Tolerance and As Low as Reasonably Practicable (ALARP)

Q. Why does SCE state that it is compelled to adopt an alternative mitigation framework to MARS?

A. SCE states that: "*In Severe Risk Areas, the threat to lives and property is elevated to such an extent that SCE has determined that for public safety reasons it is prudent to not just significantly reduce ignition risk expeditiously but minimize it in the long term to the extent practicable*."[45]

This statement needs to be broken down into its components:

- *Severe Risk Areas* – It is important to note that because IWMS is consequence only, and has no probability component, "Severe Risk Areas" should be better designated "Severe Consequence Areas"
- *Threat to lives and property is elevated to such an extent* – The consequences have exceeded a tolerance value that merits additional action.
- *SCE has determined that for public safety reasons* – SCE is the decision-maker with regard to public safety risk tolerance
- *reasons it is prudent to not just significantly reduce ignition risk expeditiously but minimize it in the long term to the extent practicable* – adopting a zero tolerance policy that minimizes risk to the extent practicable. This is exactly the term used by the ALARP framework (As

[45] SCE-04 Vol. 05 Pt. 1A; p. 20.

Low As Reasonably Practicable) evaluated by the Commission several years ago and ultimately deferred.

Q. What is an ALARP framework and has SCE adopted one?

A. As defined in D.16-08-018: "*ALARP (As Low As Reasonably Practicable) refers to a risk management framework that is used to decide whether risk mitigation is needed, when it is needed, and how much should be spent before the benefits of mitigation are disproportionately outweighed by the additional cost*."[46]

ALARP was introduced by Safety and Enforcement Division (ESD) staff "*to address the lack of risk tolerance standards and the lack of a formal decision structure to decide when and to what extent mitigation activities must continue in a resource-constrained environment.*"[47]

ALARP is a formal framework, which comprises three components:

"1. *The upper and lower risk tolerance limit lines define three regions: the intolerable region, the ALARP region, and the broadly acceptable region.*

2. The cost/benefit gross disproportionality ratio.

3. 'FN' curves (also known as loss exceedance curves)."[48]

It is clear that ALARP contains a number of elements, such as formal tolerance regions, a cost/benefit ratio, and formal "exceedance" curves that are not part of the IWMS framework. The sole element adopted from ALARP is the concept of a tolerance threshold beyond which risk must be reduced as much as "practicable", which within IWMS is applied as technical practicability rather than unreasonable cost.

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[46] D.16-08-018; p. 9.
[47] Id; p. 60.
[48] Id; p. 62.

Q. What is the approach to risk tolerance taken in SCE's IWMS framework?

A. First, SCE states that all HFTD areas should be hardened because they are inherently risky: "*One of the primary observations in the SPD Report is that SCE can 'buy down' 85% of the ignition risk associated with its infrastructure in its WCCP and TUG proposals by spending 40% of the money SCE proposes to invest in grid hardening mitigations. Setting aside whether those particular calculations are accurate, SPD's conclusion fundamentally misses the point. In its Test Year 2021 GRC, SCE explained at length the dangers of the logical fallacy of conflating the concepts of relative and absolute risk. Because certain circuit segments in the High Fire-Threat Districts (HFTD) are relatively riskier than other certain circuit segments in the HFTD by orders of magnitude (at least from a modelling perspective), they unsurprisingly constitute the majority of the relative risk on the system.*

But that is ultimately irrelevant: the important question is how much absolute risk would remain if SPD's recommendation is accepted and SCE does not harden those remaining areas— areas that the Commission has already deemed inherently risky by designating them as part of the HFTD. It is the remaining (i.e., residual) absolute risk that is relevant, not the amount of relative risk that can be bought down by making the limited investments SPD recommends. This is an important distinction with potentially critical safety implications. Indeed, accepting SPD's recommendation would leave an unacceptably high amount of total risk – potential for thousands of customer homes and acres burned – unmitigated by system hardening."[49]

Hardening also is not enough. Expanding on SCE's previous statement about Severe Risk Areas:

"*For Severe Risk Area locations, the threat to lives and property is elevated to such an extent that SCE has determined that for public safety reasons it is prudent to not just significantly reduce ignition risk expeditiously but minimize it in the long term to the*

[49] SCE-04 Vol. 05 Pt. 1A; pp. 54-55.

extent practicable. Therefore, undergrounding is preferred unless covered conductor has already been installed or specific terrain or local issues require alternatives such as covered conductor with supplementary mitigations."[50]

So for SCE, the goal is to achieve minimum practicable risk, with the limits of practicability being technical rather than financial. This is effectively setting a "zero tolerance" policy. The Commission warns of the pitfalls of such an approach in D.16-08-018: "*Inherent in risk management is the unavoidable fact of limited resources and other constraints. Without resource constraints, an operator could simply apply an infinite amount of an infinite number of risk mitigation activities and the risks would be driven to zero. Clearly this is reduction of the argument to an absurdity. Therefore, risk management always assumes recognition of some constraints (rate shock, availability of trained personnel, and limitation of resources). And, optimization is always tied to risk tolerance. These concepts are all tied together*."[51]

Return on Equity and Perverse Incentive

Q. What is the return on equity allowed for SCE capital projects?

A. As per Decision 22-12-031, SCE is allowed to earn a return of approximately 10% on capital improvements.[52]

Q. How can the rules under which SCE earns its rate of return create a perverse incentive?

A. The Return on Equity (ROE) allowed by the Commission is intended to enable SCE to recover its costs for improvements to its infrastructure and to earn a reasonable rate of return. However, this ability also creates an incentive for utilities to choose, when

[50] Id; p. 48.
[51] D.16-08-018; p. 98.
[52] D. 22-12-031; p. 52.

given the option, a capital-intensive solution over an operational one, and a more expensive capital solution over a cheaper one. This provides a strong economic incentive for choosing undergrounding over other potential mitigations, since undergrounding is the most expensive capital-intensive wildfire mitigation.

There are other compelling financial and corporate considerations supporting undergrounding:

- Reducing wildfires reduces the utilities' financial, regulatory and reputational risks that arise from catastrophic utility wildfires.
- Reducing PSPS frequency reduces the utilities' regulatory and reputational risks that arise from frequent power shutoff.

As has been noted by corporate leaders, incentives matter:

"*Show me the incentive and I will show you the outcome*."
--- Charlie Munger

"*Incentive structures work, so you have to be very careful of what you incent people to do, because various incentive structures create all sorts of consequences that you can't anticipate*."
--- Steve Jobs

Q. What conclusions of fact can be reached regarding SCE's consequence-only approach to IWMS and its attitude to risk tolerance?

A. The acceptability of SCE's IWMS from the standpoint of the Commission's Risk-Based Decision-making Framework and SCE's attitude to risk tolerance are matters for argument that will need to be decided by the Commission, preferably in proceeding R.20-07-013 (the RDF proceeding), but also very practically in the present proceeding, since many of SCE's proposals are based on these underpinnings. However, it is possible to make the following factual observations:

- SCE's IWMS is not a risk framework because it lacks a probability component.
- IWMS is a heuristic model that is focused on identifying extreme risk situations and addressing them on an ad-hoc basis.
- The success of IWMS would depend on 1) whether SCE successfully identifies and prioritizes different types of risk and 2) is able to obtain adequate resources to address these risks.
- SCE has determined that it is in a position to determine acceptable public risk, and has set a zero-tolerance policy to the extent this is technically practicable.
- Maximizing the use of undergrounding will also maximize profits for SCE because of its guaranteed return on equity.

ASSESSMENT OF SCE'S MARS RISK ANALYSIS

Q. How does SCE's MARS risk analysis affect its General Rate Case?

A. SCE's MARS analysis forms the basis for both the wildfire component of its enterprise risk calculation and of its ranking of asset risks based on geographic location, and thereby also its prioritization and choice of mitigation. Until recently, MARS was the only basis for these decisions, but with SCE's introduction of IWMS (discussed in the next section) MARS prioritization decisions may be overridden by other considerations.

MGRA has filed extensive comment on SCE's MARS framework and its methodologies, primarily described by SCE in its annual Wildfire Mitigation Plan

Update.[53] In its analysis over the years since MARS introduction, MGRA has identified a number of biases and errors in the model. These errors and biases can lead to an over or underestimation of overall wildfire risk and distribution of wildfire risk across the landscape. The main sources of error and bias that MGRA has raised are:

- Truncation of wildfire simulations at 8 hours, leading to underestimation of risk from large fires,
- Machine learning models use annual aggregated weather data and thereby underweight extreme weather events,
- Decoupling of probability and consequence for extreme weather events underweights drivers that are correlated with extreme weather,
- Failure to incorporate risk from wildfire smoke,
- Underestimation of PSPS risks, and
- Use of historical outage and ignition data in machine learning models without correcting for PSPS outages.

Both SDG&E and PG&E's models have suffered or still suffer from these same issues. However, both SDG&E and PG&E have made some efforts to improve on a number of them. As mentioned earlier, both PG&E and SDG&E have adopted a truncated Pareto distribution (a power law) for their enterprise loss model. PG&E now incorporates PSPS damage data into its machine learning model.[54]

SCE has for the most part resisted modifying its risk model to address these issues in MARS and held to its original technical approach. However, SCE's IWMS framework in many ways "bypasses" these problems by directly addressing root causes. This will be discussed in more detail in the IWMS section. The subsections below briefly summarize

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[53] OEIS Docket 2023-2025 WMPs; Southern California Edison; 2023-2025 Wildfire Mitigation Plan; March 27, 2023; pp. 90-101. (SCE 2023-2025 WMP) TN11952-2_20230327T125844_20230327_SCE_2023_WMP_R0.pdf

[54] A.21-06-021; MUSSEY GRADE ROAD ALLIANCE OPENING BRIEF ON PACIFIC GAS AND ELECTRIC COMPANY'S 2023 GENERAL RATE CASE; November 4, 2022; p. 22.

the known issues with MARS and how they would be expected to bias SCE's risk estimation and the prioritization of its mitigations.

Limitations in Consequence Modeling

Q. What are the limitations of SCE's MARS consequence modeling?

A. The wildfire spread model used by SCE (as well as PG&E and SDG&E) is Wildfire Analyst by Technosylva.[55] Technosylva consequence modeling consists of running a "match drop" fire spread simulations using a variety of historical weather and vegetation condition records. Fire spread simulations become less accurate the longer they run, so utilities limit their fire spread simulations to 8 hours.[56]

MGRA raised issues with regard to the implications of this 8 hour fire spread since its 2021 Wildfire Mitigation Plan comments.[57] Essentially, this limitation puts a cap on the effective fire size, severely suppressing the potential for catastrophic fire spread.

MGRA has submitted filings showing the limitation of wildfire sizes for both PG&E and SCE Technosylva data, and this also illustrates the cut-off:

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[55] Ramírez, J., Monedero, S., Buckley, D., 2011. New approaches in fire simulations analysis with Wildfire Analyst, in: The 5th International Wildland Fire Conference. Sun City, South Africa. pp. 1–17. https://technosylva.com/

[56] WP SCE-04 Vol.05 Part 1A; p. 11.

[57] OEIS Docket; 2021-WMPs; MUSSEY GRADE ROAD ALLIANCE COMMENTS ON 2021 WILDFIRE MITIGATION PLANS OF PG&E, SCE, AND SDG&E; March 29, 2021; pp. 50-53. (MGRA 2021 WMP Comments)

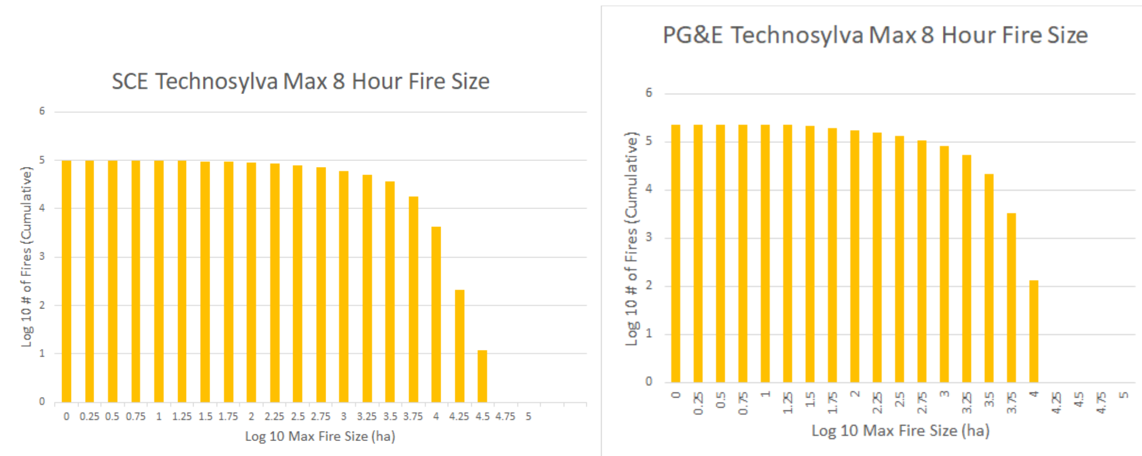

Figure 1 - Raw Technosylva simulation data was provided by SCE and PG&E in response to MGRA data requests, and the logarithm of maximum wildfire size for each set of 8-hour runs was accumulated into histograms.[58]

The danger of ignoring large fires in consequence calculations is amply demonstrated in Figure 2, which uses an identical approach to Figure 2 but calculates cumulative damage per bin.

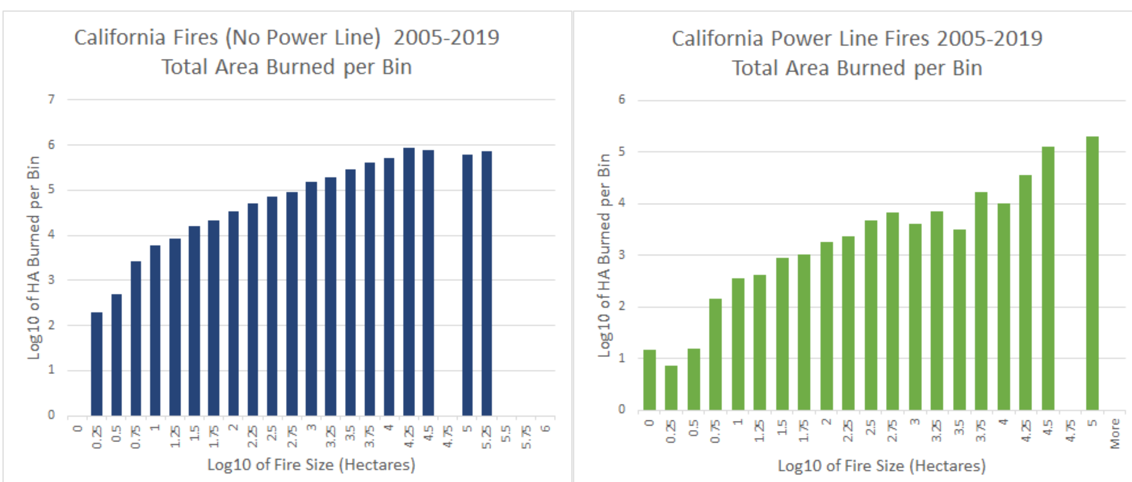

Figure 2 - Total area burned per logarithmic bin for California wildfires 2005 to 2019, calculated by multiplying logarithmic mean of bin by number of wildfires in the bin. Power line related wildfires are compared against full sample with non-power line wildfires removed.[59]

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[58] Workpapers:
Technosylva-sizes-2021WMP_ClassB_Action-PGE-15_Atch01-jwm.xlsx
MGRA_001_01_wf_acre_dist_jwm.xlsx.

[59] Supplemental workpaper perimeters_19_1.xlsx.

The cutoff in wildfire size creates a bias in the consequence model that artificially increases risk for circuits near population centers (where the potential losses are) and decreases risk in more remote areas. Accordingly, this artificially suppresses the risk of wildfires that start in a remote area where severe weather conditions are likely to occur and then spread into a large and destructive fire front that impacts the wildland urban interface.

Wildfire Smoke Effects

Q. What effect will SCE's omission of wildfire smoke risk have on its geographic and total risk assessment?

A. As noted in RAMP section, using SCE's MARS methodology and numbers obtained from recent academic studies, MGRA showed that smoke may become the predominant safety risk if a significant number of acres burn (1,600 acres using MGRA's approximation).[60] MGRA asked SCE to respond two models, one where there was one fatality from wildfire smoke for every 1,150 acres burned and one where there is one fatality from wildfire smoke for every 10,900 acres burned. These two values were determined by extrapolation from recent academic studies, as described in MGRA's comments on SDG&E's RAMP proceeding.[61] Based on this sensitivity analysis MGRA was able to derive the following relationship between safety consequence and acres burned:

$$mars\_saf\_conseq = 995/Af + .630$$

[60] MGRA RAMP Comments.; pp. 7-9..

[61] A.21-05-011-14; Safety Policy Division Staff Evaluation Report on SDG&E's and SoCalGas' Risk Assessment and Mitigation Phase (RAMP) Application Reports; November 5, 2021; MGRA Attachment
MUSSEY GRADE ROAD ALLIANCE INFORMAL COMMENTS TO THE SAFETY POLICY DIVISION REGARDING SAN DIEGO GAS AND ELECTRIC COMPANY'S RAMP FILING; pp. 5-18.

It should be noted that SCE objected to this analysis and MGRA's conclusion, listing many reasons for its objection. However, SCE does not reject the notion that wildfire smoke is dangerous and can lead to fatalities. SCE is correct that the exact magnitude of wildfire smoke health effects are at this time highly uncertain, and sources can vary across a wide range.[62] However the fact that it may be substantial means that omitting it leads to an overall underestimation of wildfire risk.

The geographic distribution of wildfire smoke damage will also be different than the geographic distribution of wildfire risk. A "more correct" methodology would require the simulation of smoke plumes in conjunction with wildfire simulations and estimation of the effect of those plumes on local populations using epidemiological data and analysis. No such analysis is currently available. However, it is possible to reasonably conclude that the omission of this effect substantially increases the uncertainty of the geographic distribution of wildfire risk.

Bias Introduced by Power Shutoff

Q. How does SCE's failure to correct for PSPS outages affect its risk estimates?

A. As noted previously, SCE does not attempt to correct for the bias introduced by including historical outage and ignition data in machine learning sets in which PSPS was operative.[63]

Power shutoff is an effective wildfire mitigation. During power shutoff, no faults, outages, or utility-related ignitions can occur. However, this also implies that there are "blind spots" in SCE's risk event history that it uses to train its risk model. The areas

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[62] Neumann, J.E., Amend, M., Anenberg, S., Kinney, P.L., Sarofim, M., Martinich, J., Lukens, J., Xu, J.-W., Roman, H., 2021. Estimating PM2.5-related premature mortality and morbidity associated with future wildfire emissions in the western US. Environ. Res. Lett. 16, 035019. https://doi.org/10.1088/1748-9326/abe82b

[63] SCE-04 Vol. 05 Pt. 1A; p. 56.

most likely to be affected by power shutoff are those that are most likely to have significant exposure to high wind conditions and high fire potential. Therefore the most dangerous areas in the SCE service territory have their wildfire risk artificially suppressed by the model.

Errors and Biases in SCE's Conductor Probability of Ignition Model

Q. How does SCE use Machine Learning to create its POI model?

A. SCE uses a machine learning model based on a "random forest" classifier that classifies whether particular variables are associated with either conductor failure (in one sub-model) or contact from object (a separate model).[64] This is a relatively common technique in machine learning. While it is different in specifics than the maximum entropy classifier used by PG&E,[65] the essential characteristics are the same: a list of potentially explanatory variables is selected, and a portion of the data is used to "train" the model. This training optimizes the selection of characteristics in such a way that the ability to successfully predict a correct result is maximized while the potential for selecting a false result is minimized. Once "trained" the model can be used to predict results based on the explanatory variables. SCE analysis shows that its model has a fairly high quality, with an "Area Under Curve" (AUC) between 0.92 and 0.95, where 1.0 would be the score for a perfect model and 0.5 would be equivalent to a coin toss.[66]

Q. What are the errors and biases in the SCE POI model?

A. The SCE POI model fails to correctly incorporate extreme weather and high winds, despite claiming to do so. The documentation states one of its base assumptions is

[64] DR Response MGRA-SCE-006-Q03; Attachment B – OH-Conductor Sub-Model: Southern California Edison (SCE); Model Documentation; Prepared for 2023 WMP Appendix B; OH Conductor Sub-Models (CFO & EFF); 3/27/23; p. B-4. (SCE OHC Model)

[65] Pacific Gas and Electric Company; 2021 Wildfire Distribution Risk Model; Last Updated 2/1/2021. (PG&E Internal Report).

[66] Op. Cite; p. B-25.

that: "*The contact types that can cause a spark will remain the same throughout the prediction period*,"[67] but in fact contact types will vary with weather conditions. Machine learning models such as random forest utilize many variables, which are then analyzed to see which variables best predict future results. SCE's POI models use a variety of weather variables in the analysis, including wind speed, rain, and humidity. SCE also calculates a bespoke weather variable it calls "downforce", which measures wind perpendicular to the wire direction.[68] However, all of these weather variables are aggregated on an annual basis and reduced to maximum, average, standard deviation, etc. So despite SCE's claim that the "*model is designed to work in both base weather and extreme weather conditions,*"[69] extreme weather conditions are averaged over a much larger sample of non-extreme weather conditions. Additionally, extreme winter and extreme fire-weather conditions are mixed together, further diluting the sample. Hence, the probability of a *catastrophic* wildfire ignition and its most probable geographic location is not determined by the analysis.

As a result, the SCE analysis indicates that weather variables are poor predictors of wildfire ignitions. Below is the POI model's estimation of equipment failure variable importance, with weather-related variables indicated by blue arrows.

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[67] SCE OHC Model; p. B-6.
[68] Id; p. B-9.
[69] Id; p. B-6.

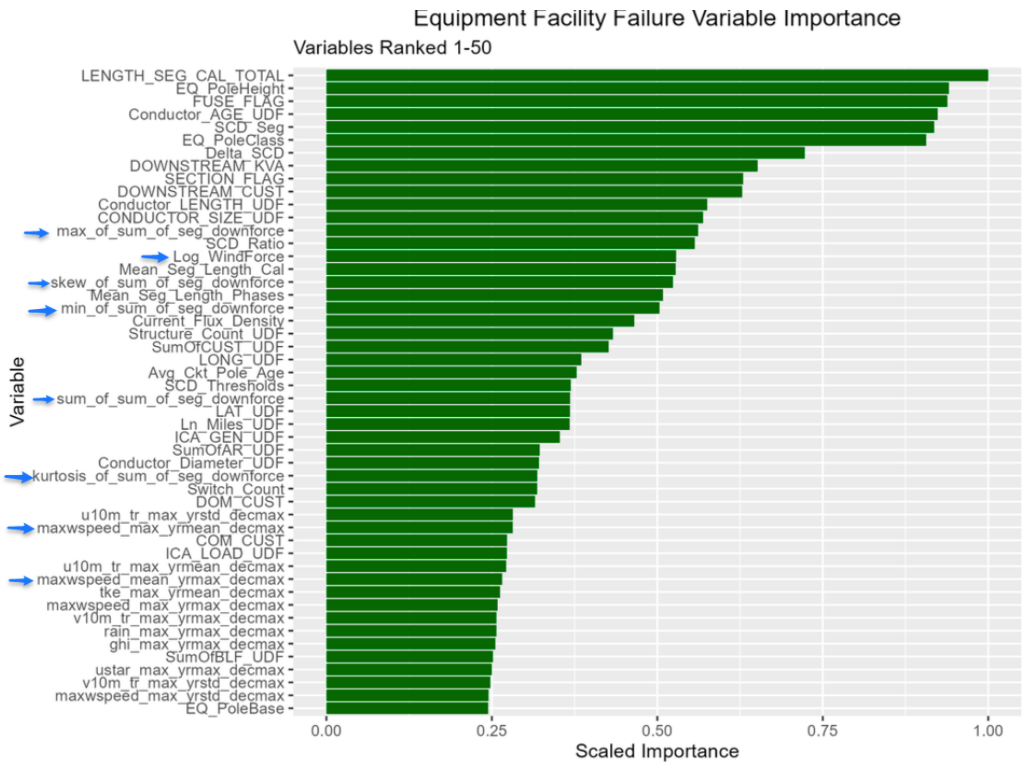

Figure 11: Variable Importance test results for EFF Conductor sub-model

Figure 3 - SCE POI model for equipment failure estimate of explanatory variable importance. Leading weather variables are indicated by blue arrows.[70]

As can be seen, the first contributing weather variable, maximum downforce, is ranked 13th, with the wind force at 15th.

The figure below shows the variables associated with contact with foreign objects, and it can be seen that weather-related variables are even smaller contributors:

[70] Id.; p. B-24.

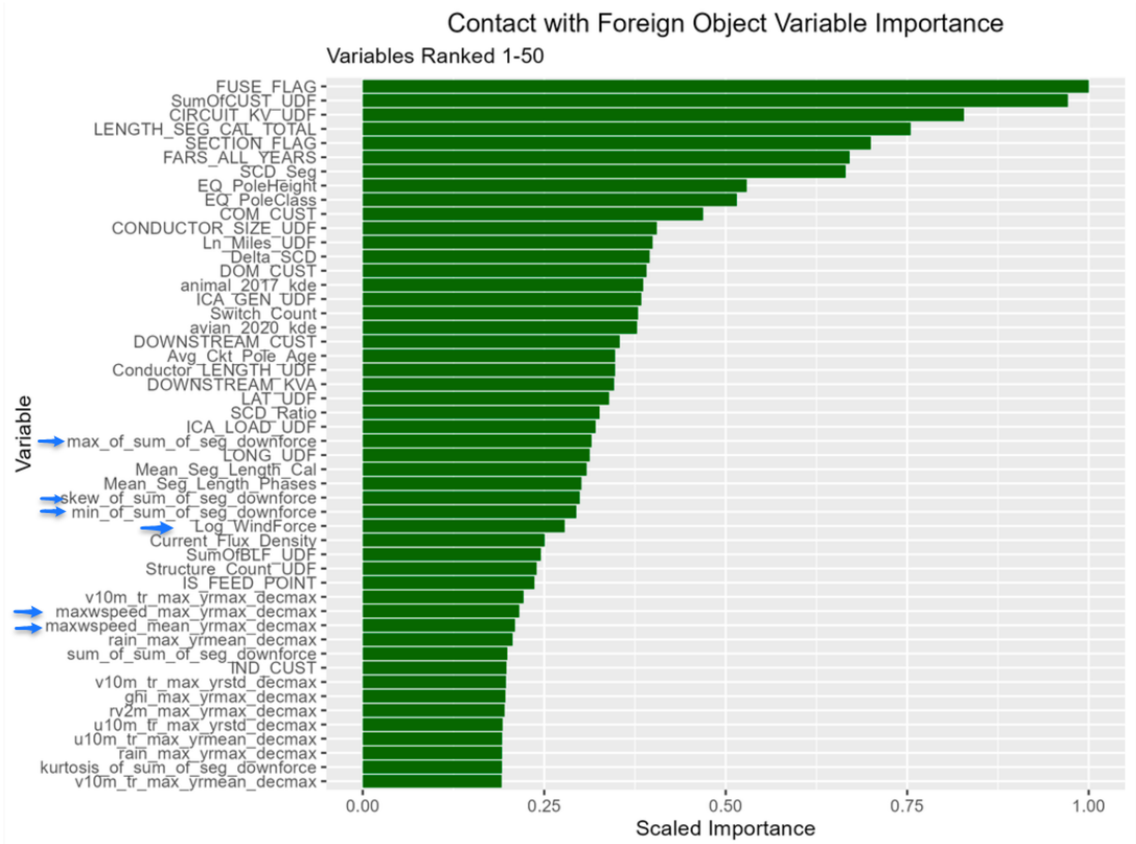

Figure 12: Variable Importance test results for CFO sub-model

Figure 4 - SCE POI model for contact with external object estimate of explanatory variable importance. Leading weather variables are indicated by blue arrows.[71]

For the external object driver, weather-related variables do not appear until the 26th entry (again, maximum downforce). When one considers how many catastrophic wildfires have occurred due to wind-driven contact of vegetation and utility equipment, this result seems absurd, but it is the inevitable result of trying to capture a transient event in an annual aggregation.

E3 consultants, hired to review PG&E's closely related MaxEnt model (with similarly suppressed effects of weather variables) reached a similar conclusion:

"*In fact, introducing the temporal dimension might be a necessity to improve the accuracy in wildfire prediction and ability for this model to interact with the PSPS*

[71] Id.

model. The current formulation cannot incorporate short but intense events. For example, PSPS calls would greatly reduce the ignition probability within a region but only for a very short time period. To properly incorporate this impact, the temporal resolution would allow either incorporation or exclusion of the events from the training data set. With temporal resolution, weather related variables such as wind might gain a more explanatory power. Annual average wind speed contributes little to ignition, but we would expect hourly wind speed would have a larger influence."[72]

The effect of this bias will be to suppress predicted risk in high wind areas and increase predicted risk outside of high wind areas.

Failure to Incorporate All PSPS Damages, and Future Shift to ICE Modeling

Q. Does SCE correctly incorporate all relevant harm caused by power shutoff?

A. For the purposes of its RAMP and GRC, SCE has created its own bespoke PSPS consequence model. For the safety component it relies on epidemiological data from historical outage events, CMI based on proactive de-energization of circuits, and a $250 cost per customer.

MGRA has made filings in a number of CPUC proceedings stating the case that current utility PSPS risk models insufficiently capture a number of elements, such as loss of communication, traffic impacts, potential for fire starts due to generator and cooking fires, and other impacts,[73] elements that IOU analyses usually lack.

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[72] MGRA SCE RAMP Comments; p. 12. Quotes:
E3 Review of PG&E's 2021 Wildfire Distribution Risk Model; May 2021; p. 37.

[73] Examples are MGRA 2022 WMP Comments; pp. 85-86;
R.20-07-013; MUSSEY GRADE ROAD ALLIANCE ADDITIONAL COMMENTS REGARDING DEVELOPMENT OF SAFETY AND OPERATIONAL METRICS; March 1, 2021; pp. 1-2.

Moving forward, CPUC Decision 22-12-027 finds that California utilities should begin to work with the ICE tool group at Lawrence Berkeley Laboratory to develop a common mechanism to determine monetized losses from de-energization.[74] This will lead to a more uniform response between utilities and will allow the special characteristics typifying wildfire-prevention shutoffs to be formally incorporated. Although apocryphal, PG&E will be using the ICE calculator for its PSPS consequences in its 2024 RAMP filing. Initial results presented at PG&E's February 7, 2024 workshop indicate that consequences from PSPS and its EPSS program may be comparable to or larger than other wildfire safety and financial risks.[75]

If SCE obtains similar results to PG&E in future filings, then the current GRC will be seen to have underestimated PSPS risk.

Biased introduced by ignoring correlation between weather and ignition drivers

Q. Why is incorporation of instantaneous wind speed important for ignition models?

A. In California in general, and even moreso in Southern California, the history of catastrophic power line fires is the story of wind-driven ignitions and wildfires. Extreme winds cause damage to equipment or nearby vegetation, the outage is more likely to proceed to an ignition under dry windy conditions, and then finally the ignition is well-poised for a rapidly spreading, difficult-to-control wildfire. This "common-cause" failure model is described in Mitchell 2013.[76]

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[74] D.22-12-027; pp. 38-41, Appendix C.
[75] Workshop held February 7, hosted by SPD. Slide presentation: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/safety-policy-division/meeting-documents/pge-ramp-prefiling-workshop-slide-deck020724.pdf
Downloaded: February 12, 2024.
[76] 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)

Q. What effects does this "common cause" failure mode have on catastrophic fire losses?

The common-cause failure mode explains the long-held observation that power line related fires are overrepresented when fire danger is high, and that these fires are more destructive than fires from other causes.[77] On the average, less than 10% of wildfires in California are caused by utility ignitions, [78] but they do inordinate harm. In California, this effect is often seen in the "Top 20" fire list that CAL FIRE publishes annually for the largest, most deadly, and most destructive fires. CAL FIRE's data from November 2022[79] shows the following:

Wildfires	Number of Electrical Caused (out of 20)	Fraction of Losses Due to Electrically Caused Wildfires
Deadliest	4	39%
Most Destructive	8	66%
Largest	3	21%

Table 1 - CAL FIRE "Top 20" deadliest (by fatalities), most destructive (by structures), and largest (by acres burned) as of November 2022 showing relative contribution of electrically ignited wildfires to total numbers and total losses. The total losses being compared to are those within the "Top 20" lists themselves, and do not include fires not ranked in the Top 20.

Q. What effect does decoupling the ignition component from the consequence component of the MAVF function have on predicted risk?

A. For ordinary MAVF risk calculations, the risk may be obtained by multiplying the

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[77] 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.

[78] D.19-04-042; p. 3. See also R.18-12-005; MUSSEY GRADE ROAD ALLIANCE COMMENTS ON PROPOSED DECISION ADOPTING DE-ENERGIZATION GUIDELINES; May 16, 2019; pp. 2-5.

[79] Mitchell, Joseph W (2023), "IAFSS_2023_JWMitchell_UtilityWildfires", Mendeley Data, V3, doi: 10.17632/8nds4cx88k.3.
https://data.mendeley.com/datasets/8nds4cx88k/3
Original documents on Cal Fire website have been removed/updated but are archived for reference purposes on Mendeley. Files are under the "CAL FIRE" folder: top20_acres.pdf, top20_deadliest.pdf, and top20_destruction.pdf.

inverse frequency of a risk event by the consequence of the risk event, and the probability and the consequence can be treated independently. However, if the probability and the consequence are *correlated*, for instance if they arise from a common risk driver (such as high winds in the case of power line fires), this correlation must be accounted for in order to yield a valid result for the risk calculation.

For its consequence model, SCE uses Technosylva's Wildfire Analyst simulation. Simulations are run with weather data from a portfolio of "worst case" wildfire days (444 days as of SCE's 2023 WMP submission).[80] This selection optimizes computing resources by only running simulations for days during which significant fire growth would be possible, but it incorrectly assumes that the probability of ignition for all drivers is uncorrelated with the weather. Some types of outage are much more likely during severe weather, such as vegetation contact and equipment damage, while other types of outage from "external agents" such as vehicles, balloons, animals, vandalism, and aircraft are not affected by extreme weather. Running all types of outage through the risk calculation without adjusting for the conditional probability of outage will result in an artificial amplification of risk associated with drivers that are <u>uncorrelated</u> with extreme weather. All three utilities introduce this bias into their planning models. PG&E, in its 2021 RAMP, adopted an MGRA suggestion to include only risk events occurring during National Weather Service Red Flag Warning days. This produces a profoundly different risk profile, as shown in the table below:

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[80] SCE 2023-2025 WMP; p. 140.

Ignition Driver	Percentage		
	SDG&E	SCE	PG&E (RFW)
Vehicle	17	7	
Balloon	17	13	
Veg Contact	15	11	59
Other Contact	8	6	4 (all external)
Animal	5	13	
Wire Contact	3	5	1
Vandalism	2	5	0
Equipment	33	42	33

Table 2 - Percentage of enterprise ignition risk represented by different risk drivers as per SCE and SDG&E's 2022 Wildfire Mitigation Plans.[81] PG&E's enterprise risk analysis[82] is limited to National Weather Service Red Flag Warning (RFW) days. All PG&E external agent contact (vehicle, balloon, animal, other) is listed under "Other Contact".

Table 2 demonstrates that SCE and SDG&E risk analyses predict large contributions from external agent contact (39% for SCE and 47% for SDG&E), while PG&E expects only 4% of its risk from external agents during Red Flag Warnings. This difference results entirely from the failure to include the conditional probability that a particular driver will occur on a "worst case" weather day in utility risk calculations.

Q. How does the artificial amplification of risk from "external agents" affect utility risk estimates?

A. In addition to artificially amplifying risk from certain drivers, thus increasing all wildfire risk, the geographical distribution of risk from certain drivers is not the same. Vegetation risk, vehicle risk, animal risk, and high wind areas will not have the same geographical distributions. It therefore follows that certain segments and circuits will

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[81] OEIS-Docket 2023-22025-WMPs; 2020-2022 WILDFIRE MITIGATION PLAN UPDATE; San Diego Gas & Electric Company; February 11, 2022; p. 46. (SDG&E 2022 WMP) OEIS-Docket 2022-WMPs; Southern California Edison Company; 2022 WILDFIRE MITIGATION PLAN UPDATE; FEBRUARY 18, 2022. (SCE 2022 WMP)

[82] OEIS-Docket 2022-WMPs; PACIFIC GAS AND ELECTRIC COMPANY; 2022 Wildfire Mitigation Plan Update; February 25, 2022. (PG&E 2022 WMP)

have true risk scores that differ substantially from those predicted by those predicted with a "worst case" wind bias, potentially leading to improper mitigations and prioritization.

To illustrate this point, I have analyzed major utility fires from SCE[83] (>100 acres) and PG&E (> 500 acres)[84] between 2015 and 2020, binning them into "Agent" and "Non-Agent" drivers. These were analyzed with a Pearson Chi-squared goodness of fit (with/without Yates correction) to compare them against the distribution that would be expected based on expected likelihoods for different drivers.[85]

Driver	Observed	Expected	Chi2	Yates
Non-Agent	31	24.09	1.98	1.71
Agent	4	10.91	4.38	5.03
Total	35	35	6	7
P - Chi2	0.01168126			
P - Yates	0.00943576			

Table 3 - Statistical analysis of combined SCE and PG&E ignition data binned into Agent (balloon, 3rd party, vehicle, and Non-Agent (vegetation, equipment) to improve statistical power. Probabilities were calculated with the Excel function CHISQ.DIST.RT, using 2 degrees of freedom.[86]

The conclusion that can be reached is that major utility fires, do not follow the same statistical pattern with respect to cause that would be expected from driver ignition rates averaged over time.

[83] Mitchell, Joseph W (2023), "IAFSS_2023_JWMitchell_UtilityWildfires", Mendeley Data, V3, doi: 10.17632/8nds4cx88k.3
https://data.mendeley.com/datasets/8nds4cx88k/3 (Mitchell Mendeley data)
DATA/SCE Ignitions 2015-2020 - 001. c Amended_2015-2020 CPUC Reportable Ignitions - jwm 22.xlsx

[84] OEIS Docket 2022-WMPs; Pacific Gas and Electric Company 2022 Wildfire Mitigation Plan Response to Revision Notice, June 27, 2022; pp. 1-13.
TN11043_20220627T144350_PGE_30Day_Revision_Notice_Responses.pdf

[85] Note that in this case, PG&E data was not limited to Red Flag Warning days but instead represented unfiltered ignition probability.

[86] Mitchell Mendeley data; Data/IgnitionRiskRankings_v2_2208.xlsx

Summary of MARS Risk Analysis and Implications

Q. How would you characterize SCE's MARS risk model?

A. With MARS, SCE takes a quantitative approach to risk calculation that is compliant with the terms of the Settlement Agreement. As shown in this section, however, there are numerous biases and errors in a number of the elements making up MARS. These errors and biases vary in their net effect, but overall likely lead to an underestimation of risk, especially in areas prone to high wind and extreme fire weather. SCE has taken issue with a number of points raised by MGRA during the course of the Wildfire Mitigation Plan reviews and the RDF proceeding. In part, these objections arise from SCE's resistance to including elements in its model that are poorly known – for example wildfire smoke effects, wildfire growth after 8 hours, and the bias introduced by PSPS. SCE's reluctance to introduce additional uncertainty into its models is understandable, however by not doing so it ignores major and perhaps dominant contributions to risk, creating a model that is perhaps "more precise" but at the same time "more wrong".

Q. What are the implications of MARS issues for the GRC?

A. MARS formed the original basis of SCE's wildfire safety spending priorities. It determines which mitigations will be chosen and how circuit segments will be prioritized. It is used to prioritize SCE's covered conductor plan. When "risk scores" and "risk buydown" is presented, it is based on the MARS risk model. Nevertheless, SCE's testimony devotes little attention to MARS, since most of its attention is currently focused on its Targeted Undergrounding program (TUG), and TUG prioritization is based on SCE's IWMS framework, discussed in the next section. MARS remains, however, SCE's only quantitative model that calculates risk and allows direct comparison between different mitigations. SCE has developed additional mechanisms to estimate relative consequence for IWMS but these do not contain a probability component, and thus it is not possible to directly compare these risks or rank circuits in priority order. To the extent that IWMS contributes new techniques, these should be quantified, associated with a probability, and incorporated into the MARS framework for future WMPs and GRCs.

In the meantime, MARS scores should be considered to be a gauge of risk, but to be approximate and subject to error and bias. As described in the next section, IWMS addresses a number of the biases in the MARS model, but does so in a heuristic rather than quantitative manner. For the purposes of the current GRC, IWMS classifications should be considered in combination with MARS risk rankings to determine the optimal level of risk reduction, spending, and choice of mitigation.

SCE'S INTEGRATED WILDFIRE MITIGATION STRATEGY (IWMS)

Q. What is SCE's IWMS framework?

A. SCE's IWMS (Integrated Wildfire Mitigation Strategy) is a framework[87] for assessing which mitigations to apply for circuits. SCE uses IWMS as an alternative to MARS to apply more stringent mitigations in areas that meet certain criteria. These criteria include:

- Areas where egress is constrained, there is a high frequency of wildfire, and where fires are likely to burn-in to the area,
- Areas where 8 hour Technosylva simulations burn areas over 10,000 acres,
- Areas with winds gusting over 58 mph (which SCE designates alternatively as "high" or "extremely high" wind locations,[88]
- Infrastructure near what it calls "Communities of Elevated Fire Concern" (CEFCs), which are areas that could be subject to a rapidly moving fire, such as hilltop communities above canyons with dense vegetation.[89]

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[87] SCE0405P01; pp. 17-40.
[88] Id; p. 28.
[89] Id; p. 30.

These areas are designated Severe Risk Areas (SRAs). SCE has specified that undergrounding is its preferred mitigation for SRAs, with covered conductor, preferably with REFCL, as the alternative if undergrounding is impractical.[90] IWMS also includes a "High Consequence Area" designation if Technosylva simulations of an unsuppressed wildfire grow to between 300 and 10,000 acres.[91] Covered conductor plus REFCL is SCE's preferred mitigation for High Consequence Areas.[92]

A schematic of SCE's IWMS decision process is shown below:

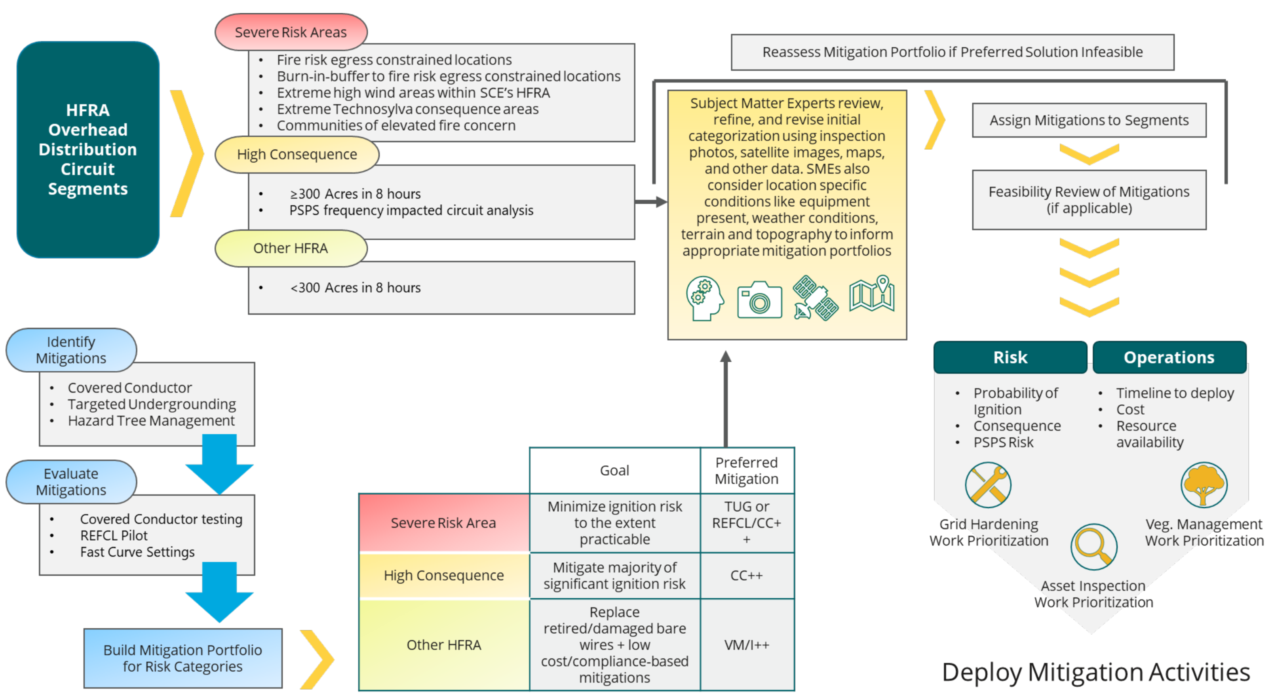

Figure 5 - Diagram of SCE's IWMS framework

An example map showing SCE's IWMS categorizations in the area surrounding Los Angeles is shown below:

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[90] Id; p. 42.
[91] Id; p. 33.
[92] Op. Cite.

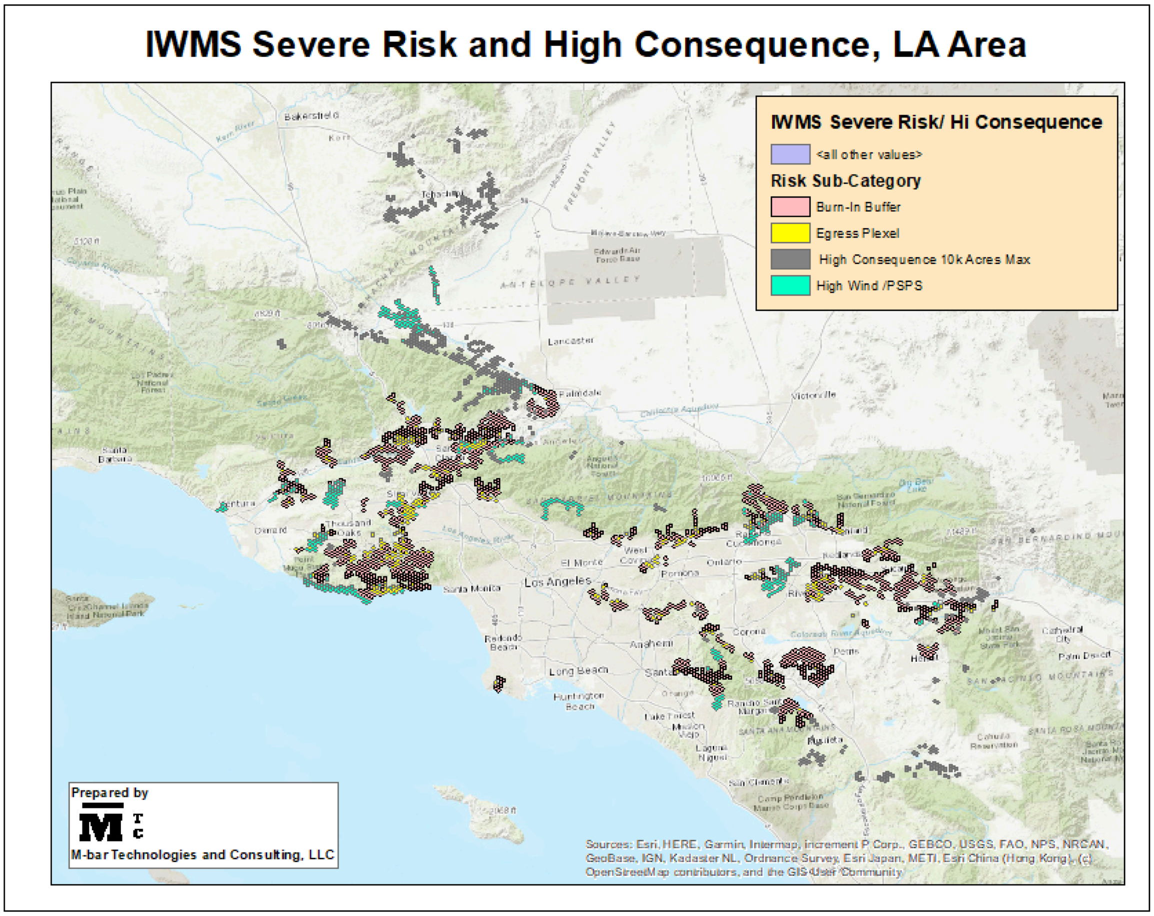

Figure 6 - SCE's designated Severe Risk and High Consequence areas, showing areas near previously unmitigated high wind circuits (blue), areas with limited egress (yellow) into which wildfires can rapidly burn (rose), and areas with a potential for a large fire (grey).[93]

[93] DR Response MGRA-SCE-003-Q3-6.

The way that these classifications are applied at the distribution level is indicated in the map below:

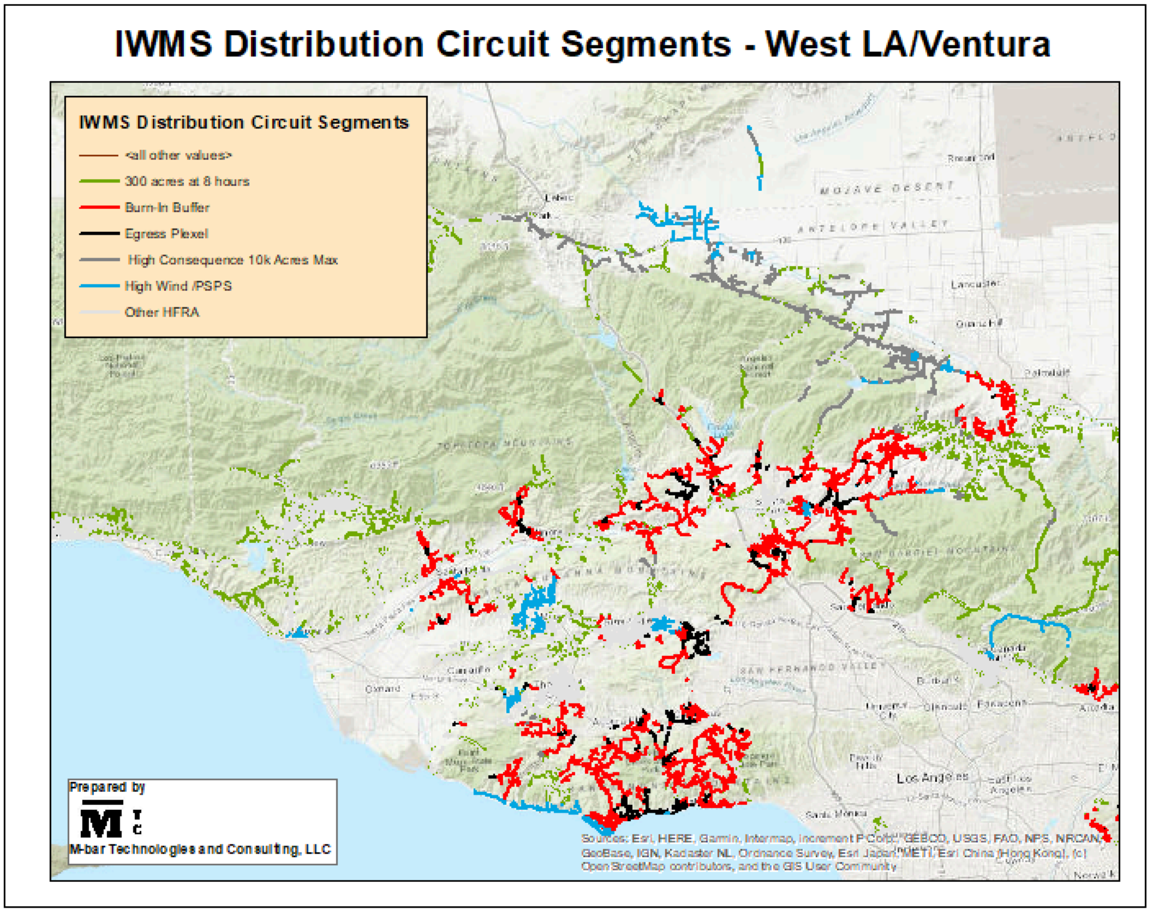

Figure 7 - SCE's designated Severe Risk and High Consequence areas as they are applied to distribution circuits, showing previously unmitigated high wind circuits (blue), circuits within areas with limited egress (black) or into which wildfires can rapidly burn (red), and areas with a potential for a large fire (grey).[94]

The maps above do not show communities of elevated fire concern. These are shown separately in the map provided by SCE:

[94] DR Response MGRA-SCE-003-Q3-8.

MGRA-SCE-003: 3-10.a-c
Page 2 of 2

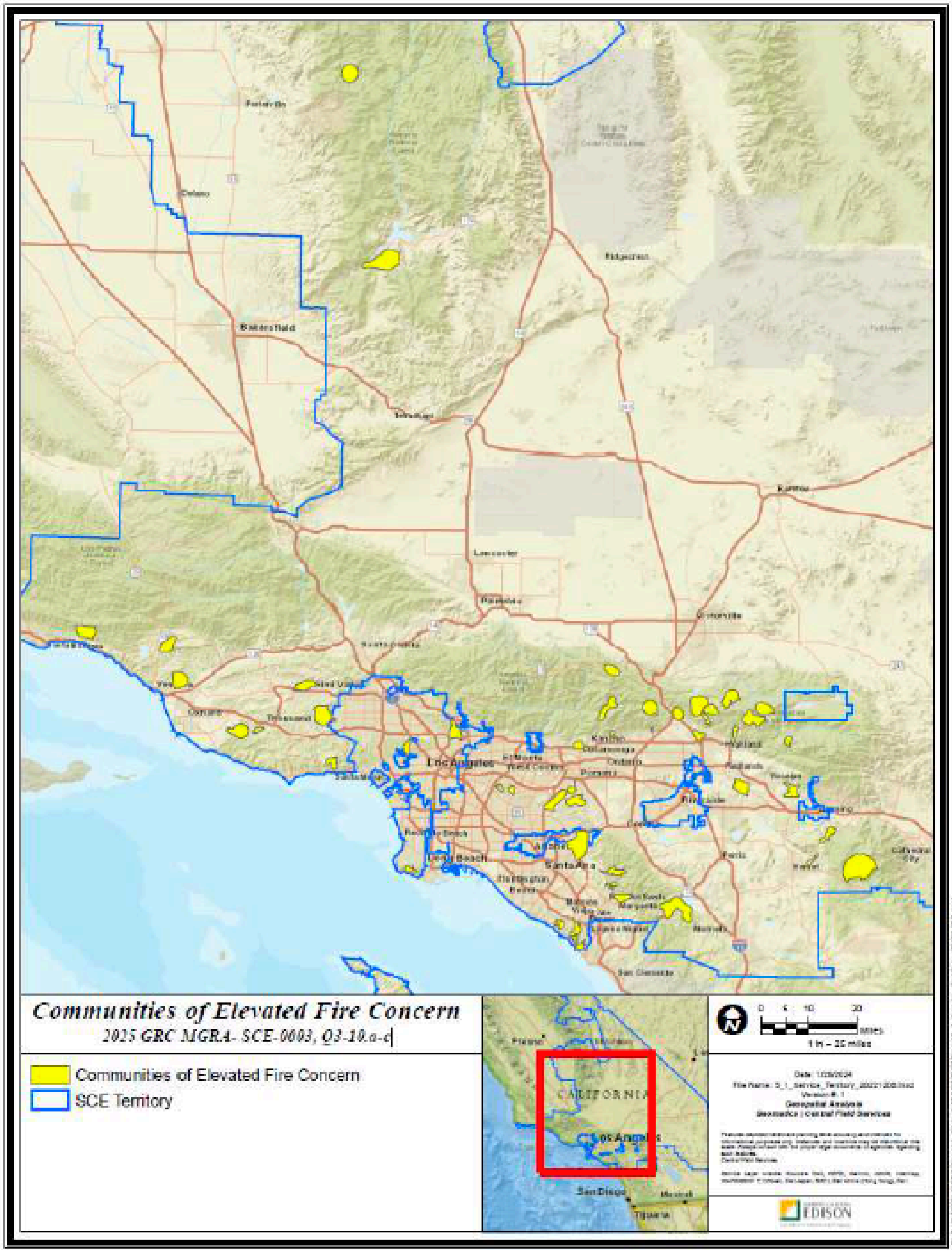

Figure 8 - SCE's Communities of Elevated Fire Concern, highlighted in yellow.[95]

[95] DR Response MGRA-SCE-003-Q3-10.

Q. Is IWMS a risk model?

A. No. As described previously, IWMS does not contain a probability component, only a consequence, and therefore cannot be considered a risk model.

Q. What are the issues with SCE's IWMS approach?

A. SCE's IWMS model has a number of issues that make it non-transparent and non-quantitative, and therefore problematic as an approach to risk:

- As detailed in the Risk Management and Policy section,[96] IWMS is not compliant with the Risk-Based Decision-Making Framework.
- IWMS classifications, specifically the selection of threshold criteria and final review, are based on SME judgement,[97] and thus are prone to irreproducibility and personal bias.
- The IWMS identification classes use different measures for ranking, and therefore cannot be compared with each other in a quantitative manner in order to rank risk.
- IWMS and MARS cannot be directly compared, since they are entirely different approaches to assessing priority and mitigations.
- SCE makes an artificial link between preferred mitigation and the IWMS model, declaring TUG preferred mitigation for Severe Risk Areas. This is not an inherent characteristic of IWMS classifications themselves, but rather an arbitrary choice on the part of SCE.

Q. What are the benefits of SCE's IWMS approach?

A. IWMS applies a broad brush approach of addressing all circuits that meet certain consequence criteria. It is a heuristic rather than quantitative method and in its own way

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[96] p. 14.
[97] SCE-04 Vol. 05 Pt. 1A; p.41.

bypasses a number of the inaccuracies and biases of the MARS model. Rather than putting work into improving the MARS model and reprioritizing mitigations, IWMS adopts a "just go fix it" approach to known sources of risk that are hard to quantify. There is something attractive about this tactic and its pragmatism. However, one needs to seriously consider the limitations listed in the previous section.

Because the IWMS categories are orthogonal to the MARS risk calculations they can cover issues that MARS biases may introduce. These are detailed in the table below, which describes the known MARS bias and the IWMS category or categories that help to reduce the impact of that bias:

MARS Bias	Net Effect	Geographic	IWMS Category	Comment
PSPS removes outages/ignitions	Underweight risk	Underweight high wind areas	High Wind Locations	Compensates for bias by mitigating all HW areas
8 hour wildfire simulation limit	Underweight risk	Overweight areas close to ignition. Underweight distant population centers.	High Consequence	Compensates for bias by mitigating all catastrophic fire spread potential
Failure to incorporate correlation between ignition and wind	Mixed	Areas with wind-related drivers underweighted, other areas overweighted.	High Wind Locations	Compensates for bias by mitigating areas with more wind-related drivers.
Wildfire smoke health effects not included	Underweight risk	Complex. Greater near wildfire but significant elsewhere.	High Consequence	Will reduce bias, since generally smoke impacts correlate with wildfire size
PSPS risk underestimated	Underweight risk	Underweight high PSPS risk areas.	High Wind Location	Bias will be reduced by reducing overall number and scope of PSPS events through mitigation.

Table 4 - Effect of IWMS mitigations on known biases in the MARS risk model.

One reason that IWMS mitigations can have a significant effect is that the fraction of unhardened conductor in SCE's system has been significantly reduced over their multi-year covered conductor program. This makes a "brute force" approach more effective because prioritization is no longer as important as it was when the hardening initiative was beginning and the time frame was longer.

Q. How should MARS and IWMS be used in the future?

A. Theoretically, the optimal way to move forward in future GRCs is to accurately quantify and incorporate additional risks identified by IWMS into the MARS risk model. Practically, SCE's hardening program is nearly complete so from the hardening standpoint this would be a moot exercise. However, SCE will continue to make improvements to mitigations such as deployment of additional advanced technologies such as REFCL, so having an accurate risk model may help to determine whether these mitigations are cost effective and help to prioritize locations for deployment.

Q. Are SCE's IWMS category criteria correct and optimized?

A. In general, SCE's IWMS category criteria are arbitrary and chosen based on SME input, even if the classification itself is automated. It is therefore hard to say whether or not they are correct. Comment on specific IWMS categories is found in the following sections.

IWMS High Wind Locations

Q. How does IWMS designate "High Wind Locations"?

A. IWMS identifies areas with "*extremely high wind speeds*",[98] or alternatively: "*Locations, which if fully covered with covered conductor, would still be subject to high PSPS likelihood*."[99] Technically, SCE's designation applies to areas that "*have experienced high sustained wind speeds above 40 mph and wind gusts above 58 mph (current PSPS de-energization threshold for fully covered isolatable conductor segments)*."[100] However, SCE adds in a footnote that: "*This may change as SCE modifies thresholds based on further analyses and data over time*."[101]

[98] SCE-04 Vol. 05 Pt. 1A; p. 17.
[99] Id.; p. 21.
[100] Id; p. 28.
[101] Id.

The actual circuits that SCE has designated as being in high wind locations are shown in the figure below, with data provided in a response to an MGRA data request. Additionally Figure 9 shows the weather stations that SCE associates with these circuits. MGRA also requested wind speed exceedance data collected between 2018 and 2023 from those weather stations, i.e. the number of measurements (taken every 10 minutes) in which the wind gust speed exceeds a given value. Figure 9 shows weather stations for which the mean annual number of wind gust measurements above 58 mph is greater than 1.0 by larger blue circles, and weather stations for which the mean annual number of gust measurements is less than 1.0 by smaller green circles. Circuits are indicated by magenta lines, and the remainder of SCE's weather stations are indicated by black dots.

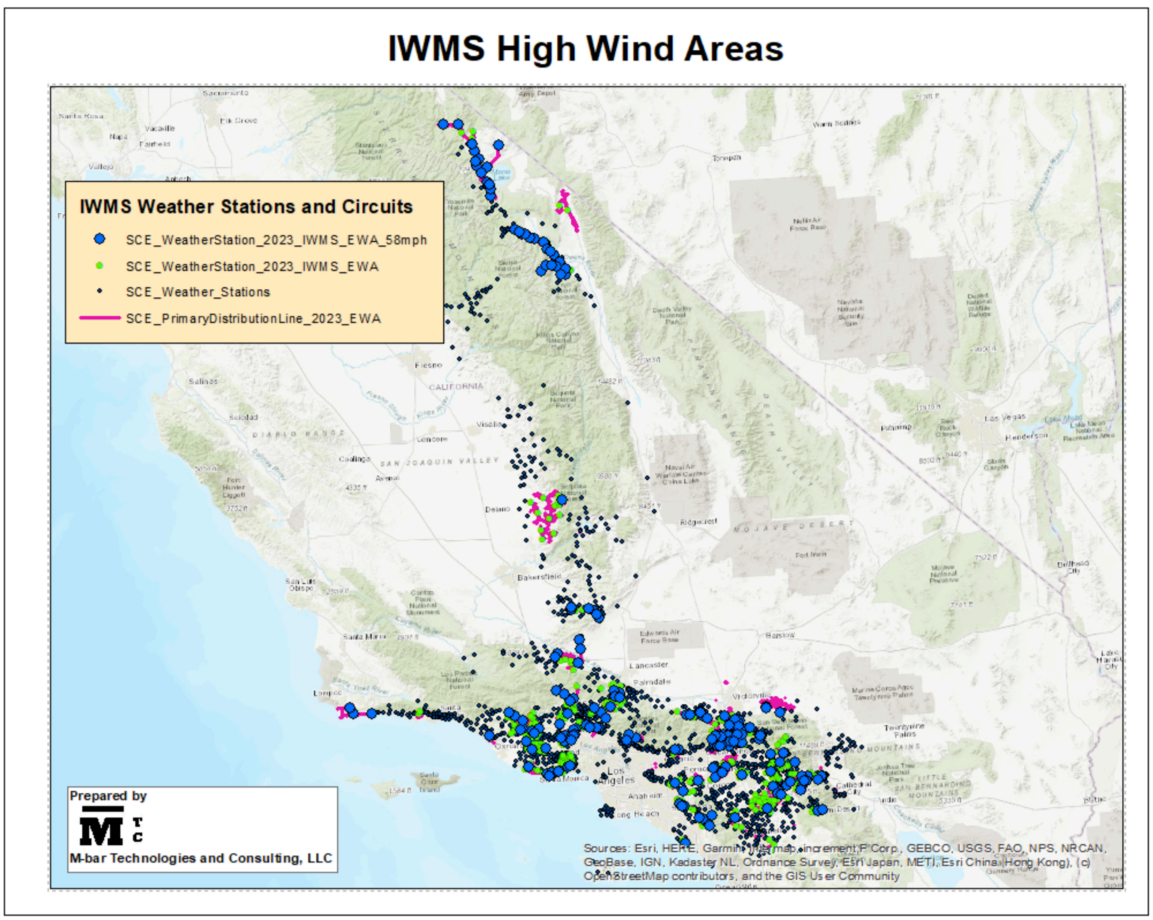

Figure 9 - Circuits in Severe Risk Areas designated as "High/Extreme Wind". The circuits are designated by magenta lines. Weather stations associated with these circuits are shown by small green dots

(exceedance of measurements over 58 mph / year < 1.0) or larger blue dots (exceedance of 58 mph / year > 1.0). Small black dots are SCE weather stations outside of IWMS-designated high wind areas.[102]

Q. Are SCE's designated high wind criteria consistent with weather station data?

A. Some portion of SCE's weather station data is consistent with a 58 mph gust threshold. On most of the circuits designated by SCE as high wind location there are corresponding weather station data measurements showing wind gusts in excess of 58 mph, although there are also often many other weather stations in which wind gusts do not exceed this threshold. There are two anomalous circuits. The Sagehen circuit in Benson Valley in the northern part of SCE's territory is measured by two weather stations, neither of which shows high wind speeds. The Jordan circuit northeast of Bakersfield is measured by 16 weather stations, only one of which shows moderate gust readings.

Of course, surface measurements represent only one point along the circuit, and the fact that existing weather stations do not measure excessive gusts does not necessarily mean that gusts of higher magnitude don't occur somewhere on the circuit. However, it is interesting that so many of the weather stations monitoring "high wind locations" (304 out of 496) do not measure gusts over 58 mph more frequently than once per year. SCE should re-examine its "high wind" designation in light of surface wind data.

Q. How would raising the threshold for PSPS affect the number of "high wind" events and impact PSPS extent and duration?

A. Based on the wind gust exceedance data provided by SCE,[103] it is possible to show that raising the threshold would drastically reduce the number of stations affected, and the time during which they are affected. This serves as a proxy for PSPS shutoffs:

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[102] DR Response MGRA-SCE-005-Q2.
Workpaper MGRA-SCE-005_Q1-WindGustFrequency – jwm.xlsx

[103] Id.

The greater the extent of the wind-affected area, and the longer the duration of winds above threshold the more impactful a PSPS will be. Likewise, a long, intense wind event will affect more weather stations (geographic extent) and for a longer time (more measurements collected over threshold. The Figure below indicates the effect of raising the exceedance threshold to 65 mph.

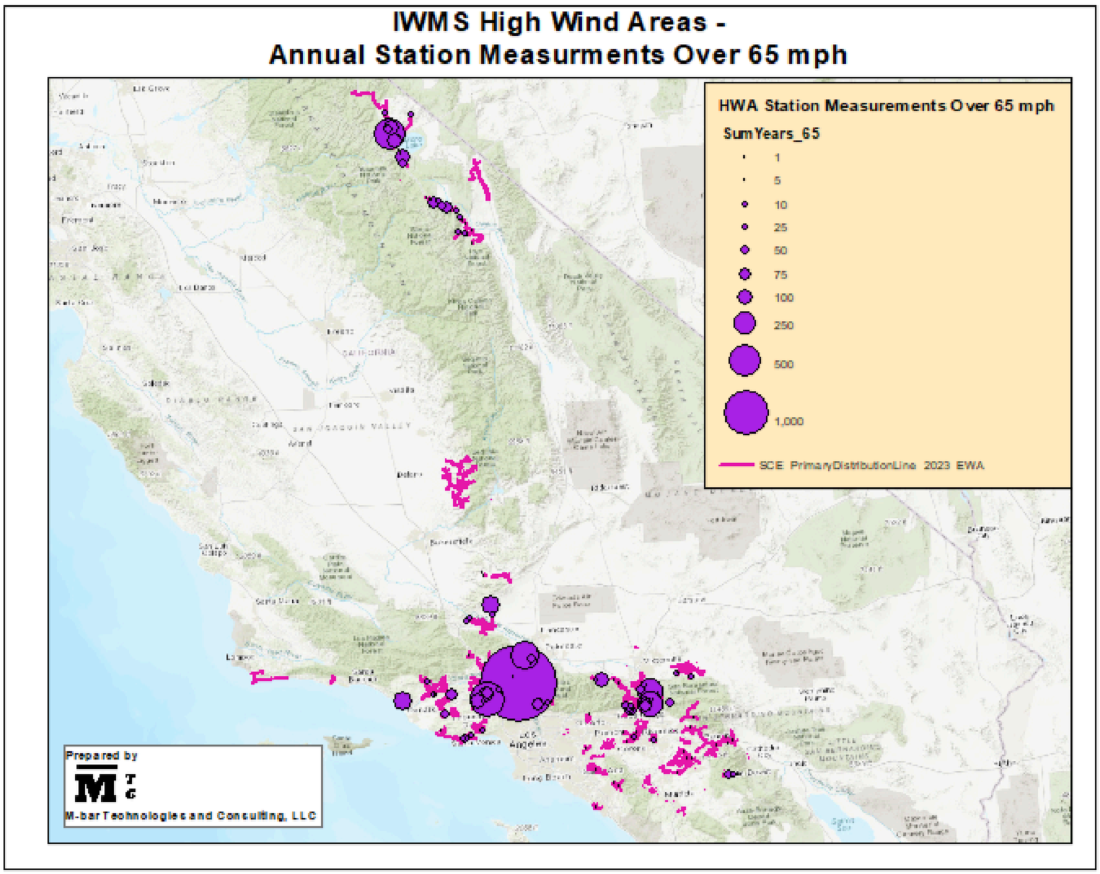

Figure 10 - IWMS "High Wind Location" circuits and weather stations that have a mean number of wind gust measurements above 65 mph greater than 1.0. Circles are proportional to the mean number of measurements per year measured by the station. Circuits designated as “high wind location” are shown by magenta lines.[104]

What Figure 10 makes evident is that high wind locations as measured by ground stations are 1) localized to certain areas and regions, 2) highly variable in the number of

[104] DR Response MGRA-SCE-005-Q2, and
Workpaper MGRA-SCE-005_Q1-WindGustFrequency – jwm.xlsx

exceedance measurements they will experience 3) do not experience significant gusts above 65 mph.

Raising the threshold for PSPS to 65 mph for instance, might make it unnecessary to perform further mitigation (such as TUG) on circuits such as Jordan, Concepcion, Tecolote, Taiwan, and others, with the expectation that these circuits would rarely experience PSPS events. Other circuits such as Tahquitz, Galahad, and Birchim would experience some PSPS events, but greatly reduced in frequency, scope, and duration. Locations in the Santa Monica mountains and Simi Valley, in contrast, are often exposed to wind gusts over 65 mph, so more stringent mitigation such as TUG should be prioritized on circuits such as Energy, Shovel, Sand Canyon, and Penstock.

The number of exceedance measurements drop sharply with threshold, and therefore so would the potential extent and duration of required PSPS events. This effect can be seen int the following table, which shows aggregated weather station data for all of SCE's IWMS "High Wind Location" zones.

Number of Stations	**Gust Threshold (mph)**	**Annual Count**
	58	250
	65	150
	70	92
	84	22
Measurements above threshold		
	58	5922
	65	2137
	70	1045
	84	126

Table 5 - Effect of wind gust threshold on number of weather stations exceeding threshold and total number of measurements over threshold.[105]

[105] Id.; Tab "Plots"

Recommendations:

- The "High Wind Location" IWMS categorization is overly broad and arbitrarily sets a threshold at 58 mph, which is by no means an "extreme" wind value in Southern California.
- Using weather station data to validate ground wind speeds indicates some circuits designated as "high wind" may not even be regularly experiencing the 58 mph threshold. These circuits should be reviewed and possibly removed from this classification.
- Because SCE is still evaluating raising its PSPS threshold for covered conductor, permanent, expensive solutions such as TUG should not be applied for circuits for which a raise in threshold would lead to a substantial drop in the number, duration, and extent of PSPS events.
- On the other side, weather station data can be used to validate areas that do have extreme weather and help to prioritize circuits for prompt significant mitigation of TUG or CC+REFCL.
- SCE should be required to continue to study the impacts of raising thresholds, using damage events identified in post-PSPS inspections as proxies in order to validate the safety of raising thresholds.

Limited Egress Areas

Q. Is limited egress to communities a valid concern that should be incorporated into utility wildfire risk models?

A. Yes. Ingress and egress are issues that have significant bearing on wildfire outcomes. Ingress is important to allow emergency responders to access wildfire sites in a timely manner and can affect whether a wildfire is effectively controlled or becomes larger. Egress can be even more important if communities are unable to evacuate from an approaching wildfire threat. The worst recent mass casualty events from wildfire, the burning of Paradise in the Camp fire and destruction of Lahaina on Maui were greatly exacerbated by lack of effective evacuation. So it is entirely appropriate that utilities incorporate egress in their wildfire models and prioritize areas prone to limited egress for mitigation.

Q. Does SCE's IWMS egress model adequately prioritize egress issues?

A. Yes. SCE incorporates egress into both its IWMS as a classification and into its MARS RSE by calculating a "multiplier" based on an egress score.[106] SCE was the first utility to attempt to develop a metric for measuring and comparing the relative egress risks of different areas. It does so by:

- Comparing density of roads to population and assigns scores on a 1-9 scale (rp)
- Comparing frequency of historical wildfires and assigns scores on a 1-9 scale (wf)
- Creating a multiplier scores [Fire Risk Egress] = 1 + (rp X wf) / 81

Egress score is used as a classification criterion for the Severe Risk Areas used in IWMS. SCE adds an additional "burn in buffer" to identify equipment locations where an ignition could burn into a Fire Risk Egress Constrained Area before safe evacuation can occur.[107]

While I am familiar with no research that would validate that SCE's approach is actually proportional to risk, SCE distinguishes itself by being the first California utility to even attempt to quantify egress risk.

[106] SCE-04 Vol. 05 Pt. 1; p. 14.
[107] SCE-04 Vol. 05 Pt. 1; p. 26.

SCE WILDFIRE RISK MITIGATION

Effectiveness of SCE Wildfire Mitigation

Q. How effective does SCE estimate its wildfire mitigation efforts have been to date?

A. SCE, like other California utilities, has had its infrastructure linked to the ignition of catastrophic wildfires. Among these have been the Thomas fire[108] (2017, 1,300 structures destroyed or damaged,[109] and 23 dead in subsequent mudslides[110]) and the Woolsey fire[111] (2018, 2,000 structures destroyed or damaged and 3 fatalities[112]).

In 2018, SCE developed its MARS risk analysis to quantify risk in a manner required by the S-MAP framework.[113] Additionally, in 2018 SCE conceived a plan to install over 6,200 miles of covered conductor in high fire risk areas.[114] That plan has since been carried out and SCE plans to continue it through 2025, when its efforts will primarily switch to undergrounding.[115] These mitigation efforts have been accompanied by other improvements such as improved vegetation management, adjustments to fault sensitivity (Fast Curve or FC), and development of new technologies such as REFCL, Open Phase Detection, and Electronic Fault Detection, and of course PSPS, which is both a risk and mitigation. By the end or 2023, SCE had deployed CC in over half of its HFRA. According to SCE MARS risk calculations, this has led to a significant drop in overall risk, as shown in the figures below.

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[108] https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/safety-and-enforcement-division/investigations-wildfires/sed-investigation-report---thomas-fire---redacted.pdf
[109] https://www.fire.ca.gov/incidents/2017/12/4/thomas-fire
[110] https://news.caloes.ca.gov/remembering-the-montecito-mudslides-two-years-later/
[111] https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/safety-and-enforcement-division/investigations-wildfires/sed-investigation-report---woolsey-fire---redacted.pdf
[112] https://www.fire.ca.gov/incidents/2018/11/8/woolsey-fire
[113] SCE-04 Vol. 05 Pt. 1A; p. 15.
[114] Id.; p 19.
[115] SCE-04 Vol. 05 Pt. 2A; p. 29.

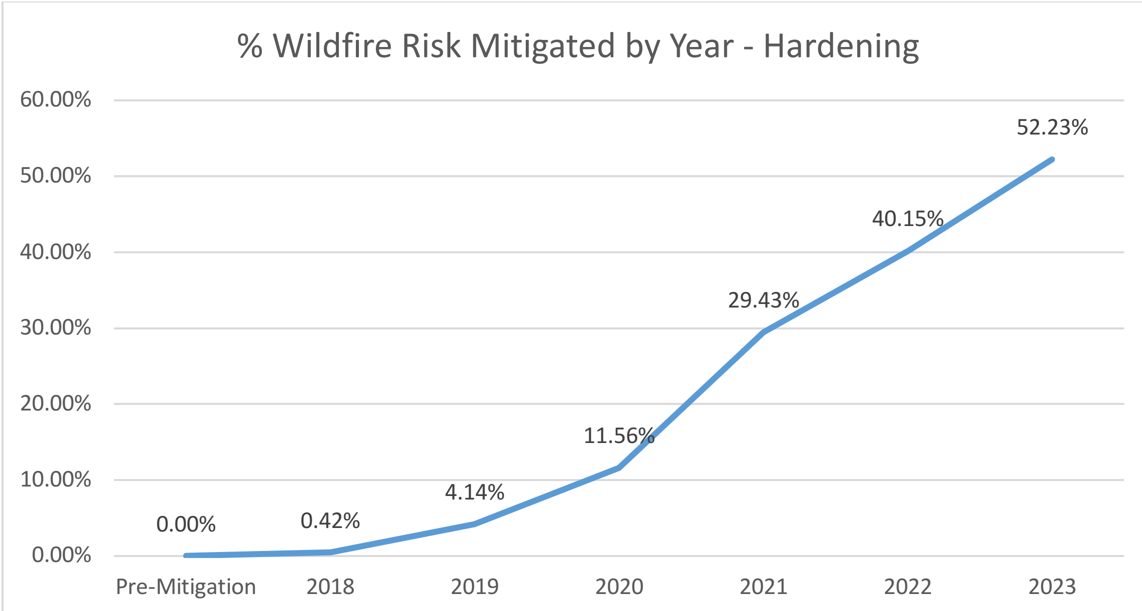

Figure 11 - SCE's MARS wildfire risk calculations based on its estimate of the effectiveness of covered conductor and undergrounding, compared to a 2017 baseline.[116]

As described in the risk analysis section (p. 44), there are many issues with the MARS risk model. Some biases lead to overestimation and others to underestimation of wildfire risk. Nevertheless, SCE claims that its hardening program has managed to reduce wildfire risk by 50% in the seven years since its initiation. However if we include other mitigations, the results are even better:

[116] DR Response MGRA-SCE-002-Q2;
Workpaper 2-2_MGRA-SCE-002_Q2-BuyDown-jwm.xlsx.

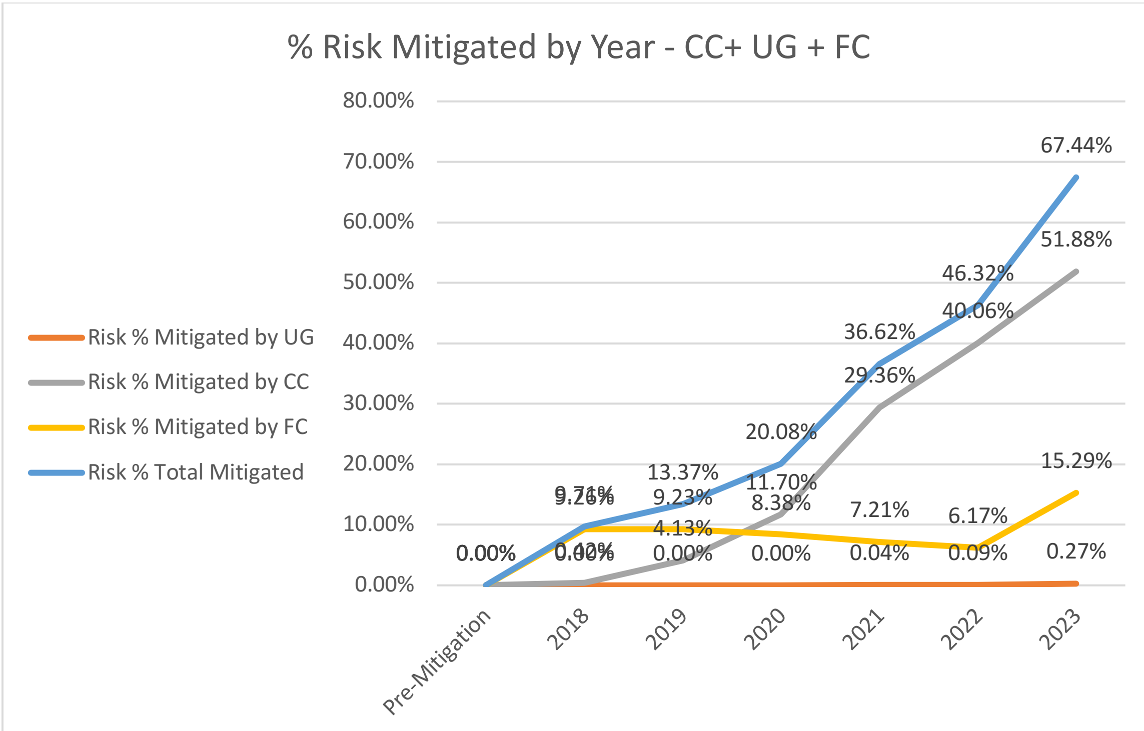

Figure 12 - SCE MARS estimated risk reductions from 2017 to 2023 broken down into covered conductor, undergrounding, fast closing, and total.[117]

According to SCE's analysis, if Fast Curve is taken into account, approximately 2/3 of the pre-mitigation 2017 wildfire risk has been mitigated by SCE actions to date. The greatest contribution, about 52% , comes from the introduction of covered conductor, a smaller part being played by Fast Curve, and a very small role played to date by undergrounding. It is important to note that these mitigations do NOT include:

- SCE's vegetation management program, which it claims is 33-36% effective in reducing ignitions from vegetation,[118]
- Distribution asset ground inspections, which can be 50%-87% effective for certain drivers,[119]

[117] DR Response MGRA-SCE-002-Q2;
Workpaper 2-2_MGRA-SCE-002_Q2-BuyDown-jwm.xlsx.
[118] SCE 2023-2025 WMP; Appendix F7: Joint IOU Covered Conductor Working Report; Table CC-6; p. 897.
[119] Id.

- Power shutoff, which is 100% effective in reducing wind-related ignitions in targeted high-wind areas
- Advanced technologies such as Early Fault Detection, Rapid Earth Fault Current Limiter (REFCL), and Open Phase Detection (DOPD) which are entering limited use in the SCE system.

SCE estimates that vegetation ignition risks are reduced by 99% when covered conductor, asset inspections, and vegetation management mitigations are combined.[120]

Taking these other mitigations into account, and even given the uncertainties associated with its risk models, it would not be unreasonable to assert that SCE has lowered the wildfire risk of its system by an order of magnitude since it intensified its wildfire mitigation efforts in 2017.

Q. Have SCE's efforts been successful in eliminating catastrophic wildfire to date?

A. At least two catastrophic wildfires have been alleged to be related to SCE equipment since 2020. The Bobcat fire was alleged to have been started by tree contact with a bare 12 kV conductor.[121] The Fairview fire has been alleged to have resulted from contact between a conductor and a communication line under windy conditions, according to a news outlet with access to the confidential Cal Fire investigation report.[122]

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[120] Id; p. 897.
[121] CALIFORNIA PUBLIC UTILITIES COMMISSION; Safety and Enforcement Division; Electric Safety and Reliability Branch; Incident Investigation Report E20200915-03; August 31, 2022;
https://www.cpuc.ca.gov/-/media/cpuc-website/industries-and-topics/documents/wildfire/staff-investigations/sed-bobcat-fire-investigation-report.pdf
SED found no GO-95 violations, however the US government is suing for damages:
Vives, R., 2023. U.S. sues Edison and tree contractor over Bobcat fire. Los Angeles Times.
https://www.latimes.com/california/story/2023-09-02/u-s-sues-sce-and-tree-contractor-over-bobcat-fire-damages
[122] Bloxsom, I., January 19, 2024. Cal Fire Report Provides More Information on 2022 Fairview Fire [WWW Document]. NewsData, LLC. URL

While publicly available information does not state whether the equipment involved in the Fairview fire was hardened, covered conductor is considered to be 99% effective in preventing wire-to-wire contact.[123] Hence we can conclude that recent catastrophic wildfires with alleged association with SCE equipment likely occurred on unhardened portions of its infrastructure.

Hardening

Q. What part does hardening play in SCE's rate case and mitigation program?

A. As shown in the table below, if SCE's current revenue request is approved it would spend over $6 billion on capital expenditures on hardening between 2023 and 2028, the majority of which would be due to its undergrounding program:

Activity	2023 - 2028 Capital Expenditure Forecast (Nominal $000s)
Covered Conductor	$2,641,485
Targeted Undergrounding	$3,341,235
Other	$301,061
Total	**$6,283,781**

Table 6 - SCE's projected capital expenditures based on the current application, broken into activities.[124]

As can be seen, capital expenditures outside of hardening would be less than 5% of the total.

Q. What is SCE's Schedule for Hardening?

A. SCE proposes to shift its spending from its current covered conductor program to its undergrounding program in the next few years. This is demonstrated by its proposed revenue plan for both programs.

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https://www.newsdata.com/california_energy_markets/regional_roundup/cal-fire-report-provides-more-information-on-2022-fairview-fire/article_e801d596-b667-11ee-88c5-77978cedd97e.html (accessed 2.21.24).

[123] See Table 8.

[124] DR Response MGRA-SCE-003-Q3-5.

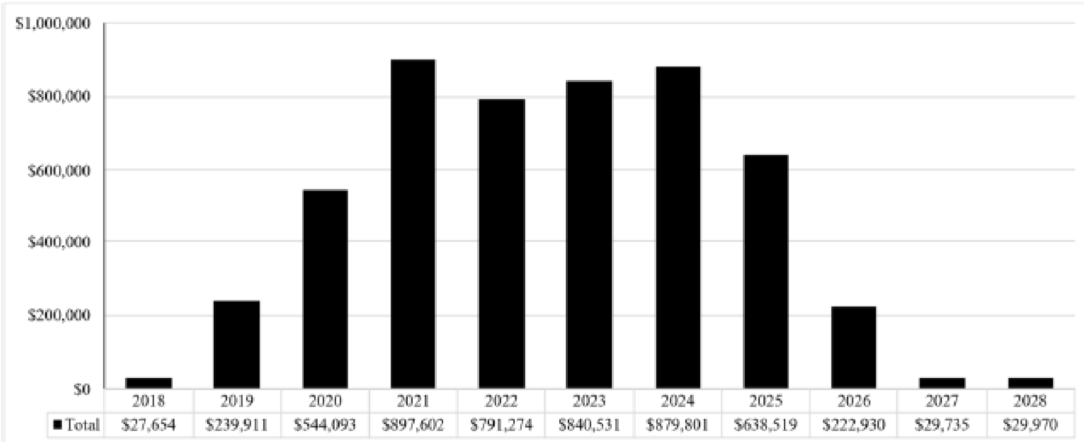

Figure 13 - SCE Figure I-6, showing its proposed spending on its covered conductor project through 2028.[125]

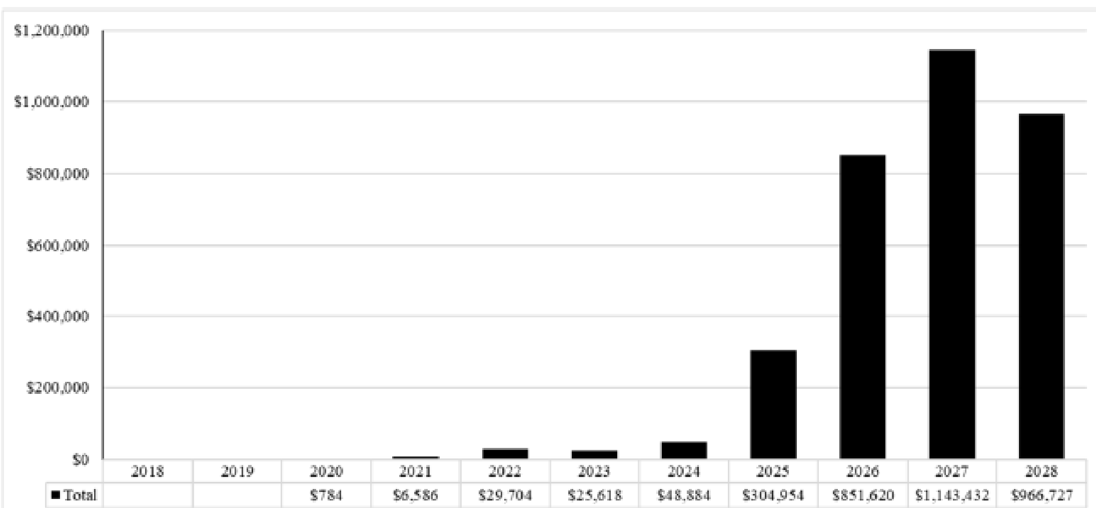

Figure 14 - SCE proposed spending on its Targeted Undergrounding Program through 2028.[126]

In general, SCE's planned WCCP deployments appear to be more extensive and target foothill areas and isolated areas such as Paso Robles and Catalina Island.

[125] SCE-04 Vol. 05 Pt. 2; p. 30.
[126] Id.; p. 6.

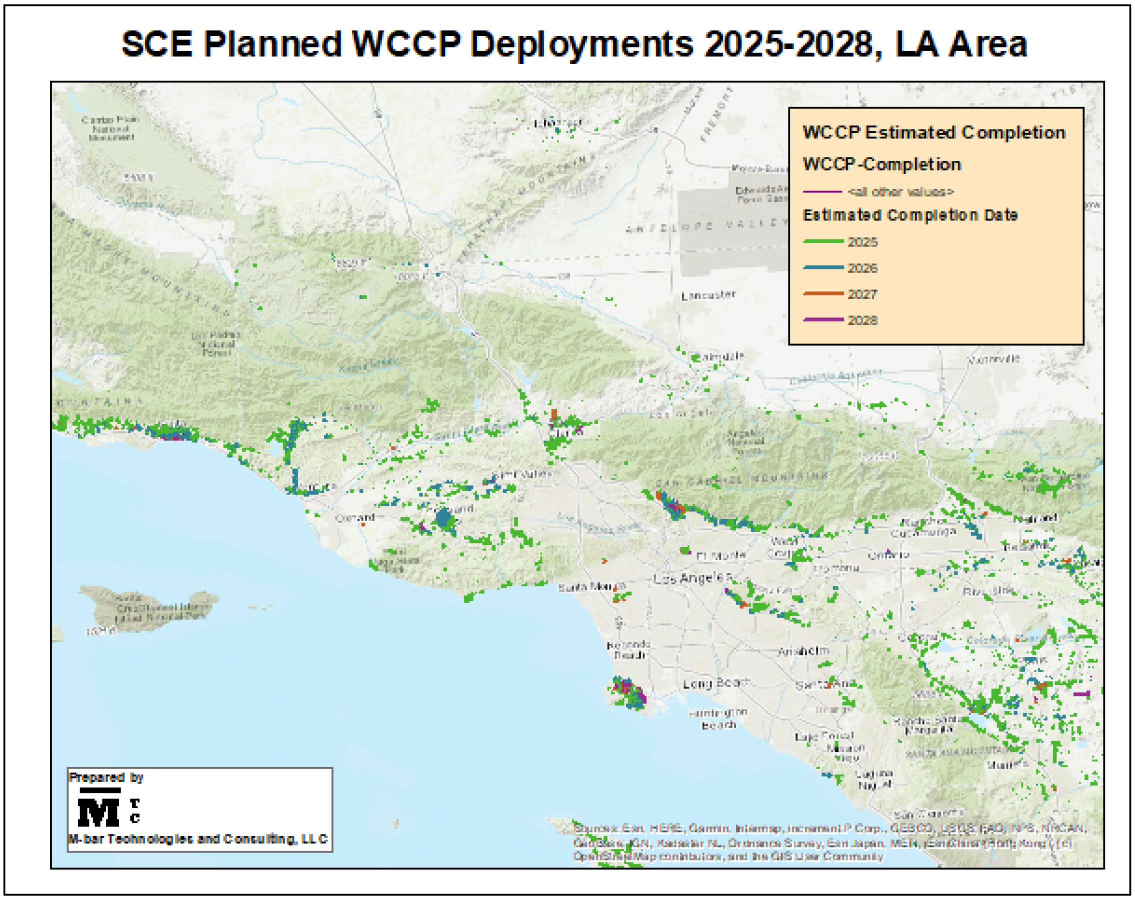

Figure 15 - Map of SCE's planned WCCP deployment[127] between 2025 and 2028. Planned completion dates are color coded, with 2025 being green and 2028 being purple.

SCE's deployment of undergrounding is more limited, more likely to be in mountainous terrain, and would be extensively deployed in the Malibu area.

[127] DR Response; PubAdv-SCE-338-MGN-Q4 (geodatabase).

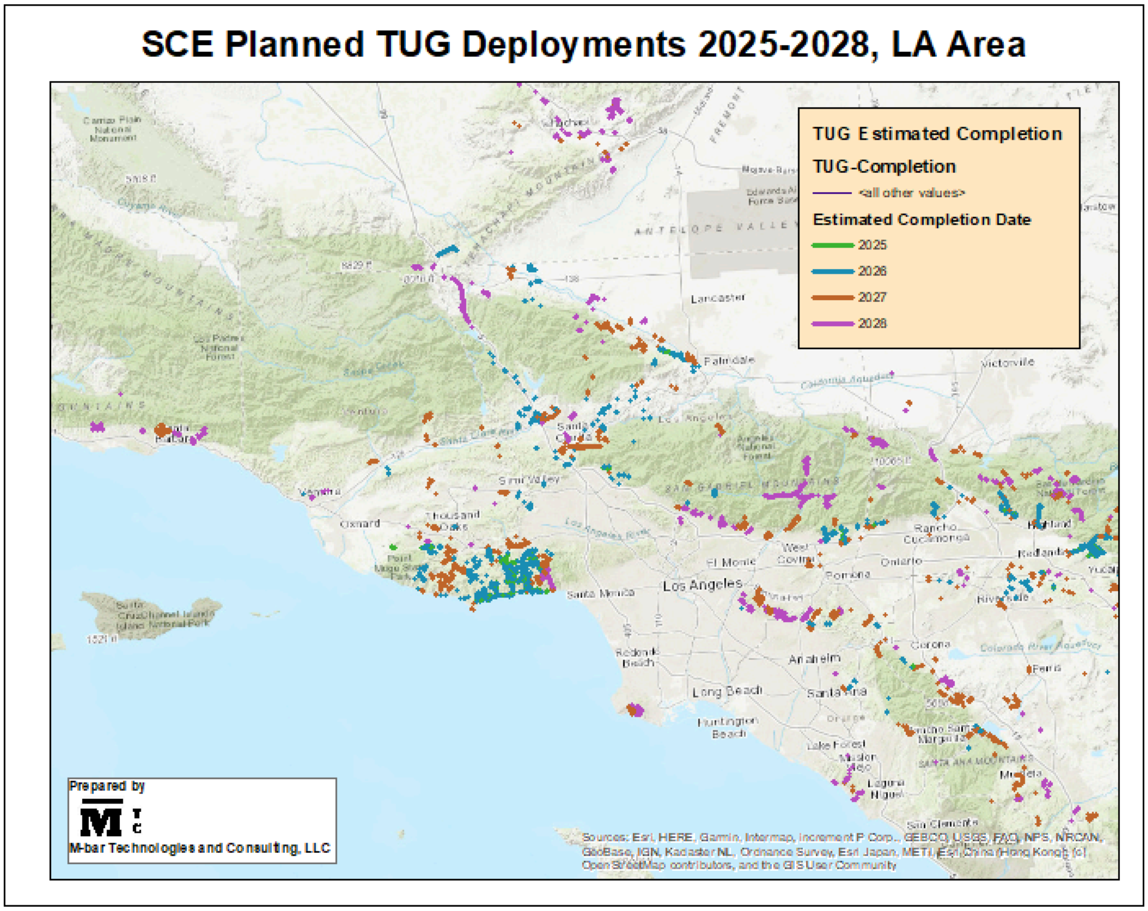

Figure 16 - Map of SCE's planned TUG deployment[128] between 2025 and 2028. Planned completion dates are color coded, with 2025 being green and 2028 being purple.

Covered Conductor

Q. What is Covered Conductor and how does it help prevent wildfire ignitions?

A. "Covered Conductor" refers to distribution lines for which the conductor is covered by protective coatings. Specifically in SCE's case these are a semiconducting plastic covering the conductor itself, a thick layer of low density polyethylene (XL-LDPE), and on the outside a layer of high density polyethylene (XL-HDPE) that is resistant to abrasion, tracking, and UV.[129] Covered conductor is an effective insulator and helps to prevent wildfire drivers in which a conductor comes in contact with and external

[128] Id.
[129] SCE-04 Vol. 05 Pt. 2A; p. 33.

object – vegetation, animals, balloons, other conductors, and reduces potential points of ground contact for downed conductors.

Q. What is the history of SCE's covered conductor program?

A. SCE began deploying covered conductor in its HFRA in 2019, and by the end of 2023 over half of the conductor mileage in its HFRA was covered, as shown in the table below:

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

Table 7 - Deployment of SCE covered conductor between 2019 and 2023. Weight shows the relative amount of covered conductor deployed in any given year.[130]

Q. How has SCE rapid installation of covered conductor affected its overall wildfire risk?

A. SCE' indicates that SCE's installation of covered conductor has reduced its residual risk to well less than half of what it what in 2017, according to its MARS model, as shown in the subsequent figure:

[130] DR-MGRA-SCE-002-Q2 (Excel)

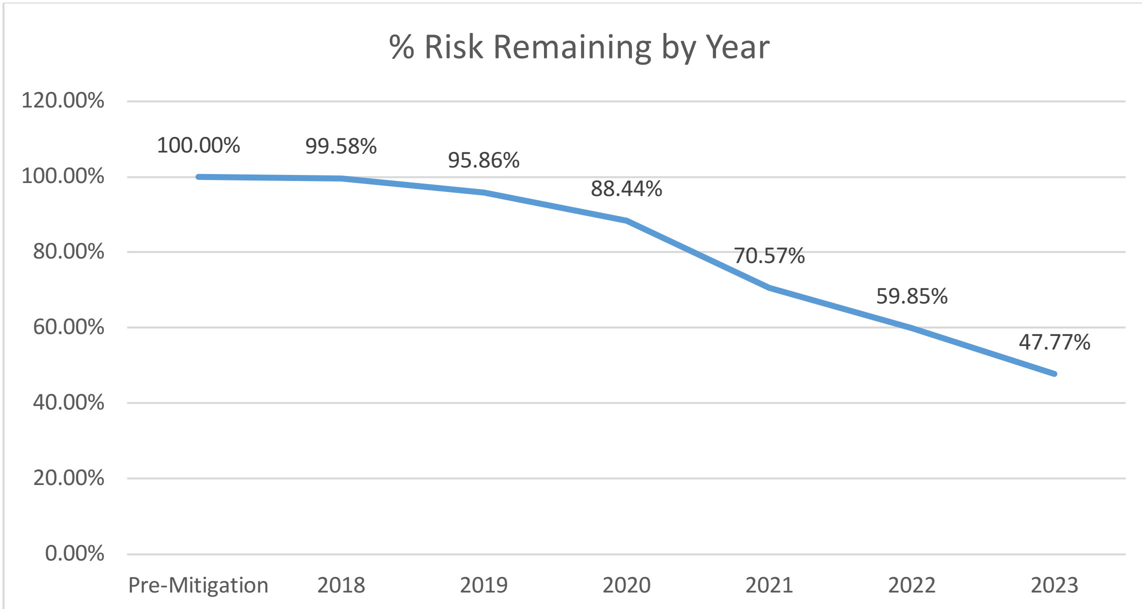

Figure 17 – SCE's estimate of remaining risk after apply covered conductor and Fast Circuit Setting s FCS, using its MARS risk analysis frameworks.[131]

Q. What is SCE's claimed effectiveness of mitigating wildfire ignitions for covered conductor?

SCE calculates that the effectiveness of covered conductor as a wildfire mitigation varies between 60% and 90% depending on risk driver, with an overall effectiveness of 72%.[132] The CC effectiveness for different drivers used in SCE's RSE and risk ranking are given in its workpapers:

WCCP	
Driver	**Mitigation Effectiveness**
D-CFO-Veg. contact - Distribution	71%
D-CFO-Animal contact - Distribution	65%
D-CFO-Balloon contact - Distribution	99%

[131] DR Response MGRA-SCE-002-Q2;
Workpaper 2-2_MGRA-SCE-002_Q2-BuyDown-jwm.xlsx.
[132] SCE-04 Vol. 05 Pt. 2A; p. 41.

D-CFO-Vehicle contact - Distribution	82%
D-CFO-Unknown contact - Distribution	81%
D-UNK-Unknown - Distribution	65%
D-CFO-Other contact from object - Distribution	77%
D-WTW-Wire-to-wire contact / contamination	99%
D-EFF-Anchor / guy damage or failure - Distribution	0%
D-EFF-Conductor damage or failure - Distribution	90%
D-EFF-Connection device damage or failure - Distribution	90%
D-EFF-Connector damage or failure - Distribution	90%
D-EFF-Crossarm damage or failure - Distribution	50%
D-EFF-Fuse damage or failure - Distribution	2%
D-EFF-Insulator and bushing damage or failure - Distribution	90%
D-EFF-Lightning arrestor damage or failure - Distribution	0%
D-EFF-Other - Distribution	15%
D-EFF-Pole damage or failure - Distribution	0%
D-EFF-Recloser damage or failure - Distribution	5%
D-EFF-Splice damage or failure - Distribution	90%
D-EFF-Tie wire damage or failure - Distribution	0%
D-EFF-Voltage regulator / booster damage or failure - Distribution	0%
D-CTM-Contamination - Distribution	0%
D-EFF-Capacitor bank damage or failure - Distribution	0%
D-EFF-Switch damage or failure - Distribution	2%
D-EFF-Transformer damage or failure - Distribution	20%
D-EFF-Tap damage or failure - Distribution	0%
D-EFF-Sectionalizer damage or failure - Distribution	0%
D-OTH-All Other - Distribution	0%
D-UTW-Utility work / Operation - Distribution	0%

Table 8 - SCE estimates for the efficiency of covered conductor as a wildfire mitigation for various risk drivers.[133]

SCE claims to have obtained these estimates from laboratory testing conducted by Exponent and Kinetics as part of its activity in the "Joint IOU Covered Conductor Working Group".[134]

Q. Are SCE's estimates compatible with its observed number of outages?

A. In the joint report on covered conductor presented in SDG&E's 2022 WMP, SCE presented experimental data regarding the effect of covered conductors on faults that demonstrated that fully covered circuits reduce 69% of the faults. Figure 18 below shows that fault rates dropped from 0.204 faults per mile with bare conductor to .081 faults per mile for circuits that are completely covered. This is a 60% decrease and roughly compatible with the SME estimates.

[133] DR Response TURN-SCE-007-Q1b-Revised; WP SCE-04 Vol. 05 Pt. 1 - WCCP-UG-RSE_Amended

[134] SCE-04 Vol. 05 Pt. 2A; p. 40-42.

Figure 8: SCE Faults on HFRA Circuits in 2021

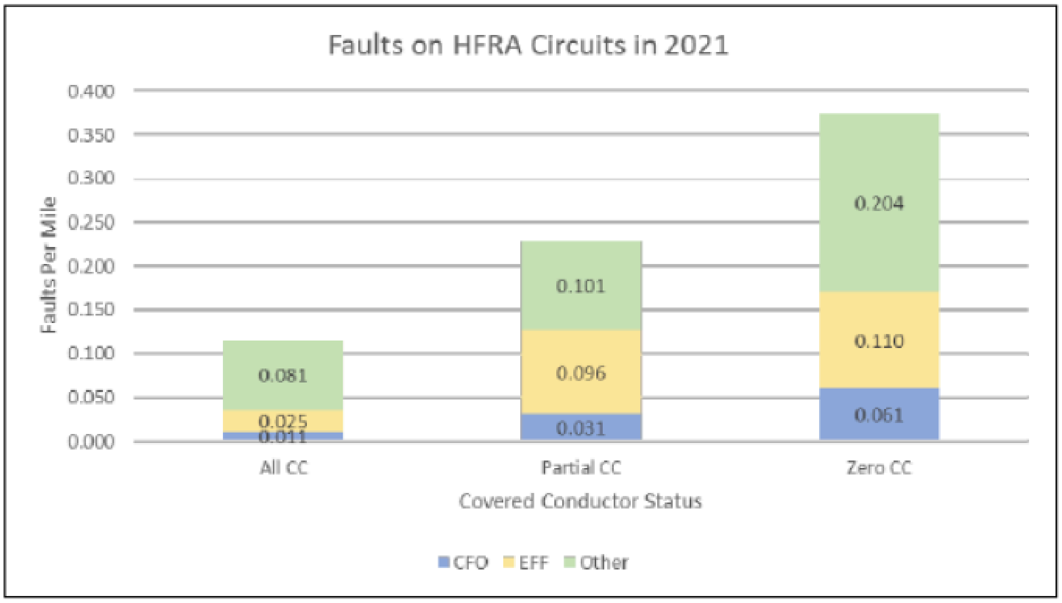

Figure 18 - SCE faults on HFRA circuits for circuits with, without, and partially with covered conductor. CFO is "contact from object" and EFF is "electrical facility failure"[135]

Q. Are SCE's estimates for its covered conductor effectiveness accurate?

A. Based on SCE field data, ignition rates are significantly lower than would be expected for a 72% net mitigation effectiveness compared with bare wire.

SCE has been collecting data on downed conductor and ignitions for its bare wire and covered conductor circuits since its hardening program began. The results for ignitions and additional analysis are shown in the table below:

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

	2019	2020	2021	2022	2023	**Total or Wtd Avg**
Bare Wire Reportable Ignitions	37	49	46	36	15	**183**
Covered Conductor Reportable Ignitions	0	1	2	5	3	**11**
BW Ignitions / mile-yr	0.0040	0.0058	0.0065	0.0063	0.0033	**0.0052**
CC Ignitions / mile-yr	0.0000	0.0007	0.0007	0.0012	0.0005	**0.0008**
Reduction %		87.2%	89.3%	81.5%	83.6%	**85.0%**
Expected CC ignitions	1.5	7.8	18.7	27.0	18.3	**73.3**

Table 9 - Reportable ignitions on bare wire and covered conductor circuits for the period 2019 to 2023. Aggregated results are also shown.[136]

As can be seen, over the 2019 to 2023 period the mean number of ignitions observed in SCE' HFRA on covered conductor per unit mile deployed was 85.0% less than the number of ignitions observed on unhardened bare wire, significantly more than the 72% predicted by SCE. This is a factor of two fewer ignitions than SCE predicts (15% versus 28%). In fact, given the observed number of events it is possible to put a 95% confidence level at 75.3% reduction, thus excluding the hypothesis that the observed number of ignitions is the result of a statistical fluctuation consistent with SCE's 72% prediction.[137]

The observed reduction in ignition rate is significantly higher than the observed reduction in outage rates. In the Joint IOU Covered Conductor Working Group report, SCE reports a reduction in outage rate of 70.5% for fully covered circuits.[138]

The observed reduction in ignition rate is also significantly higher than the observed reduction in wire-downs. There is a 69.7% reduction in wire-downs for covered

[136] DR Response MGRA-SCE-002-Q2. (.xlsx file), and
MGRA Workpapers 2-1.a-f_MGRA-SCE-002_Q2-CCUG-WD-Ign-jwm.xlsx, Tab Ignitions
[137] There were 11 ignitions observed on covered conductor segments, with 73.3 predicted based on the bare wire ignition rate. Assuming Poisson statistics, the single-tail 95% confidence interval was calculated using the Excel formula CHISQ.INV.RT(0.05,2*(D15+1))/2, where D15=11. This gives an upper limit of 18.2 events, and 18.2/73.3 = 75.3%. See:
MGRA Workpaper 2-1.a-f_MGRA-SCE-002_Q2-CCUG-WD-Ign-jwm.xlsx, Tab 'CL Stats'.
[138] SCE 2023-2025 WMP; Appendix F7; pp. 887-888.

conductor vs bare wire.[139] This is similar to the reduction in outages observed by SCE and their predicted 72% reduction in wildfire ignitions

Q. What is the cause of the unexpectedly low ignition rate seen in SCE's field data?

A. The reason that SCE's field data and its SME estimates for covered conductor wildfire mitigation efficiency differ needs to be further investigated, and may require the accumulation of more data. It is unlikely that the simultaneous deployment of "Fast Curve" circuit breaker settings is a conflating factor. According to SCE, implementation of "Fast Curve" circuit breaker settings and the deployment of covered conductor are uncorrelated.[140]

It is peculiar that the reduction in outage rate, wire downs, and SCE's predicted reduction in wildfire ignitions are roughly compatible with each other, while the observed number of wildfire ignitions is much lower than predicted. It would appear that in addition to whatever virtues covered conductor has in preventing faults from occurring, it also makes it half as likely that the residual faults will proceed to a wildfire ignition, and that SCE SMEs and modeling are not capturing this supplemental protective effect.

These results should be applied cautiously. I have not investigated, for instance, whether the reduction in ignition rates applies to all drivers or just some of them. Most importantly, it is not known whether the reduction of ignition rates for drivers correlated with catastrophic wildfire ignitions (vegetation contact and equipment damage due to high wind) show the same level of reduction as the mean. So while the field performance of covered conductor is extremely promising, further study is needed.

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[139] DR Response MGRA-SCE-002-Q2. (.xlsx file), and
MGRA Workpapers 2-1.a-f_MGRA-SCE-002_Q2-CCUG-WD-Ign-jwm.xlsx, Tab Wire Downs.

[140] DR Response MGRA-SCE-007-Q3:
"The reconductor work associated with covered conductor deployment is typically completed separately from updates to substation circuit breakers setting configuration changes which can enable Fast Curve. The work executions functions require different expertise for relay settings changes compared to reconductor efforts."

Q. How resilient is covered conductor to high winds?

A. SCE sets a higher wind speed threshold for de-energization on fully-covered covered conductor circuits: "*Due to covered conductor's ability to reduce risk of contact from foreign objects, SCE was able to raise wind speed de-energization thresholds from the National Weather Service Wind Advisory levels (at 31 mph sustained wind speed and 46 mph gust wind speed) to the National Weather Service High Wind Warning levels (at 40 mph sustained and 58 mph gusts) on portions of overhead circuitry that had covered conductor installed*."[141]

Additionally, SCE continues to evaluate data to determine whether higher wind speed thresholds would be beneficial. As described in the section on IWMS High Wind Locations,[142] SCE continues to evaluate higher wind speed thresholds for covered conductor.[143] MGRA Table 5 shows how higher thresholds would substantially reduce the number of, extent of, and duration of PSPS events. Raising thresholds should be done carefully through study of damage events occurring during PSPS events.

Q. What are the residual vulnerabilities of covered conductor and how can it be addressed?

A. Covered conductor is not a perfect mitigation and has remaining vulnerabilities. Among these, the most concerning is the risk of tree fall-in, which has already been associated with ignitions on covered conductor circuits.[144] The tree falling with enough force can break the protective polymers at the point of contact, and either remain in contact with the broken and exposed conductor or can break the conductor, potentially causing it to fall with exposed ends.

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[141] SCE-04 Vol. 05 Pt. 2A; p. 46.
[142] p. 46.
[143] SCE-04 Vol. 05 Pt. 1A; p. 28.
[144] SCE 2023-2025 WMP; p. 889. TURN-SCE-008-Q3b.

However there are several technologies that can be used in tandem with Covered Conductor to reduce these risks by de-energizing the conductor once it is broken or electrical flow is unstable. The primary of these is REFCL, described in more detail in the section on REFCL and Other Advanced Technologies[145] Though difficult to deploy and maintain, REFCL has established a strong safety record in Australia. REFCL is capable of detecting very small current aberrations, so would cover the case where a tree branch has broken the cover on one conductor. Other technologies being deployed by SCE include DOPD[146], which terminates current if there is a break in the line in a short amount of time that should prevent ignitions. A third mitigation that can be put in place with covered conductor is Hi-Z, or high impedance circuit breaker settings. These detect smaller current losses, say through a still-standing tree, and will de-energize a circuit accordingly. SCE has stated that these protection technologies are basically orthogonal and can be deployed simultaneously at relatively low cost. Between these mitigations, the risk of covered conductor ignition during extreme weather events can be substantially reduced.

Q. What is the cost and cost per mile of SCE's Covered Conductor Program?

A. SCE projects that between 2023 and 2028 it will have spent $2.64 billion to remediate 3,726 circuit miles in its HFRA area,[147] working out to approximately $708k per mile.

Q. What is SCE's plan in the longer term for covered conductor?

A. SCE intends to ramp down its deployment of covered conductor starting in 2025, replacing its expenditures with Targeted Undergrounding (TUG), as was shown clearly in Figure I-6 of its testimony (Figure 13):

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[145] REFCL and Other Advanced Technologies; p. 81.
[146] p. 103.
[147] SCE-04 Vol. 05 Pt. 2A; p. 30.

Undergrounding

Q. What is SCE's "Targeted Undergrounding Program" (TUG)?

A. SCE's Targeted Undergrounding Program (or TUG) is designed to be paired with its IWMS framework and SCE claims that it "*specifically targets areas with egress constraints, high consequence ignition risks, communities of elevated fire concern, and those areas that may experience extremely high winds and dry fuels where overhead hardening may not sufficiently reduce the impact of Public Safety Power Shutoff (PSPS) events*."[148]

SCE's proposal is to underground 716 miles of line (equivalent to 611 overhead miles), ramping up slowly to a peak of over 200 miles per year in 2027, as shown in its table below:

Table I-3
Targeted Undergrounding Program[13,14]
Capital Expenditure Forecast (2023 – 2028)
(Total Company - Nominal $000)

Targeted Undergrounding	2023	2024	2025	2026	2027	2028	Total
Forecast Circuit Miles (OH Miles)	11	20	60	150	200	170	**611**
Forecast Circuit Miles (UG Miles)	11	20	65	180	240	200	**716**
Forecast Cost (Nominal $000s)	$ 25,618	$ 48,884	$ 304,954	$ 851,620	$1,143,432	$ 966,727	**$ 3,341,235**

Table 10 - SCE Table I-3, showing the rollout of its proposed Targeted Undergrounding Plan in miles and cost per year.[149]

The cost can be seen to increase substantially, essentially replacing and exceeding SCE's expenditure on covered conductor, as shown in Figure 14.

While relative to its size, SCE's proposed undergrounding program is more modest than either PG&E's or SDG&E's, it still ends up dominating SCE's proposed capital expenditures due to its extremely high cost per mile. It is also slow, with a

[148] SCE-04 Vol. 05 Pt. 2A; p. 6.
[149] Id.; p. 10.

maximum of 200 miles per year mitigated compared to over 1,200 miles per year for covered conductor.[150]

Q. Is SCE's claim that undergrounding is a necessary mitigation for circuit segments identified in its IWMS a compelling argument?

A. No. As discussed in the Policy section,[151] the idea that only undergrounding is the only mitigation for certain risk classes because it is the closest to complete mitigation, and that some risks are "unacceptable" according to SCE's risk tolerance model, is not compelling. In order to adequately evaluate SCE's claim, it would need to be shown that alternative mitigation such as covered conductor in conjunction with REFCL and other advanced technologies would not provide adequate protection for a segment. The only way to measure this, however, is the MARS model, and as shown above MARS priorities (which if flawed are at least transparent) and IWMS priorities (which differ according to classification and have SME judgment involved) have little to do with each other. Essentially, we have only SCE's word that a specific segment needs to be undergrounded. Given the perverse incentive involved due to 10% revenue return on capital projects, SCE's claim needs to be further investigated. This testimony performs such an investigation in the Portfolio section,[152] after covered conductor and advanced technologies are discussed.

Q. What is the relationship between SCE's planned TUG program priorities and MARS risk scores?

For the most part, the TUG program priorities have little to do with the MARS risk score of the segment to be treated:

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[150] Id.; p. 31.
[151] p.14.
[152] p. 83.

SCE's circuit segments that traverse the HFTD, ranked by decreasing per-segment MARS wildfire risk	Total number of circuit- segments that traverse the HFTD	Number of circuit-segments being undergrounded	Number of circuit-miles being undergrounded
Top 5% riskiest circuit segments	7,319	439	40
Top 5% to top 10% riskiest circuit segments	7,320	511	39
Top 10% to top 20% riskiest circuit segments	14,639	1,116	78
Top 20% to top 30% riskiest circuit segments	14,639	1,050	82
Top 30% to top 40% riskiest circuit segments	14,639	1,074	69
Top 40% to top 50% riskiest circuit segments	14,639	1,084	84
Top 50% to top 60% riskiest circuit segments	14,639	1,008	88
Top 60% to top 70% riskiest circuit segments	14,639	542	31
Top 70% to top 80% riskiest circuit segments	14,639	606	26
Top 80% to top 90% riskiest circuit segments	14,639	765	28
Bottom 10% riskiest circuit segments	14,620	902	43
Total	**146,371**	**9,097**	**609**

Table 11 - SCE's planned TUG circuits ranked in the order of their MARS risk.[153]

As is clear, aside from some "front loading" in the top 60% riskiest circuits, there is not strong correlation between MARS risk and IWMS prioritization. In fact, even the circuits with the lowest 10% estimated MARS risk are planned for more undergrounding than the 60-70, 70-80, and 80-90% tranches. This is compatible with SCE's claim that IWMS identifies areas that are high risk but that MARS does not adequately detect.

REFCL and Other Advanced Technologies

Q. Are there other technologies that can be used to significantly reduce wildfire risk?

A. Yes. California utilities have been exploring a number of additional technologies that can significantly lower the risk of wildfire. When deployed in conjunction with

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[153] Data Request Response MGRA-SCE-007-Q1, contains redacted PubAdv-SCE-370-MGN.xlsx

covered conductor these can dramatically reduce wildfire risk by compensating for residual covered conductor vulnerabilities.

Q. Why would alternative technologies enhance covered conductor wildfire risk reduction?

A. Covered conductor is highly effective against certain wildfire ignition drivers. There is general consensus among utilities that covered conductor is highly effective (90% or more) against animal contact, balloon contact, conductor clashing, and light vegetation contact.[154] There are a number of failure modes in which covered conductor can still fail and produce an arc that ignites a wildfire. Contact with a falling tree or heavy limb may break the protective covering or the conductor itself. An event that causes extreme damage to the utility pole such as a vehicle collision or failure of the supporting structure during wind events may cause conductor or its insulation to break and come into contact with the ground or with external objects.

Advanced technologies can provide supplemental protection in some of the situations under which covered conductor fails. One technology, REFCL (Rapid Earth Fault Current Limiter), can rapidly de-energize a conductor that comes into contact with the ground or any object that is grounded. Other technologies developed by SCE are Distribution Open Phase Detection (DOPD), which is able to de-energize a broken conductor, and Hi-Z circuit breaker settings, which can detect high impedance faults to ground and rapidly de-energize the line, significantly reducing the released energy.

Q. How are California utilities planning to utilize REFCL?

A. REFCL is an advanced current limiting technology originally developed in Australia.[155] Both SCE and PG&E have REFCL programs. PG&E was the first to test

[154] SDG&E 2022 WMP; Covered conductor appendix; pp. 573-589/699.
[155] Riley, R., Bernardo, J., 2020. REFCL Functional Performance Review Report for Energy Safe Victoria (Power Systems Consultants Australia Pty Ltd No. JA8648- 0– 0). Energy Safe Victoria. https://esv.vic.gov.au/wp-content/uploads/2021/01/REFCL-Functional-Performance-Review.pdf

REFCL, but suffered a catastrophic failure of its equipment.[156] As PG&E describes in its 2022 WMP: "*After the initial positive tests, the Calistoga REFCL pilot demonstration was stalled due to the failure of the substation REFCL equipment. In addition, PG&E had difficulty obtaining replacement equipment from various overseas suppliers due to supply chain issues and the ongoing COVID-19 pandemic*."[157]

This caused a halt in PG&E's REFCL R&D program.[158] Just before the release of PG&E's REFCL results, PG&E announced its 10,000 mile undergrounding program. MGRA noted in its 2022 WMP comments that "*Undergrounding obviates any need for REFCL.*"[159]

SCE in the meantime has taken leadership of the development of Rapid Earth Fault Current Limiter (REFCL) technologies, and has successfully deployed them on its circuits. SCE announced the results of its successful REFCL pilot in its 2022 WMP. It stated: "*These pilots demonstrated the capability to increase the sensitivity to detect ground faults by more than a factor of 100 and reduce the energy release from ground faults by more than 99.9%.*"[160] It installed and operated a Ground Fault Neutralizer (GFN) at its Neenach substation, Resonant Grounding on its Arrowhead substation, and an Isolation Transformer at its Stetson substation. Its system was able to successfully detect faults as low as 0.5 ampere. SCE is currently planning plans to install REFCL projects at its Acton, Phelan, Del Sur, and Banducci substations[161] SCE notes that "*REFCL currently has the highest RSE score in SCE's WMP portfolio*,"[162] though it warns that actual costs may be higher.

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[156] MGRA PG&E 2023 GRC Testimony;
Full report on PG&E's REFCL tests is available in Data Request Response GRC-2023-PhI_DR_MGRA_003-Q005Atch01.
[157] 2022-WMPs; PG&E WMP; p. 556.
[158] 2022-WMPs; WMP-Discovery2022_DR_CalAdvocates_013-Q11.
[159] MGRA 2022 WMP Comments; p. 78.
[160] SCE-04, Vol. 5, Part 2; p. 75.
[161]DR Response; PubAdv-SCE-075-MGN: 01.a-g.
[162] SCE 2022 WMP; pp. 325.

Q. Are there shortcomings and challenges with REFCL systems?

A. SCE staff have provided an extensive and detailed report with their 2023 WMP filing that describes the work SCE has put in to develop its current REFCL options.[163] This document describes the various options and configurations tried in the course of REFCL development, and above all describes the difficulty of developing working and stable configurations. So while REFCL is not simple to deploy and maintain, GFN installations will be deployed at the substation level and offer significant protection to wide areas.

SCE plans to have 2,000 miles of overhead conductor protected by REFCL by 2028,[164] making it by far the leader in the deployment of this technology.

SCE states that: "*REFCL is also limited primarily to use on three-wire systems, although it can be economically applied to 4-wire systems in select cases*,"[165] which means that REFCL may not be economically feasible for all covered conductor segments.

Challenges were encountered during the first deployments of REFCL in Australia, and there were significant cost overruns.[166] However, according to a white paper written by Australian power line fire specialist Tony Marxen, the REFCL system is performing overall better than expected, with overall ignitions down 70% versus an expected 50%.[167]

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[163] OEIS; 2023-2025 WMPs; TN11964-6_20230327T172137; Rapid Earth Fault Current Limiter (REFCL) Projects at Southern California Edison; December 29, 2022. 93pp. (SCE 2022 REFCL Report)

[164] DR Response; PubAdv-SCE-075-MGN: 01.a-g

[165] SCE-04, Vol. 5, Part 2; p. 52.

[166] Carey, A., 2018. Power companies warned MPs fire safety plan would blow out by millions. The Age. https://www.theage.com.au/politics/victoria/power-companies-warned-mps-fire-safety-plan-would-blow-out-by-millions-20181002-p507dl.html

[167] Marxen, T., 2019. How do Victoria's REFCLs deliver more fire-risk reduction than simple theory and experience elsewhere say they should? | LinkedIn [WWW Document]. URL https://www.linkedin.com/pulse/how-do-victorias-refcls-deliver-more-fire-risk-than-simple-marxsen%3FtrackingId=YoM4zpCp9cG1uYmCn5Lkcg%253D%253D/?trackingId=YoM4zpCp9cG1uYmCn5Lkcg%3D%3D (accessed 5.16.23).

In a data request in response to its 2023-2024 WMP PG&E also referred to a technical report on REFCL written by an Australian consulting group in 2020.[168] This report notes that "*Our overall assessment is that the operational performance of the installed REFCLs is meeting expectations in relation to bushfire risk mitigation. In some instances, the installed REFCLs have exceeded these expectations by responding to more complex faults and reducing bushfire risk. Each distributor has identified specific cases where a fire start is likely to have been prevented as a result of REFCL operation*."[169] While noting that REFCL has had some reliability issues and ran into supply difficulties, it was effective at preventing ignitions. Australian companies AusNet and Powercor recorded 47 REFCL operations during high fire days with no ignitions, while Powercorp's REFCL detected 67 faults on high fire days with no ignitions. There was one small fire during on a non-fire day.[170]

REFCL will often require upgrades of a number of system components as shown in SCE's chart below:

[168] PG&E Data Request Response WMP-Discovery2023_DR_CalAdvocates_011-Q008g. REFCL Functional Performance Review; Report for Energy Safe Victoria; PSC Reference: JA8648-0-0 REFCL Functional Performance Report. (Downloaded 2/24/2024). https://www.esv.vic.gov.au/sites/default/files/2022-12/REFCL-Functional-Performance-Review.pdf
[169] Id; p. 4.
[170] Id; p. 28.

7.1.5 Summary of Equipment Requiring Upgrades

Table 9 Summary of Equipment Requiring Upgrades

Equipment Type	4 kV	12 kV	16 kV	33 kV	55/66 kV	115 kV
Substation Transformers	Keep	Keep	Keep	Keep	Keep	Keep
Grounding Transformers	Keep	Keep	Keep	Keep	Replace	Replace
Distribution Overhead Transformers	Replace	Keep	Keep	Keep	NA	NA
Distribution Underground Phase-to-Phase Transformers	Keep	Keep	Keep	Keep	NA	NA
Distribution Underground Phase-to-Neutral Transformers	Replace	Replace	Replace	NA	NA	NA
Open Delta Voltage Regulators	NA	Upgrade	Upgrade	Upgrade	NA	NA
Circuit Breakers	Keep	Keep	Keep	Keep	Keep	Keep
Disconnect Switches	Keep	Keep	Keep	Keep	Keep	Keep
Voltage Transformers Phase to Phase	Keep	Keep	Keep	Keep	Keep	NA
Voltage Transformers Phase to Ground	Keep	Replace Some	Keep	Keep	Keep	Replace
Current Transformers	Replace Some	Replace Some	Replace Some	Replace Some	Replace Some	Replace Some
Metering Units	Keep	Keep	Keep	Keep	Keep	Replace
Line Arresters	Keep	Keep	Keep	Keep	Keep	Keep
Substation Arresters	Replace Some	Replace Some	Replace Some	Replace Some	Replace Some	Replace Some
Insulators	Keep	Keep	Keep	Keep	Keep	Keep
Capacitor Banks	Keep	Keep	Keep	Keep	Keep	Replace
Cable	Replace Some	Replace Some	Replace Some	Replace Some	Replace Some	Replace Some
Automatic Reclosers	Replace Some	Replace Some	Replace Some	NA	NA	NA
Primary Connected Customer Equipment	Replace Some	Replace Some	Replace Some	Replace Some	Replace Some	Replace Some

Table 12 - Components in need of upgrade for a REFCL conversion, listed by circuit voltage.[171]

REFCL does not provide risk reduction for multiphase faults.[172] However, this is where the combination with covered conductor is mutually enforcing, since covered conductor protects each individual phase and prevents multi-phase contact except under the most catastrophic circumstances.

In cases where neither TUG nor CC+REFCL is feasible, remote grid or a spacer cable system may be deployed. Spacer cables have higher strength and may be used in heavily forested areas. SCE is currently piloting a spacer cable CC system as a pilot and evaluating cost and performance, with planned pilot completion date in 2025.[173]

Q. What is the comparative difference in cost, effectiveness, and RSE between undergrounding and a CC+REFCL combination?

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[171] SCE 2022 REFCL Report; p. 88.
[172] DR Response; PubAdv-SCE-075-MGN: Q5.
[173] SCE-04 Vol. 05 Pt. 2A; pp. 16-17.

A. SCE, in response to data request ED-SCE-004_Q3c provided comparison for 33 circuits planned for remediation, providing information on cost and effectiveness for both TUG and CC+REFCL scenarios. Results are shown below:

Row Labels	Sum of Segment Length (Miles)	Average of pre_risk	Average of post_risk	Sum of Total Spend ($000s)	Average of RSE	Count of PIF
REFCL_CC	119.296	0.085	0.034	183717.808	2082.548	33
TUG	119.296	0.085	0.020	607696.168	789.766	33
Grand Total	**238.593**	**0.085**	**0.027**	**791413.977**	**1436.157**	**66**

Table 13 - SCE analysis for 33 circuits comparing TUG option to CC+REFCL option.[174]

As can be seen in the table, average reduced risk for CC+REFCL mitigated circuits is 60% while average reduced risk for TUG is 76%. Total costs are estimated at 3.4X higher for TUG, giving an RSE that is roughly 3X higher for the CC+REFCL combination.

Q. How many miles of distribution line does SCE propose to enable with REFCL by 2028, and what is its projected cost?

A. SCE states that by 2028, "*SCE seeks to have installed REFCL protections to cover 20% of HFRA (approximately 2,000 miles) with REFCL GFN technology. This assumes four installations per year over the GRC period, with a total of 21 stations to be completed by the end of 2028. While the miles covered for each station will vary, SCE estimates an average of approximately 100 miles of HFRA are protected per station.*"[175]

Q. What other technical mitigations does SCE have in development or distribution?

[174] Workpaper ED-SCE-004_Q3c.-TUG-CCREFCL-RSE-jwm.xlsx
[175] SCE-04 Vol. 05 Pt. 2A; p. 82.

A. Other technologies SCE is evaluating for use in reducing wildfire risk are Open Phase Detection Program (DOPD), Hi-Z relays (Hi-Z), and Early Fault Detection (EFD). Fast Curve settings are also being deployed along with REFCL.

Q. What is DOPD?

One of the programs that SCE currently has in test deployment mode is the Distribution Open Phase Detection (DOPD) Program.[176] This technology uses specially equipped reclosers to transmit radio transmissions when open phase (broken wire or splice) conditions are detected on one or more conductors. When the signal is received by a recloser it can either alarm or isolate the circuit.

Q. What are the advantages and disadvantages of DOPD?

DOPD is relatively inexpensive, giving it a high RSE ranking (1,324). One of the greatest advantages of DOPD is that it would provide additional protection to one of the major known covered conductor vulnerabilities: specifically when a tree falls into the line with enough force to break one or more conductors. SCE has been asked to estimate the combined wildfire mitigation efficiency of CC and DOPD and produced the following table:

Drivers	Driver/ Consequence Type	Subdriver/ Consequence Type	Mitigation Effectiveness
Driver 1	D-CFO	Veg. contact - Distribution	78%
Driver 2	D-CFO	Animal contact - Distribution	66%
Driver 3	D-CFO	Balloon contact - Distribution	99%
Driver 4	D-CFO	Vehicle contact - Distribution	87%
Driver 5	D-CFO	Unknown contact - Distribution	81%
Driver 6	D-UNK	Unknown - Distribution	65%
Driver 7	D-CFO	Other contact from object - Distribution	77%
Driver 8	D-WTW	Wire-to-wire contact / contamination - Distribution	99%
Driver 9	D-EFF	Anchor / guy damage or failure - Distribution	2%

[176] SCE-04 Vol. 05 Pt. 3A; p. 16.

Driver 10	D-EFF	Conductor damage or failure - Distribution	90%
Driver 11	D-EFF	Connection device damage or failure - Distribution	90%
Driver 12	D-EFF	Connector damage or failure - Distribution	90%
Driver 13	D-EFF	Crossarm damage or failure - Distribution	51%
Driver 14	D-EFF	Fuse damage or failure - Distribution	2%
Driver 15	D-EFF	Insulator and bushing damage or failure - Distribution	90%
Driver 16	D-EFF	Lightning arrestor damage or failure - Distribution	0%
Driver 17	D-EFF	Other - Distribution	17%
Driver 18	D-EFF	Pole damage or failure - Distribution	2%
Driver 19	D-EFF	Recloser damage or failure - Distribution	5%
Driver 20	D-EFF	Splice damage or failure - Distribution	90%
Driver 21	D-EFF	Tie wire damage or failure - Distribution	0%
Driver 22	D-EFF	Voltage regulator / booster damage or failure - Distribution	0%
Driver 23	D-CTM	Contamination - Distribution	2%
Driver 24	D-EFF	Capacitor bank damage or failure - Distribution	0%
Driver 25	D-EFF	Switch damage or failure - Distribution	2%
Driver 26	D-EFF	Transformer damage or failure - Distribution	20%
Driver 27	D-EFF	Tap damage or failure - Distribution	2%
Driver 28	D-EFF	Sectionalizer damage or failure - Distribution	0%
Driver 29	D-OTH	All Other - Distribution	2%
Driver 30	D-UTW	Utility work / Operation - Distribution	2%
Driver 31	D-VAN	Vandalism / Theft - Distribution	2%

Table 14 - SCE's estimated combined CC+DOPD wildfire risk reduction.[177]

SCE is currently unaware whether DOPD will interoperate with REFCL, and if so what sort of combined protection these two technologies would have.

Q. What are Hi-Z relays and what are their advantages and disadvantages?

A. Hi-Z relays are designed to detect high impedance faults. Currently, they are being operated in test mode. They have been verified to detect high impedance fault conditions, but SCE has concerns that unless properly adjusted these may create nuisance

[177] DR Repsonse MGRA-SCE-004-Q3.
Workpaper MGRA 0004 Q4_3 WCCP DOPD ME-jwm.xlsx.

faults.[178] There is a possibility that Hi-Z relays may supplement REFCL in that Hi-Z relays can detect multi-phase faults. One reportable ignition due to vegetation contact with a secondary line was detected by a Hi-Z relay in alarm mode. While it has the ability to adjust Hi-Z settings in the field, SCE currently has no plans to change settings due to ambient conditions such as fire weather. SCE estimates Hi-Z has a high cost effectiveness, with an RSE of 5,062.[179] SCE estimates wildfire reduction effectiveness for a CC + Hi-Z combination:

Driver 1	D-CFO	Veg. contact - Distribution	72%
Driver 2	D-CFO	Animal contact - Distribution	66%
Driver 3	D-CFO	Balloon contact - Distribution	99%
Driver 4	D-CFO	Vehicle contact - Distribution	82%
Driver 5	D-CFO	Unknown contact - Distribution	81%
Driver 6	D-UNK	Unknown - Distribution	66%
Driver 7	D-CFO	Other contact from object - Distribution	77%
Driver 8	D-WTW	Wire-to-wire contact / contamination - Distribution	99%
Driver 9	D-EFF	Anchor / guy damage or failure - Distribution	2%
Driver 10	D-EFF	Conductor damage or failure - Distribution	90%
Driver 11	D-EFF	Connection device damage or failure - Distribution	90%
Driver 12	D-EFF	Connector damage or failure - Distribution	90%
Driver 13	D-EFF	Crossarm damage or failure - Distribution	51%
Driver 14	D-EFF	Fuse damage or failure - Distribution	4%
Driver 15	D-EFF	Insulator and bushing damage or failure - Distribution	90%
Driver 16	D-EFF	Lightning arrestor damage or failure - Distribution	2%
Driver 17	D-EFF	Other - Distribution	17%
Driver 18	D-EFF	Pole damage or failure - Distribution	2%
Driver 19	D-EFF	Recloser damage or failure - Distribution	7%
Driver 20	D-EFF	Splice damage or failure - Distribution	90%
Driver 21	D-EFF	Tie wire damage or failure - Distribution	2%
Driver 22	D-EFF	Voltage regulator / booster damage or failure - Distribution	2%
Driver 23	D-CTM	Contamination - Distribution	2%
Driver 24	D-EFF	Capacitor bank damage or failure - Distribution	2%
Driver 25	D-EFF	Switch damage or failure - Distribution	4%
Driver 26	D-EFF	Transformer damage or failure - Distribution	22%

[178] DR Response MGRA-SCE-004-Q4-4.
[179] SCE-04 Vol. 05 Pt. 3A; p. 26.

Driver 27	D-EFF	Tap damage or failure - Distribution	2%
Driver 28	D-EFF	Sectionalizer damage or failure - Distribution	2%
Driver 29	D-OTH	All Other - Distribution	2%
Driver 30	D-UTW	Utility work / Operation - Distribution	2%
Driver 31	D-VAN	Vandalism / Theft - Distribution	2%

Table 15 - SCE estimations of wildfire risk reduction obtained by a combination of covered conductor and Hi-Z relays.[180]

The results shown in both Table 15 and Table 14 appear to be overly conservative when compared with Covered Conductor alone (Table 8). Deployment of Hi-Z relays is proceeding slowly and SCE has no plans to accelerate it during the 2025-2028 period.

Q. What is Early Fault Detection and how is it being deployed?

A. SCE and other utilities are implementing and Early Fault Detection system (EFD) that uses high frequency radio emissions that are sometimes emitted from arcing or partial discharge conditions in an electrical system. The purpose of this system is to locate damaged, degraded, or compromised assets before a visible issue can be seen and before a risk event occurs. These systems can be installed on distribution, transmission, and even underground systems. They are quite inexpensive, giving them a high RSE of 5,490.[181] One ESD sensor covers approximately 3.5 miles of conductor. There were 277 EFD units deployed as of December 31, 2023. At SCE's present rate of deployment it estimates that it would have 50% of its HFRA covered by 2028 and 10% of its transmission HFRA. SCE states that it could accelerate its deployment of EFD in 2027-2028 with additional funding.[182]

Q. How effective is EFD?

[180] SCE-04 Vol. 05 Pt. 3A; p. 20.
[181] Id; p. 22.
[182] DR Response MGRA-SCE-004-Q4-5

A. It is difficult to estimate the effectiveness of EFD as a mitigation such as CC or REFCL because it detects incipient or potential faults before they occur, which requires a subsequent field inspection for repair. However, between August 2020 and July 2023, 38 potential faults were detected. The number of each type are listed in the table below:

Fault Cause	Count
Arcing damage on secondary triplex	1
Arcing Primary Surge Arrester	1
Broken bond wire	5
Broken conductor strands	1
Broken strands	1
Broken strands/melting damage	1
Broken wire to arrester	1
Conductor damage	9
Damaged connector	1
Damaged Utilco bar	1
Insulator removed for evaluation	1
Line spacer connection	1
Loose bond wire	1
Loose insulator clamp	1
Missing insulator hardware, floating bond	1
North structure, bonding issue	1
Primary Transformer Tap	1
Secondary connector	2
Surge arrester	2
Tracking insulator	1
Tracking insulator with flash marks	1
Transformer fuse operated then detections ceased	1
Vegetation Grow-In to Primary	1
Wildlife cover tracking	1

Grand Total	38

Table 16 - Incipient faults detected by EFD and remediated by field personnel.[183]

It is important to note that 24 of the 38 faults detected were due to damaged or loose contacts, bad connections, or vegetation contact. These might have been more prone to fail under high wind conditions, creating the prerequisites for catastrophic wildfire. Because EFD works in a different way than other mitigations it is hard to calculate its effectiveness when combined with them. However, it appears to be a highly useful and cost effective mitigation that should be deployed with all alacrity.

Q. How do the risk/spend efficiencies of advanced technologies compare and how do they rank against undergrounding and covered conductor?

A. The advanced technologies being evaluated and deployed by SCE generally have a very high RSE, as SCE calculates in its workpapers:

Mitigation	Program	RSE (GRC)
Distribution and Transmission Routine Vegetation Management	N/A	125,341
Rapid Earth Fault Current Limiters (REFCL)	M2	20,708
Early Fault Detection (EFD)	M5	5,538
High Impedance (Hi-Z) Relays	M6	5,144
Distribution Open Phase Detection (DOPD)	M4	1,532
WCCP & FR Poles	C1 and C1a	865
Targeted Undergrounding - Distribution	M1	700

Table 17 - Overall RSE for wildfire mitigation programs as calculated in SCE's GRC workpapers.[184]

[183] Id., and
Workpaper SCE EFD Faults 2020-2023 – jwm.xlsx
[184] WP SCE-01 Vol. 02; p. 21.

Q. What advantages are be established when covered conductor is combined with advanced technologies such as REFCL?

A. Because covered conductor and advanced technologies mitigate risks that are different, their combined effect can be multiplicative.

SCE, in a WMP Data request response to MGRA, estimated the combined effectiveness of covered conductor and REFCL in preventing wildfire ignitions for various drivers. This is shown in the table below:

D-EFF	Conductor damage or failure — Distribution	95%
D-EFF	Connection device damage or failure - Distribution	95%
D-EFF	Connector damage or failure- Distribution	95%
D-EFF	Crossarm damage or failure - Distribution	65%
D-EFF	Fuse damage or failure - Distribution	31%
D-EFF	Insulator and brushing damage or failure - Distribution	95%
D-EFF	Lightning arrestor damage or failure- Distribution	50%
D-EFF	Other - Distribution	57%
D-EFF	Pole damage or failure - Distribution	40%
D-EFF	Recloser damage or failure - Distribution	9%
D-EFF	Splice damage or failure — Distribution	95%
D-EFF	Tie wire damage or failure - Distribution	50%
D-EFF	Voltage regulator / booster damage or failure - Distribution	50%
D-CTM	Contamination - Distribution	30%
D-EFF	Capacitor bank damage or failure- Distribution	1%
D-EFF	Switch damage or failure- Distribution	2%
D-EFF	Transformer damage or failure - Distribution	88%
D-EFF	Tap damage or failure - Distribution	50%
D-EFF	Sectionalizer damage or failure - Distribution	70%
D-OTH	All Other- Distribution	50%
D-UTW	Utility work / Operation - Distribution	25%
D-VAN	Vandalism / Theft - Distribution	1%

Driver Type	Subdriver Type	CC/REFCL ME
D-CFO	Veg. contact- Distribution	85%
D-CFO	Animal contact- Distribution	96%
D-CFO	Balloon contact- Distribution	99%
D-CFO	Vehicle contact- Distribution	85%
D-CFO	Unknown contact - Distribution	90%
D-UNK	Unknown - Distribution	82%
D-CFO	Other contact from object - Distribution	88%
D-WTW	Wire-to-wire contact / contamination- Distribution	99%
D-EFF	Anchor / guy damage or failure - Distribution	70%

Table 18 - SCE's estimate of combined efficiency of covered conductor and REFCL in reducing wildfire ignitions.[185]

Additionally, SCE estimates that Fast Curve settings will improve REFCL by 5%, because: "*In general, REFCL provides effectiveness for single phase to ground faults which overlaps with Fast Curve settings; however, Fast Curve settings also offer benefits for phase-to-phase faults and multiple phase-to-ground faults, which REFCL does not mitigate*."[186]

Q. Is SCE's estimate for the combined effectiveness of CC and REFCL accurate?

A. While it is not possible to accurately estimate to what degree the CC+REFCL combination reduces wildfire risk until significant field experience has been accumulated, there are a number of factors that would lead to the reasonable conclusion that the numbers provided by SCE underestimate the effectiveness of CC+REFCL, and particularly the impact of other mitigations combined with REFCL and CC:

- Current field data shows a reduction in wildfire ignitions for CC alone of 85.0% rather that SCE's estimate of 72%. (p. 62, Covered Conductor section)
- SCE estimates a net effectiveness of REFCL of 50%, whereas Australian sources indicate it is likely significantly higher.

[185] 2023-2025 WMPs; DR Response MGRA-SCE-003; May 8, 2023.
[186] DR Response MGRA-SCE-007-Q6a-e.

- SCE does not take into account the potential deployment of additional technologies EFD, DOPD, and Hi-Z in combination with CC+REFCL.
- In the case of extreme weather events that would take CC beyond safe operational limits, PSPS remains an option that eliminates ignition potential.

Correctly Balancing SCE's Mitigation Portfolio

Q. What factors would need to be considered to provide a more reasonable balance of SCE's mitigation portfolio?

A. SCE has been continuing the classic covered conductor program that it has executed rapidly and successfully since 2018. Prioritization for this program has been and is based upon its MARS model. SCE's new IWMS framework prioritizes additional circuits based on SME-derived criteria, and most of the designated categories are slated for undergrounding where undergrounding is feasible (Figure 5).

Questions that need to be asked regarding SCE's hardening program include:

1. Is SCE using the correct efficiency for covered conductor mitigation, or are its numbers too low?
2. Is SCE incorporating the contribution of REFCL and other advanced technologies such as HiZ, DOPD, and EFD in its mitigation decisions?
3. Has SCE optimized the balance of covered conductor and undergrounding to provide a cost efficient reduction of risk, and
4. Is SCE doing everything it can to eliminate wildfire risk in its HFRA?

SCE has provided a highly transparent tool to allow intervenors and staff to study the effect of trade-offs between covered conductor and undergrounding.[187] SCE has also

[187] The primary source is based on Workpaper SCE-04 Vol. 05 Pt.1, Excel Spreadsheet, which has been delivered in response to a number of intervenor data responses (TURN-SCE-007,

provided estimates from its SMEs regarding the effect of its advanced technologies when paired with covered conductor on the reduction of wildfire risks from various drivers. These have been provided in the previous sections.[188]

Using this data, MGRA has combined a number of different assumptions into a collection of scenarios, and then compared the overall risk buy-down, risk/spend efficiency, and cost for each of the combination of assumptions.

Q. What different assumptions did MGRA test in its scenario analysis?

A. MGRA tested the following assumptions in its scenario analysis, using different combinations of assumptions to create its scenarios:

1. **CC Efficiency (MAX) –** As noted in the Covered Conductor section,[189] SCE field data indicates that ignitions for fully covered circuit segments are reduced 85.0% as compared to the 72% predicted by SCE SMEs over bare wire circuit segments. Correspondingly, overall mitigation efficiency is increased by this amount in estimates of risk reduction, NPV, and RSE. While the cause of the reduction in ignition probability is not certain, and it is unknown whether this is true for ignition drivers most related to catastrophic wildfires, MAX estimate should be considered conservative because it also does not incorporate:
    a. Fast Curve circuit breaker settings
    b. Hi-Z circuit breaker settings
    c. Distribution Open Phase Detection (DOPD)

TURN-SCE-036). The version used in the following scenario analysis is MGRA-SCE-005-Q2. MGRA has created a number of derivative Excel file Worksheets for the following scenario analysis:
MGRA-SCE-005_Q2 - UG-CC-REFCL-Master-jwm.xlsx
MGRA-SCE-005_Q2 - UG-CC-REFCL-UG3-jwm.xlsx
MGRA-SCE-005_Q2 - UG-CC-REFCL-UG3UH-jwm.xlsx

[188] pp. 72, 68. See also

[189] p. 57.

d. Early Fault Detection

each of which would be expected to provide a substantial reduction in the residual risk of ignition of covered conductor circuits.

2. **Changing mitigation for 2/3 of Severe Risk Areas to CC (3)** – scenarios having a '3' in the scenario name have had two-thirds of the circuits designated as "TUG" moved to "WCCP". Because there is little correlation between MARS risk scores and TUG prioritization, MGRA re-sorted the TUG circuits randomly (using SCE's randomly generated anonymous circuit identifier) to select the 2/3 of TUG circuits to move to the WCCP spreadsheet.
3. **REFCL (REFCL) –** REFCL scenarios use the risk reduction estimates for CC + REFCL supplied by SCE SMEs. MGRA believes these to be underestimates, and also subject to higher risk mitigation efficiencies if REFCL is deployed along with Fast Curve, Hi-Z, DOPD, and EFD. Therefore combinations of "MAX" and "REFCL" were also explored. Because there are limitations in the annual deployment rate for REFCL, these scenarios show the "long term" efficiency when the REFCL deployments complete.
4. **Unhardened Circuits (UH) –** Noting that SCE's proposed plan would leave 680 miles of unhardened circuit in its HFRA, and noting that SCE plans to start ramping down its covered conductor program in 2025, some scenarios included adding the remaining UH circuit segments to SCE's WCCP spreadsheet, thus completing the hardening of SCE's HFRA.

Combinations of these four assumptions were used to create a set of scenarios. Scenario assumptions can be determined from the conventions listed above. For example "TOT3UH" would be a scenario that assumes that 2/3 of TUG circuit segments and all unhardened circuit segments are added to SCE's WCCP program. "TOTREFCLMAX3" would be a scenario that assumes REFCL is deployed on all circuits, that 2/3 of TUG circuits are WCCP instead, and that higher (field data) efficiencies are used for CC mitigation rather the SME efficiency estimates.

Q. What are the limitations and caveats regarding the scenario analysis?

A. There are a number of limitations and caveats that need to be kept in mind when comparing these scenarios:

- These are “scenarios”, not “plans”. They are not intended to be actual implementable proposals for hardening SCE’s circuits, which is a matter for their engineering teams who have the relevant expertise in the area. Whether a particular mitigation shown for a particular circuit segment is practical, feasible, or cost effective is unknown. The scenarios are intended to show the net effect of changing system assumptions: “more WCCP / less TUG”, higher CC efficiency, REFCL, and completing HFRA hardening.
- While the tool provided by SCE is transparent and relatively easy-to-use, it is still SCE’s tool and I cannot vouch for its accuracy. Likewise, there is also the possibility that I am not aware of some potential aspects or limitations of the tool and am not using it as the makers intended.
- Some estimates are approximations. For instance, “MAX” values scale overall risk buydown efficiencies rather than calculate buydown for individual circuits.
- As discussed in the MARS section, SCE’s overall risk model has many biases and inaccuracies, so using it as an overall gauge of risk buydown is also prone to inaccuracy, and should be considered an approximation.
- PSPS risk reduction is also handled on the aggregate level, rather than on an individual circuit basis.
- MGRA has stated in past filings that it believes SCE’s estimates of PSPS risk are significantly low. As stated previously, PG&E’s initial experience using the ICE model suggests a much higher contribution of PSPS risk. If this proves to be the case then overall NPV from covered conductor would be reduced by some amount in comparison to undergrounding.

- REFCL deployments are difficult, and while SCE may improve its efficiency with experience, it will not be able to deploy all REFCL to all eligible CC circuits by 2028. Hence, the actual CC+REFCL scenario would begin as the CC scenario, and evolve into the REFCL scenario over time.
- REFCL is most straightforward to deploy on 3-wire configurations. System and design modifications are required for 4-wire configurations which may make REFCL economically impractical for some segments.
- The fact that SCE is deploying REFCL is not taken into account in standard "base" scenario, however if SCE were to deploy REFCL everywhere it is feasible this would be the SCE+REFCL scenario.

Q. What are the results of the scenario analysis?

A. Tabular results of the scenario analysis can be found in the tables below:

	Miles	Total Pre	Total Red	Total Resid	Buydown	PSPS pre	PSPS red	NPV	NPV Spend	RSE
WCCP	1250.033	8.752	4.594	4.158	52.5%	0.203	0.015	119.722	$ 937,080.33	1277.610
WCCPMAX	1250.033	8.752	5.907	2.845	67.5%	0.203	0.015	176.756	$ 937,080.33	1886.238
TUG	577.634	9.169	8.963	0.206	97.8%	0.112	0.000	218.375	$ 2,859,303.29	763.735
Unhardened	680.618	5.260		5.260						
TOTAL	1827.667	26.673	19.465	9.624	73.0%	0.314	0.015	338.097	$ 3,796,383.62	890.577
TOTALMAX	1827.667	26.673	20.778	8.311	77.9%	0.314	0.015	395.131	$ 3,796,383.62	1040.808
CCREFCL	1250.033	8.752	6.970	1.782	79.6%	0.203	0.015	179.212	$ 1,082,626.76	1655.340
CCREFCLMAX	1250.033	8.752	7.960	0.791	91.0%	0.203	0.015	205.388	$ 1,082,626.76	1897.124
TOTREFCL	1827.667	26.673	21.840	7.248	81.9%	0.314	0.015	397.586	$ 3,941,930.05	1008.609
TOTREFCLMAX	1827.667	26.673	22.831	6.258	85.6%	0.314	0.015	423.763	$ 3,941,930.05	1075.013

Table 19 - Basic scenario, showing SCE's plan for WCCP and TUG, and then adding variants using higher CC efficiencies (MAX) based on field data, and REFCL improvements, assuming full deployment of REFCL on CC.[190]

This table shows SCE's base scenario, with relative NPV, NPV Spend, RSE, and risk buydown for WCCP and TUG programs. The "risk" being bought down is the total remaining HFRA risk, including unhardened lines not currently planned for 2025-2028. "MAX" values show higher CC mitigation efficiencies based on field data and potential deployment of additional advanced technologies. As can be seen, TUG is the most

[190] Workpaper MGRA-SCE-005_Q2 - UG-CC-REFCL-Master-jwm.xlsx
Summary in: Workpaper MGRA-SCE-005_Q2-Totals.xlsx

expensive and has the lowest RSE, but is able to achieve a greater risk buydown on the circuits where it is applied. Adding REFCL to the WCCP program leads to marginally higher costs but also a significantly higher risk buydown.

	Miles	Total Pre	Total Red	Total Resid	Buydown	PSPS pre	PSPS red	NPV	NPV Spend	RSE
WCCP3	1637.076	14.950	7.864	7.086	52.6%	0.203	0.015	198.383	$ 1,208,073.08	1642.147
WCCPMAX3	1636.979	14.912	10.082	4.829	67.6%	0.203	0.015	255.702	$ 1,207,998.86	2116.743
TUG3	190.591	2.971	2.906	0.065	97.8%	0.036	0.000	70.783	$ 943,857.72	749.936
Unhardened	680.618	5.260		5.260						
TOTAL3	1827.667	23.182	10.770	12.411	46.5%	0.238	0.015	269.167	$ 2,151,930.80	1250.815
TOTALMAX3	1827.667	23.182	12.988	10.155	56.0%	0.238	0.015	326.486	$ 2,151,930.80	1517.175
CCREFCL3	1637.076	14.950	11.850	3.100	79.3%	0.203	0.015	296.597	$ 1,394,418.46	2127.032
CCREFCLMAX3	1637.076	14.950	13.561	1.389	90.7%	0.203	0.015	340.093	$ 1,394,418.46	2438.957
TOTREFCL3	1827.667	23.182	14.756	8.425	63.7%	0.238	0.015	367.381	$ 2,338,276.19	1571.160
TOTREFCLMAX3	1827.667	23.182	16.466	6.715	71.0%	0.238	0.015	410.876	$ 2,338,276.19	1757.175

Table 20 - This table shows "lower cost" scenarios that demonstrate the effects of moving 2/3 of the TUG project into the WCCP project. Otherwise, assumptions are the same as in Table 19.[191]

Table 20 shows "lower cost" scenarios where the scope of the TUG program is 1/3 that proposed by SCE. The other 2/3 of TUG circuits are moved to the WCCP program. TUG circuit segments were selected randomly since there is little relation between TUG prioritization and MARS risk scores. Total costs are roughly $1.5 billion less than SCE's base scenario, but risk buydown is also significantly less. This reduction in risk buydown could be offset over time by REFCL deployment.

	Miles	Total Pre	Total Red	Total Resid	Buydown	PSPS pre	PSPS red	NPV	NPV Spend	RSE
WCCP3UH	2283.115	20.210	10.646	9.564	52.7%	0.203	0.015	263.729	$ 1,645,806.11	1602.428
WCCPMAX3UH	2283.018	20.172	13.654	6.518	67.7%	0.202	0.015	339.584	$ 1,645,731.90	2063.421
TUG3	190.591	2.971	2.906	0.065	97.8%	0.036	0.000	70.783	$ 943,857.72	749.936
Unhardened	0.000	0.000		0.000						
TOT3UH	2473.706	23.182	13.552	9.630	58.5%	0.238	0.015	334.512	$ 2,589,663.83	1291.720
TOTMAX3UH	2473.706	23.182	16.560	6.584	71.4%	0.238	0.015	410.367	$ 2,589,663.83	1584.634
CCREFCL3UH	2283.115	20.210	15.944	4.267	78.9%	0.203	0.015	392.746	$ 1,897,014.33	2070.339
CCREFCLMAX3UH	2283.115	20.210	18.280	1.930	90.4%	0.203	0.015	450.991	$ 1,897,014.33	2377.370
TOTREFCL3UH	2473.706	23.182	18.849	4.332	81.3%	0.238	0.015	463.530	$ 2,840,872.06	1631.645
TOTREFCLMAX3UH	2473.706	23.182	21.186	1.996	91.4%	0.238	0.015	521.774	$ 2,840,872.06	1836.668

Table 21 - These show a "complete HFRA" scenario, in which TUG deployments are reduced by 2/3, and instead unhardened circuits are added to an expanded WCCP program.[192]

[191] Workpaper MGRA-SCE-005_Q2 - UG-CC-REFCL-UG3-jwm.xlsx
Summary in: Workpaper MGRA-SCE-005_Q2-Totals.xlsx
[192] Workpaper MGRA-SCE-005_Q2 - UG-CC-REFCL-UG3UH-jwm.xlsx

Finally, a scenario was analyzed based on the possibility that it hardens the remaining 680 miles of remaining unhardened circuit in its HFRA instead of ramping down its WCCP program in 2025, using costs savings realized through reducing its TUG program by 2/3. Such a scenario, if feasible, would leave SCE with a completely hardened HFRA by 2028. The cost of these scenarios are $1 billion less than SCE's proposed TUG+WCCP plan. If REFCL is likewise deployed on the WCCP circuits, the overall risk buydown has the potential to be greater than that in the SCE base proposal.

A comparison of cost, risk buy-down, and RSE of the scenarios is shown in the figure below:

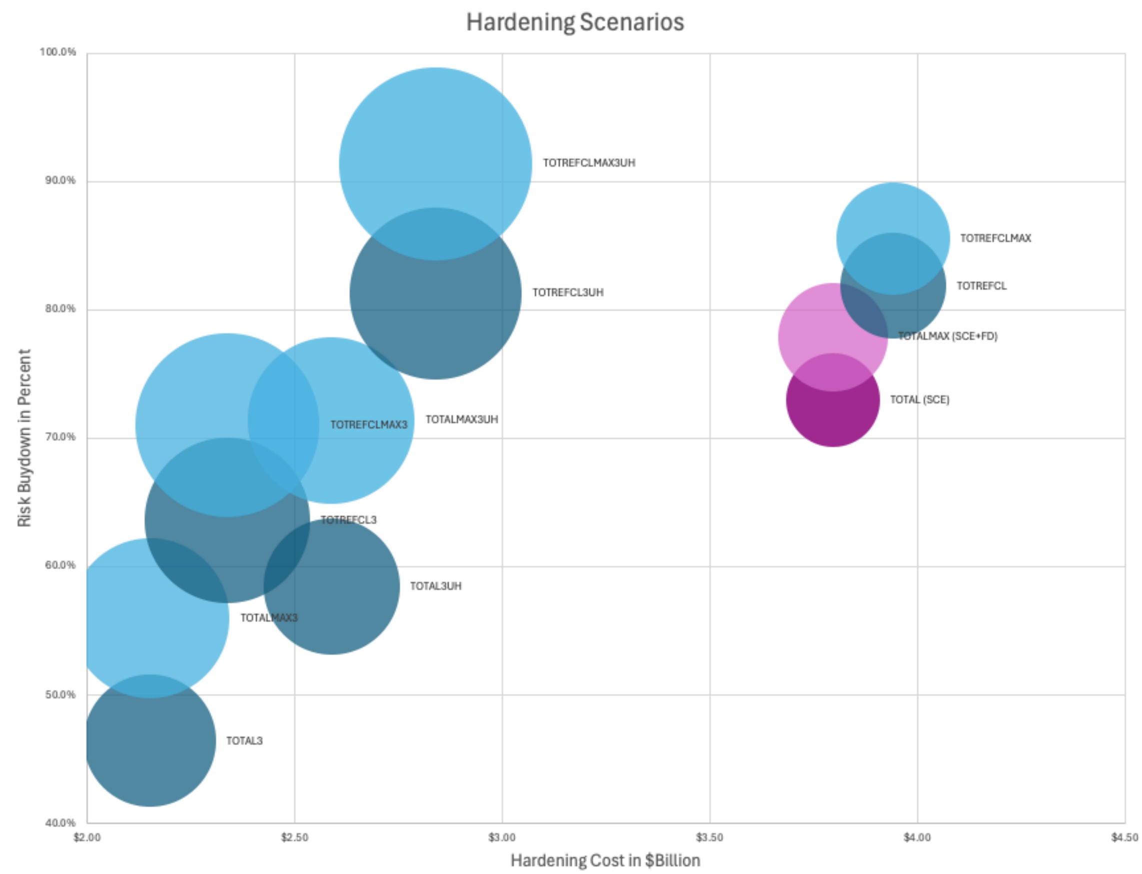

Figure 19 - A comparison of the MGRA hardening scenarios based on SCE tools, inputs and data. The X axis shows overall scenario cost. The y axis shows risk buydown in percent. Scenarios are labelled by text, with nomenclature described above. The diameter of the circle is proportional to RSE. Light shaded circles use "MAX" assumptions that WCCP risk mitigation is 85% rather than 72% based on SCE field data and on the potential for additional technology mitigations. SCE's original scenario is indicated by the magenta circles.[193]

[193] Workpaper MGRA-SCE-005_Q2-Totals.xlsx

Q. What conclusions can be drawn from the scenario analysis?

A. While SCE's proposed combination of undergrounding and covered conductor deployment has a reasonably high buydown of residual risk (73%), it also has a very low RSE (890), the lowest of all scenarios studied. Because SCE's proposal uses a lesser fraction of covered conductor than other scenarios, it also would benefit less from the likely underestimation of covered conductor efficiency than other scenarios. SCE is in fact deploying REFCL in its service area, though only in select areas, so the actual result if SCE's proposed plan goes forward would be somewhere between the TOTAL(SCE) scenario and the TOTREFCLMAX scenario.

Reducing SCE's TUG program by shifting 2/3 of planned TUG mitigation to covered conductor would be the least expensive scenario studied. While the choice of 2/3 is arbitrary, it was chosen because:

- It preserves SCE's Severe Risk categorizations, but simply changes the mitigations chosen for them,
- It represents a substantial reduction in the undergrounding program, which SCE has failed to adequately justify,
- It still allows for undergrounding of the most extreme Severe Risk Areas,
- A smaller undergrounding program can be deployed more quickly so that high risk areas can be addressed with more alacrity,
- It allows for TUG in sections where REFCL may not be economically feasible,
- It costs $1.5 billion less than SCE's proposal.

Nevertheless, overall risk buy-down remains less than 60% even accounting for a higher covered conductor efficiency.

The most cost efficient option that would also yield the greatest overall reduction in risk would be to use some of the capital that would have been used to deploy TUG in SCE's proposal to deploy additional covered conductor in areas not currently planned for hardening in 2025-2028, and additionally to accelerate REFCL deployment. SCE has amply demonstrated its ability to deploy over 1,200 miles per year of covered conductor, so this target would not seem to be unreasonable. This would allow a long-term risk buydown of over 80-90% to be achieved (depending on which covered conductor efficiency values are assumed), with 60-70% buydown guaranteed by 2028 even assuming a pessimistic REFCL rollout.

It should not be forgotten that these wildfire risk reductions are in addition to those already achieved since 2017, which SCE estimates at around 67%. Hence, we are potentially looking at a system in 2028 with wildfire risks reduced by up to 97% from where they were in 2017.

Mitigation Deployment and Time

Q. How does speed of deployment affect safety?

A. Residents only benefit from mitigations that have been deployed. One of the concerns raised by multiple parties about undergrounding in both the PG&E and SDG&E rate cases has been the fact that undergrounding is slow. This is equally true in the SCE case, but the problem is exacerbated by the fact that SCE is so competent at deploying covered conductor at scale rapidly. It is within an easy throw of hardening its entire HFRA. SDG&E also hardened the majority of its own infrastructure prior to the introduction of covered conductor, and has not had a major wildfire incident due to its equipment since 2007. PG&E has thrown its lot in with undergrounding and as a result has thousands of miles of conductor still at high ignition risk. SCE's hardening is more comprehensive than SDG&E's, and it could easily complete hardening of its entire HFRA within the scope of this rate case.

The question then is whether the added risk reduction offered by undergrounding justifies delaying mitigation offered to residents and customers that SCE claims are at the very highest risk. Professor emeritus Robert Johnston in filings[194] on SB 884 undergrounding plan implementation proposals before OEIS and the Commission proposed that risk be measured over the 50 lifetime of the project rather than over a shorter period, introducing the concept of "risk years". While his example used PG&E, which is definitively behind Edison in deployment of mitigation, some concepts apply in the SCE case as well.

In the short term, Edison's TUG proposal accepts higher risk over the next few years, as its slower TUG deployments delay protection of residents in Severe Risk Areas. Edison's proposal also leaves a substantial portion of its service area unhardened until after 2028, adding additional risk-years to its proposal. MGRA's scenarios show that TUG can be substantially reduced, allowing, if appropriate, an extended WCCP program that could complete the hardening of SCE's HFRA by 2028. While the additional technologies that make WCCP more comparable with undergrounding will not be fully deployed by 2028, the gap would close over time as these technologies can be deployed post-hardening.

The key question then is whether over long periods of time, the delta in mitigation efficiency between undergrounding and WCCP + REFCL + FC + HiZ + DOP + EFD, the yearly incremental risk, would be enough to justify the expense of undergrounding in the long term. This is a quantitative question and unfortunately SCE has abandoned its ability to address such questions by moving to the ad-hoc solution of IWMS.

Finally, affordability needs to be figured into the balance, since the impact of higher rates on the poorest and most vulnerable can leave them open to a variety of harm.

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[194] OEIS Docket 2023-Ups; Stakeholder Comments on the SB 884 Guidelines and the CPUC SPD Staff Proposal; January 17, 2024; Robert A. Johnston; Professor Emeritus; University of California at Davis; TN13579_20240117T183803_Stakeholder_Comments_on_the_SB_884_Guidelines_and_the_CPUC_SPD_Staff_Proposal https://efiling.energysafety.ca.gov/eFiling/Getfile.aspx?fileid=56173&shareable=true

AFFORDABILITY

Health and Safety Effects of Increased Rates

Q. What other public harm can arise from SCE's wildfire exposure other than wildfire safety and financial impacts and power shutoff?

A. Rate increases required to implement massive wildfire mitigation programs may be approaching the level where they are impacting public health, especially for the poorest and most vulnerable. As of January 2022, 18% of SCE customers were in arrears.[195] This has become known as an "affordability crisis",[196] and there is a dedicated CPUC rulemaking (R.18-07-006) dedicated to helping to alleviate the problem for vulnerable ratepayers. While rate relief mechanisms exist for low income ratepayers, these are not considered adequate.[197] Rates and affordability are generally reviewed as separate from other considerations. As Robert A. Thomas, Director of Pricing Design and Research at SCE reportedly emailed to the Utility Dive "*affordability must not compromise safety, reliability and state climate, clean air and electrification goals*"[198] But there is a relationship between public health / safety and income, and the cost burden from utility rate increases may now have reached a level where this relationship needs to be taken into account.

Q. On what data and expertise do you base the claim that ratepayer costs from large mitigation projects may be expected to affect public health?

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[195] 2022 SCE Monthly Disconnect Data Report-01-2022; https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/energy-utility-arrearages/iou-monthly-disconnection-reports/2022-sce-monthly-disconnect-data-report-01-2022.xlsx; Section 3 – Total customers in arrears 810k, Section 7 – Total accounts 4.49 million. 810/4490 = 0.18.
[196] Trabish, H., May 19, 2022. California's "affordability crisis" attracts innovative ratemaking and regulatory proposals. Utility Dive.
[197] Id.
[198] Id.

A. I am not a public health scientist, economist, or sociologist. Therefore, no scientific or economic conclusions should be drawn for this example and it should be assumed that it can be subject to a wide range of valid criticisms. As MGRA expert I've long advocated for cost/benefit mechanisms to find the most effective solutions for the wildfire problem. One element that has been missing from previous discussions in the wildfire sphere is what effect bearing the cost of mitigations is going to have on the public and how this might be compared to wildfire and PSPS costs and mitigation benefits. While I am unaware of any accepted mechanism to perform this comparison, as an example I looked at the relationship between income and life expectancy using peer-reviewed publicly available data. This was adjusted for California income levels, and then the effect of a $312 annual rate increase[199] was compared fractionally. While this amount is a small fraction of income for most people, it is substantial enough for lower income groups to potentially be related to a general loss of human health and life that exceeds potential wildfire and PSPS losses when applied to a large population.

The following figure shows the relationship between income and life expectancy in the United States.

[199] SCE-04 Vol. 05; p. 9; Table II-2.
Average monthly bill in 2023: $178. Average monthly bill in 2028: $204. 12 X ($204-$178) =

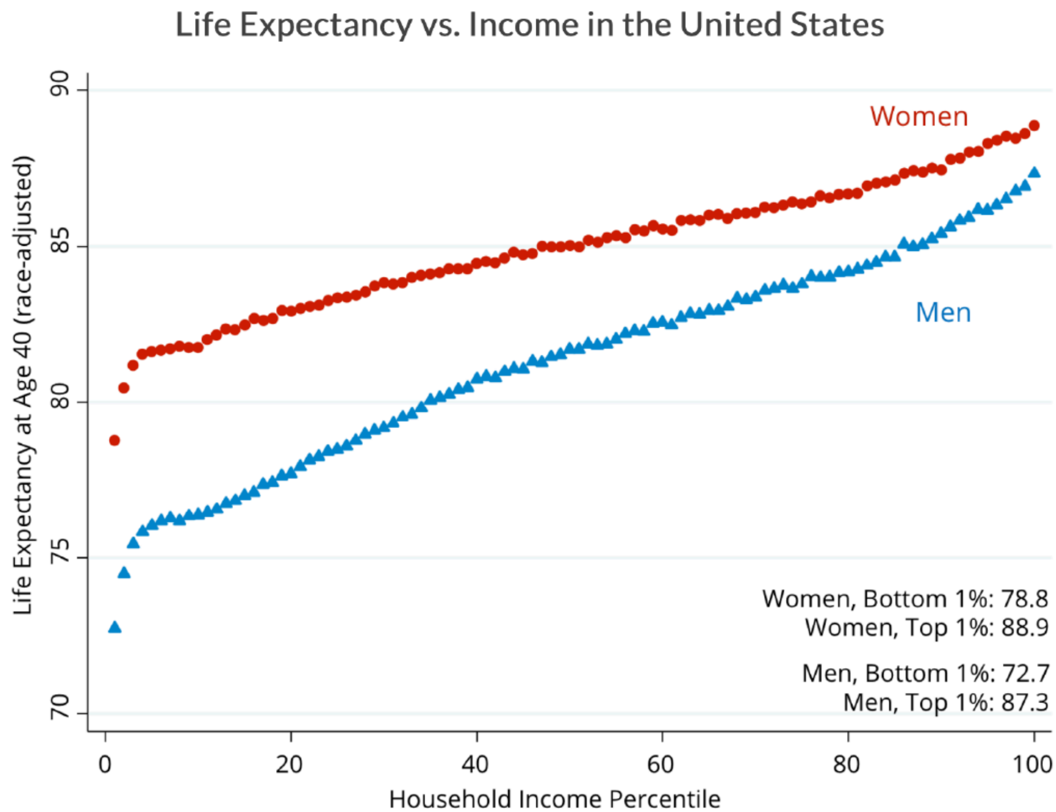

Figure 20 - Life expectancy versus household income in the US. Data from the Equality of Opportunity Project, citing data from the Journal of the American Medical Association.[200]

In California, the 20% quintile is equivalent to a household income of approximately $25,000 and a 40% quintile is equivalent to a household income of approximately $50,000.[201] For men (chosen for this example due to greater sensitivity of life expectancy to income), there is approximately a three year life expectancy difference between the 20% quintile and the 40% quintile. Therefore, in this income range, a difference of around $8000 a year is equivalent of an extra year of life expectancy.

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

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

Using these figures, a $312 per year permanent increase in utility rates would cause a $312 decrease in income. This would be correlated with a $312/$8000 or .039 year decrease in life expectancy for this portion of the population. SCE estimates that it serves a population of 15 million people. If the poorest quintile of people served by SCE (15 M / 5 = 3 million residents) were affected by this change, the number of equivalent years of life lost annually would be 117,000, or the equivalent of over 1,560 75-year lifespans.

Correlation is not (necessarily) causation, and there are many conflating factors that affect these figures. Additionally, there are rate relief programs such as CARE that aid ratepayers in need. These do not eliminate the problem, however (there are still many ratepayers in arrears, and many disconnects), but may reduce its magnitude somewhat and shift harm up the economic ladder. However, the calculation above demonstrates two things: First that we may pay for electric rate increases not only in dollars but also equivalently in human lives if people lose nutrition, medicine, and safe housing to pay additional costs of utilities. "Safety" cannot be cleanly decoupled from rates. The second is that while expensive safety programs shift risk away from residents of Wildland Urban Interface areas other risks can be shifted onto those least able to afford it.

Q. How can rate impacts be balanced against wildfire safety?

A. Just as the effects of power shutoff need to be balanced against the risk of wildfire, the impact of rate increases on the public should be balanced against wildfire and PSPS risks. While the example shown above is for demonstration purposes only, makes a number of assumptions regarding cause and effect, and excludes rate relief programs and other factors, it demonstrates that the effect of high rate increases spread over a large population may have substantial health and safety impacts. Poverty kills, though less dramatically than wildfire. The Commission should develop and adopt a cost/benefit methodology for optimizing for the public good that includes health, safety, and financial effects of increased rates on the public to ensure that risk is not merely being shifted from one portion of the population to another.

CONCLUSION

Q. What is the current status of SCE's wildfire mitigation program?

A. According to its own estimates, since 2017 SCE's wildfire mitigation program has reduced wildfire risk in its High Fire Risk Area by 67%, primarily through the deployment of approximately 5,500 miles of covered conductor (as of the end of 2023) and the introduction of "Fast Curve" circuit breaker settings. SCE's estimate is based upon its SME estimate of 72% effectiveness for covered conductor. However, MGRA analysis of SCE field data shows that the measured rate of reportable ignitions is reduced by 85% compared to bare wire, so SCE's numbers appear to be significant underestimates. There have been two catastrophic wildfires allegedly associated with SCE equipment since 2020 (Fairview and Bobcat), but these appear to be linked to as yet unhardened circuit segments.

Q. What is the status of SCE's wildfire risk models?

A. SCE's MARS wildfire risk model follows the guidelines set forth in the Settlement Agreement, however it has a number of inaccuracies and biases. On the whole, it likely underestimates overall wildfire risk and the risk of very large catastrophic wildfires. Biases also lead to relative underestimation of wildfire risk in high-wind areas. While SCE includes PSPS risk in its RSE calculations, it is likely that this too is underestimated.

SCE's IWMS framework, which it uses to support its Targeted Undergrounding program (TUG), is not formally a risk model, since it has no probability component. IWMS classifies circuit segments using several heuristic criteria, specifically identifying high wind, limited egress, communities at risk, and high consequence. Because IWMS is not tied to a specific risk definition, it is not possible to directly compare IWMS categories against each other or against MARS risk calculations. However, IWMS categorization does tend overall to compensate for biases in the MARS model. The ideal approach would have been to properly quantify IWMS categories and incorporate them into MARS. However, if SCE carries out its proposed hardening between now and 2028, there will be relatively few unhardened circuits in its HFRA, making this somewhat of a moot exercise. Given the potentially serious biases in MARS raised in this testimony and previous MGRA work, and given that this proceeding needs to decide funding priorities in short order, using the IWMS heuristic to prioritize hardening (though ***not*** choice of mitigation) of specific circuit segments is reasonable.

Q. Are SCE's justifications for its TUG program reasonable?

A. No. SCE has also adopted a zero-tolerance policy for catastrophic wildfire potential in combination of an "as low as reasonably practicable" approach to risk reduction. Consequently, SCE has made undergrounding the default mitigation for circuit segments meeting criteria that SCE defines according to its own risk tolerance policy. The fact that undergrounding is the most expensive mitigation, and that SCE earns a return on equity of 10% on capital improvements, creates a condition of perverse incentive in which SCE is incentivized to choose higher-costing capital mitigations.

There is no dispute that undergrounding is the most effective wildfire mitigation. And there may be specific circuits for which residual risk remaining after covered conductor and advanced technology solutions are applied is still considerable and undergrounding is a good option. However, SCE's stance that any remaining "absolute risk" must be removed, regardless of other considerations, is in conflict with previous Commission determinations. Additionally, IWMS classification is a "binary" criteria that does not distinguish (aside from applied SME judgement) which members of a class present more risk than others. It is therefore of little help in determining which circuits would be particularly beneficial to underground.

Q. What options does SCE have for wildfire risk mitigation other than undergrounding?

A. SCE's covered conductor program is highly effective at reducing wildfire risk. Additionally, SCE is deploying a number of advanced technology solutions that when used in combination with covered conductor substantially reduce residual risk. The most effective of these is REFCL. While it is slow and difficult to deploy and may not be cost effective for all circuits, over time it can bring the greatest benefits in risk reduction. Another technology – DOPD – like REFCL also addresses one of covered conductor's most significant residual vulnerabilities – tree fall-in. These technologies can detect damage from tree contact and de-energize the line so that it that a charged conductor does not remain on the ground.

SCE should also be encouraged (and funded) to accelerate evaluation and deployment of other technical solutions such as HiZ circuit breaker settings and Early Fault Detection. Between underestimation of covered conductor efficiency and the added protection of advanced technologies (possibly in tandem), SCE can mitigate a significant amount of risk.

Finally, the role of PSPS in eliminating residual wildfire risk should not be ignored. While it may be that SCE is underestimating PSPS risk, PSPS is an extremely effective wildfire mitigation for extreme weather conditions. As shown in this testimony, raising the threshold for PSPS drastically reduces the number, duration, and scope of PSPS events. The deployment of covered conductor and advanced technologies may make it safe to further raise PSPS thresholds, a topic that SCE should study using damage report surveys taken after PSPS events.

Q. Is SCE's hardening plan reasonable?

A. No. The SCE hardening plan begins well, with SCE continuing its covered conductor roll-out. However, it rapidly ramps down WCCP in 2025 and then ramps up its undergrounding program, effectively replacing one with the other. In 2028, the program halts, having bought down 73% of the 2023 risk, having spent $3.8 billion, and still having 680 miles of circuit still unhardened.

There are two issues with SCE's plan: First that it is expensive and second that it does not optimally reduce absolute wildfire risk. MGRA presented a number of scenarios that examined cost, risk buydown, and RSE for a number of combinations of undergrounding, covered conductor, and advanced technologies, also examining the effect of underestimation of covered conductor efficiency based on SCE field data.

Of the scenarios examined by MGRA, several offered potential for cost savings of over $1 billion and for absolute risk buy down equaling or exceeding SCE's proposal. These would entail a substantial reduction of the TUG program, moving de-scoped TUG circuits to CC+REFCL, expanding the WCCP program so that SCE's entire HFRA is hardened by 2028, and finally expanding advanced technology solutions such as REFCL as they become available.

Q. What other factors need to be weighed in as the Commission decides on the appropriate balance of mitigations?

A. Other factors need to be taken into account that are not currently quantified in a manner that can be directly used in a cost/benefit or risk/benefit approach. First, the Commission needs to be aware that affordability is not just a matter of preference or convenience for some customers, it has direct impacts on how well, healthily, and safely they live their lives. So it is reasonable for consumer advocates to question the extent of SCE's hardening program. Additionally, PSPS risk may be significantly underestimated by SCE, which would support undergrounding, but countering this is the potential for SCE to further raise its threshold for hardened circuits. Finally, the "correct" approach to wildfire mitigation should look at overall lifecycle costs for risks and mitigations. However, SCE's use of IWMS does not allow direct quantification of risks, so this type of analysis can't be performed in the current framework unless SCE quantifies probabilities for IWMS risks and properly incorporates them into MARS.

SUMMARY

Q. What are the major conclusions you have reached in this testimony?

A. My major conclusions are:

- SCE's MARS risk model underestimates catastrophic losses, particularly at a greater distance from the ignition point, due to its 8 hour limitation on wildfire spread simulations.
- SCE's MARS risk model underestimates risk in high wind areas due to lack of historical data during PSPS outages.
- MARS does not combines probability of Ignition (POI) and consequences during extreme weather events correctly and thereby underweights risk drivers likely to occur during high wind events.
- SCE has abandoned the use of Risk Spend Efficiency (RSE) for the choice of mitigation, focusing on removal of "absolute risk" to "as low as reasonably practicable", which is not in compliance with the Settlement Agreement.
- SCE has provided estimates for combined wildfire mitigation efficiencies for covered conductor and REFCL, as well as other advanced technologies.
- SCE earns a return of 10% on capital improvements, which creates a perverse incentive to choose more expensive capital mitigations.
- IWMS is a heuristic approach that does not contain a probability component, and therefore is not a risk model, and is not compliant with the Settlement Agreement.
- IWMS classification categories identify specific elevated risk scenarios that are not identified adequately by MARS, and therefore have merit.

- Using a heuristic approach can be justifiable when potential consequences are large and probabilities and risk models have large uncertainties.
- SCE adopts a very low value for PSPS harm, and this is may possibly increase once it shifts to the ICE model.
- The correct manner for SCE to have incorporated the risks identified in IWMS is to develop quantitative risk descriptions including probabilities and incorporate them into MARS. Doing so in the future may help prioritization of advance technology deployments and doing long-term planning.
- IWMS categorizations, specifically High Wind Location and High Consequence, when used to prioritize circuits may compensate for specific MARS biases.
- The IWMS High Wind Location criterion of 58 mph gust threshold is not extreme in the SCE service area. Nevertheless, weather stations proximate to some circuits that are classified as "High Wind Locations" fail to exceed this threshold.
- Raising the wind threshold for PSPS shutoff would substantially reduce the number, scope, and duration of PSPS events.
- While SCE's limited egress model may or may not be fully proportional to actual risk experienced by residents of limited egress areas, SCE is the first large IOU to implement such a model and its model is valuable in classifying areas in need of mitigation.
- SCE claims to have mitigated 2/3 of its wildfire risk since 2017 through the deployment of 5,400 miles of covered conductor and implementation of Fast Curve circuit breaker settings.
- The actual risk reduced may be significantly higher because of enhanced vegetation management, distribution asset ground inspections, power shutoff, and the limited introduction of advanced technologies such as EFD, REFCL, and DOPD.
- SCE is planning to ramp down its successful WCCP (covered conductor) and replacing it with TUG starting in 2025.

- While SCE claims that the effectiveness of covered conductor in reducing wildfire ignitions is 72%, analysis of its field data shows an 85% reduction when compared to bare wire. This is a statistically significant difference.
- SCE has established leadership in the understanding and deployment of REFCL technology, which in combination with covered conductor leads to significant reductions in wildfire risk.
- Analysis of different combinations of undergrounding, REFCL, and covered conductor in SCE's service territory shows that significant savings may be obtained while still achieving risk buy-down equivalent to or possibly better than SCE's TUG proposal.
- Because of undergrounding's slow deployment, some of the highest risk areas may remain at risk for longer while waiting for underground hardening.
- When potential rate increases are compared to the curve of life expectancy versus income it shows that the number of potential years of life lost is considerable and possibly comparable to wildfire losses if one assumes a causal relationship.

RECOMMENDATIONS

Q. What are your primary recommendations regarding SCE's General Rate Case?

A. My recommendations are listed below.

- SCE's zero risk tolerance policy requiring reduction of absolute risk to "as low as practicable" regardless of cost or implementation time is not compliant with the Settlement Agreement and prior Commission decisions, and should not be permitted as a basis for mitigation choices.
- Using weather station data to validate indicates some circuits may not even be regularly experiencing the 58 mph threshold. These circuits

should be reviewed and possibly removed from this classification. Examples include Sagehen and Jordan circuits.

- SCE should provide a quantitative study of increasing its PSPS shutoff threshold using WRF and surface wind data and circuit incidents identified during PSPS inspections with a goal of reducing the number, scope, and duration of PSPS events.
- Undergrounding or CC+REFCL should be prioritized for circuits with compelling and quantitative justifications such as limited community ingress and egress, excessive tree removal, excessive vegetation management or asset maintenance costs, favorable coincidences of geography and property, and the most extreme wind areas as identified by surface weather station data, such as the Energy, Shovel, Sand Canyon, and Penstock circuits.
- SCE should be required to accelerate its evaluation and deployment of REFCL, Hi-Z, DOPD, and EFD, and should be provided adequate funding to expand these programs.
- Fast Curve circuit breaker settings should be deployed in combination with REFCL because it mitigates multi-phase and phase-to-ground faults that REFCL does not.
- Over $1.5 billion in savings could be obtained by deploying CC+REFCL instead of undergrounding on 2/3 of circuits proposed as part of SCE's TUG program, though this would result in 10% less risk buy-down than SCE's proposal.
- Over $1 billion in savings might be obtained by deploying CC+REFCL instead of undergrounding on 2/3 of circuits proposed as part of SCE's TUG program and also the 680 miles line that SCE did not plan to harden before 2028. This scenario may also lead in the longer term to more risk buy-down than SCE's proposal as REFCL is fully deployed.
- Affordability should be given serious and quantitative consideration when considering risk reduction, since the lowest income and vulnerable ratepayers will suffer a variety of risks from substantial rate increases.

Q. Have you provided workpapers to support this testimony?

A. Yes. The workpapers and files supporting this testimony have been posted on the Github public repository at:

https://github.com/jwmitchell/Workpapers/tree/main/SCEGRC25

Some workpapers have also been posted to Mendeley, as specified in the corresponding references:

https://data.mendeley.com/datasets/8nds4cx88k/3

Q. Do you have further testimony?

A. This concludes my testimony for MGRA.

APPENDICES

APPENDIX A – Joseph W. Mitchell, Ph.D. Vitae

JOSEPH W. MITCHELL, PH.D.

19412 Kimball Valley Rd.
Ramona, CA 92065
jwmitchell@mbartek.com
https://www.mbartek.com
858 228 0089

Joseph Mitchell's career has spanned several fields over the decades of his professional life. As a an experimental particle physicist, he developed excellence in scientific methodology at laboratories in the United States (Los Alamos National Laboratory) and Europe (CERN in Geneva, DESY in Germany). He switched to the software industry while still living in Europe, working for Sony in Brussels and San Diego, and finally for Intuit, Inc. Over the 23 years of his software career, he worked as both an engineer and manager, supporting the creation of embedded software for consumer products and financial software products such as QuickBooks and TurboTax.

After settling in California, at the request of his wife he applied his scientific skills to develop a novel wildfire protection system (WEEDS) for their home. This system protected their home in the 2003 Cedar fire, after which Dr. Mitchell published the design of the system in the world's leading fire engineering journal and founded M-bar Technologies and Consulting, LLC to publicize the importance of protecting homes from embers during wildfires. In 2009 he was selected to serve on the California State Fire Marshal Task Force which established a framework for testing ignition-resistant construction proposed for the 2010 update to the California Building Code. With this background, Dr. Mitchell was able to establish himself as an expert in wildfire at the California Public Utilities Commission (CPUC).

Dr. Mitchell has been an expert witness at the CPUC on issues regarding wildfire and powerlines since 2006 and has authored academic papers on wildfires caused by utility infrastructure. He was the first to recognize and warn of the potential for catastrophic power line firestorms. He proposed and successfully advocated at the CPUC for the first utility fire protection plans aimed at preventing catastrophic fire ignitions. He also proposed the process that led to the statewide utility fire hazard maps created by the CPUC and CAL FIRE, and regulations requiring utilities to provide fire ignition data to the CPUC. As expert witness for and board member of the Mussey Grade Road Alliance (MGRA or Alliance), a grass-roots organization on the wildland urban interface in the San Diego backcountry that seeks to improve fire safety in California, he has helped to oppose utility applications that would compromise public safety, offering both testimony and comment.

Physics and Fire Science Vitae

2020-2024 – Dr. Mitchell has become deeply involved in the General Rate Case cycles, for PG&E, SDG&E, and SCE. These rate case cycles begin with a risk assessment phase (RAMP), during which Dr. Mitchell has provided substantial input to improve utility risk model, much of which has been supported by the Commission and adopted by utilities. He has also worked on the rate cases as well and supports a holistic cost/benefit analysis approach to ratemaking that takes into account wildfire risks, power shutoff risks and mitigations, new technologies, hardening programs, wildfire smoke effects, and the impact of rate increases on the health and safety of the poorest segment of the population.

Dr. Mitchell has also supported the Mussey Grade Road Alliance in the review of the 2019, 2020, and 2021 Wildfire Mitigation Plans from the three major California utilities. Dr. Mitchell's unique contributions result from his ability to perform detailed physical, statistical, mathematical, regulatory, and logical analyses of utility submissions, and many of his suggestions have been adopted by the CPUC, the Wildfire Safety Division, and the Investor-Owned Utilities (IOUs). Dr. Mitchell and MGRA continue to advocate for a more active role for the CPUC in the regulation of utility power shutoff ("PSPS"), and were the first to suggest that shutoff thresholds need to balance risks and benefits from both wildfire and power shutoff. Conducted a review of PG&E's website failure during the October 2019 power shutoff events. Another theme of Dr. Mitchell's work is that utility undergrounding programs are extremely expensive and in most cases should be replaced by covered conductor in combination of advanced technologies including REFCL.

2018-2019 – Supported the Mussey Grade Road Alliance in the aftermath of the Northern California 2017 and 2018 power line firestorms in their opposition to legislation that would compromise fire safety. Authored expert comment in CPUC proceedings following from passage of Senate Bill 901, including utility wildfire mitigation plans, proactive power shutoff, utility liability, and the safety culture and potential re-organization of PG&E. Made substantive contributions to the development Wildfire Mitigation Plans and guidelines for utility proactive power shutoff.

2017-2018 – Authored a chapter on radiant heat in the Encyclopedia of Wildfires and Wildland Urban Interface (WUI) Fires.

2009-2017 – Provided key fire safety testimony used in San Diego Gas and Electric Company's (SGE&E) WEBA and WEMA CPUC applications, which were utility proposals to pass on wildfire liability costs to ratepayers. Applications and appeals were denied.

2008-2017 – Participation in ongoing California Public Utility Commission (CPUC) safety proceedings on behalf of MGRA. Jointly sponsored proposed rules with the Consumer Protection and Safety Division (CPSD/SED) and facilitated participation of CAL FIRE. Four rule changes that were proposed on behalf of MGRA (or jointly proposed with the CPSD) were fully or partially accepted by a decision of the California Public Utilities Commission. Continuing to participate on issues of fire data collection and high-resolution fire threat maps for utilities. Made key contributions to the Safety Model Assessment Proceeding (S-MAP). Also analyzed utility fire safety data as a component of SDG&E's 2016 rate case.

2012-2013 – Presented on the power line fire threat at the International Conference on Engineering Failure Analysis conference in the Hague, Netherlands. Published in Engineering Failure Analysis in 2013.

2011 – Presented on the power line fire threat and California's regulatory response at the annual Wildland Fire Litigation Conference.

2009 – Presented paper and presentation at *Fire and Materials 2009* on catastrophic power line fires, which was the first paper to demonstrate the relationship between wind, fire suppression efficiency, and power line failure rates. Served on a California State Fire Marshal Task Force, which established a framework for testing ignition-resistant construction proposed for the 2010 update to the California Building Code. WEEDS water spray system was featured in a news segment by San Diego television station KGTV.

2008-2009 – Successfully opposed an application by San Diego Gas & Electric Company to shut off power under regularly occurring wind conditions, arguing instead for a cost/benefit analysis – a recommendation that was adopted by the CPUC.

2007-2008 – Submission of expert witness testimony on behalf of MGRA in the CPUC hearings for the proposed SDG&E "*Sunrise Powerlink*" transmission line on the subject of power lines and wildland fire, which included cross-examination and contribution to briefs. Demonstrated potential fire risks from transmission lines, and also found a significantly larger number of power line fires in San Diego County.

2007 – Presented work with Oren Patashnik at *Fire & Materials 2007* conference in San Francisco, whose Scripps Ranch data demonstrated potential ember vulnerability of curved-tile roofing (confirmed in 2009 by NIST research). Provided comment on and criticism of San Diego County's 'shelter-in-place' guidelines. Wrote an op-ed piece published in the San Diego Union Tribune and provided commentary for News 8 KFMB piece on shelter-in-place. Submitted expert testimony for CPUC on *Sunrise Powerlink* project.
2006 – Publication of peer-reviewed paper on the WEEDS water-spray wildland fire protection system in the *Fire Safety Journal*. Presentation of results at the *Third International Fire Ecology and Management Congress*, San Diego, CA.
2001-2005 – Developed the WEEDS method for structure defense during wildland fires. Completed in time for the October 26, 2003 Cedar fire, when it was validated under wildfire conditions. Founded M-Bar Technologies and Consulting to promulgate knowledge regarding WEEDS and the importance of designing for firebrand protection under high-wind conditions. Poster session at *Wildfire 2004* conference, Reno, NV. Articles published in *San Diego Reader* magazine and in *Home&fire* and *Wildfire* trade magazines. Computer modeling validates WEEDS principles.
1999 – Returned to the United States from Europe, settling in San Diego, CA.
1996-2019 – Work in software engineering and management for major multinational corporations.
1989-1998 – Lived and worked in Europe first as a postdoctoral physicist and then in software engineering for a multinational corporation. Resided in Switzerland, Germany, France, and Belgium.
1993-1996 – Postdoctoral work for University of California at Davis in heavy ion physics, performed at CERN. Continuing with work in lasers, optical systems and computer modeling.
1989-1993 – Postdoctoral work for McGill University in high energy physics at CERN (Center for European Nuclear Research, Geneva, Switzerland) and DESY (Deutsches Electron-Synchrotron, Hamburg, Germany). Developed expertise in energy measurement, computer modeling, lasers and optical systems.
1989 – Ph. D. in Physics received from Ohio State University, Columbus, Ohio
1981-1989 – Graduate research in elementary particle (neutrino) physics, Columbus and Los Alamos National Laboratory, NM. Trained in electronics, mechanical engineering, computing, energy measurement and statistics.
1981-1983 – Graduate teaching assistant, OSU physics department.
1981 – Bachelor of Science in Physics received from Ohio State University, Columbus, Ohio

Expert Testimony and Technical Commentary

Provided all technical input on wildland fire for the following CPUC Proceedings for the Mussey Grade Road (MGRA):

A.06-08-010 – San Diego Gas & Electric Sunrise Powerlink transmission line application
P.07-11-007 – SDG&E fire safety petition.
R.08-11-005 – Wildfire safety rulemaking.
A.08-12-021 – SDG&E application for pro-active power shutoff.
(includes J. W. Mitchell report "*When to Turn Off the Power? Cost/Benefit Outline for Proactive De-energization*", March 27, 2009)
A.09-08-021 – SDG&E application to recover costs of 2007 wildfires.
A.13-11-006 - Rulemaking to Develop a Risk-Based Decision-Making for Energy Utilities.
A.14-11-003 – SDG&E 2016 rate case.
A.15-05-002-5 –Review of SDG&E Safety Model Assessment

R.15-05-006 – Rulemaking to Develop and Adopt Fire-Threat Maps and Fire-Safety Regulations.
A.15-09-010 – SDG&E application to recover costs of 2007 wildfires.
R.18-10-007 – Order Instituting Rulemaking to Implement Electric Utility Wildfire Mitigation Plans Pursuant to Senate Bill 901.
R.18-12-005 – Order Instituting Rulemaking to Examine Electric Utility De-Energization of Power Lines in Dangerous Conditions
I.15-08-019; PG&E safety culture investigation.
R.19-01-006 – Order Instituting Rulemaking to Implement Public Utilities Code Section 451.2 Regarding Criteria and Methodology for Wildfire Cost Recovery Pursuant to Senate Bill 901 (2018).
I.19-11-010-11 – SDG&E RAMP Proceeding (suspended)
I.19-11-013 – Order Instituting Investigation on the Commission's Own Motion on the Late 2019 Public Safety Power Shutoff Events
2020 Wildfire Mitigation Plans
A.20-06-012 – PG&E RAMP Proceeding
A.21-05-013 – SDG&E RAMP Proceeding
A.21-06-021 – PG&E General Rate Case
A.22-05-013 – SCE RAMP Proceeding
A.22-05-015/6 – SDG&E General Rate Case
R.20-07-013 – Risk-based Decision-making Framework Rulemaking
2021 Wildfire Mitigation Plans
2022 Wildfire Mitigation Plans
2023 Wildfire Mitigation Plans

Publications

Fire Publications & Presentations - Academic

Mitchell, J.W., 2023. Analysis of utility wildfire risk assessments and mitigations in California. Fire Safety Journal 140, 103879. https://doi.org/10.1016/j.firesaf.2023.103879
Supported by dataset:
Mitchell, J.W., 2023. IAFSS_2023_JWMitchell_UtilityWildfires. https://doi.org/10.17632/8nds4cx88k.3

Mitchell, Joseph W. "Analysis of Utility Wildfire Risk Assessments and Mitigations in California." Presented at The 14th International Symposium on Fire Safety Science, Tsukuba, Japan, October 27, 2023. https://14th-iafss.boxcn.net/s/tmjdompfpx6vh6fcje8b192a5r119wgs.

Mitchell, J.W., 2018. Radiant Heat, in: Manzello, S.L. (Ed.), Encyclopedia of Wildfires and Wildland-Urban Interface (WUI) Fires. Springer International Publishing, Cham, pp. 1–6. https://doi.org/10.1007/978-3-319-51727-8_65-1 (in press)

Mitchell, Joseph W.; Power line failures and catastrophic wildfires under extreme weather conditions; Engineering Failure Analysis; Volume 35, 15 December 2013, Pages 726–735 (ICEFA V, The Hague, The Netherlands, July 3, 2012) http://www.sciencedirect.com/science/article/pii/S1350630713002343

Mitchell, Joseph W.; "Power Lines and Catastrophic Wildland Fire in Southern California"; Presentation to the Fire & Materials 2009 Conference, San Francisco CA, Jan 26, 2009. http://www.mbartek.com/images/FM09_JWM_PLFires_1.0fc.pdf

Mitchell, Joseph W. and Oren Patashnik**;** Firebrand Protection as the Key Design Element for Structure Survival during Catastrophic Wildland Fires; Fire and Materials 2007, San Francisco, CA; Jan 29-31, 2007.
http://www.mbartek.com/images/FM07_FirebrandsWildfires_1.1F.pdf

Mitchell, Joseph W.; REDUCING URBAN INTERFACE ECOLOGICAL IMPACTS AND FIRE LOSSES THROUGH STRUCTURAL FIREBRAND PROTECTION; Third International Fire Ecology and Management Conference; San Diego, CA; Nov. 13-17, 2006.

Mitchell, Joseph W.; Wind-enabled ember dousing; Fire Safety Journal; v. 41 (2006); pp 444-458. https://www.sciencedirect.com/science/article/abs/pii/S0379711206000567

WEEDS poster session; Wildfire 2004 conference, Reno, NV; Mar. 2004.

Presentations to Public Officials

Senate Energy, Utilities and Communications Subcommittee on Gas, Electric and Transportation Safety Hearing of 05-03-2016
https://ca.digitaldemocracy.org/hearing/1083?startTime=698&vid=1OQ4lwsNiZY Starting 23:37

Fire Publications & Presentations – Trade and General Public – Press Articles

Worth, K., Pinchin, K., Sullivan, L., 2020. "Deflect, Delay, Defer": Decade of PG&E Wildfire Safety Pushback Preceded Disasters [WWW Document]. KQED. URL https://www.kqed.org/news/11833283/deflect-delay-defer-decade-of-pge-wildfire-safety-pushback-preceded-disasters (accessed 6.6.21).

Mitchell, Joseph W.; Goaded into Action: California's Regulatory Response to the Power Line Fire Threat
Presented at the 5th Annual Wildland Fire Litigation Conference, April 16, 2011

Conklin, Diane and Joseph W. Mitchell; The PUC should deny this plan outright; The San Diego Union Tribune; May 10, 2009.
http://www3.signonsandiego.com/stories/2009/may/10/puc-should-deny-plan-outright/?uniontrib

Mitchell, Joseph W; Wind-Enabled Ember Dousing - A comparison of wildland fire protection strategies; Prepared for the Ramona Fire Recovery Center, 8/12/2008.
http://www.mbartek.com/images/Mbar_WEEDS_Comparison_web.pdf

Mitchell, Joseph W.; Playing with fire: The county's 'Shelter in Place' gamble; The San Diego Union-Tribune; May 2, 2007, p. B7.
http://www.signonsandiego.com/uniontrib/20070502/news_lz1e2mitchell.html

Mitchell, Joseph W.; Brand Dilution (Cover article); Wildfire Magazine; Mar. 2005
http://wildfiremag.com/wui/brand_dilution/

Mitchell, Joseph W.; WEEDS: Wind Enabled Ember Dousing System; Home&fire Magazine; Spring,2005; p. 32

Mitchell, Joseph; Engineering a Miracle; San Diego Weekly Reader Magazine; April 29, 2004

Physics: List of neutrino, high-energy, and heavy ion physics publications is available upon request, or at Google Scholar:
https://scholar.google.com/citations?hl=en&user=IuKprhoAAAAJ&view_op=list_works&sortby=pubdate

Software Industry Experience

Intuit, San Diego – Staff Engineer

2005 - 2019

Led and contributed to transitions through multiple generations of build and deployment pipelines, emphasizing automation and seamless end-user experience.
Built enterprise-wide Jenkins build system based on AWS, Chef, and CloudFormation and transitioned major projects such as TurboTax onto the corporate infrastructure.
Built tools and engaged with business unit teams to migrate builds from both internal and AWS-based build infrastructure to Kubernetes-based AWS build infrastructure.
Worked across organizational boundaries to develop, acquire and proselytize DevOps best practices.
Designed and built three generations of build systems using best current technology for Intuit's Central Technology Organization.
Designed, drove and implemented user engagement models that enabled a small team with one rotating support engineer to support 60% of builds for the entire enterprise.
Led migration of Central Technology Organization through two generations of source control systems (first to Perforce, then to Git).

Sony, Brussels and San Diego — Software Developer, SCM Engineer, SCM Manager

1996 - 2005

Managed a four person SCM team developing embedded software for Sony cable and satellite television products.
Developed virtualized build system following standard patterns and transitioned development team onto best of breed source control.

Contact info:

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Ramona, CA 92065
Phone: 858 228 0089
Email: jwmitchell@mbartek.com
Website: www.mbartek.com

Appendix B – SCE Responses to MGRA Data Requests

GIS Data:

Please provide the GIS data set provided to the Office of Energy Infrastructure Safety. This should be a complete and not incremental set, provided in geodatabase format. Data should be current as of December 12, 2023. This includes data not provided in previous data requests, including 2022 Q4, 2023 Q1, 2023Q2, 2023 Q3 (if available)

Please remove any confidential attributes that may have been added to the requested records.

MGRA-1-1 Please provide for Asset Point data for Camera, Support Structure, and Weather Station.

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

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

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

MGRA-1-5 Under Initiatives, please provide Grid Hardening data, including Hardening Log, Hardening Point, and Hardening Line data. Inspection data is not requested at this time.

MGRA-1-6 Under Other Required Data, please provide Red Flag Warning Day polygon data.

MGRA-1-7 Please provide a layer indicating calculated circuit-level risk using the methodology presented in the WMP.

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

2025 General Rate Case
SCE
MGRA Data Request No. 2
January 5, 2024

SCE Hardening and Risk Reduction

MGRA-2-1 MGRA-2-4 Please provide an excel spreadsheet table that provides for 2019, 2020, 2021, 2022, and 2023:

a) Number of miles of fully covered conductor circuit segments in the HFRA.

b) Number of miles of fully “bare wire” conductor circuit segments in the HFRA

c) Number of wires down for fully covered conductor circuit segments in the HFRA.

d) Number of wires down for fully “bare wire” conductor circuit segments in the HFRA,

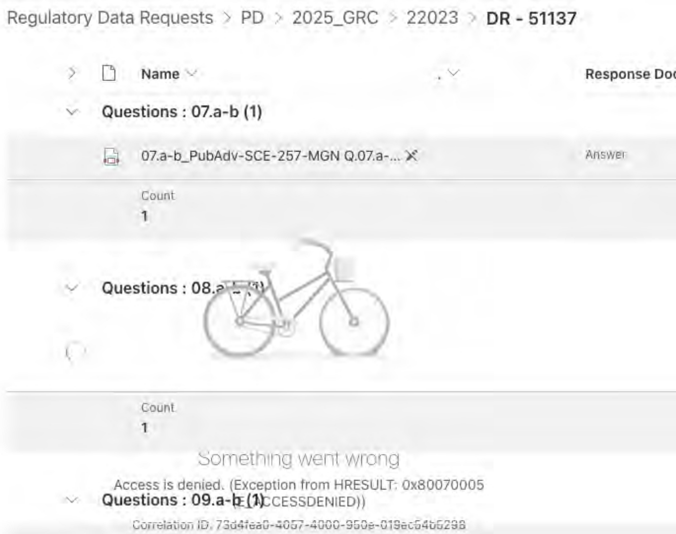
e) Number reportable ignitions for fully covered conductor circuit segments segments in the HFRA.

f) Number reportable ignitions for fully “bare wire” conductor circuit segments in the HFRA

MGRA-2-2 What is SCE's estimate of risk buydown from 2018 to 2019 and absolute and relative risk remaining in the system? Provide YoY estimate by circuit. Provide both total risk and risk per mile. Use single MARS version if possible and most recent MARS model if possible.

MGRA-2-3 Provide a version of file released in response to PubAdv-SCE-074-MGN “sce_2025_grc_wildfire_covered_conductor_and_targeted_undergrounding_projects.xlsx” with confidential fields redacted.

MGRA-2-4 Provide document PubAdv-SCE-257-MGN Q8ab attachment.xlsx, if necessary redacting any confidential fields. This document does not appear to have been correctly uploaded and causes sharepoint to produce an error (shown below).


Regulatory Data Requests > PD > 2025_GRC > 22023 > DR - 51137
Name
Response Doc
Questions : 07.a-b (1)
07.a-b_PubAdv-SCE-257-MGN Q.07.a-...
Answer
Count
1
Questions : 08.a
Count
1
Something went wrong
Access is denied. (Exception from HRESULT: 0x80070005
CCESSDENIED))
Questions : 09.a-b (1)
Correlation ID: 73d4fea0-4057-4000-950e-019ec54b5298

Southern California Edison
A.23-05-010 – SCE 2025 GRC

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

To: MGRA
Prepared by: Kyle Ferree
Job Title: Senior Advisor
Received Date: 1/5/2024

Response Date: 1/22/2024

Question 2-1.a-f:
MGRA-2-4 Please provide an excel spreadsheet table that provides for 2019, 2020, 2021, 2022, and 2023:

a) Number of miles of fully covered conductor circuit segments in the HFRA.
b) Number of miles of fully “bare wire” conductor circuit segments in the HFRA
c) Number of wires down for fully covered conductor circuit segments in the HFRA.
d) Number of wires down for fully “bare wire” conductor circuit segments in the HFRA,
e) Number reportable ignitions for fully covered conductor circuit segments in the HFRA.
f) Number reportable ignitions for fully “bare wire” conductor circuit segments in the HFRA

Response to Question 2-1.a-f:

a) Please see file “MGRA-SCE-002_Q2-1 for miles of overhead HFRA distribution by wire type, HFRA wire down events by wire type, and HFRA ignitions by wire type.
b) See part a. Bare miles were calculated by subtracting WCCP miles from the total HFRA miles.
c) See part a.
d) See part a.
e) See part a. Provided are counts of HFRA CPUC Reportable ignition counts split by whether the structure had CC installed prior to ignition or not. The fact that covered conductor was installed does not indicate covered conductor was not performing to expectation. These outages can be on the secondary system and do not interact with the covered conductor or were associated with risk drivers that covered conductor was not expected to be effective against.
f) See part a.

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

To: MGRA
Prepared by: Daniel Komula
Job Title: Senior Advisor
Received Date: 1/5/2024

Response Date: 1/16/2024

Question 2-3:
Provide a version of file released in response to PubAdv-SCE-074-MGN "sce_2025_grc_wildfire_covered_conductor_and_targeted_undergrounding_projects.xlsx" with confidential fields redacted.

Response to Question 2-3:

Please see the attached file, PubAdv-SCE-074-MGN-01a-x-Revised_Attachment that has anonymized circuit IDs.

Southern California Edison
A.23-05-010 – SCE 2025 GRC

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

To: MGRA
Prepared by: Daniel Komula
Job Title: Senior Advisor
Received Date: 1/5/2024

Response Date: 1/16/2024

Question 2-4:
Provide document PubAdv-SCE-257-MGN Q8ab attachment.xlsx, if necessary redacting any confidential fields. This document does not appear to have been correctly uploaded and causes sharepoint to produce an error (shown below).

Response to Question 2-4:

SCE has fixed the link in the referenced question:

https://edisonintl.sharepoint.com/:f:/t/Public/regpublic/Eu6Pouxw79NFiS2z5277KWgByAaTDwn3SvRpo2EbBHXsgQ

SCE has also added the attachment, which is public, to this response as well.

2025 General Rate Case
SCE
MGRA Data Request No. 3
January 12, 2024

Non-Confidential and Enhanced Versions

MGRA-3-1 Please provide a non-confidential version of file Confidential_PubAdv-SCE-155-MGN_Q1.xlsx.

MGRA-3-2 Please provide a non-confidential and updated version of Confidential_ED-SCE-003_Q1_WCCP-TUG-RSEs.xlsx

MGRA-3-3 As described in SCE's Wildfire Mitigation Plan Section 8.3.3.4, please provide SCE's FIPA ignitions including all non-confidential fields. Geodatabase is preferred, alternatively Excel spreadsheet format.

MGRA-3-4 Provide Figure II-3 in higher resolution.

MGRA-3-5 For expenditures, Table I-1 (O&M Expenditures) and Table I-2 (capital expenditures), please break grid hardening into "Covered Conductor", "Targeted Undergrounding", and "Other"

MGRA-3-6 Please provide the geodatabases underlying maps II5, II6, and II 7, II-10

MGRA-3-7 Please provide a map of HFRA areas. Mark areas that 1) now part of the Cal Fire HFTD zones, 2) for which HFTD status.has been applied and 3) SCE consideres the are HFRA and has not yet requested Cal Fire review

MGRA-3-8 Provide a GIS file showing which circuits are subject to IWMS and why.

MGRA-3-9 Please provide a geodatabase version of map on page 37 IWMS Risk Tranche Designations

MGRA-3-10 Show a map of SRA Critera #4, Communities of Elevated Concern.

a. What were the criteria applied to identify these communities.

b. Were algorithms used do classify these areas, if so what algorithm?

c. Or were SMEs making this distincition if so under what criteria?

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 3

To: MGRA
Prepared by: Daniel Komula
Job Title: Senior Advisor
Received Date: 1/12/2024

Response Date: 1/22/2024

Question 3-1:
Please provide a non-confidential version of file Confidential_PubAdv-SCE-155-MGN_Q1.xlsx

Response to Question 3-1:

Please see the attached file, Public_PubAdv-SCE-155-MGN_Q1.xlsx, that has anonymized data. This is the revised response that incorporates updates made consistent with our amended testimony.

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 3

To: MGRA
Prepared by: Daniel Komula
Job Title: Senior Advisor
Received Date: 1/12/2024

Response Date: 1/22/2024

Question 3-2:
Please provide a non-confidential and updated version of Confidential_ED-SCE-003_Q1_WCCP-TUG-RSEs.xlsx

Response to Question 3-2:

Please see the attached file, Public_ED-SCE-003_Q1_WCCP-TUG-RSEs.xlsx, that has anonymized data. This is the revised response that incorporates updates made consistent with our amended testimony.

DATA REQUEST SET M G R A - S C E - 0 0 3

To: MGRA
Prepared by: Jonathan Brownstein
Job Title: Manager
Received Date: 1/12/2024

Response Date: 1/29/2024

Question 3-3:
As described in SCE's Wildfire Mitigation Plan Section 8.3.3.4, please provide SCE's FIPA ignitions including all non-confidential fields. Geodatabase is preferred, alternatively Excel spreadsheet format.

Response to Question 3-3:
FIPA (Fire Investigation Preliminary Analysis) ignitions include all completed, non-claims related ignition events that have some interaction with SCE facilities. There are SCE facility-involved ignitions as well as 3rd party-involved ignitions within the data. Please see the attached Excel file titled "MGRA_SCE_003_FIPA_Extract.xlsx". Collection of FIPA data began in 2019 and continues to present day.

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 3

To: MGRA
Prepared by: Daniel Komula
Job Title: Senior Advisor
Received Date: 1/12/2024

Response Date: 1/22/2024

Question 3-4:
Provide Figure II-3 in higher resolution

Response to Question 3-4:

Please see the attached file, MGRA-SCE-003_Q4.pptx, with the image for Figure II-3.

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 3

To: MGRA
Prepared by: Daniel Komula
Job Title: Senior Advisor
Received Date: 1/12/2024

Response Date: 1/22/2024

Question 3-5:
For expenditures, Table I-1 (O&M Expenditures) and Table I-2 (capital expenditures), please break grid hardening into “Covered Conductor”, “Targeted Undergrounding”, and “Other”.

Response to Question 3-5:

SCE assumes that this question is referring to Table I-1 and Table I-2 in SCE-04 Vol. 05 Part 1A. Please see the tables below for the requested breakdowns.

Activity	TY 2025 O&M (Constant 2022 $000s)	Notes
Covered Conductor	$927	The O&M forecast for this is under the GRC activity Supplemental System Hardening Activities
Targeted Undergrounding	N/A	There are no forecasted O&M expenses associated with Targeted Undergrounding
Other	$785	This is associated with REFCL

Activity	2023 2028 Capital Expenditure Forecast (Nominal $000s)
Covered Conductor	$2,641,485
Targeted Undergrounding	$3,341,235
Other	$301,061
Total	**$6,283,781**

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 3

To: MGRA
Prepared by: Bryan Landry
Job Title: Senior Advisor – Enterprise Risk Management
Received Date: 1/12/2024

Response Date: 1/29/2024

Question 3-6:
Please provide the geodatabases underlying maps II5, II6, and II 7, II-10

Response to Question 3-6:

See GDB files entitled "Figure_II_5;" "Figure_II_6;" "Figure_II_7;" "Figure_II_10a;" and "Figure_II_10b" attached.

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 3

To: MGRA
Prepared by: Bryan Landry
Job Title: Senior Advisor
Received Date: 1/12/2024

Response Date: 1/29/2024

Question 3-7:
Please provide a map of HFRA areas. Mark areas that 1) now part of the Cal Fire HFTD zones, 2) for which HFTD status.has been applied and 3) SCE consideres the are HFRA and has not yet requested Cal Fire review

Response to Question 3-7:

SCE interprets this question to mean "CPUC Tiers" instead of "Cal Fire HFTD zones." We note that while Cal Fire has separate Fire hazard Severity Zone (FHSZ) maps, those maps are used to designate areas where California's defensible space standards and wildland urban interface building codes are required and are separate and distinct from CPUC High Fire Threat District Tiers. CPUC HFTD maps are used to identify locations "where there is an elevated hazard for *utility-associated* [emphasis added] wildfires to occur and spread rapidly, and where communities face an elevated risk from utility-associated wildfires."[1]

In December of 2020, the CPUC approved SCE's Petition for Modification (PFM) (Decision 20-12-030) to incorporate SCE's High Fire Risk Areas (HFRA), which had been previously separate and distinct from draft CPUC HFTD locations into updated CPUC HFTD maps.

However, SCE has reserved the right to designate locations outside of the officially adopted HFTD boundaries as HFRA, until such time as those locations can be submitted (through a PFM) as HFTD.

Currently, SCE maintains a 200-foot buffer around CPUC HFTD and has designated these locations HFRA. These SCE HFRA locations amounts to less than 1% difference in total surface area from CPUC HFTD maps.

See map "HFTD compared to HFRA" attached, which identifies:

1. Locations of CPUC HFTD within SCE's service territory – in yellow/red.

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[1] Decision 17-01-009, issued January 19, 2017, pg. 2. Utilities are directed to utilize these maps to meet fire safety regulations as adopted in Decision 17-12-024.

2.) N/A. SCE has no open PFM for portions of CPUC HTFD within SCE's service territory.

3.) Locations in which SCE considers HFRA but are not considered HFTD in fuchsia and purple. See callout in top right for additional detail.

DATA REQUEST SET M G R A - S C E - 0 0 3

To: MGRA
Prepared by: Kyle Ferree
Job Title: Senior Advisor
Received Date: 1/12/2024

Response Date: 1/29/2024

Question 3-8:
Provide a GIS file showing which circuits are subject to IWMS and why.

Response to Question 3-8:
Please see the attached file, "MGRA_SCE_003_Q8.gdb.zip". All of SCE's overhead distribution circuits in HFRA are subject to IWMS. SCE has mapped them and included the HFRA tier and IWMS Risk Category for each.

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 3

To: MGRA
Prepared by: Kyle Ferree
Job Title: Senior Advisor
Received Date: 1/12/2024

Response Date: 1/29/2024

Question 3-9:
Please provide a geodatabase version of map on page 37 IWMS Risk Tranche Designations

Response to Question 3-9:
Please see the attached file, "MGRA_SCE_003_Q9.gdb.zip".

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 3

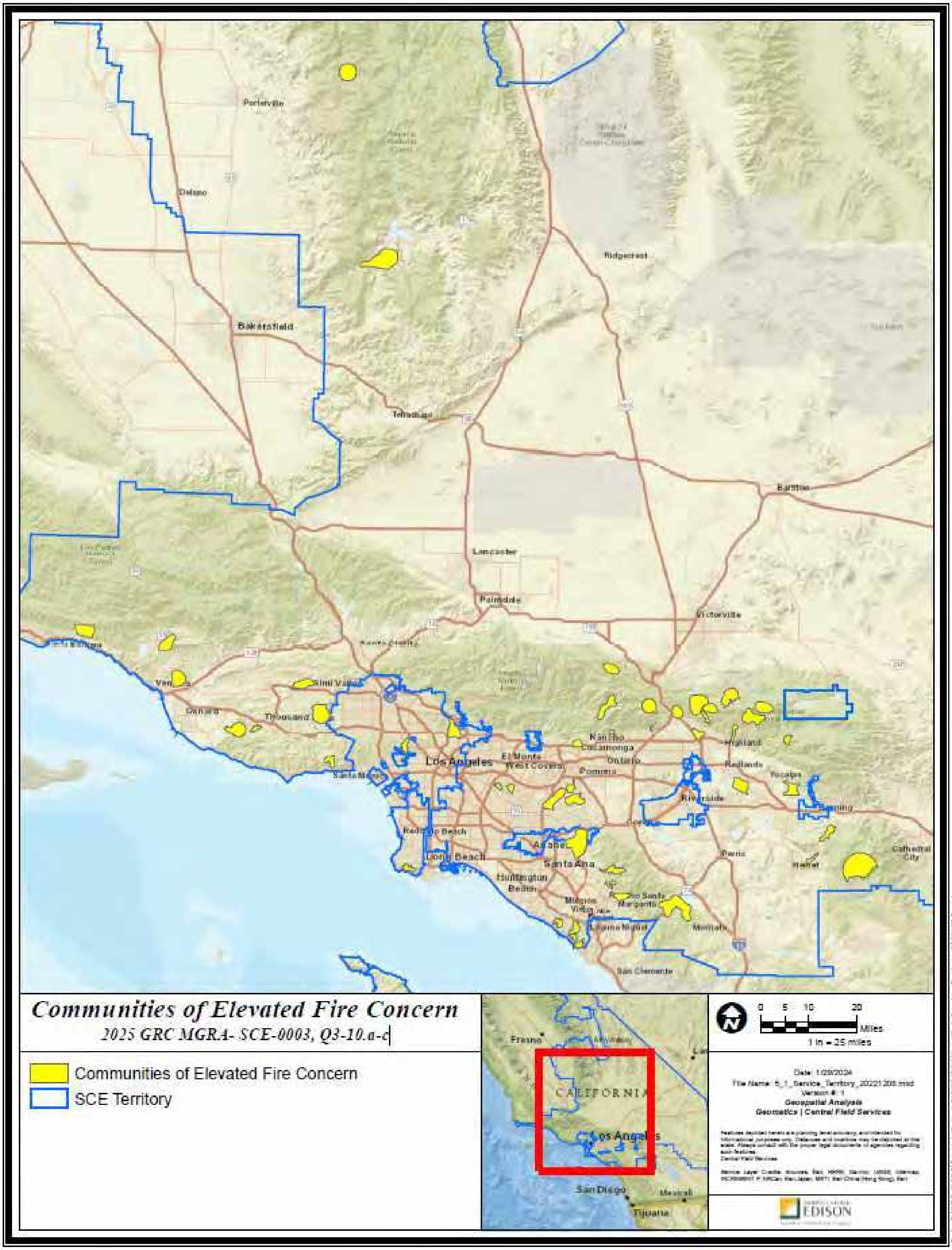
To: MGRA
Prepared by: Bryan Landry
Job Title: Senior Advisor – Enterprise Risk Management
Received Date: 1/12/2024

Response Date: 1/29/2024

Question 3-10.a-c:
Show a map of SRA Critera #4, Communities of Elevated Concern.
a. What were the criteria applied to identify these communities.
b. Were algorithms used do classify these areas, if so what algorithm?
c. Or were SMEs making this distincition if so under what criteria

Response to Question 3-10.a-c:
Please see map of CEFC entitled “CEFC_GRC_MGRA_SCE_0003_Q3_10_a_c “ attached and next, page, below.

a. Communities of Elevated Fire Concern (CEFCs) are smaller geographic areas where terrain, construction, and other factors could lead to smaller, fast-moving fires threatening populated locations under benign (normal) weather conditions. The criteria to select these communities are: (1) communities/subdivisions situated on hilltops with powerlines located in valleys below where fires could run uphill; and (2) rural communities in locations with limited escape routes that could become encapsulated by fire and trap residents.
b. Algorithms were not used to classify these areas.
c. These locations were identified by Fire Science Subject Matter Experts (SMEs) with feedback from local emergency planning officials.


Communities of Elevated Fire Concern
2025 GRC MGRA- SCE-0003, Q3-10.a-c
Communities of Elevated Fire Concern
SCE Territory
Porterville
Delano
Ridgecrest
Bakersfield
Tehachapi
Barstow
Lancaster
Palmdale
Victorville
Simi Valley
Oxnard
Thousand
Los Angeles
El Monte
West Covina
Rancho
Cucamonga
Ontario
Pomona
Highland
Redlands
Riverside
Redondo Beach
Long Beach
Santa Ana
Huntington
Beach
Perris
Hemet
Cathedral
City
Mission
Viejo
Laguna Niguel
Murrieta
San Clemente
0 5 10 20
Miles
1 in = 25 miles
Fresno
CALIFORNIA
Los Angeles
San Diego
Tijuana
Mexicali
EDISON

2025 General Rate Case
SCE
MGRA Data Request No. 4
January 19, 2024

REFCL and Advanced Protection Technologies

MGRA-4-1 REFCL Status:

a. What is the status as of 12/31/2023 for REFCL installation and planning, if this differs from any previous data request responses or testimony updates?

b. WP SCE-04 Vol.05 Part 1A, p. 52 shows that REFCL spending plateaus at around $45 M per year. Why is this?

c. Is REFCL being implemented in areas where TUG is planned?

d. What is the RSE for a REFCL + covered conductor (CC) combination?

MGRA-4-2 If SCE wished to increase the rate of its REFCL deployment by a substantial amount, for example by 50%,

a. What additional resources would be required?

b. What are the “long-pole” issues and how might these be addressed given adequate resources?

c. What additional risks, if any, might SCE or customers be subject to aside from increased cost?

MGRA-4-3 Distribution Open Phase Detection (DOPD) Program:

a. Can DOPD be installed in addition to covered conductor (CC)?

b. What risk scenarios would be covered by a CC + DOPD combination that would not be mitigated by CC alone?

c. What residual risk scenarios remain with a CC + DOPD combination?

d. What is the RSE for a CC + DOPD combination?

e. Can DOPD be installed in addition to REFCL? Do they provide complimentary protection?

f. Are there scenarios that DOPD covers that REFCL does not?

g. How does DOPD differ from SDG&E’s Falling Conductor Program?

h. What limits the DOPD deployment to 12 locations per year starting in 2025? (Exhibit No.: SCE-04 Vol. 05 Pt. 3; p. 19.) Could this be accelerated with additional funding?

i. Is DOPD planned for areas that are potential future TUG areas?

MGRA-4-4 Hi-Z Relays: p. 30 – "*SCE installed new Hi-Z relays at 20 locations in 2022 and will monitor the performance of all schemes, including those installed prior to 2022, through 2023. A technology recommendation report will be developed in Q3 of 2023. SCE plans to deploy Hi-Z relays at 20 locations per year in years 2025-2028. The costs to deploy Hi-Z in 2025 through 2028 is approximately $1.190 million per year, as depicted in Table I-23*"

a. Summarize the conclusion of SCE's technology recommendation report.

b. Please provide a non-confidential version of the Hi-Z technology recommendation report.

c. Compare and contrast the Hi-Z modifications versus REFCL. What situations would argue for REFCL over HiZ or vice versa?

d. Can Hi-Z be switched on depending on ambient conditions, including fire index and weather conditions?

e. List reportable ignition events that may have occurred with Hi-Z operational.

f. How many circuit miles does each installation of Hi-Z relays currently protect?

g. How many Hi-Z relays were deployed as of December 31, 2023?

h. What is the RSE for a CC + Hi-Z combination?

i. Deployment of Hi-Z relays remain flat through 2028. Could this be accelerated with additional funding?

j. Are Hi-Z relays planned for areas that are potential future TUG areas?

MGRA-4-5 Early Fault Detection (EFD): "*For 2024, the RAMP had originally forecasted deploying 150 units of EFD; however, during planning discussions this was reduced to 100 EFD units for the GRC. The minimal cost variance between the RAMP and the GRC is due to the application of an updated cost estimate*."

a. How many miles of circuit does one EFD unit cover?

b. How many units of EFD are deployed as of December 31, 2023?

c. Why was the request for ESD downgraded from 150 to 100?

d. What limits the effectiveness of EFD and how could the program be expanded?

e. Provide a list of EFDs and the incidents they have detected, including circuit name, EFD identifier, date of detection, date of identification, and incident description.

f. Why does EFD plateau at $13 M after 2025? Could deployment be accelerated with additional funding?

g. Are EFD units planned for areas that are potential future TUG areas?

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 4

To: MGRA
Prepared by: Andrew Swisher
Job Title: Consulting Engineer
Received Date: 1/19/2024

Response Date: 2/2/2024

Question 4-1.a-d:
REFCL Status:

a. What is the status as of 12/31/2023 for REFCL installation and planning, if this differs from any previous data request responses or testimony updates?
b. WP SCE-04 Vol.05 Part 1A, p. 52 shows that REFCL spending plateaus at around $45 M per year. Why is this?
c. Is REFCL being implemented in areas where TUG is planned?
d. What is the RSE for a REFCL + covered conductor (CC) combination?

Response to Question 4-1.a-d:
a. What is the status as of 12/31/2023 for REFCL installation and planning, if this differs from any previous data request responses or testimony updates?

As of 12/31/2023:
REFCL GFN locations in operation = 1 unit
REFCL GFN locations in construction or completed construction pending commissioning = 2 units
REFCL GFN location selected for design/planning = 5 units

REFCL GC locations in operation = 2 units
REFCL GC locations in construction or completed construction pending commissioning = 1 unit
REFCL GC locations selected for design/planning = 4 units

b. WP SCE-04 Vol.05 Part 1A, p. 52 shows that REFCL spending plateaus at around $45 M per year. Why is this?

SCE interprets this question to reference WP SCE-04 Vol.05 Part 2, p. 52 which provides capital spending for REFCL projects. The quantities of GFN and GC projects are constant from 2025 through 2028, this results in a fairly uniform spend as shown in the table. SCE's unit counts for the REFCL program target applications of approximately 2,000 HFRA circuit miles by the end of 2028. Much like SCE's covered conductor ramp up that was initiated in 2018 for wildfire mitigation, SCE is leading utility applications for REFCL in North America and has forecast considerable deployment of the technology through 2028. The REFCL technology is still relatively new at SCE; as such, SCE has a thoughtful balance of REFCL applications along with other wildfire mitigations such as Targeted Undergrounding and Covered Conductor for the GRC application time period.

c. Is REFCL being implemented in areas where TUG is planned?
SCE examined the selected scope for REFCL and TUG to identify areas where both mitigations may be applied. SCE presently has approximately 7 miles of future scope overlap with TUG and REFCL out of Ritter Ranch substation.

d. What is the RSE for a REFCL + covered conductor (CC) combination?

The Risk Spend Efficiency will vary based on specific risks for an application as well as the deployment location. Depending on the REFCL specific installation costs, the specific driver probabilities, and the consequences, the RSE values will vary. SCE completed a REFCL + CC vs TUG RSE comparison for Energy Division that SCE is attaching to this response. Below is what was provided in our response to ED-SCE-004_Q3. SCE also attached the mitigation effectiveness (ME) values assumed for REFCL + CC (MGRA-SCE-004_Q4.1 REFCL&CC_ME_Values.pdf).

- Using the GRC TUG scoped project data and all potential upstream REFCL installations.
    - For this analysis SCE will look at the currently scoped TUG projects to see which have the potential for an upstream REFCL installation and calculate a combined RSE for REFCL and CC in comparison to TUG.
        - *SCE Response:* Please see the attached file, ED-SCE-004_Q3c.xlsx. The assumptions used in this analysis are discussed below.

1. Year of analysis – SCE made a simplifying assumption that all TUG, WCCP and REFCL installations were completed in 2025 such that there was no need to do any discounting.
2. Unit Costs - 2025 TUG and WCCP unit costs are used.
    a) SCE used our 2025 GRC TUG unit cost of $5,094k/mi
    b) SCE used our 2025 GRC CC unit cost of $766k/mi
3. TUG to REFCL Mapping
    a) SCE analyzed all current TUG projects that have been scoped and have a Project Identification Form (PIF) and determined the upstream substation.
4. Costs for REFCL installations.
    a) For purposes of this DR response, SCE used certain simplifying assumptions from internal experts to provide an estimation of the upstream REFCL installation costs. Also, we assumed these REFCL installations are feasible, which in some cases, may not be true.
    b) This cost was then proportioned to the length of the segments that comprised the TUG project. A hypothetical example is shown below for illustrative purposes.
        i. REFCL cost of substation A: $1M
        ii. Total segment length connected to the substation A: 100 miles
        iii. REFCL cost of the segments connected to the substation A: $10k/mi
        iv. TUG Project consists of 10 miles of downstream circuitry from Substation A.
        v. Total CC + REFCL Costs = $766k/mi X 10 miles+ $10k/mi X 10 miles = $7,760K
    c) The REFCL cost per mile was used to enable an “apples-to-apples” comparison to TUG. However, it is important to note that, in reality, for each identified project in this DR response to have a functioning CC and REFCL combination, SCE would

have to implement the full REFCL solution at the substation and incur the associated total costs for that full REFCL implementation. For example, in reality, SCE would need to spend $1M plus the CC costs to enable a functioning CC+REFCL combination.

5. Useful Life of REFCL + CC
    a) SCE used a useful life of 45 years. Please note that in the GRC, WCCP and REFCL use 45 and 40 years, respectively.

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 4

To: MGRA
Prepared by: Daniel Komula
Job Title: Senior Advisor
Received Date: 2/12/2024

Response Date: 2/16/2024

Question 4-1.a-d Supplemental:
REFCL Status:

a. What is the status as of 12/31/2023 for REFCL installation and planning, if this differs from any previous data request responses or testimony updates?
b. WP SCE-04 Vol.05 Part 1A, p. 52 shows that REFCL spending plateaus at around $45 M per year. Why is this?
c. Is REFCL being implemented in areas where TUG is planned?
d. What is the RSE for a REFCL + covered conductor (CC) combination?

Response to Question 4-1.a-d Supplemental:

Please see the attached file, MGRA-SCE-004_Q4_Supplemental.xlsx. This file provides RSE analysis for covered conductor and REFCL combined versus covered conductor only. The assumptions used in this analysis are discussed below.

SCE notes that some of the covered conductor PIFs are relatively smaller in size.[1] There are several explanations for this. First, some of these miles may have been from a subset of a larger covered conductor project that was already partially completed, and these miles were carried over. Second, SCE's IWMS methodology may target unhardened areas adjacent to where a large amount of covered conductor was already installed per previous scoping methodologies. Essentially, some of these PIFs may be hardening smaller parts of circuits where adjacent segments were already hardened. Third, there are cases where the smaller projects are tied to a larger project for operational efficiency purposes. As an example, the WCCP project on the Magic circuit (as highlighted in red below) has 0.01 miles but is tied to a larger WCCP project on the Val Verde circuit (as highlighted in blue below) which has 1.5 miles. These projects are tied together because a portion of the Magic circuit shares the same path as Val Verde. It is important to consider other operational factors, not just project lengths, when assessing a project. Lastly, as SCE continues to harden our system, there will naturally be projects that may be smaller in size as the overall miles that are yet to be hardened continue to decrease. For example, some smaller CC work may be the

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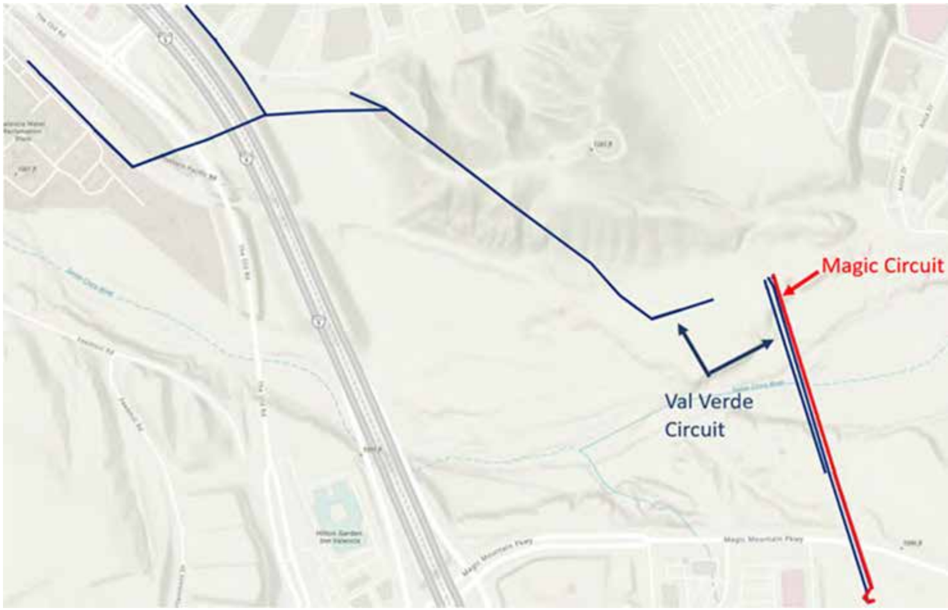
[1] As noted in our response to ED-SCE-003, Question 6, SCE's WCCP proposed projects for the 2024-2025 period, range in size from 0.01 to 53.3 miles. Typically, the average project length for WCCP is 3 miles.

result of non WCCP work from in-system failures, storm restoration, etc that could result in field crews installing covered conductor on ½ spans of conductor. Therefore, SCE is now going back to ensure the full spans are fully covered on those circuits.



1. Year of analysis – SCE made a simplifying assumption that all WCCP and REFCL installations were completed in 2025 such that there was no need to do any discounting.
2. Unit Costs - SCE used our 2025 GRC CC unit cost of $766k/mi
3. WCCP to REFCL Mapping
    a. SCE analyzed all current WCCP projects that have been scoped and have a Project Identification Form (PIF) and determined the upstream substation.
4. Costs for REFCL installations.
    a. For purposes of this DR response, SCE used certain simplifying assumptions from internal experts to provide an estimation of the upstream REFCL installation costs. Also, we assumed these REFCL installations are feasible, which in some cases, may not be true.
    b. This cost was then proportioned to the length of the segments that comprised the WCCP project. A hypothetical example is shown below for illustrative purposes.
        i. REFCL cost of substation A: $1M
        ii. Total segment length connected to the substation A: 100 miles
        iii. REFCL cost of the segments connected to the substation A: $10k/mi
        iv. WCCP project consists of 10 miles of downstream circuitry from Substation A.
        v. Total CC + REFCL Costs = $766k/mi X 10 miles+ $10k/mi X 10 miles = $7,760K
5. The REFCL cost per mile was used to enable an "apples-to-apples" comparison to WCCP. However, it is important to note that, in reality, for each identified project in this DR response to have a functioning CC and REFCL combination, SCE would have to implement

the full REFCL solution at the substation and incur the associated total costs for that full REFCL implementation. For example, in reality and using the hypothetical example above, SCE would need to spend $1M plus the CC costs to enable a functioning CC+REFCL combination.

6. Useful Life of REFCL + CC
    a. SCE used a useful life of 45 years. Please note that in the GRC, WCCP and REFCL use 45 years and 40 years, respectively.

Southern California Edison
2023-WMPs – 2023-WMPs

DATA REQUEST SET M G R A - S C E - 0 0 3

To: MGRA
Prepared by: Andrew Swisher
Job Title: Consulting Engineer
Received Date: 5/3/2023

Response Date: 5/8/2023

Question 02:
Please provide an additional column for the Mitigation Effectiveness Values table that represents a combination of Covered Conductor and REFCL.

Response to Question 02:
SCE continues to build its understanding of the combined effectiveness of covered conductor (CC) and Rapid Earth Fault Current Limiter (REFCL). As one approach to estimate the combined mitigation effectiveness, SCE considers the effectiveness of covered conductor to establish the remaining risk once CC is applied, then evaluates the effectiveness of REFCL to this remaining risk. The REFCL mitigation effectiveness is strongly correlated to the potential for single line to ground faults. SCE's approach for each driver considers the phase to ground fault ratio relationship to be the same between covered conductor and bare wire systems, and develops mitigation effectiveness values to the remaining risk following CC application. Based on this approach, the following mitigation effectiveness values are estimated and presently used by SCE as an input for evaluating the combination of CC and REFCL applications for distribution system ignition drivers. SCE notes these are estimates and subject to continued evaluation, including through field validation of REFCL installations and performance over the coming years. Please see Section 7.1.4.2 of SCE's WMP for additional discussion on the use of covered conductor alongside REFCL and other mitigations.

Driver Type	Subdriver Type	CC/REFCL ME
D-CFO	Veg. contact- Distribution	85%
D-CFO	Animal contact- Distribution	96%
D-CFO	Balloon contact- Distribution	99%
D-CFO	Vehicle contact- Distribution	85%
D-CFO	Unknown contact - Distribution	90%
D-UNK	Unknown - Distribution	82%
D-CFO	Other contact from object - Distribution	88%
D-WTW	Wire-to-wire contact / contamination- Distribution	99%
D-EFF	Anchor / guy damage or failure - Distribution	70%

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 4

To: MGRA
Prepared by: Andrew Swisher
Job Title: Consulting Engineer
Received Date: 1/19/2024

Response Date: 2/2/2024

Question 4-2.a-c:
If SCE wished to increase the rate of its REFCL deployment by a substantial amount, for example by 50%,

a. What additional resources would be required?
b. What are the "long-pole" issues and how might these be addressed given adequate resources?
c. What additional risks, if any, might SCE or customers be subject to aside from increased cost?

Response to Question 4-2.a-c:

a.) SCE objects to this question due to the request being vague, ambiguous, and overbroad. SCE is unclear what the phrase "additional resources" refers to, but notes that increasing deployment would come with increased costs and labor personnel requirements.
b.) SCE does not understand the question regarding the reference to "long-pole" issues.
c.) SCE objects to this question due to the request being vague, ambiguous, and overbroad. Subject to these objections, SCE notes that other jurisdictions have experienced a decrease in reliability from certain REFCL configurations.

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 4

To: MGRA
Prepared by: Andrew Swisher
Job Title: Consulting Engineer
Received Date: 1/19/2024

Response Date: 2/2/2024

Question 4-3.a-i:
Distribution Open Phase Detection (DOPD) Program:

a. Can DOPD be installed in addition to covered conductor (CC)?
b. What risk scenarios would be covered by a CC + DOPD combination that would not be mitigated by CC alone?
c. What residual risk scenarios remain with a CC + DOPD combination?
d. What is the RSE for a CC + DOPD combination?
e. Can DOPD be installed in addition to REFCL? Do they provide complimentaryprotection?
f. Are there scenarios that DOPD covers that REFCL does not?
g. How does DOPD differ from SDG&E's Falling Conductor Program?
h. What limits the DOPD deployment to 12 locations per year starting in 2025? (Exhibit No.: SCE-04 Vol. 05 Pt. 3; p. 19.) Could this be accelerated with additional funding?
i. Is DOPD planned for areas that are potential future TUG areas?

Response to Question 4-3.a-i:

a. Can DOPD be installed in addition to covered conductor (CC)?
SCE's Response: Distribution Open Phase Detection can be installed in addition to covered conductor.

b. What risk scenarios would be covered by a CC + DOPD combination that would not be mitigated by CC alone?
SCE's Response: SCE interprets the term "risk scenarios" to ask about ignition drivers which are not mitigated by CC alone, or the difference between the CC ME and CC + DOPD ME (with DOPD operated in trip mode). SCE's present DOPD system is operating in alarming mode. The DOPD system does not provide additional ignition reduction beyond CC effectiveness when operated in alarming mode. The response to part d of this question includes the estimated ME for CC + DOPD when operating a tripping mode.

c. What residual risk scenarios remain with a CC + DOPD combination?
SCE's Response: Please refer to the responses to parts b and d of this question.

d. What is the RSE for a CC + DOPD combination?
SCE's Response: The Risk Spend Efficiency will vary based on specific risks for an application as well as the deployment location. Depending on the DOPD specific installation costs, the specific driver probabilities, and the consequences, the RSE values will vary. Please

refer to the attached file named "MGRA 0004 Q4_3 WCCP DOPD.xlsx" for estimated Mitigation Effectiveness (ME) for CC + DOPD based on the expectation that DOPD is configured for tripping rather than alarming.

e. Can DOPD be installed in addition to REFCL? Do they provide complimentary protection?
SCE's Response: SCE's review for DOPD has primarily been focused on application to solidly grounded systems. At this time SCE has not established the feasibility of operating DOPD on REFCL networks. SCE intends to further review the applicability of DOPD technology on REFCL systems over the next few years as these new technologies are applied to SCE's distribution system.

If REFCL and DOPD can be applied together, the complimentary benefits may largely be from ignitions involving downed conductor for more than one phase, specific to mainline circuitry. The mainline circuitry is due to present application approaches for DOPD between reclosers as described on page 17 of SCE-04 Vol. 05 Part 3: "The DOPD scheme leverages existing recloser installations at circuit tie-points in conjunction with upstream source reclosers."

f. Are there scenarios that DOPD covers that REFCL does not?
SCE's Response: SCE interprets this question to ask if DOPD can provide complimentary benefits to REFCL. Please see the response to part e.

g. How does DOPD differ from SDG&E's Falling Conductor Program?
SCE's Response: SCE cannot comment on SDG&E's program nor differences between our utility efforts.

h. What limits the DOPD deployment to 12 locations per year starting in 2025? (Exhibit No.: SCE-04 Vol. 05 Pt. 3; p. 19.) Could this be accelerated with additional funding?
SCE's Response: SCE's forecast for DOPD in the 2025-2028 years is dependent on integration of a communication infrastructure to support high speed communication between sensing and interrupting devices. SCE describes the communication system integration on pages 19 and 20 of SCE-04 Vol. 05 Part 3. SCE is anticipating updates to the existing communication system as part of other programs that can serve the functionality required for the DOPD scheme. The dependency of the communication and integration of the new radio system may limit SCE's ability to accelerate the DOPD program in HFRA applications. The forecast presented by SCE allows small scale deployment of targeted installations to gain operational experience with the new technology on SCE's network. At present, SCE's DOPD applications are configured for alarming and have not been converted to trip functionality.

i. Is DOPD planned for areas that are potential future TUG areas?
SCE's Response: At this time SCE has not selected future planned areas for DOPD. DOPD is applied covering an entire circuit or portion of a circuit, typically between recloser devices spanning multiple miles. Since a circuit may be constructed with both overhead conductor and underground cable, DOPD could end up applied in TUG areas (or for other undergrounding reasons) due to the application of both underground cable and overhead conductor on a theoretical circuit.

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 4

To: MGRA
Prepared by: Andrew Swisher
Job Title: Consulting Engineer
Received Date: 1/19/2024

Response Date: 2/2/2024

Question 4-4.a-j:
Hi-Z Relays: p. 30 – "SCE installed new Hi-Z relays at 20 locations in 2022 and will monitor the performance of all schemes, including those installed prior to 2022, through 2023. A technology recommendation report will be developed in Q3 of 2023. SCE plans to deploy Hi-Z relays at 20 locations per year in years 2025- 2028. The costs to deploy Hi-Z in 2025 through 2028 is approximately $1.190 million per year, as depicted in Table I-23"

a. Summarize the conclusion of SCE's technology recommendation report.
b. Please provide a non-confidential version of the Hi-Z technology recommendation report.
c. Compare and contrast the Hi-Z modifications versus REFCL. What situations would argue for REFCL over HiZ or vice versa?
d. Can Hi-Z be switched on depending on ambient conditions, including fire index and weather conditions?
e. List reportable ignition events that may have occurred with Hi-Z operational.
f. How many circuit miles does each installation of Hi-Z relays currently protect?
g. How many Hi-Z relays were deployed as of December 31, 2023?
h. What is the RSE for a CC + Hi-Z combination?
i. Deployment of Hi-Z relays remain flat through 2028. Could this be accelerated with additional funding?
j. Are Hi-Z relays planned for areas that are potential future TUG areas?

Response to Question 4-4.a-j:

a. Summarize the conclusion of SCE's technology recommendation report.
SCE's Response: SCE's evaluation of the Hi-Z relay pilots identified an impact to customer reliability may be experienced with operating the Hi-Z relays in tripping mode without additional configuration changes. During the evaluation period, two events were experienced where the relays properly identified a high impedance fault condition. Relay settings adjustments and the relay vendor refinement of the algorithms are capable of reducing the nuisance alarms. Expansion of the pilot program to small scale deployment is recommended allowing a larger circuit sampling for the technology assessment and necessary support for improvements to allow tripping functionality.

b. Please provide a non-confidential version of the Hi-Z technology recommendation report.
SCE's Response: SCE has not developed a non-confidential report and is working to summarize the report in a non-confidential manner.

c. Compare and contrast the Hi-Z modifications versus REFCL. What situations would argue for REFCL over HiZ or vice versa?
SCE's Response: Hi-Z relays are applied at recloser devices where REFCL is applied at a substation for GFN application or in conjunction with a recloser for a GC application. At this time, SCE's Hi-Z relay applications are in alarming mode, where SCE is forecasting the additional installations to support operational experience and development of the technology. However, even if and when the technology is validated for tripping configuration, it is still intended to detect high impedance faults phase to ground fault or faults involving multiple phases. REFCL, on the other hand, is intended to detect both low and high impedance phase to ground faults, and more importantly reduce ground fault energy to a point where an ignition is unlikely.

Accordingly, the application of these two technologies are not selected as alternative mitigations. These mitigations may be applied together to gain experience partnering these technologies.

d. Can Hi-Z be switched on depending on ambient conditions, including fire index and weather conditions?
SCE's Response: It is technically possible to toggle the Hi-Z settings; however, at this time SCE intends to operate the scheme year-round, also gaining improvements in public safety situations that can develop from Hi-Z faults along with the potential ignition mitigation improvements.

e. List reportable ignition events that may have occurred with Hi-Z operational.
SCE's Response: One reportable vegetation ignition was captured on August 19, 2022 involving a secondary conductor failure that was identified with Hi-Z relay applied at an upstream recloser.

f. How many circuit miles does each installation of Hi-Z relays currently protect?
SCE's Response: The present Hi-Z applications are configured for alarming. The below charts show primary voltage circuit miles associated with each of the recloser applications of the Hi-Z relay technology. RSR 9421 is a normally open tie between two circuits and is not assigned a quantity of circuit miles.

HiZ Relay Device	Primary Circuit Mileage
RSR 4192	7.83
RSR 1992	1.14
RSR 0121	9.9
RAR 9167	7.46
RSR 9519	11.36
RAR 0664	14.07
RAR 0153	9.43
RAR 7369	13.61

HiZ Relay Device	Primary Circuit Mileage
RSR 7595	24.83
RSR 3031	24.85
RSR 2119	7.6
RAR 0048	23.62
RSR 7780	16.24
RSR 1139	17.55
RSR 0178	8.44
RAR 0447	9.53

HiZ Relay Device	Primary Circuit Mileage
RAR 1102	16.36
RSR 2325	30.03
RAR 9670	15.31
RSR 9421	0
RSR 1572	13.48
RSR 0724	47.19
RAR 9237	17.34
RAR 1177	2.78

RAR 1089	0.75	RSR 0346	6.43	RAR 1025	12.01
RSR 8267	10.03	RSR 0335	17.54	RAR 0228	36.99
RAR 0210	10.42	RAR 1490	21.1	RSR 0841	4.75
RAR 2177	8.02	RSR 3404	42.47	RAR 1103	59.16
RSR 1192	18.31				

g. How many Hi-Z relays were deployed as of December 31, 2023?
SCE's Response: SCE deployed 37 installations between 2020-2023 for the Hi-Z relay program.

h. What is the RSE for a CC + Hi-Z combination?
SCE's Response: The Risk Spend Efficiency will vary based on specific risks for an application as well as the deployment location. Depending on the Hi-Z relay specific installation costs, the specific driver probabilities, and the consequences, the RSE values will vary. The Hi-Z relays are presently configured for alarming, and when applied in this mode do not provide additional ignition mitigation effectiveness beyond CC by itself. SCE can provide the estimated Mitigation Effectiveness for the application of CC and Hi-Z together, with the Hi-Z relay configured for tripping. Please see the attached file titled "MGRA 0004 Q4_4 WCCP HiZ ME.xlsx".

i. Deployment of Hi-Z relays remain flat through 2028. Could this be accelerated with additional funding?
SCE's Response: SCE believes the quantities presented in the forecast through 2028 are appropriate for the present state of the technology and SCE experience.

j. Are Hi-Z relays planned for areas that are potential future TUG areas?
SCE's Response: At this time, SCE has not selected future installation locations for Hi-Z relay applications. The Hi-Z relay provides coverage of a circuit or portion of a circuit. It may be possible that the Hi-Z relay is installed providing coverage for overhead circuitry as well as portions of underground cable which were part of the TUG program on a hypothetical circuit.

DATA REQUEST SET M G R A - S C E - 0 0 4

To: MGRA
Prepared by: Andrew Swisher
Job Title: Consulting Engineer
Received Date: 1/19/2024

Response Date: 2/2/2024

Question 4-5.a-g:
Early Fault Detection (EFD): "For 2024, the RAMP had originally forecasted deploying 150 units of EFD; however, during planning discussions this was reduced to 100 EFD units for the GRC. The minimal cost variance between the RAMP and the GRC is due to the application of an updated cost estimate."

a. How many miles of circuit does one EFD unit cover?
b. How many units of EFD are deployed as of December 31, 2023?
c. Why was the request for ESD downgraded from 150 to 100?
d. What limits the effectiveness of EFD and how could the program be expanded?
e. Provide a list of EFDs and the incidents they have detected, including circuit name, EFD identifier, date of detection, date of identification, and incident description.
f. Why does EFD plateau at $13 M after 2025? Could deployment be accelerated with additional funding?
g. Are EFD units planned for areas that are potential future TUG areas?

Response to Question 4-5.a-g:

a. How many miles of circuit does one EFD unit cover?

SCE response: On average, SCE estimates one EFD sensor provides 3.5 circuit miles of coverage. The EFD sensors operate by monitoring the circuitry between two sensors functioning in a pair where SCE estimates roughly 4 miles of circuitry between typical distribution EFDs and 4.5 miles for transmission EFD installations.

b. How many units of EFD are deployed as of December 31, 2023?

SCE response: Based on available information in January 2024, SCE has 277 EFD units installed as of December 31, 2023.

c. Why was the request for ESD downgraded from 150 to 100?

SCE response: SCE interprets this question to ask why the EFD units were reduced from 150 to 100 for 2024 applications. In 2024, SCE is shifting the EFD program into normal processes as the program moves to larger deployment levels in 2025. The program through 2024 has been managed by a dedicated team, and with the existing fleet as well as additional applications for 2025, SCE is updating the internal management processes. SCE decided to lower the 2024 deployment levels to help prepare and execute on the change management needed to work processes during the 2024 year.

d. What limits the effectiveness of EFD and how could the program be expanded?

SCE response: The ignition mitigation effectiveness is primarily limited by (1) the quantity/frequency of event occurrences that EFD can detect and (2) the ability for SCE to identify and remediate the cause of the EFD detection prior to components creating an ignition or potential ignition event. SCE's present EFD forecast through 2028 is estimated to provide coverage to approximately 50% of SCE's distribution HFRA, and 10% of the transmission HFRA. SCE believes this program is already sufficiently ambitious and quickly provides coverage using EFD over a substantial portion of SCE's HFRA system. SCE's approach to the EFD program provides consistent workload for each year of the program; expansion of the program may be possible in 2027-2028 with increased funding.

e. Provide a list of EFDs and the incidents they have detected, including circuit name, EFD identifier, date of detection, date of identification, and incident description.

SCE response: The detection / evaluation date in the table captures the date for the field inspection.

Evaluation / detection Date	Substation	Circuit	Distribution or Transmission	EFD Identifier	Evaluation Findings / Description
8/7/2020	Auld	Appalousa	Distribution	Appalousa A-B	Transformer fuse operated then detections ceased
10/6/2020	Auld	Palomino	Distribution	Palomino A-B	Conductor damage
10/6/2020	Auld	Palomino	Distribution	Palomino A-B	Conductor damage
1/15/2021	Auld	Palomino	Distribution	Palomino B-C	Conductor damage
2/20/2021	Casitas	Tico	Distribution	Tico E-F	Conductor damage
2/20/2021	Casitas	Tico	Distribution	Tico L-G	Conductor damage
2/20/2021	Casitas	Tico	Distribution	Tico L-G	Conductor damage
8/14/2021	Casitas	Canet	Distribution	Canet B-C	Arcing Primary Surge Arrester
8/19/2021	Casitas	Riva	Distribution	Riva G-H	Primary Transformer Tap
9/3/2021	Casitas	Tico	Distribution	Tico E-F	Vegetation Grow-In to Primary
1/21/2022	N/A	Devers-Banning-Windpark	Transmission	Devers-Banning-Windpark 2-3	Broken bond wire
1/21/2022	N/A	Devers-Banning-Windpark	Transmission	Devers-Banning-Windpark 3-9	Conductor damage

Evaluation / detection Date	Substation	Circuit	Distribution or Transmission	EFD Identifier	Evaluation Findings / Description
1/21/2022	N/A	Blast-Bottle-Windfarm	Transmission	Blast-Bottle-Windfarm 2-3	Broken bond wire
1/21/2022	N/A	Devers-Banning-Windpark	Transmission	Devers-Banning-Windpark 2-3	Tracking insulator with flash marks
1/21/2022	N/A	Blast-Bottle-Windfarm	Transmission	Blast-Bottle-Windfarm 2-3	Broken bond wire
1/21/2022	N/A	Blast-Bottle-Windfarm	Transmission	Blast-Bottle-Windfarm 2-3	Broken bond wire
1/21/2022	N/A	Devers-Banning-Windpark	Transmission	Devers-Banning-Windpark 2-3	North structure, bonding issue
4/21/2022	Yucaipa	Bench	Distribution	Bench C-E	Line spacer connection
8/22/2022	Auld	Appalousa	Distribution	Appalousa C-D	Damaged Utilco bar
9/27/2022	Casitas	Tico	Distribution	Tico L-G	Conductor damage
11/29/2022	Pechanga	Chawa	Distribution	Chawa 17-18	Wildlife cover tracking
12/1/2022	Shawnee	Cherokee	Distribution	Cherokee A-B	Damaged connector
12/1/2022	Shawnee	Cherokee	Distribution	Cherokee A-B	Conductor damage
4/20/2023	Aqueduct	Penstock	Distribution	Penstock E-J	Missing insulator hardware, floating bond
4/20/2023	Aqueduct	Penstock	Distribution	Penstock G-H	Surge arrester
4/20/2023	Yucaipa	Bench	Distribution	Bench F-H	Arcing damage on secondary triplex
4/27/2023	Shawnee	Cherokee	Distribution	Cherokee A-B	Broken strands/melting damage
5/3/2023	N/A	Blast-Bottle-Windfarm	Transmission	Blast-Bottle-Windfarm 2-6	Loose insulator clamp
5/3/2023	N/A	Blast-Bottle-Windfarm	Transmission	Blast-Bottle-Windfarm 3-4	Broken bond wire
5/3/2023	N/A	Blast-Bottle-Windfarm	Transmission	Blast-Bottle-Windfarm 4-5	Broken strands
5/3/2023	Cabazon	Poppet Flats	Distribution	Poppet Flats C-D	Secondary connector
5/3/2023	N/A	Devers-Banning-Windpark	Transmission	Devers-Banning-Windpark 5-6	Insulator removed for evaluation
5/3/2023	N/A	Devers-Banning-Windpark	Transmission	Devers-Banning-Windpark 4-5	Broken conductor strands
5/18/2023	Yucaipa	Bench	Distribution	Bench F-I	Loose bond wire
5/18/2023	Arrowhead	Jeep	Distribution	Jeep E-G	Secondary connector
7/20/2023	Cabazon	Poppet Flats	Distribution	Poppet Flats D-F	Broken wire to arrester

Evaluation / detection Date	Substation	Circuit	Distribution or Transmission	EFD Identifier	Evaluation Findings / Description
8/16/2023	Casitas	Riva	Distribution	Riva B-C	Tracking insulator
9/26/2023	Yucaipa	Bench	Distribution	Bench F-J	Surge arrester

f. Why does EFD plateau at $13 M after 2025? Could deployment be accelerated with additional funding?

<u>SCE response:</u> Refer to response “d” for further details on deployment and acceleration of installations.

g. Are EFD units planned for areas that are potential future TUG areas?

<u>SCE response:</u> SCE is presently in the process of planning 2024 and 2025 scope. It is possible that future TUG (or other undergrounding efforts) may apply underground cable for a portion of circuitry that is monitored by EFD. SCE expects EFD to be able to monitor for degradation in underground and overhead facilities.

D-EFF	Conductor damage or failure — Distribution	95%
D-EFF	Connection device damage or failure - Distribution	95%
D-EFF	Connector damage or failure- Distribution	95%
D-EFF	Crossarm damage or failure - Distribution	65%
D-EFF	Fuse damage or failure - Distribution	31%
D-EFF	Insulator and brushing damage or failure - Distribution	95%
D-EFF	Lightning arrestor damage or failure- Distribution	50%
D-EFF	Other - Distribution	57%
D-EFF	Pole damage or failure - Distribution	40%
D-EFF	Recloser damage or failure - Distribution	9%
D-EFF	Splice damage or failure — Distribution	95%
D-EFF	Tie wire damage or failure - Distribution	50%
D-EFF	Voltage regulator / booster damage or failure - Distribution	50%
D-CTM	Contamination - Distribution	30%
D-EFF	Capacitor bank damage or failure- Distribution	1%
D-EFF	Switch damage or failure- Distribution	2%
D-EFF	Transformer damage or failure - Distribution	88%
D-EFF	Tap damage or failure - Distribution	50%
D-EFF	Sectionalizer damage or failure - Distribution	70%
D-OTH	All Other- Distribution	50%
D-UTW	Utility work / Operation - Distribution	25%
D-VAN	Vandalism / Theft - Distribution	1%

IWMS Criteria

MGRA-5-1 With regard to circuit segments in Severe Risk Areas (SRAs) designated as "extreme high wind areas", please provide an Excel spreadsheet listing all weather stations associated with circuit segments that are in "extreme high wind areas", including columns:

a. Abbreviation of the weather station (used for reporting to public websites)

b. Common name of weather station

c. Circuit associated with weather station

d. Date weather station came into service

e. Number of updates per hour (note: if all weather stations are identical, a column will not be necessary and specify update frequency in the text reply.)

For each year weather station is in service add additional four columns that show the total number of readings over the following thresholds in each specified year:

f. Counts over 58 mph

g. Counts over 65 mph

h. Counts over 70 mph

i. Counts over 84 mph

MGRA-5-2 Referring to the Excel file WP SCE-04 Vol. 05 Pt. 1 - WCCP-UG-RSE_Amended.xlsx (non-confidential) returned in response to TURN-SCE-036_Q3, please construct a modified file containing:

a. An additional tab identical to the TUG and WCCP tabs (same columns and calculations) with all unhardened circuit segments in the HFRA that are not already listed in the TUG and WCCP sheets (i.e. those not planned for mitigation in the 2025-2028 time frame). In this case post-mitigation values will be equal to pre-mitigation values, and NPV and RSE columns may be left blank.

b. On the TUG, WCCP, and not-yet hardened tabs, add a column after "Reporting Tranche" specifying the criterion that was used to designate the circuit as "Severe" or "High Consequence" – i.e. High Wind, Egress, Burn-in, High Frequency Fire, etc.

c. On the TUG, WCCP, and not-yet hardened tabs, add a column after the new column specified in b. specifying the year that the circuit will be REFCL enabled. If REFCL is not planned for that circuit leave the value blank.

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 5

To: MGRA
Prepared by: Kyle Ferree
Job Title: Senior Advisor
Received Date: 1/23/2024

Response Date: 2/6/2024

Question 5-1.a-i:
With regard to circuit segments in Severe Risk Areas (SRAs) designated as "extreme high wind areas", please provide an Excel spreadsheet listing all weather stations associated with circuit segments that are in "extreme high wind areas", including columns:

a. Abbreviation of the weather station (used for reporting to public websites)
b. Common name of weather station
c. Circuit associated with weather station
d. Date weather station came into service
e. Number of updates per hour (note: if all weather stations are identical, a column will not be necessary and specify update frequency in the text reply.)

For each year weather station is in service add additional four columns that show the total number of readings over the following thresholds in each specified year:

f. Counts over 58 mph
g. Counts over 65 mph
h. Counts over 70 mph
i. Counts over 84 mph

Response to Question 5-1.a-i:
Please see the attached file, "MGRA-SCE-005_Q1.xlsx".

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 5

To: MGRA
Prepared by: Kyle Ferree
Job Title: Senior Advisor
Received Date: 2/7/2024

Response Date: 2/8/2024

Question 5-1.a-i Revised:
With regard to circuit segments in Severe Risk Areas (SRAs) designated as "extreme high wind areas", please provide an Excel spreadsheet listing all weather stations associated with circuit segments that are in "extreme high wind areas", including columns:

a. Abbreviation of the weather station (used for reporting to public websites)
b. Common name of weather station
c. Circuit associated with weather station
d. Date weather station came into service
e. Number of updates per hour (note: if all weather stations are identical, a column will not be necessary and specify update frequency in the text reply.) For each year weather station is in service add additional four columns that show the total number of readings over the following thresholds in each specified year:
f. Counts over 58 mph
g. Counts over 65 mph
h. Counts over 70 mph
i. Counts over 84 mph

Response to Question 5-1.a-i Revised:
Per MGRA's February 7, 2024 follow-up request after receiving SCE's response to MGRA-SCE-005-Q1, please see the attached file containing additional weather station naming conventions, as well as the latitude and longitude for each station.

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 5

To: MGRA
Prepared by: Arianne Luy
Job Title: Engineering Manager
Received Date: 1/23/2024

Response Date: 2/6/2024

Question 5-2.a-c:
Referring to the Excel file WP SCE-04 Vol. 05 Pt. 1 - WCCP-UGRSE_ Amended.xlsx (non-confidential) returned in response to TURN-SCE-036_Q3, please construct a modified file containing:

a. An additional tab identical to the TUG and WCCP tabs (same columns and calculations) with all unhardened circuit segments in the HFRA that are not already listed in the TUG and WCCP sheets (i.e. those not planned for mitigation in the 2025-2028 time frame). In this case post-mitigation values will be equal to pre-mitigation values, and NPV and RSE columns may be left blank.
b. On the TUG, WCCP, and not-yet hardened tabs, add a column after "Reporting Tranche" specifying the criterion that was used to designate the circuit as "Severe" or "High Consequence" – i.e. High Wind, Egress, Burn-in, High Frequency Fire, etc.
c. On the TUG, WCCP, and not-yet hardened tabs, add a column after the new column specified in b. specifying the year that the circuit will be REFCL enabled. If REFCL is not planned for that circuit leave the value blank.

Response to Question 5-2.a-c:

a) An additional tab identical to the TUG and WCCP tabs (same columns and calculations) with all unhardened circuit segments in the HFRA that are not already listed in the TUG and WCCP sheets (i.e., those not planned for mitigation in the 2025-2028 time frame). In this case post-mitigation values will be equal to pre-mitigation values, and NPV and RSE columns may be left blank.
   - *SCE Response*: The requested information is included in the attached file titled MGRA-SCE-005_Q2.xlsx. Note that SCE applies a 1.1 multiplier to its segment mileage data in HFRA for spatial accuracy. Additionally, mileage data used for completed CC miles are based on work order mileages calculated during design. Combining these two systems of record to calculate remaining miles may yield discrepancies.

b) On the TUG, WCCP, and not-yet hardened tabs, add a column after "Reporting Tranche" specifying the criterion that was used to designate the circuit as "Severe" or "High Consequence" – i.e. High Wind, Egress, Burn-in, High Frequency Fire, etc.
   a. *SCE Response*: The requested information is included in the attached file titled

MGRA-SCE-005_Q2.xlsx. Note that Egress, Burn-in, Significant Fire Consequence (>10k Acres), High Winds (PSPS), and Communities of Elevated Fire Concern (CEFC) are designations for severe risk areas and therefore only provided for severe risk segments. Additionally, SCE's review and revise process is still in progress. Therefore, these designations are subject to change. Also, some severe risk segments may not yet have specific designations because SCE has not completed the review and revise process and updated its data.

c) On the TUG, WCCP, and not-yet hardened tabs, add a column after the new column specified in b. specifying the year that the circuit will be REFCL enabled. If REFCL is not planned for that circuit leave the value blank.

   a. *SCE Response*: The requested information is included in the attached file titled MGRA-SCE-005_Q2.xlsx. SCE only included known and scoped REFCL projects in this analysis. SCE is still in the process of finalizing the exact location of all our 2025 – 2028 REFCL installations.

2025 General Rate Case
SCE
MGRA Data Request No. 6
January 25, 2024

Existing Documents

MGRA-6-1 Please provide redacted versions of Excel files:

a. Confidential_TURN-SCE-039_Q6a.xlsx

b. Confidential_TURN-SCE-039_Q6.xlsx.

MGRA-6-2 If there are any updates to document*: December 22, 2022. https://www.sce.com/sites/default/files/AEM/Supporting Documents/2023-2025/Joint IOU Covered Conductor Testing Cumulative Report 12-22-22_Redacted.pdf*.
or from Exponent regarding covered conductor please provide a non-confidential version, or

a. Provide a non-confidential version of any new reports from the Joint IOU Covered Conductor working groups not provided in the 2023 WMP filings.

MGRA-6-3 Please provide working papers from POI machine learning models that have been redacted to remove confidential information.

IWMS GIS data

Please provide geodatabase information containing the data underlying the following maps/figures:

MGRA-6-4 Figure II-5, egress-constrained areas

MGRA-6-5 Figure II-6, areas with a high frequency of fires

MGRA-6-6 Figure II-7, areas with high frequency of fires and egress constraints

MGRA-6-7 Figure II-10, areas with extremely high windspeeds

MGRA-6-8 Figure showing IWMS Risk Tranche Designations

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 6

To: MGRA
Prepared by: Daniel Komula
Job Title: Senior Advisor
Received Date: 1/25/2024

Response Date: 2/7/2024

Question 6-1.a-b:
Please provide redacted versions of Excel files:

a. Confidential_TURN-SCE-039_Q6a.xlsx
b. Confidential_TURN-SCE-039_Q6.xlsx.

Response to Question 6-1.a-b:

Please see the attached files, Public_TURN-SCE-039_Q6a.xlsx and Public_TURN-SCE-039_Q6.xlsx.

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 6

To: MGRA
Prepared by: Kyle Ferree
Job Title: Senior Advisor
Received Date: 1/25/2024

Response Date: 2/7/2024

Question 6-2.a:
If there are any updates to document: December 22, 2022.
https://www.sce.com/sites/default/files/AEM/Supporting Documents/2023-2025/Joint IOU Covered Conductor Testing Cumulative Report 12-22-22_Redacted.pdf.
or from Exponent regarding covered conductor please provide a non-confidential version, or

a. Provide a non-confidential version of any new reports from the Joint IOU Covered Conductor working groups not provided in the 2023 WMP filings.

Response to Question 6-2.a:
SCE has not updated the referenced covered conductor report or performed any new testing since that time. No new reports have originated out of the Joint IOU covered conductor working groups, though SDG&E has independently performed in-house testing that was presented to Energy Safety in one of those Joint IOU meetings. MGRA may request that presentation from SDG&E if they wish.

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 6

To: MGRA
Prepared by: Jonathan Wuo
Job Title: Senior Manager, Data Science
Received Date: 1/25/2024

Response Date: 2/7/2024

Question 6-3:
Please provide working papers from POI machine learning models that have been redacted to remove confidential information.

Response to Question 6-3:

Please reference Supplemental Appendix B, Attachments A through D for the sub-model documentation:

- Attachment A – OH-Capacitor Sub-Model
- Attachment B – OH-Conductor Sub-Model
- Attachment C – OH-Switch Sub-Model
- Attachment D – OH-Transformer Sub-Model

DATA REQUEST SET M G R A - S C E - 0 0 6

To: MGRA
Prepared by: Kyle Ferree
Job Title: Senior Advisor
Received Date: 1/25/2024

Response Date: 2/7/2024

Question 6-4:
Please provide geodatabase information containing the data underlying the following maps/figures:

Figure II-5, egress-constrained areas

Response to Question 6-4:
Please see SCE's response to MGRA-SCE-003 Q6. SCE is not aware of a difference between these two questions.

DATA REQUEST SET M G R A - S C E - 0 0 6

To: MGRA
Prepared by: Kyle Ferree
Job Title: Senior Advisor
Received Date: 1/25/2024

Response Date: 2/7/2024

Question 6-5:
Please provide geodatabase information containing the data underlying the following maps/figures:

Figure II-6, areas with a high frequency of fires

Response to Question 6-5:
Please see SCE's response to MGRA-SCE-003 Q6. SCE is not aware of a difference between these two questions.

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 6

To: MGRA
Prepared by: Kyle Ferree
Job Title: Senior Advisor
Received Date: 1/25/2024

Response Date: 2/7/2024

Question 6-6:
Please provide geodatabase information containing the data underlying the following maps/figures:

Figure II-7, areas with high frequency of fires and egress constraints

Response to Question 6-6:
Please see SCE’s response to MGRA-SCE-003 Q6. SCE is not aware of a difference between these two questions.

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 6

To: MGRA
Prepared by: Kyle Ferree
Job Title: Senior Advisor
Received Date: 1/25/2024

Response Date: 2/7/2024

Question 6-7:
Please provide geodatabase information containing the data underlying the following maps/figures:

Figure II-10, areas with extremely high windspeeds

Response to Question 6-7:
Please see SCE's response to MGRA-SCE-003 Q6. SCE is not aware of a difference between these two questions.

Southern California Edison
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To: MGRA
Prepared by: Kyle Ferree
Job Title: Senior Advisor
Received Date: 1/25/2024

Response Date: 2/7/2024

Question 6-8:
Please provide geodatabase information containing the data underlying the following maps/figures:

Figure showing IWMS Risk Tranche Designations

Response to Question 6-8:
Please see SCE's response to MGRA-SCE-003 Q6. SCE is not aware of a difference between these two questions.

2025 General Rate Case
SCE
MGRA Data Request No. 7 - Amended
February 2, 2024

Existing Documents and Updates

MGRA-7-1 Please provide redacted version of PubAdv-SCE-370-MGN responses.

MGRA-7-2 Please provide information in Tables I-12 and I-13 updated with 2023 PSPS events.

Fast Curve and Covered Conductor

MGRA-7-3 When circuits are hardened with covered conductor, are "Fast Curve" settings also enabled for associated circuit breakers, or are these mitigations unrelated?

MGRA-7-4 What fraction of circuit breakers in SCE's HFRA currently have "Fast Curve" settings enabled?

MGRA-7-5 Please provide a table showing the fraction of circuit breakers in SCE's HFRA with "Fast Curve" settings enabled for years 2017 to 2023:

a. For total HFRA

b. For portion of HFRA with bare wire

c. For portion of HFRA with covered conductor

MGRA-7-6 Describe the relationship between "Fast Curve" circuit breakers and REFCL, specifically:

a. Will circuit breakers continue to operate with "Fast Curve" once REFCL is installed?

b. Is REFCL a replacement for "Fast Curve" circuit breakers?

c. If REFCL replaces "Fast Curve" circuit breaker settings, what is the incremental difference (quantitative) in ignition reduction estimated between "Fast Curve" and REFCL?

d. If REFCL and "Fast Curve" circuit breaker settings are complimentary, what is the quantitative increase in ignition reduction over REFCL alone?

e. For SCE's estimates of combined CC + REFCL ignition reduction (Ex. PubAdv-SCE-139-MGN), does this estimate reflect the assumption that Fast Curve settings are in place or does it assume they are not in place?

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 7

To: MGRA
Prepared by: Daniel Komula
Job Title: Senior Advisor
Received Date: 2/2/2024

Response Date: 2/14/2024

Question 7-1:
Please provide redacted version of PubAdv-SCE-370-MGN responses.

Response to Question 7-1:

Please see the attached file Public_PubAdv-SCE-370-MGN.xlsx.

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 7

To: MGRA
Prepared by: Andrew Swisher
Job Title: Consulting Engineer
Received Date: 2/2/2024

Response Date: 2/14/2024

Question 7-3:
When circuits are hardened with covered conductor, are "Fast Curve" settings also enabled for associated circuit breakers, or are these mitigations unrelated?

Response to Question 7-3:

These mitigations are largely unrelated. The reconductor work associated with covered conductor deployment is typically completed separately from updates to substation circuit breakers setting configuration changes which can enable Fast Curve. The work executions functions require different expertise for relay settings changes compared to reconductor efforts.

Southern California Edison
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DATA REQUEST SET M G R A - S C E - 0 0 7

To: MGRA
Prepared by: Kyle Ferree
Job Title: Senior Advisor
Received Date: 2/2/2024

Response Date: 2/16/2024

Question 7-4:
What fraction of circuit breakers in SCE's HFRA currently have "Fast Curve" settings enabled?

Response to Question 7-4:
882 out of 1,068 circuits have circuit breakers with fast curve settings enabled, but SCE uses other devices like reclosers to provide protection in some cases. SCE has identified 39 circuit breakers in 2024 to close out fast curve relay update work for HFRA applications.

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DATA REQUEST SET M G R A - S C E - 0 0 7

To: MGRA
Prepared by: Kyle Ferree
Job Title: Senior Advisor
Received Date: 2/2/2024

Response Date: 2/16/2024

Question 7-5.a-c:
Please provide a table showing the fraction of circuit breakers in SCE's HFRA with "Fast Curve" settings enabled for years 2017 to 2023:

a. For total HFRA
b. For portion of HFRA with bare wire
c. For portion of HFRA with covered conductor

Response to Question 7-5.a-c:
Please see the attached file "MGRA-SCE-007_7-5.xlsx" which shows all circuits in HFRA with and without fast curve settings enabled at the circuit breaker.

Southern California Edison
A.23-05-010 – SCE 2025 GRC

DATA REQUEST SET M G R A - S C E - 0 0 7

To: MGRA
Prepared by: Andrew Swisher
Job Title: Consulting Engineer
Received Date: 2/2/2024

Response Date: 2/16/2024

Question 7-6.a-e:
Describe the relationship between "Fast Curve" circuit breakers and REFCL, specifically:

a. Will circuit breakers continue to operate with "Fast Curve" once REFCL is installed?
b. Is REFCL a replacement for "Fast Curve" circuit breakers?
c. If REFCL replaces "Fast Curve" circuit breaker settings, what is the incremental difference (quantitative) in ignition reduction estimated between "Fast Curve" and REFCL?
d. If REFCL and "Fast Curve" circuit breaker settings are complimentary, what is the quantitative increase in ignition reduction over REFCL alone?
e. For SCE's estimates of combined CC + REFCL ignition reduction (Ex. PubAdv-SCE-139-MGN), does this estimate reflect the assumption that Fast Curve settings are in place or does it assume they are not in place?

Response to Question 7-6.a-e:
a. Will circuit breakers continue to operate with "Fast Curve" once REFCL is installed?

Response to a: Yes, circuit breakers and their relays can be equipped to operate with Fast Curve for a location which is also configured with REFCL.

b. Is REFCL a replacement for "Fast Curve" circuit breakers?

Response to b: No, REFCL is not a replacement for Fast Curve operational settings.

c. If REFCL replaces "Fast Curve" circuit breaker settings, what is the incremental difference (quantitative) in ignition reduction estimated between "Fast Curve" and REFCL?

Response to c: See response to part b.

d. If REFCL and "Fast Curve" circuit breaker settings are complimentary, what is the quantitative increase in ignition reduction over REFCL alone?

Response to d: SCE estimates REFCL, in combination with Fast Curve settings, provides an increase in ignition reduction of 5% over REFCL alone for the overall mitigation effectiveness. In general, REFCL provides effectiveness for single phase to ground faults which overlaps with Fast Curve settings; however, Fast Curve settings also offer benefits for phase-to-phase faults and multiple phase-to-ground faults, which REFCL does not mitigate.

e. For SCE's estimates of combined CC + REFCL ignition reduction (Ex. PubAdv-SCE-139-MGN), does this estimate reflect the assumption that Fast Curve settings are in place or does it assume they are not in place?

Response to e: The estimated CC+REFCL Mitigation Effectiveness (ME) evaluation does not include Fast Curve operational settings. The addition of Fast Curve to the CC+REFCL mitigation results in an estimated 1% increase in the overall effectiveness.