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Office of Energy Infrastructure Safety
Natural Resources Agency

COMMENTS OF THE GREEN POWER INSTITUTE ON THE 2023-2025 BASE WILDFIRE MITIGATION PLANS OF THE IOUs

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The Green Power Institute (GPI), the renewable energy program of the Pacific Institute for Studies in Development, Environment, and Security, provides these *Comments of the Green Power Institute on the 2023-2025 Base Wildfire Mitigation Plans of the IOUs*.

Introduction

The GPI performed a review of the IOUs' 2022 WMP Updates with a general focus on Risk Methodology and Assessment (WMP Section 6), Wildfire Mitigation Strategy Development (WMP Section 7), Wildfire Mitigation (WMP Section 8), and the intersection of these risk management elements, particularly with respect to the electrical distribution system. Our comments and recommendation cover the following topics:

- PG&E and SCE should advance their vegetation and fuels management residue plan to emulate SDG&E's sustainable management approach.
- Wildfire Risk Planning Models: Probability of Ignition
- Wildfire Risk Planning Models: Quantifying granular consequence of risk event (CoRE) scores and risk planning frameworks.
- Wildfire Risk Planning Models: Wildfire consequence tranche definitions
- Wildfire Risk Planning Models: SCE should be required to report on progress towards remedying RSE issues identified by the third-party review.
- Wildfire Risk Planning Models: The IOUs should provide a plan for how they will integrate egress in their risk-informed mitigation selection and should develop a joint egress model.
- Wildfire Risk Planning Models: Program/activity Risk Spend Efficiency assessments must be compared on the same circuits/circuit segments.

- Risk Mitigation Activities: The IOUs should evaluate whether Undergrounding plans could result in unforeseen impacts, unanticipated reliability challenges, and higher future costs.
- Risk Mitigation Activities: The IOUs should coordinate their wildfire mitigation activities with the Distribution Planning Process at the CPUC.
- Risk Mitigation Activities: The IOUs should continue to make progress toward increasing PSPS wind speed thresholds based on covered conductor installation
- Risk Mitigation Activities: PG&E and SDG&E should actively advance their REFCL pilot programs to yield timely results
- Risk Mitigation Activities: PG&E's open tag backlog elimination plan does not meet OEIS standards
- WMP Reporting Improvements: IOUs should be required to make their risk modeling outputs publicly available on a web-based platform
- Cross-agency coordination: OEIS and the CPUC should work together to align activities associated with SB 884 and the WMP
- Cross-agency coordination: The role of IOU oversight includes ratepayer cost management

Comments

PG&E and SCE should advance their vegetation and fuels management residue plan to emulate SDG&E's sustainable management approach.

Ignition risk associated with vegetation blow-in, grow-in, and fall-in trees, as well as localized fuels, continues to necessitate aggressive vegetation management along utility right of ways for both distribution and transmission systems. Mitigation activities to manage tree risk, including strike trees as well as blow-in and grow-in trees, result in the removal or trimming of hundreds of thousands of trees, and produces fuels and slash materials that include woody biomass, also known as residues or frequently termed waste. We use the term biomass, residues, and waste interchangeably. However, we discourage using the terminology "waste," as these woody materials can be used as feedstock for a range of applications, including renewable (biomass) energy production.

Table 1. IOU total annual and forecasted tree removals.[1,2,3]

Year		SDG&E	SCE	PG&E	Total Trees Removed
2019	Actual	9,346	45,699	349,448	404,493
2020	Actual	12,508	101,343	378,109	491,960
2021	Actual	9,637	66,524	480,660	556,821
2022	Actual	9,598	71,229	579,173	660,000
2023	*Forecast*	*NA*	*54,787*	*347,000*	*401,787*
2024	*Forecast*	*NA*	*56,911*	*351,000*	*407,911*
2025	*Forecast*	*NA*	*56,143*	*354,000*	*410,143*
Total	**2019-2022**	**41,089**	**284,795**	**1,787,390**	**2,113,274**
Average	**2019-2022**	**10,272**	**71,199**	**446,848**	**528,319**
Standard deviation	**2019-2022**	**1,496**	**22,955**	**104,666**	**107,714**

The IOUs only provide patchy metrics on tree removals for individual VM programs in their WMPs that downplay the total trees removed and resultant woody biomass generated. PG&E reported removing over 48,000 trees in 2019.[4] This WMP cycle PG&E reported plans to remove 15,000 trees in 2023, 20,000 in 2025, and 25,000 in 2025, in their new "Tree Removal Inventory" (TRI) activity (VM-04).[5] This activity is touted as their management solution for the more than 300,000 trees (or approximately 385,000 trees) remaining in their legacy EVM program, which PG&E describes as closing in 2022.[6,7,8] The TRI activity includes re-inspecting the entirety of the legacy EVM tree inventory, resulting in either tree removal or rollover into

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[1] PG&E Data Response WMP-Discovery2023_DR_GPI_002-Q001
[2] GPI-SDGE-2023WMP-03 SDG&E RESPONSE
[3] SCE DATA REQUEST SET GPI-SCE-2023WMP-02

[4] PGE 2020 Revised WMP, Executive Summary, p. 3
[5] PGE 2023-2025 Base WMP, p. 501
[6] PGE 2023-2025 Base WMP, pp 527-528
[7] PG&E Data Response WMP-Discovery2023_DR_CalAdvocates_008-Q009
[8] PG&E Data Response WMP-Discovery2023_DR_GPI_002-Q001

their routine vegetation management and tracking program. The new transitional TRI activity is anticipated to last 9 years.[9] The reported tree removal numbers reported in the WMPs are a fraction of the actual annual average tree removal rate of 446,848 trees (Table 1, Figure 1).

PG&E projects a small but steady increase in total tree removals from 2023-2025 (Table 1).[10] Given the size of the EVM tree inventory, the ramp-up in tree removal over the current 3-year WMP, and the 9-year-long timeline for the TRI program, we anticipate similar annual tree removal targets for the coming decade. There is some indication that closing the EVM program will level out the rate of annual tree removals (Table 1, Figure 1).[11] However, trees that are not abated in PG&E's TRI program and work previously scoped in the EVM program will be rolled into the Routine Vegetation Inspections and Management program.

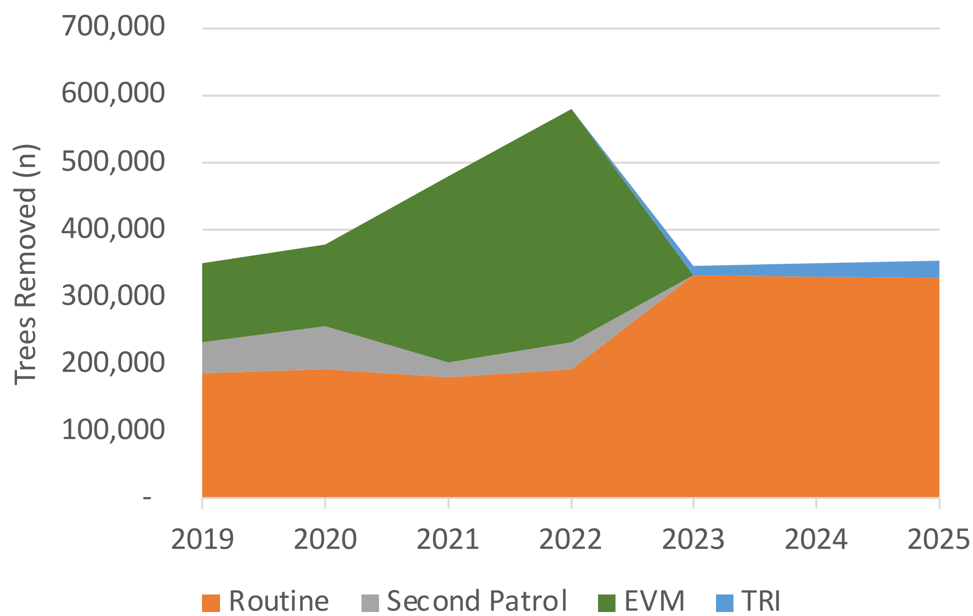

Figure 1. Trees removed by program from 2019-2022 and forecasted tree removals for 2023-2025

[9] PGE Data Response WMP-Discovery2023_DR_CalAdvocates_008-Q002
[10] PG&E Data Response WMP-Discovery2023_DR_GPI_002-Q001
[11] PG&E Data Response WMP-Discovery2023_DR_GPI_002-Q001

SCE's 2023-2025 Base WMP does not measure tree removal activity targets in terms of tree count. They do report an inventory of 95,000 palms and the removal of 20,000 palm trees since 2021, suggesting a removal rate of approximately 10,000 palm trees annually. In their 2022 WMP, SCE reports removing more than 15,600 trees since 2018, with identified removals totaling 13,500 trees in 2019, and 9,000 trees in 2020, and nearly 3,400 tree removals in 2021.[12] Their removal programs include the Dead and Dying Tree Removal Program, Hazard Tree Management Program, and Routine VM. An SCE data response shows that they removed an annual average of 71,199 ± 22,955 (1 SD) trees from 2019-2022, totaling approximately 285,000 trees in a 4 year period (Table 1). SCE's active tree inventory (transmission and distribution) totals 1.6 million trees.[13]

SCE previously reported mountain pine beetle outbreaks and the initial impacts of the invasive Gold Spotted Oak Borer in their territory resulting in the decline and death of oak trees beginning circa 2019.[14] While SCE's 2022 WMP reported a scale-down of their Dead and Dying Tree Removal Program due to lower find rates, this trend should not be taken for granted in the 2023-2025 WMP period and the coming decade. The USDA Forest Service reported the death of approximately 36 million trees across California in 2022 alone, up from 9.2 million in 2021, linked to drought and invasive species (Figure 1).[15] These high tree mortality rates generally occur in the HFTD, and are relevant to all utility WMP vegetation management risk-tree abatement programs and the amount of woody VM residues these programs produce.

SDG&E's 2023-2023 WMP provides minimal quantitative description regarding tree removal resulting from their 'Fall-in Mitigation Program" (Activity WMP.494).[16] Quantitative metrics in their 2023 Base WMP regarding tree risk abatement include trimming or removing 30 percent of their 255,000 HFTD inventory trees annually. In their 2020 WMP SDG&E reported removing

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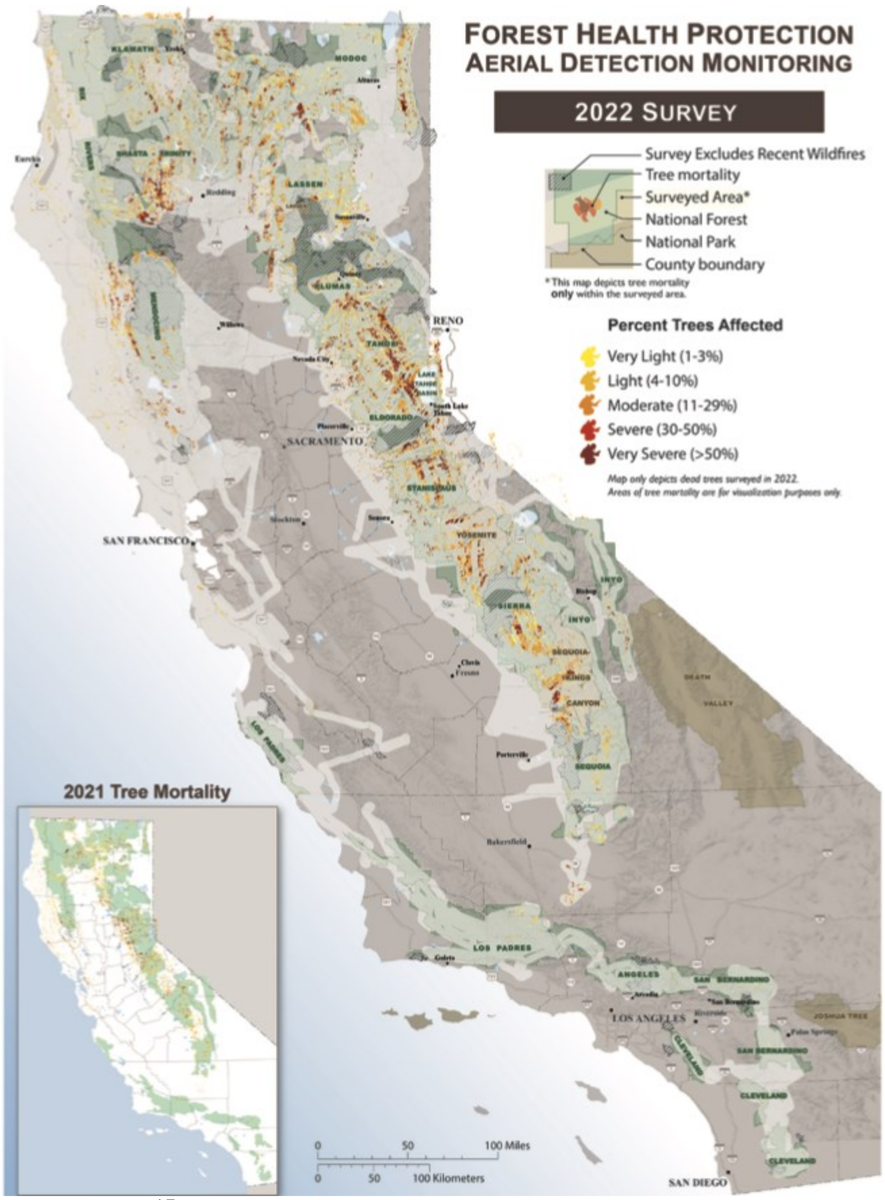
12 SCE 2022 Update WMP, p. 146
13 SCE Data Response attachment 01_VM Performance Review QC December 2022
14 SCE 2022 Update WMP, p. 47
15 USDA Forest Service Aerial Detection Survey https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd1088611.pdf
16 SDGE 2023-2025 Base WMP, p. 276



approximately 3,700 trees.[17] An SDG&E data response shows a relatively steady average tree abatement rate of 10,000 trees per year (Table 1).

Figure 2. Tree Mortality map reproduced from the USDA Forest Service Aerial Detection Survey: 2022 Summary Report[18]

[17] SDG&E 2020 revised WMP, p. 5
[18] USDA Forest Service Aerial Detection Survey https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd1088611.pdf

Vegetation management in the HFTD also includes aggressive tree trimming and fuel management activities. The IOUs regularly employ enhanced tree clearances ranging from 12 feet upwards to 25 feet.[19] Enhanced tree trimming work is conducted on thousands of line miles and thousands of trees in the HFTD. SDG&E, the smallest of the three IOUs, projects performing enhanced clearances on 10,000-11,000 trees annually, which they define as 12-foot or larger clearances, with some locations trimmed to 20 – 25-foot clearances. IOU fuel management programs include pole and structure brushing and clearances. SDG&E, SCE, and PG&E generally implement a standard 10-foot vegetation clearance around structures, which includes removing ground-based and tree vegetation. However, PG&E and SDG&E also deploy 50-foot clearances around some poles in the HFTD. PG&E now deploys these clearances in "Areas of Concern" as part of their Utility Defensible Space program. SDG&E treats a 50-foot radius around structures by thinning vegetation to 30 percent.[20] These activities are expected to produce large amounts of biomass, including woody biomass.

Based on data request responses the IOUs have removed 2.1 million trees since 2019, and anticipate removing another 1.25 million trees by the end of the WMP cycle (2025, Table 1). PG&E alone has over 861,000 additional trees marked for removal.[21] It is apparent that Utility vegetation management work along transmission and distribution right of ways is producing consistently large volumes of vegetation residues. The fate of this biomass is dictated first by whether it is removed from the work site, and second by where utilities dispose of the vegetation management residues that are removed. These plans are described in 2023-2025 Base WMP Section 8.2.3.2 Wood and Slash Management.

On-site dispersal versus removal – Vegetation management debris includes a wide range of vegetation types and sizes ranging from slash to large woody biomass such as that produced from tree felling. The IOUs by-in-large seem to describe similar standards for chipping and lop and scatter practices. However, their high-level descriptions suggest large variability in the

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[19] e.g. SDGE 2023 WMP, p. 274

[20] SDG&E 2023 WMP, p. 268

[21] PG&E Data Response WMP-Discovery2023_DR_GPI_002-Q001

application, as well as the potential for large amounts of fuel left in place following VM activities. SDG&E reports that:

> Most of the wood and slash debris resulting from routine trimming and removal activities are chipped on site and removed from the property the same day the work is performed. Large wood debris (generally greater than 6 inches diameter) is cut into manageable lengths and left on site.[22]

SDG&E's plan is somewhat contradictory, stating they remove most of the material but appears to leave branches and debris larger than 6" in place.

In contrast, SCE does not distinguish between wood and slash size for treatment approach and rather removes all residues within 100' of road access:

> SCE's contract crews strive to remove all wood and material resulting from mitigation for Routine Line Clearing, Structure Brushing, HTMP, and the Dead and Dying Tree Program typically within 100 feet of a dirt or paved road, subject to site conditions. On private property, crews will typically strive to remove all wood, providing that crews are able to maneuver and operate their equipment close enough to the area (e.g., skid steers). On federal lands, crews will typically remove logs, branches, and debris within 100 feet of a road or structure. Beyond 100 feet, SCE lops and scatters the limbs and brush with a height no greater than 18 inches above the ground and leaves logs greater than four inches in manageable sections, subject to site conditions.[23]

PG&E's plan includes dispersal treatments for wood < 4", leaving this material in place, and offers optional program for larger wood:

> Debris less than 4 inches in diameter that is generated during pruning activities are chipped or lopped and scattered on the property in accordance with applicable regulations. … The Wood Management program addresses large wood generated by PG&E's VM activities. This includes post-fire work activities, and wood generated by the EVM Program. Wood Management is a voluntary program in which property owners must opt in to participate. The program is designed to help alleviate the potential burden caused by the presence of larger diameter wood on customer properties resulting from PG&E activities. Wood larger than 4 inches in diameter belong to the landowner and wood management varies based on the owner's preference.[24]

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[22] SDG&E 2023 WMP, p. 273

[23] SCE 2023 WMP, p. 411

[24] PGE 2023 WMP, p. 535

PG&E's voluntary Wood Management Program for larger wood is of particular concern. PG&E references that the Wood Management Program is linked to the EVM program, which they have ended. It is not apparent whether this program now applies to the transitional and routine vegetation activities the EVM program is subsumed into. PG&E also fails to describe in their 2023 WMP that they offer a *Wildfire* Wood Management Program that is only available in fire scars from specific 2020, 2021, and 2022 fires.[25,26] On the Wildfire Wood Management Program Website Q and A section PG&E states:

> Will PG&E be offering wood removal for all its vegetation programs?
>
> We currently offer wood hauling and management to landowners in the identified 2020, 2021 and 2022 fire footprints where PG&E has cut down trees in response to wildfires.
>
> For questions about wood management for PG&E's other vegetation management work, please call 1-800-564-5080 or email treesafety@pge.com.[24]

An internet search also produced a 2017 PDF describing a Wood Management Program that includes wood removal for drought-affected trees, but that: "The program may only be in effect for a limited time."[27] This PDF was posted on the CalFire readyforwildfire.org website, but we were unable to locate the document via the website homepage. It appears that the described "Wood Management Program" described in the 2023-2025 WMP may actually be a "Wildfire Wood Management Program," and that wildfire mitigation or prevention activities are not eligible for, or included in, PG&E's wood removal program.

PG&E's [Wildfire] Wood Management Program is also "voluntary" meaning they do not automatically remove large wood generated from pro-active VM or post-wildfire VM activities and doing so would require a specific request. This suggests that a robust landowner outreach and communication process would need to be in place, including with private, state, and federal

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[25] PG&E Wildfire Wood Management Program. https://www.pge.com/en_US/safety/yard-safety/powerlines-and-trees/wood-management.page?WT.mc_id=Vanity_woodmanagement (Accessed May 12, 2023)
[26] PG&E Offering to Remove Wood Debris from Trees Cut Down for Safety During 2021 Wildfires. https://www.pgecurrents.com/articles/3379-pg-e-offering-remove-wood-debris-trees-cut-safety-2021-wildfires (Accessed on May 12, 2023)
[27] Wood Management Program. 2017 https://www.readyforwildfire.org/wp-content/uploads/PGE-Compliant-Wood-Management-Brochure.pdf (Accessed May 12, 2023).

landowners or managers, regarding fuel management decisions prior to, during, and/ or after the vegetation management work is completed.

Notably, a letter filed in 2021 from the Rural County Representatives of California and Napa and Sonoma Counties and the City of Santa Rosa, raised concerns over PG&E's wood and slash management methods and Wood Management Program when PG&E removed between 150,000 to 200,000 trees in the area in 2020 and left large amounts of "whole and chipped trees and limbs" on site.[28] The 2023 Maturity Survey does include question 4.3.2.Q2: "Does the electrical corporation inform relevant communities of vegetative waste removal?"[29] However, the wording of this question will technically allow PG&E to answer "Yes" for years 2023-2026, though its outreach efforts may be insufficient.

The community letter also raises concerns regarding loose commitments as to when the vegetation material would be removed. Timeliness of removal and customer communication regarding removal timeline may still be an issue given that PG&E's Wildfire Wood Management Program website vaguely states:

> When will PG&E complete wood removal work on my property?
>
> PG&E has been offering wildfire wood management since 2020. Conducting this work can take considerable time and resources. We are committed to completing this work as soon as possible. Weather, ground conditions, safety precautions and permitting issues, among other factors, may impact our schedule to manage or haul wood.[30]

PG&E also appears to employ restrictive definitions for wood size that are not expressed in the WMP. Its "Land Owner Permission Form for Wildfire Tree Removal" states that: "Tree removal under this Permission Form constitutes the hauling away of wood on the ground that is greater than 6 inches in diameter (measured at the smaller end), created by PG&E in response to tree work resulting from 2020, 2021 or 2022 wildfires."[31] Measuring at the smaller end suggests that

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[28] Local Governments' Response to PG&E Wood Haul Program. September 24, 2021

[29] Office of Energy Infrastructure Safety 2023 Electrical Corporation Wildfire Mitigation Maturity Survey - Revised Final April 24, 2023

[30] PG&E Wildfire Wood Management Program. https://www.pge.com/en_US/safety/yard-safety/powerlines-and-trees/wood-management.page?WT.mc_id=Vanity_woodmanagement (Accessed May 12, 2023)

[31] PG&E Land Owner Permission Form for Wildfire Tree Removal https://www.pge.com/pge_global/common/pdfs/safety/yard-safety/powerlines-and-trees/2022-Wildfire-Wood-Hauling-Permission-Form.pdf (accessed on May 12, 2023).

a large branch with >= 6" originating near the tree base but with twigs at the end could be left in place. It's not clear whether other IOUs also apply this narrow definition for wood diameter.

PG&E does contract wood yards to manage woody biomass from the [Wildfire] Wood Management Program and despite PG&E's preference to remove as little woody biomass as possible. While they do not track all vegetation management slash and fuel production, they do estimate the tonnage of wood that has "come through" their wood yards (Table 2).[32] It is important to note that this is likely a fraction of the woody biomass that PG&E's VM activities produce. These data also show that PG&E is already transporting woody biomass to collection points, collecting data on the material mass, and appears to be moving this material onto other end-points based on their verbiage.

Table 2. Recorded tonnage of removed wood that "passed through" PG&E's contracted wood yards from various VM programs including their Wildfire Wood Management Program[33]

Year	Total (tons)	Wildfire Wood Management (tons)
2021	151,033	35,890
2022	152,321	39,067

Based on the variability between IOU slash and fuels management programs and practices it should be expected that the IOUs leave varying amounts and sizes of vegetation management residues *in situ* for variable amounts of time. While it is not entirely clear, PG&E appears to have the least aggressive slash and fuels management and removal policies, leaving behind all VM residues less than 4 inches in diameter measured from the small end, and only reporting the removal of larger wood on a request basis for eligible wildfire scars. This is of particular concern since PG&E has the largest and most densely forested territory of the IOUs. In the case of the 2023-2025 WMP, it appears that PG&E will leave most slash and fuels in place that are

[32] PG&E Data Response WMP-Discovery2023_DR_GPI_002-Q003
[33] PG&E Data Response WMP-Discovery2023_DR_GPI_002-Q003

generated during the approximate 1 million tree removals scoped for 2023-2025 (Table 1), as well as any fuel management and tree trimming. A fraction of this material, totaling approximately 150,000 tons of woody biomass is moved through contracted wood yards each year (Table 2).

Dead and dry fuel build-up, especially in and around ignition sources, such as powerlines, is a concern in terms of both probability of ignition as well as wildfire consequence. Utility-produced slash and fuels and management policies, such as lop and scatter and leaving large wood in place, should not be directly compared to forest management fuels work. For example, forest management practices that reduce fuels may include piling slash and fuels, which are routinely burned during prescribed conditions to ensure safe disposal. While utilities are not expected or unable to engage in slash-pile burns, the large amounts of slash and wood that are left in place from VM activities can create a wildfire hazard. This is particularly concerning in locations that require frequent and annual tree work and given the dramatic increase in tree mortality across California from 2021 to 2022.[34] The practice of leaving vegetation management material in place and without robust land-owner communication can also affect customer relationships and willingness to allow utilities such as PG&E onto their land, thereby slowing vegetation management work.

In their 2020 WMP, PG&E stated plans to discuss with the USFS regarding fuel reduction initiatives and residue disposal approaches such as timber sale, lop and scatter, or chipping.[35] However, PG&E and the other IOUs have not described the outcome of these communications in their WMP. In their 2021 WMP, SCE contracted EPRI:

> …conduct a study for determination of best practices for fuel management." Results of the study are expected to provide a combination of risk-based and environmentally sound options for fuel management within SCE's diverse service area.
>
> Through 2021, SCE plans will review and analyze the results of the study and implement more regionally appropriate fuel management standards.[36]

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[34] USDA Forest Service Aerial Detection Survey https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd1088611.pdf
[35] PGE 2020 revised WMP, p. 5-255
[36] SCE 2021 WMP Update, p. 260

A follow-up OEIS-issued action statement required SCE to provide a copy of the study in their 2022 WMP Update. The report was later made public after the 2022 WMP filing in April 2022. This report acknowledges that "mechanical techniques of vegetation management that are routinely used, such as trimming, felling, and thinning may result in additional accumulation of debris on the forest floor."[37] While findings generally outline challenges associated with current USFS guidance on felled/cut vegetation debris and a wide range of options for fuels management, the content is presented at a high level and does not provide substantive direction regarding fuel management, such as the need for and optimal methods of removal.

In order to understand the scope of the fuels management challenge it is imperative that the IOUs provide more detailed and transparent descriptions of their fuels management policies and practices. These descriptions and the programs themselves should include quantitative estimates of the total amount of VM slash and fuels produced as well as the amount removed versus left in place for each program. Without more insight into the tons of vegetation residues produced each year via annual IOU VM activities, and the amount left in place, the wildfire risk these policies may be creating will remain masked and unverifiable.

The fate of VM residues – There are multiple fates for the slash and woody materials produced during VM activities and that are removed from the work site. The two high-level options are offloading the materials as waste or for value-added, beneficial-use end-uses. Value-added end uses can include a wide range of applications such as lumber, pellet production, mass timber, particle board production, woodchips, firewood, biochar, biomass feedstock, bio-fuels production, and other applications. These value-added pathways can provide revenue streams and/or generally improve the sustainability of annual utility VM activities by diverting the resultant materials from landfills and mitigating *in situ* fuel buildup.

Despite this potential, the WMPs have included few plans for value-added VM residue end-uses since 2019. Utilities generally state that VM residues (e.g. chipped or firewood) are made available to land owners upon request, or by default. Each Utility also describes options for land owner input regarding whether slash and wood are left in place or removed following vegetation

[37] EPRI. SCE Fuel Removal Assessment for Wildfire Mitigation (2022) https://www.epri.com/research/programs/025035/results/3002023370 (accessed on May 12, 2023)

management activities. SCE reports 1,333 tree removals completed with "instructions to cut to firewood" in their Routine Line Clearing program, totaling just 0.6 percent of 2019-2022 tree removals for the program are recorded for customer firewood end-use.[38] PG&E and SDG&E do not track customer requests regarding biomass treatment on private property.[39, 40] These limited data suggest that utility customer firewood programs make up a small fraction of the fate of vegetation management woody biomass.

In 2020 PG&E referenced plans to discuss with the USFS regarding fuel reduction initiatives and residue disposal approaches such as timber sale, lop, and scatter, or chipping.[41] Also in 2020, SCE was the only LSE that clearly indicated routing some of its VM residues to a biomass plant. In the 2021 WMP, SCE indicated a forthcoming consultant report on fuels management options. However, as discussed above the EPRI report was relatively high-level and did not address either the amount of VM material being produced or value-added end-use pathways that could improve the sustainability of mechanical VM treatments.[42] In their 2023-2025 Base WMPs, neither PG&E nor SCE mention the results of these end-use opportunities such as the amount of biomass diverted to value-added end uses, and whether they are ongoing.

In their 2022 WMP, Liberty provided the first quantitative metrics on VM woody biomass for their Fuel Management Projects. These data included project names, line-miles treated, acres treated, trees removed, landowner participation, tons of biomass removed, the facility where biomass was deposited, end-use, and due dates.[43] Notably, these tables provide some of the first estimates of biomass removed and show large variations in tons of biomass removed for different project scopes. For example, Liberty's Hobart Project removed 1,090 tons of biomass from fuels management work on 3.1 line miles, totaling 10.18 acres treated and removing 1,372 trees. This biomass has a listed end-use of "decked for transport." A different project that removed 1,302 trees lists the removal of 650 tons of biomass. In a third example, project "650 Row work"

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[38] SCE Data Request Response DATA REQUEST SET GPI-SCE-2023WMP-02
[39] GPI-SDGE-2023WMP-03 SDG&E RESPONSE
[40] PG&E Data Response WMP-Discovery2023_DR_GPI_002-Q004
[41] PGE 2020 revised WMP, p. 5-255
[42] EPRI. SCE Fuel Removal Assessment for Wildfire Mitigation (2022) https://www.epri.com/research/programs/025035/results/3002023370 (accessed on May 12, 2023)
[43] Liberty 2022 WMP, pp 136-138

included 6.28 line miles and 33.23 acres with 8,72 trees removed, but the tons of biomass removed is listed as N/A. Facilities and end-uses for the listed biomass include landfills/ woodchips, a compost facility, and firewood. We have not yet reviewed Liberty's 2023 WMP.

SDG&E's 2023 WMP includes the only IOU reference to employing ongoing sustainable management practices for vegetation residues that are removed during VM activities:

> Wood and slash associated with tree operations is taken to one of several landfills located in San Diego County or to a wood recycling facility. As part of its larger sustainability initiative, SDG&E continues to increase the amount of its wood and slash material that is diverted to a recycling facility. Currently, approximately 55 percent of total wood debris is diverted to a recycling facility to be rendered into composting or other environmentally sustainable materials.[44]

Its annual green waste disposal metrics from 2020-2022 show a steady increase in the amount routed to recycling facilities (Figure 3). SDG&E also indicates ongoing efforts to increase the percentage of total wood debris diverted from landfills to other value-added end-use facilities. In addition, SDG&E is the only IOU that provides tree rebates to customers, with plans to dole out upwards of 3,000 tree rebates annually.[45] While this does not directly improve the sustainability of VM debris production, GPI suspects it is likely to facilitate customer relations, "right tree right place" practices, and the sustainability of mechanical VM work overall.

Annual IOU tree removal rates suggest that the IOUs and SMJUs may be producing in the range of a million tons of biomass every year through VM work. The biomass removed and reported by Liberty (2,118 tons in 2022), SCE (annual average of 12,183 tons of green waste, Figure 3), and PG&E (annual 150,000+ tons of biomass, Table 2) point to the removal of hundreds of thousands of tons of biomass each year. Based on VM practices and these estimates, it is likely that most of the woody biomass generated from wildfire mitigation VM will remain in place, near utility assets, and the residues that are removed will largely be disposed of in landfills. This current situation represents an enormous lost opportunity for California, the IOUs and the landowners through whose properties the powerlines run.

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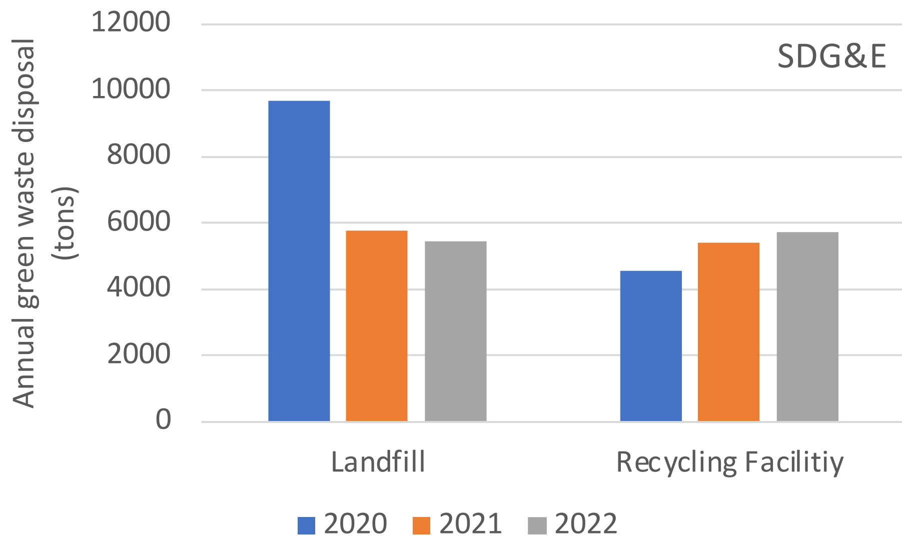
[44] SDG&E 2023-2025 WMP, p. 273
[45] GPI-SDGE-2023WMP-03 SDG&E RESPONSE p. 8

Figure 3. SDG&E annual green waste disposal (tons) in landfills and recycling facilities.[46]



In 2016 California recognized the need for sustainable woody feedstock markets and passed SB 859 Section 9(a):

> The Secretary of the Natural Resources Agency shall establish a working group on expanding wood product markets that can utilize woody biomass, especially biomass that is removed from high hazard zones, as determined by the department. These markets include, but are not limited to, animal bedding, biochar, cross-laminated timber, mulch, oriented strand board, pulp, post, shredding, and veneer products.[47]

This resulted in the 2017 Wood Products Working Group report that identifies barriers and strategies for barrier removal toward expanding California wood product markets.[48] By 2020 California initiated a cross-agency assessment of woody feedstock and as recently as February 2022, the Governor's offices of Planning and Research, as well as Business and Economic Development issued the following vision statement:

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[46] GPI-SDGE-2023WMP-03 SDG&E RESPONSE

[47] SB 859 Public resources: greenhouse gas emissions and biomass. (2015-2016)

[48] SB 859 Wood Products Working Group. Recommendations to Expand Wood Products Markets in California. (2017) https://resources.ca.gov/CNRALegacyFiles/wp-content/uploads/2014/07/Wood-Products-Recommendations.pdf (Accessed May 13, 2023)

> Agricultural, urban, and forest woody feedstock, produced through sustainable land management practices, can become the basis for a thriving wood products market that aligns with and supports California's State policy priorities including reducing wildfire risk, achieving carbon neutrality, protecting the environment and vulnerable communities, and supporting sustainable, resilient, and inclusive regional economies.[49]

This announcement further outlines millions in state funding for projects that facilitate market development such as feedstock aggregation demonstration projects. The progression of these discussions and the injection of funding suggest the forthcoming expansion of woody feedstock markets in California that can absorb utility VM residues.

In 2022, UCLA School of Law Emmitt Institute on Climate Change and the Environment and UC Berkley Law School Center for Law Energy and Environment issued a joint policy report on barriers to waste biomass applications and policy solutions.[50,51] This report outlined existing barriers to developing a market for woody feedstocks in California. The IOU's steady annual tree removal rate is directly relevant to these barriers, especially in regard to mitigating market challenges associated with the heightened risk to investors given unpredictable woody feedstock supplies. The annual VM work that utilities conduct may prove to be a reliable source of woody biomass that is well suited to a wide range of sustainable applications. In turn, the need for a steady supply of woody feedstocks may make it easier for utilities to reliably offload their VM residues to market participants.

Key solutions to identified barriers included "support data mapping and brokerage initiatives for regional supply chain management."[50] The WMPs present an opportunity to collect and publicize data on annual Utility woody feedstock production, removal, and end-uses. These data

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[49] California Govenor's Office. Sustainable Woody Biomass Industry Development in California. (2022) https://static.business.ca.gov/wp-content/uploads/2022/02/GO-Biz-Interagency-Biomass-Market-Development-Framework.pdf (Accessed May 13, 2023)

[50] Branching Out: Waste Biomass Policies to Promote Wildfire Resilience and Emission Reduction (2022) http://www.climatepolicysolutions.org/wp-content/uploads/2022/05/Branching-Out.pdf (Accessed May 13, 2023)

[51] Wildfire Treatments & Waste Biomass: Policy Options to Boost New End Uses (2022) https://www.kaltura.com/index.php/extwidget/preview/partner_id/1368891/uiconf_id/41443412/entry_id/1_39uym7f9/embed/iframe? (Accessed May 13, 2023)

have the potential to facilitate the creation of markets for VM woody biomass, an official California initiative, while also providing transparency into the sustainability of current WMP fuels and slash management methods relevant to the sustainability goals of the 2020 WSD Roadmap.[52] Collecting these data is also in accordance with WMP Guideline requirements to develop and report on best practices for utility slash and fuels management policies and methods.

WMP Guideline and Maturity Survey Gaps and Recommendations – Based on data provided in the IOU 2023-2025 Base WMPs, the updated 2023 WMP Guidelines and Maturity Survey unfortunately request insufficient data to determine whether VM fuels and slash management and removal methods are creating wildfire ignition and consequence risk, are sustainable, or are maturing. The WMP Guidelines allow utilities to customize activity targets. However, these VM targets are not comparable between IOUs (e.g. grids treated, line-miles, tree removals). The IOUs are also not required to report on vegetation management units that would allow for biomass production estimates, such as the number of trees and tonnage, or estimates of the proportion of VM residues left in place versus amounts removed and its fate (e.g. landfill, beneficial use). Utilities likely already have a substantial amount of data available to estimate VM waste/residue production rates. IOU tree inventory databases include individual tree species and size data as well as how many and which trees are removed each year. Forestry tools such as tree mass calculators and look-up tables can assist in converting these data into estimated tonnage. SDG&E, PG&E, and Liberty have also recorded woody biomass tonnage, indicating that the utilities are already collecting at least some direct measurements of vegetation management removals mass.

The 2023 Maturity Survey removed maturity tracking of "vegetation waste/residues." The development of sustainable VM residue removal and end-use applications was previously included in the 2022 Maturity Survey in Capabilities 24 and 25 (Figure 4). A review and keyword search of the 2023 Maturity Survey yields no questions or scores pertaining to slash or

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[52] REDUCING UTILITY-RELATED WILDFIRE RISK Utility Wildfire Mitigation Strategy and Roadmap for the Wildfire Safety Division (2020) p. 22

fuels management, or vegetation waste/residues. The most salient questions are under Capability 20. Vegetation treatment:

> 4.3.2.Q2 Does the electrical corporation inform relevant communities of vegetative waste removal?

and

> 4.3.2.Q5 How quickly are the vegetative waste removed after trimming and outside the wildland (e.g., in a homeowner's yard, along a street, etc.) after trimming?[53]

These prompts are unable to inform OEIS and stakeholders how communities are informed, whether and how much of the produced VM biomass is removed from worksites, and whether utilities are maturing their sustainable treatment of removed material (i.e. fate and end-use).

Figure 4. Capability 24 in the 2022 Maturity Survey included maturation goals for sustainable treatment of VM waste/residues.

24. Vegetation grow-in mitigation	Utility often fails to maintain minimum expected clearances around lines and equipment. Utility does not remove vegetation waste/residue along right of ways.	Utility maintains vegetation around lines and equipment according to minimum expected clearances. Utility i) removes vegetation waste/residue along right of ways ii) within 1 week of cutting vegetation across entire grid	Utility meets or exceeds minimum expected clearances during all seasons around electric lines and equipment in the HFTD at circuit level. Utility i) removes vegetation waste/residue along right of ways ii) within 3 days of cutting vegetation across entire grid, and iii) works with landowners to ensure wood removed from potential ignition areas	Utility meets or exceeds minimum expected clearances where relevant based on input from ignition risk modeling during all seasons around electric lines and equipment in the HFTD, with clearances also determined by species growth rates and species limb failure estimates at the span level and engages with communities on clearances protocols. Utility i) removes vegetation waste/residue along right of ways ii) on same day as cutting vegetation	Utility meets or exceeds minimum expected clearances, with clearances being determined based on species growth rates, species limb failure rates cross-referenced with local climatological conditions and an accurate ignition and propagation risk modeling and works with community organizations to cooperatively set local clearances and protocols. Utility i) removes vegetation waste/residue along right of ways on ii) same day as cutting vegetation; iii) utility collaborates with local landowners to provide a use for cutting vegetation across entire grid; iv) utility works with partners to identify new cost-effective uses for vegetation waste/residue and v) takes into consideration environmental consequences and emissions of vegetation waste/residue

[53] 2023 ELECTRICAL CORPORATION WILDFIRE MITIGATION MATURITY SURVEY pp 299-306

Based on the vague descriptions of slash and fuels management in the IOUs' 2023-2025 WMPs, the 2023 WMP Guidelines and Maturity Survey requirements, and California's goal to develop a sustainable market for woody biomass, GPI recommends the following:

- Require the IOUs to plan and detail customer engagement efforts regarding vegetation management residue removal, including outreach and customer notification methods, the efficacy of these methods (e.g. the number of customers reached), the number of customer requests to leave or remove VM debris, customer feedback on their VM residue removal work and offerings, and any recent communications and outcomes regarding fuels management on state and federal lands. By requiring IOUs to clarify their methods including customer outreach and quantitatively estimate VM residue production and removal, OEIS and stakeholders will be able to assess the size and scope of the VM slash and fuels management challenge.
- Require PG&E to provide additional detail on their Wood Management Program, including which VM residues and which customers are eligible for the program, the customer notification and outreach methods, and the time it takes for PG&E to clear woody biomass that is designated for removal.
- Require the IOUs to provide additional detail on their fuels and slash management practices, including whether size cutoffs are based on the smallest end of wood pieces.
- All Utilities should be required to report on the number of trees they remove each year and under which programs; an estimate of the total amount of biomass produced in tons for tree removals and for other VM activities; an estimate of the total biomass (tons) removed from VM worksites; and the fate of the removed biomass per defined categories that include material format (e.g. wood chips, firewood, lumber/logs) and end-use/point (e.g. landfill, recycling facility, biomass facility, mass timber facility, woody biomass aggregation facility). Utilities are already collecting tree removal count; this data will provide insight into an easily quantifiable fraction of the woody biomass produced during vegetation management work.
- Establish SDG&E's sustainable woody biomass recycling goals as current best practices in fuels and slash management for all of California's wire utilities.

- Require PG&E and SCE to develop VM biomass sustainability goals and practices akin to SDG&E's recycling efforts.
- Require utilities to report on their current efforts and future plans to mitigate fuel build-up and to identify sustainable pathways for VM woody waste/residues.
- The WMP Guidelines and Maturity Survey should include the above information as reporting requirements. This will enable OEIS and stakeholders to evaluate whether VM woody biomass may become a hazard in and of itself and whether Utilities are working towards interfacing with California's emerging sustainable woody biomass markets.
- Require the utilities to provide additional information on their existing and developing agreements with federal and state lands regarding best management practices for woody biomass produced during vegetation management activities.

Wildfire Risk Planning Models: Probability of Ignition

Wildfire risk is quantitatively defined as:

$$\text{Wildfire risk} = \text{Probability(ignition)} \times \text{Consequence(ignition)}$$

IOU PoI models, while serving the same function, have a range of names. SCE uses the term Probability of Ignition (POI) models, while SDG&E and PG&E use the terminology Likelihood of Risk Event (LoRE) for their PoI models. For clarity, we will use the term Probability of Ignition models, or PoI models, for all IOUs.

The probability of ignition (PoI) is further defined as:

$$\text{Probability (ignition)} = \text{Probability (failure)} \times \text{Probability (ignition|failure)}$$

We use the term failure to mean outage, hazard, or risk event, since the IOUs are expanding input data sets to include PSPS hazards, risk events, and outages which specifically refer to loss of customer power. GPI also notes that PoI model descriptions in both the WMP and the supporting technical documentation have improved substantially since the 2022 WMP. This improvement is facilitating model review.

By the 2022 WMP filings, PG&E and SCE were generally converging on similar methods using Machine Learning algorithms to quantify granular-, asset- and span-level Probability of Ignition across their service territories. The IOUs were also developing PoI sub-models or adjustment factors for specific risk drivers such as equipment failure events and Contact from Object – Vegetation (CFO-Veg). The IOUs also applied PoI as per the complete wildfire risk equation to risk-rank circuit segments and circuits for mitigation selection and prioritization. The 2023-2025 WMPs show an evolution not only in terms of PoI sub-model build out, but also the quantitative valuation of likelihood of ignition given an outage, and whether and how PoI model outputs are used in risk-informed mitigation selection and prioritization. We discuss these three aspects of PoI modeling and their potential implications when applied to wildfire mitigation selection. In general, GPI strongly recommends requiring the IOUs to develop a joint PoI modeling framework to the extent possible based on data that are available to the IOUs.

Probability of failure sub-models and performance – The IOUs developed distribution planning probability of failure, or P(f), models using a range of approaches and sub-models for each risk driver. PG&E and SCE both employ machine learning for their P(f) modeling. SDG&E developed what they term an "Ignition Rate Normalization Factor Model" that uses condition-based adjustment factors and normalization. We discuss these three models and model performance from the viewpoint of applying the model output to inform wildfire mitigation selection and prioritization.

Advancements to PG&Es WDRM (v3) P(f) model include factors such as modeling across their entire territory, increasing from 2 sub-models to 17, expanded data inputs, and "'causal pathways' to ignitions" that extend beyond weather to include equipment wear and tear (e.g. overloading).[54] PG&E models are trained on "failures," which include outages, ignitions, and PSPS hazards/damages that occurred from June-November 2015-2021.[55] P(f) model spatial granularity varies by model type: CFO-Vegetation (100m pixel); Animal (100m pixel); Third party (100m pixel); Conductor and Other Equipment (100 m pixel); and Support Structures and Transformers (asset-based node).

[54] PG&E WDRM v3 Documentation, p. 10

[55] PG&E WDRM v3 Documentation, p. 18

PG&E's P(f) models are characterized according to three risk event categories: Object Contact (i.e. CFO), Equipment, and Support Structure/Transformer. Within these three categories, PG&E identifies 7 risk-event types and 17 sub-drivers, resulting in the most sub-models of the three IOU P(f) models (Table 3). The 17 sub-models mapped to sub-drivers address 17 different risk sub-drivers, giving PG&E's P(f) model the most risk diver specificity. Sub-drivers appear capable of capturing nuances in risk such as vegetation outage caused by blow-in/grow-in versus fall-in. The 17 sub-models suggest PG&E's PoI evaluation can inform risk mitigation efforts that target asset-level risk for 17 non-overlapping risk drivers. This level of granularity and sub-driver-specific PoI modeling suggests progress toward more targeted, mitigation-specific risk-spend efficiency (RSE) valuations, and the subsequent surgical deployment of risk mitigations to maximize portfolio RSE and timely risk-buydown. However, model performance accuracy and the implications for output application must be taken into account.

There are four possible types of model predictions for failure events: true positive, true negative, false positive, and false negative. The relative proportions of these outcomes from the test data inform the model fit. PG&E provides Receiver Operating Characteristic (ROC) curves and Area Under the Curve (AUC, Table 3), as well as co-variate analyses (sensitivity) for each sub-model in their WDRM v3 Documentation. AUC values indicate model performance, with a value of 0.5 meaning the model predictions are no better than chance, and a value of 1 indicating a perfect predictive model. PG&E also developed a: "Top 20 percent concentration factor" metric to assess "true positives in the top 20 percent of a model prioritization," which was developed to track with PG&E's target for 80 percent of work in the top 20 percent of risk segments.[56] Providing these performance metrics in the technical documentation is an improvement from the 2022 WMP filings, and allows OEIS and stakeholders to better understand the relationship between model outputs, risk planning gap, and application suitability, as well as whether model version updates affect performance.

[56] PG&E WDRM v3 Documentation, p. 12

Table 3. PG&E P(f) (and P(i|f)) model structure and P(f) sub-model performance metrics.[57]

Category	Risk event type	Sub-driver	Performance (AUC)
LoRE v3 (2021 for use in 2022+)	All	All	0.68
Object Contact (CFO)	Vegetation Outage Model	Vegetation_other	0.755
		Vegetation_branch	0.775
		Vegetation_trunk	0.851
	Animal Outage Models	Animal_bird	0.703
		Animal_squirrel	0.889
		Animal_other	0.742
	3rd Party Outage Models	Third_party_balloon	0.813
		Third_party_vehicle	0.725
		Third_party_other	0.636
Support Structure/Transformer	Support Structure Outage Model	Support_structure equipment_cause	0.664
		Support_structure equipment_electrical	0.868
	Transformer Outage Model	Transformer equipment_leaking	NA
		Transformer equipment_cause	0.541
Equipment	Conductor Outage Model	Primary_conductor	0.702
		Secondary_ Conductor	0.663
	Voltage Control Outage Model	Voltage_control equipment_type	0.857
	[Other]	Other_equipment_ Type	0.670

[57] PG&E WDRM v3 Documentation, p. 14

PG&E's aggregate P(f) model has an AUC value of 0.68 (Table 3). AUC values for each of the sub-models range from relatively good fits (0.889, animal_squirrel) to rather poor fits (0.541, transformer_equipment_cause). The model performance metrics suggest PG&E's aggregated PoI model has a relatively large error, or many false negatives and false positives. Notably, model performance for system hardening dropped from WDRM v2 to v3, while vegetation models improved. The range of model performance for each sub-model also implies that some sub-models are better suited for application to inform specific mitigations and RSE. For example, PG&E's Support_structure_equipment_electrical subset and sub-model show both a high likelihood of ignition given an event (27.77%, Figure 4), and an AUC-ROC of 0.868, respectively. The combination of a relatively high ignition-risk event type and high-performing predictive model suggests this P(f) sub-model could reasonably facilitate the granular deployment of specific mitigations or mitigation portfolios. Poor preforming P(f) models could suggest a range of intrinsic data limitations (e.g. missing critical covariates, many causes underlying failure events, low event count). Given the current level of sub-driver disaggregation and nominal model improvements since 2022, it's not clear if substantial incremental improvements can be expected in the future.

SCE's P(f) models are disaggregated into 5 sub-models grouped by 4 overhead equipment types including conductors, transformers, switches, and capacitors (Table 4). This framework is somewhat inverse to PG&E's risk driver categories and sub-models. Transformers, switches, and capacitor models have an asset granularity, while conductors are analyzed on a segment level. SCE appears to utilize year-round failure data from their entire territory (HFTD and non-HFTD). This partially contrasts with PG&E's P(f) models, which only utilize failure and ignition events that occur between June-November. The year-round dataset may provide SCE with additional event counts that facilitate model predictions since they have a smaller territory and overall fewer failure and ignition events compared to PG&E. Fewer risk events may be a limiting factor preventing SCE from disaggregating its data to the extent of PG&E's selective data use and 17 sub-models. They do plan to add a secondary conductor model during the 2023 WMP cycle. SCE does not include the following equipment in their P(f) models:

- arrestors (n=14 failures HFTD-Distribution system 2022, 2022 QDR4),
- circuit breakers (NA)

- connection points (n=128 failures in HFTD-Distribution 2022, 2022 QDR4),
- crossarms (n=14 failures in HFTD-Distribution 2022, 2022 QDR4)
- fuses (n=248 failures in HFTD-Distribution 2022, 2022 QDR4)
- poles (n=39 failures in HFTD-Distribution 2022, 2022 QDR4)
- splices (n=2 failures in HFTD-Distribution 2022, 2022 QDR4)
- tie wires (n=0 failures in HFTD-Distribution 2022, 2022 QDR4)

These 8 equipment types accounted for approximately 10 percent of SCE's total distribution system HFTD risk events in 2022.[58]

Table 4. SCE PoI Model structure and sub-model performance metrics

Risk event type	Sub-driver	Classification	Model	Performance (AUC)
OH Conductor	Equipment/Facility Failure – Conductor (EFF)	Binary (Yes/No)	Random Forest	0.93
	CFO	[All] Animal Balloon Vegetation Vehicle Unknown Other	Random Forest	[0.95] 0.89 0.91 0.88 0.87 0.96 0.84
OH Transformer		Binary		0.81
OH Switch		Binary	Random Forest	0.85
OH Capacitor		Binary	Random Forest	0.91

[58] SCE 2022 QDR4, Filed in Q1 2023

GPI recommends that SCE and PG&E provide additional context linking the lack of a PoI model, or a poor performing PoI model, with asset specific mitigation activities that address the risk modeling gap. For example, if fuse failures and resulting ignitions are associated with non-exempt CalFire fuses and a fuse replacement program will replace the fuses within the next n years, with work prioritized based on consequence risk tranches, then the lack of a P(f) model for fuses is a granular ignition risk modeling gap that is largely managed by a comprehensive asset-specific replacement program.

SCE provides total average failure events, covariate "importance tests," AUC-ROCs for different modeling approaches as well as the selected model training and test datasets, and confusion matrices for each P(f) model. SCE also provides an annual average failure rate for each sub-model that puts the risk exposure that each model addresses into some context. This level of detail regarding model performance facilitates model review and allows stakeholders to better understand the limitations of model application for mitigation planning purposes. GPI recommends that SCE's model performance metrics be promoted as current best practices, and as a documentation template for other utility machine-learning models.

SCE's OH capacitors total an average of 338 failures annually. The model has an AUC-ROC of 0.91. SCE also provides confusion matrices that show 85 percent and 15 percent accuracy and failure rates, respectively. It may be suitable to focus on false negatives as risk gaps for the purpose of model application in wildfire mitigation planning per our discussion below. The false negative rate is 11 percent.

SCE's OH conductor P(f) model is at a segment granularity. It contains two sub-models for Equipment failure – conductor and CFO. The average combined risk events per year is 3,500. In 2022, CFO and EFF-conductor risk events in Tier 3 and Tier 2 HFTD totaled 648 events of 2,652 events total, or 24.4% of risk.[59] These are also high-performing ML models, with AUC of 0.93 and 0.95 for the EFF-Conductor and CFO sub-models, respectively. The CFO-Veg model does not distinguish between branches (e.g. grow-in/blow-in) and trunks (e.g. fall-in). Many covariates with high predictive values include system design factors such as segment length, pole

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[59] SCE 2022 QDR4, Filed Q1 2023

height, and protective device presence (fuses, RCS/RAR protection). However, the model performance was not sensitive to changing segment length or pole height. GPI wonders if this simply suggests that these covariates are linked to the presence of an OH system, which is a prerequisite for OH system failures.

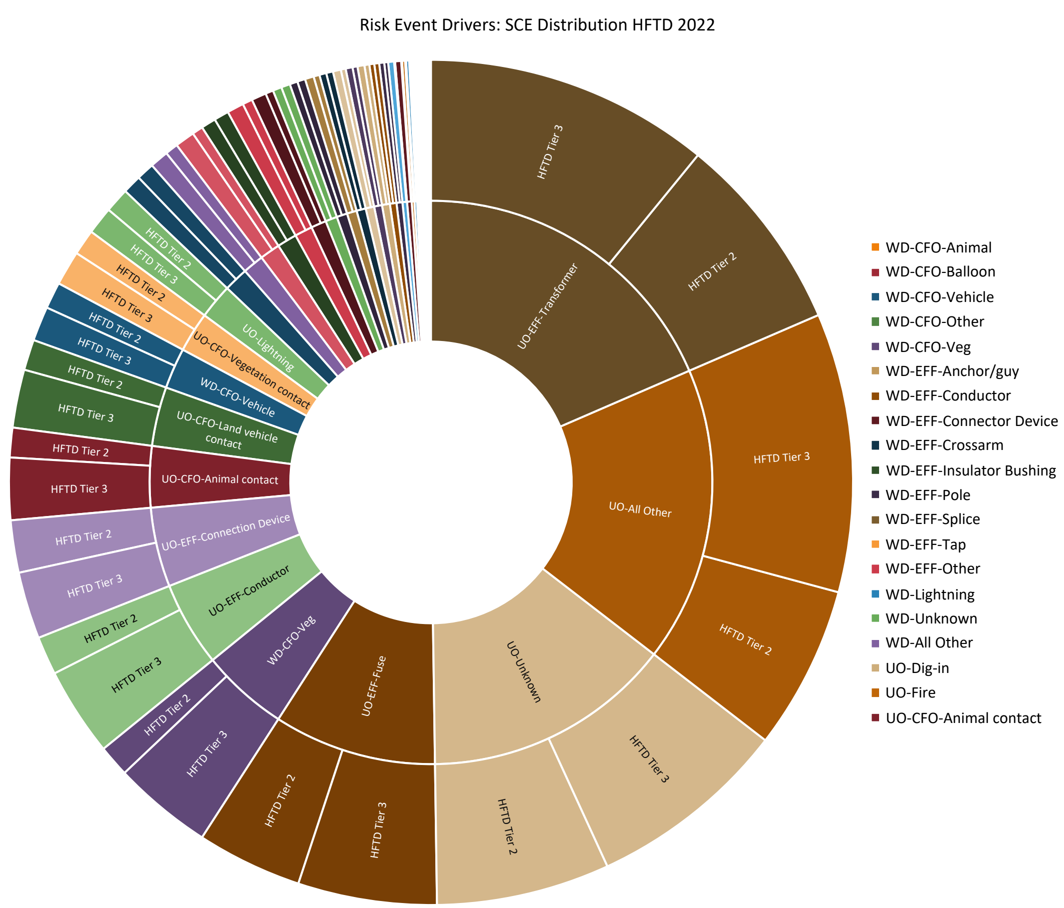
In general, the IOUs should include model interpretations in their WMP and technical modeling documentation, and link the interpretations to their reasoning for PoI model applications that inform risk-mitigation selection or prioritization. This should also include a description of interpretations that result in an IOU deciding to not apply their PoI model outputs for a given use case (e.g. SCE decision to not use PoI as an input to risk mitigation tranches).

OH switch failures only account for an average of 60 annual failures. The model AUC is 0.85 with an accuracy rate of 93.8 percent. The highest-ranked covariate predictors are system parameters such as voltage and age. SCE's OH transformers account for an average of 2,311 failures annually. The sub-model has an AUC of 0.81, with system parameters such as age, model, and manufacturer as the most influential covariates. Asset age is perhaps not a surprising predictor of equipment failure. However, as previously stated, the IOUs should include a narration of model interpretation and whether those interpretations are leveraged to inform actionable or pro-active wildfire mitigation efforts. For example, age-based pre-emptive equipment replacement versus run-to-failure operating standards.

Estimating the amount of system risk captured by a suite of models, in this case P(f) models, is important to consider when applying the model for planning purposes. It is not readily apparent the extent to which PG&E and SCE's P(f) (and P(i|f)) models provide coverage for distribution system ignition risk exposure. The implications of applying PG&E and SCE's machine learning P(f) models for the purpose of wildfire risk mitigation planning is likely a complex function of model performance, model bias, covariate insights, and risk coverage. While PG&E P(f) models cover more risk sub-drivers than SCE, some of their sub-models exhibit low accuracy. There is no doubt that SCE's P(f) models are high performing based on the presented suite of performance metrics. While there is no perfect model, P(f) error, and perhaps especially false negatives, equate to risk identification gaps. However, each model addresses a different "slice" of total distribution system failures and ignition risk, and therefore the risk coverage contribution of each sub-model varies. For example, PG&E's total P(f) model, with an AUC of 0.68, suggests only 68 percent of failure events are predicted by the model, though the correlation of high-performing failure event sub-models with ignition events is important for discerning risk coverage.

We utilized the updated data tables provided in the 2022 QDR4 report, which only provides 2022 risk event and ignition data (Figures 5 and 6), to qualitatively assess P(f) and P(i|f) risk exposure coverage. SCE's 2022 failure events are widely distributed across many failure modes, including with a high proportion of unplanned outage causes listed as "All other" or "unknown." Unplanned outage risk events are not linked to ignition events in the 2022 QDR4 data tables, although they are the most frequent risk event drivers. Many low-probability risk event drivers,

Figure 5. SCE 2022 HFTD Tier 3 and Tier 2 Distribution system risk event drivers reported in the 2022 QDR4 Table 5. Unplanned Outages – Emergency Repairs (n=1,756) and risk event types with no failures are removed for clarity.



likely with insufficient data to model, also comprise a large proportion of SCE's risk events (Figure 5). It is not readily apparent what percent of distribution system failure-event risk is captured in the models. As discussed in the following section, risk event drivers have different ignition rates. P(f) models will therefore capture different amounts of ignition risk, not only due to performance, but also due to P(i|f). On an ignition risk basis, SCE's models provide predictive capabilities for 7 of the top 10 ignition risk drivers observed in 2022. It is also, therefore, difficult to discern the ignition-risk coverage that SCE and PG&E's P(f) and P(i|f) models provide.

Figure 6. SCE 2022 HFTD Tier 3 and Tier 2 Distribution system ignition drivers reported in the 2022 QDR4 Table 6. Unplanned Outages that are listed in the risk event data are not listed as ignition drivers. Ignition event types with no failures are not shown.

Typical sources of modeling output gaps include but are not limited to model error/performance, model bias, data limitations (e.g. available covariates, insufficient data to develop a robust model), and model assumptions that result in output prediction gaps. GPI is concerned that these inherent gaps are leading the IOUs to forgo model application for the purpose of mitigation selection and deployment in light of a deterministic risk planning standard to prevent "all" catastrophic wildfires. If utilities are liable for **very** low-probability (e.g. very low likelihood of ignition) but potentially high-consequence events (e.g. 1-in-100 year return) this could be sufficient to make the perfect the enemy of very good, and deter the use case for PoI models to inform mitigation selection (e.g. CC+ versus UG) and granular deployment. This challenge is minimally twofold: (1) setting risk planning thresholds at the state level that inform what level of mitigation and risk management coverage is acceptable, and (2) a better understanding of the current risk "coverage" or gaps that P(f) and P(i|f) models provide. GPI recommends the IOUs assess and report on the known and estimable ignition risk gaps of their PoI models, including the risk gap contributions from both P(f) and P(i|f) models.

It is also important to conceptualize what model performance means in the context of applying the output for the use case, in this case wildfire mitigation selection and location (planning). P(f) model false negatives may represent a larger planning risk compared to false positives. A false negative indicates that the model did not predict a failure/event in a location where one occurred. This constitutes a location where applying the model may underestimate risk or overlook locations where risk was present but was not identified by the model. In contrast, false positives identify locations where the model predicts a failure occurrence that did not occur in the dataset. In the real world these could include locations where risk was not present or near-miss locations where risk was present but has not yet been manifested in a failure/event. This type of model error is more likely to overestimate event risk. In an application context, mitigations deployed on the basis of false positives may result in outcomes such as the prevention of future risk events and near misses and/or elevated costs to ratepayers for mitigations in locations where risk was over-estimated. In either case, false positive rates are not necessarily risk gaps in the context of wildfire mitigation planning. A large false positive rate for a given P(f) model of course demarks lower selectivity and performance and therefore usefulness for the purpose of mitigation selection and granular deployment. However, for relatively well-performing models the rate of false negatives may be a better indicator of residual risk gaps when using PoI models to inform granular wildfire risk mitigations.

It may also be possible for modelers to force models to minimize the false negative rate. While this may amplify the number of false positives, it would narrow the risk gap associated with false negatives. GPI cautions that models designed to minimize false negative results, and/or that also exhibit a relatively larger false positive rate, should be used judiciously and with careful evaluation of mitigation selection. For example, planning extensive and costly undergrounding informed by a low false negative but high false positive model output may result in an overbuilt system on account of over-estimating risk. Any model forcings should be compared to previous model outputs and undergo rigorous review, such as sensitivity and bias testing, to better understand model outputs and implications prior to their application by SMEs.

We further recommend requiring the IOUs to assess and report on P(f) (and P(i|f)) model bias. Model bias occurs when the algorithm systematically errs such that the output does not represent the population. A theoretical example would be if a P(f) primary conductor model with overall good performance systematically predicts failure events associated with equipment that ages better than the database implies, it can predict a failure event caused by high winds on newer equipment. In this theoretical example, a relatively high-performing model can output a biased true positive output that is weighted towards asset-age risk drivers and a false negative output largely populated with wind-driven risk events. Carrying this example through to a model use case, it would be critical to know whether the model largely informs where to retire old equipment versus where to enhance the system hardening approach, or if the causal conditions (e.g. high wind driven failures) could portend different consequence outcomes.

SDG&E does not utilize P(f) modeling or employ machine learning algorithms. SDG&E instead developed an Ignition Rate Normalization Factor Model. This model distributes an annual ignition rate across the HFTD based on OH mileage. The granularity of their model is at the Sub-circuit or segment-level defined as between two SCADA devices. Granular ignition rates are then sequentially adjusted based on a series of factors and re-normalized to the total annual ignition rate to ensure that the total annual ignition rate remains constant. Sequential adjustment factors include wind (wind speed -max), vegetation (Tree strike), Asset Health (Circuit Health

Index – proxy for wire down due to pole deterioration, conductor age), significant wildfire rate (1 in 15-year return), and the impacts of hardening (miles and percent UG and OH). For HFTD and non-HFTD segments with no CHI data, an average value was assigned. GPI suggests that imputing CHI based on next-nearest segments may be a more accurate approach.

SDG&E does not provide details on how their adjustment factors are quantified and only provides minimal information on the data inputs to adjustment factors. The documentation also refers to "changes" due to historic likelihood of fires, climate change, and increased OH mileage that was estimated using models.[60] SDG&E does not detail what models were used, the nature and magnitude of the changes, or the resulting changes in P(i) output. SDG&E does provide some model performance metrics based on WiNGS score correlations with HFTD and PSPS occurrence.[61] It is reasonable for WiNGS outputs to align with HFTD classification since the baseline ignition rate is the average HFTD ignition rate. However, SDG&E does not provide any model performance metrics such as whether the granular P(i) scores align well with actual outage and ignition data. GPI recommends issuing an ACI that requires SDG&E to provide the missing information in updated Appendix B model documentation.

We do not want to imply that SDG&E should adopt a machine-learning modeling approach. As the smallest of the three IOUs, we recognize that SDG&E's failure and ignition datasets have fewer events compared to PG&E and SCE, which may introduce challenges to machine-learning-type modeling. PG&E and SCE's P(f) and P(i) methodologies may therefore not be directly applicable to SDG&Es territory. However, drawbacks to SDG&E's method may include failing to take into account equipment health for equipment types other than conductors and poles. Insights from SCE and PG&E covariate dependencies may inform critical predictive failure and ignition risk factors relevant to SDG&E's model development. We also recommend that SDG&E explain why it relies on ignition data versus the larger failure dataset, provide additional context for why it selected its current modeling approach (e.g. data limitations etc.), and provide an estimate of the distribution system P(i) risk coverage their model provides (e.g. what specific risk drivers are taken into account). We also note that more detailed

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[60] SDG&E Model Documentation – WiNGS Planning v1, p. 11

[61] Model Documentation WiNGS Planning v1, p. 30

documentation on SDG&E's approach and model performance may facilitate predictive model development by the SMJU's, which are also risk event data limited.

Quantifying likelihood of ignition given a failure – PG&E and SCE quantify granular and driver/sub-driver-specific probability of ignition given an outage (*Probability(ignition|failure)*), whereas SDG&E determines P(i|f) as a function of HFTD and FPI. These alternate approaches suggest a continued need for methodological alignment.

SDG&E's does not have an independent granular P(i|f) model akin to PG&E and SCE, but rather models P(i) as described above. SDG&E does determine the 5-year average likelihood of ignition given a risk event as a function of HFTD location (i.e. non-HFTD, Tier 2 of HFTD, and Tier 3 of HFTD) and operating risk condition (i.e. FPI ratings of All, Normal, Elevated, or Extreme).[62] For the purpose of measuring pre- and post-mitigation effectiveness for each WMP activity, SDG&E generally applies the 5-year average likelihood of ignition rate as a function of All FPI for Tier-3, Tier-2, and non-HFTD locations, valued at 2.91, 2.56, and 1.13 percent, respectively. This includes the ignition rates of all risk-driver types, and is not risk-driver specific. These percentages are used in effectiveness calculations for most mitigations including covered conductor installation, undergrounding, distribution overhead system hardening (traditional), distribution pole replacement/reinforcement, transmission-distribution underbuilt, advance protection, early fault detection, strategic pole replacement, corrective maintenance program and distribution asset inspections (detailed, IR, wood pole intrusive, ground/OH, drone), SCADA capacitor maintenance and replacement, expulsion fuse replacement, and the hotline clamp replacement program. Only select activities, such as transmission mitigations and their Avian Cover program use alternate and risk-event-specific ignition rates. For example, their Avian Cover program determines an animal-contact sub-driver ignition rate based on location by dividing the Tier-3, Tier 2, and non-HFTD 5-year animal contact events by the corresponding location-specific 5-year animal contact ignition rates.

SDG&E's approach makes the assumption that ignition location and FPI are more critical determinates of the likelihood of ignition given a risk event rather than the risk event driver

[62] SDG&E 2023 WMP p. 329

itself. Average ignition rate dependence on both FPI and location is shown in SDG&E's efficacy study (Figure 7). However, while HFTD Tier 3 and Tier 2 may indicate relative risk, more granular risk models have shown variable ignition and consequence risk within the HFTD tiers that do not necessarily align with Tier designations. At a higher granularity, zones within Tier 2 may be at higher risk than areas within HFTD Tier 3. Applying an FPI and HFTD-based ignition rate to calculate mitigation activity risk reduction also assumes that risk events have the same ignition rate regardless of the driver (e.g. wire down, CFO-Vegetation).

Figure 7. Reproduced from SDG&E's 2023-2025 Base WMP, SDG&E Table 8-35 shows the dependence of probability of ignition given a risk event on HFTD location and FPI rating.

SDG&E Table 8-35: 5-Year Average Ignition Rate

Location	Normal FPI	Elevated FPI	Extreme FPI	All FPI
Non-HFTD	0.88%	2.15%	0.00%	1.13%
Tier 2	1.37%	3.57%	12.90%	2.55%
Tier 3	1.28%	4.99%	10.53%	2.91%
System	1.03%	3.35%	7.59%	1.79%
HFTD (Tier 2 and Tier 3)	1.32%	4.26%	12.00%	2.72%

SDG&E also appears to define ignitions and the resultant P(i) somewhat differently from SCE and PG&E, stating:

> Wildfire likelihood of risk event (LoRE) – The total anticipated annualized number of fires reaching each spatial location resulting from utility-related ignitions at each location in the service territory. This considers the ignition likelihood and the likelihood that an ignition will transition into a wildfire based on the probabilistic weather conditions in the area (Model Documentation - WiNGS Planning v1, p. 4).

This definition includes a likelihood of an ignition becoming a fire, perhaps akin to "burn probability," as a function of weather. SCE does not include a similar term, and instead assumes each ignition is essentially a "match drop" as measured in Technosylva Wildfire Consequnce outputs. Although not directly comparable, PG&E weights P(i) based on conditions present during high failure frequencies. GPI strongly recommends that the IOUs align their definitions of ignition and burn probability.

PG&E uses logistical regression to determine the granular likelihood of ignition given an outage/event for each of 17 risk event drivers. This approach captures variability between the likelihood of ignition for specific risk sub-drivers, which is reflected in the ignition-to-event count ratios for each subset (Figure 8). In the simple ratio analysis, some events such as transformer_equipment_causes exhibit a relatively low P(i|o) (0.7 percent), while others show an order of magnitude higher likelihood of ignition given an event, such as support_structure_equipment_electrical events that register a 27.77 percent likelihood of ignition. The greater variability in risk event ignition rate in the simple ratio, relative to SDG&E's ignition rate variability by HFTD suggests that the likelihood of an ignition given a failure event is more sensitive to the failure type than it is to HFTD.

PG&E's spatially and temporally granular P(i|o) as a function of sub-driver risk takes into account covariates such as HFTD, wind speed, and fuel moisture, as well as subset-specific covariates like equipment type. This approach is capable of reflecting that not all utility risk events may have the same mode of initiating an ignition. For example, risk events that release eject molten metal versus result in contact between an energized bare conductor and fuels may have different likelihoods of ignition. The sub-driver-specific P(i|o) values include conditions (e.g. wind, fuel moisture) and location factors (i.e. HFTD) similar to those considered in SDG&E's HFTD and FPI-based P(i|o) models. PG&E then aggregates the P(i|o) into fire-season values by weighting daily contributions based on the number of outages in order to develop a P(i|o) that better reflects conditions associated with high outage rates.[63]

Taking into account risk event drivers when estimating P(i|o) allows for a more nuanced assessment of mitigation effectiveness and downstream risk spend efficiency calculations. For example, ignition rate ratios calculated for each PG&E risk event driver reveal that while transformer equipment risk events may be four times more frequent than support structure-electrical failure risk events across the service territory, the latter risk event is more likely to cause an ignition. In this example, preventing support structure-electrical failure would reduce the system probability of ignition more than an activity targeted at preventing transformer risk events. Notably, PG&E's total likelihood of ignition for all outages, 3.69 percent, is on par with

[63] PG&E WDRM v3 Documentation, pp 39-40

SDG&E's Tier 2 and Tier 3 event ignition rates (All FPI, Figure 8). Equivalent system-wide ignition rates are not available for SDG&E and PG&E in order to make a direct comparison of ignition rates and their impact on mitigation risk reduction evaluation (e.g. RSE). However, if PG&E were to evaluate post-mitigation risk reduction based on the total average ignition rate, similar to SDG&E HFTD specific ignition rates versus a sub-driver-specific ignition rate, the outcomes including mitigation effectiveness and risk-spend efficiency would vary substantially (Table 5). It is possible and perhaps likely that SDG&E's ignition rates are more variable as a function of risk driver versus HFTD, their mitigation-specific risk reduction estimations may systematically be over or underestimated in their WMP.

Figure 8. Reproduction of PG&E table showing the likelihood of ignition for each of 17 risk drivers.

**TABLE PG&E-6.2.1-2:
WDRM v3 TARGET DATASET**

Line No.	Subset	Event Count	Ignition Count	Ignition per Outage
1	Other_equipment_type	46,981	316	0.67%
2	Primary_conductor	12,343	974	7.89%
3	Transformer_equipment_cause	8,809	62	0.70%
4	Third_party_vehicle	6,952	265	3.81%
5	Vegetation_branch	6,912	406	5.87%
6	Animal_bird	4,831	219	4.53%
7	Support_structure_equipment_cause	4,631	194	4.19%
8	Vegetation_trunk	4,388	329	7.50%
9	Secondary_conductor	3,801	216	5.68%
10	Animal_squirrel	3,694	40	1.08%
11	Third_party_other	2,202	102	4.63%
12	Third_party_balloon	2,127	103	4.84%
13	Support_structure_equipment_electrical	2,096	582	27.77%
14	Vegetation_other	1,655	184	11.12%
15	Transformer_equipment_leaking	1,126	0	0.00%
16	Animal_other	834	106	12.71%
17	Voltage_control_equipment_type	502	99	19.72%
18	Totals	113,884	4,197	3.69%

Table 5. Example of a simplified risk reduction estimation following SDG&E's calculation method and using PG&E's average and risk event-specific ignition rates.

Variable	Value
Pre-mitigation Events: Structure-electric Failure	100
Ignition Rate (Average)	3.69%
Ignition Rate (Event-specific: Structure-electric failure)	27.77%
Pre-mitigation Ignitions (Average)	0.369 x 100 = 3.69
Pre-mitigation Ignitions (Event-specific: Structure-electric failure)	0.2777 x 100 = 27.77
Mitigation Effectiveness	100%
Mitigation Installations (e.g. Structures replaced/hardened)	200
Total Mitigation Installations Required	1000
Total Ignitions Reduced (Average)	(200/1000) x 3.69 = 0.738
Total Ignitions Reduced (Event-specific: Structure-electric failure)	(200/1000) x 27.77 = 5.55

The intended application of a model output is also a critical consideration when selecting a modeling approach. Ignition rates based on HFTD Tier versus risk event not only make the assumption that ignition risk is more a function of location versus driver, they also guide the selection and implementation of mitigations based on location versus risk driver. Ignition rates differentiated by HFTD tier preferentially inform whether a mitigation should be prioritized in HFTD Tier 3 versus Tier 2. It cannot, for example, accurately inform whether replacing all transformers versus all poles will have a larger impact on risk reduction.

Ignition rates specific to risk events can inform the extent to which an effective mitigation can reduce event-specific risk on average at any location on the system, or how it compares to risk reduction from other mitigation-risk event solution pairs. With event-specific ignition rates, the risk reduction evaluation for a given mitigation can also more accurately reflect and aggregate the benefits of mitigations that address multiple risk events. For example, mitigations such as Covered Conductors can reduce or eliminate ignition risk associated with multiple risk event types, which can be better captured using ignition rates for risk events versus HFTD Tier. This also creates a pathway for more nuanced risk spend efficiency comparisons between mitigations capable of addressing the same (or similar/ overlapping) risk event(s), such as covered conductors and undergrounding. Ignition rate valuation that is based on the risk events that mitigations are designed to prevent, versus on relatively immutable location conditions (e.g. fuels, weather), is likely more effective for assessing risk reduction and risk spend efficiency of specific mitigations.

SCE's Probability(ignition | failure) is rolled into their PoI model output via a frequency of ignition term. This term uses a calibration factor that is based on the forecasted ignitions for each risk event sub-driver.[64] Similar to PG&E, SCE determines the likelihood of ignition as a function of risk-event type. For their equipment and contact from object (CFO) PoI models this includes the likelihood of ignition at a sub-driver level (e.g. CFO-balloon, CFO-animal, EFF-OH capacitor, etc.). SCE's use of forecasted ignitions based on a 5-year average is similar to the 5-year average historic ignitions used by PG&E and SDG&E.[65]

All three of California's large IOUs are employing a rolling 5-year average of failures and ignitions. Both PG&E and SCE also expanded their ignition dataset to include non-CPUC reportable ignitions (e.g. FIPA, SCE 2023 WMP, p. 169). SDG&E should report on whether they plan to integrate non-CPUC reportable ignitions into their modeling.

GPI recommends the IOUs align their ignition rate calculations for risk mitigation planning models, and consider the uniform adoption of determining the probability of ignition given a failure as a function of risk event type or sub-driver, similar to PG&E and SCE, and not based on HFTD. We recognize that data availability (e.g. event count) may limit the usefulness of disaggregating the event/ignition datasets to 17 sub-models like that of PG&E's approach. However, it may be possible for SDG&E to improve their risk evaluation and risk mitigation effectiveness estimates by introducing risk-event-specific P(i|f).

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[64] SCE 2023 WMP Appendix B, p. A-15

[65] SCE 2023 WMP Appendix B, p.A-6

Wildfire Risk Modeling – Planning: PoI application for risk-informed mitigation selection and prioritization

SCE, PG&E, and SDG&E are adopting increasingly divergent applications for their PoI models.

SCE has downgraded the PoI model output use case to inform inspection prioritization and frequency. Specific use cases and methods include:

- Distribution and Transmission Detailed Inspections. SCE divides system-wide PoI and consequence values into 5 bins for each of its three consequence-based tranches in order to create three tranche-based risk matrices that inform prioritization and frequency.[66]
- IR inspections of OH assets. Aggregated PoI x Consequence values are quantified for each work district to inform work plans.[67]
- Transmission IR and Corona scanning program. PoI is employed to assist in selecting high-risk circuits for the inspection program.[68]
- Generation Inspection frequency is based on wildfire risk that includes both PoI and consequence.
- Inspection QA/QC targets are partially tied to PoI via the 5x5 matrix.
- The Routine Line Clearing, Hazard Tree Management Program, and High-Risk Species work also indirectly use the PoI CFO-Veg output via its use as an input into the Tree Risk Index.
- PoI is a term in the notification backlog prioritization method.[69]

PG&E's System Hardening Risk buydown curve is based on WDRM v3 risk scores which include PoI. While this risk buydown informs where mitigations are prioritized, it's not clear whether PoI is used to inform risk mitigation type. PG&E states:

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[66] SCE 2023 WMP, p.291-293

[67] SCE 2023 WMP, p. 299

[68] SCE 2023 WMP, p. 301-302

[69] SCE 2023 WMP, p. 759

> If a mitigation program ties to a specific element in our probability model, we rely on the output from the model to inform work prioritization. If a program does not tie to a specific probability model, or if we lack quality data, we prioritize our activities based on wildfire consequence.[70]

And

> In areas of our system where we are confident that the data in our risk models accurately reflects the local conditions, we prioritize our mitigations considering both the probability of an event and the consequence of that event.
>
> In areas of our system where we are less confident that the data in our risk models accurately reflects the local conditions, we assume that the probability of an event is equal across the system, and we prioritize our mitigations by only the potential consequence of the risk event. An example of this would be how distribution inspection cadence is defined in the HFTD and HFRA. As local conditions can change regardless of the modeled asset probability of failure, the inspection cadence is defined by wildfire consequence to ensure PG&E has the appropriate level of eyes-on-risk in the right places.71

While this approach is reasonable in concept PG&E does not provide a clear description of which risk mitigation planning decisions are informed by PoI output, and/or wildfire risk scores, and how the output is used for mitigation selection, prioritization, and/or location. Their sole example is the use of wildfire consequence and not P(f) to inform inspection frequency. This approach is opposite of SCE which only uses their PoI model to inform inspection prioritization and frequency. While SCE's decision to remove PoI output from their mitigation selection process altogether is concerning, their descriptions of where the PoI models are used and how provide concrete information that clearly links PoI output to applications informing specific WMP activities.

SCE and, to an unknown extent PG&E have made a large shift in their use of modeling from their 2022 to 2023 WMPs by eliminating PoI models as a guide for wildfire mitigation selection, location, or prioritization. These IOUs forego the use of the complete risk equation and instead use granular consequence values as the sole determinate of long-term mitigation investments. The reasons provided for this wildfire consequence-informed planning approach are that high consequence values alone, regardless of whether a location has a very low likelihood of failure/ignition or under what conditions that failure/ignition occurs, are sufficient justification to

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[70] PG&E 2023 WMP, p. 226

[71] PG&E 2023 WMP, p. 237

warrant mitigation selection and resultant risk-reduction investments. It cannot be ignored that this decision is also accompanied by a fervent interest and large increase in planned undergrounding. Consequently, even if an asset or location may have a very low probability of failure or probability of ignition, given a failure that equates to a very infrequent catastrophic wildfire return rate, the granular risk may still be mitigated by undergrounding, putatively the most effective and certainly most expensive solution. This approach runs the risk of seriously overbuilding the system with high-cost investments that only mitigate small fractions of wildfire risk.

GPI suspects that part of the decision to forego use of the PoI models is not only due to risk exposure gaps in the output, but also a lack of quantitative risk planning and mitigation thresholds. While the OEIS updated the definition of catastrophic wildfires to provide a quantitative definition, the risk planning definition still lacks a return rate or probabilistic standard. That is, in order to mitigate "all" catastrophic wildfires one would need to reduce ignition risk to 0 in any location where a catastrophic wildfire had any probability of occurring even if it was, for example, a 1-in-200-year return rate. In which case IOUs would logically eliminate use of PoI model outputs and make the safe assumption that all locations have at least some PoI, however small, and then use worst-case wildfire consequence values to determine where to underground.

SDG&E only uses their WiNGS model output, and embedded PoI, to inform their Strategic Undergrounding and Covered Conductor Programs. This is understandable given their PoI modeling approach is based on average ignition rates adjusted for factors that link to conductor-based ignitions (e.g. vegetation fall-in). SDG&E's PoI model design is unable to inform risk for specific asset types (e.g. capacitors, transformers, connections), for a range of risk drivers (e.g. some CFO drivers), or take into account failure-specific ignition rates beyond HFTD or FPI-based rates. Rather it seems these more nuanced risk factors are effectively averaged out into a granular PoI model that results in a granular risk value more representative of an average system unit such as a segment/circuit (e.g. a unit package of poles, conductors, splices, connectors, switches etc.). Undergrounding Programs constitute entirely dismantling and rebuilding the existing system, which aligns with the average risk valuation the PoI model provides. Similarly, Covered Conductors, in conjunction with all the other parallel and combined OH mitigation programs (e.g. pole replacement, capacitor replacement etc.), constitute a system overhaul while also adding additional hardening (e.g. CC), and which therefore tracks with the system level risk valuation insights the PoI is capable of providing. The use of WiNGS wildfire risk scores to inform both UG and CC programs means SDG&E is using PoI to inform their most aggressive wildfire mitigation activities. However, GPI recommends exploring whether data availability will allow SDG&E to develop a model that supports more nuanced PoI at the asset and risk driver level that could inform risk buydown for mitigation portfolios (e.g. CC plus other mitigations).

SDG&E's 2023 WMP also states:

> The LoRE occurring in a given year is estimated based on historical data when it exists. If data does not exist, subject matter experts estimate LoRE values (SDG&E 2023 WMp, p. 52).

In addition to our recommendations above, GPI recommends the following:

- PoI uncertainty should be included in a Risk Spend Efficiency uncertainty metric.
- Require SCE to provide a summary of why they have chosen to eliminate their PoI model outputs for use in mitigation selection, deployment, and prioritization. The description should include but not be limited to discussing model interpretation, limitations, and internal risk planning thresholds.
- Requiring PG&E to provide a comprehensive report on which PoI models are in use in their WMP for planning and operational activities, the specific WMP activities and activity elements (e.g. inspection frequency or prioritization) that they inform, and how the model output is applied (e.g. binned output to define risk levels, as part of the granular total risk score, to inform mitigation of specific risk drivers, to inform the potential effectiveness of a mitigation).
- Model documentation should describe all current and planned use cases for the PoI and Consequence models, as well as any directly applied sub-models. Documentation should include whether and how the final output is adjusted and ultimately applied to inform each wildfire mitigation activity, whether quantitatively or via SME consideration.

- Additional quantitative and probabilistic risk planning thresholds should be determined at the state level and should form the model design scenario basis for all PoI and consequence models.

- The IOU's should be required to provide greater transparency into their granular PoI model and sub-model outputs along with visual overlay capabilities with planned mitigation locations. Transparency into the co-location of PoI, consequence, and planned mitigation type and location can provide OEIS and stakeholders with a better understanding of granular risk-mitigation alignment and how risk models are used, or not used, in the mitigation selection process.

- Require SDG&E to report on the percent of the distribution system (i.e. total, HFTD Tier 2, Tier 3) that does not have a LoRE score and is instead estimated by SMEs as well as the estimation process and considerations.

- SDG&E should incorporate non-CPUC reportable ignition in their PoI modeling and model evaluation.

Wildfire Risk Planning Models: Quantifying granular consequence of risk event (CoRE) scores and risk planning frameworks.

We reviewed the wildfire consequence models of the IOUs and their implications for a planning-use case.

SDG&E employs a range of design basis scenarios in their WiNGS Planning model. These include Wind Loading conditions 1-4 (Baseline, Very High and 2x Extreme), Weather conditions 1 and 2 (Near-term Anticipated and Long-term), and three vegetation conditions (Existing, Short-term and Long-term – Extreme). It is not entirely clear how SDG&E combines these Design Basis Scenarios for use in Technosylva match-drop simulations, and whether all possible 24-condition combinations or other scenarios are used (e.g. WL1+WC1+VC1 etc.).[72] Descriptions of Technosylva modeling for *WiNGS-Ops* are somewhat more detailed and describe the use of 141 simulations based on the worst historical fire weather days to model wildfire

[72] SDG&E 2023 WMP, P. 107

consequence "at regular intervals along the electric distribution system."[73] SDG&E does not provide a sufficient description or quantitative metric for the granularity of their WiNGS-Planning or -Ops applied Technosylva simulations. In their Section 6. Risk Method overview, SDG&E states:

> The average consequence for each attribute and sub-attribute is estimated based on the range of known possible consequences (SDG&E 2023 WMP, p. 52).

These average "estimates" are then entered into the MAVF. SDG&E's WiNGS model documentation only provides general information on the wildfire consequence modeling approach, which uses the MAVF to convert 8 hr Technosylva match drop fire simulation into unitless consequence scores.

GPI is concerned with SDG&E's use of averages. Determining a single CoRE value by averaging wildfire consequence attribute scores (e.g. buildings, acres burned) across a range of disparate Design Basis Scenarios has little identifiable meaning in terms of risk planning thresholds (e.g. 1-in-15 year return). More information is required to understand the wildfire consequence risk planning standard or threshold SDG&E uses to generate WiNGS-Planning Wildfire risk scores, which inform Undergrounding and Covered Conductor programs. GPI recommends requiring that SDG&E substantially expand the level of detail regarding CoRE methods in their 2023 WMP and in their Appendix B modeling documentation. Updated content should include more detailed information on WiNGS-Planning match drop simulation inputs and scenarios (e.g. count and combinations of weather and environmental condition scenarios), the number of simulations at each location, the granularity of Tecnosylva match drop simulations (e.g. every asset or 100 mx 100 m pixel), and what is meant by "estimating" consequence attribute averages. SDG&E's method is also not clearly relatable to the OEIS definition of catastrophic wildfires.

PG&E's 2023 Wildfire Consequence (WFC) method is calibrated to "Destructive Fires," which they operationally define as fires that destroy 100 or more structures but do not result in serious

[73] SDG&E 2023 WMP, p. 354

injury or fatalities.[74] CoRE values are determined at a 100 x 100 m pixel granularity along the grid. Inputs to the CoRE score include daily 2x2 km FPI scores (R1-5), Tecnosylva match drop simulation outputs, and VIIRS data. Daily FPI scores are generated for the fire season, though GPI was unable to locate the dataset duration. In 2022 PG&E analyzed and applied an FPI model to CoRE valuation that included hourly FPU scores from 2004 to 2020.[75] Assuming the same timeframe and a daily FPI score from June to November (182 days per year), this totals 2,912 FPI scores for each 100m pixel. The FPI considers weather, fuel moisture, topography, and fuel type (4 types) at a 2km resolution.[76] An FPI threshold of R4 is calibrated to "Destructive Fire" potential based on actual fire data.

A similar calibration approach is used for Tecnosylva match drop simulations which use "worst conditions day" conditions analyzed at 200 m intervals. Tecnosylva 8h match drop simulation outputs with a flame length greater than 5 and rate of spread greater than 12 chains per hour are classified as "destructive wildfire" thresholds. We were unable to locate the number of match drop simulations at each pixel, but are under the impression that FPI scores are intended to fill-in around the relatively lower number of match drop simulations.

A third calibration determines average consequence scores from historic Destructive Fires as well as non-Destructive fires in and outside the HFTD (Figure 9). Each pixel is then assigned a CoRE score based on the Destructive Potential Classifier (Destructive = FPI >= R4 OR Tecnosylva FL >=5 and Spread >= 12 ch/h) and the associated average consequence score. Assuming FPI n = 2,912, the maximum and minimum CoRE scores for each pixel are 777,504 and 195.104, respectively. Based on the colloquial knowledge that PG&E inputs far fewer Tecnosylva match drop consequence scores compared to FPI scores, the CoRE is weighted towards the FPI calibration for Destructive Fires. This same or similar method was first deployed in PG&E's 2022 WMP.

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[74] PG&E 2023 WMP, p. 155

[75] PG&E 2022 WMP, p. 163

[76] PG&E 2023 WMP, p. 614

Figure 9. Reproduction of PG&E Destructive Fire classification method (step 1) and mean consequence matrix (Step 2)

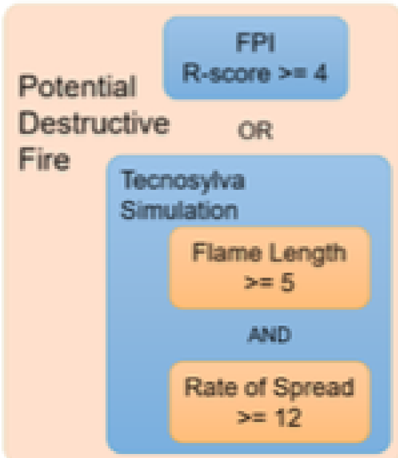

Figure 38 – Destructive Potential Classifier

Table 10 – WFC FPI Model

HFRA	Predicted Destructive Potential	CoRE from mean MAVf of historic fires
True	True	267
True	False	1.15
False	True	0.195
False	False	0.0670

GPI is concerned that PG&E's CoRE scores are weighted towards the lower granularity FPI. The FPI's 2 km grids are much lower resolution than the WDRM CoRE pixel size of 100x100 m. At the 2km resolution, 400 CoRE pixels fit within one FPI grid square. At the distribution system level, this means that FPI scores constitute a segment or circuit-level consequence risk score, or nearly 500 acres (0.77 square miles). While the FPI does include topographic features that include ruggedness and slope these inputs are smoothed out by the FPI, which aggregates 30m granular data up to the 2km grids. Using the FPI does provide long-term weather data for each grid square, allowing PG& E to take into account weather and climatic conditions or trends over long timeframes (i.e. decades).

While an FPI score threshold of >=R4 does encapsulate historic conditions associated with wildfires classified as Destructive Fires, it also includes many non-destructive fires.[77] This approach is not in and of itself an unreasonable calibration, and may in part serve to overcome the limited ability of 8 h Technosylva simulations to capture catastrophic outcomes past the 8 h mark. However, it does weight CoRE values on factors such as the frequency of high risk FPI

[77] PG&E 2023 WMP, p. 166

scores (i.e. a function of circuit-level weather patterns and fuel moisture, vegetation, and topography), while dissociating scores from other granular risk factors such as population and building density.

The FPI does not include population or buildings. It cannot "see" if and how many buildings or people are at risk within the 2 km grid. The only FPI input pertaining to developments is an Urban fuel type. Its ability to granularly discern between a potentially Destructive Fire and a non-destructive fire, or any definition of a fire that includes population impacts or building damage is limited. It is of course not possible to quantify a granular MAVF-based consequence score from the FPI and therefore requires a Destructive Fire consequence calibration (Figure 9). This means that when a remote/very rural or Rural/WUI or Urban distribution segment experiences an FPI of >=R4 they will all be ascribed the same CoRE score. The likely outcome is flattened risk scores as a function of population and building density.

Technosylva match drop simulations do include building and population layers, as well as a plethora of other higher spatial granularity data layers (e.g. fuels, topography etc.) that allow for local, output-based MAVF consequence estimations. However, PG&E is also using a consequence calibration for Technosylva outputs that eliminates localized population and building impacts and substitutes in outcome average consequences. This approach is likely required in order to combine the FPI and Technosylva datasets, but ultimately eliminates the opportunity to present 200m resolution CoRE values that include localized population and building impacts, in addition to more granular vegetation, weather, and topography factors, proximal to each ignition point.

Between the two datasets PG&E's CoRE granularity likely ranges from 200x200m at best and 2km at worst, and is most likely weighted towards the FPI resolution as well as the FPI consequence calibration since the FPI dataset is larger than the Technosylva dataset. While the location-specific Technosylva simulations can inform building and population consequences these data outputs are not used. GPI is concerned that PG&E's CoRE values are largely divorced from building and population density, resulting in flattened risk scores as a function of these risk factors. The 100x100m granular CoRE values also likely reflect a substantive amount of smoothing in terms of topography risk, and possibly vegetation risk, since the FPI input data are a larger dataset and are analyzed on a 2km granularity. These factors will smooth or flatten localized very high or even low risk that may exist, and may expand putatively high consequence risk areas.

In 2022, SCE expanded its Technosylva modeling simulations from 41 to 444 weather scenarios, implemented a Severe Risk Area framework that takes into account egress, high fire frequency, burn-in buffer, and extreme wind, and began to evaluate consequence risk calibrations that relate to fire acreage. This same method, with some changes, is applied in their 2023 WMP, and forms the baseline for undergrounding versus CC++ mitigation selection. Here we focus on the SCE's CoRE term that is based on Technosylva outputs. SCE's 444 weather scenarios include both wind and fuel-driven wildfire conditions and constitute spatial condition maps for worst fire weather days from 20 years of historical data. An 8 h Technosylva match drop simulation is run for each of the 444 weather scenarios at every asset location. Granular CoRE values are equal to the maximum consequence value. The worst-case natural unit outputs are translated via an MAVF into MARS scores. This approach seems to roughly translate to an asset-level 1-in-20-year worst case scenario consequence map based on a modeled 2030 fuels layer.

Unlike PG&E, SCE's CoRE scores do not hinge on a definition of fire consequence tranches. SCE only bins locations into wildfire consequence risk tranches after granular CoRE values are assigned. SCE's granular CoRE scores also reflect worst-case conditions observed over a defined timeframe (20 years) from a single risk modeling approach (i.e. Technosylva simulations). This method avoids the pitfalls of PG&E's approach that combines model outputs with different granularities. It also eliminates the pitfalls of PG&E's risk-unit based consequence conversion factors (e.g. FPI >= R4 could produce a "Destructive Fire"), and instead retains all risk unit metrics (e.g. buildings, safety, acres) at each asset.

It is impossible to directly compare the IOU's granular, FPI, and Technosylva-based CoRE quantification methods and the resulting risk thresholds used for mitigation selection and planning. As best we can tell, if the same datasets (e.g. vegetation, topography, weather scenarios etc.) were used as inputs to each of the IOU's granular CoRE quantification frameworks they would most likely produce somewhat or very different results. For example, all the IOUs have model frameworks that smooth or flatten the output in one form or another.

Smoothing or flattening is not in and of itself an unreasonable model feature, but the way in which it is achieved can result in very different CoRE outputs.

Each of the IOU's granular CoRE maps also reflects a completely different risk definition and/or planning threshold. All CoRE models by design contain some form of risk planning threshold that includes consequences and something akin to a return rate. SDG&E's granular CoRE threshold is the average of a set of simulation scenarios. PG&E's CoRE thresholds are contained in multiple model elements including fire consequence tranches, calibrations, and sub-model outputs – all of which are funneled into an aggregated number of "risk days" assigned an average potential consequence score that is calibrated to their definition of "Destructive Fire." We interpret this as a CoRE definition and threshold that is essentially based on the number of times a location was subject to "high" wildfire risk conditions over the past decades. SCE's CoRE risk threshold seems to roughly translate to a granular 1-in-20-year worst-case outcome.

GPI provides the following recommendations:

- IOU ratepayers should not be subject to different definitions of wildfire consequence risk that ultimately inform risk spend efficiency and mitigation selection.

- The IOU's should develop a joint-IOU granular CoRE quantification method. At a minimum the method should be based on the same definition of consequence risk (e.g. max, average, frequency), have the same general framework, include data or sub-model inputs with similar granularities, use data from the same timeframe (e.g. 20-year data set), and continue to use Technosylva simulations.

- California, or at least OEIS, should update or establish a more detailed wildfire consequence risk-planning standard or threshold. For the Utility WMP's this would provide a unifying design basis for their CoRE models. GPI suspects that the lack of a comprehensive and unifying wildfire consequence planning standard or threshold is partially the cause for today's disparate IOU CoRE methods. A state-wide definition would inform cross-sector wildfire mitigation planning and activities.

- The IOUs should be required to provide a web-based GIS viewing platform with their CoRE outputs similar to the IOU distribution planning mapping tools. This will facilitate model review by allowing insight into factors such as potential model biases and outcomes of smoothing or flattening functions.

- To facilitate OEIS and stakeholder understanding the current CoRE model dynamics and definitions, the IOUs should be required to provide the following information in an ACI and in the risk management working group:

    - SCE should provide additional detail on how they select their 444 weather scenarios including a breakdown of how they define wind- versus fuels-driven conditions, the number of scenarios for each condition type, and a granular map of maximum risk by fire type across the territory. The relative distribution of these two fire types across the territory may help inform mitigation selection and risk spend efficiency since planning/design standards and operations mitigation approaches must consider wind speed.

    - SDG&E should be required to substantially expand the level of detail regarding CoRE methods in their 2023 WMP and in their Appendix B modeling documentation. Updated content should include more detailed information on WiNGS-Planning match drop simulation inputs and scenarios (e.g. count and combinations of weather and environmental condition scenarios), the number of simulations at each location, the granularity of Tecnosylva match drop simulations (e.g. every asset or 100mx100m pixel), and what is meant by "estimating" consequence attribute averages. SDG&E's method is also not clearly relatable to the OEIS definition of catastrophic wildfires. SDG&E should explain how their method related to identifying and mitigating the OEIS definition of Catastrophic wildfires.

    - Require PG&E to provide the number of FPI days and years (i.e. data points) and the number of technosylva simulations used to determine the final CoRE score for each location.

Wildfire Risk Planning Models: Wildfire consequence tranche definitions

The SCE and PG&E define and apply different wildfire consequence thresholds or tranches. SDG&E does not define any tranches or operational wildfire consequence definitions.

SCE's three wildfire consequence tranches are defined based on acreage burned, fatalities, or structure damage:

> **Significant Fires** are simulated fires that, at 8 hours after ignition, burned more than 10,000 acres or had at least one fatality or had at least 50 structures impacted.
>
> **Destructive Fires** are simulated fires that, at 8 hours after ignition, burned between 300 acres and 10,000 acres with zero fatalities and/or had fewer than 50 structures impacted.
>
> **Small Fires** are simulated fires that, at 8 hours after ignition, burned less than 300 acres with zero fatalities and no structures impacted (SCE 2023 WMP, p. 118).

The use of the logical operator "or" is an important distinction since any one consequence type can qualify a location into a tranche. These wildfire CoRE tranches are one of multiple consequence model outputs that qualify locations for one of three risk-based planning tranches: Severe Risk Area (SRA), High Consequence Areas (HCA), and Other HFRA. These planning tranches directly inform long-term mitigation selection including undergrounding, CC++/REFLC, and CC++. However, SCE's Significant Fires and Destructive Fires only classify as SRAs and HCAs, respectively, on the basis of fire size.[78] SCE should clarify whether their Risk Framework Risk Tranche rubric also includes locations based on the complete definition of their fire consequence tranches (i.e. buildings and loss of life).

In 2021, PG&E included four consequence tranches: Small, Large, Destructive, and Catastrophic. PG&E now uses two consequence tranches, Destructive and non-destructive fires. Their operational definition of Destructive Fires are fires that destroy 100 or more structures but do not result in serious injury or fatalities.[79] As described above, this definition is used to develop consequence calibrations and average consequence values that result in granular CoRE

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[78] SCE 2023 WMP, p. 112

[79] PG&E 2023 WMP, p. 155

scores. It is not clear whether PG&E utilizes CoRE score thresholds or other tranches to inform their mitigation selection. Put another way, how many FPI R4 days in a given location does it take for PG&E to decide undergrounding versus another activity is required to mitigate the risk?

GPI is concerned that PG&E and SCE have adopted different operational definitions of wildfire severity. The most transparent difference between the consequence definitions is whether acreage, building damage, and/or loss of life is considered. SCE's fire consequence definitions include acreage and loss of life as qualifying metrics. PG&E and SCE both take into account building damage. However, as previously discussed, PG&E's CoRE framework does not use granular structure damage as a direct input. PG&E uses FPI and simulated flame length and fire spread rate as a proxy for potential building damage and all other consequence risks.

It may seem that SCE's 50 structure qualifier for their top risk tranche ("Severe Fires") has a lower risk planning threshold than PG&E's top risk fire type ("Destructive Fires"), which is defined as at least 100 structures damaged. However, PG&E and SCE determine and translate granular consequences into fire consequence tranches very differently. Digging into the consequence model design and tranche definitions reveals very complex differences in the IOU's consequence score output and final tranche designation. For example, an 8h match drop simulation that results in 10,000+ acres burned but occurs in remote locations (i.e. no building damage or fatalities) would qualify for SCE's top risk tranche. A smaller fire in a more densely populated area that threatens more than 50 buildings could also be ranked in the top fire risk tranche. This approach uses the range of wildfire consequence natural units to capture risk across locations with very different development densities and characteristics (e.g. Urban, rural, very rural).

Disparate wildfire consequence definitions combined with different frameworks for quantifying granular CoRE scores and assigning risk-based planning tranches make it very difficult, if not impossible, to compare the effects of each IOU's method on risk ranking, risk spend efficiency calculations, and resultant long-term mitigation selection and planning. GPI recommends the following:

- PG&E and SCE should develop unified wildfire consequence tranche definitions. These definitions should complement the existing OEIS definition of Catastrophic wildfires, and/or include calibrations that allow direct comparison to Catastrophic wildfires.

- OEIS, stakeholders, and ratepayers should be able to directly compare IOU wildfire consequence risk scores and the way that risk is used to inform mitigation selection.

- Risk planning thresholds should be transparent and high-level risk planning thresholds such be uniformly adopted and comparable between the IOUs.

Wildfire Risk Planning Models: The IOUs should be able to correlate their planning thresholds to the OEIS definition of Catastrophic wildfires.

The IOU-defined wildfire tranches, granular CoRE scores, and risk planning thresholds are not directly mapped onto or aligned with the OEIS definition of Catastrophic wildfires. OEIS updated the definition of a Catastrophic wildfire to a fire that caused at least one death, damaged over 500 structures, or burned over 5,000 acres. This is 5 times the 100 damaged structures PG&E defines as a Destructive Fire. PG&E also repeatedly refers to mitigating catastrophic wildfires, for example:

> Risk drivers that the FPI models account for include fire weather parameters (wind speed, temperature, and vapor pressure deficit), dead and live fuel moisture data, topography, and fuel type data to predict the probability of a large and/or catastrophic ignition.[80]

They provide two methods that define "Catastrophic" wildfire risk. One method is used to inform PSPS decisions and is based on a "fire intensity analysis" that includes flame length and fire intensity.[81] While these are of course high-risk conditions it is not calibrated to the OEIS definition and seems to redefine "Catastrophic" relative to the updated OEIS decision. In response to ACI-PG&E-22-01, they convert their Destructive Fire tranche into a Catastrophic Fire accordingly:

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[80] PG&E 2023-2025 WMP, p. 156

[81] PG&E 2023-2025 WMP, p. 771

> Based on Energy Safety's updated definition, the analysis assumed that: 100 percent chance that Destructive Fires would be Catastrophic Wildfires in the HFTD; 50 percent chance that Destructive Fires would be Catastrophic Wildfires in Non HFTD; 28 percent chance that Large Fires would be Catastrophic Wildfires in the HFTD; and 16 percent chance that Large Fires would be Catastrophic Wildfires in Non HFTD. The "Catastrophic Wildfires" designation is based on Energy Safety's 2023 WMP guidance while the "Destructive Large Fires" designation is PG&E's definition from our bow tie.[82]

We were unable to locate the quantitative basis for this conversion factor in their 2023 WMP. PG&E does not provide adequate quantitative evidence, approach, or justification that clearly links PG&E's risk planning threshold to the OEIS definition of Catastrophic wildfire.

The OEIS definition of Catastrophic wildfire is 10 times higher than SCE's 50-building threshold and 2 times higher than SCE's highest acreage threshold (Significant Fire). SCE "*Fire Size at 8 Hours Relative to Final Fire Size*" analysis provides some transparency regarding how their fire consequence acreage threshold aligns with the OEIS Catastrophic wildfire definition (5,000 acres).[83] The likelihood that an 8 h Technosylva simulation resulting in *n* acres of damage will result in a fire greater than 5,000 acres based on historic fires is the sum of the yellow and dark gray bars in Figure 10. Based on simulated acreage burned thresholds, SCE's Other HFRA and HCA tranches are likely to include locations with increasing likelihood for Catastrophic wildfires. The calibration maxes out for 8 h Technosylva simulations that result in 2,500+ acres burned, below the SRA threshold. SCE is setting the simulated acreage burned risk threshold relatively high to define the baseline scope of their targeted undergrounding program. SCE's acreage-based CoRE tranches provide a relatively robust example of a traceable risk planning threshold that models the quantitative metric, relates the metric to like-unit real-world outcomes and the OEIS definition of Catastrophic wildfires, applies it via a rubric to a risk-based planning tranche, and applies that tranche in a clear use case that determines a system hardening standard/plan.

SCE does not, however, provide equivalent frameworks for their CoRE building or loss of life thresholds. Since their wildfire consequence tranches (Signification, Destructive, Small fires)

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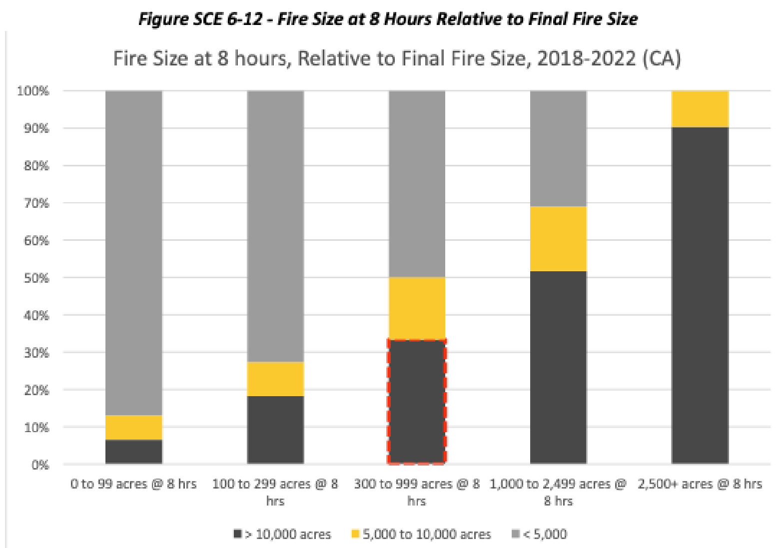
[82] PG&E 2023-2025 WMP p. 894

[83] SCE 2023-2025 WMP, p. 111

include acreage, structure, and safety risk thresholds, but the risk-based planning tranches (Severe, High Consequence, and Other HFRA Areas) only refer to acreage burned, it is not clear whether the other CoRE consequence units are used to classify locations into planning tranches. SCE also does not provide analyses linking their structure consequence threshold to the OEIS definition of Catastrophic wildfires. SCE should clarify if and how their structure and loss of life wildfire consequence outputs are used to classify locations into planning tranches.

Figure 10. Reproduction of SCE 2023 WMP Figure SCE 6-12.



IOU ratepayers should not be subject to dramatically different wildfire consequence tranche definitions that underlie wildfire consequence risk quantification and inform risk mitigation approaches. GPI strongly recommends that the IOU's develop a joint wildfire consequence risk modeling framework. The framework should include analyses that correlate consequence risk thresholds, CoRE scores, and the resultant risk-informed mitigation activities with the OEIS definition of Catastrophic wildfires.

Wildfire Risk Planning Models: SCE should be required to report on progress towards remedying RSE issues identified by the third-party review.

The OEIS issue ACI SCE-22-22 Third Party Confirmation of RSE Estimates in 2022, stating:

> Description: SCE does not confirm its RSE estimates with independent experts or other utilities in California.

> Required Progress: In its 2023 WMP, SCE must show that its RSE estimates are confirmed by a third party or detail an action plan and associated timeline for third party confirmation of all RSE estimates.[84]

SCE retained Exponent to review RSE process, inputs, calculations, and results. A data request by CalAdvocates made the redacted report publicly available.

The Exponent RSE review highlights multiple critical issues regarding RSE accuracy and useability. GPI is concerned by the finding that all of SCE's RSE values for mitigations that address wildfire risk are based on at least one "influential risk driver with a frequency that is entirely zero throughout the provided dataset." We interpret risk driver frequencies to constitute PoI, including both probability of failure and probability of ignition given a failure.

The Exponent report details reveal that SCE is assessing their Covered Conductor program in two components SH-1c and SH1-ab. We assume these two components refer to fire resistant pole replacements and covered conductor installation, although there are no references in the report or WMP regarding the specific sub-activity assignment.[85] The data QA/QC for covered conductor activities SH-1ab and SH-1c show that every risk driver classified as informative also have at least some frequencies listed as zero. Unfortunately, the report truncated the risk driver identifier. However, it appears that SCE has modeled the PoI of many of these risk drivers such as the suite of CFO-distribution risk drivers (i.e. Vegetation, Animal, Balloon, Vehicle). Informative risk drivers with all zero entries appear to include risk drivers that do not have a PoI model (e.g. CFO-Unknown, Splices). Given the incomplete risk driver identifier we cannot directly compare the QA/QC results with SCE's PoI models. Covered conductor activity data quality also suffered from missing WMP tranche data that may affect reporting.

In contrast, only a select few mitigation activities have a high occurrence of informative risk driver frequencies listed as "All Complete & Non-zero." One such activity is SH-2, or undergrounding. The Undergrounding RSE includes 12 of a total 30 informative risk drivers with "All complete & Non-zero" risk driver frequency inputs. The only other mitigation

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[84] SCE 2023 WMP, p. 780

[85] SCE 2023-2025 WMP p. 201

activities that have an equivalent RSE data quality are the Circuit Breaker Relay Hardware for Fast Curve (SH-6) and the Branch Line Protection Strategy (SH-4) programs.

The report shows that 33 of 60 total wildfire risk drivers all have frequency values of zero. Only 11 of the total 38 programs evaluated have risk driver frequencies with "All complete & Non-zero" data quality.

These data completeness and quality checks reveal that RSE values have variable accuracy between activities. It further shows that the RSE of covered conductor likely has lower accuracy than the undergrounding RSE value. This raises concerns about the ability to compare these two critical system-hardening activities which form the basis for all IOU long-term wildfire mitigation approaches. Furthermore, assessing the RSE of wildfire mitigation portfolios or packages, such as covered conductors combined with other overhead system hardening activities, is likely a better comparison to undergrounding RSE. However, the relatively low RSE input data quality for most of SCE system hardening activities raises additional concerns regarding whether individual or portfolio RSEs for overhead systems are systematically underestimated due to the presence of informative risk driver frequencies with zeros.

The report recommends that SCE should "Explore incorporating uncertainty into data-derived mitigation effectiveness evaluations."[86] It concludes:

> …it would be an overreach to characterize the RSE results as accurate. For programs whose asset selection criteria and risk reduction results would be affected by parameters still under development, we recommend SCE provide appropriate language, notification, and disclaimers when discussing and presenting the results of these programs.[87]

And

> However, it appears that there are at least some models that are anticipated to inform SCE's RSE calculations for addressing the Wildfire risk that may still be under development. Thus, we recommend exercising caution when considering the evaluated RSEs of these affected programs for decision-making purposes until the informative models are complete and implemented.[86]

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[86] Exponent. (2023) Findings from Review of Southern California Edison's 2023 Wildfire Mitigation Plan Risk-Spend Efficency Calculations date February 7, 2023. pp 19

[87] Exponent. (2023) Findings from Review of Southern California Edison's 2023 Wildfire Mitigation Plan Risk-Spend Efficency Calculations date February 7, 2023. pp 1-2

In SCE's response to the CalAdvocate data request they only address risk driver frequencies with zero that were ascribed to transmission inspections, resulting in an RSE of zero.[88] Other SCE actions include some data quality corrections and other improvements that do not impact RSE values. SCE does not report on any remedies for all other wildfire risk mitigation activities that also have influential risk driver frequencies assigned zeros. SCE states:

> While none of Exponent's findings are technically infeasible, not all of them may be prudent to implement. SCE will assess longer-term refinements to determine which are prudent to implement and the appropriate timing of those changes considering resource constraints, value gained, time requirements, etc.[86]

This response raises concerns that SCE is not considering improvements to the underlying PoI models and resultant risk modeling gaps, or to their RSE calculation for informative risk drivers with zero entries that are identified as undermining the usefulness of RSE values for most wildfire mitigation activities, including covered conductors and other overhead system hardening programs. The report's findings and SCE's vague plans for long-term refinements to the RSE calculations raise substantial doubt as to whether SCE's RSE values are accurate enough to inform risk mitigation selection, including the comparison between undergrounding and overhead system risk mitigation activities such as covered conductor, either independently or in combination with other overhead programs. However, SCE lists RSE as one of three "Critical factors that drive initiative selection."[89] The other two Critical Factors informing mitigation selection, "Risk Drivers and Consequences Addressed" and "Risk Reduced," also hinge on accurate risk driver frequency inputs and mitigation effectiveness. SCE's use of RSE to inform capital allocation addresses ACI SCE-22-24. However, the report findings suggest that SCE's quantitative evaluation for each of these Critical Factors may have large uncertainties that render them unsuitable for a decision-making use case at this time.

GPI strongly agrees with the report's recommendation that SCE should include uncertainty into their mitigation effectiveness evaluations. While SCE refers to Risk Mitigation Effectiveness uncertainty in their WMP they do not provide the available quantitative uncertainty for this

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[88] SCE Data Response. DATA REQUEST SET CalAdvocates-SCE-2023WMP-08 4/7/2023 pp. 1-2
[89] SCE 2023-2025 WMP, p. 199

metric or for their RSE values, which include additional inputs each with uncertainty.[90] This directly ties to the need for all IOUs to quantify the risk gaps in their PoI models in order to better inform mitigation selection on the basis of risk mitigation effectiveness and risk spend efficiency.

GPI recommends the following:

- SCE should be required to report on the zeroes in their informative risk driver frequency inputs to the RSE evaluation. This requirement should include a report of the source of the zeros, the uncertainty that each zero entry contributes to the overall RSE uncertainty (e.g. a zero entry for an informative high versus low ignition rate risk driver will have more influence on RSE uncertainty), and a tractable plan for improving RSE accuracy over the 2023-2025 WMP cycle.

- All IOUs should be required to provide uncertainty on their RSE values. This is necessary to inform appropriate metric use cases, such as whether RSE values are sufficiently accurate to compare risk mitigation activities.

- It would be prudent to require that all IOU RSE evaluations undergo a similar review of RSE input data, including QA/QC and RSE accuracy verification. RSE is an important metric for quantitatively comparing the effectiveness and cost efficiency of very high-cost mitigations that the IOU's long-term risk mitigation strategies hinge on, such as undergrounding, covered conductors, and other overhead system hardening mitigations.

Wildfire Risk Planning Models: The IOUs should provide a plan for how they will integrate egress in their risk-informed mitigation selection and should develop a joint egress model.

The WMP guidelines require IOUs to summarize CalFire-identified Sub-Divisions With Limited Egress or No Secondary Egress within their territories. PG&E for example, summarizes their

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[90] SCE 2023-2025 WMP, p. 201

request for data and ongoing CalFire survey work. PG&E does not provide a plan for whether or how they will use these data. SCE states:

> …many of the neighborhoods in SCE's service territory have not been assessed under this program. Only select portions of Los Angeles, Orange, and Kern counties have complete assessments made available to the public. SCE has developed an alternate methodology to assess population egress with high fire frequency through its Severe Risk Areas (SRA) methodology …[91]

SCE's narration suggests they do not plan to use CalFire's currently available or future dataset detailing locations with egress risk. GPI recommends requiring all IOUs to develop a plan and timeline for integrating this data into their WMP risk-informed mitigation selection process as it becomes available.

SCE and PG&E are also developing in-house egress models that are expected to identify additional locations compared to CalFire-identified egress risk areas.

SCE is currently the only IOU that is actively using an egress model to inform mitigation selection. The egress model is a three-step risk modeling framework that uses hexagonal pixels at a granularity of 214 acres. Egress is based on the ratio of roads to population within each pixel. SCE's quantitative threshold defining egress-constrained areas is 0.5 miles of road per person. The model output results in egress-constrained pixels across urban, rural, and highly rural areas as well as HFTD and non-HFTD areas. The egress output is overlain with an HFRA high-fire frequency pixel map based on a 50-year dataset of historic fire scars as an indicator of the likelihood that a pixel will burn. Co-located egress-constrained areas and high fire frequency areas are deemed Fire Risk Egress Constrained Areas. Lastly, a burn-in buffer is calculated for each egress-constrained area. Fire Risk Egress Constrained Areas and associated burn-in buffer areas are qualifying criteria for SCE's Sever Risk Area (SRA, Criteria 1) tranche which directly informs their targeted Undergrounding Program scope.

SCE's egress approach may be biased toward identifying egress in urban areas. They do not explain how they calibrated or determined the 0.5 miles of road per person threshold. For example, if this threshold is based on the road-to-population ratio of locations that have

[91] SCE 2023-2025 WMP, p. 78

experienced egress risk in the past, or another analysis. SCE also uses this method in lieu of CalFire's in-progress egress assessment. However, SCE does not provide any assessment regarding whether their method is capable of identifying the same egress-constrained areas as CalFire's available Sub-Divisions With Limited Egress or No Secondary Egress locations. It is not clear whether SCE's egress method is a suitable substitute for CalFire's egress risk assessment.

The fire frequency term is essentially necessary to filter out urban areas that pass the egress constrained threshold while also focusing the egress-constrained pixels in areas with elevated fire risk. GPI appreciates that this approach also directly applies historical data in the risk assessment framework and mitigation selection. There are, however, locations in IOU territories that may not have burned yet or have burned infrequently (e.g. fire suppression policies) but are at high risk for wildfires based on PoI and consequence. These locations would not be captured by the egress + historic data overlay. An egress + Technosylva-based wildfire risk overlay may increase the area covered by SCE's Fire Risk Egress Constrained Areas (SRA Criteria 1). However, this would also require selecting a wildfire risk planning threshold for egress areas. The closer the threshold is to SCE's Significant Fire Consequence planning threshold (SRA Criteria 1), the more the egress criteria will be subsumed into the Significant Fire Consequence criteria. Alternatively, past wildfire scar areas from earlier years in the 50-year dataset (e.g. 1970's – 2000) may have been urbanized, changing the fuelscape since the fires took place. If this has occurred, the model could over-estimate risk. SCE could perform sensitivity or other assessments on their egress model to assess model gaps. GPI suspects some model testing has already been completed and recommends providing additional detail in their narration, including on how egress thresholds were set.

In the April 28, 2023 workshop, SCE mentioned that the potential egress risk gap associated with using a historic fire scar overlay is addressed by their communities of elevated fire concern (CEFCs, SRA criteria 4). SCE defines CEFCs as:

> CEFCs are smaller geographic areas where terrain and other factors could lead to smaller, fast-moving fires threatening populated locations under benign (normal) weather conditions. Examples of these types of communities are those on the edge of a hill, where if an ignition were to occur

> downhill from that community, the ignition could immediately impact those population centers, even under low to no wind conditions.[92]

SCE does not provide a summary of how these locations are identified across their territory. SCE should expand their narration to include a high-level summary of how they identified CEFCs.

GPI appreciates comments by the IOUs in the Wildfire Risk Management Working group and various other WMP development platforms that raise the concern that wildfire egress challenges are not only a function of geography and road access, but are also tied to demographics and socioeconomics. In their 2023-2025 WMP, PG&E outlines progress toward developing a new egress model that includes features beyond geography and infrastructure constraints, stating:

> An approach has been developed for an egress adjustment factor that will be implemented in the next version of WFC Model.
>
> Despite the challenges listed above, the failures of evacuations are observable through CAL FIRE fatality counts and building destructions. Our current approach quantifies data relationships that predict these fatalities using variables derived from a range of data such as road access, resident mobility, and other AFN data.93

At this stage, GPI is primarily concerned that the IOUs are independently developing egress models that have very different inputs, and therefore will likely have outputs that target different facets of wildfire egress. The multi-faceted challenges associated with egress limitations make this topic open to broad interpretation for the purpose of wildfire mitigation planning. For example, whether a mass exodus from a community will result in grid-lock, whether utility equipment could block a critical egress route, or whether a subset of the population has the means or mode to act on an evacuation order. California ratepayers and the distribution grids that serve them should not be subject to wildfire mitigation activities based on drastically different definitions of risk and risk planning thresholds. This includes how egress-risk is defined and modeled. GPI strongly recommends developing a unifying definition for egress that includes which factors and considerations utilities are minimally expected to take into account

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[92] SCE 2023-2025 WMP, p. 109

[93] PG&E 2023-2025 WMP, p. 218

with their egress models (e.g. equipment-cause obstructions, geographic, socioeconomic). GPI further recommends requiring the utilities to develop a joint Egress model that includes unified data inputs (e.g. AFN, road:population ratios). This approach will level set egress modeling between the three IOUs and will provide guidance to the SMJUs regarding how to account for egress in their territories.

GPI recommends the following:

- The IOUs should provide a plan and timeline in their 2024 WMP update regarding how they will integrate CalFire egress-constrained communities into their WMP risk-informed mitigation selection process.

- SCE should provide additional detail on how egress thresholds were set and how the model has been tested to ensure it is achieving actionable outputs that identify egress constrained communities in high wildfire risk areas. This should include comparisons to CalFire's available data on Sub-Divisions With Limited Egress or No Secondary Egress.

- SCE should expand their narration to include a high-level summary of how they identified CEFCs. The description should include a summary of assumptions and qualifying thresholds (quantitative and qualitative).

- Developing a unifying definition for egress that includes which factors and considerations utilities are minimally expected to take into account with their egress models (e.g. equipment-cause obstructions, geographic, socioeconomic).

- Require the utilities to develop a joint Egress model that includes unified data inputs (e.g. AFN, road:population ratios).

Wildfire Risk Planning Models: The IOUs should evaluate the mitigation effectiveness and risk spend efficiency of mitigation activity portfolios

The IOU's long-term risk mitigation activities are treated as siloed programs that each incrementally reduce risk from a subset of all ignition risk drivers. This is especially the case for overhead (OH) system hardening activities that are parsed into asset-specific risk mitigation activities including but not limited to covered conductor installation, tree attachment remediation, long-span initiatives, pole replacement programs, REFCL, protective devices, non-exempt expulsion fuse replacements, non-exempt surge arrestors replacement, hot-line clamp replacement, and transformer replacements. Most of these OH asset replacement activities generally constitute an asset-level incremental improvement that is made to individual components of the OH system. Asset-level mitigation programs have generally been designed to address the most asset-specific risk the fastest, focusing work on high-risk but easy-to-access locations first. These OH asset-based improvements are not necessarily made on the same OH circuits, resulting in marginal risk buy-down that is distributed across the HFTD. The risk reduction and RSE of these siloed activities spread across individual circuits are relatively small.

Most of the IOUs multi-asset or system-level mitigation initiatives are essentially collections of siloed asset-level replacement activities or only combine a couple of asset-level mitigations. For example, PG&E's System Hardening – Distribution Initiative Activity (GH-01) constitutes undergrounding or covered conductor installation, which they also term "Overhead System Hardening".[94] This is deceptive terminology because PG&E's covered conductor activity only includes two asset-level mitigations, conductor and associated framing replacements, and is not an OH system-level mitigation. SCE's covered conductor program also combines two asset-level activities, fire-resistant pole replacements and covered conductor installation. SDG&E's covered conductor work is limited to conductor replacement. The covered conductor programs are asset-level mitigations that do not incorporate other high ignition risk and aging OH assets known to contribute to OH system risk.

SCE's CC++ and CC++/REFCL OH distribution mitigation portfolios are the first instances of utility OH system-level mitigations. SCE's CC++ package includes a collection of OH asset-level mitigations including Covered Conductor, Branch Line Protection Strategy, Automatic Reclosers, Circuit Breaker Relays for Fast Curve, Early Fault Detection, multiple inspection types, and vegetation management activities. REFCL is added to the CC++ portfolio in SCE's top risk tranche as an alternative to their Targeted Undergrounding Program.[95] SCE developed

[94] PG&E 2023-2025 WMP, p. 271

[95] SCE 2023-2025 WMP, pp. 206-207

the CC++ and CC++/REFCL portfolios with the objective of creating an OH system-level mitigation:

> Due to the potential impacts that a wildfire would have in these areas, when designing REFCL/CC++, SCE looked to mitigate all risk drivers to the extent reasonably possible. This necessarily means some cost efficient redundancy, which is desirable since no mitigation matches undergrounding on its own. Thus REFCL/CC++ includes covered conductor, fast curve, vegetation management, and fusing to address contact from object; REFCL, asset inspections, and covered conductor to address equipment failure; and covered conductor to address wire to wire contact.[96]

SCE's CC++ and CC++/REFCL mitigation portfolios come the closest to reflecting an OH system-level mitigation package. However, SCE does not provide quantitative portfolio effectiveness scores or RSE values for these programs. They do qualitatively score the programs against undergrounding. CC++ and CC++/REFCL portfolios are lower cost, faster to implement, and score on par with undergrounding ("high") for phase-to-phase, phase-to-ground, and distribution wire-down ignition risks.

A weak point of the CC++ OH mitigation package is a "Medium" score for Equipment Failure mitigation, compared to "high" for undergrounding. Undergrounding programs are system-level risk mitigations. Converting an OH system to an underground system includes the complete or near-complete removal of the aging OH infrastructure. All aging and outdated OH system components are replaced with new equipment. These system-level replacements are not only new equipment, but likely also benefit from improved designs and technology advancements. The risk reduction achieved from undergrounding is linked to the removal of OH system assets, but also the fact that it is removing aging, outdated, and potentially overloaded OH distribution components at the system level.

OH asset and system risk is not just a function of the presence of the equipment. It is also linked to system age, increasing demand, and outdated design standards. SCE's P(f) models indicate that asset age has substantive predictive power for some equipment failure risk drivers. This aligns with the increasing awareness that California's IOUs and utilities nationwide are

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[96] SCE 2023-2025 WMP, pp. 205-206

experiencing increased rates and capital expenditures in order to maintain an aging electric grid.[97, 98] WMP modeling and asset failure mode investigations have also shown grid operation parameters and loading influence failure rate. System load factors are also likely linked to not only an aging distribution system but also a strained distribution system that is unprepared to accommodate the rapidly increasing load of Distributed Energy Resources (DERs) and energy demand during record heat waves.

In response, the IOUs are already deploying many other pathways to OH asset risk reduction in the HFTD that include replacing aging and high-risk assets with new and more advanced equipment (e.g. fuses, transformers etc.). The IOUs do not consider these OH asset-level replacement activities (e.g. fuse replacement, transformer replacements) as complementary risk mitigations that are part and parcel to OH grid hardening at a system level. There is a mitigation portfolio paradigm that seems to assume that existing versus novel system components have different intrinsic risk mitigation values that preclude them from including replacement programs as a part of an OH grid hardening portfolio.

Undergrounding, a system-level program, cannot be equitably compared to asset-level mitigations such as covered conductor programs. Making this comparison falsely implies that covered conductor programs are equivalent to system-level programs that can mitigate wildfire ignition risk associated with the entirety of the OH system. The IOUs must develop OH system mitigation portfolios and assess risk mitigation effectiveness and RSE at the portfolio level in order to directly compare OH system hardening to undergrounding.

An OH system-level mitigation package that is comparable to undergrounding RSE would include novel solutions to reducing wildfire risk (e.g. covered conductor, automatic reclosers in new locations, REFCL, EDF), improved system design and/or capacity to better accommodate current and forecasted distribution system demand/generation, and the replacement of

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[97] DOE Major utilities continue to increase spending on U.S. electric distribution systems https://www.eia.gov/todayinenergy/detail.php?id=36675 (Accessed on May 21, 2023)
[98] PG&E Rates Increase- How it Affects You. Nrg Clean Power https://nrgcleanpower.com/learning-center/pge-rate-increase-2023/#:~:text=According%20to%20Paul%20Doherty%2C%20PG%26E,new%20natural%20gas%20pipeline%20construction (Accessed on May 21, 2023)

aging/outdated OH assets. These portfolios could include span or circuit-level OH-system mitigation packages that are customized to the existing distribution circuit. For example, OH-system mitigation packages could begin with a baseline OH system standard that can be tailored to each circuit/span based on existing asset equipment, PoI, consequence, environmental conditions, and forecasted demand (i.e. existing Distribution Planning Processes and Grid Needs Assessments).

GPI recommends the following:

- The IOUs should be required to develop OH system-level mitigation portfolios that aggregate novel design (e.g. covered conductors) and replacement activities. These OH system-level mitigation portfolios should parallel the risk reduction features associated with undergrounding to the maximum extent possible.

- Risk mitigation effectiveness, RSE, and cost-benefit analyses should be developed for the OH system-level mitigation portfolios.

Wildfire Risk Planning Models: Program/activity Risk Spend Efficiency assessments must be compared on the same circuits/circuit segments.

Mitigation effectiveness and RSE can be expressed as either a system average or a location-specific estimate. Location-specific effectiveness and RSE are important for targeted mitigation selection and prioritization. Comparing granular RSEs between program scopes has limited value since the baseline risk is different. The effectiveness and RSE of alternative mitigations must be evaluated on the same circuits or program scope.

The IOUs wildfire mitigation plans do not compare the risk spend efficiency of alternative mitigations on the same circuits. For example, in their "Risk impact of Mitigation initiatives" PG&E states:

> For each mitigation initiative, risk reduction is calculated based on: (1) the amount of risk targeted within the scope of the program and (2) the amount of risk the program provides overall to reducing wildfire risk. For example, the complete replacement of all non-exempt equipment to exempt equipment provides 100 percent reduction of the non-exempt equipment risk, but for the overall wildfire risk it provides only a small subset of risk reduction, given that non-exempt equipment is only a small percentage of the overall wildfire risk. Below we describe the high-level

calculation and provide example calculations for each mitigation category. These calculations are done individually at the circuit segment or structure levels, calculating both pre- and post-mitigation frequency and risk across the entire work portfolio.[99]

By scoping undergrounding for the highest risk segments, the baseline risk for this work is higher than all other locations where OH mitigation activities are scoped. The risk mitigation potential in these locations is innately higher. Covered conductor work scoped for lower-risk locations has lower risk mitigation potential partially on account of the lower baseline system risk.

Table 6. Example of how baseline risk impacts program scope-specific mitigation effectiveness and RSE

Program Scope Baseline Risk	Mitigation/ effectives	Cost ($ millions)	RSE (Baseline Risk x (1-effectiveness) / cost)
1000	Undergrounding (0.90)	3.0	33.33
1000	Covered Conductor - only (0.70)	1.5	200
100	Covered Conductor - only (0.70)	1.5	20

GPI recommends the following:

- The IOUs should be required to present alternative risk mitigation portfolios with RSE scores that are based on the same circuits as the program scope.

[99] PG&E 2023-2025 WMP, p. 339

Risk Mitigation Activities: The IOUs should evaluate whether Undergrounding plans could result in unforeseen impacts, unanticipated reliability challenges, and higher future costs.

At the same time that distribution undergrounding removes OH asset risk at a system level, it also increases system complexity and exchanges OH system-level challenges with different challenges. We discuss some of the potential pitfalls of undergrounding here.

Increased distribution system footprint and complexity – PG&E anticipates that replacing 8,000 miles of OH distribution system will require 10,000 miles of undergrounded distribution lines due to rerouting. Other IOUs also anticipate similar distribution grid footprint increases from tier undergrounding programs. This constitutes a 20% increase in the distribution system footprint. During the IOU WMP workshop utility representatives also noted that undergrounded systems have more switches compared to OH distribution systems.[100] Additional components and expanded asset footprints equate to more failure points. As the undergrounded system reaches its lifetime and begins to fail the failure events will occur across the system's larger footprint. The asset-specific failure rate will also be proportional to the number of assets in the system. For example, more switches equate to more failures as the system ages. For undergrounded systems that have shorter lifetimes than overhead systems, this may equate to more higher-cost repairs sooner.

System lifetime and repair costs – Estimates for OH system lifetimes are longer than underground system lifetimes by decades. The utilities have not reported on lifetime costs and cost-effectiveness of their long-term undergrounding scope of work.

The IOUs identified that covered conductor was susceptible to rapid wear and tear due to aeolian vibrations. These mitigation-specific failure modes are addressed by vibrational dampener installation activities and inspections in the WMPs. Underground lines are obviously susceptible to different wear-and-tear modes compared to overhead systems. Microbial degradation can reduce the lifetime of direct-bury conductors and their housings.[101] Undergrounding in a range of different soil types, not just urban environments, may affect optimal and cost-effective

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[100] Public Workshop on 2023-2025 Wildfire Mitigation Plan Submissions, April 27-28 2023

[101] Szatmári, I., Lingvay, M., Tudosie, L., Cojocaru, A., & Lingvay, I. O. S. I. F. (2015). Monitoring results of polyethylene insulation degradability from soil buried power cables. *Rev. Chim*, *66*(3), 304-311.

undergrounding design (e.g. use of conduit). These factors could affect underground system lifetimes. The utilities do not report on undergrounding system design and whether degradation and other failure modes are taken into account when scoping undergrounding projects for specific locations.

Reliability – Most utility undergrounding is located in urban areas. Utility experience with outage rates and repair times is based on urban undergrounding. The utilities have not provided an assessment of undergrounding reliability in rural or very rural areas.

Underground system repairs are also reported to take longer on average than OH system repairs. This can lead to longer customer outages when a failure occurs. Repairs and replacement work for underground systems may also be more expensive than overhead system repairs.

Vegetation management – We presume that the utility right of way (ROW) and remaining OH assets associated with undergrounded lines cannot simply be abandoned in terms of ongoing vegetation management. Ongoing vegetation management may be needed to keep ROWs clear in locations like rural and very rural areas especially where undergrounded lines do not follow paved roads. The IOUs have not scoped vegetation management methods for the undergrounding right of ways.

Trenching for undergrounding will likely require the removal of many trees along the new right of ways. This process may also damage other tree root systems resulting in delayed impacts to trees or die-offs along the right of ways. Undergrounded systems may also be susceptible to root system grow-in. The IOUs reported in the April 27, 2023, WMP workshop that they had not completed an assessment of undergrounding interactions with vegetation such as root system grow-in.

Distribution system planning alignment – IOU's WMP undergrounding projects should be coordinated with their Distribution Planning Process and informed by granular load forecasting. More discussion is provided under *Risk Mitigation Activities: The IOUs should coordinate their wildfire mitigation activities with the Distribution Planning Process*.

The IOUs have not provided a sufficiently detailed narrative on their undergrounding programs to substantiate the claims that undergrounding is a cost-effective long-term solution to wildfire mitigation that has been sufficiently thought-out. GPI recommends minimally requiring the IOUs to report on the following:

- Provide lifecycle costs of undergrounding versus OH system-level mitigations.
- Detail the vegetation management activities anticipated for undergrounded systems.
- Provide a narration regarding how undergrounding failure modes and wear-and-tear are taken into account when the systems are designed.
- Provide a narration regarding how utilities will manage the impacts of undergrounding trenching on vegetation.
- Describe any analyses completed or planned to estimate the reliability of underground distribution systems in urban and non-urban environments.
- If the utility has not considered any of the above factors, provide a plan to analyze each missing consideration.

Risk Mitigation Activities: The IOUs should coordinate their wildfire mitigation activities with the Distribution Planning Process.

California's electricity demand continues to grow due to a range of factors including but not limited to climate change (e.g. AC demand, water pumping), population growth, and statewide goals for distributed energy resource (DER) adoption (e.g. EV's) and building electrification. Load growth is anticipated to result in stress on the existing distribution grid, requiring many distribution system upgrades on account of an aging and constrained system that was not built to accommodate the anticipated demand.

The Distributed Resources Planning proceeding R.14-08-013 (now closed) required utilities to develop location-specific load growth forecasts to inform distribution planning. This resulted in the IOUs' annual Grid Needs Assessment reports, which detail hundreds of anticipated grid needs across the distribution system.[102] The impacts of demand forecasts, the need for forecast scenarios, and the importance of granular load growth on distribution grid needs and the IOU Distribution Planning Process are now under review in the High DER proceeding (R.21-06-017).

PG&E's plan to convert 8,000 miles of a total 24,911 overhead distribution system circuit miles into 10,000 miles of undergrounding constitutes 32 percent of the HFTD Tier 2 and Tier 3 distribution grid. SDG&E also plans to underground approximately 1,500 miles or 43 percent of its remaining HFTD overhead distribution system. SCE plans to underground 100 miles between 2023-2025, and an additional 580 from 2025-2028.[103] They do not provide 10-year targets for their Targeted Undergrounding program. SCE's undergrounding scope of work through 2028 totals 7.1 percent of their 9,549 HFTD overhead circuit miles. Distribution grid projects of this scale and scope must take into account critical distribution planning considerations such as granular forecasted demand growth over the lifetime of the investment. This is especially the case for undergrounding projects, as they are a system-level overhaul. Utility undergrounding projects should be built to support load growth in the HFTD.

SDG&E includes one line regarding their coordination with distribution planners:

> Distribution Planners are engaged in early scoping stages to incorporate appropriate conductor and cable sizing for anticipated load growth as well as to provide input on cutovers and necessary rerouting.[104]

GPI is concerned that a one-time engagement with Distribution Planners at the scoping stage may be inadequate to ensure that the undergrounded projects address the most recent distribution load forecast. In recent 2022 the IOUs adopted more aggressive distribution load forecasts to better reflect electric vehicle demand. The IOU Grid Needs Assessments also indicate a trend of rapidly increasing demand associated with EV charger interconnection requests that are difficult to predict even just three years out.[105] At this time granular demand and demand forecasts are

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[102] CPUC High DER Future Grid Proceeding https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/distribution-planning (Accessed May 21, 2023)

[103] SCE 2023-2025 WMP, p. 753

[104] SDG&E 2023-2025 WMP, p. 166

[105] 2023 IPE Post DPAG Report_3.29.23 Final p. 15

changing rapidly and this trend should be expected to continue over the WMP cycle and decade. It is important for the IOUs to use the most up-to-date demand forecasts per the Distribution Planning Process during the design phase of their undergrounding projects. It is not clear how far in advance SDG&E's "early scoping stages" are prior to construction. At the current rate of change, due to both new load growth and policy, demand forecasts that underpin distribution planning have a shelf-life of approximately 1 year. Beyond 1 year it is likely that an updated demand forecast, granular modeling method, and/or planning standard will paint a different picture of circuit-level distribution needs.

Wildfire mitigation planning is of course largely focused on wildfire risk reduction. However, failure to coordinate wildfire mitigation grid hardening programs with Distribution Planning may decrease the lifetime of the new assets and/or obfuscate the investment if the grid is already constrained at a given location or if localized load growth requires them to be replaced again before the approach of their useful lifetime. It is especially critical to coordinate system-level rebuilds, such as undergrounding projects, with IOU Distribution Planners in order to prevent the need for upgrades that would otherwise be necessary to accommodate increasing demand. The same considerations should be taken into account for other asset replacement programs that can constrain the amount of load served or generation that can be accommodated on a circuit or segment. For example, whether the utilities are replacing like-for-like assets where overloading events have or will cause wear and tear on the new equipment.

GPI recommends the following:

- All IOUs should be required to provide a short narration that includes:
    - Whether they coordinate with Distribution Planners on location-specific undergrounding projects. At what stage of the development process and how far in advance of construction. The lag time between system design and construction. Whether there is a process that allows for design updates prior to construction and based on the most up-to-date Distribution Planning standards.
    - Whether they coordinate with Distribution Planners on location-specific covered conductor projects. At what stage of the development process and how far in

advance of construction. The lag time between system design and construction. Whether there is a process that allows for design updates prior to construction and based on the most up-to-date Distribution Planning standards.

- Whether they coordinate with Distribution Planners regarding other location-specific asset replacement activities (e.g. transformers, capacitors) projects. At what stage of the development process and how far in advance of construction. The lag time between system design and construction. Whether there is a process that allows for design updates prior to construction and based on the most up-to-date Distribution Planning standards.

Risk Mitigation Activities: The IOUs should continue to make progress toward increasing PSPS wind speed thresholds based on covered conductor installation

SCE's has approximately 45 percent covered conductor coverage in their HFTD. Their 2023-2025 WMP includes substantive additional covered conductor installation:

> SCE plans to install more than 2,850 additional circuit miles of covered conductor over this WMP period. By the end of 2025, we expect to have replaced more than 7,200 circuit miles, or approximately 75%, of distribution primary overhead conductors in HFRA with covered conductor. Covered conductor deployment is prioritized, not only by wildfire risk, but also by the probability of PSPS de-energizations for historically impacted circuits.[106]

SCE does adjust PSPS wind speed thresholds based on covered conductor coverage:

> SCE's PSPS wind speed thresholds are higher for circuits or isolatable circuit segments that are fully hardened with covered conductor, thereby potentially limiting the frequency, duration and number of customers affected by PSPS during fire weather events. However, during severe conditions, there is heightened risk of ignitions at higher windspeeds primarily due to the possibility of infrastructure damage which can cause wind-driven foreign objects or airborne vegetation coming into contact with and damaging SCE's equipment. Under these circumstances, the deployment of covered conductor may not sufficiently mitigate wildfire and public safety risk, and PSPS is necessary as a last resort mitigation measure to prevent ignitions that may lead to significant wildfires.107

[106] SCE 2023-2025 WMP, p. 6

[107] SCE 2023-2025 WMP, p. 623

It is not clear to what extent covered conductor installation is reducing PSPS risk in their territory. SCE should provide metrics on how many circuits or line miles are eligible for higher PSPS wind speed thresholds and on instances when covered conductor resulted in a decision to not instate a PSPS.

In regards to their REFCL installations, SCE states:

> … at this point in time SCE does not see REFCL as an alternative to covered conductor or as a basis for increased PSPS wind speed thresholds.108

GPI recommends requiring that SCE include PSPS windspeed threshold assessments in their REFCL study including as a CC++/REFCL portfolio, since REFCL complements covered conductor and CC++/REFCL is SCE's substitute for their targeted undergrounding program.

PG&E and SDG&E continue to state that covered conductor can increase the PSPS wind threshold, but do not update the threshold for any circuits. In their 2023 WMP, SDG&E's covered conductor installation activity states:

> To support its initial wildfire resiliency and hardening efforts, SDG&E performed a study to calculate design wind speeds such that SDG&E infrastructure could withstand potential extreme wind events. Infrastructure must be designed to a higher wind speed to allow for a design and safety factor. Based on the study, design wind speeds for infrastructure to withstand the impacts of wind speeds over 85 mph with a max of 111 mph were adopted…
>
> …The Covered Conductor Program has the potential to raise the threshold for PSPS events to higher wind speeds compared to bare conductor hardening; however, as of the end of 2022 no circuits have been fully hardened with covered conductor and therefore the threshold for PSPS events has not been raised on any circuits with covered conductor installed.109

In response to ACI SDGE-22-11 in Appendix D, SDG&E expects to complete covered conductor testing and finalize the threshold by December 2023.

In response to ACI PG&E-22-31, PSPS Wind Threshold Change Evaluations, PG&E is not currently adjusting their PSPS thresholds based on covered conductor installations. They also

[108] SCE 2023-2025 WMP, p. 746

[109] SDG&E 2023-2024 WMP, pp. 151-152

appear to have no plans to take covered conductor installations into account to increase their PSPS wind speed thresholds. They state homogenous effectiveness due to vegetation, wind speed effects, and tree fall-in as barriers.

GPI recommends the following:

- SCE should provide metrics on how many circuits or line miles are eligible for higher PSPS wind speed thresholds and on instances when covered conductor resulted in a decision to not instate a PSPS.

- SDG&E and PG&E should continue to advance their ability to increase PSPS wind speed thresholds based on covered conductor installation and overhead system hardening portfolios. This should include the ability to assess homogenous risk that allows PG&E and SDG&E to selectively increase PSPS wind speed thresholds depending on granular conditions and the presence of covered conductor.

Risk Mitigation Activities: PG&E and SDG&E should actively advance their REFCL pilot programs to yield timely results

Since 2022, SCE has elevated its RECFL pilot to a deployment scale mitigation that complements its CC++ overhead distribution system hardening portfolio by reducing ignition risk from wire-to-ground faults. SCE continues to actively advance its understanding of REFCL technology, including its benefits and limitations, while also leveraging the known benefits in overhead system hardening portfolios that function as an alternative to undergrounding. Notably, Rapid Earth Fault Current Limiter technology has also been widely adopted and deployed since 2019 in Victoria, Australia as a grid-scale wildfire mitigation technology.[110]

PG&E and SDG&E are far behind in their REFCL assessment in comparison to SCE. PG&E's description of their REFCL testing suggests they have minimal plans to expand their pilot. PG&E implemented REFCL at Calistoga substation in 2018. Notably, the Calistoga substation was identified in PG&E's Distribution Planning Process 2020 Grid Needs Assessment which

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[110] Energy Safe Victoria. Rapid Earth Fault Current Limiter (REFCL) reports https://www.esv.vic.gov.au/about-us/our-organisation/reports/rapid-earth-fault-current-limiter-refcl-reports

identified required upgrades to support a capacity need, and in their 2020-2021 Distribution Deferral Opportunity Report which identifies grid needs with the potential for deferring traditional wires solutions via DER installations.[111] The REFCL installation is described as showing positive results but also experiencing equipment failure and subsequent delayed repairs due to supply chain issues. PG&E should report on whether capacity grid needs at Calistoga influenced the REFCL equipment failure.

PG&E states that they will resume testing their REFCL installation in 2023, but simultaneously imply they do not intend to seriously pursue this technology:

> While PG&E is looking at opportunities for REFCL deployments in our distribution substations to mitigate wildfire risk and evaluating combinations of REFCL with EPSS and other mitigations, implementing it would require significant and costly changes to the grid. Instead of making costly changes to the grid, we are moving forward with more cost-effective solutions such as DCD and Partial Voltage Detection.[112]

PG&E cites barriers to REFCL installation that include limited space within substation footprints, the proportion of 3-phase versus 4-phase conductors, and undergrounding. It is not clear whether the undergrounded line miles they refer to are planned or completed. However, PG&E did previously identify 25 possible substations within the HFTD that could be suitable for REFCL installations.[113] Vague arguments that implementing REFCL is too costly and suffers from supply chain issues are weak. PG&E does not provide a cost comparison of REFCL and OH system hardening portfolios that contain RECFL with undergrounding. This would be a first step to providing clear evidence that RECFL may not be a suitable mitigation in PG&E's territory. While the REFCL supply chain may be a challenge, other utilities such as SCE have managed to navigate this barrier. The widespread use of REFCL in Victoria, Australia, and recent deployment by SCE suggests this emerging technology may have a growing market that could mitigate sourcing challenges. Blanket statements about cost and supply chain should not result in the write-off of REFCL as a complementary wildfire mitigation strategy and potential element in OH system-level mitigation portfolios.

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[111] Distribution Planning Advisory Group (DPAG) Follow-up Webinar. October 12, 2020
[112] PG& 2023-2025 WMP, p. 275
[113] PG&E Data Request Response to Data Request CalAdvocates_011-Q003. WMP-Discovery2023_DR_CalAdvocates_011-Q003.pdf

SDG&E was issued three ACI's in 2022 that require exploring alternative or additional mitigations including but not limited to, REFCL. SDG&E does not include any discussion of REFCL in their 2023-2025 Base WMP mitigation (Section 8) narration or in their response to the three ACIs: SDG&E-22-11, Applying Joint Lessons Learned Concerning Covered Conductor; SDGE-22-13, New Technologies Evaluation and Implementation; and SDGE-22-21 Consideration of Alternatives to Fuels Treatment Activity.

In 2022 OEIS expanded the scope of the Joint IOU Covered Conductor Working Group and study to encompass other wildfire risk mitigation technologies, including REFCL. The updated working group report only provides a high-level update regarding REFCL, stating that SDG&E does not have any REFCL activities, PG&E is at the pilot stage, and SCE has transitioned from the pilot phase to deployment. The working group has scheduled an August 2023 workshop on REFCL "implementation strategies, practices, and effectiveness."

It is critical to advance lab and field-based understandings of emerging technologies, especially for technologies such as REFCL that complement overhead system hardening mitigation portfolios and covered conductor. These studies are necessary to inform the most up-to-date cost-effective solutions to utility wildfire mitigation towards cost-effective risk buydown that simultaneously reduces wildfire risk and reduces the impact of these activities on rising electricity costs.

There is clearly a wide range of maturity between the IOU's REFCL activities or lack thereof. PG&E and SDG&E's assessments of REFCL feasibility or other similar technologies in their territories are weak or nonexistent and should not be permitted to stagnate at this stage. Neither IOU has provided sufficient justification to warrant sidelining REFCL as a potentially valuable and cost-effective wildfire mitigation technology. GPI strongly recommends requiring PG&E and SDG&E to proactively build out and report on REFCL feasibility studies and subsequent pilots. An ACI should stipulate a reporting requirement for REFCL feasibility studies for these two IOUs. Reporting should require an update, both quantitative and qualitative, regarding the current state of REFCL feasibility studies that include, but are not limited to cost estimates, eligible installation locations (substations and circuit basis), associated line miles that could be protected by REFCL installations, accompanying overhead system hardening portfolios (e.g.

SCE's CC++/REFCL), and whether the locations are scoped for undergrounding. If PG&E and SDG&E cannot adequately justify their decisions to sideline REFCL they should be required to develop a plan to expand feasibility and pilot studies.

Risk Mitigation Activities: PG&E's open tag backlog elimination plan does not meet OEIS standards

PG&E was issued two ACIs on account of their expansive backlog of overdue work tags. ACI PG&E-22-17, Future Quantitative Targets to Reduce the Backlog of Repairs, required:

> In its 2023 WMP, PG&E must provide quantitative targets for addressing repairs for infractions found during inspections, broken down by severity level of the finding, accounting for the entire backlog. Prioritization should be given for risk tags presenting the most ignition risk within the HFTDs/High Fire Risk Areas.[114]

ACI PG&E-22-22 issued a more aggressive requirement that PG&E

> … must come into compliance with and eliminate its maintenance backlog pursuant to the relevant, overdue GO work order backlog requirements by the end of 2023. In its 2023 WMP, PG&E must:
>
> - Provide its resource plan describing how it will progress on closing outstanding and overdue work orders in the HFTD to eventually reach a functional capability whereby more work orders are being closed than are being opened;
> - Provide an update of its progress on addressing remaining work tags in 2022, including the number of work tags opened and closed per quarter;
> - Provide a remedial plan to address its full maintenance backlog including GO backlogs as soon as feasible; and
> - By the end of 2023, develop a plan detailing how PG&E will clear the GO repair backlog no later than the end of the 2023-2025 WMP cycle and demonstrating capability to maintain its repair cycle within GO requirements. PG&E must include this plan in its WMP Update submitted in 2024.[115]

These ACI requirements are somewhat confusing. The third and fourth ACI requirements in PG&E-22-22 seem to provide PG&E with two possible timelines for addressing their GO backlogs, either "as soon as feasible" or "no later than the end of the 2023-2025 WMP cycle." Alternatively, the third stipulation could be interpreted as a requirement to provide a "remedial

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[114] PG&E 2023-2025 WMP, p. 912

[115] PG&E 2023-2025 WMP, p. 934

plan" as soon as feasible. While the fourth requirement gives PG&E until the end of 2023 and their 2024 WMP Update to develop a plan.

PG&E provide a backlog correction plan in their 2023 WMP (GM-02 and GM-03). Their Transmission system overdue work tag backlog management plan achieves the requirements of the ACI by providing a plan that will address all overdue work order by 2023.[116] However, their distribution system overdue work tag backlog elimination plan only addresses 77% of the wildfire risk associated with ignition risk tags by 2025. In the narration PG&E's work plan is vague and extends through 2029:

> Reduce the backlog of approximately 210,000 ignition-risk notifications in the HFTD/HFRA by the end of 2029;[117]

And later:

> Our plan is to eliminate the ignition-risk notification backlog by the end of 2029 and to eliminate the non-ignition risk backlog by the end of 2032.118

"Reduce" is not the same as "eliminate" and implies that PG&E may anticipate having overdue work tags associated with ignition risk through the end of the decade. PG&E's work plan leaves known ignition risk issues in the HFTD unaddressed through the next three 3-year WMP Cycles. Furthermore, PG&E's work plan does not comply with the most stringent interpretation of ACI PG&E-22-22 that requires PG&E to eliminate their backlog by the end of the 2023-2025 WMP cycle.

PG&E also reports finding higher than expected new tags in 2021 and 2022. Their 2022 inspection programs had a 17 percent higher find rate compared to 2021, which they attribute to improved inspection quality.[119] Damages may also be linked to record precipitation during 2022 as well as their ageing distribution system. Workforce and resources are likely spread thin across

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[116] PG&E 2023-2025 WMP, p. 292

[117] PG&E 2023-2025 WMP, p. 454

[118] PG&E 2023-2025 WMP, p. 455

[119] PG&E 2023-2025 WMP, p. 457

the many concurrent wildfire mitigations. With PG&E doubling down on their undergrounding program, the sorely needed overhaul of an ageing OH distribution system will likely be slower compared to deploying widespread OH system-level grid hardening portfolios in the HFTD. The overdue work order backlog trend signals that PG&E currently cannot keep up with the degradation rate of their overhead distribution system, and portends that they have not developed a sufficient workforce to be capable of keeping up with their work order generation rate.

PG&E also proposed a "new transitional program" from their EVM program, titled Tree Removal Inventory. This program involves removing or re-inspecting the 300,000 remaining trees in the EVM inventory.[120] Our primary concerns are the need to re-inspect so many trees and the resources required to complete the re-inspection. The need to re-inspect trees previously identified for removal suggests that the original inspection method, guidance, QA/QC process, or other program element was flawed. This is not the first time PG&E has proposed re-inspecting work orders, suggesting that they may be prone to develop and fully launch inspection methods that produce improperly classified work order results. It is especially concerning that PG&E touts this as a new program and therefore is "still developing" the inspection process and does not provide a process chart. GPI is concerned that the Tree Removal Inventory is another inspection program intended to correct improperly classified risk trees and/or to push out work order due dates for vegetation management work orders.

GPI recommends the following:

- PG&E should be ordered to eliminate all overdue work tags associated with ignition risk by the end of the 2023-2025 WMP Cycle. They should update and clarify their plan to consistently include definitive language.

- Issue a new ACI that clarifies when PG&E must provide a backlog elimination plan and when they must achieve complete backlog elimination. We recommend OEIS require PG&E to submit an updated workplan in their 2024 WMP Update that resolves 100% of overdue work orders associated with ignition risk by the end of the 2023-2025 WMP cycle. Each

[120] PG&E 2023-2025 MWP, p. 528-529

WMP updates should include a status report and the 2026-2028 Base WMP should confirm that all overdue work orders associated with ignition risk are closed. PG&E should provide an updated work plan in their 2026-2028 Base WMP for any residual overdue work orders not associated with ignition risk.

- The OEIS should continue to track PG&E's progress towards developing an adequate work order workforce.

- OEIS should issue an ACI requiring PG&E to provide a method, work schedule, review process, and QA/QC program for their EVM transitional programs, including their Tree Removal Inventory program. The review process should include clear objectives and targets that inform whether the transitional program is effective or necessary. PG&E should be required to provide an update on the results of the program review.

WMP Reporting Improvements: IOUs should be required to make their risk modeling outputs publicly available on a web-based platform

SDG&E outlines plans to advance a Visualization platform for their WiNGS planning and WiNGS- Ops risk model outputs. The platform will include an interactive map view that provides circuit and segment risk insight as well as a portfolio scoping tool that compares modeled mitigation portfolios.[121] GPI strongly recommends that all IOUs be required to provide public access to wildfire risk model data layers at the granularity of the distribution systems via a web-based platform. We recommend the IOUs leverage the existing distribution-level maps that were developed under the Distributed Resources Planning proceeding (R14-08-013) and under continued development per the HDER proceeding (D.21-06-017). Distribution risk model output and mitigation maps have limited value for the purpose of model output and mitigation deployment review at the scale of an 8.5x11" page.

[121] SDG&E 2023-2023 WMP, p. 106

Cross-agency coordination: OEIS and the CPUC should work together to align activities associated with SB 884 and the WMP

California recently passed SB 884, which outlines a process for IOUs to submit 10-year undergrounding plans for the purpose of wildfire mitigation. This bill encroaches on the WMP and review process by both being less rigorous than the WMP review process and including additional elements that are not currently required in the WMPs. GPI strongly recommends the OEIS seek to develop cross-agency coordination with the CPUC with respect to the WMPs and SB 884.[122]

We further encourage OEIS to consider integrating elements that are required in SB 884, but not in the WMP, as potential additions to the WMP requirements. In particular, SB 884 requires that IOUs proposing a 10-year plan must also seek third party funding to defray the costs of undergrounding. IOUs could avoid this requirement by simply not taking part in SB 884 and instead continuing to submit their aggressive undergrounding plans in 3-year increments and 10-year visions via the consistently approved WMPs. California ratepayers should not be subject to different grid hardening cost burdens depending on the legislative pathway that oversees the work.

While the SB 884 stipulation to seek third party funding is well intended it is also flawed. IOUs could make minimal effort to apply for federal, state, or private funds yet still satisfy the bill's requirements. The WMPs should include an improved third-party funding requirement for undergrounding plans that exceed a threshold scope of work (e.g. miles per year). Third-party funding requirements should also include the following elements: a grant/funding seeking workforce plan, an annual plan for grant seeking strategy, a list of identified funding sources/ opportunities and the total potential value (i.e. grants and funding availability), a 1-page narration on how the IOU has prepared to satisfy the stipulations of a targeted award opportunity (e.g. established non-profit partnership, etc.), an annual summary of funding request submissions, statuses, and next steps.

[122] Informal Comments of the Green Power Institute on SB 884 Implementation, Filed March 10, 2023

Third party funding and grant seeking programs should also be closely reviewed for cost benefit. Grant seeking can prove to be a time-consuming endeavor with variable return on investment. Both the CPUC and OEIS will have to balance the oversight of adequate grant/fund seeking efforts with reasonable return on investment outcomes that ensure the cost-benefit of the SB 884 requirement. GPI cautions that the SB 884 and a WMP equivalent requirement for third party funding should neither become an empty and distracting promise from the IOUs or an additional wildfire mitigation cost without net benefit outcomes.

Cross-agency coordination: The role of IOU oversight includes ratepayer cost management

A critical role of IOU oversight by the state government includes ratepayer cost management. GPI is concerned by the rapid expansion of undergrounding projects across all three IOU territories in order to reduce long-term wildfire risk. It has long been highlighted in the WMP process, over the tenure of both CPUC and OEIS oversight, that utility wildfire risk can be mitigated but that the cost of that mitigation depends on the risk threshold and planning standard. As colloquially mentioned in WMP workshops and comments, buying down 99 percent of risk can prove to be much more expensive and impactful (e.g. PSPS, EPSS) than buying down 90 percent of risk. PG&E relatively transparently expresses that the cost of wildfire mitigation is not a consideration in their wildfire mitigation plan development, stating:

> PG&E focuses on three key elements in developing our wildfire mitigation portfolio:
>
> 1) Identifying and selecting mitigation initiatives based on the greatest amount of risk reduction;
>
> 2) Considering geographic specific limitations and other constraints to develop a balanced portfolio of mitigations; and
>
> 3) Optimizing resources to maximize risk reduction across the system.[123]

While the WMP is not a ratemaking proceeding or a cost approval process, it does influence cost approvals by way of approving the Wildfire Mitigation Plans. These costs affect ratepayers disproportionately and may be substantive enough to push many more California rate payers into

[123] PG&E 2023-2025 WMP, p. 248

the category of energy disadvantaged (i.e. energy costs total 10 percent of income). Towards transparency, GPI is disappointed that the WMP Guidelines removed the estimated cost per customer metric required in the 2020-2022 WMPs.

It is well known that the scope of undergrounding is now the largest contributor to WMP costs. Prior to the development of granular wildfire risk models, covered conductor was the most expansive wildfire risk mitigation intended to reduce HFTD-wide ignition risk. With the onset of granular wildfire risk modeling came the relatively myopic shift from covered conductor to undergrounding. Notably, the intention of granular risk models was to improve the surgical deployment of expensive mitigations, not to promote grid-wide deployment. In a follow up to the data mindset, it is possible that the outcome of novel risk models could show a need for above-anticipated "maximum security" mitigations. However, GPI is not convinced the IOU risk models clearly or at a minimum, collectively, justify the current scope of undergrounding work. This is not only a function of the many different risk modeling methods the IOUs currently in use, but also due to a need for a clear risk-based planning standard.

The related challenge state decisionmakers and IOUs are faced with is whether risk gaps and risk uncertainty require maximum possible risk buydown or are acceptable risk. The OEIS definition of catastrophic wildfire is a deterministic planning target that defines what an unacceptable outcome is. It does not define the probabilistic element of the risk standard or planning threshold. A risk standard or planning threshold must include what level of residual risk is acceptable (e.g. a probabilistic return rate). For example, California adopted a 1-in-10-year loss of load expectation (LOLE) that informs CAISO generation procurement, and that was translated into a 15 percent Planning Reserve Margin. This risk planning threshold does not eliminate all risk, nor does it set a deterministic target (e.g. no customer power loss). Rather it establishes what is acceptable risk that balances the importance of system reliability and ratepayer cost. This type of top-down planning standard is necessary to guide wildfire risk model development that will in turn inform mitigation type and location. It may also alter the focus away from the concept of risk spend efficiency and instead establish a metric more akin to minimum mitigation and associated cost requirements necessary to achieve the planning standard.

From this perspective the WMP process has a way to go from both a state-level guidance and IOU model alignment standpoint. As in risk modeling comments above, GPI urgently recommends that the next step in risk model development should result in joint IOU risk models that use a unified quantitative and model-based definition of wildfire risk for the entirely of the IOU footprint. Of course, wildfire mitigation work should not stop while models and planning standards are hashed out. A reasonable alternative is to require an even more stringent "least regrets" risk buydown strategy that prioritizes undergrounding, the most costly and slow to implement mitigation, in the absolute highest risk locations first, based on our current understanding of granular wildfire risk. This is in contrast to a deployment strategy that prioritizes easier to approve and construct projects in moderately high-risk areas. By pushing near-term high-cost undergrounding investments to the top 1 or 5 percent of riskiest circuits/segments it is more likely that investments in the current WMP cycle will align with forthcoming risk model adjustments, planning standards, cost-benefit requirements, and alternative technological solutions to risk mitigation (e.g. CC+REFCL).

Conclusions

We respectfully submit these comments and look forward to reviewing future wildfire mitigation plans and related filings.

For the reasons stated above, we urge the OEIS to adopt our recommendations herein.

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Respectfully Submitted,

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