Pacific Gas and Electric Company®

Jay Leyno
Director,
Wildfire Mitigation PMO

Mailing Address: 300 Lakeside Drive
Oakland, CA 94612
Telephone: (925) 239-3126
Email: Jay.Leyno@pge.com

December 5, 2024

Via Office of Energy Infrastructure Safety E-Filing

Caroline Thomas Jacobs, Director Office
of Energy Infrastructure Safety
California Natural Resources Agency
715 P Street, 20th Floor
Sacramento, CA 95814

Re: **Pacific Gas & Electric Company's Revised 2025 Wildfire Mitigation Plan (WMP) Update**

Dear Director Thomas Jacobs:

On November 19, 2024, the Office of Energy Infrastructure Safety (Energy Safety) published a final decision on PG&E's 2025 Wildfire Mitigation Plan (WMP) Update. Pursuant to the 2023-2025 Wildfire Mitigation Plan Process and Evaluation Guidelines,[1] PG&E is submitting an updated version of its 2025 WMP Update that reflects errata previously submitted by PG&E to Energy Safety.

This version reflects the following:

- PG&E's non-substantive errata submitted to OEIS on May 14, 2024.

PG&E's Wildfire Mitigation Plan and associated documents, including the submission noted above, are available on PG&E's website at the following link: https://www.pge.com/en/outages-and-safety/safety/community-wildfire-safety-program.html.

Sincerely,

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Jay Leyno
Director, Wildfire Mitigation PMO

[1] Energy Safety 2023-2025 WMP Process and Evaluation Guidelines (Revised), Section 4.3, p. 6.

2025 Wildfire Mitigation Plan Update R2

Pacific Gas and Electric Company®

December 5, 2024

Docket Title: 2023 to 2025 Electrical Corporation Wildfire Mitigation Plans
Docket #: 2023-2025-WMPs

PACIFIC GAS AND ELECTRIC COMPANY
2025 WILDFIRE MITIGATION PLAN

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PACIFIC GAS AND ELECTRIC COMPANY

2025 WILDFIRE MITIGATION PLAN UPDATE

A. Executive Summary Update

Pacific Gas and Electric Company (PG&E) remains committed to our stand that catastrophic wildfires shall stop. In furtherance of this goal, our 2025 Wildfire Mitigation Plan (WMP) Update is driven by a continuous commitment to safety. This 2025 WMP Update reflects the refinement of our integrated strategy to manage and reduce wildfire ignition risk, as well as updates to the execution of existing mitigation initiatives.

Pursuant to the directions given in the 2025 WMP Update Guidelines issued by the Office of Energy Infrastructure Safety (Energy Safety), we submit this 2025 WMP Update to report our progress and changes to the Base 2023-2025 WMP.[1] Consistent with the 2025 WMP Update Guidelines, the reportable updates are limited to five categories: (1) Significant Updates to Risk Models; (2) Changes to Approved Targets, Objectives, and Expenditures; (3) Quarterly Inspection Targets for 2025; (4) New or Discontinued Programs; and (5) Progress on Areas for Continued Improvement.

PG&E identified 57 updates that fall within these five categories and have outlined these changes at a high level in the Figure PG&E-Executive Summary-1 below:

[1] 2025 WMP Update Guidelines, pp. 3-4.

FIGURE PG&E-EXECUTIVE SUMMARY-1:
2025 WMP UPDATE SUMMARY

PG&E Updates	OEIS Guideline Categories	Category Breakdown	
2025 WMP Update 57	Significant Updates to Risk Models 2	Distribution Risk Model 1	• WDRMv4 is updated to incorporate ingress and egress attributes, 24-hour simulations, updated dry wind data sets, and community vulnerabilities
		Transmission Risk Model 1	• WTRMv2 is updated to incorporate new machine learning models for avian and veg risk, model refinements for wind caused outages and polymer degradation, and account for updated ATS/Field data
	Changes to Approved Targets, Objectives, and Expenditures 13	Target Changes 6	• Address backlog tag ACI by committing to 154,200 tags across the WMP period • New conductor segment replacement target to address two transmission lines • Four target changes from 2024 Change Order that meet the 2025 update criteria
		Expenditure Changes 7	• Grid design and maintenance expenditure updates to account for the GRC decision, increased transmission hardening, EPSS operational costs, and QA/QC • Vegetation management updates to account for full FTI program costs
	Quarterly Inspection Targets 21	Quarterly Targets 21	• Provide updated quarterly targets for 21 commitments • Where needed/possible provide update risk impact percentages
	New or Discontinued Programs 0	New & Discontinued Programs 0	• PG&E is not proposing any new or discontinued programs that meet criteria
	Progress on ACIs 21	ACI 21	• OEIS provided 26 ACIs in the 2023 – 2025 WMP Decision of which 21 require a progress response in the 2025 WMP Update

Below we provide a more detailed overview of the progress and changes in our 2025 WMP Update for each of these five categories.

A.1. Significant Updates to Risk Models

We continue to improve our wildfire risk modeling to help identify and eliminate risk on our system. To this end, we developed and adopted the next evolution of the Wildfire Distribution Risk Model (WDRM), Version (v) 4, which incorporated both internal and external feedback to improve upon the WDRM v3. This iteration of the WDRM refines our understanding of how wildfires are initiated and their likelihood of becoming catastrophic. Key improvements include the addition of new equipment asset models, updates to the vegetation model, improvements to the asset, ignitions, and outage data quality, as well as important changes to the probability and consequence models. The outputs from the WDRM v4 are expected to inform some risk-prioritized, short-cycle work in 2025 and other risk-prioritized long-cycle work in 2026 and beyond.

In addition, the updated Wildfire Transmission Risk Model (WTRM) informs risk-prioritized workplans for certain types of transmission inspections. Version 2 of the WTRM, developed in 2023, underwent a series of updates from v1. The three main objectives of these updates were to: (1) add two machine learning-based hazard models; (2) implement internal feedback; and (3) refine model functionality to improve output accuracy. With this latest evolution of the WTRM, PG&E will continue to target work and programs that will provide the greatest risk reduction for our customers.

These significant updates fall under the "Qualitative Updates" criteria of the 2025 Guidelines as a change to an existing model per 2025 WMP Update Guidelines.[2]

A.2. Changes to Approved Targets, Objectives, and Expenditures

Aligning Distribution Hardening and Undergrounding Programs With the CPUC's General Rate Case Decision

As outlined in our 2024 WMP Change Order, we proposed a necessary change in our distribution hardening and undergrounding programs to align the WMP with the mileage targets, risk reduction targets, and associated cost recovery amounts authorized in the California Public Utilities Commission's (CPUC) final General Rate Case (GRC) decision.[3] As this change will also impact our 2025 targets in a volume sufficient to meet the 2025 WMP Update Guidelines, we included it here.

As the reduction of Public Safety Power Shutoff (PSPS) impacts on customers is directly correlated to completing the undergrounding program, the change to the undergrounding program target in 2025 will affect the PSPS impact reduction target. While the number of PSPS customer events mitigated for 2025 will decrease due to this

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2 2025 WMP Update Guidelines, pp. 6-11.

3 D.23-11-069 (Nov. 17, 2023).

change, PG&E will continue to advance existing mitigation measures to help reduce the impact of PSPS events on customers.

Updating the Portable Battery Program to Account for Outperformance in 2023

We also provide an update to our Portable Battery Program. This program delivers backup batteries to vulnerable customers and lessens the impact of PSPS and Enhanced Powerline Safety Settings (EPSS) events. We updated the 2025 target to account for outperforming our target in 2023, as this program has a cumulative 3-year goal. This update does not impact our commitment in our Base 2023-2025 WMP to provide 12,000 batteries over the 3-year WMP period.[4]

Reducing Our Backlog of Distribution Tags

We revised the target for distribution backlog tags in response to Area for Continued Improvement (ACI) PG&E-23-12. This change will increase the total number of tags expected to be closed over the 3-year period and confirm our commitment to eliminate our asset tag backlog.

New Target for Transmission Conductor Segment Replacement

To continue to reduce the likelihood of asset failure driven ignitions, we created a new target to focus on the replacement of conductor segments of transmission circuits in High Fire Threat District (HFTD) areas. This target demonstrates our commitment to improving in this area and our plan to expand our segment replacement program going into the next WMP cycle.

Targets in the 2024 Change Order That Do Not Meet the Update Criteria

We proposed several target changes in the 2024 Change Order that do not meet the 2025 WMP Update criteria for inclusion in this WMP. Given this limitation, we will seek to update these targets through the 2025 WMP Change Order process.

Update to Expenditures

In Section B.2.2.1, we provide an updated forecast on our 2025 expenditures, as required by the 2025 WMP Update Guidelines. These updates reflect both the impacts of strategic program changes discussed throughout this document, as well as the effect of changes in cost due to other economic factors.

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4 PG&E's 2024 Change Order for PS-06 highlighted our proposal to include both permanent and portable battery solutions to better meet our customers' needs. In alignment with the 2024 Change Order, we plan to operate under a consistent strategy for 2025 for this updated target.

A.3. Updating Our Quarterly Inspection Targets for 2025

We are updating our 2025 quarterly targets for the Asset and Vegetation Inspection programs to account for adjustments to our quarterly execution plans. However, the total number of units addressed by these initiative mitigations remain unchanged from what was approved in the Base 2023-2025 WMP filing.

A.4. Identifying New or Discontinued Programs

PG&E is not proposing to discontinue or create any new programs in 2025.

A.5. Demonstrating Progress on Areas for Continued Improvement

As directed, we provide an update on the progress of the Areas for Continued Improvement (ACI) identified by Energy Safety in its approval of our Base 2023-2025 WMP.[5] Our responses to these ACIs demonstrate our commitment to continuous improvement and we look forward to continuing to work with Energy Safety on the issues identified in these ACIs.

Note on the Transfer of Generation Assets From PG&E to Pacific Generation

On September 28, 2022, PG&E and our new subsidiary, Pacific Generation LLC (Pac Gen), filed Application 22-09-018 with the CPUC. This application seeks to transfer substantially all of PG&E's non-nuclear generation assets to Pac Gen. If approved as proposed, this will cause Pac Gen to become a CPUC-regulated cost-of-service public utility. However, even if approval is received and the assets are transferred to Pac Gen, a service agreement exists between PG&E and Pac Gen under which PG&E personnel will continue to operate and maintain Pac Gen's assets. Importantly for this WMP, this means that all wildfire mitigation work would continue to be performed by PG&E personnel as described in the Base 2023-2025 WMP and this 2025 WMP Update, regardless of any transfer of ownership.

At the time of this filing, this Application remains pending before the CPUC and all assets remain with PG&E.[6] However, should the application to transfer assets be approved—given that all wildfire mitigation work described in this WMP would continue to be performed by PG&E pursuant to the service agreement—this WMP would cover both Pac Gen and PG&E, as well as their assets. Any transfer would cause no change to the wildfire mitigation work as it is described in PG&E's Base 2023-2025 WMP, 2024 Change Order, or this 2025 WMP Update.

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5 2025 WMP Update Guidelines, p. 17.

6 A final decision on this application has not been issued. However, on March 15, 2024, the CPUC issued a Proposed Decision denying the transfer of assets, which is available at the following link: https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M527/K510/527510567.PDF.

B. 2025 WMP Updates

We provide details on each of the five categories of reportable updates as defined in the 2025 WMP Update Guidelines in the sections below.[7]

B.1. Significant Updates to Risk Models

Updates to our WDRM and WTRM described below are significant updates because they fall under the "Qualitative Updates" criteria of the 2025 Guidelines as a change to an existing model.[8] Specifically, we introduced new data types and changed data sources.

Table 1-1 Top 5 Percent Ignition Risk Circuit Segments and Table 1-2 Top 5 Percent PSPS Risk Circuit Segments below summarize the updated top 5 percent of highest-risk circuit segments based on WDRM v4. These risk models are still being adopted across the company at the time of filing.

We do not have any non-significant updates to report on our risk models.

TABLE 1-1:
TOP 5 PERCENT IGNITION RISK CIRCUIT SEGMENTS

Risk Rank	Circuit Segment Name	Mile Weighted Ignition Risk Score	Total Ignition Risk	% of Total Ignition Risk in Top 5%
1	CLAYTON 2212681608	0.22	125.19	10.13
2	BALCH NO 11101105414	0.84	123.71	10.01
3	CLOVERDALE 1102672	0.23	106.43	8.61
4	PLACERVILLE 21067522	0.06	91.52	7.40
5	MIDDLETOWN 1101644756	0.23	87.93	7.11
6	PLACERVILLE 210611132	0.09	84.16	6.81
7	STANISLAUS 1701CB	0.11	83.98	6.79
8	ALLEGHANY 1102CB	0.22	80.82	6.54
9	CALPINE 1144CB	0.14	79.70	6.45
10	MARIPOSA 210237282	0.06	78.13	6.32
11	CALAVERAS CEMENT 1101544800	0.16	77.14	6.24
12	EL DORADO PH 210119752	0.09	74.91	6.06
13	WEST POINT 11024788	0.05	73.83	5.97
14	COLUMBIA HILL 1101CB	0.07	68.52	5.54
	Total	2.57	1,235.97	100.0

7 2025 WMP Update Guidelines, p. 3.

8 2025 WMP Update Guidelines, pp. 6-11.

TABLE 1-2:
TOP 5 PERCENT PSPS RISK CIRCUIT SEGMENTS

Risk Rank	Circuit Segment Name	Mile Weighted PSPS Risk Score	Total PSPS Risk	% of Total PSPS Risk in Top 5%
1	ORO FINO 11012022	0.92	20.07	19.4
2	ORO FINO 1101CB	0.73	15.66	15.2
3	WYANDOTTE 1110747922	1.35	14.37	14.0
4	HIGHLANDS 110275140	1.07	12.17	11.8
5	TEJON 1102732836	0.67	11.63	11.3
6	ORO FINO 11022090	0.58	10.07	9.8
7	REDBUD 1101323962	0.58	9.85	9.5
8	OREGON TRAIL 110335002	0.17	9.31	9.0
	Total	6.07	103.13	100.0

B.1.1. WDRM v4

The WDRM is used to inform our risk-prioritized workplans for system hardening, Vegetation Management (VM) work, inspections, and maintenance activities. WDRM version 3 (WDRM v3) provided predictions of where, why, and how much wildfire risk occurs during a typical wildfire season. It quantified risk for additional risk drivers and incorporated other improvements compared to previous WDRM versions, such as: (1) expanding machine learning to predict ignition in the HFTD; (2) differentiating risk by location and/or individual assets so higher-risk areas could be prioritized; (3) assisting in understanding the factors contributing to risk by modeling relationships among risk, environmental characteristics, and asset characteristics; (4) improving the consequence portion of the model; and (5) estimating where specific mitigations are likely to be the most effective.[9]

In 2023, PG&E developed and adopted the next evolution of the WDRM Version 4 (WDRM v4), which incorporated both internal and external feedback to improve WDRM v3. This iteration of WDRM refines our understanding of how wildfires are initiated and their likelihood of becoming catastrophic. Key improvements include an addition of new equipment asset models, updates to the vegetation model, improvements to the asset, ignitions, and outage data quality, as well as important changes to the probability and consequence models. The outputs from the WDRM v4 are expected to inform risk-prioritized short-cycle work such as tags and inspection programs as early as 2025, and long-cycle work, such as undergrounding and system hardening in 2026 and beyond.

Justification for Updates

In developing WDRM v4, PG&E responded to internal and external feedback and suggestions to improve WDRM v3. Figure PG&E-B.1.1-1 below provides a visual summary of the changes and improvements made to the WDRM as part of v4.

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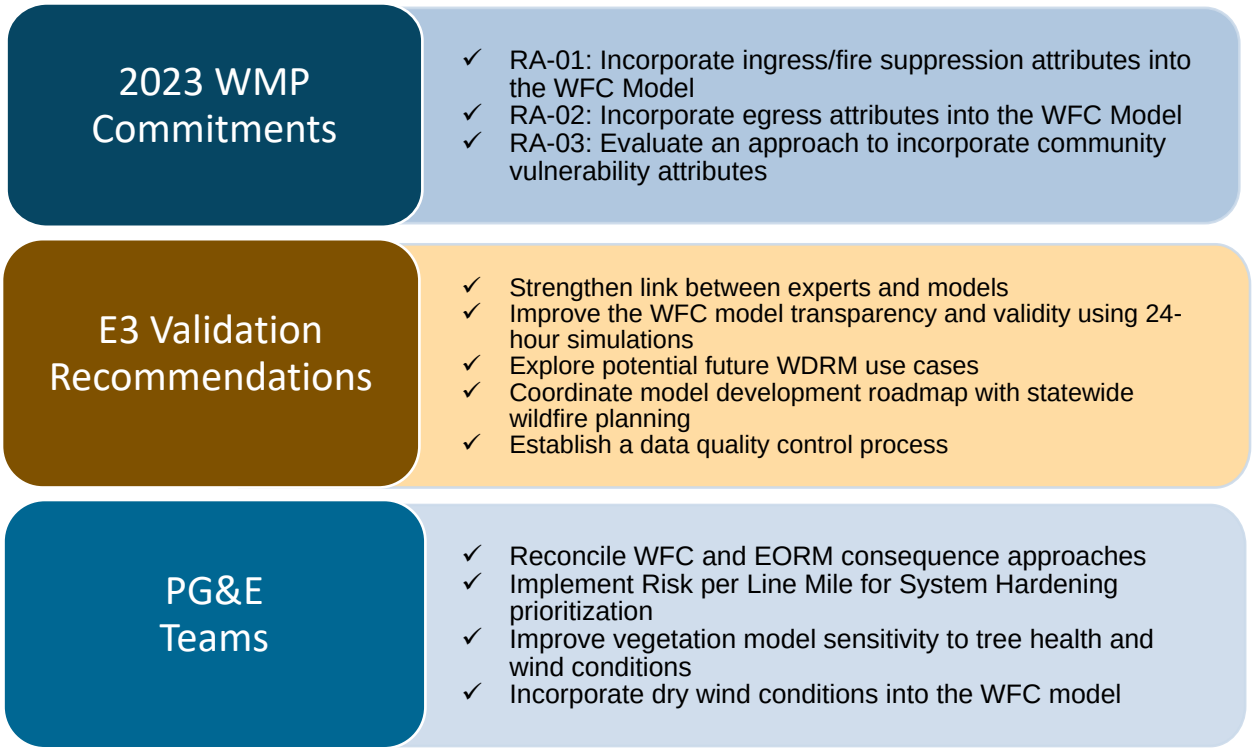
9 For specifics on WDRM v3 see PG&E 2023-2025 WMP, R4, pp. 144-228.

FIGURE PG&E-B.1.1-1:
SUMMARY OF IMPROVEMENTS TO WDRM



Updated Methodology and Models

Distribution Event Probability Models

As subparts to the WDRM, the Distribution Event Probability Models, which include the Probability of Ignition Model and the causal Probability of Outage Models, continued their ongoing improvement process. Highlighted developments for v4 include:

- Adding four new equipment asset models;
- Four v3 equipment asset models were converted from spatial-based models to asset-based models;
- Tree health and wind direction covariates were added to the vegetation models; and
- Significant efforts were made to improve asset, ignitions, and outage data quality.

Table PG&E-B.1.1-1 below provides a visual summary of the improvements to the Distribution Event Probability Model over the past five years. An 'x' indicates a specific feature was not included in a particular version of the model, while a check mark indicates that feature was included.

TABLE PG&E-B.1.1-1:
DISTRIBUTION EVENT PROBABILITY MODEL IMPROVEMENTS

Feature	v1 (2019)	v2 (2021)	v3 (2022)	v4 (2023)
Service Scope	HFTD Tier 2/3	HFTD Tier 2/3	Service Territory	Service Territory
GIS Vintage	2018	2018v/2020c	January 2022	January 2023
Ignitions Event Domain	2015 – 2018	2015 – 2019	2015 – 2020	2015 – 2022
Failures Event Domain	n/a	n/a	2015 – 2021	2015 – 2022
Circuit Segment Aggregation	x	x	Mean Pixel	Risk per Line Mile
Model Compositing	x	x	✓	✓
Asset Models				
Primary Conductor	Pixel-based	Pixel-based	Pixel-based	Asset-based
Secondary Conductor	x	x	Pixel-based	Pixel-based
Support Structure	x	x	Pixel-based	Asset-based
Transformer	x	x	Pixel-based	Asset-based
Voltage Control	x	x	Pixel-based	Asset-based
Capacitor Bank	x	x	x	Asset-based
Switch	x	x	x	Asset-based
DPD	x	x	x	Asset-based
Fuse	x	x	x	Asset-based
Vegetation Models	Pixel-based	Pixel-based	Pixel-based	Pixel-based
LiDAR Data	x	x	✓	✓
with Tree Canopy Density	x	x	x	✓
Tree Health	x	x	x	✓
Wind Direction	x	x	x	✓
Animal Models	x	x	Pixel-based	Pixel-based
Third Party Models	x	x	Pixel-based	Pixel-based

Performance of the Event Probability Models is ultimately measured through the predictive capability of the Probability of Ignition Model, which uses the results of the Probability of Outage Models as inputs. Most models provided very strong predictive performance using metrics for Area Under the Curve (AUC) and Concentration Factors, which can be seen in the Table PG&E-B.1.1-2 below. AUC is a measure of model predictive that ranges from 0 to 1 where a value of 1.0 is perfect prediction and 0.5 is no better than a random guess. Within this range, AUC scores of 0.70 to 0.80 are good, 0.8 to 0.9 are excellent, and scores over 0.9 represent near-perfect predictions. As models are for insights in developing workplans, models with improved predictive performance should be followed more closely than those with lower predictive performance. In many cases model performance can be improved in the future by

identifying and preparing key data sets that will better characterize failure modes. Table PG&E-B.1.1-2 below depicts the model's performance for specific categories of events.

TABLE PG&E-B.1.1-2:
EVENT PROBABILITY MODEL PREDICTIVE PERFORMANCE

Event Probability Model	Mean Annual Wildfire Season Ignitions (2015-2022)	Ignitions per Outage	p(i) Prediction AUC	p(i) Top 20% Concentration Factor
Animal – Squirrel	8.5	1.14%	0.85	3.9
Support Structure – Electrical	131.2	19.75%	0.85	3.7
Transformer Leaking	0.2	0.13%	0.85	5.0
Vegetation – Trunk	58.3	7.11%	0.83	3.5
Vegetation – Branch	71.2	5.50%	0.82	3.4
3rd Party – Balloon	20.0	4.96%	0.82	3.4
Vegetation – Other Cause	37.2	10.82%	0.77	2.7
Primary Conductor – Line Slap	6.5	4.11%	0.76	3.3
Animal – Other Cause	17.5	8.13%	0.76	2.9
Transformer Equipment	48.3	2.03%	0.75	3.5
Secondary Conductor	36.8	6.66%	0.73	2.6
Voltage Regulator Equipment	4.8	10.14%	0.72	2.0
3rd Party – Vehicle	50.5	3.63%	0.71	2.2
Primary Conductor – Other Cause	31.2	9.29%	0.71	2.5
Animal – Bird	42.8	4.73%	0.68	2.2
Fuse Equipment	40.8	5.47%	0.68	2.1
3rd Party – Other Cause	24.5	5.29%	0.67	2.1
Support Structure – Equipment	34.2	4.61%	0.65	2.0
Other Equipment	33.5	0.37%	0.65	2.0
Primary Conductor – Wire Down	91.8	10.27%	0.64	1.8
Switch Equipment	9.8	7.49%	0.61	1.7
Capacitor Bank Equipment	20.7	33.79%	0.55	1.4
DPD Equipment	11.7	11.22%	0.47	1.5

Wildfire Consequence Model

There were several important changes for v4 of the Wildfire Consequence Model. Significant efforts were made to:

- Improve the quality of historic fire data and expand the number of historical fires used for calibrating the Consequence model;

- Use an expanded set of asset locations as well as all known historical fire locations for fire simulations provided by Technosylva;
- Increase fire simulation times from eight to 24 hours;
- Introduce an assessment of dry wind conditions for predicting areas of high consequence; and
- Add impacts for Egress and Suppression to the Consequence value.

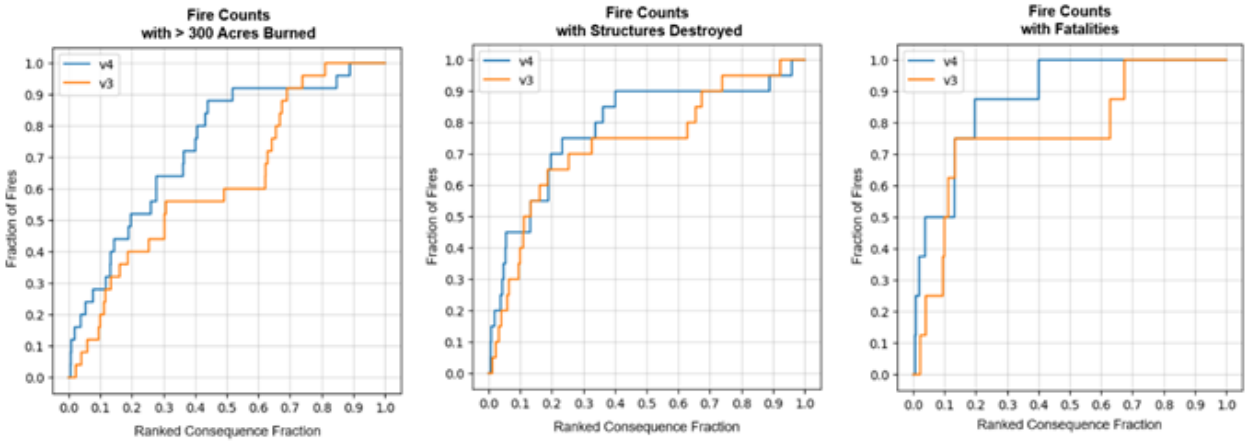
Table PG&E-B.1.1-3 below provides a visual summary of the improvements to the Wildfire Consequence Model over the past five years. Check marks indicate where a specific feature was included in a version of the model.

TABLE PG&E-B.1.1-3:
SUMMARY OF IMPROVEMENTS TO THE WILDFIRE CONSEQUENCE MODEL

Feature	v1 (2019)	v2 (2021)	v3.4 (2022)	v4 (2023)
Service Scope	HFTD Tier 2/3	HFTD Tier 2/3	Service Territory	Service Territory
GIS Vintage	July 2016	April 2019	January 2022	January 2023
Fuels	2012 LANDFIRE	2020 Fuels Snapshot	2030 Forecast Growth	2030 Forecast Growth
Fire Simulation	6 hours	8 hours	8 hours	24 hours
Historical Fire Locations	No	No	Nearest Asset	At Ignition Location
Model Formulation				
REAX, Vol. & Struct.	✓	x	x	x
Fire Burn Index (FBI)	x	✓	x	x
Acres Burned	x	✓	x	x
Fire Potential Index (FPI)	x	x	✓	✓
Flame Length	x	x	✓	✓
Rate of Spread	x	x	✓	✓
Dry Wind Conditions	x	x	x	✓
Egress Impact	x	x	x	✓
Suppression Impact	x	x	x	✓

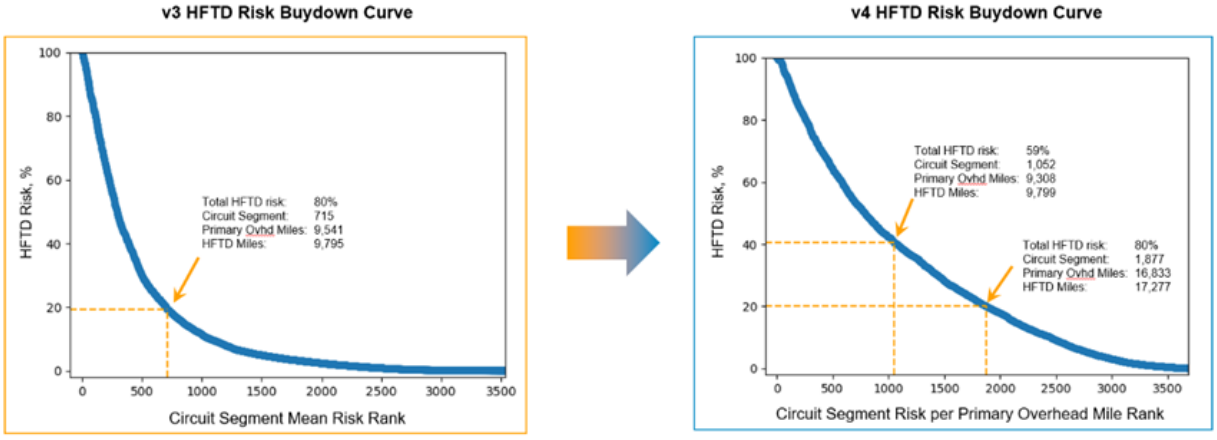
Wildfire Consequence model performance is judged by how well the model accounts for historical fires from three perspectives: (1) large fires (over 300 acres burned); (2) fires that destroyed structures; and (3) fires with fatalities. Wildfire Consequence v4 improved its performance over that of v3 in all three categories, as can be seen from the three graphs in Figure PG&E-B.1.1-2 below.

FIGURE PG&E-B.1.1-2:
WILDFIRE CONSEQUENCE MODEL PERFORMANCE IMPROVEMENT



Improvements implemented for WDRM v4 through the Distribution Event Probability and the Wildfire Consequence models have refined our understanding of how wildfires are initiated and their likelihood of becoming catastrophic. WDRM v4 features a broader distribution of wildfire risk than v3, resulting in a flatter risk buydown curve in Figure PG&E-B.1.1-3 below.

FIGURE PG&E-B.1.1-3:
RISK BUYDOWN CURVE COMPARISON BETWEEN WDRM V3 AND V4



As a result of model improvements, and the subsequent flattening of the risk buydown curve, WDRM v4 shifts individual risk rankings relative to v3. While the change in ranking will impact the order of future mitigation work, projects that have been scoped

and initiated on prior modes will not be rescoped based on the v4 model. Going forward, as the WDRM v4 is applied in the development of future workplans throughout 2025, the resulting changes will be reported in the 2026-2028 WMP.

B.1.2. WTRM v2

The WTRM is used to inform our risk-prioritized workplans for certain types of transmission inspections to target work and programs that will provide the greatest risk reduction for our customers. Beginning in 2024 and throughout 2025, as the WTRM v2 is applied in the development of future transmission workplans, the resulting changes will be reported in the 2026-2028 WMP.

Justification for Updates

WTRM version 2 (WTRM v2) underwent a series of updates as compared to version 1 (WTRM v1).[10] The three main objectives of these updates were to:

1) Add areas of WF Risk that were not included in WTRM v1;

2) Implement feedback from T-Line Asset Strategy and Applied Technology Services (ATS); and

3) Refine model functionality to improve model accuracy.

Updated Methodology and Models

New Hazard Models

WTRM v2 includes the risk of wildfires from contact with vegetation and birds. We achieved this by adding two machine learning-based hazard models to WTRM to address “Veg Hazard” and “Avian Hazard.”

The Veg Hazard model is trained on transmission line outages attributed to contact with vegetation from the years 2015 to 2022. The model also uses as input the: (1) location, dimensions, and species of trees that are likely to come in contact with a PG&E asset (strike trees); and (2) weather data such as daily average temperature, precipitation, and vapor pressure deficit. Figure PG&E-B.1.2-1 below depicts the most important categories of hazards, as identified by the model. The performance score of the model shows an area under the receiver operating characteristic curve (AUC) value of 0.92. A high AUC value, like this one, indicates that the model is very good at isolating areas of high vegetation risk and low vegetation risk. AUC is a measure of model predictive that ranges from 0 to 1 where a value of 1.0 is perfect prediction and 0.5 is no better than a random guess. Within this range, AUC scores of 0.70 to 0.80 are good, 0.8 to 0.9 are excellent, and scores over 0.9 represent near-perfect predictions.

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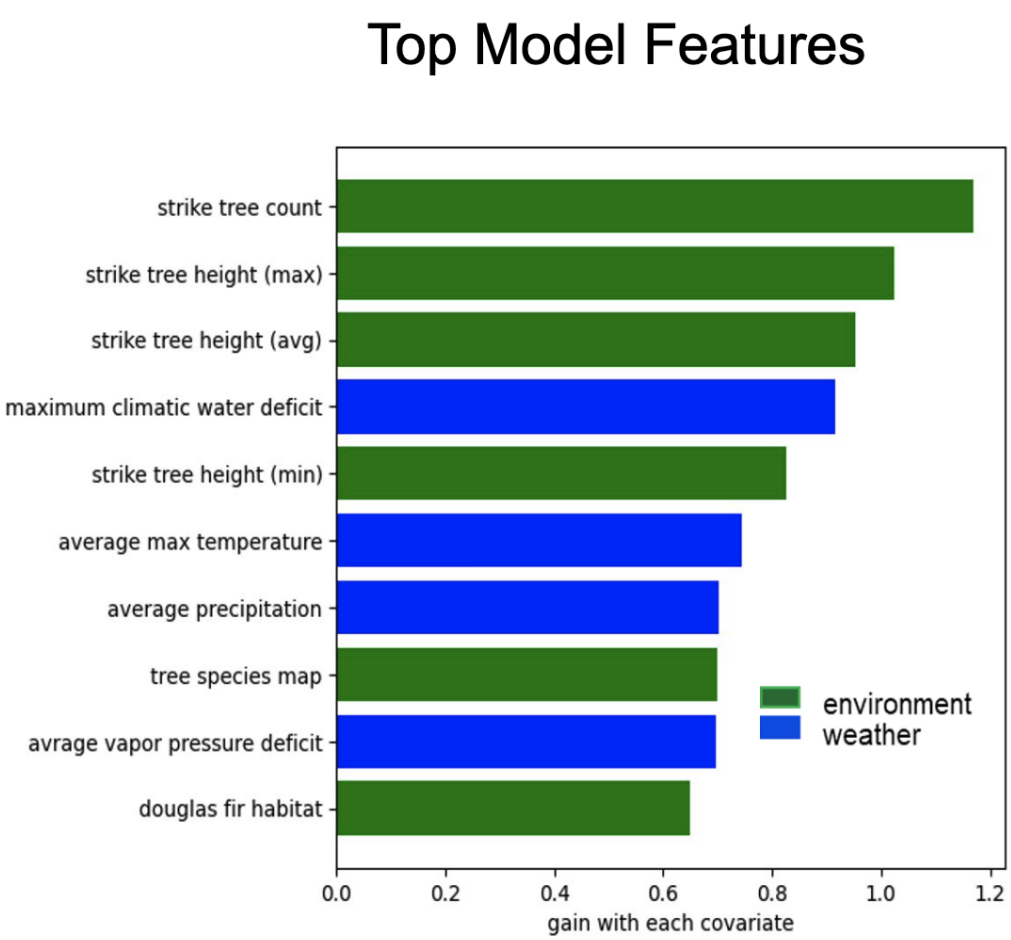
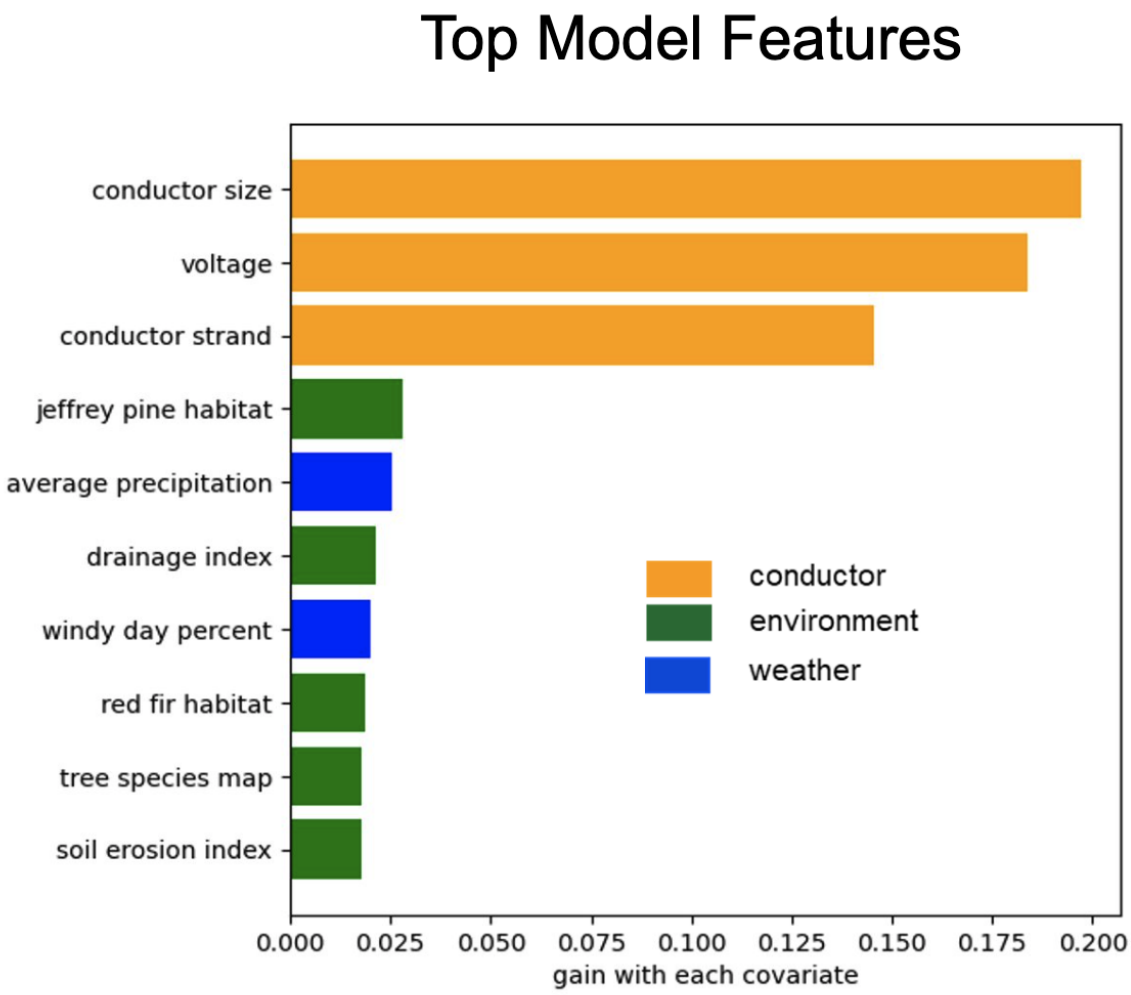
[10] For specifics on WTRM v1, please see PG&E 2023-2025 WMP, R4, pp. 139-228.

FIGURE PG&E-B.1.2-1:
VEG HAZARD MODEL HAZARD CATEGORIES



The Avian Hazard model is trained on transmission line outages attributed to contact with birds from the years 2015 to 2022. The model also uses as input asset characteristics such as conductor dimensions and voltage class of the structure. The categories depicted in Figure PG&E-B.1.2-2 below are the most important features identified by the model. The performance score of the model shows an AUC value of 0.78. Similar to the Veg Hazard model, this high AUC value indicates that the model is very good at isolating areas of high avian risk and low avian risk.

FIGURE PG&E-B.1.2-2:
AVIAN HAZARD MODEL ASSET CHARACTERISTIC CATEGORIES

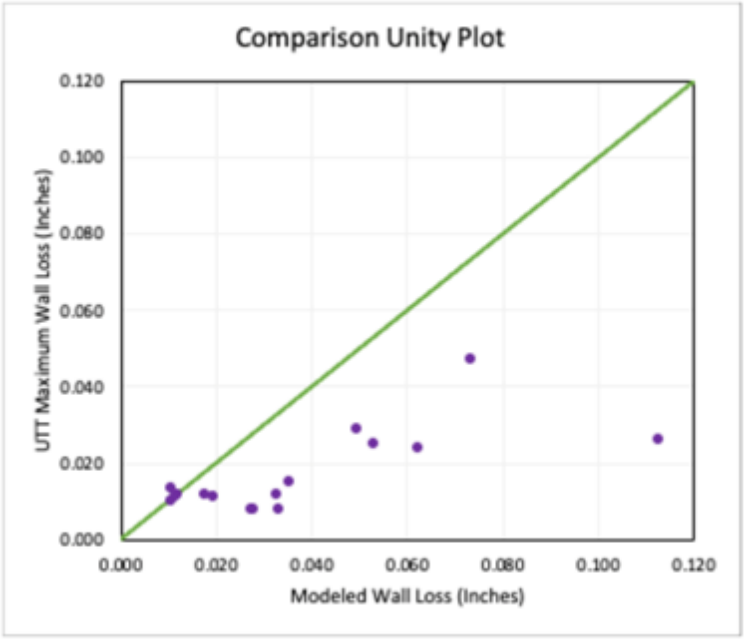


Model Updates Based on Field Testing and Data

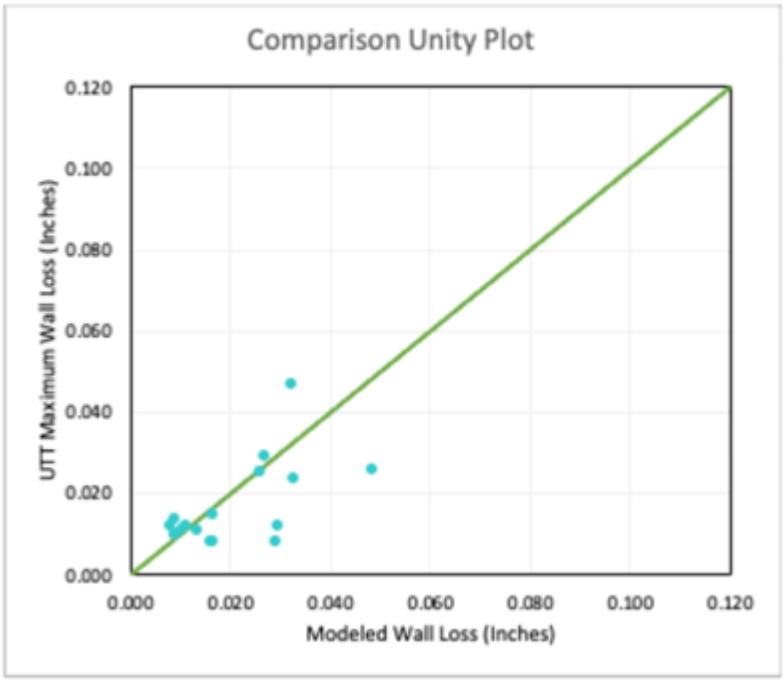
The Atmospheric Corrosion module was updated based on field testing of steel structures conducted by PG&E's ATS group. The field testing, and subsequent review of the results, concluded that version 1 of the model was too conservative with respect to prediction of wall loss compared to field results for tubular steel poles/light duty steel poles. The wall loss calculation was adjusted, resulting in a 36 percent reduction in average error for the new model (modeled wall loss compared to field measurements) as can be seen in Figure PG&E-B.1.2-3 below.

FIGURE PG&E-B.1.2-3:
WALL LOSS ON POLES COMPARISON BETWEEN WTRM V1 AND V2

WTRM V1.0



WTRM V2.0



The Wood Pole module was updated to include the effect of pole reinforcements which was present in WTRM v1, but which resulted in an overconservative estimate of failure rates for reinforced poles. Thus, in the WTRM v2 update, we corrected this overly conservative estimate by applying a remaining strength of 92 percent (equivalent to Condition Code 2) to reinforced poles, in order to provide more accurate results.

Model Refinements

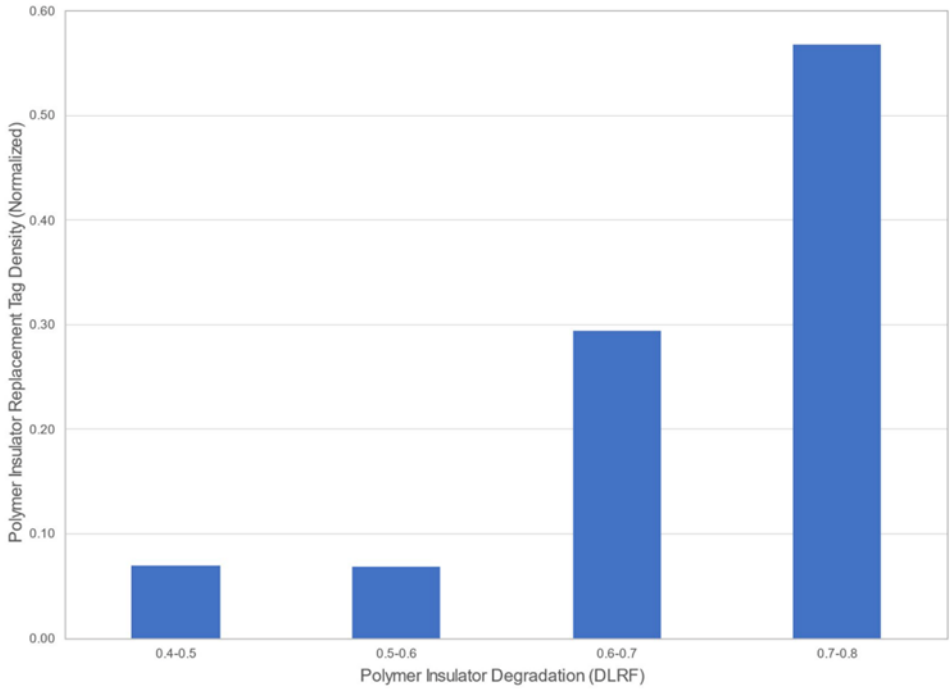
The outage calibration method for wind-caused outages (Bayesian update) used in the WTRM was updated to use a larger pool of outage data to more accurately reflect the nature of outages that impact the transmission line grid. WTRM v1 only used historical outages, labelled as "wind caused" for calibration. Analysis showed a correlation between wind and other outage categories. As a result of this finding, WTRM v2 expanded the pool of outages to include all outages labelled as "wind caused," "equipment," and "unknown." With this expanded pool of outages, as can be seen in Table PG&E-B.1.2-1 below, the model statistically determines the likelihood that a given outage is likely to have been caused by wind. This updated pool of outages is then used to calibrate the model. With this change, the outages considered expanded from approximately 300 to approximately 5,400. This methodology is now less reliant on the potential variability of SME-assigned outage categories and more reliant on historic wind speeds. This result is a more accurate data driven approach to determine the likelihood that an outage was caused by high wind speeds.

TABLE PG&E-B.1.2-1:
OUTAGE CAUSE COMPARISON BETWEEN WTRM V1 AND V2

Outage Cause Category	Count: V1.0	Count: V2.0
Wind	298	298
Equipment Failure	N/A	2,624
Unknown	N/A	2,443
Total	298	5,365

For the Polymers Insulators Degradation model in WTRM V2, the model was updated to more accurately calculate the Design Life Reduction Factor (DLRF) based on where the polymer insulators were located. The resulting DLRF of the updated model was compared to the replacement tags for polymer insulators. The results showed that assets with the highest modeled polymer insulator degradation DLRF were approximately eight times more likely to have polymer insulator replacement tags compared to assets with lowest polymer insulator degradation DLRF, as can be seen in Figure PG&E-B.1.2-4 below.

FIGURE PG&E-B.1.2-4:
DLRF AND REPLACEMENT TAGS COMPARISON



The individual probability models can be composited to represent the combined probabilities of failure for all failure modes at a point in the electric grid. When combined with wildfire consequence to produce wildfire risk, these risk values can be aggregated to the line level to represent the wildfire risk for each transmission line. When viewed on a line weighted basis, the relative average risk of each transmission line can be viewed for insights. It should be noted that these mile weighted values will tend to highlight short lines such as taps.

Redlines to Base 2023-2025 WMP Due to Reportable Changes

Please see the table below for redlines in the 2023-2025 WMP R5 due to the reportable changes discussed in this section.

Section	Table or Figure (if applicable)	Page Number(s)	Description of Redline Changes
Appendix B	Figure PG&E-B-6	1009	Edits to Wildfire consequence calculation procedure schematic
Appendix B	N/A	1012-1013	Edits to the calculation procedure

B.2. Changes to Approved Targets, Objectives, and Expenditures

Each of the updates described below are considered to be changes to targets, objectives, and expenditures from PG&E's approved Base 2023-2025 WMP because they fall under the:

> …lessons learned, internal policy changes, new laws or regulations, corrective actions resulting from Energy Safety's compliance process, or other explanations for change.[11]

The section is discussed in the following two groups:

1) Update to targets per 2025 WMP Update criteria; and

2) Changes to the expenditures.

PG&E does not have any changes to the forecasted initiative objectives as described in the 2025 WMP Update Guidelines.

Table PG&E-B.2-1 below is a summary of the target updates and the reason for the update.

[11] 2025 WMP Update Guidelines, pp. 13-14.

TABLE PG&E-B.2-1:
SUMMARY OF TARGET UPDATES

Target Name	Tracking ID	Justification	2025 WMP Update Criteria Met	2025 WMP Update Section	Base 2023-2025 WMP Section
System Hardening – Distribution	GH-01	Align to 2023 GRC decision	>10% Target Change	Section B.2.1.1.1	Section 8.1.2.1
10K Undergrounding	GH-04	Align to 2023 GRC decision	>10% Target Change	Section B.2.1.1.2	Section 8.1.2.2
Reduce PSPS impacts by ~55 thousand customer events (3.4 percent) for 2023-2025 period by completing planned wildfire mitigation projects including, but not limited to Motorized Switch Operator (MSO) switch replacements and undergrounding	PS-07	Directly linked to GH-04/ align to 2023 GRC decision	>10% Target Change	Section B.2.1.1.3	Section 9.1.5
Provide 12,000 cumulative new or replacement portable batteries to PG&E customers at risk of PSPS or EPSS, focusing on, but not limited to Access and Functional Needs, medical baseline, and self-identified vulnerable populations	PS-06	To account for over-performance in 2023	>10% Target Change	Section B.2.1.2	Section 8.5.3
HFTD/HFRA Open Tag Reduction – Distribution Backlog	GM-03	Response to ACI PG&E-23-12	>10% Target Change	Section B.2.1.3	Section 8.1.7.2
System Hardening – Transmission Conductor Segment Replacement	GH-11	Progress on ACI PG&E-22-14	>10% Target Change	Section B.2.1.4	Section 8.1.2.5.1

B.2.1. Target Changes – Update to Targets Based on 2025 WMP Update Criteria

We are updating six targets based on the 2025 WMP Update criteria. Five target updates described below are considered large volume work (equal to or greater than 100 units) that changed our 2025 target 10 percent or more from the forecasted target in the approved Base 2023-2025 WMP. One new target is considered small volume work (less than 100 units) that meets the 20 percent or greater threshold set out in the 2025 WMP Update Guidelines.

The updates in this section are discussed in the following groups:

1) Aligning system hardening and undergrounding programs with the GRC decision;

2) Update to PS-06: Update Portable Battery targets to account for 2023 performance;

3) Update to GM-03: Update the Distribution Backlog tags target in response to ACI PG&E-23-12; and

4) New target addition for 2025.

B.2.1.1 Aligning System Hardening and Undergrounding Programs With the GRC Decision

PG&E proposes a necessary change to align with the CPUC's decision on PG&E's 2023 GRC. This change will update the circuit miles and risk impact of our distribution system hardening program in 2025.[12] This adjustment is required to align PG&E's WMP with the system hardening and undergrounding mileage targets, risk reduction targets, and associated cost recovery amounts authorized in PG&E's final 2023 GRC decision.[13] All three targets in this section meet the 10 percent update threshold for large volume targets in accordance with 2025 WMP Update Guidelines.

For both the covered conductor and undergrounding programs, the updated miles for 2025 are based on PG&E's current business planning estimates. For target PS-07, the target is based on the work to be completed in our undergrounding program (target GH-04) and must necessarily change when target GH-04 changes.

This change is part of a larger update that PG&E is making to our 2023-2026 system hardening and undergrounding workplan to align to the GRC requirements. The projects included in the revised workplan will align with the GRC requirements regarding the increased number of overhead circuit miles (738) and the decreased number of underground circuit miles (1,230). In addition, the revised workplan will be designed to achieve the 18 percent risk reduction that PG&E projected for the full 2,000 underground circuit miles that PG&E requested in our 2023 WMP for the 2023-2026 GRC period.

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[12] This also aligns with the changes proposed in PG&E's 2024 Change Order.

[13] D.23-11-069 (November 17, 2023).

By the time of the GRC approval in November 2023, PG&E had already completed the vast majority of work for 2023 projects and significant project development work on 2024 projects. In response to the GRC Decision, PG&E is significantly updating our 2025 and 2026 workplans to achieve the requirements adopted in the final GRC decision.

B.2.1.1.1. GH-01: Covered Conductor Installation – Distribution (Section 8.1.2.1)

Given the level of funding provided in the final GRC decision, PG&E must align the overhead hardening covered conductor program and the associated GH-01 target with the GRC decision by reducing the number of planned system hardening circuit miles in 2025 from 580 miles to 520 miles.[14] This will necessitate a further change to target GH-01, reducing the forecasted wildfire risk impact in 2025 from approximately 5 percent to approximately 4.7 percent. In order to achieve the GRC cumulative risk reduction requirement of 18 percent by 2026, the 2025-2026 workplan (projects identified for execution within the established mileage targets) is being updated.

This change also reflects that, while PG&E requested $6,389 million in funding for 2,285 miles of undergrounding and overhead covered conductor work (collectively referred to as system hardening miles) from 2023 to 2026, the GRC decision authorized $4,723 million of funding for 1,230 undergrounding miles and 778 overhead miles (2,008 combined miles).[15] Given this lower authorized funding amount, PG&E is revising our 2025 System Hardening workplan, which will result in a reduction of both undergrounding and line removal, while increasing overhead hardening miles.

The change in system hardening miles will result in an overall decrease in the number of distribution miles hardened between 2023 and 2026, as described in our Base 2023-2025 WMP—from 2,285 miles[16] to an estimated 2,008 miles, as outlined in Updated Table PG&E-8.1.2-1 below. The change includes an increase in the number of

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14 PG&E's current list of projects (also referred to as the "workplan") shows more miles than PG&E's 2025 target of 520 miles. The revised risk reduction forecast is based on completing approximately 310 miles of undergrounding, 200 miles of overhead hardening, and 10 miles of line removal. Additional miles are intentionally built into the workplan to account for unforeseen delays to individual projects due to access, weather, permitting, land rights acquisition, materials, or other constraints. The individual projects included in the workplan could change. Risk reduction calculations reported in the WMP are based on PG&E's WDRM, Version 3 (WDRM v3). Note that risk reduction amounts reported through the GRC consider the percentage of total wildfire risk mitigated by each project from either WDRM v2 or WDRM v3, depending on which risk model was used to select the project, so the risk reduction percentages in the WMP and GRC are similar but not the same.

15 See D.23-11-069, p. 273. D.23-11-069 notes that the approved amount of $4,723 million is $1,720 million less than PG&E's original proposal, which assumes an original forecast of $6,443 million. The correct forecast is $6,390 million. The difference is due to an error in the forecast for overhead covered conductor. The forecast for covered conductor—on page 271, Figure D, in D.23-11-069—is $517 million, whereas the correct forecast is $464 million (see PG&E's GRC Reply Brief, Table 4-12). With this correction, the correct forecast amount is $5,926 million + $464 million, or $6,390 million total.

16 See PG&E 2023-2025 WMP, R4, Table PG&E-8.1.2-1, p. 399.

overhead hardened miles from 360[17] to 778 miles,[18] and a reduction in the number of undergrounding miles from 2,000[19] to 1,230 miles. While the current WMP is focused on PG&E's WMPs from 2023 through 2025, PG&E consistently provided information about our system hardening plans from 2023 through 2026 at Energy Safety's request.

UPDATED TABLE PG&E-8.1.2-1:
OVERALL SYSTEM HARDENING MILEAGE FORECAST

Year	Estimated Overhead Covered Conductor Miles	Estimated Line Removal Miles	Estimated System Hardening Undergrounding Miles	Overall System Hardening Target	Estimated Butte County Rebuild Undergrounding Miles
2023	110	30	280	420	70
2024[(a)]	60	10	210	280	40
2025	200	10	310	520	20
2026	348	10	430	788	10
Total[(b,c)]	718	60	1,230	2,008	140

(a) This chart reflects the approved 2024 Change Order.
(b) The 2023 WMP requires annual targets for 2023-2025. The 2026 miles are provided as a forecast only.
(c) PG&E's reference to 778 overhead hardened miles includes both covered conductor and line removal miles.

B.2.1.1.2. GH-04: Undergrounding of Electric Lines and/or Equipment-Distribution (Section 8.1.2.2)

PG&E must also align target GH-04 with the final GRC decision by reducing the number of underground circuit miles from 550 circuit miles in 2025 to 330 circuit miles. This will require a further change to target GH-04 by reducing the forecasted wildfire risk impact in 2025 from approximately 5 percent to approximately 3.5 percent, and also reducing the PSPS risk impact mitigation from 22,000 customer events to 13,000 customer events (see Section B.2.1.1.3 below for an update to target PS-07).

This change reflects the fact that, while PG&E requested $5,926 million[20] in funding for 2,000 miles of system hardening undergrounding work from 2023-2026 to achieve the

17 This number includes 285 overhead covered conductor miles plus 75 line removal miles. See PG&E 2023-2025 WMP, R4, Table PG&E-8.1.2-1, p. 399.

18 The estimated Line Removal miles included in the forecast are associated with the overhead hardening milage estimate from the GRC D.23-11-069 target of 778 miles. As described in PG&E 2023-2025 WMP, R4, p. 453, there is greater uncertainty of the number of Line Removal miles that will contribute to the System Hardening portfolio, as these mitigations are used only when the opportunity presents itself to remove these miles when service is no longer needed.

19 This number includes System Hardening Undergrounding and Line Removal. See PG&E 2023-2025 WMP, R4, Table PG&E-8.1.2-1, p. 399.

20 D.23-11-069, Figure D, p. 271.

originally planned 18 percent risk reduction, the GRC decision authorized $3,674 million[21] to complete 1,230 miles of system hardening undergrounding work.[22]

In response to the lower authorized funding amount, PG&E is reducing the total number of undergrounding miles, while increasing the total number of miles of overhead hardening from 2023 to 2026, as discussed in relation to target GH-01 above. A breakdown of the 1,230 miles of system hardening undergrounding work targeted is provided in Updated Table PG&E-8.1.2-2 below.

UPDATED TABLE PG&E-8.1.2-2:
PG&E UNDERGROUNDING MILEAGE FORECAST

Year	Estimated System Hardening Undergrounding Miles	Estimated Butte County Rebuild Miles	Total Annual Underground Miles Target
2023[(a)]	280	70	350
2024[(b)]	210	40	250
2025	310	20	330
2026[(c)]	430[(c)]	10[(c)]	440[(c)]
2023-2025 Total	800	130	930
2023-2026[(c)] Total	1,230	140	1,370

(a) Miles provided for 2023 represent the updated estimated mileage associated with each sub-program. The overall system hardening target miles remains the same (420 miles).

(b) This estimate assumes that the target changes requested in the 2024 Change Order will be approved.

(c) Please note that the 2023-2025 Base WMP only requires annual targets for 2023-2025. The 2026 miles are provided here as a forecast only.

PG&E is currently refining our workplans for both overhead hardening and undergrounding projects through the end of the GRC period (2026) to account for the direction provided in D.23-11-069. As we update the workplan, we continue the approach described in the Base 2023-2025 WMP of intentionally building additional miles into the workplan to account for unforeseen delays to individual projects, such as: property access, weather, permitting, land rights acquisition, materials, or other constraints. Thus, some of the projects included in this workplan may not be completed in the 2023-2026 timeframe. Generally, PG&E will continue working on these projects until they can be completed. Finally, additional projects may be identified and added to the workplan going forward for potential completion between 2023 and 2026.

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21 D.23-11-069, Conclusions of Law 92, p. 863.

22 The GRC final decision confirmed that undergrounding work associated with the Butte Community rebuild should seek cost recovery through the Catastrophic Event Memorandum Account and therefore the associated budget is not included here; however, these miles remain associated with WMP Undergrounding target GH-04.

B.2.1.1.3. PS-07: Reduce PSPS Impacts to Customers (Section 9.1.5)

As stated above, PG&E must also update target PS-07 in alignment with the change made to GH-04. The 2023-2025 targeted number of customer events being mitigated from PSPS events is directly tied to the number of miles of undergrounding completed and Motorized Switch Operator (MSO) devices replaced. The decrease in 2025 targeted undergrounding miles will result in a reduction of the number of customer events mitigated from 22,000 to 13,000. As a result, during the 2023 to 2025 period, the cumulative customer events mitigated are being adjusted from approximately 55,000 customer events to approximately 38,000 customer events.[23]

While the number of PSPS customer events mitigated for 2025 will decrease due to the final GRC decision, PG&E will continue to advance other existing mitigation measures to help reduce the impact of PSPS events on customers.

The Base 2023-2025 WMP target for PS-07 was calculated using the 2,100 miles of undergrounding that was submitted for the 2023-2026 GRC period, which is 770 miles more than what the CPUC ultimately approved in the final GRC decision. PG&E must adjust the number of customer events mitigated through the undergrounding program to account for this overall reduction in authorized miles. Thus, the number of undergrounding miles for 2025 is being adjusted from 550 miles to 330 miles. This 40 percent decrease in underground miles corresponds to the proposed 40 percent decrease in PS-07's targeted customer events reduced. No adjustments will be made to the customer events mitigated through MSO devices replacements since there is no MSO planned work for 2025.[24]

B.2.1.2. Update to PS-06: Provide 12,000 Cumulative New or Replacement Portable and Permanent Batteries (Section 8.5.3)

PG&E seeks to update the 2025 annual target to account for outperforming our target in 2023. This proposed update meets the 10 percent update threshold for large volume targets in accordance with 2025 WMP Update Guidelines.

We are revising the 2025 target for this program from 4,000 units to 3,300 units to align with our 3-year strategy for this work. We remain committed to cumulatively provide 12,000 batteries over the 3-year period, as stated in our Base 2023-2025 WMP. In 2023, we completed 700 units more than the annual target; therefore, we are reducing the 2025 target by these 700 units Table PG&E-B.2.1.2-1 below illustrates the shift in annual target units between 2023 and 2025.

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23 The approximate cumulative customer events of 38,000 assumes approval of 9,980 from the 2024 Change Order, and 13,000 from the 2025 update.

24 The calculation methodology for PS-07 to determine customers mitigated remains the same.

TABLE PG&E-B.2.1.2-1:
PS-06 TARGET CHANGE IN 2025

	2023	2024	2025	Cumulative
Original Target	4,000	4,000	4,000	12,000
2023 Actuals & Updated Target	4,700[(a)]	4,000	3,300[(b)]	12,000
Change from Original to Update	700	–	(700)	–

(a) In 2023, PG&E out-performed its annual target.
(b) PG&E's commitment to provide 12,000 batteries cumulatively over the 3-year period results in a decrease of 700 in 2025.

B.2.1.3. Update to GM-03: Distribution Backlog Tags Target in Response to ACI PG&E-23-12 (Section 8.1.7.2)

PG&E revised the target for distribution backlog tags, GM-03, in response to Energy Safety's direction in ACI PG&E-23-12. We updated the target in GM-03 for 2025 from 55,000 units to 63,747 units. The proposed update meets the 10 percent update threshold for large volume targets in accordance with the 2025 WMP Update Guidelines. For additional information regarding the distribution backlog tags, see PG&E's response to ACI PG&E-23-12.

B.2.1.4. New Target Addition for 2025

GH-11: Traditional Overhead Hardening – Transmission Conductor (Section 8.1.2.5.1)

PG&E proposes to add a 2025 target (System Hardening – Transmission Conductor Segment Replacement (GH-11)) to perform conductor segment replacement on two transmission lines. We were able to accelerate our conductor segment replacement work, which was forecasted in the Base 2023-2025 WMP to "not have work completed until after 2025," and can introduce it as a new target for 2025.[25] Conductor segments are defined as single or multiple, consecutive conductor spans. Typically, this will be from one dead-end structure to another dead-end structure.

A transmission line may consist of different conductor types installed at different times, with exposure to localized threats (i.e., aeolian vibration from low velocity, persistent wind) and hazards (i.e., high gusty winds). This may result in certain conductor segments having significantly higher risks compared to the rest of the line. This program aims to cost-effectively reduce risk for a line by replacing higher-risk conductor segments without rebuilding the entire line. Assessment will be done to confirm that the supporting structures are in good condition and that there is no electrical capacity need to increase the conductor size. Conductor segment risk is assessed with the WTRM v2. The acceleration of the program, and creation of a new target, also continues to address ACI PG&E-22-14, which sought improvements related to "Decreased

[25] See PG&E 2023-2025 WMP, R4, p. 437.

Transmission Hardening Targets," and will further demonstrate progress in this area in 2025.[26]

Redlines to Base 2023-2025 WMP Due to Reportable Changes

Please see the table below for redlines in the 2023-2025 WMP R5 due to the reportable changes discussed in this section.

26 See PG&E 2023-2025 WMP, R4, p. 1066.

Section	Table or Figure (if applicable)	Page Number(s)	Description of Redline Changes
1.2 Summary of the 2023-2025 Base WMP	N/A	10-11	Edits to total number of initiative targets and objectives and applicable initiative summary
7.2.1 Overview of Mitigation Initiatives and Activities	Revised Table 7-3-2	271, 280-283, 333-348	Edits to targets GH-01, GH-04, PS-06, PS-07, GM-03, GH-11 and applicable narrative to reflect target changes
8.1.1.2 Targets	Revised Table 8-3	379-382, 390, 393	Edits to targets GH-01, GH-04, GH-11, GM-03 to reflect changes
8.1.2.1 Covered Conductor Installation - Distribution	N/A	400-403	Edits to narrative to reflect GH-01 target changes
8.1.2.2 Undergrounding of Electric Lines and/or Equipment – Distribution	N/A	404-436	Edits to narrative to reflect GH-04 target changes
8.1.2.5.1 Traditional Overhead Hardening – Transmission Conductor	N/A	441-442	Edits to narrative to reflect GH-11 target changes
8.1.2.9.2 Line Removal (in the HFTD) – Distribution	Table PG&E-8.1.2-4	460	Edits to align with GH-01 target changes
8.1.7.2 Open Work Orders – Distribution Tags	Table RN-PG&E-23-04-2	538-565	Edits to narrative to reflect GM-03 target changes
8.5.3 Engagement With Access and Functional Needs Populations	N/A	902, 906	Edits to narrative to reflect PS-06 target changes
9.1.4 Targets	Table PG&E-9-5	926	Edits to targets PS-06 and PS-07 to reflect target changes
9.1.5 Performance Metrics Identified by the Electric Corporation	N/A	927-928	Edits to narrative to reflect PS-07 target changes
Appendix D ACI PG&E-22-35 Quantify Mitigation Benefits of Reducing PSPS Scale, Scope, and Frequency	Table PG&E-22-35-1	1140-1142	Edits to align with PS-07 target changes

B.2.2. Expenditure Updates

Since filing our Base 2023-2025 WMP, PG&E updated our planned expenditures in response to the GRC, Energy Safety's Revision Notice, ACIs, and changes in priority within activity areas. Section B.2.2.1 below provides a comparison of the updated 2025 expenditure forecast for each category and activity compared to the original forecast provided in the Base 2023-2025 WMP and subsequent Quarterly Data Reports. The updates shown in this section meet the criteria set forth in the 2025 WMP Update Guidelines of a change greater than 20 percent and more than $10 million.[27]

Below are updates to our 2025 expenditure forecast based on changes identified at the time of filing. As of April 2024, PG&E has not completed its 2025 budgeting process and further changes to our forecasts may be identified. We are providing Energy Safety with seven updates to activities outlined in Section B.2.2.1 with explanations for these updates provided in Section B.2.2.2 below.

[27] 2025 WMP Update Guidelines, p. 14.

B.2.2.1 Table of Expenditure Changes

WMP Initiative Category	WMP Initiative Activity	Variance Explanation Group	2025 Original CAPEX	2025 Updated CAPEX[(a)]	2025 CAPEX Variance	2025 Original OPEX	2025 Updated OPEX[(a)]	2025 OPEX Variance
Grid Design, Operations, and Maintenance	Covered conductor installation	B.2.2.2.1. Covered Conductor Installation & Undergrounding	41,432	241,639	200,206	–	–	–
Grid Design, Operations, and Maintenance	Undergrounding of electric lines and/or equipment	B.2.2.2.1. Covered Conductor Installation & Undergrounding	1,878,931	1,228,853	(650,078)	–	–	–
Grid Design, Operations, and Maintenance	Traditional overhead hardening	B.2.2.2.2 Traditional Overhead Hardening	20,469	66,538	46,069	–	–	–
Grid Design, Operations, and Maintenance	Quality assurance/ quality control	B.2.2.2.3. Quality Control & Quality Assurance	–	–	–	11,306	30,641	19,335
Grid Design, Operations, and Maintenance	Equipment Settings to Reduce Wildfire Risk (Grid Ops)	B.2.2.2.4. Equipment Settings to Reduce Wildfire Risk (Grid Ops)	35,708	71,879	36,170	141,555	121,892	(19,662)
Vegetation Management and Inspection	Vegetation Inspections – Transmission	B.2.2.2.5. Vegetation Inspections – Transmission	–	–	–	32,891	87,554	54,664
Vegetation Management and Inspection	Fall-in mitigation	B.2.2.2.6 Fall-in mitigation	–	–	–	148,910	305,083	156,173

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(a) Updates provided for PG&E's 2025 expenditure forecast are based on changes identified at the time of filing that meet the criteria for an update under guidelines. As of the time of this filing on April 2, 2024, PG&E has not completed its 2025 budgeting process and further changes to our forecasts could potentially be necessary.

B.2.2.2. Expenditure Variance Explanations

B.2.2.2.1. Covered Conductor Installation and Undergrounding

PG&E updated its expenditure forecasts for Covered Conductor Installation and Undergrounding initiative activities to align with the CPUC's final decision for PG&E's 2023 GRC. This decision caused significant modifications to our 2025 workplan, which are discussed further in Section B.2.1.1.1. Due to this change in workplan, PG&E provides here the corresponding financial updates, seen in Section B.2.2.1, which increase covered conductor expenditures and decrease undergrounding expenditures.

B.2.2.2.2. Traditional Overhead Hardening

PG&E forecasts a $46.1 million increase in Traditional Overhead Hardening investments driven by: (1) the addition of a new transmission overhead hardening target; and (2) updated project-level forecasts for transmission system hardening projects.

In 2025, PG&E began to execute upon target GH-11 System Hardening – Transmission Conductor Segment Replacement, which is further discussed in Section B.2.1.4. The forecasted costs associated with this work were added to the Traditional Overhead Hardening activity and will be reported in this activity going forward.

PG&E is also updating its 2025 forecast to reflect costs for transmission hardening projects that will begin execution in 2025 but are not expected to be in service by the end of the year. We anticipate including the hardening miles associated with these projects in our commitment for the next WMP period.

B.2.2.2.3. Quality Control and Quality Assurance

PG&E developed our original $11.3 million WMP forecast for asset inspection quality management based on the scope of the program at the time of filing in early 2023. Through the Revision Notice process, PG&E committed to two new targets that specified the scope and performance of our asset inspection quality, GM-01 and GM-09. These targets increased PG&E's financial forecast for this work, which is reflected in its revised 2025 forecast of $30.6 million, an increase of $19.3 million.

B.2.2.2.4. Equipment Settings to Reduce Wildfire Risk (Grid Ops)

PG&E's updated 2025 forecast for EPSS reflects increased investment in sectionalizing devices that provide additional operational capability, reduced customer impact, and reduced operational costs driven by program efficiencies.

The 2025 capital forecast for this activity includes a $36.2 million increase in investment to install additional transmission relays and distribution protective devices. These investments broaden our operational flexibility and allow us to reduce wildfire risk while providing service to our customers.

The 2025 expense forecast reflects an updated understanding of costs and operational efficiencies that PG&E implemented, leading to a $19.7 million forecast reduction. At

the time of the 2023-2025 WMP filing, EPSS was a new program with less than one year of historical data to rely upon. Due to this, our financial forecast at the time was created using high-level conservative estimates. PG&E now has financial data from two years of EPSS implementation which show the costs are lower than originally anticipated.

B.2.2.2.5. Vegetation Inspections – Transmission

PG&E's original forecast for transmission vegetation management—of $32.9 million—reflected the cost of the patrol and inspection of transmission lines and did not include the cost of mitigating the work identified. For consistency and added transparency, we provide here two updates: (1) providing revised patrol and inspection costs; and (2) providing the cost of vegetation management mitigation activities not previously represented.

First, the transmission patrol and inspection forecast has been revised from $32.9 million to $44.8 million. This $11.9 million increase has primarily been driven by inflationary pressure resulting in increased labor and contract costs.

Second, we are also providing a $42.8 million forecast associated with the cost of mitigating trees identified through the inspections and patrols. This forecast is based on the historical costs for transmission tree work and was inadvertently excluded from the previous forecast due to the category being described only as "Inspections."

PG&E provides both of these updates to give Energy Safety a more complete view of transmission vegetation management cost, forecasted to be $87.6 million in total. This view is consistent to how PG&E presented other vegetation management activities, including both the costs of inspection and mitigation.

B.2.2.2.6 Fall-in Mitigation

PG&E's forecast for fall-in mitigation work includes the costs associated with three programs: Tree Removal Inventory (TRI), Vegetation Management for Operational Mitigation, and Focused Tree Inspection (FTI). At the time of filing our 2023-2025 WMP, PG&E had just begun implementing these programs and had only scoped the FTI Program for a pilot. Through the Revision Notice process, PG&E committed to targets for each of these programs, which included the expansion of the FTI Program from the 250-mile pilot to a 1,500 mile-per-year program. The forecasted 2025 cost increase from $148.9 million to $305.1 million is a reflection the expanded scope and increased maturity of these programs.

Redlines to Base 2023-2025 WMP Due to Reportable Changes

Please see the table below for redlines in the 2023-2025 WMP R5 due to the reportable changes discussed in this section.

Section	Table or Figure (if applicable)	Page Number(s)	Description of Redline Changes
4.3 Proposed Expenditures	Table 4-1	73	Edits to update the 2025 planned expenditures reflect the seven changes outlined above with all other expenditure activities remaining the same.

B.3. Quarterly Inspection Targets for 2025

In accordance with 2025 WMP Update Guidelines, Section 3, we are providing quarterly and end-of-year (EOY) targets for 2025 asset and vegetation inspection work, as approved in the Base 2023-2025 WMP. See Table 3-1 below for asset inspection quarterly targets, and Table 3-2 for vegetation inspection quarterly targets.

B.3.1. Asset Inspections

TABLE 3-1:
ASSET INSPECTIONS TARGETS BY QUARTER

Initiative Activity	Tracking ID	Target End of Q2 2025 and Unit	Target End of Q3 2025 and Unit	EOY Target 2025 and Unit	x% Risk Impact 2025
Detailed Inspection Transmission – Ground	AI-02	13,200 transmission structures	22,000 transmission structures	22,000 transmission structures	TBD[(a)]
Detailed Inspection Transmission – Aerial	AI-04	13,000 transmission structures	19,000 transmission structures	19,000 transmission structures	TBD[(a)]
Detailed Inspection Transmission – Climbing	AI-05	900 transmission structures	1,200 transmission structures	1,200 transmission structures	TBD[(a)]
Perform transmission infrared inspections	AI-06	1,000 miles	2,500 miles	3,500 miles	TBD[(a)]
Detailed Ground Inspections – Distribution	AI-07	109,000 distribution poles	190,000 distribution poles	244,000 distribution poles	45% (Eyes-on-Risk)
Supplemental Inspections – Substation Distribution	AI-08	71 distribution substations	78 distribution substations	78 distribution substations	TBD[(a)]
Supplemental Inspections – Substation Transmission	AI-09	38 transmission substations	41 transmission substations	41 transmission substations	TBD[(a)]
Supplemental Inspections – Hydroelectric Substations and Powerhouses	AI-10	37 hydroelectric substations and powerhouses	40 hydroelectric substations and powerhouses	40 hydroelectric substations and powerhouses	TBD[(a)]

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(a) Estimates of the 2025 risk impact for these inspection targets are calculated using workplans that will not be finalized until late-2024. Due to this timing, the risk impact for these targets are shown here as “TBD.”

B.3.2. Vegetation Management Inspections

TABLE 3-2:
VEGETATION INSPECTION TARGETS BY YEAR

Initiative Activity	Tracking ID	Target End of Q2 2025 and Unit	Target End of Q3 2025 and Unit	EOY Target 2025 and Unit	x% Risk Impact 2025
LiDAR Data Collection – Transmission[a]	VM-01	16,000 circuit miles	17,000 circuit miles	17,500 circuit miles	N/A
Pole Clearing Program	VM-02	39,000 distribution poles	52,000 distribution poles	52,000 distribution poles	<1%
Focused Tree Inspections (FTI)[b]	VM-03	300 circuit miles	1,050 circuit miles	1,500 circuit miles	<1%
Tree Removal Inventory (TRI)[c]	VM-04	5,000 trees	17,500 trees	25,000 trees	<1%
Defensible Space Inspections – Distribution Substation	VM-05	124 distribution substations	131 distribution substations	131 distribution substations	53% (Eyes-on-Risk)
Defensible Space Inspections – Transmission Substation	VM-06	49 transmission substations	54 transmission substations	55 transmission substations	22% (Eyes-on-Risk)
Defensible Space Inspections – Hydroelectric Substations and Powerhouses	VM-07	48 hydroelectric substations and powerhouses	59 hydroelectric substations and powerhouses	61 hydroelectric substations and powerhouses	25% (Eyes-on-Risk)
Routine Ground –Transmission	VM-13	16,396 circuit miles	17,738 circuit miles	17,740 circuit miles	100% (Eyes-on-Risk)
Second Patrol – Transmission[d]	VM-14	0 circuit miles	0 circuit miles	5,625 circuit miles	100% HFTD/HFRA (Eyes-on-Risk)
Integrated Vegetation Management – Transmission	VM-15	2,500 acres	5,000 acres	6,504 acres	TBD[g]
Routine Patrol – Distribution[e]	VM-16	31,280 circuit miles	50,830 circuit miles	78,200 circuit miles	<1%

TABLE 3-2:
VEGETATION INSPECTION TARGETS BY YEAR
(CONTINUED)

Initiative Activity	Tracking ID	Target End of Q2 2025 and Unit	Target End of Q3 2025 and Unit	EOY Target 2025 and Unit	x% Risk Impact 2025
Second Patrol – Distribution[(e)]	VM-17	10,274 circuit miles	16,695 circuit miles	25,685 circuit miles	<1%
VM for Operational Mitigations[(f)]	VM-18	3,000 trees	5,000 trees	6,500 trees	TBD[(g)]

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(a) VM-01 LiDAR is flown in late summer and early fall in the prior year to enable ground inspection's next cycle to begin in November. This timing then allows tree work to commence on January 1 of the following year.

(b) VM-03 FTI Program is a new pilot that began in Q2 2023 and stems from the conclusion of the Enhanced Vegetation Management (EVM) Program. Given the program's limited operational experience executing this program, we provide here conservative estimates for rolling, quarterly targets in 2025.

(c) VM-04 TRI Program is a new program stemming from the conclusion of the EVM Program. As indicated in the 2023-2025 WMP, we are still developing our inspection process. Given our limited operational experience executing this program, we provide here conservative estimates for rolling, quarterly targets in 2025. For purposes of target VM-04, the term "Mitigate" is intended to refer to a tree identified from the legacy EVM Program that is either: (1) removed by the TRI program; (2) removed by another PG&E VM program and no longer present; or (3) no longer poses a threat to PG&E facilities because the facilities have been relocated.

(d) The Second Patrol – Transmission target, VM-14, is fully contained in the fourth quarter of 2025 because that is when the LiDAR work takes place in the HFTD areas each year.

(e) The Distribution Routine VM – HFTD targets, VM-16, and VM-17, include audit locations and associated pass rates for distribution second patrols. The second patrol is now managed as part of the overall Distribution Routine VM program.

(f) The VMOM Program, target VM-18, has provided conservative, estimated rolling quarterly targets for 2025 based on our current, best forecasts for this work.

(g) Estimates of the 2025 risk impact for these inspection targets are calculated using workplans that will not be finalized until late-2024. Due to this timing, the risk impact for these targets are shown here as "TBD."

Redlines to Base 2023-2025 WMP Due to Reportable Changes

Please see the table below for redlines in the 2023-2025 WMP R5 due to the reportable changes discussed in this section.

Section	Table or Figure (if Applicable)	Page Number(s)	Description of Redline Changes
8.1.1.2 Targets	Table 8-4	394	Edits to 2025 asset inspection targets to reflect quarterly values
8.2.1.2 Targets	Revised Table 8-15	623-624	Edits to 2025 vegetation inspection targets to reflect quarterly values

B.4. New or Discontinued Programs

PG&E does not have any new or discontinued programs to be included in the 2025 WMP Update.

B.5. Progress on Areas for Continued Improvement

ACI PG&E-23-01 – Cross-Utility Collaboration on Risk Model Development

Description:

Pacific Gas and Electric Company (PG&E) and the other Investor-Owned Utilities (IOU) have participated in past Energy Safety-led Risk Modeling Working Group (RMWG) meetings. The risk model working group meetings facilitate collaboration among the IOUs on complex technical issues related to risk modeling. The RMWG meetings are ongoing.

Required Progress*:*

PG&E and the other IOUs must continue to participate in all Energy Safety-led RMWG meetings.

PG&E Response:

PG&E attended each Energy Safety-led RMWG meeting and will continue to participate in these meetings moving forward.

The Joint Utilities look forward to continued engagement in Energy Safety-sponsored RMWG meetings. These meetings are valuable to discuss technical aspects of wildfire and PSPS risk modeling for planning and operational purposes. They provide a venue for Energy Safety to gather multiple perspectives from various stakeholders, including utilities, state agencies, and intervening parties. These working group meetings also complement similar working groups sponsored by the International Wildfire Risk Mitigation Consortium and the Edison Electric Institute. The Joint Utilities appreciate that Energy Safety revised the cadence and organization of these meetings in 2023, most notably through the development of a schedule of topics for discussion well in advance of each session. These modifications allow the utilities to properly prepare for working group sessions, ensure appropriate subject matter experts (SME) are available, and balance internal resource constraints, particularly during peak wildfire season.

For future workshops, PG&E urges Energy Safety to consider broadening the scope of the topics to include level-setting presentations from utilities that cross over into the areas addressed by the California Public Utilities Commission (CPUC or Commission) Rulemaking to Further Develop a Risk-Based Decision-Making Framework (Rulemaking 20-07-013) and/or the Order Instituting Investigation on the Commission's Own Motion on the Late 2019 Public Safety Power Shutoff (PSPS) Events (Investigation 19-11-013). We also urge Energy Safety to continue to consider the impact of peak wildfire season, and resource constraints in drafting Wildfire Mitigation Plans (WMP), in crafting its RMWG agenda for the following year.

ACI PG&E-23-02 – PSPS and Wildfire Risk Trade-Off Transparency

Description:

PG&E does not provide adequate transparency regarding PSPS and wildfire risk trade-offs, or how it uses risk ranking and risk buy-down to determine risk mitigation selection.

Required Progress*:*

In its 2025 Update, PG&E must describe:

- *How it prioritizes PSPS risk in its risk-based decisions, including trade-offs between wildfire risk and PSPS risk; and*
- *How the rank order of its planned mitigation initiatives compares to the rank order of mitigation initiatives ranked by risk buy-down estimate, along with an explanation for any instances where the order differs.*

PG&E Response:

PG&E appreciates the interest in better understanding the trade-off between wildfires and PSPS events. Given the tremendous risk of wildfire, PG&E implements PSPS events as a mitigation of last resort to reduce the potential for catastrophic wildfires during extreme weather events that could lead to wildfire. However, the use of PSPS events have negative impacts to customers, in the form of de-energization, as well as potential indirect safety impacts resulting from long duration outages.

As part of PG&E's Risk Register, PG&E represents wildfire that includes the use of, as well as the negative impacts from, the use of PSPS and EPSS. In order to represent the trade-off of PSPS events and wildfire, PG&E assesses the effectiveness of a PSPS event as a form of wildfire mitigation and offsets the risk reduction benefits by the negative reliability and indirect safety that the PSPS event causes.

Figure ACI-PG&E-23-02-1 below is a chart that depicts this wildfire with Enhanced Powerline Safety Settings (EPSS) and PSPS trade-off.[28] While the results depicted in the figure are still preliminary and may be updated in the upcoming 2024 RAMP filing, the general information presented is relevant to understanding the wildfire/PSPS risk trade-off.

This waterfall chart can be explained by the following definitions:

- Wildfire (pre-EPSS/PSPS): The inherent wildfire risk based on the data from 2017 to 2022, absent of the use of PSPS and EPSS operational mitigations. This captures ignitions that would occur if EPSS and PSPS ignitions were not deployed.

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28 This chart was presented at PG&E's February 7, 2024 Pre Risk Assessment and Mitigation Phase (RAMP) Filing CPUC Workshop.

This represents the inherent risk of PSPS on the system; the risk that permanent system resilient mitigations would help permanently drive down.

- Wildfire Mitigation (EPSS/PSPS): The wildfire risk reduction benefits that EPSS and PSPS operational mitigations provide.

- Wildfire (post-EPSS/PSPS): The residual wildfire risk after utilizing EPSS and PSPS. This figure represents a substantially lower risk that PG&E and its customers bear, however, is not permanent.

- PSPS Consequence: The customer impact of PSPS. PG&E performs a lookback against historical weather events with its current PSPS protocols to examine the number of PSPS events, the customer scope, and the duration of de-energization given such weather events. Based on the customer minutes interrupted, PG&E calculates the reliability impact, as well as the indirect safety impact of a long duration outage, in the form of a risk score.[29]

- EPSS Consequence: The customer impact of EPSS. PG&E performs a lookback against historical outages with its current EPSS activation protocols to examine the number of outages that, if they occurred at the present time, would become an EPSS outage. Generally speaking, the size of the outage in the form of customer minutes interrupted is expected to be larger and would not exist if not for the use of EPSS. PG&E calculates the reliability impact, as well as the indirect safety impact of a long duration outage, in the form of a risk score.

- Wildfire + EPSS + PSPS: This represents the net impact of wildfire with the implementation of EPSS and PSPS, net of the negative impact of EPSS and PSPS consequence.

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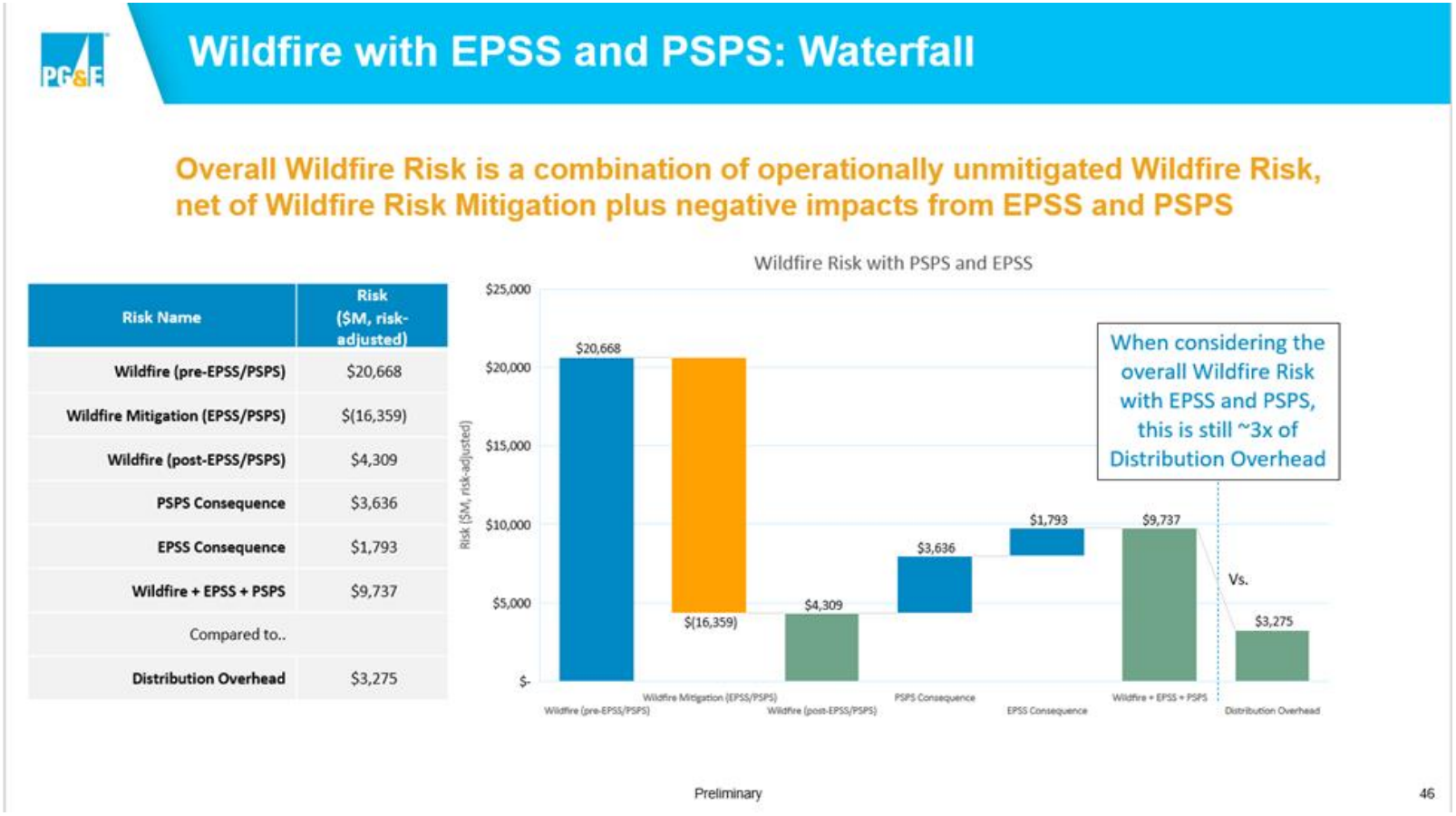
29 See https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/safety-policy-division/meeting-documents/pge-ramp-prefiling-workshop-slide-deck020724.pdf, February 7, 2024, p. 17.

FIGURE ACI-PG&E-23-02-1:
WILDFIRE WITH EPSS AND PSPS TRADE OFF



Note: This presentation is from PG&E's February 7, 2024 Pre-RAMP CPUC Workshop filing. The information contained is preliminary and subject to future updates.

Based on the above analysis, we strongly believe that the data demonstrates that the program level trade-offs between wildfire mitigation and PSPS event impact are reasonable.

Recognizing that no single model can perfectly quantify all risks with the electrical system, PG&E uses multiple models to review and prioritize wildfire mitigation measures. For many of the mitigation programs, wildfire risk is the primary driver of prioritization. This is true of our inspections risk-informed approach, the tag backlog strategy, and a portion of the Vegetation Management mitigation activities.

In addition to wildfire risk, PSPS risk is utilized as an input to an overall risk informed approach for our system hardening and undergrounding program. PG&E prioritizes PSPS risk, along with wildfire risk, when looking at its overall undergrounding approach, as outlined in our draft Wildfire Benefit Cost Analysis (WBCA). The WBCA will be used as we begin to implement the requirements of Senate Bill (SB) 884. Included below are some basic calculations of the WBCA that show the related nature of PSPS risk and Wildfire Risk.

WBCA is calculated as:

$WBCA_m = (\text{Net Cost})_m = \text{Costs}_m - \text{Benefits}_m$

Where "Costs_m" = (Initial Capital Spend + O&M Capital Spend + O&M Expense Spend + Lifetime Vegetation Management Expense); and

"Benefits_m" = (Wildfire Benefit + Public Safety Benefit + Reliability Benefit + EPSS Benefit + PSPS Benefit)

The wildfire component of the WBCA score quantifies the wildfire risk associated with each circuit segment. It also can be referred to as the "Wildfire Benefit" as shown in the above calculation.

The Wildfire Benefit (wildfire risk reduction) is calculated as:

Wildfire Benefit = Wildfire Risk Reduction = (Wildfire Exposure) * (Wildfire Mitigation Effectiveness)

Mitigation effectiveness is composed of a weighted approach of wildfire risk drivers.

Similar to the Wildfire Benefit, the PSPS risk reduction is calculated at the circuit segment level. Then a system level value is obtained by summing together the customer minutes impacted over all of the segments.

The PSPS Benefit, as included in the WBCA calculation, is composed of the following:

PSPS Benefit = PSPS Risk Reduction = PSPS Exposure ($M) * PSPS Mitigation Effectiveness

More details about the system hardening and underground approach, as well as further details about the WBCA, are included in the response to ACI PG&E-23-05 later in this document.

Risk calculations and methods such as WBCA provide a quantitative guide for workplan development. Strict rank order or strict risk buydown (RBD) does not always allow for the most efficient execution of work, as it disregards the operational considerations of work execution. One such example is the performance of maintenance and inspection activities in the same area. This allows for operational efficiency as opposed to forcing workers to travel to geographically disparate areas simply to follow a strict rank order.

The rank order for mitigation selection can vary due to a number of factors. For example, prioritizing our open tag backlog utilizes a risk spend efficiency approach to aid in reducing the risk from backlog tags as quickly as possible. This allows for the bundling of work, which is a more efficient way to execute. On the other hand, Asset Inspection utilizes the wildfire consequence value when determining how frequently to inspect assets within the High Fire Threat District (HFTD) as this is the most appropriate way to perform the work.

Model applications for the various mitigations also drive differences in the rank order. Vegetation work utilizes the vegetation model, whereas system hardening and undergrounding utilize a composite model, inclusive of all risk drivers. This approach means that a particular circuit segment can be ranked differently based on the model that is applied to it. A universal model application for all mitigations would not account for the most probable risk drivers for a given circuit segment.

ACI PG&E-23-03 – Incorporation of Extreme Weather Scenarios Into Planning Models

Description:

PG&E currently relies on wind conditions data collected over the past 30 years that does not consider rare but foreseeable and significant risks. PG&E does not directly evaluate the risk of extreme wind events in its service territory to prioritize its wildfire mitigations using the Wildfire Transmission Risk Model (WTRM) Planning model.

Required Progress:

In its 2026-2028 Base WMP, PG&E must report on its progress developing statistical estimates of potential wind events over at least the maximum asset life for its system. PG&E must evaluate results from incorporating these into WTRM-Planning when developing its mitigation initiative portfolio or explain why the approach would not serve as an improvement to its mitigation strategy.

PG&E Response:

As instructed, progress on this Areas for Continued Improvement (ACI) will be addressed in PG&E's 2026-2028 WMP.

ACI PG&E-23-04 – Cross-Utility Collaboration on Best Practices for Inclusion of Climate Change Forecasts in Consequence Modeling, Inclusion of Community Vulnerability in Consequence Modeling, and Utility Vegetation Management for Wildfire Safety

Description:

PG&E and the other IOUs have participated in past Energy Safety-sponsored scoping meetings on these topics but have not reported other collaboration efforts.

Required Progress:

PG&E and the other IOUs must participate in all Energy Safety-organized activities related to best practices for:

- *Inclusion of climate change forecasts in consequence modeling;*
- *Inclusion of community vulnerability in consequence modeling; and*
- *Utility vegetation management for wildfire safety.*

PG&E must collaborate with the other IOUs on the above-mentioned best practices. In their 2025 Updates, the IOUs (not including independent transmission operators) must provide a status update on any collaboration with each other that has taken place, including a list of any resulting changes made to their WMPs since the 2023-2025 WMP submission.

PG&E Response:

In 2023, PG&E actively participated in the monthly RMWG meetings held by Energy Safety. The schedule of topics for the 2023 meetings is shown in Table ACI-PG&E-23-04-1 below:

TABLE ACI-PG&E-23-04-1:
2023 RISK MODELING WORKING GROUP SCHEDULE

Date	Topic
February 15	Coordination of Government Wildfire Plans with Utility Wildfire Mitigation Plans
March 8	Creating and Maintaining an Out-Year Fuelscape
April 12	Wildfire Consequence Modelling – Conflagration Risks
May 10	Approaches to Factoring Suppression into Fire Models
June 14	Approaches to Factoring Ingress and Egress into Fire Models
July 12	Approaches to Modeling Long Duration, High Intensity Wildfires
August 9	PSPS Planning Models
September 13	Avoiding Bias in Wildfire Probability Modeling
October 11	Review of Wildfire Related Operational Models
November 8	Model Maintenance and Data Collection
December 13	Standardized Wildfire Risk Type Classifications and in situ Wildfire Risk Assessment

While specific sessions were not dedicated to the three requested topics, they were discussed during the May and June workshops focusing on suppression and ingress and egress. These topics were also discussed during the March workshop on Maintaining an Out-Year Fuelscape. Beyond the collaboration as part of the RMWG workshops, PG&E collaborated with the other utilities in different forms, as outlined below by topic.

In addition to the monthly RMWG meetings, PG&E participated in the CPUC Climate Change and Fire Risk Consequence workshop held on July 25, 2023. This workshop highlighted the future value of continued coordination between the CPUC focus on climate modeling and the incorporation of climate impacts in the wildfire risk models.

Inclusion of Climate Change Forecasts in Consequence Modeling

In line with this objective, PG&E continues to meet independently as part of the monthly meetings to collaborate with the other utilities in a number of forums. This work is focused on developing sensitivity forecasts to characterize the potential changes in wildfire consequence due to future climate change. Specifically, this relates to the ongoing series of California Climate Assessments, adjustments to the CPUC's HFTD areas and the Office of Energy Infrastructure Safety's (Energy Safety) climate workshops.

PG&E also has a strong partnership with San Jose State University and the Wildfire Interdisciplinary Research Center (WIRC).[30] PG&E is a member of the Industry Advisory Board that helps direct WIRC research for wildfire research including impacts

[30] Please see https://www.wildfirecenter.org/ for more information about the WIRC.

to climate change. Members of the board include researchers from other California utilities, firefighting agencies, defense contractors, and other research entities.

Through the WIRC, PG&E scientists co-authored a study published in the journal Nature in 2023 titled *Climate warming increases extreme daily wildfire growth risk in California*.[31] The study used a novel machine learning modeling approach to assess how wildfire risk would change and by what degree in future warming scenarios.

Across these collaborations and published research, it is clear that wildfire risk will increase due to increased fuel aridity. The linkage between increased temperature and resulting increases in fuel aridity has now been well-established and peer-reviewed and presents a potential robust pathway and methodology for inclusion into risk models. However, supportive evidence for changes in windspeed, precipitation, and other climate change effects on wildfire is still lacking and is an area of continued study.

Specifically, for wind, the Fourth California Climate Assessment work is inconclusive as to whether wind speed and/or intensity will increase or decrease in the future. However, the current California Fifth Climate Assessment has begun to utilize a new scenario methodology that may signal progress in this area.

For fuels, there are many vendors offering their forecasts of current and future fuels. Uncertainty around establishing an official state source for fuels data as well as population growth in the Wildland Urban Interface, and vegetation are key next steps. All of these data sets are key inputs to the identification and continued adjustment of the HFTD to represent climate change impacts. The state and federal plans for forest and fuels management over the next several decades are unclear and represent an area for further collaboration. PG&E looks forward to continued coordination with state and federal agencies in ongoing improvement efforts for forest and fuel management plans.

Inclusion of Community Vulnerability in Consequence Modeling

PG&E participated in Energy Safety-led efforts related to the inclusion of community vulnerability in consequence modeling. As part of the May and June RMWG meeting, PG&E—along with the other utilities—presented on and discussed our methodologies for incorporating community vulnerability into our wildfire and PSPS consequence models.

While wildfire consequences do not impact all customers or groups equally, the disproportionate impacts on more vulnerable communities are of particular focus. Specific focus has been placed on the varying ability of customer groups to relocate, resiliently respond to power outages, or understand and act based on safety notices from evacuation notices, health warnings, or other general community communications. As outlined in Section 6, the Wildfire Consequence model now accounts for egress, which utilized vulnerable community information.[32]

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31 This study is available at: https://www.nature.com/articles/s41586-023-06444-3.

32 See PG&E 2023-2025 WMP, R4, pp. 175-176.

Utility Vegetation Management for Wildfire Safety

PG&E continues to collaborate with the other utilities on vegetation management, including work on the Effectiveness of Enhanced Clearances Study (detailed in ACI PG&E-23-22). We also collaborated with the other utilities on Hazard Tree Mitigation practices (detailed in the response to RN-PG&E-23-07).[33] PG&E engaged in annual benchmarking with other major utilities within California and has an open dialogue with those utilities that we maintain throughout the year. We are aligned on the codes that we must follow and have an understanding of each utility's internal Standards and Procedures. Additionally, we engaged in discussions regarding our WMP commitments, inspection criteria and frequency, as well as our interactions with those performing the work. This ensures that industry best practices are shared and keeps PG&E on the path that best supports our local communities and the hometowns that we serve.

We continue to participate in annual benchmarking activities focusing on the best practices in vegetation management quality, including quality assurance, training, and quality records management. We will continue to benchmark our Wood Management program and identify best practices with the other utilities who wish to participate, including the addition of Liberty Utilities, to ensure a comprehensive comparison and identify the origin of any potential differences in scope. We look forward to continued collaboration with the other utilities on the topic of utility vegetation management for wildfire safety.

Providing a Status Update on Any Collaboration That Has Taken Place, Including a List of Any Resulting Changes Made to the WMP Since the 2023-2025 WMP Submission

The Joint Utilities conduct a monthly meeting that discusses many areas of the WMP in depth. PG&E, Southern California Edison Company (SCE), and SDG&E each take turns leading the meetings. Topics for these meetings generally cover mitigation strategy and implementation, regulatory developments, and knowledge sharing.

In accordance with the 2025 WMP Update, the Joint Utilities' participation in this monthly forum has influenced its approach to the following:

- The interpretation and consistency in approach to applying the risk model changes in Section B.1;
- The approach and eligibility criteria for 2025 program target changes in Section B.2.1 of the WMP;
- Information sharing on new programs discussed in Section B.4 of the WMP;
- The interpretation and consistency in approach to the ACIs that were received by more than one utility, including:
  - SCE ACIs 1, 2, 3, 4, 5, 7, 11, 17, and 18;

33 See PG&E 2023-2025 WMP, R4, pp. 624-652.

- SDG&E ACIs 1, 2, 3, and 5; and
- PG&E ACIs 1, 3, 4.

Additionally, the utilities met weekly in 2023 to benchmark and share information regarding covered conductor effectiveness. Furthermore, as described above, PG&E, SCE, and SDG&E developed standing monthly Joint Utility meetings, creating a forum to keep one another updated and discuss wildfire topics. These are full day meetings, which are attended in person every other month. Lastly, the utilities also developed an undergrounding working group to discuss lessons learned and the challenges associated with undergrounding.

ACI PG&E-23-05 – Updating Grid Hardening Decision Making

Description:

PG&E's current methodology does not appropriately account for various factors needed for grid hardening decision making.

Required Progress*:*

In its 2025 Update, PG&E must:

- *Provide more accurate effectiveness estimates for its hardening efforts when calculating cost effectiveness scores. The estimates must include:*
  - Details on **effectiveness** calculations for mitigations, including justification based on observed in-field effectiveness.
  - Analysis based on ignition and wildfire risk reduction.
  - Location-specific undergrounding effectiveness compared to combinations of mitigations, including any new mitigations being deployed from pilot stages (such as covered conductor, distributed fault anticipation, Early Fault Detect (EFD), falling conductor protection, other advanced protection, and EPSS).
  - An estimate of the cumulative risk exposure of its mitigation initiative portfolio taking into account the time value of risk as part of mitigation comparisons.
  - For each location where PG&E's analysis recommends a mitigation other than undergrounding, PG&E must provide justification for choosing undergrounding.
- *Details on any projects driven by reliability risk as opposed to wildfire risk. This consists of projects with the largest percentage of monetary risk within the cost effectiveness scores coming from the summation of reliability-related risks. Details must include:*
  - A list of these projects.
  - The breakdown of cost effectiveness scores for such projects.
  - Whether or not the projects are within the HFTD or High Fire Risk Area (HFRA).
  - An explanation as to why the project was included for prioritization within the WMP for hardening.
  - If applicable, adjustments to PG&E's hardening scope to account for the above evaluation. If PG&E is not adjusting its hardening scope, it must provide an explanation as to why adjustments are not necessary.

PG&E Response:

Introduction:

PG&E continues to update our grid hardening decision-making process to reflect changes in risk, costs, the requirements of CPUC decisions,[34] legislation,[35] technology, as well as operational lessons and improvements. The evolution of our decision-making and our analytical modeling tools is detailed in our annual WMP filings. In our 2020 and 2021 WMPs, we described how we utilized undergrounding as one mitigation tool in our system hardening and risk mitigation toolbox for work planned through 2022.

In our 2022 WMP, we noted our July 2021 announcement of a multi-year program to underground 10,000 distribution circuit miles in and near high wildfire risk areas. The goal of this work is to address the effects of climate change leading to drought, hotter temperatures, and higher winds in California that have significantly increased the risk of catastrophic wildfires. This program involved a fundamental shift in our system hardening work in which we identified undergrounding as the preferred mitigation after line removal or remote grids. Thus, while other mitigations were implemented where appropriate, or where undergrounding was infeasible due to environmental factors, undergrounding became the preferred mitigation for system hardening projects selected in 2022 for completion in approximately 2023-2024.[36] At that time, PG&E was using version two (v2) of our Wildfire Distribution Risk Model (WDRM) to select undergrounding projects based on wildfire risk.

In our 2023 WMP, we described our continued, targeted undergrounding approach and our updated WDRM, v3, which incorporated new features such as a feasibility analysis to account for factors that affect project timing and costs. We used the Wildfire Feasibility Effectiveness score (incorporating WDRM v3) to select the undergrounding projects to be completed from approximately 2024 to 2026 and supplemented these projects with fire rebuild work, projects to reduce PSPS impacts, and projects in HFRAs identified by our public safety specialists. Pursuant to this plan, we exceeded our ambitious target of completing 350 miles of undergrounding in 2023.

With our 2024 WMP Change Order, and this 2025 WMP Update, we are providing details on how we are evolving our system hardening decision-making in response to the system hardening requirements in Decision (D.) 23-11-069 for PG&E's 2023-2026 General Rate Case. Since the issuance of D.23-11-069 in November 2023, we were required to revise our 2025 and 2026 workplan projects to align with the Commission's requirements. Specifically, we updated our workplan to meet the reduced undergrounding mileage, the increased overhead hardening mileage, and the 18 percent risk reduction target for 2023 to 2026.

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34 For example, see D.23-11-069.

35 For example, see SB 884.

36 See PG&E 2022 WMP (Jul. 26, 2022), p. 555.

As part of our continual improvement—and in response to D.23-11-069 and the SB 884 guidance to prioritize both wildfire risk reduction and reliability improvement through undergrounding—PG&E is developing a WBCA tool to incorporate cost effectiveness components, reliability considerations, and location-specific mitigation effectiveness calculations. The WBCA, described in further detail below, is an analytical framework that will compute the total lifetime costs and total lifetime benefits of different mitigations, and combinations of mitigations, at the circuit segment level. While PG&E made significant progress in developing the WBCA tool, it is not yet final. It may be adjusted, if necessary, to align with Energy Safety's guidelines for SB 884 10 Year Plans that are expected in Q2 of 2024.

PG&E anticipates finalizing the WBCA in support of our 10 Year Plan filing and using it to select undergrounding projects for completion in 2027 and beyond. This timing reflects the multi-year process involved with analyzing system-hardening sites and determining mitigations, scoping projects, compiling a workplan and then implementing the various stages of project implementation from surveying and permit acquisition to construction and final energization. This multi-year process means that projects scoped with the WBCA in 2024 and 2025 will likely have a completion date in 2027 or later.

Below, we address each of the items highlighted by Energy Safety in this ACI.

Estimating System-Hardening Mitigation Effectiveness

Calculation Detail: Effectiveness Values

PG&E's WBCA will incorporate effectiveness values of several mitigation alternatives, including combinations of mitigations, to determine the costs and benefits of each mitigation or combination of mitigations at the circuit segment and portfolio levels. The WBCA will calculate the costs and benefits of each mitigation utilizing location-specific data based on the unique risk factors captured by the WDRM for each circuit segment. PG&E monitors outage history, vegetation conditions, and field observations/insights and may update the inputs to the WBCA if substantial changes are observed.

For each mitigation alternative, the WBCA will address wildfire risk, electric reliability, public safety, and cost efficiencies. One key development from previous models and tools is that the WBCA considers benefits and costs over the *lifetime* of the assets. Given that undergrounding equipment has an expected lifetime of about 50 years, lifetime benefits and costs are an important consideration. Examples of the elements of the WBCA benefit-cost model include:

- Wildfire mitigation effectiveness values and benefits;
- Outage (reliability) improvement effectiveness values and benefits;
- Other (non-wildfire) public safety benefits;
- Construction costs; and
- Ongoing operations and maintenance costs or avoided costs.

To calculate wildfire mitigation effectiveness, we are incorporating effectiveness values for the various mitigations and combinations of mitigations into the WBCA by evaluating how successful each of them would be in mitigating a potential ignition resulting from particular combinations of unplanned outage events and equipment attributes ("outage combinations"). We assessed the effectiveness of each of the mitigation alternatives against more than 2,200 outage combinations that have occurred in PG&E's HFTD during wildfire season. PG&E SMEs reviewed each of the outage combinations, which consist of a basic event plus three additional attributes (supplemental cause of an ignition, failed/involved equipment, and equipment condition), and assigned an effectiveness rating for each mitigation at preventing each outage combination. The effectiveness rating describes how effective each of the mitigation alternatives would be in mitigating that type of outage combination.

Table ACI-PG&E-23-05-1 below shows how the basic cause of the event, plus three additional attributes (including the primary, secondary or service line equipment), combine and become a unique outage combination. The table includes eight examples, one for each of the eight basic causes of a failure.

TABLE ACI-PG&E-23-05-1:
MITIGATION EFFECTIVENESS ASSESSMENT – FAILURE MODE EXAMPLES

Line No.	Basic Cause of a Failure/Outage	Supplemental Cause of a Failure/Outage	Failed/ Involved Equipment	Equipment Condition	Outage Combination
1	Third Party	Vehicle	Secondary	Broken, Wire on Ground	Third Party | Vehicle | Secondary | Broken Wire on Ground
2	Animal	Squirrel	Primary Overhead Conductor	Burned/ Flashed	Animal | Squirrel | Primary Overhead Conductor | Burned/Flashed
3	Company Initiated	Improper Construction	Primary Overhead Conductor	Deteriorated	Company Initiated | Improper Construction | Primary Overhead Conductor | Deteriorated
4	Environmental /External	Ice or Snow	Service Conductor	Broken, Wire on Ground	Environmental/External | Ice or Snow | Service Conductor | Broken, Wire on Ground
5	Equipment Failure/Involved	Other	Primary Fuse	Broken	Equipment Failure / Other | Primary Fuse | Broken
6	Unknown Cause	Patrol, Found Nothing	Primary Pole – Wood	Burned/ Flashed	Unknown Cause | Patrol, Found Nothing | Primary Pole – Wood | Burned/Flashed
7	Vegetation	Tree – Branch Fell on Line	Primary Anchor or Guy	Broken	Vegetation | Tree – Branch Fell on Line | Primary Anchor or Guy | Broken
8	Wildfire Mitigation	PSPS	Circuit Breaker	Normal	Wildfire Mitigation | PSPS | Circuit Breaker | Normal

PG&E recognizes that the number and location of outages varies and therefore analyzed outages and mitigation effectiveness across three different periods (2018-2022, 2015-2022, and 2020-2022). The mitigation effectiveness percentage is similar across time frames, varying by no more than 1 percent. In the WBCA, PG&E plans to use the 2015-2022 period because it is the longest time frame.

Mitigation Effectiveness and Location-Specific Inputs

Table ACI-PG&E-23-05-2 below continues the example analysis. The table includes three mitigations and a rating of how effective each would be at preventing ignitions from the eight example outage combinations shown above.[37] The rating scale used in the effectiveness assessment is:

- All: 100 percent effective – Assumes no ignition events;
- Very High: 90 percent effective – Assumes the mitigation addresses most ignition concerns, but still leaves a potential for ignition;
- High: 75 percent effective – Assumes the mitigation provides significant ignition reduction, however, there is still a chance for contact failure;
- Medium High: 60 percent effective – Better than average ignition reduction for an event;
- Medium: 40 percent effective – Less than average ignition reduction for an event;
- Low: 10 percent effective – Some ignition reduction mitigation, but not significant; and
- None: 0 percent effective – No protection against ignition.

[37] These are averages based on review of 8 years of unplanned outage history between 2015 and 2022. This historical review differs from the methodology used to calculate the annual effectiveness reported by PG&E for any given year.

TABLE ACI-PG&E-23-05-2:
IGNITION MITIGATION EFFECTIVENESS RATINGS FOR THREE EXAMPLE MITIGATIONS

Line No.	Outage combination	UG primary (Alt 2)	Covered Conductor Overhead with EPSS (Alt 4)	Bare Conductor Rebuild with EPSS and DCD (Alt 5)
1	Third Party I Vehicle I Secondary I Broken Wire on Ground	Medium	Medium	None
2	Animal I Squirrel I Primary Overhead Conductor I Burned/Flashed	All	Very High	High
3	Company Initiated I Improper Construction I Primary Overhead Conductor I Deteriorated[(a)]	N/A	N/A	N/A
4	Environmental/External I Ice or Snow I Service Conductor I Broken, Wire on Ground[(b)]	None	None	None
5	Equipment Failure / Other I Primary Fuse I Broken	All	Very High	Medium High
6	Unknown Cause I Patrol, Found Nothing I Primary Pole – Wood I Burned/Flashed	All	Very High	High
7	Vegetation I Tree – Branch Fell on Primary Line I Anchor or Guy I Broken	All	Very High	High
8	Wildfire Mitigation I PSPS I Circuit Breaker I Normal[(a)]	N/A	N/A	N/A

(a) Line numbers 3 and 8 indicate N/A because PG&E-initiated outages were excluded from this analysis of effectiveness of ignition mitigation because a PG&E-initiated outages would not cause an ignition.

(b) The outage combination in line 4 relates to a conductor on a service line; none of these mitigations involves secondary or service lines, and so this outage scenario would not be prevented by any of these mitigations.

After determining how effective each alternative mitigation would be at preventing an ignition based on the outage combination characteristics, PG&E will use this information to analyze circuit-segment level wildfire mitigation effectiveness of different mitigations or combinations of mitigations. To determine circuit segment-level mitigation effectiveness, the WBCA will adjust for the outage combinations likely to occur on a given circuit segment, their estimated frequency, and their contribution to overall risk on the circuit segment.

For illustrative purposes, PG&E also determined the overall weighted effectiveness of mitigation/outage combinations based on the number of outage combinations from 2015 to 2022. Table ACI-PG&E-23-05-3 presents the blended average effectiveness values for each of the 10 current possible alternatives PG&E anticipates using in our WBCA.[38] While 10 possible mitigations are presented in this table, these mitigations are not all applicable to every location. Because these values reflect the blended average

[38] The number of alternatives compared by the WBCA may change in future to reflect on new technologies, new combinations, etc.

effectiveness, they are not the exact number that will be applied to each distinct circuit segment in the WBCA. Instead, as described above, when analyzing a potential project, the WBCA will use specific effectiveness values for those circuit segments based on the unique risk sub-drivers (outage combinations) for that location, as identified by the WDRM.

TABLE ACI-PG&E-23-05-3:
IGNITION MITIGATION EFFECTIVENESS: REPRESENTATIVE BLENDED AVERAGE VALUES

Scenario	Blended Average Effectiveness[(a)]
Alt. 1 – Baseline	0%
Alt. 2 – Underground Primary	97.7%
Alt. 3 – Underground All	99.2%
Alt. 4 – Covered conductor (CC) Overhead with EPSS and Downed Conductor Detection (DCD)	78.2%
Alt. 5 – Bare Conductor Rebuild with EPSS and DCD	60.9%
Alt. 6 – Line Removal w/ Remote Grid	97.7%
Alt. 7 – EPSS including DCD/Partial Voltage (with bare conductor)	60.4%
Alt. 8 – EPSS, DCD, and PSPS (with bare conductor)	91.3%
Alt. 9 – Rapid Earth Fault Current Limiter (REFCL), CC Overhead, EPSS and DCD	65.0%
Covered Conductor Rebuild – New	66.4%[(b)]

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Assumptions:

- Analysis assumes no Overhead degradation for life of the asset;
- All EPSS solutions include Downed Conductor Detection (DCD);
- EPSS and DCD are only active when conditions are greater than R1;
- Ground sensitivity on 4 wire systems for high impedance faults similar to DCD mitigation; and
- Mitigation effectiveness for other Environmental caused outages: None for Overhead and All for Underground.

(a) These are averages based on review of 8 years of outage history between 2015 and 2022. This historical review differs from the methodology used to calculate the annual effectiveness reported by PG&E for any given year.

All of these effectiveness values represent a blended average effectiveness at the circuit segment level with the exception of "Alt. 9 – REFCL, CC Overhead, EPSS and DCD" which is a substation effectiveness score. Not all substations are capable of having REFCL applied, and it cannot be isolated to a circuit segment only.

The approach to calculating outage risk considered the following outage types, however they were deemed not applicable and therefore excluded:

No improvement for existing Underground Type outages; and

All company-initiated outages, Community Wildfire Safety Program and PSPS outages fire forest/grass outages – potential wildfire cause outage/force out.

(b) The mitigation effectiveness value for CC used in the WBCA (66.4 percent) is similar to the value arrived at as part of the joint California IOUs CC effectiveness study for 2022 (64 percent). See PG&E's 2023-2025 WMP, Revision 1, April 26, 2023, page 900.

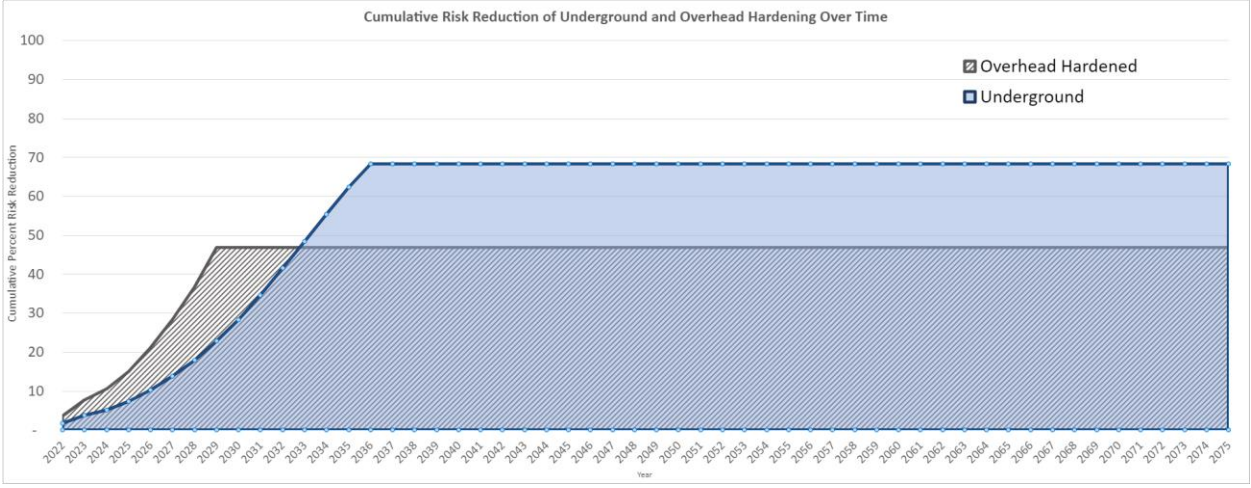
PG&E expects to conduct periodic reviews of the mitigations and effectiveness values used in the WBCA and anticipates updating the WBCA in the future to include new mitigations and updated effectiveness values.

Cumulative Risk Exposure

PG&E's wildfire mitigation plan is designed to minimize cumulative risk exposure, and account for the time value of risk based on the useful life of the asset. Specifically, PG&E uses an integrated mitigation strategy to manage wildfire risk across our system while we implement permanent risk reduction strategies like undergrounding and other system hardening work. PG&E's objective when scheduling mitigation initiatives is to ensure that we have built sufficient risk mitigation into the system to minimize risk exposure as we develop our long-term system hardening programs. PG&E achieves this through a suite of Comprehensive Monitoring and Data Collection programs designed to provide insight into the changing environmental hazards around our assets and the condition of our equipment (e.g., the Hazard Awareness and Warning Center and wildfire cameras) and Operational Mitigations (e.g., EPSS and vegetation management) that provide on-going risk reduction and influence how we manage the environment around the electric grid. As we contemplate the alternative solutions for permanent risk reduction, PG&E considers the time value of risk and cumulative risk reduction. In addition, by factoring in the lifetime benefits and costs of various possible mitigations, the WBCA tool will account for the cumulative risk exposure of PG&E's mitigation initiative portfolio.

PG&E recognizes that overhead hardening can be installed more quickly than an undergrounding solution. However, as depicted in Figure ACI-PG&E-23-05-1 below, the initial, permanent risk reduction achieved from quicker installation of an overhead mitigation does not compensate for the greater total, permanent risk reduction achieved over the lifetime of an underground solution. This figure shows an illustrative comparison of the cumulative wildfire risk reduction for overhead hardening and undergrounding over the life of the assets. This demonstrates that, for the possible portfolio miles in our 10 Year Plan workplan, the risk exposure (i.e., residual risk) is greater if the miles were overhead hardened rather than if those miles were undergrounded. Thus, while overhead hardening can scale quickly and thus reduce some wildfire risk sooner than undergrounding, it is a less effective solution in the long term because of the higher residual risk left by overhead assets. As depicted, overhead hardening can be completed at a rate of approximately three times that of undergrounding but while those miles may be mitigated quicker in the overhead hardening scenario, doing so would achieve approximately 21 percent less risk reduction, which is then compounded as cumulative exposure every year for the life of the asset.

FIGURE ACI-PG&E 23-05-1:
CUMULATIVE RISK REDUCTION FOR UNDERGROUNDING AND OVERHEAD HARDENING OVER ASSET LIFETIME



Non-Underground Mitigations

PG&E's WBCA is a cost-benefit tool that will be used to inform the mitigation strategy in combination with other data and inputs. The WBCA will compare the various costs and benefits of different mitigations at the circuit segment level and will identify the mitigation with the highest benefits, but it will not unilaterally determine the mitigation deployed at a specific location. When selecting the mitigation to implement, PG&E will use the WBCA output and then evaluate location-specific factors (e.g., tree fall-in risk, ingress and egress issues, reliability impacts) and risk sub-drivers (e.g., vegetation, animals, vehicles, etc.) along the target circuit segment. This consideration of location-specific benefits and risks is consistent with the prior decision-tree approach we used to select projects and mitigations for completion in 2023 to 2025. The ultimately selected mitigation will be re-run through the WBCA tool to validate the benefits and costs of the selected mitigation as compared to the modeled alternative mitigations.

Reliability and Risk Projects

As stated above, PG&E continues to refine an updated undergrounding workplan to reflect the hybrid system hardening approach ordered by the Commission in D.23-11-069. The current workplan (as of January 31, 2024) includes 45 sub-projects (i.e., jobs), of approximately 53 miles (5 percent of the current program portfolio), which were selected primarily due to their significant reliability benefits in reducing PSPS customer impacts. Because there is overlap of wildfire risk and PSPS impacts, there are also projects within the top 20 percent risk-ranked circuit segments that will reduce PSPS impacts on customers. The projects listed in Table ACI-PG&E-23-05-4 below are those PSPS projects that are outside the top 20 percent risk-ranked circuit segments.

Regarding cost effectiveness scores, the undergrounding projects in PG&E's current workplan were previously selected using a methodology (WDRM V2 and V3) that did not incorporate cost effectiveness scores for individual projects. Therefore, cost effectiveness scores are not available.

Table ACI-PG&E-23-05-4 lists the 45 sub-projects selected primarily for their reliability benefits. These projects are included in PG&E's workplan for consideration because they are all within a Tier 2 or Tier 3 HFTD and meet PG&E's definition of highest risk areas, which includes projects identified to reduce PSPS customer impact.[39] In addition, these projects are aligned with SB 884 which requires large electric corporations to incorporate reliability considerations into their undergrounding program project selection processes. The Table provides additional explanations, specific to each project or sub-project, as to why they are included in PG&E's workplan.

These projects were selected based on PG&E's standard analysis and decision-tree process, which includes consideration of areas with historical PSPS risk. Therefore, no adjustment is needed to PG&E's hardening standard ("scope") to account for these projects.

39 See PG&E 2023-2025 WMP, R4, p. 401.

TABLE ACI-PG&E 23-05-4:
PSPS PROJECTS IN PG&E'S WORKPLAN (AS OF 1/31/2024) THAT ARE OUTSIDE THE TOP 20 PERCENT RISK RANKED CIRCUIT SEGMENTS

Order Number/ Sub-Project	Circuit Protection Zone	City	County	Applicable Risk Model	HFTD Tier or HFRA	Total Planned Overhead Miles	Total Planned Underground Miles	Total Planned Removal Miles	Total Planned Circuit Miles
Explanation: High Frequency PSPS event impact in Oroville south of Paradise. This project builds from a substation an Underground mainline up to an existing tie into the Underground work on a neighboring circuit.									
35299634	CLARK ROAD 11022070	Oroville	BUTTE	v2	Tier 2	0.00	2.32	0.00	2.32
35329014	CLARK ROAD 11022070	Oroville	BUTTE	v2	Tier 2	0.00	2.72	0.00	2.72
35384087	CLARK ROAD 11022070	Oroville	BUTTE	v2	Tier 2	0.00	0.43	0.00	0.43
35299633	CLARK ROAD 11022094	Oroville	BUTTE	v2	Tier 2	0.00	1.66	0.00	1.66
35329012	CLARK ROAD 11022094	Paradise	BUTTE	v2	Tier 2	0.00	1.55	0.00	1.55
35329013	CLARK ROAD 11022094	Paradise	BUTTE	v2	Tier 2	0.06	1.38	0.00	1.44
35299635	CLARK ROAD 110247006	Paradise	BUTTE	v2	Tier 2	0.00	2.33	0.00	2.33
35329016	CLARK ROAD 110247006	Paradise	BUTTE	v2	Tier 2	0.00	3.43	0.00	3.43
Explanation: High volume PSPS event impact in Walnut Creek through Lime Ridge south of Ygnacio Valley Rd. This project builds from a substation in Concord to Walnut creek where a large non-tiered bubble of residential customers would be impacted.									
35145001	CLAYTON 2215184604	Concord	CONTRA COSTA	v2	Tier 2 & 3	0.04	1.88	0.00	1.92
Explanation: Critical Customer PSPS event impact project for two critical emergency health facilities in Sonora. This project builds from the source, an underground mainline towards a portion of non-tiered customer in Sonora including the critical emergency health facilities.									
35312541	CURTIS 1701CB	Sonora	TUOLUMNE	v2	Tier 2	0.00	0.47	0.00	0.47
35332868	CURTIS 1701CB	Sonora	TUOLUMNE	v2	Tier 2	0.00	2.21	0.00	2.21
35332870	CURTIS 1701CB	Sonora	TUOLUMNE	v2	Tier 2	0.00	0.70	0.00	0.70
35424427	CURTIS 1701CB	Sonora	TUOLUMNE	v2	Tier 3	0.00	0.08	0.05	0.13
Explanation: High Volume and High Frequency PSPS impact in Kenwood and Santa Rosa. This project undergrounds a few HFTD crossings that improves reliability for a large group of non-tiered customers.									
35223063	DUNBAR 1101CB	Santa Rosa	SONOMA	v2	Tier 2	0.00	0.20	0.00	0.20
35228774	DUNBAR 1101CB	Santa Rosa	SONOMA	v2	Tier 2	0.00	1.06	0.00	1.06
35228775	DUNBAR 1101CB	Santa Rosa	SONOMA	v2	Tier 2	0.00	1.07	0.00	1.07
Explanation: High Volume PSPS event impact in Glen Ellen along Highway 12. This project undergrounds a few HFTD crossings along Highway 12 south of a substation towards Sonoma that unlocks a large area of non-tiered customers.									
35312542	DUNBAR 1103534	Glen Ellen	SONOMA	v2	Tier 2 & 3	0.00	0.67	0.00	0.67
35343741	DUNBAR 1103534	Sonoma	SONOMA	v2	Tier 2 & 3	0.00	0.71	0.00	0.71
Explanation: High Volume PSPS event impact in Auburn south of Interstate 80. This project undergrounds from a substation in the HFTD to a non-tiered area of customers along Auburn Folsom Road and undergrounds the tail-end of the circuit as it crosses back into the HFTD as it approaches the North Fork of the American River.									
35326790	FLINT 1101958726	Auburn	PLACER	v2	Tier 2	0.00	0.13	0.00	0.13

TABLE ACI-PG&E 23-05-4:
PSPS PROJECTS IN PG&E'S WORKPLAN (AS OF 1/31/2024) THAT ARE OUTSIDE THE TOP 20 PERCENT RISK RANKED CIRCUIT SEGMENTS
(CONTINUED)

Order Number/ Sub-Project	Circuit Protection Zone	City	County	Applicable Risk Model	HFTD Tier or HFRA	Total Planned Overhead Miles	Total Planned Underground Miles	Total Planned Removal Miles	Total Planned Circuit Miles
Explanation: High Volume PSPS event impact in Angels Camp along Highway 49. This project undergrounds from a substation out of the HFTD into an area of non-tiered customers.									
35145540	FROGTOWN 1702CB	Angels Camp	CALAVERAS	v2	Tier 3	0.61	0.53	0.00	1.15
Explanation: High Frequency PSPS event impact North of Fairfield along Suisun Valley Rd. This project undergrounds lines along Suisun Valley Rd and Gordon Valley Rd as the circuits enter the Tier 2 HFTD area.									
35320442	JAMESON 110265516	Fairfield	SOLANO	v2	Tier 2	0.10	0.74	0.00	0.84
35342143	JAMESON 110265516	Fairfield	SOLANO	v2	Tier 2	0.00	3.25	0.00	3.25
35342144	JAMESON 110265516	Fairfield	SOLANO	v2	Tier 2	0.00	2.32	0.00	2.32
35342145	JAMESON 110265516	Fairfield	SOLANO	v2	Tier 2	0.00	0.18	0.00	0.18
35342146	JAMESON 110265516	Fairfield	SOLANO	v2	Tier 2	0.00	1.70	0.00	1.70
35342147	JAMESON 110265516	Fairfield	SOLANO	v2	Tier 2	0.00	1.83	0.00	1.83
35342148	JAMESON 110265516	Fairfield	SOLANO	v2	Tier 2	0.00	1.04	0.00	1.04
35342151	JAMESON 110265516	Fairfield	SOLANO	v2	Tier 2	0.00	0.08	0.00	0.08
35473992	JAMESON 110265516	Fairfield	SOLANO	v2	Tier 2	0.00	0.48	0.00	0.48
35320462	JAMESON 1105371694	Fairfield	SOLANO	v2	Tier 2	0.00	0.29	0.00	0.29
Explanation: High Volume PSPS event impact in Cottonwood. This project undergrounds line south of a substation where the HFTD crosses and helps to exclude a portion of non-tiered customers east and south of the work location.									
35320464	PANORAMA 1101CB	Anderson	SHASTA	v2	Tier 2	0.00	0.22	0.00	0.22
35338402	PANORAMA 1101CB	Anderson	SHASTA	v2	Tier 2	0.00	1.41	0.00	1.41
Explanation: Critical Customer and High Volume PSPS event impact in Sutter Creek. This project undergrounds line to exclude a portion of non-tiered customers as well as to help exclude a water treatment plant from PSPS.									
35234526	MARTELL 1101CB	Sutter Creek	AMADOR	v2	Tier 2	0.00	0.88	0.00	0.88
Explanation: High Frequency PSPS event impact in Vacaville. This project undergrounds line as it enters the HFTD and helps to exclude high risk HFTD customers in Circuit Protection Zone (CPZ) Vacaville 11088762.									
35320335	VACAVILLE 110847860	Vacaville	SOLANO	v2	Tier 2	0.00	0.45	0.00	0.45

TABLE ACI-PG&E 23-05-4:
PSPS PROJECTS IN PG&E'S WORKPLAN (AS OF 1/31/2024) THAT ARE OUTSIDE THE TOP 20 PERCENT RISK RANKED CIRCUIT SEGMENTS
(CONTINUED)

Order Number/ Sub-Project	Circuit Protection Zone	City	County	Applicable Risk Model	HFTD Tier or HFRA	Total Planned Overhead Miles	Total Planned Underground Miles	Total Planned Removal Miles	Total Planned Circuit Miles
Explanation: This project has high PSPS risk and high tree fall in risk, and supports the completion of a high wildfire risk segment Placerville 210611132 (V3 rank 68).									
35233995	PLACERVILLE 21067522	Georgetown	EL DORADO	v2	Tier 3	0.00	0.66	0.00	0.66
35233996	PLACERVILLE 21067522	Georgetown	EL DORADO	v2	Tier 3	0.00	0.64	0.00	0.64
35353435	PLACERVILLE 21067522	Georgetown	EL DORADO	v2	Tier 3	0.00	0.00	0.70	0.70
Explanation: High Volume and High Frequency PSPS impact in East Oroville, South of Lake Oroville. This project undergrounds line from a substation from Hwy 162 up Ward Blvd and Canyon Dr towards a large existing Underground development near Kelly Ridge Rd, improving reliability for the customers in that development.									
35312560	WYANDOTTE 1110980944	Oroville	BUTTE	v2	Tier 2	0.00	2.13	0.00	2.13
35331306	WYANDOTTE 1110980944	Oroville	BUTTE	v2	Tier 2	0.00	1.70	0.00	1.70
35331307	WYANDOTTE 1110980944	Oroville	BUTTE	v2	Tier 2	0.00	2.08	0.00	2.08
35343394	WYANDOTTE 1110980944	Oroville	BUTTE	v2	Tier 2	0.00	1.25	0.00	1.25
35343395	WYANDOTTE 1110980944	Oroville	BUTTE	v2	Tier 2	0.00	1.99	0.00	1.99
35343396	WYANDOTTE 1110980944	Oroville	BUTTE	v2	Tier 2	0.00	1.09	0.00	1.09
35343397	WYANDOTTE 1110980944	Oroville	BUTTE	v2	Tier 2	0.00	0.64	0.00	0.64
35343398	WYANDOTTE 1110980944	Oroville	BUTTE	v2	Tier 2	0.00	0.00	0.32	0.32

ACI PG&E-23-06 – Continuation of Grid Hardening Joint Studies

Description:

The utilities have jointly made progress addressing the continued Joint IOU Covered Conductor Working Group area for continued improvement (PGE-22-09 and PGE-22-10). Energy Safety expects the utilities to continue these efforts and meet the requirements of this ongoing area for continued improvement.

Required Progress*:*

In its 2025 Update, PG&E, along with all other IOUs (not including independent transmission operators), must continue the relevant studies and meetings and report on the progress and outcomes of these studies and meetings in the Joint IOU Covered Conductor Working Group Report. This must include:

- *Progress made on any next steps included in the report;*
- *A description of any lessons learned PG&E has applied to its WMP, including a list of applicable changes and a timeline for expected implementation;*
- *A summary of any completed workshops, including a list of topics and dates, and takeaways; and*
- *A list of additional workshops and proposed dates.*

Additionally, PG&E must continue to collaborate with other utilities on efforts relating to grid hardening. In its 2026-2028 Base WMP, PG&E, along with other utilities, must submit a report which discusses continued efforts including:

- The IOUs' joint evaluation of the effectiveness of undergrounding. This must *account for any remaining risk from secondary or service lines, analysis on in-field observations from potential failure points of underground equipment, and ignition risk, as well as PSPS risk;*
- *The IOUs' joint lessons learned on undergrounding applications. This must include the use of resources to accommodate undergrounding programs, any new technologies being applied to undergrounding, and cost or deployment maximization efforts being used;*
- *The IOUs' joint evaluation of various approaches to implementation of protective equipment and device settings. This must include analysis of the effectiveness of various settings, lessons learned on how to minimize reliability and associated safety impacts (including use of DCD and partial voltage detection devices), variations on settings being used including thresholds of enablement, and equipment types in which such settings are being adjusted;*
- *The IOUs' continued efforts to evaluate new technologies being piloted and deployed. This must include, but not be limited to: REFCL, EFD, Distribution Fault*

Anticipation (DFA), falling conductor protection, use of smart meter data, open phase detection, remote grids, and microgrids; and

- *The IOUs' joint evaluation of the effectiveness of mitigations in combination with one another, including, but not limited to overhead system hardening, maintenance and replacement, and situational awareness mitigations.*

PG&E Response:

Progress Made on Any Next Steps Included in the Report

Please refer to the Joint Utility summary below.

A Description of Any Lessons Learned That PG&E Applied to Its WMP, Including a List of Applicable Changes and a Timeline for Expected Implementation

Based on the lessons learned through the testing, PG&E incorporated the testing results in the 2024 update to the criteria on how we conduct overhead inspection on covered conductors. Details on this update can be found in PG&E's Overhead Assessment Inspection Job Aid TD-2305M-JA02, as described in response to ACI PG&E-23-08.[40]

Furthermore, as described in response to ACI PG&E-23-08, based on results from corrosion testing, PG&E is planning an evaluation of additional conductor types to mitigate water intrusion. This effort will be conducted outside of the Joint Utility efforts.

A Summary of any Completed Workshops, Including a List of Topics and Dates, and Takeaways

TABLE ACI PG&E-23-06-1:
SUMMARY OF COMPLETED WORKSHOPS

Workshop Title	Date
Kickoff and Corrosion Testing	May 3, 2023
Aging Susceptibility	June 12, 2023
New Technologies	July 17, 2023
Maintenance and Inspections	July 24, 2023
Effectiveness Testing	August 7, 2023
New Technologies – EFD	September 20, 2023
New Technologies	November 8, 2023

[40] This job aid is available on the PG&E Community Wildfire Safety Program website, under the 2023-2025 Wildfire Mitigation Plan and associated documents section: https://www.pge.com/en/outages-and-safety/safety/community-wildfire-safety-program.html#accordion-99016a73ab-item-c788794778.

A List of Additional Workshops and Proposed Dates

Currently there are no further workshops planned, however PG&E will be accommodating with the other utilities if future workshops are scheduled.

Please see the following Joint Utility Covered Conductor Working Group Report that outlines the working group activities in 2023 and results.

2025 WMP Update – Joint IOU Covered Conductor Working Group Report

Introduction

In the 2021 WMP Update Final Action Statements, Energy Safety ordered the Joint Utilities to coordinate to develop a consistent approach to evaluating the long-term risk reduction and cost-effectiveness of covered conductor (CC) deployment, including: (1) the effectiveness of CC in the field in comparison to alternative initiatives and (2) how CC installation compares to other initiatives in its potential to reduce PSPS risk.[41] The utilities formed a Joint IOU Covered Conductor Working Group and developed an approach and preliminary milestones to enable the utilities' to better discern the long-term risk reduction effectiveness of CC to reduce the probability of ignition, assess its effectiveness compared to alternative initiatives, and assess its potential to reduce PSPS risk in comparison to other initiatives. The approach consisted of multiple workstreams including:

- Benchmarking;
- Testing;
- Estimated Effectiveness;
- Recorded Effectiveness;
- Alternatives Comparison;
- Potential to Reduce PSPS Risk; and
- Costs.

In the 2022 WMP Update filings and subsequently in the 2023-2025 WMP, the utilities produced a joint report that provided an update on their progress for each of the workstreams, added efforts, and preliminary plans for 2023.

In the 2022 WMP Update Final Decisions, Energy Safety identified Areas of Continued Improvement and Required Progress (ACI) for all utilities to expand this working group to include:

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41 In this progress report, "Joint Utilities," "Joint IOUs," "IOUs," or "utilities" refers to San Diego Gas & Electric Company (SDG&E), PG&E, SCE, PacifiCorp, Bear Valley Electric Service, and Liberty.

1) Joint CC Lessons Learned;

2) CC Maintenance and Inspection (M&I) Practices; and

3) New Technologies Implementation.

Given these directions, the utilities expanded the Joint IOU Covered Conductor Working Group to include ten workstreams and began meeting on the new workstreams in Q3/Q4 2022. Below is the summary of process made in 2023 to address the commitments identified in the report.

Overview

In 2023, the utilities conducted workshops across the various workstreams. New workstreams evaluated CC M&I best practices, assessed data and information on effectiveness of new technologies and shared practices and implementation strategies, and review studies on CC's ability to reduce PSPS impacts. The utilities continued to further benchmark efforts, improve methods for estimating and measuring effectiveness, and continue to track and compare unit costs. Below, the utilities describe the progress made on each workstream.

Testing

In our 2023-2025 Base WMPs, the utilities committed to conducting meetings and workshops to assess the testing results, determine if any additional tests are needed, and determine if any mitigations are warranted such as changes to materials, construction methods, or inspection practices. The Joint Utilities held bi-weekly meetings to review testing results. In addition, workshops were held with Energy Safety to discuss the following topics relating to testing:

- May 2023 – Corrosion Testing;
- June 2023 – Aging Susceptibility testing; and
- July 2023 – Status of IOUs remaining testing results.

Corrosion testing resulted in minor aluminum degradation below the covering following the corrosion testing, though copper CC had similar performance as the exposed bare conductor. SCE continues to inspect in-service installations of CC for monitoring the applied performance of the conductor. As a result of the discussions and outcome of the supplemental testing results, the Joint Utilities concluded that no additional testing was warranted at this time. All results have been submitted to Energy Safety. The Joint IOUs have concluded this workstream.

PG&E has incorporated the lessons learned from the testing results in 2024 update to PG&E's Overhead Assessment Inspection Job Aid TD-2305M-JA02, as described in

response to ACI PG&E-23-08.[42] Furthermore, please also see the response to ACI PG&E-23-08 for PG&E's planned evaluation of additional conductor types to mitigate water intrusion. This effort will be conducted outside of the Joint Utility efforts.

Recorded and Estimated Effectiveness

The Joint Utilities have met monthly in 2023 to discuss the results of recorded and estimated effectiveness for covered conductor. These discussions have demonstrated that while there is a need to align consistent methods, based on the individual constraints each utility faces, some of the drivers and data will ultimately be different. The Joint Utilities will continue to compare risk drivers, the results of recorded and estimated effectiveness, identify current alignment and opportunities for alignment and understand differences.

Alternatives, New Technology, Benchmarking and PSPS

The team decided to combine the alternatives, benchmarking, PSPS and new technologies workstreams. The team met bi-weekly to discuss the various technologies being considered and/or adopted by each Joint Utility, shared lessons learned, and discussed if these new technologies had any impact on PSPS. As a workstream the team identified questions on some of the new technologies for benchmarking. The team is finalizing the questions and plan to complete the benchmarking survey in 2024.

The Joint Utilities held three workshops with Energy Safety to discuss these workstreams:

- June 2023 – Distribution Fault Anticipation (DFA) – Discuss implementation strategies, practices, and effectiveness;
- July 2023 – Early Fault Detection (EFD) – Discuss implementation strategies, practices, and effectiveness; and
- August 2023 – Rapid Earth Fault Current Limited (REFCL) – Discuss implementation strategies, practices, and effectiveness.

During the workshops, the Joint Utilities shared how each utility was using the technology, the current status of implementation, and impacts to PSPS. No additional technology is being considered, therefore this workstream has concluded.

M&I Practices

In 2023, the utilities met monthly to discuss utility specific general and CC M&I practices and presented the materials in a workshop with Energy Safety on July 24, 2023. At the

[42] This job aid is available on the PG&E Community Wildfire Safety Program website, under the 2023-2025 Wildfire Mitigation Plan and associated documents section: https://www.pge.com/en/outages-and-safety/safety/community-wildfire-safety-program.html#accordion-99016a73ab-item-c788794778.

conclusion of the workshop, it was determined that no additional workshops were necessary.

For SCE, please see the response to ACI SCE-23-11, regarding CC inspection and maintenance.

In 2023, PG&E worked on the update of the Electric Distribution Overhead inspection Job Aid and, in December, released the updated Job Aid TD-2305M-JA02 that includes additional guidance for the inspection of Covered Conductor.[43]

Costs

In 2023, the utilities discussed the unit costs of CC and undergrounding and compared, at a high level, the different cost drivers. This discussion better informed the utilities of the differences behind the unit costs. The utilities meet regularly and will continue to share as information changes and costs are better defined with more installation.

Conclusion

All of the utilities met regularly on all workstreams in 2023 and addressed all of the commitments identified in the 2023-2025 Joint IOU Covered Conductor Effectiveness Report. In addition, all of the utilities developed standing monthly Joint Utility meetings, which created a forum to share updates on wildfire topics and to stay updated on key developments. The utilities also developed an undergrounding working group, to discuss challenges with undergrounding and related lessons learned. These forums will allow the Joint Utilities to continue data sharing and knowledge transfer on important wildfire mitigation topics.

[43] This job aid is available on the PG&E Community Wildfire Safety Program website, under the 2023-2025 Wildfire Mitigation Plan and associated documents section: https://www.pge.com/en/outages-and-safety/safety/community-wildfire-safety-program.html#accordion-99016a73ab-item-c788794778.

ACI PG&E-23-07 – Deployment of New Technologies

Description:

PG&E is behind its peers when it comes to the deployment of new technologies and has not provided active plans to meet the same levels of implementation.

Required Progress*:*

In its 2025 Update, PG&E must:

- *Report on the progress of its pilots for new technologies. This must include, but may not be limited to, EFD, DFA, Falling Conductor Protection (FCP), and REFCL.*
- *Provide estimates of the wildfire mitigation effectiveness and cost effectiveness of each new technology at scale compared to and in combination with other mitigations, such as CC and undergrounding.*
- *Provide a detailed workplan to demonstrate the expected rollout of the new technology. In addition, PG&E must adjust any targets associated with new technologies if pilots prove to be successful and PG&E is moving toward deployment.*
- *For any pilots that PG&E has found successful and that do not lead to target changes, PG&E must explain why it does not plan to pursue the pilot technology further at this time. The explanation must include detailed analysis to demonstrate that this decision promotes the maximum safety, reliability, and cost effectiveness to its customers. It must also include discussion of intended plans to move the new technology forward in the future, if applicable.*
- *Account for new technologies when evaluating mitigations in combination as part of its decision-making process.*

PG&E Response:

In response to this ACI, below we provide a report on the progress of our pilots for new technologies.

<u>Rapid Earth Fault Current Limiter</u>

The PG&E REFCL pilot at the Calistoga substation continues to progress but is still currently in the testing and evaluation stage. Since installation, operationalizing REFCL to work on a legacy distribution system has required significant upgrades, testing, and training. Although we are committed to continuing this demonstration project, several factors have caused delays in commissioning this program, including equipment failure, extended lead time of equipment, and the need to procure additional equipment to further stabilize the system.

Once we can successfully operate the system for an extended period, lessons learned from the pilot will be used to inform the further evaluation of using this technology as a viable wildfire mitigation tool in conjunction with other technologies. Additionally, in

reviewing mitigation alternatives as part of our upcoming SB 884 filing, we estimate a 65 percent mitigation effectiveness for REFCL, as shown in Table ACI-PG&E-23-05-3. An important outcome of the Calistoga REFCL pilot will be to validate these estimates along with the implementation cost and additional complexity of operations on the PG&E system.

To address the fundamental assumption of this ACI, we also believe that our deployment of REFCL technology is comparable or better than that of our peers. It is our understanding that only one other utility in California has deployed a similar REFCL system.

Falling Conductor Protection

Falling Conductor Protection (FCP) is defined as a protective scheme that attempts to de-energize a broken wire before it contacts the ground (or shortly thereafter) to prevent an ignition. This scheme requires sensing devices and communication links, which can be difficult to implement at scale on a distribution system in highly forested terrain. Additionally, to be effective circuit-wide, every lateral branch of the circuit would need a sensing device at the end of the line to be able to detect broken wires before they contact the ground (or shortly thereafter), which would be cost prohibitive. Finally, the majority of PG&E CPUC-reportable ignitions within HFRA occur because of vegetation contact or other external contact, which FCP cannot always mitigate.

However, in certain strategic and high-risk locations, it may be possible to implement a FCP scheme to provide coverage for a targeted section of distribution overhead circuitry. PG&E is currently in the early stages of a pilot initiative to attempt to provide FCP online reclosers over existing cellular connectivity to determine the overall feasibility of this type of solution. Lessons learned, such as cellular connectivity latency, device compatibility, and ignition mitigation effectiveness, will be evaluated as part of this effort.

In the meantime, PG&E will continue to leverage and expand the EPSS Program to mitigate distribution falling conductor related ignitions—which includes an algorithmic based high impedance ground fault DCD capability and SmartMeter partial voltage detection—to mitigate distribution wire down-related ignitions.

Early Fault Detection/Distribution Fault Anticipation

As of December 2023, PG&E moved beyond pilot and into production of these technologies, having deployed EFD technology on 103 locations over 6 distribution circuits and DFA technology at 79 substations. EFD/DFA risk reduction is incremental to system hardening. Risk reduction is achieved through the maintenance and replacement of assets identified by our EFD and DFA sensors. In 2023, as part of WMP Objective SA-03, PG&E developed field investigation procedures and analysis methodologies for select use cases. Additionally, PG&E implemented a system to track technology effectiveness, which will enable calculation of cost and mitigation effectiveness going forward.

PG&E's 2023-2025 EFD deployments are comparable in quantity to its peers. In 2023, PG&E deployed 57 EFD units across two circuits totaling 152 miles. Our 2024 design calls for deployment of 103 EFD units across two circuits spanning approximately 240 miles. The 2025 EFD deployment is currently in the planning stage and estimates installing approximately 200 units across four circuits.

In 2023, PG&E deployed sensors across 5 circuits totaling 362 miles and has plans to install DFA devices on 15 circuits per year in 2024 and 2025, which will span over 2,750 miles.

In addition to incipient fault detection and remediation, PG&E plans to perform a feasibility study in the 2024-2025 period on the potential use of EFD/DFA incipient failure identifications as a supplement to field inspections (see WMP Objective SA-09). A decision and implementation plan for large scale deployment will be made based on the results of the study.

The 2023-2025 DFA and EFD detailed work plans are included with this document as Attachment 2024-04-02_PGE_2025_WMP-Update _R0_ACI-23-07_Atch01 and Attachment 2024-04-02_PGE_2025_WMP-Update _R0_ACI-23-07_Atch02, respectively.

ACI PG&E-23-08 – Covered Conductor Inspection and Maintenance

Description:

PG&E has not shown that its current inspection and maintenance programs have been updated to sufficiently address covered conductor. While PG&E has adjusted its inspection practices to address some of the failure modes related to covered conductor, it does not account for the water intrusion failure mode.

Required Progress*:*

In its 2025 Update, PG&E must:

- *Discuss how the water intrusion failure mode unique to CC will be accounted for in its inspections.*
- *If PG&E determines no changes are necessary, PG&E must discuss and show how the current inspection and maintenance processes comprehensively address CC failure modes.*
- *If PG&E determines changes are necessary, PG&E must provide its inspection checklists and procedures demonstrating changes tailored to addressing covered conductor, as identified through the utility CC joint studies.*

PG&E Response:

PG&E agrees that water intrusion is a threat for covered conductors. However, PG&E does not consider water intrusion as a failure mode for CC by itself. This is because water contact to the conductor would not result in immediate failure but could potentially accelerate other degradation modes for covered conductors that could lead to failure over time. As examples, water intrusion could accelerate or exacerbate the following degradation modes:

- Accelerated corrosion of the conductor;
- Increased weight on the span, causing additional sag beyond design thresholds; and
- Water trapped underneath the covering could undergo freeze/thaw cycles that put additional hoop stress on the covering.

Given that water contact could potentially exacerbate these degradation methods, PG&E updated the existing inspection and maintenance processes to check for signs of each of the degradation modes listed above. For reference, PG&E's Overhead Assessment Job Aid (TD-2305M-JA02) is available on our website.[44]

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[44] This job aid is available on the PG&E Community Wildfire Safety Program website, under the 2023-2025 Wildfire Mitigation Plan and associated documents section: https://www.pge.com/en/outages-and-safety/safety/community-wildfire-safety-program.html#accordion-99016a73ab-item-c788794778.

The bullet points below provide details for how each of the failure modes are evaluated to determine degradation:

- Corrosion: Excessive corrosion causes an increase in resistance of the conductor and in the worst cases causes localized arching. Heating and arching will visually damage the covering of the covered conductor. PG&E's updated inspection process does look for indications of covering degradation caused by heating / arching.

- Water Weight: Excessive water intrusion can also increase the weight of the CC span. The excess weight would cause sagging and pull-through of the conductor at the tie points. PG&E's updated inspection process does look for signs of overloading and excessive sag.

- Freeze/Thaw cycle: Water that intrudes beneath the covering of the conductor could freeze and expand, putting additional hoop stress on the covering. This could cause bulging and cracking of the covering, which are both visual defects that are in the inspection checklist for PG&E's updated inspection process.

In addition to our existing inspection program, PG&E is also performing accelerated aging testing of covered conductors as part of our proactive asset risk assessment process. Testing includes corrosion testing in our new environmental chamber and evaluation of hoop stresses from freeze/thaw cycles. Findings and recommendations from this testing will continue to inform future improvements to the inspection and maintenance programs should they be necessary. This work will also provide PG&E with a better understanding of the useful life of covered conductors in various environmental conditions.

Furthermore, PG&E is developing a test plan to evaluate new types of CC that could provide improved protection against water intrusion.

ACI PG&E-23-09 – Decrease in Detailed Distribution Inspections

Description:

PG&E is adjusting its detailed distribution program inspection frequency to be based on plat maps instead of the HFTD. Under the new approach, PG&E will significantly reduce the number of distribution detailed inspections it performs each year. PG&E has not demonstrated that its proposed approach will mitigate risk more effectively than alternatives.

Required Progress*:*

In its 2025 Update, PG&E must:

- *Provide analysis supporting its decision to inspect the "high" risk plat map every two years, as opposed to annually. This analysis must include the find rate of Priority A and B conditions in the HFTD Tier 3 that overlap with "high" risk plat map, and a risk cost comparison of the currently proposed approach to an approach inspecting "extreme," "severe," and "high" risk plat maps annually.*
- *Provide analysis supporting its decision to inspect the "medium" risk plat map every three years, instead of every two years.*
- *Discuss how it will monitor risk in the "high," "medium," and "low" risk plat maps given less frequent detailed distribution inspections.*
- *Discuss if any alternatives to distribution detailed inspections will be implemented covering the structures that will experience less frequent detailed inspection.*

PG&E Response:

PG&E's decrease in detailed ground inspections in 2023 relative to previous years reflects our focus on delivering a more effective inspection program rather than simply maintaining similar inspection counts as were used in past years. We are excited to introduce a risk-based approach to match inspection frequency to wildfire risk. PG&E achieved this goal using two new critical tools: (1) the WDRM v3.0; and (2) the new aerial inspection program. The WDRM v3 risk model indicated that the vast majority of wildfire risk and consequence is concentrated in relatively few structures, enabling us to have a more targeted and data-based method for assigning certain areas for more frequent inspections. The new aerial inspection program in 2023 also increased our effectiveness by allowing us to identify additional critical conditions that would be challenging to see from ground inspections alone and to develop a coordinated 2023 plan to achieve more eyes on risk across both ground and aerial inspection programs.

Together, these developments were the basis for the inspection frequencies underlying the 2023 inspection plan and enabled PG&E to improve its eyes-on-risk in HFTD, relative to previous years, while inspecting fewer structures than in previous years. In 2023, PG&E was able to achieve a combined eyes on risk for its distribution inspection program of approximately 56 percent by inspecting approximately 273,000 structures, approximately 236,000 structures by ground and approximately 37,000 structures by

aerial.[45] This provided a comparable amount of eyes-on-risk achieved by the previous strategy in 2022 that relied on approximately 400,000 ground inspections alone and did not utilize any risk models. This 2023 outcome was attained by inspecting extreme and severe (E&S) consequence plat maps annually, high plat maps every other year, and medium and low plat maps once every three years, all frequencies that exceeded the GO 165 compliance requirements of inspecting all distribution assets every five years. This risk-based plan averages about 220,000 structures a year in HFTD. The updated inspection strategy provides PG&E with a comparable amount of eyes-on-risk while reducing the total number of annual inspections, providing increased value for our customers.

The reasoning behind inspecting High consequence areas every other year, and medium consequence areas every three years, is discussed below along with the analyses required by the ACI.

1) Different levels of risk underlie different frequencies between extreme/severe and high and between high and medium consequence structures.

The decision to inspect high consequence structures every other year was based on the risk per structure in high consequence areas relative to the risk per structure in E&S areas. Table ACI-PG&E-23-09-1 shows that overall, the risk per structure in high consequence areas (5.5×10^{-6} risk/structure) is considerably less than the risk per structure in E&S consequence areas (9.2×10^{-6} risk/structure), justifying a lower inspection frequency.

Similarly, the decision to inspect medium consequence structures every three years was based on the risk per structure in high consequence areas relative to the risk per structure in medium areas. Table ACI-PG&E-23-09-1 shows that overall, the risk per structure in medium consequence areas (2.9×10^{-6} risk/structure) is considerably less than the risk per structure in high consequence areas (5.5×10^{-6} risk/structure), justifying a lower inspection frequency.

2) The high consequence assets receiving a lower frequency relative to the older inspection strategy have a lower risk than the structures that were formerly being inspected every three years and are now being inspected every year.

The approach of inspecting high consequence structures every other year also makes sense when you consider the transition to the 2023 plan from the inspection plan of previous years. Between 2020 and 2022, PG&E inspected all of Tier 3 annually, and 1/3 of Tier 2 each year. When comparing annual or every other year cycles for high consequence areas, the only high consequence structures that receive a less frequent inspection in the new strategy, relative to the older strategy, are the structures that are in Tier 3, since the high consequence structures from Tier 2 would be shifting from a 1-in-3 to a 1-in-2 year cycle. However, the risk of these Tier 3 high consequence structures (5.6×10^{-6} risk/structure) is actually *lower* than the risk of the structures that we were inspecting every three years in the past and are now being inspected every year (Tier 2 areas of E&S consequence, 9.0×10^{-6} risk/structure), justifying a lower

[45] The 2023 target for distribution ground inspection (Target AI-07) achieved a risk impact percent of 41 percent.

inspection frequency. It makes sense to assign these structures to an inspection cycle that is between the annual cycles that were previously assigned to Tier 3 and the 1-in-3 year cycles previously assigned to Tier 2.

A similar argument can be made to explain why it makes sense to inspect medium risk assets once every three years. The risk of these Tier 3 medium consequence structures (3.0×10^{-6} risk/structure) is actually *lower* than the risk of the structures that we were inspecting every three years in the past and are now being inspected every other year (Tier 2 high consequence, 5.4×10^{-6} risk/structure), justifying a lower inspection frequency.

TABLE ACI-PG&E-23-09-1:
RISK PER STRUCTURE BY CONSEQUENCE LEVELS

Consequence Rank	All HFTD/HFRA Structures	Eyes-on-Risk (EOR)	Risk/Structure
E&S	11,464	10.60%	9.2×10^{-6}
E&S-Tier 3	2,874	2.80%	9.7×10^{-6}
E&S-Tier 2/HFRA	8,590	7.70%	9.0×10^{-6}
High	68,481	37.80%	5.5×10^{-6}
High-Tier 3	27,697	15.60%	5.6×10^{-6}
High-Tier 2/HFRA	40,784	22.20%	5.4×10^{-6}
Medium	93,218	27.40%	2.9×10^{-6}
Medium-Tier 3	33,408	10.00%	3.0×10^{-6}
Medium-Tier 2/HFRA	59,810	17.40%	2.9×10^{-6}
Low	485,488	24.30%	0.5×10^{-6}
Low – Tier 3	138,965	8.50%	0.6×10^{-6}
Low – Tier 2/HFRA	346,523	15.80%	0.5×10^{-6}

3) Many high consequence structures were already included in PG&E's aerial inspection plan for 2023.

The decision to inspect high consequence structures every other year also considered the opportunity to optimize across ground and aerial inspection plans beginning in 2023. Because the aerial inspection can detect conditions that are challenging to see from ground (as described in Base 2023-2025 WMP Section 8.1.3.2.7 reference), we wanted to not only scale this inspection but to target it where an ignition would potentially have the greatest consequences while also using this new inspection to achieve eyes-on-risk on additional structures that were not included in the ground inspection plan. In 2023, aerial inspections included all E&S areas in addition to a portion of high consequence areas not covered by the ground inspections.

Of the approximately 68,000 structures in high consequence plat maps, roughly 30,000 structures were inspected by ground and an additional 26,000 structures were inspected by aerial. In other words, PG&E implemented a 2023 inspection plan where 82 percent of structures in high consequence plat maps were inspected in 2023 by

either ground or aerial. Since aerial has considerably higher A and B tag find rates compared to ground, by using aerial for those additional 26,000 structures on high consequence plat maps, PG&E actually detected more A and B priority conditions on its high consequence areas than if we had inspected those structures from the ground in 2023.

4) Riskiest structures are already included in the inspection plan every year regardless of their plat map consequence level.

All of the inspection frequency decisions (including both the decisions to assign a two-year frequency to high plat maps and a 3-year frequency to medium plat maps) were made with the understanding that the riskiest structures would be captured in the annual inspection plan regardless of the consequence ranking of their plat map. As described in Base 2023-2025 WMP Section 8.1.3.2.1, structures that constitute the top 10 percent of wildfire risk but are not already included in a plat map that is being inspected by ground or aerial was also included in the ground inspection plan.[46] Adding these structures to the inspection plan as stand-alone structures rather than entire plat maps enables us to be efficient while ensuring that the riskiest structures get inspected annually.

5) Inspecting all high consequence structures would come at an additional cost of roughly $4.3 million. Inspecting all of medium consequence structures would come at an additional cost of roughly $1.7 million.

Inspecting high consequence assets annually by ground would increase both the eyes-on-risk and the cost of the inspection plan relative to inspecting these assets every other year. PG&E calculates that approximately 37,000 additional inspections would need to be performed annually at a cost of roughly $4.3 million. Similarly, inspecting medium consequence structures every other year would result in 15,000 more inspections at an additional annual cost of $1.7 million.

These additional inspections would come at the cost of reductions elsewhere, including potentially to the aerial pilot. For example, inspecting all high consequence structures every year means that approximately 28,700 fewer aerial inspections can be executed as a tradeoff, and inspecting medium consequence structures every other year in addition to high means that no aerial inspections could have been executed in 2023.

Additional inspections could also require us to reduce activities that actually mitigate risk. While inspections identify risks on our system (eyes-on-risk), they do not mitigate risk unless maintenance work is actually performed. Under a finite budget, additional inspections means potentially removing work that mitigates risk such as the tag work, system hardening or PG&E's other critical WMP activities.[47] For 2023, PG&E's risk goal for inspections was to leverage the risk model to target inspections to the highest

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46 See PG&E 2023-2025 WMP, R4, p. 481.

47 For example, the pole replacement cost is estimated to be $26,500 per pole and the expense of closing an asset tag is estimated to be $2,700 per tag. Therefore, with the incremental $4.3 million cost of inspecting high consequence structures every year, PG&E could complete 1,593 expense tags or 162 pole replacements.

risk areas while achieving similar levels of eyes-on-risk compared to 2020 to 2022. The proposed plan for 2023 achieves this target while enabling us to continue to pilot and scale the aerial inspection program as well as execute significantly higher volumes of tags than we have in the past.

6) A and B find rates in 2023 are higher for high consequence areas in Tier 2, compared to those high consequence areas in Tier 3.

Table ACI-PG&E-23-09-2 shows the requested ground inspection find rates for priority A and B conditions in the HFTD areas that overlap with "high" risk plat maps.

Note that we do not necessarily expect a correlation between v3 wildfire consequence tier and find rates, as consequence is primarily based on factors that determine how a fire spreads (e.g., terrain and vegetation) while find rates are indicative of the condition of an asset, the guidance and training provided to inspectors, and the year last inspected, with assets that have received inspections more recently having lower find rates. For this last reason, find rates in 2023 are generally lower in Tier 3 areas since these structures were inspected annually between 2020 and 2022. Table ACI-PG&E-23-09-2 shows lower A and B find rates for the high consequence areas that are in Tier 3 compared to Tier 2.

TABLE ACI-PG&E-23-09-2:
GROUND INSPECTION FIND RATES FOR PRIORITY A & B CONDITIONS

	Priority	2023 Find Rate
High Plat Map and Tier 2	A	0.32%
	B	2.37%
High Plat Map and Tier 3	A	0.29%
	B	1.37%

PG&E continues to monitor risk in the "high," "medium," and "low" risk plat maps through other programs and activities:

1) Aerial Inspections: As described above, PG&E scaled its distribution aerial inspection program considerably in 2023 and can leverage this highly effective inspection to monitor risk. In 2023, PG&E targeted nearly 40 percent of high consequence areas with an aerial inspection, exclusively focusing on high consequence areas that did not receive a ground inspection. 82 percent of structures in high consequence plat maps were inspected in 2023 by either ground or aerial.

2) GO 165 Patrol Program: Any distribution structure in HFTD/HFRA that does not receive a detailed ground inspection, including those in High, Medium, and Low consequence areas will receive a patrol inspection once a year as described in Base 2023-2025 WMP Section 8.1.3.2.6.

3) Programs to Assess Open Tags: PG&E conducts a standalone field visit to assess open tags to check if they have escalated in severity to a higher risk level in order to

prioritize them for immediate or short-term repair or replacement. In 2023, nearly 100,000 of these stand-alone visits were conducted as part of PG&E's Field Safety Re-assessment program. PG&E also piloted using its aerial and intrusive inspection programs to reassess open tags as part of a new program called Comprehensive Pole Inspection (CPI). Moving forward in 2024, PG&E will continue to use CPI to monitor risk on open tags on eligible structures that are not part of the ground or aerial inspection plans.

4) Aerial Patrol Pilot: In 2024, PG&E will pilot an aerial patrol program in areas that are not receiving a detailed inspection this year. If successful, aerial technologies could be used to patrol areas that do not receive a detailed inspection in any given year.

5) Sensing and Monitoring Devices: As described in Base 2023-2025 WMP Section 8.3.3 Grid Monitoring Systems, PG&E deployed various devices to signal when real-time asset conditions may warrant attention. PG&E will continue to deploy these devices to monitor our system and will better integrate their outputs into inspection and asset management programs.

6) Other Activities: PG&E monitors risk and get additional eyes on risk in HFTD through its many other WMP activities, including EPSS and PSPS patrols, infrared inspections,[48] equipment inspections,[49] and vegetation management programs.

[48] See PG&E 2023-2025 WMP, R4, p. 484.

[49] See PG&E 2023-2025 WMP, R4, p. 487.

ACI PG&E-23-10 – Current Limiting Fuse Replacement

Description:

PG&E has experienced an increase in current limiting fuse failures and identified the root cause to be an internal weld separation associated with certain models. PG&E has stopped the installation of the affected current limiting fuses but does not provide a plan to address the inventory that has already been installed.

Required Progress*:*

In its 2025 Update, PG&E must provide a plan that outlines specific steps and measures PG&E will take to reduce the risk of the affected fuses installed in its service territory.

PG&E Response:

PG&E primarily uses current limiting fuses to protect equipment, such as overhead distribution transformers. Our most commonly used current limiting fuse is called a Fault Tamer® Current Limiting Fuse (FTCLF), which is constructed with a low current fuse in series with a current limiting fuse, which is designed to combine the benefits of each fuse type in one unit. The backup limiter portion operates only during high current faults, usually caused by overhead distribution transformer failures. During low current faults, the backup limiter portion is reusable if the low current fuse element is re-fused.

Between April 2020 and April 2023, PG&E is aware of 26 incidents where a FTCLF burned and the causal investigation indicated that the root cause was an internal weld separation within the backup limiter portion of the fuse, caused by a manufacturing defect. Based on these findings, we immediately implemented a full stop on installing FTCLFs and purged all uninstalled inventory. This stop was executed in October 2022.

The cause investigation determined that the weld defect leads to internal “micro-arcing” under normal loading conditions—as opposed to in response to a fault—and can lead to a thermal runaway event where the backup limiter portion of the fuse melts and burns. Thermal runaway results in melted plastic and hot sand dropping to the ground, which has the potential to start a ground fire. Our evaluation of the available installation and mis-operation dates of the failed FTCLFs showed that 88 percent failed within 300 days of installation, and the remaining within 543 days. Based on this evaluation, and that we began installing these fuses over 20 years ago and have many years of data, we have concluded that the probability of failure decreases with time.

Since the FTCLFs fail under load, and not in response to a fault, an installed unit is susceptible to this failure mode under normal operating conditions. However, as discussed above, the probability of failure is inversely correlated with time in service, and we are beyond 500 days since the last FTCLF was installed. There have been no known new or FTCLF failures since April 2023. Accordingly, we do not currently have plans to proactively replace the existing FTCLFs in the field.

Laboratory testing performed by PG&E to simulate the failure mode showed that the FTCLFs run hot for a period of approximately 1 to 90 days before a thermal runaway event occurs. In 2022, we piloted an infrared inspection trial of the most recently

installed FTCLFs, which did not flag any thermal anomalies. FTCLFs were also added into our Distribution Infrared Inspection program in 2023, and again there were no findings. In addition, for the past 18 months, we have worked with the manufacturer to align on the development and implementation of strong controls for the weld quality and for all parts of the manufacturing process. Once the manufacturer releases its updated FTCLF in 2024, we anticipate testing the new device as part of our recertification process. If the updated FTCLF is recertified, we will evaluate it for future use in the field, including potential replacement of existing FTCLFs, where appropriate.

Thus, PG&E took, or will take, the following specific steps and measures to reduce the risk from the affected current limiting fuses: (1) implementing a full stop on installing FTCLFs manufactured prior to 2023; (2) purging all existing inventory of potentially defective FTCLFs; (3) instituting an investigation to determine the cause of the issue; (4) considering the inverse relationship between FTCLF failures and time in service; (5) conducting laboratory testing to simulate the failure mode; (6) piloting an infrared inspection trial of the most recently installed FTCLFs to identify thermal anomalies; (7) adding FTCLFs to our Distribution Infrared Inspection program in 2023; (8) working with the manufacturer to align on additional controls in the manufacturing process to mitigate the root cause; (9) testing the new FTCLFs once they are released by the manufacturer; and (10) determining whether the new FTCLFs should be used in the field, including potential replacement of existing current limiting fuses, where appropriate.

ACI PG&E-23-11 – Transformer Predictive Maintenance

Description:

PG&E states it has developed a modeling tool that can identify distribution transformers with a high probability of failure but does not commit to leveraging this model to proactively replace transformers in areas of high fire risk.[50]

Required Progress*:*

In its 2025 Update, PG&E must:

- *Provide a timeline for the evaluation and production roll out of Electric Program Investment Charge (EPIC) 3.20 Data Analytics for Predictive Maintenance, Part 1 – Distribution Transformers.*
- *Describe how the model will be incorporated into PG&E's existing maintenance and/or inspection programs.*

PG&E Response:

The core objective of the EPIC 3.20 project was to determine if machine learning models can be developed using existing utility data sets to predict electric distribution equipment failures and outages, so that corrective action can be taken before either occurs.

The base model, developed as part of EPIC 3.20, was found to have a strong ability to successfully identify voltage related anomalies with the transformer. Although this helps PG&E identify transformers operating outside of operational standards, the base model struggled to precisely predict when a transformer will fail, which makes it difficult to properly prioritize replacement of transformers that have high risk of failure.

Therefore, two actions were taken after conclusion of EPIC 3.20 project:

1. Operationalized Power Quality Management Tool: Given the strength of the base model in identifying voltage anomalies, a power quality tool was operationalized in December 2022. This tool leverages the base model to detect High Rule 2 violations (high voltage) for distribution transformers and their associated service points. This tool has allowed the power quality team to conduct increased reviews with higher efficiency. Additionally, it has increased the data quality and reduced process error risk.

2. Continued Model Development to Predict Transformer Failure (Funded Outside of the EPIC Program): In May 2022, the Epic 3.20 Transformer Predictive Maintenance Model transitioned to the IONA project. This transition allows us to further enhance the EPIC's research-oriented model framework to improve prediction accuracy for transformer failures.

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50 See PG&E 2023-2025 WMP, R4, p. 513.

In 2023, significant improvements were made to the prediction model to improve the prediction accuracy. These improvements included:

a) Incorporating transformer oil temperature and transformer aging calculations using Institute of Electrical and Electronics Engineers C57.91-2011 standards;

b) Incorporated more years of data for model training; and

c) Labeled more transformer outages to provide as input to the training model.

In 2024, PG&E will work on testing the accuracy of the prediction model in predicting transformer failures. If the improvement in accuracy level enables us to achieve beneficial risk spend efficiency, then PG&E will operationalize the IONA model.

ACI PG&E-23-12 – Distribution Backlog Open Tag Reduction Targets

Description:

In its Supplemental Revision Notice Response, PG&E provided a revised plan to address its distribution tag backlog that it stated will address distribution ignition tags at a faster pace than its original submission. PG&E expects this approach to enable closure of 66,200 ignition tags in 2024 and 59,000 ignition tags in 2025, as opposed to the original submission's 46,000 in 2024 and 55,000 in 2025. The targets PG&E committed to only reflect the original submission's 46,000 in 2024 and 55,000 in 2025.

Required Progress*:*

PG&E's targets must reflect the pace of its revised plan for addressing tags over the 2024-2025 period. In its 2025 Update, PG&E must provide an update to its distribution backlog targets in Tables 7-3-2, 8-3, and RN-PG&E-23-04-2 to reflect distribution ignition backlog tag closures of 79,200 in 2025, as stated in the revised plan narrative. The number 79,200 includes the 59,000 target for 2025, plus an additional 20,200 tags. The balance of the additional tags PG&E expects to complete in 2024 is 20,200 under its revised plan, but this is not reflected in its 2024 target. If PG&E completes the additional 20,200 tag closures in 2024 as projected, PG&E must only meet its stated 59,000 target in 2025.

PG&E Response:

PG&E will increase its targeted amount of backlog ignition tags to meet the increased 3-year cumulative target of 154,200 units by 2025. However, we note that by increasing the number of backlog ignition tags to be completed as part of this target, we lose the flexibility to work newly discovered high-risk tags if more of these tags are discovered than anticipated. This is why—to maintain this flexibility—we initially set the target at 46,000 backlog ignition tags in 2024, and 55,000 backlog ignition tags in 2025. If more high-risk backlog tags are discovered, and we are forced to choose between working these high-risk tags or lower risk backlog tags, we will have to prioritize the newer high-risk tags since working these high-risk tags first will reduce a higher proportion of risk on our system. If this situation occurs, we would urge Energy Safety to take this into consideration when it performs its compliance review as we will have chosen to make our system safer rather than allowing additional risk to remain on the system simply to meet a compliance target.

Additionally, in 2023, we were able to exceed our target by closing an additional 15,453 distribution ignition backlog tags than originally forecasted. Consistent with the precedent set in this ACI, we are applying these additional tags executed in 2023 toward the cumulative 2023-2025 target of 154,200 by reducing the 2025 target number in an equivalent amount. We understand that Energy Safety was not aware of PG&E's outperformance of the 2023 target at the time this ACI was provided, but urge Energy Safety to consider these backlog tags as counting toward the higher 3-year cumulative total since these tags were closed as part of this same 3-year WMP cycle. Indeed, we should not be penalized for resolving these backlog tags earlier than anticipated, rather than waiting until 2024 to resolve them and remove this risk from our system. Consequently, we have updated the revised 2025 target to reflect the 15,453 additional units already completed and the 63,747 units targeted in 2025. This will bring the

3-year total for this work to the 154,200 units identified by Energy Safety in Table RN-PG&E-04-2.

Table ACI-PG&E-23-12-1 below is an updated target table showing the original target numbers proposed by PG&E, the higher target numbers set by the ACI, and the higher target numbers reduced by the supplemental backlog units completed in 2023.

TABLE ACI-PG&E-23-12-1:
SUMMARY OF UPDATED TARGET FOR 2023 2025

Version	2023	x% Risk Impact 2023[(a)]	2024	x% Risk Impact 2024[(a)]	2025	x% Risk Impact 2025[(a)]	2023-2025
Target (Original + RN)	29,000	2.4%	46,000	<1%	55,000	<1%	130,000
ACI PG&E 23-12	29,000	2.4%	46,000	<1%	79,200	<1%	154,200
Actuals + Updated Commitment	44,453	3.6%	46,000	<1%	63,747	<1%	154,200

(a) The percent Risk Impact provided in this table is calculated based on the risk reduction of the mitigation initiative divided by total overall utility risk as defined in Section 6.4.2, Section 7.2.2.2, and Section 7.2.2.3 of PG&E's 2023-2025 WMP, R4.

We would also like to make Energy Safety aware that the table which the higher targets were based on—Table RN-PG&E-23-04-1—contains a typographical error. The table inadvertently defines PG&E's asset tag backlog as consisting of only ignition risk tags.[51] While ignition risk tags are certainly our priority given their higher risk value, they constitute only a portion of the total backlog, which also consists of non-ignition risk tags. Indeed, Table RN-PG&E-23-04-1 identifies 259,000 backlog tags forecasted to be executed between 2023 and 2027, and this number includes both ignition risk tags as well as non-ignition risk tags.

51 See PG&E 2023-2025 WMP, R4, p. 541, footnote (f) ("Backlog is defined as the open ignition EC notifications known as of January 5, 2023, and found prior to January 1, 2023, in HFTD/HFRA locations.").

ACI PG&E-23-13 – Workforce Planning and Resource Allocation to Respond to EPSS Events

Description:

PG&E does not provide an adequate demonstration of plans for operational resources to respond to outages that occur when EPSS is enabled, particularly given that historically PG&E's use of EPSS was either at a smaller scale or during a year with a low number of high wind events.

Required Progress:

In its 2025 Update, PG&E must provide:

- *PG&E's workplan for resourcing EPSS-enabled outages. The workplan must include discussion of how PG&E plans to obtain additional workforce resources, additional training, how PG&E plans to develop additional resources, and how PG&E intends to balance its existing workforce.*

- *An analysis showing proper workforce coverage and planning to respond to both EPSS-enabled outages as well as potential ignitions during high-risk weather events.*

PG&E Response:

PG&E's restoration response and resource staffing plan involves a multifaceted and nimble approach to identify and allocate resources to support patrol and restoration activities. This approach is based on existing practices in place within local divisions that support escalated outage response activity. It is enhanced by the EPSS Program's daily monitoring of patrol and restoration performance against established metrics. The EPSS Program also developed additional strategies to support resource planning and augmentation for response to EPSS outages and potential ignitions during high-risk weather events. These additional strategies include: (1) an update to the Storm Outage Prediction Project (SOPP) model; (2) the staging of helicopter assets throughout our service territory; (3) a plan to surge when necessary, using internal and contract inspection personnel; and (4) shifting our local teams from planned work to outage response when high volumes of customers are out for extended duration.

PG&E believes our resource plan for responding to outages while EPSS protection is enabled is adequate and that this adequacy has been demonstrated through our performance in responding to EPSS outages. To monitor performance of field personnel response, and restoration, of outages on EPSS-enabled circuits, the EPSS Program established a Customer Average Interruption Duration Index (CAIDI) metric to restore all outages on EPSS enabled circuits within 240 minutes or less in 2022 and 210 minutes or less in 2023. In both years, PG&E exceeded those targets, with customers on average experiencing EPSS outages of 176 minutes in 2022 and 193 minutes in 2023.[52] Furthermore, in 2022, the likelihood of customers

[52] We note that the CAIDI score when excluding Major Event Days (MED) was 183 minutes for 2023.

experiencing an extended outage (i.e., an outage of 12 hours or more) on EPSS enabled lines was 29 percent lower than for all PG&E outages.

Additionally, we continuously monitor our EPSS outages and response times to ensure we have an appropriate workplan and workforce. On a daily basis, through Regional EPSS Outage Reviews, all EPSS outages from the prior day are reviewed. If the target is exceeded, it is identified through the Daily Outage Review process. The Project Management Office's Operations Section, in partnership with its Field Operation partners, will look to identify the driver of the CAIDI miss and determine appropriate corrective actions. Furthermore, PG&E set a response target to respond within 60 minutes for all outages initiated at an EPSS-enabled device. In 2023, PG&E maintained a 90 percent response rate within 60 minutes, with an average response time of 45 minutes, exceeding our target of an 85 percent response rate within 60 minutes. This metric is also examined through the Daily Outage Review process to ensure continued performance to the target, an appropriate work plan, and adequate workforce levels.

PG&E's restoration response and resource staffing plan is detailed below:

a) Standard Outage Response Protocols and Resource Escalation: PG&E's standard protocols for outage response include dispatch of trouble personnel resources from within the division where the outage has occurred. When local trouble personnel resources are exhausted, division leadership in coordination with the local control center dispatch will assign local crew resources to support the patrol and restoration of the outage. If outage activity increases or durations are extended, the division will look to general construction crews or neighboring divisions within the region to draw on available resources.

b) SOPP Model: A key resource to support local divisions in planning for daily resource requirements for anticipated outage activity is the Distribution System Operations SOPP. SOPP is a modeling system (a collection of models) that is used to predict the number of transformer level and above sustained outages per division for each of the next four days. The model combines wind, snow, and heat models into a single modeling system. The resource needs (crew and trouble personnel resources) are derived from the predicted storm outage numbers. For fair weather days, a historical background estimator has been developed to estimate the number of storm outages.

In 2022, the PG&E Meteorology team incorporated actual EPSS outage data into the model to adjust the historical background data. This will allow division leadership to have visibility into a four-day period the estimated number of storm outages, including those that may be associated with EPSS enabled circuits and therefore allow for better planning of the resources needed in response to an EPSS related outage.

c) Rapid Response Patrol Helicopters: Through our PSPS Program, PG&E conducted an analysis of the resource requirements to conduct patrols on circuits within the HFRA. The EPSS Program used this analysis to identify the aerial resource requirements necessary to augment ground patrols during the patrol and restoration of outages on EPSS-enabled circuits. The EPSS Program's Rapid Response Helicopter patrol strategy augments field resources and allows for aerial patrols to

take place in locations that are geographically challenged or unsafe to patrol by ground. This Rapid Response Helicopter plan provides for 16 helicopters to be staged in nine locations throughout the service territory. These helicopter resources can be operational, patrolling a zone, within 50 minutes or less from dispatch.

d) Surge Personnel: When the EPSS Program, in partnership with their field operations partners, identifies resource shortfalls to support patrol and restoration activities, PG&E's surge plan includes supplementing field resources with system inspection staff. While internal resources are redirected to support EPSS operations, System Inspections would utilize contract resources to maintain normal inspection operations. The program will evaluate in-season requirements and work with the System Inspection program if additional resources are required to support the program.

ACI PG&E-23-14 – Effectiveness Analysis for EPSS Including Implementation of DCD

Description:

PG&E currently includes DCD within its mitigations but has not provided adequate analysis demonstrating effectiveness of DCD, particularly in comparison to potential reliability impacts when combined with EPSS.

Required Progress:

In its 2025 Update, PG&E must provide an updated analysis of the potential reliability impacts and mitigation effectiveness of implementing EPSS based on observed data from implementation in 2023, particularly in combination with DCD. This must include:

- *Evaluation of effectiveness based on EPSS outage causes in relation to avoided ignitions.*
- *Number of outages and outage frequency that occurs on circuits with DCD implemented.*
- *PG&E's methodology for determining effectiveness for DCD, including ignitions that have occurred when each is implemented.*
- *Measures to alleviate any associated reliability and safety impacts PG&E has observed since implementation of DCD.*

PG&E Response:

In 2023, PG&E expanded a limited DCD pilot, that began in 2022, to approximately 17,000 miles of protection. The enablement of this technology at scale is unprecedented in the industry. In 2023, several key learnings related to ignition effectiveness, reliability, and risk management were collected and will be incorporated into improvements as this technology is further deployed.

Evaluation of Effectiveness Based on EPSS Outage Causes in Relation to Avoided Ignitions.

Our evaluation of the effectiveness of DCD—based on EPSS Distribution outage causes in relation to avoided ignitions through 2023—identified that CPUC reportable fire ignitions on EPSS enabled circuits were reduced by approximately 72 percent relative to the 3-year historical average. This EPSS effectiveness calculation compares current EPSS deployment against historical ignitions that occurred when and where EPSS would have been enabled leveraging current criteria and historical meteorology data.

Number of Outages and Outage Frequency That Occurs on Circuits With DCD Implemented.

During the year 2023, there were 332 outages on EPSS circuits that were DCD-enabled and the System Average Interruption Frequency Index for these circuits was 0.062.

PG&E's Methodology for Determining Effectiveness for DCD, Including Ignitions That Have Occurred When Each Is Implemented.

PG&E's DCD effectiveness is calculated using the current year percentage reduction in ignition count using CPUC-reportable ignition data at the circuits where EPSS is enabled relative to historical average number of total reportable ignitions. During 2023, two ignitions occurred where DCD was enabled. However, DCD settings mitigated at least 17 events that likely would have resulted in an ignition had DCD not been enabled. These 17 events are a subset of the overall 332 DCD outages where fault types such as wire on ground or vegetation into line were observed which could have led to an ignition. Other fault types such as DCD trips for underground equipment faults were not considered as part of this selection.

Measures to Alleviate Any Associated Reliability and Safety Impacts PG&E Has Observed Since Implementation of DCD.

PG&E implemented multiple operational measures to improve reliability and continues to work with vendors who supply DCD technology to improve the algorithms to reduce reliability impacts while maintaining protection sensitivity. These operational mitigations include:

- The performance of real-time engineering analysis when events occur to further distinguish credible versus suspect nuisance operation to provide restoration more quickly without full patrol in cases where sustained and specific arcing signatures are not present;

- Planned switching and clearance work restoration procedures in the event DCD protection trips during known field switching conditions allowing for direct restoration without patrol;

- Post-restoration detailed patrols to determine if cause of DCD trip may be related to internal equipment, protection equipment issues, or incipient faults; and

- The creation of a settings tuning strategy that incorporates adjustment and alarm only period to ensure nuisance fault events are reduced to the extent possible.

In addition to the above operational mitigations, technology improvements in the DCD algorithm include:

- Review of all DCD events for categorization and learning, as well as providing data and analysis back to vendors for future enhancements;

- The tuning of parameters and settings via post-event playback to reduce nuisance trip events;

- The development of improved algorithm features to reduce nuisance trip events while preserving detection capability; and

- The evaluation of additional DCD algorithms which may be more effective on 4-wire vs. 3-wire circuits.

During the 2023 widespread DCD pilot, the above identified lessons learned have come out of the field deployment. These have been directly used to inform future DCD algorithm firmware changes which will be able to be implemented in 2024 to further reduce nuisance trip events. These changes will be employed to existing commissioned devices as well as to new devices.

ACI PG&E-23-15 – Implementation of Focused Tree Inspections and Addressing the Risk from Hazard Trees

Description:

PG&E has committed to further implementing Focused Trees Inspections and to addressing the risk from hazard trees but details regarding recordkeeping, refinement of the Areas of Concerns, and long-term planning remain unclear.

Required Progress*:*

In its 2025 Update, PG&E must:

- *Describe the enhancements it has made and will make to its vegetation management recordkeeping, by, in part, providing:*
  - *A list of the information that will be digitally recorded during Focused Tree Inspections (FTI), Routine, Second Patrol, Vegetation Management for Operational Mitigations (VMOM), and Tree Removal Inventory (TRI) that capture factors for prescribing trees for removal.*
  - *A list of the information PG&E will collect during FTIs on all potential strike trees inspected using a digitized Tree Risk Assessment form.*
- *Describe how it has updated the Areas of Concern for 2024 FTIs including, but not limited to, what inputs were used to create the polygons and how those polygons are ranked by risk.*
- *Describe its decision-making process for selecting Areas of Concern for 2024 FTIs.*
- *Describe its plan to update the Areas of Concern for 2025 FTIs including, but not limited to, what inputs were used to create the polygons and how those polygons will be ranked by risk.*
- *Describe how it has or will select Areas of Concern for 2025 FTIs.*

Additionally, in its 2026-2028 Base WMP, PG&E must present its plan for consistent HFTD-wide hazard tree-related risk reduction by inspection and remediation. In its development of this plan, PG&E must continue its dialogue with its peer electrical corporations and Energy Safety and remain abreast of hazard tree inspection and remediation strategies, including, but not limited to, tools for risk assessment, recordkeeping practices, and frameworks for risk-informed inspections (i.e., when, where, and how often to inspect for hazard trees based on risk).

PG&E Response:

<u>A List of the Information that Will Be Digitally Recorded During FTIs, Routine, Second Patrol, VMOMs, and TRI that Captures Factors for Prescribing Trees for Removal.</u>

For our FTIs, Routine, Second Patrol, VMOM, and TRI programs, the following information will be digitally recorded for trees prescribed for removal, as per the scope of each program: address, tree location, time and date of inspection, inspector's name

and LAN ID, site factors, tree health, species profile, load factors, tree defects and conditions affecting the likelihood of failure, and mitigation options, if any.

A List of the Information PG&E Will Collect During FTIs on All Potential Strike Trees Inspected Using a Digitized Tree Risk Assessment Form.

PG&E will be making digital record enhancements to FTI potential strike trees. To this end, the following fields will be digitally collected from all potential strike trees at the time of inspection: address, tree location, time and date of inspection, inspector's name and LAN ID, site factors, tree health, species profile, load factors, tree defects and conditions affecting the likelihood of failure, and mitigation options, if any.

How PG&E Has Updated the Areas of Concern for 2024 FTIs Including, But Not Limited to, What Inputs Were Used to Create the Polygons and How Those Polygons Are Ranked by Risk.

For a detailed description of Areas of Concern version 1 (AOCv1) methodology and development, please refer to Attachment 2024-04-02_PGE_2025_WMP-Update _R0_ACI-23-15_Atch01. Phase 5 defines reviews and actions taken in 2023 to update AOCv1 to complete a plan for 2024. Phases 1 through 3 describe the data and inputs and development steps taken to develop AOCv1. Phase 6 describes the steps taken to approve the plan that is planned for implementation in 2024.

The plan to create Areas of Concern version 2 (AOCv2) for 2025 FTI is currently in development. The methodology and development will utilize insights gained from the pilot program and the understanding of lessons learned. Initial AOCv2 is likely to be comprised of a collection of end-to-end CPZs. This approach will consider a shift away from AOCv1 polygons that only covered portions of CPZs.

How PG&E's Decision-Making Process for Selecting Areas of Concern for 2024 FTIs.

The prioritized 2024 Areas of Concern (AOC) and FTI workplan originate from the same three tranche workplan and methodology used in 2023 and is detailed in Attachment 2024-04-02_PGE_2025_WMP-Update _R0_ACI-23-15_Atch01. This decision-making process incorporated a mix of qualitative feedback from SMEs and various quantitative, data-informed factors. A key element in determining AOCs and FTI workplan is the final risk ranking WDRMv3 prioritized the 2024 workplan.

How PG&E's Plan to Update the Areas of Concern for 2025 FTIs Including, But Not Limited to, What Inputs Were Used to Create the Polygons and How Those Polygons Will Be Ranked by Risk.

Additionally, several quantitative factors are under consideration to potentially influence the AOC design. These include the recent condition of vegetation, as indicated by health index and evapotranspiration data, outputs from the Outage Probability Weather (OPW) model, recent vegetation-related outage and PSPS damage clusters, Fire Potential Index (FPI), and the updated locations of potential strike trees on the system. These factors aim to provide a comprehensive and nuanced understanding of the AOCs for 2025.

How PG&E Has or Will Select Areas of Concern for 2025 FTIs.

The selection process for the AOCv2 is presently being developed. The approach for selecting AOCs, will consider incorporating complete CPZs. Inputs will involve a blend of quantitative inputs and qualitative feedback from SMEs. This strategy is geared towards establishing a replicable and model-based quantitative framework, which will be utilized to initially select an updated set of AOCs. Following this, the selected set will undergo a review and potential adjustments by SMEs utilizing a process similar to the phased development of AOCv1. This review process will be guided by specific quantitative factors, aiding the SMEs in their decision-making and ensuring a balanced and informed selection of the AOCs.

As instructed, PG&E will present our plan for HFTD-wide hazard tree-related risk reduction by inspection and remediation in the 2026-2028 Base WMP.

ACI PG&E-23-16 – Updating the Wood Management Procedure

Description:

PG&E's Wood Management procedure only addresses large wood generated by post-fire activities and EVM, does not consider wildfire and safety risks associated with leaving wood on site, and may not sufficiently take into consideration potential benefits to the program from improved customer relations.

Required Progress*:*

In its 2026-2028 Base WMP, PG&E must:

- *Benchmark the scope of its Wood Management program with, at minimum, SCE and Liberty Utilities, and justify the differences in scope.*
- *Provide a response detailing whether PG&E has considered how offering wood removal and disposal services to customers may reduce refusals related to vegetation management and how that consideration has informed any updates to PG&E's Wood Management program for the 2026-2028 WMP Base WMP.*
- *Attach an updated version of its Wood Management Procedure (TD7102P-26) that:*
  - *Reflects its current portfolio of vegetation management programs (e.g., FTI, TRI, VMOM).*
  - *Considers the wildfire risk related to accumulated fuels generated by PG&E's vegetation management activities.*
  - *Considers the risk and safety impact of leaving large woody debris onsite including, but not limited to:*
    - *Blocking, hindering, or potentially blocking (e.g., roll or blow into) ingress or egress (roads, driveways, walkways, etc.).*
    - *Violating defensible space laws or ordinances such as Public Resources Code section 4291 and Government Code section 51182.*
    - *Impede watercourses and drainages.*
    - *Otherwise create a hazard.*

PG&E Responses:

As instructed, this ACI will be addressed in PG&E's 2026-2028 WMP.

ACI PG&E-23-17 – Consolidation of Vegetation Inspection Programs

Description:

PG&E's vegetation management program for distribution circuits is complex, resulting in multiple touchpoints for customers and overlapping scopes of work for PG&E's personnel.

Required Progress*:*

In its 2026-2028 Base WMP, PG&E must present a plan to consolidate its vegetation inspection programs for distribution circuits in the HFTD with the following objectives:

- *Reduce the number of annual touchpoints from inspectors and tree crews due to overlapping scopes of work.*
- *Streamline the distribution inspection procedure, including reduction and/or consolidation of its attachments, to reduce confusion among government agencies, PG&E's customers, and vegetation personnel.*

Address the risk from vegetation contact through vegetation inspection, trimming, and removal while complying with applicable laws and Regulations.

PG&E Response:

As instructed, this ACI will be addressed in PG&E's 2026-2028 WMP.

ACI PG&E-23-18 – Improving Vegetation Management Inspector Qualifications

Description:

It is essential that PG&E ensure it has qualified personnel for vegetation inspections and has trained these personnel to adequately perform vegetation inspections.

Required Progress:

In its 2026-2028 Base WMP, PG&E must:

- *Present a plan to improve the level of qualifications and training of its current Vegetation Management Inspectors (VMI) (both contract and employee).*
- *Explain and provide the decision-making process for its consideration of updates to the minimum qualification and training requirements for its VMIs.*

PG&E Response:

As instructed, this ACI will be addressed in PG&E's 2026-2028 WMP.

ACI PG&E-23-19 – Continued Progression of Vegetation Management Maturity

Description:

In response to RN-PG&E-22-09, PG&E identified several initial steps to mature in certain capabilities in its vegetation management program.

Required Progress:

In its 2025 Update, PG&E must report on progress, outcomes, and lessons learned related to the development and implementation of these steps, including any resulting plans and timelines for Implementation.

PG&E Response:

Below is an update on the commitments made, and actions taken by PG&E, in response to RN-PG&E-22-09.[53]

Commitment #1

Identify one or two of the highest risk regions in PG&E's service territory to implement a pilot process for inspections and to guide clearances. Given the substantial efforts being undertaken by our vegetation management team in multiple areas, we are proposing to implement this pilot in Q2 2023.

Actions Taken

1) Developing AOCs: PG&E began and completed a system-wide, county-by-county data- and SME-informed review starting in 2022 with the last revisions in September 2023. This initiative resulted in the development of the Areas of Concern Version 1 (AOCv1). AOCv1 produced 106 polygons in 20 counties intended to identify highest risk areas and regions specific to vegetation-caused outages and ignition drivers.

2) Implementing a Pilot Program: The FTI Program was first implemented as a pilot in Q2 of 2023. It was implemented in four AOCs, which were distinct vegetation regions within our service territory.

3) Analyzing Pilot Results: The 2023 FTI Program explored enhanced inspection practices and evaluated improvements to situational awareness to further inform and guide clearance recommendations. Based on results of the program, PG&E is moving forward with executing 1,500 miles of work in 2024.

Commitment #2

The pilot process would use our Targeted Tree Species Study to identify the tree species with the highest growth and highest failure potential. Using this information,

53 See PG&E 2022 WMP, Response to Revision Notice, July 26, 2022, pp. 7-16.

through the inspection process, identify additional clearances and begin inventory of tree by species and considerations (growth and highest failure rates).

Actions Taken

In addition to the development of AOCv1 and the piloting of the FTI Program, PG&E developed outage and ignition dashboards to aid evaluation of regional outage and ignition trends based on the data available. These dashboards allow for more detailed evaluation of tree species and failure drivers in advance of inspection cycles, including FTI. These actions align with recommendations identified in the 2022 Targeted Tree Species Study.

Starting in 2024, PG&E's FTI Program will begin an inventory of trees by species and considerations (growth and highest failure rates) through the program's inspection process.

Commitment #3

Based on the results of the pilot process, implement in other regions once developed and mature in the pilot regions.

Actions Taken:

In PG&E's 2023-2025 WMP, we made the commitment to annually perform 1,500 miles of FTI work within AOCv1 risk-ranked ranked polygons in both 2024 and 2025. This will further mature the program towards a more holistic, system-wide implementation.

Commitment #4

Develop a collaborative, cross-functional team similar to SCE in creating Areas of Concern and having the cross-functional team develop guidelines to inform inspections to include tree species, fire footprint, ignitions and to consider re-sequencing mid-cycle inspections, potentially increasing clearances, and enhancing prioritization of vegetation management work that is identified during inspections.

Actions Taken

PG&E developed a collaborative, cross-functional team, similar to that created by SCE, beginning in September 2022. Stakeholders contributed data, work-products and/or SMEs to develop AOCv1. This methodology and approach are planned to continue through annual or ongoing engagement as new data, technologies or enhancements become available. AOCv2 will be developed by June 30, 2024, which will improve or enhance the approved FTI plan for 2025.

Commitment #5

Review the Process and Procedures for collecting and enhancing checklists for field inspections and current clearance guidance.

Action Taken

PG&E is currently in the process of reviewing and implementing changes to our VM inspection procedures. PG&E published updated documentation for our FTI, VMOMs, and TRI programs in Q1, 2024. PG&E is continuing to evaluate procedures on an annual basis. Please see the following attachments for recently published procedural attachments:

- Vegetation Management Distribution Inspection Procedure: Attachment 6, Tree Removal Inventory Program- TD-7102P-01-Att06.
- Vegetation Management Distribution Inspection Procedure: Attachment 7, Focused Tree Inspection Instructions – TD-7102P-01-Att07.
- Vegetation Management Distribution Inspection Procedure: Attachment 8, Vegetation Management Operational Mitigation (VMOM) Procedures – TD-7102P-01-Att08.[54]

In 2023, the Vegetation Management Distribution Inspection Procedure (DIP) (TD-7102P-01_Rev.2[55]) was published providing guidance on obtaining enhanced clearances. Please see Section 4.1.2.a of the TD-7102P-01 Rev.2: "Prescribing Work to Maintain EVM Clearances" where PG&E details that VMI prescribing work need to do so in a matter that a clear vertical plane with a minimum of four feet from the outside conductor and a radial clearance with a minimum of 12 feet is to be met at the time of trim.

Second Patrol, and Routine procedural updates, are anticipated to be completed by the end of Q3 2024. The information collected for trees prescribed for removal, as per the scope of each program, may include: property address, tree location, time and date, inspector's name and LAN ID, site factors, tree health, species profile, load factors, tree defects and conditions affecting the likelihood of failure, and mitigation options, if any.

Commitment #6

Develop a process to guide optimal clearance beyond statutory requirements by species and region.

Action Taken

Under the FTI Program, PG&E's approach to guide optimal clearances is to utilize Tree Risk Assessment Qualification (TRAQ) certified arborists to inspect AOC's. The FTI

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54 Each of these three procedures are available on the PG&E Community Wildfire Safety Program website, under the 2023-2025 Wildfire Mitigation Plan and associated documents section: https://www.pge.com/en/outages-and-safety/safety/community-wildfire-safety-program.html#accordion-99016a73ab-item-c788794778.

55 This procedure is available on the PG&E Community Wildfire Safety Program website, under the 2023-2025 Wildfire Mitigation Plan and associated documents section: https://www.pge.com/en/outages-and-safety/safety/community-wildfire-safety-program.html#accordion-99016a73ab-item-c788794778.

Program will document Level 2 inspections on trees with likelihood of impact to PG&E's electrical facilities, in risk-prioritized AOC areas. Please note PG&E already implemented changes to the FTI procedure as of Q1 2024. Please see the following attachment for the current FTI procedure: TD-7102P-01-Att07.[56]

PG&E implemented in-person trainings to better support and educate inspectors on enhancements made to procedural documentation. As noted above, outage and ignition dashboards will complement the pre-evaluation of inspection areas to identify regional outage and ignition drivers specific to vegetation attributes and conditions for all programs. This approach blends high inspector resource competencies with detailed data and analysis to best inform optimal clearances and targeted tree mitigations beyond statutory requirements by species and region.

Commitment #7

Evaluate how mid cycle inspections sequence can be adjusted to align with Areas of Concerns in highest risk regions.

Action Taken

PG&E is currently evaluating how mid-cycle inspections sequence can be adjusted to align with Areas of Concerns in highest risk regions. PG&E expects to provide an update on this issue in the 2026-2028 base WMP.

Commitment #8

Evaluate the feasibility of developing a multi-year historical tree data set.

Actions Taken

PG&E implemented the functionality to capture and maintain a multi-year, historical tree data set through the technology platform called One VM, which began compiling data in late Q1 of 2023. One VM functions as a singular platform which can both host historical individual tree records from multiple PG&E systems of record and create new records for individual trees. Each of the vegetation management programs, once integrated with One VM, will ultimately have the capacity to review any existing multi-year historical inspection and tree work records, as well as capture new individual tree records.

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56 This procedure is available on the PG&E Community Wildfire Safety Program website, under the 2023-2025 Wildfire Mitigation Plan and associated documents section: https://www.pge.com/en/outages-and-safety/safety/community-wildfire-safety-program.html#accordion-99016a73ab-item-c788794778.

ACI PG&E-23-20 – Reinspection of Trees in the Tree Removal Inventory

Description:

PG&E's vegetation management personnel may be removing healthy trees under the TRI program due to a conservative interpretation of the procedure.

Required Progress*:*

In its 2025 Update, PG&E must:

- *Consider updating the TRI procedure to prevent the removal of healthy trees, requiring TRAQ VMI to perform a Level 2 inspection of trees with a Tree Assessment Tool (TAT) Abate result, and assigning thresholds for removal using the results of the "Risk Rating Matrix" of the International Society of Arboriculture (ISA) TRAQ form.*[57]
- *Explain and provide the decision-making process on the above considerations.*
- *Provide evidence of how it has ensured its TRAQ certified arborists consistently interpret the current procedure, and any modifications to the procedure (e.g., training module or memo).*

PG&E Response:

In 2024, PG&E is piloting a process to re-evaluate trees previously listed for work due to an abate result with the now retired TAT. This limited geographical area pilot will seek to develop a standardized process for evaluating previously listed trees. The process will include a Level 2 inspection by a TRAQ-certified arborist and the use of the ISA Basic Tree Risk Assessment form. The tree health characteristics collected through the Basic Tree Risk Assessment form will be captured in the Vegetation Management system of record. Each instance of potential de-listing will go through a second review by a third party TRAQ-certified arborist, and final outcomes will be reflected in the tree record.

PG&E will be evaluating the data collected during the pilot and will use that to inform the decision whether to implement changes to the existing TRI procedure and processes.

To ensure that PG&E's TRAQ-certified arborists are consistently understanding and utilizing the most current and up to date procedures, PG&E will send out email communications and/or host in-person trainings when any revisions or modifications have been made to any procedure. Attachment 2024-04-02_PGE_2025_WMP-Update _R0_ACI-23-20_Atch01_CONF is a training presentation that describes how PG&E ensures its TRAQ-certified arborists are receiving updated procedural information.

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57 For example, if the likelihood of failure and impact is "high" or "extreme," the tree is removed. If it is "low," the tree is left standing. If it is "moderate," removal is the discretion of the TRAQ VMI.

ACI PG&E-23-21 – Identification of High-Risk Species for Focused Tree Inspections

Description:

I*n the procedure for PG&E's FTI, the methodology for identifying species for which inspectors are to "apply increase scrutiny" relies exclusively on outage rates.*

Required Progress:

In its 2026-2028 Base WMP, PG&E must define criteria for determining which species warrant increased scrutiny during FTIs and other inspections. PG&E must detail its methodologies for determining these species.

PG&E Response:

As instructed, this ACI will be addressed in PG&E's 2026-2028 WMP.

ACI PG&E-23-22 – Continuation of Effectiveness of Enhanced Clearances Joint Study

Description:

The large IOUs have jointly made progress addressing the Progression of Effectiveness of Enhanced Clearances Joint Study 2022 area for continued improvement (SDGE-22-20, PGE-22-28, and SCE-22-18). Energy Safety expects the large IOUs and their contracted third party to continue their efforts and meet the requirements of this ongoing area for continued improvement.

Required Progress*:*

In its 2025 Update, PG&E, along with SCE and SDG&E, must report on the progress and outcomes of the third-party contractor's analysis and evaluation of the effectiveness of enhanced clearances. This must include:

- *A list of the aligned variables related to vegetation risk events;*
- *A description of the chosen database type and architecture to warehouse the data;*
- *A description of how the third-party contractor incorporated biotic and abiotic factors into its analysis;*
- *The third-party contractor's assessment of the effectiveness of enhanced clearances including, but not limited to, the effectiveness of enhanced clearances in reducing tree caused outages and ignitions.*

Additionally, PG&E-22-28 established the expectation that the large IOUs make incremental progress and update their analyses with each WMP submission through at least 2025. With its 2026-2028 Base WMP, PG&E, along with SCE and SDG&E, must attach a white paper which discusses:

- *The IOUs' joint evaluation of the effectiveness of enhanced clearances including, but not limited to, the effectiveness of enhanced clearances in reducing tree-caused outages and ignitions;*
- *The IOUs' joint recommendations for updates and changes to utility vegetation management operations and best management practices for wildfire safety based on this study. This may include the IOUs' recommendations for updates to regulations related to clearance distances.*

PG&E Response:

Please see the following for joint response from the three Joint Utilities and PG&E's third party contractor.

EPRI Information for ACI Response

The Joint IOU Study on Enhanced Vegetation Clearances for Wildfire Mitigation technical work started in November 2022 and is scheduled to be completed by June 2024. The study is being completed by a third-party contractor, Electric Power Research Institute (EPRI). The study is divided into four phases: Database Evaluation; Database Development; Data Analysis; and Discussion of Options. Currently, the third-party contractor is finalizing the common database and plans to populate it in the first quarter of 2024. Analysis is anticipated to begin in March 2024.

A List of the Aligned Variables Related to Vegetation Risk Events.

Immersive discussions revealed significant differences between the databases from the three Joint Utilities (SCE, PG&E, and SDG&E). There were thousands of variables across the three different databases, only a subset of which were similar in terms of definition and methods of recording. The research team and utility SMEs discussed and selected the variables which were the most instructive for understanding the effects of enhanced clearance on wildfire mitigation.

EPRI examined a wide range of aligned variables from the three companies related to vegetation risk events. These were included in the common database, i.e., the Joint Utility database, built from the individual utility databases. Variables included are the definition of clearance levels/line clearances, timing of clearances, tree growth rates, event outages, trim codes, types of disturbances, weather at the time of the outage, distance to line of tree caused outage, definition of high fire risk area, date and time of tree caused outage, tree numbering system, tree species, ignition events, tree condition, and tree height, among other variables.

EPRI streamlined the Joint Utility database to include approximately 25 variables for the overall analysis. The utilities have supplied the desired time series data to support the project that includes over a decade of time series data for some variables. EPRI built out a Structured Query Language (SQL) database that contains tables for the common variables as well as individual utility-specific tables. These datasets contain all the original data variables from the individual utilities to understand the unique characteristics of vegetation management practices more fully from each utility. There are plans to conduct individual analyses as well as the combined analysis of the datasets.

The database schema in the next section shows common variables used in the study. There are currently 10 individual tables housing the common variables. The tables are:

TABLE ACI-PG&E-23-22-1:
DATA SET

Field	Data Type and Size	Definition
[DataSetID]	[tinyint]	Database table identification ID
[UtilityID]	[tinyint]	Utility (foreign key)
[Source]	[varchar](50)	Utility data set name

TABLE ACI-PG&E-23-22-2:
UTILITY

Field	Data Type and Size	Definition
[UtilityID]	[tinyint]	Database table identification ID
[Utility]	[varchar](200)	Utility name

TABLE ACI-PG&E-23-22-3:
CHANNEL

Field	Data Type and Size	Definition
[ChannelName]	[varchar](50)	Data point
[ChannelUnit]	[varchar](10)	Data unit
[DataType]	[varchar](10)	Data type
[DataSetID]	[tinyint]	Source data set (foreign key)
[SourceDataUnit]	[varchar](10)	Source data unit
[SourceName]	[varchar](50)	Source data name
[SourceFilePosition]	[smallint]	Source data position in source data set

TABLE ACI-PG&E-23-22-4:
OUTAGE

Field	Data Type and Size	Definition
[RadialClearanceCategoryID]	[tinyint]	Database table identification ID
[DistanceTreeCausingOutage]	[real]	Distance between circuit and tree causing outage
[LastVegManDate]	[datetime2](0)	Last date of vegetation management activity
[LatDamage]	[float]	Latitude of the tree that incurred damage
[LonDamage]	[float]	Longitude of the tree that incurred damage
[HighFireRiskAreaCombined]	[bit]	Did outage occur in a High Fire Risk Area? (Y/N)
[HighFireThreatDistrict]	[bit]	Did outage occur in a High Fire Threat District (Y/N)
[DateTreeCausedOutage]	[datetime2](0)	Date of outage caused by tree
[TreeID]	[varchar](20)	Tree ID
[IgnitionRelatedToOutage]	[bit]	Is the ignition related to the outage? (Y/N)
[Species]	[varchar](200)	Tree species
[TreeInInventory]	[bit]	Is tree in SCE's tree inventory? (Y/N)
[TreeGrowthRateID]	[tinyint]	Tree Growth Rate (foreign key)
[ESA]	[bit]	Did outage occur an Environmental Sensitive Area (ESA)? (Y/N)
[DBHCategoryID]	[tinyint]	DBH Category (foreign key)
[OutageCauseID]	[tinyint]	Outage Cause (foreign key)
[TreeConditionID]	[tinyint]	Tree Condition (foreign key)
[TreeHeightCategoryID]	[tinyint]	Tree Height Category (foreign key)
[ForesterInspectionComments]	[varchar](max)	Comments from Forester Inspection
[DistributionSystem]	[bit]	Did outage occur in Distribution System? (Y/N)
[Circuit]	[varchar](20)	Circuit name
[DeadDyingTreeBranch]	[bit]	Did Dead and Dying tree branch cause outage? (Y/N)
[UtilityID]	[tinyint]	Utility (foreign key)

TABLE ACI-PG&E-23-22-5:
OUTAGE CAUSE

Field	Data Type and Size	Definition
[OutageCauseID]	[tinyint]	Database table identification ID
[OutageCause]	[varchar](200)	Description of cause of outage

TABLE ACI-PG&E-23-22-6:
RADIAL CLEARANCE

Field	Data Type and Size	Definition
[RadialClearanceCategoryID]	[tinyint]	Database table identification ID
[RadialClearanceMin]	[int]	Radial Clearance lower boundary
[RadialClearanceMax]	[int]	Radial Clearance high boundary

TABLE ACI-PG&E-23-22-7:
DIAMETER-AT-BREAST HEIGHT (DBH)

Field	Data Type and Size	Definition
[DBHCategoryID]	[tinyint]	Database table identification ID
[DBHMin]	[int]	DBH low boundary
[DBHMax]	[int]	DBH high boundary

TABLE ACI-PG&E-23-22-8:
TREE CONDITION

Field	Data Type and Size	Definition
[TreeConditionID]	[tinyint]	Database table identification ID
[TreeCondition]	[varchar](50)	Description of tree condition

TABLE ACI-PG&E-23-22-9:
TREE GROWTH RATE

Field	Data Type and Size	Definition
[TreeGrowthRateID]	[tinyint]	Database table identification ID
[GrowthRate]	[varchar](10)	Tree growth rate ??

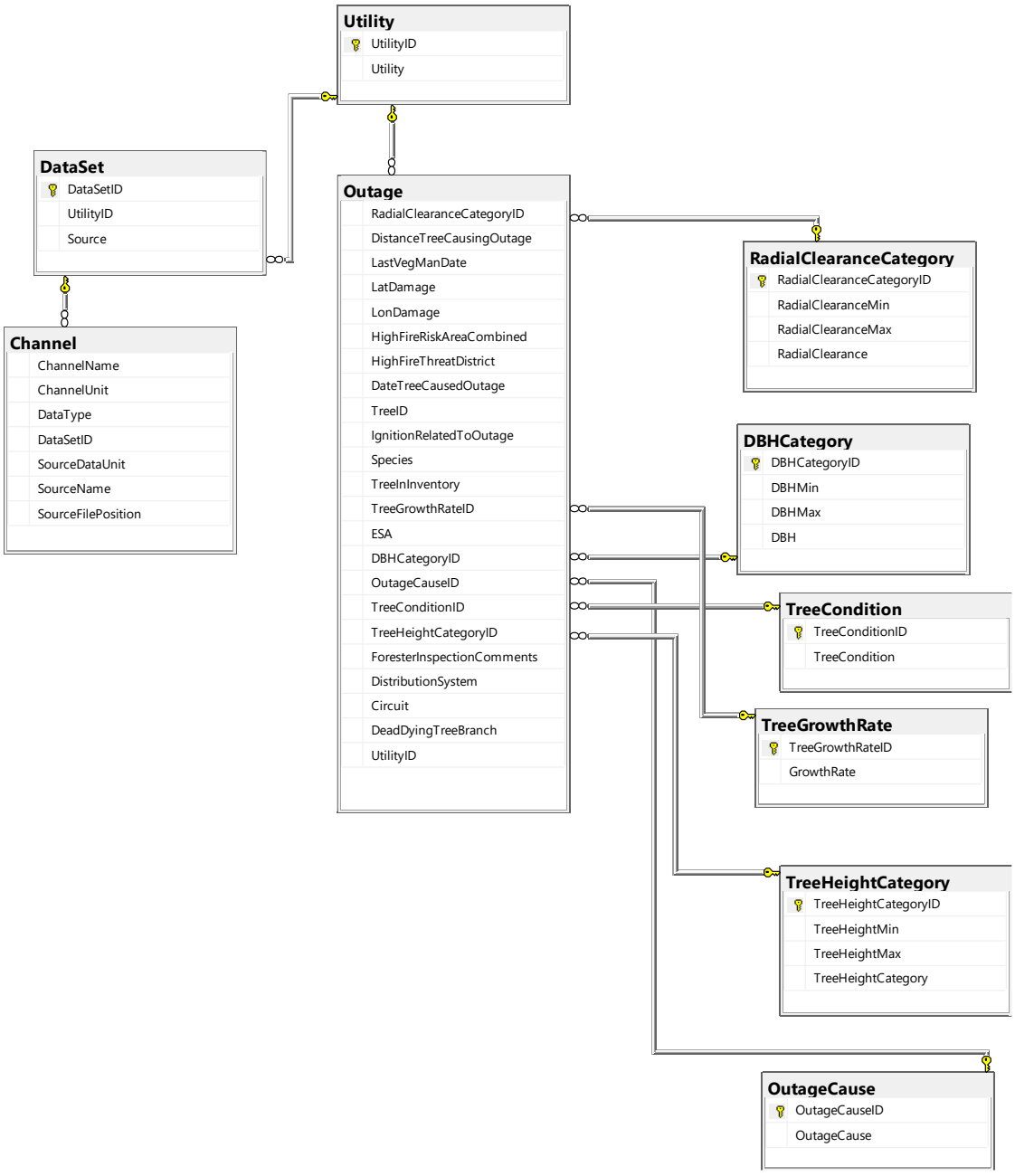
TABLE ACI-PG&E-23-22-10:
TREE HEIGHT CATEGORY

Field	Data Type and Size	Definition
[TreeHeightCategoryID]	[tinyint]	Database table identification ID
[TreeHeightMin]	[int]	Tree Height low boundary
[TreeHeightMax]	[int]	Tree Height high boundary

A Description of the Chosen Database Type and Architecture to Warehouse the Data

The SQL database sits on the EPRI Data Science Platform, a secure platform located on the EPRI-owned and -managed server that will be accessible to the Joint Utilities for querying the supplied data. The data was ingested into the Joint Utility database in its raw form (e.g., as Comma Separated Values, Excel, and/or spatial format file types). A subset of each utility's original data was incorporated into the common database. Figure ACI-PG&E-23-22-1 below is the database scheme for the common database.

FIGURE ACI-PG&E-23-22-1:
DATA WAREHOUSE ARCHITECTURE



The database includes a joint dataset as well as individualized databases for each utility so that each utility's SMEs would be able to conduct separate, individual, and confidential analyses if they would like to further explore the processed data. EPRI will provide access to the Data Science Platform for the SMEs at each utility. Additionally, virtual machines with applications specified by each utility will be created within the Data Science Platform allowing the data to remain within the secure EPRI environment.

A Description of How the Third-Party Contractor Incorporated Biotic and Abiotic Factors Into Its Analysis

EPRI is finalizing the common database and plans to populate it in the first quarter of 2024. Analysis is anticipated to begin in March 2024. EPRI will determine how to use abiotic factors, and wind speed in particular, in the analysis in a way that is standard across the utilities. EPRI will likely use a publicly available dataset for the Joint Utility analysis. Discussions are underway to determine how best to approach the abiotic factors with the EPRI climate researchers and utility SMEs.

See above for the list of common variables to be included in the analysis.

The Third-Party Contractor's Assessment of the Effectiveness of Enhanced Clearances Including, But Not Limited to, the Effectiveness of Enhanced Clearances In Reducing Tree-Caused Outages and Ignitions

EPRI is finalizing the common database and plans to populate it in the first quarter of 2024. Analysis is anticipated to begin in March 2024. At this time, an assessment of the effectiveness of enhanced clearances in reducing tree-caused outages and ignitions or for other outcomes has not been finalized.

ACI PG&E-23-23 – Weather Station Maintenance and Calibration

Description:

PG&E reports having over 1,400 weather stations in its network that collect weather data. Frequent calibration and maintenance of weather stations is crucial for ensuring accurate, reliable, and high-quality data. As PG&E performs its annual weather station maintenance and calibration, Energy Safety will need PG&E to report on the following to verify the integrity of the data collected from its weather station network.

Required Progress*:*

PG&E must:

- *Continue to maintain and keep a log of all the annual maintenance and calibration for each weather station, including the station name, location, and conducted maintenance, in compliance with PG&E's weather station calibration training document. The log must include the length of time from initiation of a repair ticket to completion and the corrective maintenance performed to bring the station back into functioning condition.*

- *In its 2025 Update, provide documentation indicating the number of weather stations that received its annual calibration and the number of stations that were unable to undergo annual maintenance and/or calibration due to factors such as remote location, weather conditions, customer refusals, environmental concerns, and safety issues. This documentation must include*

  - *The station name and location.*

  - *The reason for the inability to conduct maintenance and calibration.*

  - *The length of time since the last maintenance and calibration.*

  - *The number of attempted but incomplete maintenance or calibration events for these stations in each calendar year.*

PG&E Response:

PG&E has a program dedicated to calibrating and maintaining our weather station network. The weather station network database is maintained and tracks calibration and maintenance. This database tracks the length of time from repair ticket generation to corrective maintenance. Before installation, each weather station instrument is factory calibrated to ensure quality data is collected once deployed. During installation, field technicians work with analysts from an external vendor to ensure proper data communication before leaving the site. As discussed below, we have both automated and routine processes during the operational phase of each station to ensure data quality.

Routine Calibration After Installation

PG&E's goal is to perform a site calibration of each weather station once per calendar year and within 15 months of its last calibration. If the station is operational and without error, no maintenance is performed. If the station is not operational or falls outside of the manufacturer's standard, we perform any maintenance that may be necessary. The calibration is not marked complete until all instruments are operational, without error. Site calibrations are done using calibration kits supplied by a vendor, which are also calibrated once per year.

Due to the remote nature of many of the weather stations in the service territory, there are times when safe access via the required equipment (bucket truck) is no longer possible. Typically, this is due to road degradation, vegetation hazards, heavy snow caused by the previous winter, and customer refusals. We work with internal and external parties on each case to allow safe access. If we cannot resolve the issue, we mark the calibration record as a "Can't Get In" (CGI). We continue attempts to resolve the access issue working with internal and external parties as needed. If we are unable to resolve the access issue, we evaluate relocating the station to another area.

Mitigations

If any station goes beyond 15 months since its last calibration due to any reason, the station is considered out of compliance with PG&E's internal calibration guidelines and is blacklisted by PG&E meteorology by marking the station as "untrusted" in internal databases. An untrusted status removes the weather station and live data from situational awareness systems involved in PSPS until calibration or maintenance is completed and station can be toggled back to "trusted" status.

Non-Routine Maintenance

Physical weather station parts/components can and will fail outside routine maintenance cycles, and we have a process to identify, assign, track and perform emergent maintenance. Our external vendor collects data from each station every 10 minutes and processes it through a system of automated data and station health checks (e.g., battery voltage, range, and reasonableness checks). Alerts are generated for any anomalies and are verified by an external analyst. After verification, these alerts are sent to our Enterprise Network Operations Center, where an internal incident ticket is generated and assigned to the local telecom yard and technician for resolution. These trouble tickets are typically generated due to low or dead batteries, inconsistent or dead modems/comms, bad/dead datalogger, or suspect data. In some cases, we find stations vandalized (e.g., gunshots).

In the case of suspect data, we blacklist the station by marking the station as "untrusted" in internal databases until sensors have been replaced.

2023 Calibration and Maintenance Data

In 2023 we identified 1,417 stations in the workplan to be calibrated, comprised of stations installed in 2022 or prior. We were able to calibrate 1,390 of the 1,417 total stations (98.09 percent). The 17 stations we were unable to visit/calibrate are listed in Table ACI-PG&E-23-23-1 below.

TABLE ACI-PG&E-23-23-1:
STATIONS UNABLE TO VISIT/CALIBRATE

Station ID & Name	Work Center	Lat	Long	Last Calibration Date	Attempt Date	Number of Attempts	Reasons for Incomplete
PGE-1238 Jade Canyon Road	San Luis Obispo	35.47261	-120.5855	9/30/2022	8/19/2023	1	The gate to the property was locked. The technician contacted the CGI Hotline and got the property owner's contact information. The property owner did not want the technician on the property and is attempting to remove the Weather Station from his property. The Project team is working on getting this station relocated.
PGE-1264 Bloomer Hill	Chico	39.65268	-121.46339	9/13/2022	9/1/2023	1	The road will need to be repaired before a bucket truck can make it safely across the road. The technician got stuck trying to make it across. A request for support has been submitted and we will continue to work to get this resolved.
PGE-1325 Heller Vineyard	Salinas	36.38912	-121.6468	8/26/2021	10/28/2023	1	The property owner will not allow PG&E to access the site. The technician and Project Manager are working on relocating the station. Once the station is removed from the property and relocated to a new pole, it will be updated and calibrated.
PGE-1357 Bass Lake Road	Auburn	38.66067	-121.03274	9/10/2022	8/23/2023	2	A new road was built and now there are no access roads to the site. The pole is in a field with tall thick dry grass. There is now a fence up where the access used to be. Additionally, the road has been built up with a large bank with steep sides. There are two drains or dry creeks, one on each side of the pole a few hundred yards away blocking access through the field. The Project team is in the process of having this station relocated.
PGE-1440 Pine Mountain Tow	Bakersfield	35.55264	-118.82338	4/27/2022	5/22/2023	1	The team is currently looking for an alternative location to relocate this station as the technicians have issues accessing the site due to the property owner. Once the station is relocated, it will be calibrated and updated.
PGE-1487 Skyway Road	Chico	39.77729	-121.60652	8/4/2021	7/4/2023	1	This site was destroyed in car accident on May 21, 2022 according to the Western Weather Group records. A new site is in process to replace the destroyed site.
PGE-1548 Spolini Mountain	Santa Rosa	38.23202	-122.49816	9/6/2022	8/1/2023	1	This pole was replaced and moved down the side of a hill and it is no longer bucket truck accessible. We are in the process of finding a new location for this site.

TABLE ACI-PG&E-23-23-1:
STATIONS UNABLE TO VISIT/CALIBRATE
(CONTINUED)

Station ID & Name	Work Center	Lat	Long	Last Calibration Date	Attempt Date	Number of Attempts	Reasons for Incomplete
PGE-1620 Whimsy Mine	Salinas	36.43394	-120.66238	6/4/2022	4/24/2023	1	The access road to the site is completely washed out and the previous culvert is gone. There is not a safe way to pass through this area until the roadway is repaired. A request for support was submitted and we will continue to work to get this resolved.
PGE-1653 Arroyo Seco Road	Salinas	36.24964	-121.44279	6/10/2022	6/24/2023	1	The access road is closed until further notice, as of March 10, 2023. This is believed to be due to landslides and other unstable conditions. We will continue to monitor this location for future repairs. A request for support has also been submitted.
PGE-1735 Calistoga-Lower L	Ukiah	38.68924	-122.59557	9/12/2022	8/20/2023	1	The access road going uphill to the site is too soft and rocky to traverse. The truck started to slide towards the edge and ended up getting stuck. The technician had to get towed and lost a day of work. The road needs to be repaired before the technician can safely complete calibration. A request for support was submitted and we will continue to work to get this resolved.
PGE-1807 High School Hill	San Luis Obispo	35.28012	-120.63117	8/27/2022	7/23/2023	1	The access road is washed out at the sharpest and steepest switchback and is too difficult and dangerous to cross. A request for support was submitted and we will continue to work to get this resolved.
PGE-1978 Skaggs Hill	Santa Rosa	38.66833	-123.18921	5/2/2024	8/21/2023	1	The station was removed on July 19, 2021 due to a pole replacement. It was then determined that it should be relocated, rather than reinstalled at the same location, because there was shade preventing the station from working properly. The station was reinstalled at a new site on May 2, 2024.
PGE-1989 Monte Vista	San Jose	37.27948	-122.10709	7/30/2022	7/4/2023	2	The access road had a down tree and once it was able to be removed it was determined that the road was also damaged and needed repairs before a vehicle could safely pass. A request for support was submitted and we will continue to work to get this resolved.
PGE-2225 Gamble Road	Chico	39.63767	-121.39528	9/13/2022	8/21/2023	1	This station was removed in April of 2023 and is in the process of being relocated.
PGE-2333 Dana Foothill	San Luis Obispo	35.04055	-120.44406	4/6/2022	3/2/2023	1	The access road to the site has significant soil erosion which causes unsafe conditions for a bucket truck to park. A request for support was submitted and we will continue to work to get this resolved.

TABLE ACI-PG&E-23-23-1:
STATIONS UNABLE TO VISIT/CALIBRATE
(CONTINUED)

Station ID & Name	Work Center	Lat	Long	Last Calibration Date	Attempt Date	Number of Attempts	Reasons for Incomplete
PGE-2345 San Antonio Valley	San Jose	37.33942	-121.52733	N/A, Installed 6/18/2022	6/5/2023	1	This site is in the process of being relocated due to solar panel being blocked by a tree causing power issues.
PGE-2382 Trinity-Cottonwood	Redding	40.6811	-122.83908	N/A, Installed 7/18/2022	8/19/2023	3	The technician found three possible ways to access the site, but none were safe or available to cross. A request for support was submitted and we will continue to work to get this resolved.

ACI PG&E-23-24 – Evaluation of and Plan to Address of AFN Customer Needs

Description:

PG&E does not provide sufficient detail about its evaluation of the needs of its Access and Functional Needs (AFN) customer base, including the specific challenges the customer base faces.

Required Progress*:*

In its 2025 Update, PG&E must provide details on its evaluation of the specific needs of its AFN customer base identified through stakeholder forums and focus groups, as well as any other methods of evaluation. PG&E must also describe the needs of AFN customers it has identified as a result of this evaluation.

PG&E Response:

PG&E is continually evaluating and adjusting its plans to support AFN customers as a part of the Community Wildfire Safety Program. Within PG&E's Customer and Enterprise Solutions group is the Customer Emergency Planning and Operations department, where a dedicated AFN program manager is tasked with developing the overall program strategy. The program manager relies on community and stakeholder outreach and collaboration, as well as establishing alignment with other Joint Utilities around lessons learned and best practices. Additionally, a key area of focus has been developing solid partnering relationships with Community Based Organizations (CBO) that help deliver wildfire safety customer support resources to ensure that our AFN communities' needs are being met.

To obtain the latest information, survey results, and statistics on our AFN program and feedback outlined below, please reference the latest Annual AFN PSPS Plan, available at the following link:
https://www.pge.com/en/outages-and-safety/safety/community-wildfire-safety-program/public-safety-power-shutoffs.html#accordion-3ab60595c3-item-6be6b1125a.

PG&E continually evaluates the overall effectiveness of the programs and services offered, utilizing several methods including: (1) utilizing pre and post-season customer-level surveys; (2) using surveys to CBOs; and (3) hosting stakeholder and Joint Utility groups.

Utilizing Pre-and Post-Season Customer-Level Surveys to Gauge Satisfaction and Track Satisfaction Over Time With Our Key Performance Indicators

The Key Performance Indicators (KPI) that we track for customer satisfaction through pre and post-season surveys are:

- KPI #1: The percentage of individuals with AFN who were aware of what support and resources were available to them during a PSPS.

- KPI #2: The percentage of individuals with AFN who were able to use medical equipment to maintain necessary life functions for the duration of any PSPS event that affected them.

- KPI #3: The percentage of individuals who utilized mitigation services reported they were satisfied with the level of support (across 12 individual support programs).

Direct to Community Based Organization CBO Surveys

Surveys are deployed every two years to help PG&E understand their satisfaction level with program offerings and to solicit ideas for improvement.

Stakeholder and Joint Utility Groups

PG&E hosts and participates in regular meetings with stakeholders and Joint Utility groups, noted below. These groups serve as a sounding board and offer insight, feedback, and input on the utilities' customer strategy, programs, and priorities. Regular quarterly meetings are scheduled to actively identify issues, opportunities and challenges related to the utilities' ability to mitigate the impacts of wildfire safety strategies, namely PSPS. We also continuously meet as a statewide Joint Utilities planning and coordination team throughout the year to ensure alignment and opportunities for continuous improvement through the following venues:

- The Statewide Joint Utility AFN Council;

- The Joint Utility AFN Collaborative Council (including California Governor's Office of Emergency Services and State Council on Developmental Disabilities representation); and

- The People with Disabilities and Aging Advisory Council (hosted by PG&E).

PG&E also obtains regular feedback on issues surrounding supporting AFN customers from key stakeholders such as the Center for Independent Living, the California Providers Network of 211, the Hospital of Council Northern and Central California, the Department of Rehabilitation, and the Center for Accessible Technology.

As a result of the evaluations referenced above, and to respond the needs of the AFN community, we have implemented measures such as: (1) increased AFN education; (2) enhanced AFN communications; (3) expanded AFN outreach and access to information; (4) additional self-ID and Medical Baseline outreach campaigns; (5) increased support offerings; and (6) continuous improvement.

Increased AFN Education

Customers asked for more information regarding PSPS support program offerings. In addition to our quarterly regional webinars and wildfire safety webinars, PG&E added three additional AFN dedicated pre-season and in-season webinar communications, with an emphasis on preparation, sharing support offerings, encouraging sign-ups for alerts, and ensuring contact information is up to date.

Enhanced AFN Communications

Customers need communications in language, including American Sign Language (ASL), that gives them notice and options for support before, during, and after a PSPS. PG&E sends messages through phone, e-mail, text, and in cases where no acknowledgement is received, deploys in-person doorbell rings/knocks to ensure customer is aware of a PSPS.

Expanded AFN Outreach and Access to AFN Information

Customers tend to trust local, independent, community organizations. PG&E partnered with CBOs to provide customers with resources, support, and multilingual outreach during a PSPS. In addition, prior to and throughout wildfire season, PG&E utilizes these trusted CBO partners to help amplify our communications through various channels, creating a variety of easy-to-use resources for preparedness and support. Customers can quickly and easily dial 2-1-1, call their local California Foundation for Independent Living Centers, or utilize the many various PG&E resources to seek out information.

Additional Self-ID & Medical Baseline Outreach Campaigns

Customers may relocate, and their needs may change throughout the year. It is important to allow customers to find simplified ways to let us know they have new or additional needs. We utilize proactive outreach campaigns to encourage customers to keep us informed of their current needs. PG&E can utilize this information to add-in layers of communication, notification, and to share program offerings based on customer geography and needs.

Increased Support Offerings

Based on direct feedback from AFN communities and stakeholders, PG&E implemented support offerings that include: portable batteries for charging vital medical equipment, insulin cooler wallets, mini-fridges for medications, generator and battery rebates, accessible transportation services, accessible hotel accommodations, food replacement and/or delivery services to those impacted by outages, fuel cards for generators, and Community Resource Centers that are accessible, offer resources, and provide up-to-date PSPS information in multiple languages (including ASL).

Continuous Improvement

PG&E's offerings have evolved in terms of customer eligibility in order to respond to the support needs of AFN customers as new programs such as EPSS are implemented. For example, our Portable Battery Program has been expanded to include customers who have been impacted by PSPS and outages on circuits that are EPSS enabled.

ACI PG&E-23-25 – Fire Potential Index and Ignition Probability Weather Enhancements

Description:

PG&E reports that both the FPI and IPW models operate by learning from historical data, which includes past fires, outages, and ignitions, along with the conditions under which they occurred to forecast future fires, outages, and ignitions. As part of its responses to the Revision Notice, PG&E commits to evaluating enhancements to improve model skill for both its FPI and IPW models that involves testing new features, model configurations, and the inclusion of CC and EPSS on the system.

Required Progress*:*

In its 2025 Update, PG&E must provide an update on its assessment of potential enhancements to its FPI and IPW model. In particular, it must:

- *Provide information on the new features that were tested, and criteria used to evaluate the new features, including the findings and results;*
- *Provide information regarding different model configurations that were tested, the outcomes of these tests, and any insights gained;*
- *Discuss the methodology for evaluating the inclusion of other mitigation measures, such as CC and EPSS, into the modeling process. This should include any testing and evaluation conducted to incorporate these mitigations; and*
- *Identify any challenges or unforeseen issues encountered during the evaluations of all enhancements and a description of any adjustments or refinements made to address these challenges.*

PG&E Response:

In 2023, we trained new versions of FPI and OPW and created a new model called the Ignition Given Outage Probability Weather (IOPW) model. These models represent the fifth iteration of our fire and outage probability models and will be referred to as v5.0 models (e.g., FPI5.0). These models show enhanced statistical skill over current operational versions (v4.0), but have not been approved to be operationalized. If approved, we plan to operationalize these models in Q3 of 2024.

Fire Potential Index

<u>Introduction</u>

The fifth generation of Meteorology's FPI model version was developed in 2022 and 2023 and has several enhancements over the fourth generation FPI model developed in 2021. The FPI5.0 Model is a state-of-the-art machine learning model and represents the fifth major update to the FPI since 2015. Key enhancements include:

- The addition of fire radiative power (FRP) to better identify catastrophic fires based on rapid growth and high intensity;

- Expanded model training data to include all fire detections;
- Improved spatial intersection of weather, fuel moisture, fuels, and terrain data by spatially relating satellite fire detection polygon shapes with model data;
- Increasing FPI model granularity approximately six-fold by utilizing a 0.7 km^2 hexagonal grid compared to the previous 2x2 kilometer (4 km^2) grid;
- Improved temporal resolution and coupling of satellite fire detected fire growth and temporal relations to weather and fuel moisture features; and
- Adding new weather and fuel moisture input features such as soil moisture, enhanced dead and live fuel moisture models, new herbaceous fuel moisture model, solar radiation, and new fuel properties features.

FPI informs operational decision making for PSPS and EPSS and informs crews what precautions must be taken to reduce the risk of fires as directed by utility standard TD-1464S.[58] FPI is also a key input into the consequence formulation of PG&E's planning models (WDRM, WTRM) that informs long term wildfire risk programs of undergrounding and system hardening prioritization. Improvements in the accuracy of the FPI model allow for greater operational mitigation of utility-caused wildfire risk through PSPS and EPSS for a given customer impact and better strategic prioritization of undergrounding and other wildfire risk mitigation programs.

The weather and fuel moisture features used as inputs to the model are sourced from PG&E's 30+ year down-scaled climatology available hourly at a 2x2 kilometer resolution. The fuel categories and properties features are from Technosylva and topography features are 30x30 meter resolution. These datasets are aggregated to a new, finer spatial resolution of 0.7 square kilometer hexagons using the h3 opensource framework developed by Uber.

Model Training and Feature Evaluation

The primary goal of FPI5.0 was to enhance the model over the current operational configuration. We explored improvements through:

- Enhancing training data sets (e.g., fire occurrence, fuel moistures);
- Increasing model granularity;
- Testing new model features (e.g., soil moisture, NDVI);
- Testing different models and model configurations; and

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58 Preventing and Mitigating Fires While Performing PG&E Work Standard (TD-1464S). This standard is available on the PG&E Community Wildfire Safety Program website, under the 2023-2025 Wildfire Mitigation Plan and associated documents section: https://www.pge.com/en/outages-and-safety/safety/community-wildfire-safety-program.html#accordion-99016a73ab-item-c788794778.

- Sensitivity analyses.

Spatially and temporally accurate fire growth/occurrence data is critical to train a machine learning FPI model. Traditional fire growth or occurrence datasets across California do not contain hourly or daily growth perimeters or metrics (e.g., acres) or measures of intensity. These data are a good start to train initial iterations of FPI, but do not contain enough spatial or temporal granularity to train the model accurately using hourly, local data.

PG&E partnered with Sonoma Technology Inc. (Sti) to fund development of a novel fire occurrence dataset that fuses traditional fire occurrence datasets with satellite fire detections. The methodology and results were published in the International Journal of Wildland Fire, a peer-reviewed journal.[59] The FPI5.0 model takes advantage of this novel fire occurrence dataset to relate our 2x2 kilometer weather, fuel moisture, and finer granularity terrain and fuel type datasets to this enhanced fire growth and intensity dataset.

Another goal of FPI5.0 was to test if new model features and model configurations could improve model skill. This is discussed in detail in the model feature section below.

Model Formulation

The FPI5.0 model is a multi-classification balanced random forest model; a state-of-the-art open-source machine learning model based on decision trees. FPI is trained on the novel fire occurrence dataset developed from Sti from 2012 to 2022, and the class of each fire detect is defined by the growth and FRP of those detects. The four FPI classes predicted are small, large, critical, and catastrophic classes. Please note that the classes defined here are only for the purpose for FPI and are applied to a single satellite scan and are not used in other applications.

The model takes advantage of the FRP, which is a measure of the radiant heat (intensity) of the fire as measured by satellite. Including this metric along with growth can help the model differentiate between two fires with the same acreage burned, but with one burning much more intensely. When we analyzed FRP of historical fires, we found fires with higher FRP are more likely to escape containment and result in building losses.

The FPI model increased from a three to four-class model with the addition of a new "Critical" fire class. The Catastrophic fire class continues to focus on wind driven fires, and the new Critical fire class is focused on non-wind driven fires.

The final class breakpoints selected for FPI5.0 are shown in the Table ACI-PG&E-23-25-1 below, based on if the satellite detect interval was less than or greater than three hours. This separation between less than or greater than three hours was needed to differentiate between "limb" and "nadir" polar-orbiting satellite detections. We evaluated keeping only the nadir detections in our dataset, which occur every 12 hours, but did not want to eliminate a substantial subset of useful data

[59] The article is available at the following link: https://www.publish.csiro.au/wf/pdf/WF22048.

between “nadir” scans. Thus, we introduced a scaled less than three-hour growth and intensity breakpoints to take advantage of the full dataset.

TABLE ACI-PG&E-23-25-1:
FPI MODEL CLASSIFICATION BY FIRE GROWTH AND INTENSITY

FPI Class	VIIRS Growth (acres), Fire Radiative Power (megawatt (MW)) (<3 hours between VIIRS detects)	VIIRS Growth, Fire Radiative Power (MW) (>=3 hours between VIIRS detects)
Small	<70 acres	<70 acres
Large	<200 acres OR <200 MW	<200 acres OR <200 MW
Critical	<2,000 acres OR <2,000 MW	<7,000 acres OR <7,000 MW
Catastrophic	>=2,000 acres & >=2,000 MW	>=7,000 acres & >=7,000 MW

Each fire detection is grouped into one of the four classifications above. When we evaluate the classification of the first detection of each fire and compute the average final fire size, we find the following breakdown:

- Small: Approximately 300 acres;
- Large: Approximately 1,500 acres;
- Critical: Approximately 20,000 acres; and
- Catastrophic: Approximately 80,000 acres.

We also cross-evaluated buildings damaged or destroyed by fire per model class by utilizing the California Department of Forestry and Fire Protection (CAL FIRE) Damage Inspection (DINS) datasets, as shown in Table ACI-PG&E-23-25-2 below. The actual number and percentage of buildings damaged per FPI class, broken out by fire burning periods (days), is presented below. The data suggest most damage occurs in Critical and Catastrophic classes and skewed towards the initial phases of fires. Relatively few damages occur in the large class with almost none in the small class.

TABLE ACI-PG&E-23-25-2:
FPI MODEL CLASSIFICATION VERIFICATION USING CAL FIRE DINS DATASET

FPI Class Actual	% of Total Buildings Damaged				Buildings Damaged per 10,000 Acres			
	Small	Large	Critical	Catastrophic	Small	Large	Critical	Catastrophic
Initial Detect	0.0%	0.8%	4.6%	30.8%	2	6	78	683
Initial Burning Period (0+ to 24+ hours)	0.0%	1.2%	3.7%	31.1%	0	19	36	392
Second Burning Period (24+ to 72+ hours)	0.0%	0.0%	3.4%	8.0%	0	1	26	69
Third Burning Period (3+ to 7+ days)	0.0%	0.2%	4.4%	2.6%	0	3	19	29
Extended Burning Period (More than 7+ days)	0.0%	0.0%	1.0%	8.2%	0	0	2	34

Model Features

Over 160 features were tested in model training and sensitivity tests. Sensitivity tests included varying class breakpoints, model types, and model features. Features selected for testing resulted from emerging research from the WIRC, SMEs, vendor suggestions, and data availability and suitability. We initially trained a "kitchen sink" model with every feature, then evaluated the model using correlation heatmaps, AUC ROC skill scores, confusion matrices, model feature importance plots, shapely explanative values, and shapely dependence plots across all features. We then performed an exhaustive series of iterative tests to optimize across multiple model dimensions: model skill, operationalization suitability, and simplicity. An excerpt of the model features tested and selected in the final model are presented in a Table ACI-PG&E-23-25-3 below. For a complete list, please see Appendix A. Many of these features are model outputs at various heights below ground (soil moisture) or above ground (wind, temperature).

The FPI 5.0 model features include:

- Weather features of wind speed, turbulence, temperature, and vapor pressure deficit;
- New NDVI grass crop fuel moisture model and enhanced existing dead, herbaceous and woody fuel moisture models;
- Topography features including terrain ruggedness and slope;
- New soil moisture and solar radiation features;
- Improved fuel categories; and
- New fuel properties features including fuel bed depth and fuel complexity.

A partial list of model features we tested along with the final model features is provided in Table ACI-PG&E-23-25-3 below. Please see Appendix A for the complete list.

TABLE ACI-PG&E-23-25-3:
LIST OF MODEL FEATURES EVALUATED AND SELECTED FOR FPI5.0.

Model Feature	Model Feature Group	Final Model Feature (1 = yes, 0 = no)
alignment_vector_avg	Terrain	0
TerrainRugged_Max	Terrain	0
TerrainRugged_Mean	Terrain	1
TerrainRugged_Min	Terrain	0
Slope_Degree_Max	Terrain	0
Slope_Degree_Mean	Terrain	1
Slope_Degree_Min	Terrain	0
Aspect_Most_Common_Angle	Terrain	0
Aspect_Flat_Percent	Terrain	0
Aspect_N_NE_Percent	Terrain	0

Model Validation

During model training and sensitivity tests, we evaluated model skill across class breakpoints. The FPI5.0 model shows improved skill across all fire classes compared to the FPI4.0 mode as presented in the Table ACI-PG&E-23-25-4 below.

TABLE ACI-PG&E-23-25-4:
FPI MODEL SKILL SCORES PER CLASS

Fire Class	Current FPI 4.0 Model ROC AUC	FPI 5.0 Model ROC AUC
Catastrophic	0.88	0.95
Critical	Class Not Used	0.88
Large	0.55	0.62
Small	0.68	0.73
Macro-Average ROC AUC	0.70	0.83

Outage and Ignition Probability Weather Models

Introduction

The fifth generation of Meteorology's Operational Outage and IPW (IPW/OPW) model versions were developed in 2022 and 2023 and have several enhancements over the fourth generation OPW/IPW models developed in 2021, including improved model skill. The key enhancements include:

- Improved probability of an ignition given outage that varies with local weather, fuel moistures, solar radiation, and topography;

- Refreshed vegetation datasets that can be updated annually;
- Inclusion of asset age to better explain outages and reflect both asset replacement and asset degradation; and
- Improved model skill.

IPW was built from the ground up and focused on supporting mitigation of utility caused wildfire risk through PG&E's PSPS Program. The outage (OPW) model also supports SO forecasting and operational preparedness to respond to storm events. Improvements in the accuracy of the outage and ignition models will allow for:

- Greater mitigation of utility caused wildfire risk through PSPS for a given customer impact of PSPS; and
- Increased operational preparedness to respond to storm events reducing customer outage durations.

The models are trained on outages, PSPS event damages and hazards, PG&E CPUC Reportable Ignitions, and weather from PG&E's 30+ year down-scaled climatology at an hourly 2x2 kilometer resolution. This includes approximately 550,000 unplanned sustained and momentary outages on the distribution grid from 2008 to the end of 2022, PG&E PSPS event damages and hazards, and PG&E's CPUC-reportable ignitions from 2015 to the end of 2022.

The operational application of IPW Is updated twice per day and provides hourly outage and ignition probabilities for each 2x2 kilometer grid cell across a 129-hour forecast horizon. Key inputs into IPW include forecast weather data from PG&E's Operational Mesoscale Modelling System, which includes a deterministic and eight-member ensemble forecast derived from the Weather Research and Forecasting (WRF) model framework. The same model configuration used to construct the climatology is utilized in the forecast model application. Strategic applications of IPW are based on IPW being calculated hourly for each cell for past years across PG&E territory using PG&E's 30+ year down-scaled climatology at 2x2 kilometer resolution.

Asset data from Electric Distribution Geographic Information System, vegetation data from Planet Labs (formerly SALO), and the latest outage and ignition performance will be updated in the operational models annually.

Outage Probability Weather

Model Framework – Outage Probability Weather

The probability of an outage model is a state-of-the-art open-source gradient boosting machine learning model based on decision trees with advanced categorical feature support. The probability of outage class is output for each 2x2 kilometer grid cell and varies by weather variables, tree height and canopy cover, asset age, environmental conditions, and location categorical variables. The model is trained on every hour and grid cell from 2008 to 2022 and whether an outage class was observed or not in the outage node. The general model formulation is presented below.

$$OPW = P\left(Outage_{cell,hour}\right) = \sum_{class}^{cause\ clases} P\left(Outage_{class,cell,hour}\right)$$

The five outage classes predicted are: (1) Animal-3rdParty, such as cars and balloons; (2) Equipment-Electrical, which includes transformers and other complex electrical equipment; (3) Equipment-Structural, which includes assets such as poles, cross-arms, connectors, conductors, etc.); (4) Vegetation; (5) Unknown; and (6) with the final class being No-Outage. These classes are presented below.

$$cause\ classes = \{\text{Vegetation, Equipment Structural, Equipment Electrical, Animal} - \text{3rdParty, Unknown}\}$$

$$class \in cause\ classes$$

Model Features – Outage Probability Weather

Over 90 feature candidates were tested in machine learning model training and sensitivity tests. We initially trained a "kitchen sink" model with every feature and then evaluated model output and feature importance plots to pare down the list of features to the final model configuration.

The final model features include wind speed, turbulent kinetic energy, temperature, precipitation, soil moisture, canopy height and canopy cover of strike trees, time of day and weekend, slope, outage node id, and circuit id. The node id and circuit id are the key categorical variable that allows the model to learn outage trends specific to each location that is not otherwise explained by the other features such as asset condition, other environmental conditions, and exposure to cars, balloons, and animals. The spatial resolution of the outage nodes has been improved from 50 primary-only overhead line miles to 26 primary miles and seven secondary miles, which is equivalent to the average overhead distribution circuit length per outage node.

We also tested adding various asset features to the model such as hardened covered conductor, tree wire, percent aluminum, percent copper, pole age, etc. The model found pole age was the most important asset feature and intuitively that the probability of an outage increases as pole age increases.

The vegetation features data source changed from one-time aerial Light Detection and Ranging (LiDAR)-derived tree overstrike from 2019, to an annual satellite-derived tree heights and canopy cover of strike trees (spring 2018 to spring 2022). This update better represents changes in vegetation exposure over time. The satellite-derived tree height is based on a model and data from Planet Labs with an underlying resolution of 3x3 meter (formerly SALO). This is an important change because we will be able to update the vegetation layer in the model annually as new vegetation data is captured by remote sensing. Thus, the model will be able to respond to vegetation changes in proximity to our assets. An additional turbulence feature was added to enhance explanation of wind caused outages and a soil moisture feature was added to help with predicting saturated soil-related outages.

A partial list of model features tested, and the final model features selected, is provided in Table ACI-PG&E-23-25-5 below. Please see Appendix A for the complete list.

TABLE ACI-PG&E-23-25-5:
LIST OF MODEL FEATURES EVALUATED AND SELECTED FOR OPW5.0

Model Feature	Model Feature Group	Final Model Feature (1 = yes, 0 = no)
avg_ws_mph	Weather-Wind	1
avg_ws_mph_50m	Weather-Wind	1
avg_ws_mph_300m	Weather-Wind	0
avg_ws_mph_750m	Weather-Wind	0
avg_ws_mph_1500m	Weather-Wind	0
avg_tke_pbl_50m	Weather-Wind	1
avg_tke_pbl_300m	Weather-Wind	1
avg_tke_pbl_750m	Weather-Wind	0
avg_tke_pbl_1500m	Weather-Wind	0
wind_dir_f_10m	Weather-Wind	0

Learning and Predicting Performance Changes

As work is performed on assets and equipment, there will be changes in the outage and ignition response that should be reflected in our probability models. Instead of utilizing a global "effectiveness factor" derived from outage data evaluations and engineering assessments, that would be applied *ex post facto* to model outputs or wind thresholds, we allow the model to reflect positive or negative changes going forward.

To accomplish this, we first trained outage models individually per year from 2008 to 2022. Then we apply an exponential weighted mean approach that weights more recent years more heavily. This exponential weighting approach allows changes in local performance to be captured. In addition, as asset and vegetation data are refreshed, the model adjusts positively if there are fewer trees or newer poles in an area or negatively as trees grow over time and assets age.

OPW is updated annually with the latest asset age, vegetation exposure, and outages, and is trained on all hours since 2008, whether an unplanned outage was observed or not in each location. This allows the model to learn the most recent year's performance. For example, if an overhead segment is hardened with CC and new poles under the system hardening program, this will be reflected in the asset age feature input into OPW. Further, as the outage performance of the hardened asset is observed over time, OPW will reflect changes in local performance through the exponential weighted mean approach.

Model Validation – Outage Probability Weather

The OPW5.0 outage model shows improved skill across all outage classes compared to the current outage model OPW4.0, for both HFRA and non-HFRA models, as can be seen in Tables ACI-PG&E-23-25-6 and ACI-PG&E-23-25-7 below. The Third Party – Animal class observed a negligible improvement, which is somewhat expected as these outages are largely driven by random, non-weather processes.

We are particularly excited about the improved skill in the Vegetation class because we moved from tree overstrike data derived from LiDAR to satellite-based tree overstrike data as satellite data are less expensive and are available at higher frequency. Although there is a decrease in spatial granularity between LiDAR and satellite data, the increased temporal information helped increase performance in the vegetation class.

TABLE ACI-PG&E-23-25-6:
OUTAGE PRODUCING WEATHER MODEL SKILL SCORES PER CAUSE CLASS IN THE HFRA

Cause Class	Current OPW 4.0 HFRA Model ROC AUC	OPW 5.0 HFRA Model ROC AUC
Vegetation	0.81	0.84
Equipment-Structural	0.69	0.72
Third-Party-Animal	0.68	0.68
Equipment-Electrical	0.67	0.70
Unknown	0.64	0.68
No Outage	0.67	0.69
Macro-Average ROC AUC	0.70	0.72

TABLE ACI-PG&E-23-25-7:
OUTAGE PRODUCING WEATHER MODEL SKILL SCORES
PER CAUSE CLASS IN THE NON-HFRA

Cause Class	Current OPW 4.0 Non-HFRA Model ROC AUC	OPW 5.0 Non-HFRA Model ROC AUC
Vegetation	0.79	0.80
Equipment-Structural	0.68	0.70
Third-Party-Animal	0.65	0.66
Equipment-Electrical	0.69	0.71
Unknown	0.63	0.66
No Outage	0.65	0.66
Macro-Average ROC AUC	0.70	0.72

Ignition Given Outage Probability Weather

Model Framework – Ignition Given Outage Probability Weather (IOPW)

A significant improvement we made to translate from outage probability to ignition probability is the new IOPW model. The model is a binary classification random forest machine learning model based on decision trees.

The model predicts the probability of ignition given outage as it varies with weather and environmental conditions by location and time, improving on the previous methodology which is based on mean arrival rate of ignitions per outage by cause category during fire season in HFTD. The new model can reflect how ignition probability changes on an hour-by-hour basis due largely to fuel moisture content. The probability of ignition given outage is output for each 2x2 kilometer grid cell for each hour based on hourly weather variables, fuel moisture, solar radiation, and topography. The general IOPW model can be represented as below.

$$P(Ignition|Outage) = f(features_{cell,hour})$$

The model is trained on every unplanned overhead outage, whether a reportable ignition was observed or not, from 2015 to 2022. Fuel, weather, and topography information is passed through to the model for each outage and ignition. HFRA and non-HFRA models are trained separately because the ignition to outage patterns in HFRA and non-HFRA are sufficiently different, predominantly due to increased vegetation exposure and lower customer density in HFRA.

Model Features – Ignition Given Outage Probability Weather

Over 70 feature candidates were tested in machine learning model training and sensitivity tests. We initially trained a "kitchen sink" model with every feature then evaluated model output and feature importance plots to pare down the list of features to the final model configuration.

The final model features include hourly wind speed, temperature, vapor pressure deficit, dead fuel moisture, herbaceous fuel moisture, soil moisture, solar radiation, and slope.

We tested adding various asset features in a similar fashion as the outage model development, including whether EPSS was enabled, or not, on a given circuit by day. The model did not benefit from the inclusion of the EPSS, likely due to the limited time EPSS has been operational. As discussed in the next section below, although EPSS is not a feature in the final model, IOPW is able to account for changing ignition patterns overtime.

A partial list of model features tested, and the final model features selected, is provided in Table ACI-PG&E-23-25-8 below. Please see Appendix A for the complete list.

TABLE ACI -PG&E-23-25-8:
LIST OF MODEL FEATURES EVALUATED AND SELECTED FOR IOPW

Model Feature	Model Feature Group	Final Model Feature (1 = yes, 0 = no)
dfm_1hr	Fuel Moisture	1
dfm_10hr	Fuel Moisture	1
dfm_100hr	Fuel Moisture	1
dfm_1000hr	Fuel Moisture	1
temp2m_f	Weather-Heat	1
temp_f_50m	Weather-Heat	0
temp_f_300m	Weather-Heat	0
temp_f_750m	Weather-Heat	0
temp_f_1500m	Weather-Heat	0
vpd2m_mb	Weather-Dry	1

Learning and Predicting Performance Changes

We can easily track macro changes in the ignition to outage relations that have occurred through the training period from 2015 to 2022. Some of the changes can be attributable to weather, changes in assets, vegetation changes, and grid operations. The largest change occurred with the EPSS pilot in 2021 and widespread EPSS implementation in 2022. Although there is a clear signal of EPSS' role in reducing ignitions at the macro level, the signal becomes less clear as you zoom down to the sub-circuit level, which is the granularity needed for PSPS to be as targeted as possible.

As stated previously, we did not see immediate tangible improvement to IOPW by introducing the EPSS feature directly to the model. However, we have formulated the IOPW model to exponentially weight recent years' observations of outages and ignitions more heavily to learn ignition to outage relation changes, matching the weighting used in the OPW model. Thus, as the model is updated with the latest years' outage and ignition data, it will account for any positive trends resulting from EPSS operations or any other program or environmental changes that may nudge ignition to outage relations *at a local level*. We prefer this option over applying an "effectiveness factor" reduction/override on IOPW outputs when EPSS is enabled *ex post facto*.

Model Statistical Validation – Ignition Given Outage Probability Weather

The IOPW model results in Table ACI-PG&E-23-25-9 below establish a new validation baseline because the model is the first PG&E operational ignition machine learning model. The previous methodology was based on the mean ignition per outage by cause category during fire season in HFTD.

TABLE ACI -PG&E-23-25-9:
IGNITION GIVEN OUTAGE PROBABILITY WEATHER MODEL SKILL SCORES

Location	Ignition Model ROC AUC
HFRA	0.75
Non-HFRA	0.71

Ignition Probability Weather

Together, OPW and IOPW are multiplied together in space and time to form the IPW. This is represented in the equations below:

$$P(Ignition) = P(Outage) * P(Ignition|Outage)$$

$$IPW = OPW * IOPW$$

We first compute the outage probability (OPW), then compute the probability that an ignition would occur given an outage. Taken together, we can compute to probability of a utility caused ignition every hour at 4 km^2 resolution.

As discussed previously, IPW can reflect change in performance over time due to EPSS, vegetation management, system hardening and external factors. Consider the example of an overhead segment that is hardened with CC and new poles under the system hardening program; this will be reflected in the asset age feature input into OPW and lower the outage probability (all other inputs being equal). Further, as the outage to ignition performance of the hardened asset is observed over time, IPW will reflect these changes in local performance through the exponential weighted mean approaches of OPW and IOPW.

Challenges

1) The datasets we utilize to create and train these machine learning models are massive and require a large amount of storge and compute costs. The utilization of cloud computing resources and tools has helped scale our compute dynamically to the increased datasets.

2) Machine learning models have been proven to be more skillful, but are more opaque than linear, index-based, or logistic regression models. The use of shapely explanative values and dependence plots and other techniques (e.g., detailed back-casts) allow data scientists to evaluate how features interact in a machine learning model. Machine learning models make it much more difficult to answer questions about how a change in magnitude of a single feature would affect the size, duration, and frequency of PSPS events because in the machine learning framework, features can interact non-linearly with other features as opposed to a simple relationship in a non-linear or indexed approach.

3) We did not see an immediate tangible improvement to our ignition given outage model by introducing EPSS as a feature directly to the model. We propose this is due to the short timeframe EPSS has been implemented and the spatial granularity we are using to train our operational models for PSPS. We address this challenge by exponentially weighting our models to the most recent years. Thus, as the model is updated with the latest years' outage and ignition data, it will account for any positive (or negative) trends resulting from EPSS operations or any other program or environmental changes that may nudge ignition to outage relations *at a local level*. We prefer this option over applying an *ex post facto* "effectiveness factor" on IOPW outputs when EPSS is enabled or for any other program that may influence ignition probability.

ACI PG&E-23-26 – Evaluation and Reporting of Safety Impacts Relating to EPSS

Description:

PG&E does not fully analyze and justify safety impacts relating to EPSS, including demonstrating benefits outweigh potential risks associated with EPSS.

Required Progress*:*

In its 2025 Update, PG&E must provide:

- *Continued reporting of its EPSS-related outages, which must include via spreadsheet:*
  - *Number of outages.*
  - *CPZ in which an outage occurred.*
  - *Whether or not the outage was in the HFTD.*
  - *Duration of outage.*
  - *Number of customers impacted.*
  - *Number of impacted customers belonging to vulnerable populations (such customers with AFN, Medical Baseline customers, and customers identified as vulnerable by the Social Vulnerability Index).*
  - *Impact on community values, including intangibles (e.g., livelihood) and how PG&E is tracking these.*
  - *Response time for outages.*
  - *Asset health (open work tags, asset age, etc.).*
  - *Vegetation data.*
  - *Resource constraints (access issues, staffing numbers, etc.).*
- *Analysis pertaining to EPSS outages, which should include the following for each CPZ in which EPSS has been enabled:*
  - *Number of outages that have occurred.*
  - *Whether or not the CPZ is in the HFTD.*
  - *Cumulative number of customers impacted by those outages.*
  - *Cumulative customer minutes interrupted during those outages.*
  - *Cumulative outage time in minutes.*

- *Number of circuit-mile-days in which EPSS criteria was met, including conditions used in order for criteria to be met.*

- *Percentage of time in which EPSS was enabled.*

- *A re-evaluation of its EPSS-enablement thresholds. This must include demonstration of trade-offs between reliability and wildfire risk mitigation effectiveness for each FPI level, as well as inclusion of areas outside the HFTD.*

PG&E Response:

Continued Reporting of PG&E's EPSS-Related Outages

The attached 2023 Reliability Study addresses nine of the eleven reporting data points identified in this ACI: (1) number of outages; (2) CPZ in which the outage occurred; (3) duration of the outage; (4) number of customers impacted; (5) number of impacted customers belonging to vulnerable populations; (6) impact on community values; (7) response time for outages; (8) asset health; and (9) vegetation data.[60] The two reporting data points that are not included in the 2023 Reliability Study are: (1) whether or not the outage was in the HFTD; and (2) resource constraints. Additionally, the 2023 Reliability Study provides the percentage of time in which EPSS was enabled on a specific circuit.

Regarding whether the outage occurred in the HFTD, please note that all EPSS outages occur due to faults detected by devices that protect HFRAs. Therefore, all outages in the study would have affected at least some part of the HFRA, although not necessarily in the HFTD, which is updated less frequently, and which less accurately depicts high fire risk.

When looking at resource constraints, we have not previously identified any resource constraints that prevented us from meeting or exceeding our established metrics for the CAIDI. We established a plan to ensure appropriate resources are available to support response to EPSS outages to meet both our response metrics and outage duration metrics. For additional detail, please reference PG&E's response to ACI PG&E-23-13 earlier in this document. PG&E included the impact on community values data in the 2023 Reliability Study but the methodology, analysis and the final data will be formalized as part of PG&E's 2024 RAMP filing in May.

Lastly, the data provided is also aggregated to the CPZ that experienced outages while EPSS was enabled in 2023. Similar to the 2022 data, the requested data does not include the context of customers that did not experience any outages while being protected by EPSS in 2023. This is a significant number as 61%—more than 1 million customers—were not impacted by EPSS in 2023.

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60 See Attachment 2024-04-02_PGE_2025_WMP-Update _R0_ACI-23-26_Atch01_CONF.

Action Plan and Analysis from 2023 EPSS Reliability Study

PG&E analyzes and leverages the information included in the attached 2023 EPSS Reliability Study to inform activities meant to improve reliability for customers experiencing outages on circuits protected by EPSS. PG&E is evaluating operational mitigations executed in 2023 in combination with information in the 2022 and 2023 EPSS Reliability Study to review reliability impacts and potential improvement in support of future mitigation work scoping and further reducing outage activity on EPSS enabled zones.

In 2024, PG&E will continue to execute targeted vegetation management work, VMOMs, intended to reduce the impacts of vegetation caused outages due to increased sensitivity resulting from EPSS enabled devices. Additionally, we will continue to execute our Vegetation Extent of Condition patrols and vegetation management work for EPSS-enabled vegetation caused outages to: (1) determine if there are additional vegetation risks upstream and downstream of the fault location; and (2) attempt to remove any identified vegetation.

In addition to vegetation management work, PG&E will execute animal mitigation work for EPSS enabled animal caused outages. Animal mitigation may include installation of bird retrofitting, critter guard, and additional measures depending on asset configuration.

PG&E will continue to leverage EPSS reliability information in support of circuit sectionalization efforts and, in 2024, plans to begin installation of FuseSaver equipment with the intent to decrease customer impact from outages on EPSS-enabled zones. In addition to wildfire risk, PG&E will assess reliability impact of proposed zones to help inform prioritization.

The information included in the 2023 EPSS Reliability Study is also used to help improve our customer communication and engagement at the service point identification level including identification of our highest impacted customers and support offerings available. In 2023, the EPSS Program experienced a CAIDI of 193 minutes, or just over three hours.[61]

Re-Evaluation of EPSS-Enablement Thresholds

Biannually, PG&E evaluates options for EPSS enablement criteria. As wildfire risk begins to elevate in late spring or early summer, PG&E will evaluate meteorological forecasts, fuel models, observed conditions within the service area, and operating postures of State and Federal fire agency partners to validate that wildfire risk is escalating, warranting a transition into established “peak season” enablement criteria. The same evaluation is conducted in late fall or early winter to determine when to transition into non-peak season base criteria. Both the individual peak and non-peak season criteria and the seasonal timing of using each ensures that EPSS is appropriately postured year-round to mitigate the risk of wildfire ignitions in escalated

[61] CAIDI Excluding MED (Major Event Days) is 183 minutes for 2023.

conditions, while ensuring disablement and improved customer reliability when wildfire risk is lower.

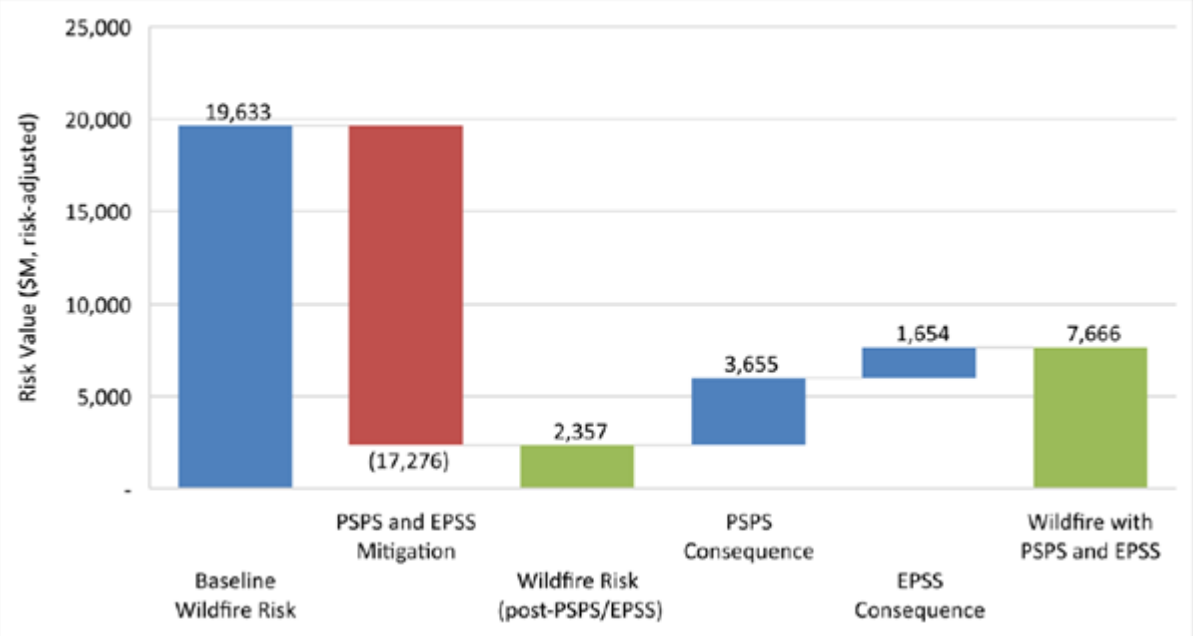
The below analysis was completed in June 2024 and addresses the portion of the ACI seeking a re-evaluation of PG&E's EPSS-enablement thresholds.

1. Background

As presented in PG&E's 2024 RAMP filing, the tradeoff analysis conducted indicates, at a programmatic level, EPSS provides greater wildfire risk reduction than the associated reliability risk. The risk adjusted cost of wildfire risk prior to PSPS and EPSS implementation amounts to $19,633 million as compared to a total of $7,666 million when PSPS and EPSS mitigation are leveraged, see Figure ACI-PG&E-23-26-1 below.

Further analysis was conducted to better understand wildfire risk and reliability trade-offs at individual FPI rating levels, leveraging methodology consistent with PG&E's 2024 RAMP filing, as well as additional considerations.

FIGURE PG&E-23-26-1:
2027 TY BASELINE – WILDFIRE WITH PSPS AND EPSS



2. EPSS Program Overview

The EPSS Program enablement criteria, established in 2022 and currently leveraged to execute the program, are based on the 2x2km model outputs from PG&E's Fire Potential Index model. Please refer to Section 8.3.6 of PG&E's 2023 – 2025 WMP for a detailed description of the FPI model. EPSS is intended to prevent catastrophic ignitions from occurring by reducing the energy density of an ignition fault should it

occur. EPSS scoped circuits are enabled where and when elevated fire potential is forecasted, as indicated by FPI model outputs.

For an overview of EPSS Program performance metrics relative to both ignitions and reliability, please refer to Section 8.1.8.1 of PG&E's 2023 – 2025 WMP.

3. EPSS Program Enablement Criteria

The EPSS Program enablement criteria were established in 2022 following analysis of historical fire consequences,[62] ignitions,[63] and outages[64] at various FPI ratings and was designed to capture fires of consequence. The enablement criteria were designed to ensure EPSS protection was enabled during conditions in which the following consequences were observed – fires resulting in 100 percent of fatalities and structures destroyed,[65] over 95 percent of acres burned from any ignition cause, and 26 percent of historical PG&E HFTD ignitions.[66] See Figure ACI-PG&E-23-26-2 below.

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62 Fatalities, Structures Destroyed, Acres burned based on 2,437 historical fires >100 acres from 2012-2020 of Any Cause.

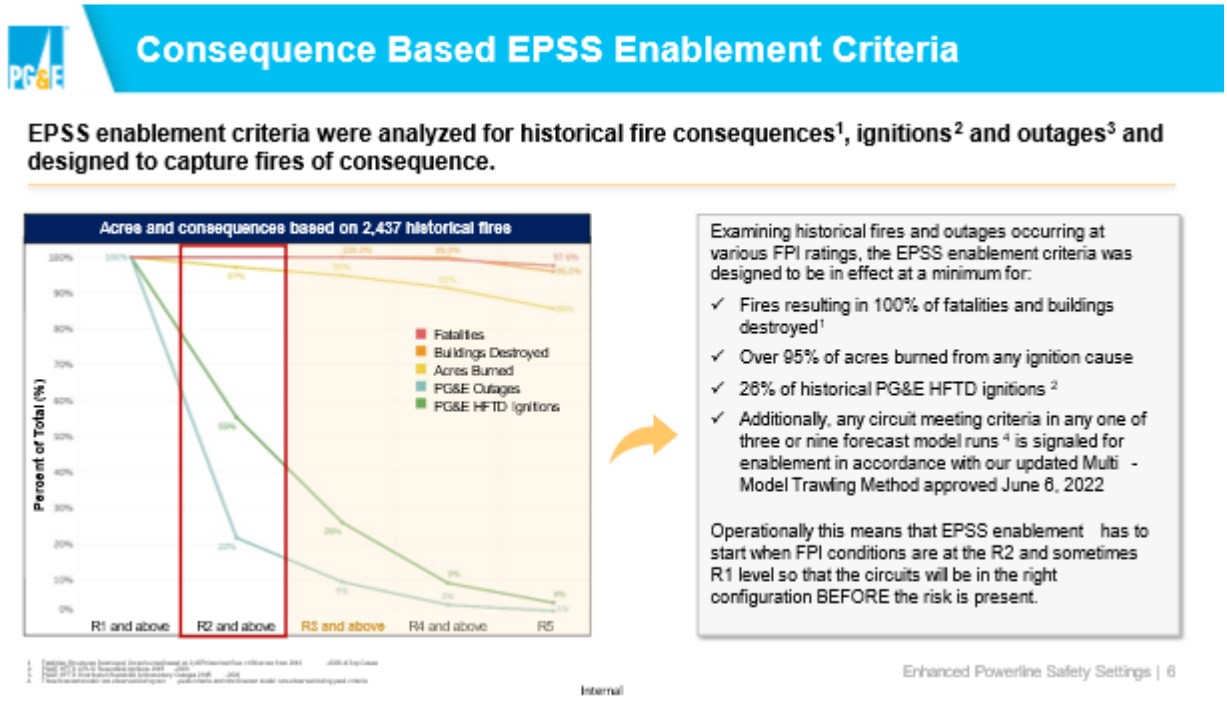
63 PG&E HFTD CPUC Reportable Ignitions 2015-2020.

64 PG&E HFTD Distribution Sustained & Momentary Outages 2015-2020.

65 Fatalities, Structures Destroyed, Acres burned based on 2,437 historical fires >100 acres from 2012-2020 of Any Cause.

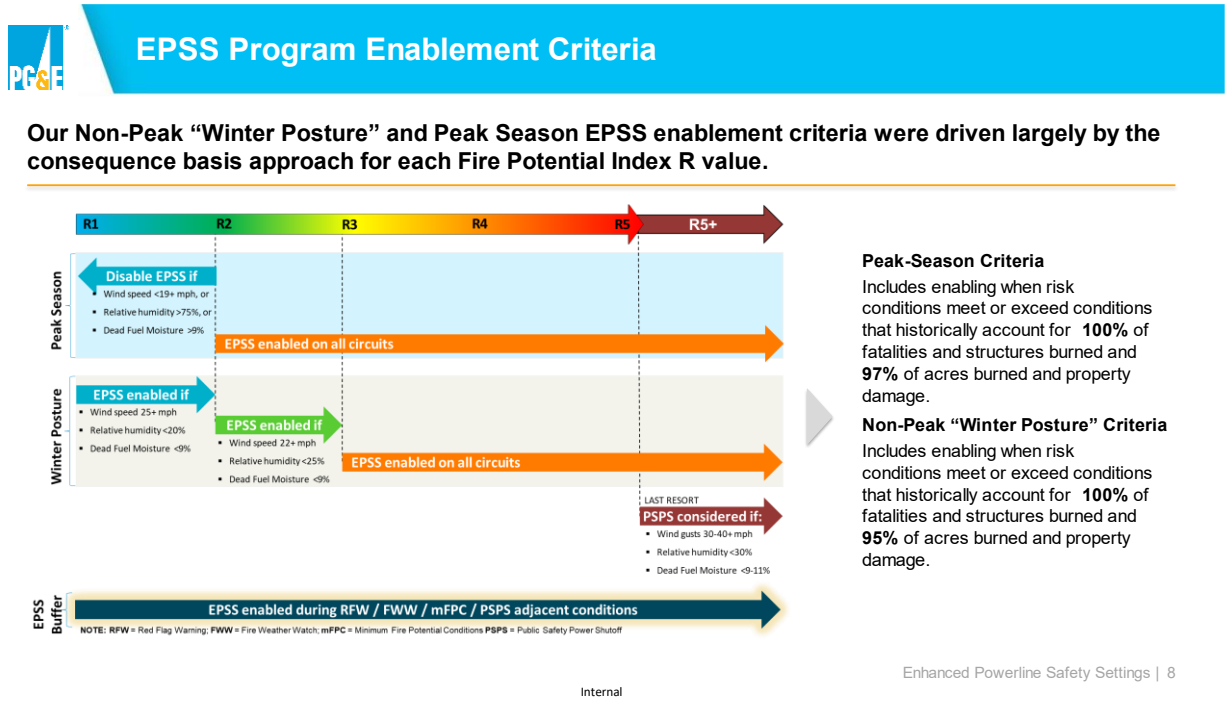
66 PG&E HFTD CPUC Reportable Ignitions 2015-2020.

FIGURE PG&E-23-26-2:
CONSEQUENCE BASED EPSS ENABLE CRITERIA



Given these conditions were observed starting at the R3 FPI rating level, the EPSS Program exercises a prudent approach to enablement by enabling EPSS settings at forecasted R1 and R2 FPI rating levels depending on various fire risk conditions observed throughout the year. Given that EPSS circuit enablement is executed once daily, based on forecasted conditions meeting criteria, and given that forecasted FPI ratings can increase throughout the same day, we exercise a prudent approach to enable EPSS settings prior to the realization of escalated risk. This allows for circuits to be enabled with EPSS protection and in the appropriate configuration prior to the escalated risk and potential for catastrophic consequences to be present. Please see Figure ACI-PG&E-23-26-3 below for the EPSS Program enablement criteria for peak and non-peak wildfire risk seasons.

FIGURE PG&E-23-26-3:
EPSS PROGRAM ENABLEMENT CRITERIA



4. EPSS Enablement Criteria FPI Stratified Risk and Reliability Comparison

As mentioned in Section 1. Background above, in support of ACI PG&E-23-26, PG&E conducted an analysis to better understand the trade-off between wildfire risk and reliability of the EPSS Program, presenting an overview of the analysis in PG&E's 2024 RAMP filing. PG&E then conducted a further analysis to evaluate trade-offs for each FPI rating.

To conduct this analysis, PG&E leveraged two approaches – the first approach (referred to as Approach 1 hereafter) leveraged methodology consistent with PG&E's 2024 RAMP filing to review historic impacts at each FPI level[4], the second approach (referred to as Approach 2 hereafter) leveraged a combination of the risk-adjusted cost methodology utilized for PG&E's RAMP filing and consequence associated with historic ignitions in PG&E's service area, regardless of CPUC reportability and attributability. Additionally, Approach 2 applied a stratified outage-to-ignition conversion rate per FPI rating[67] to account for variability in ignition probability by FPI rating. See Figure ACI-PG&E-23-26-4 below for additional details. PG&E also reviewed wildfire risk and reliability trade-offs for each approach for the full year, and for both peak and non-peak wildfire risk conditions with the assumption non-peak conditions would be applied for months January – May and peak conditions for months June – December.

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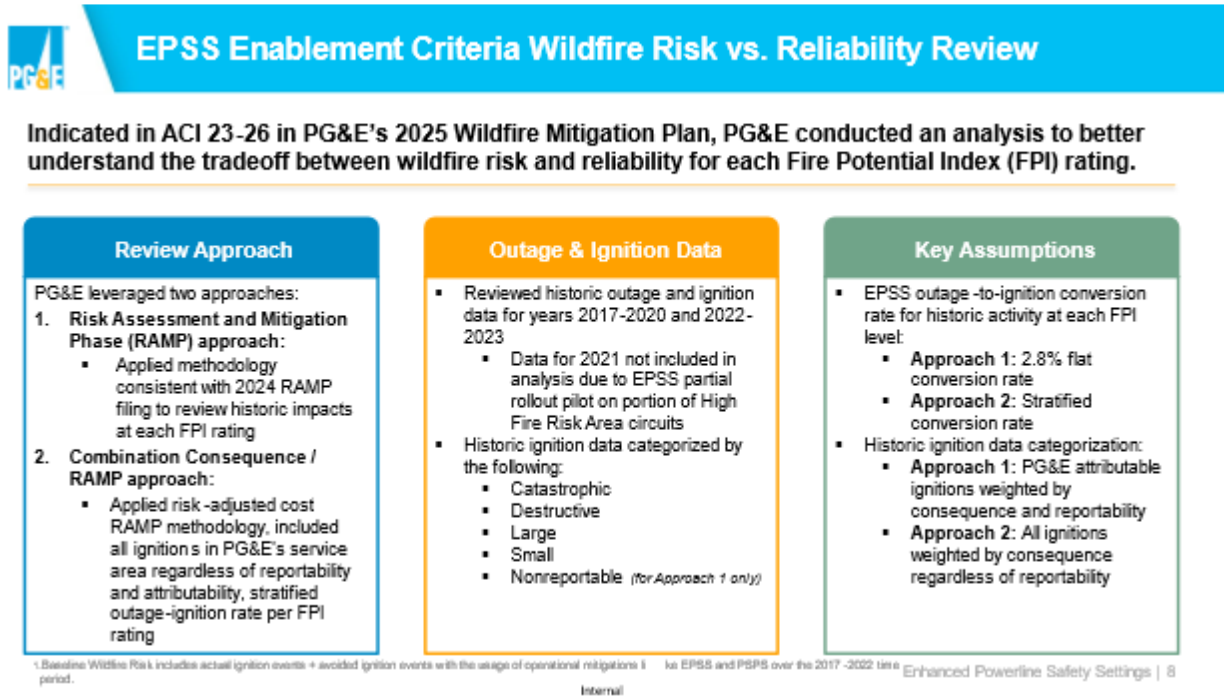
67 Back-casted FPI rating data not available for some historical outage and ignition records between 2017-2020. Outage risk and ignition risk values were still calculated for outages and ignition with "null" FPI data with negligible impact for this analysis

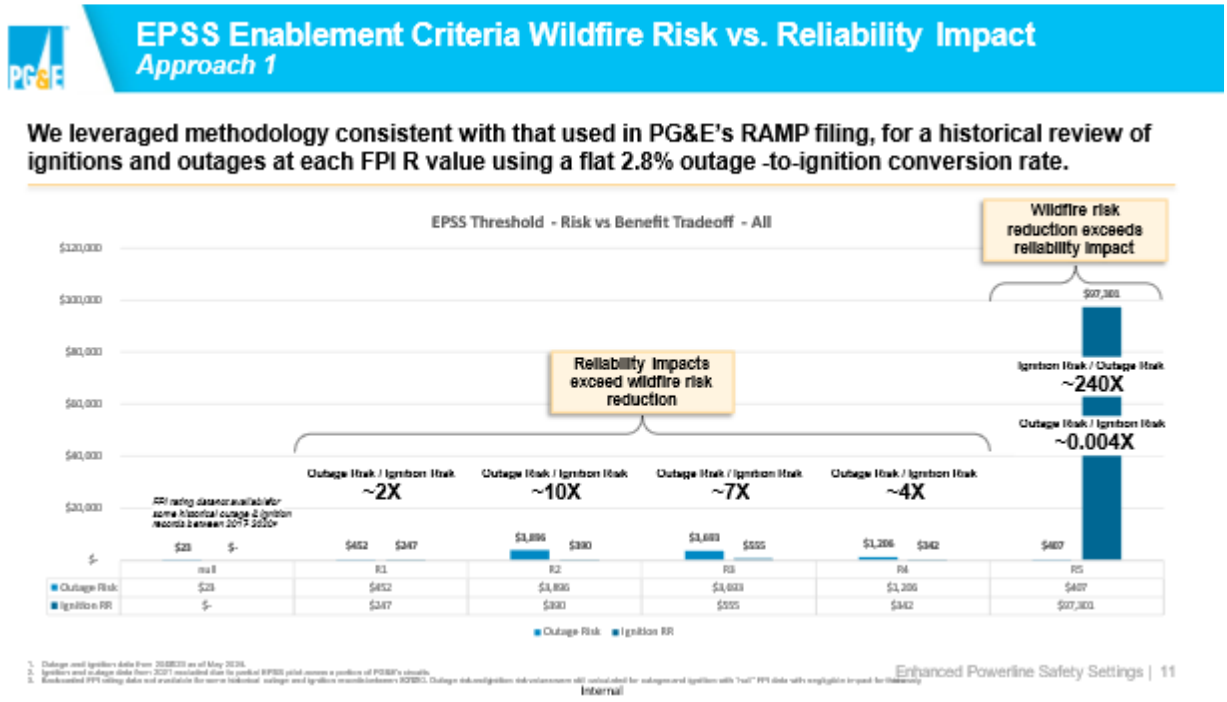
FIGURE PG&E-23-26-4:
EPSS ENABLEMENT CRITERIA WILDFIRE RISK VS. RELIABILITY REVIEW



Approach 1:

For Approach 1, PG&E leveraged methodology consistent with that used in PG&E's 2024 RAMP filing, yielding the results represented in Figure ACI-PG&E-23-26-5 below. During R5 FPI rating conditions, an ~240x greater ignition risk to outage risk was observed. By comparison, significantly lower ratios of outage risk to ignition risk were observed during R1-R4 FPI ratings conditions, with outage risk valued higher than ignition risk at each rating.

FIGURE PG&E-23-26-5:
EPSS ENABLEMENT CRITERIA WILDFIRE RISK VS. RELIABILITY IMPACT: APPROACH 1



Approach 2:

For Approach 2, PG&E leveraged a combined methodology utilizing PG&E's 2024 RAMP filing and a historical ignition consequence-basis methodology with stratified outage-to-ignition conversion rates for each FPI rating, yielding the results represented in Figure ACI-PG&E-23-26-6 below. For the full year, R4 and R5 conditions resulted in a ~40x and ~240x greater ignition risk to outage risk, respectively. During R1-R3 conditions, significantly lower outage risk to ignition risk were observed at ~2x, ~6x, and ~4x, respectively.

Additionally, PG&E leveraged the same methodology to review the ignition risk and reliability tradeoffs of the EPSS enablement criteria for both peak and non-peak wildfire risk seasons accounting for differences in ignition risk and consequence that may materialize throughout the year. For the non-peak wildfire risk season, defined in this analysis as January through May for simplicity, all FPI ratings R1-R5 were observed to have greater ignition risk to outage risk. See Figure ACI-PG&E-23-26-7. For the peak wildfire risk season, defined in this analysis as June through December, FPI ratings R4 and R5 indicated greater ignition risk to outage risk consistent with magnitudes observed in the full year analysis. See Figure ACI-PG&E-23-26-8.

FIGURE PG&E-23-26-6:
EPSS ENABLEMENT CRITERIA WILDFIRE RISK VS. RELIABILITY IMPACT: APPROACH 2

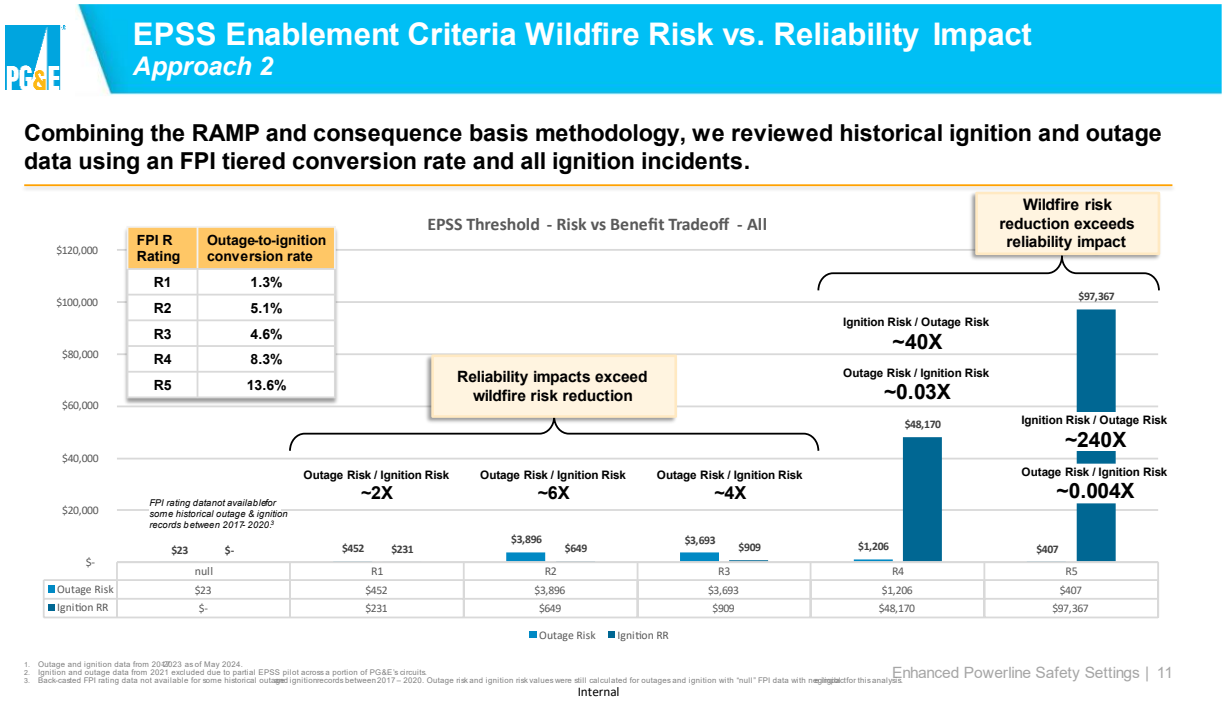


FIGURE PG&E-23-26-7:
EPSS ENABLEMENT CRITERIA WILDFIRE RISK VS. RELIABILITY IMPACT: APPROACH 2
NON-PEAK WILDFIRE RISK SEASON (JAN – MAY)

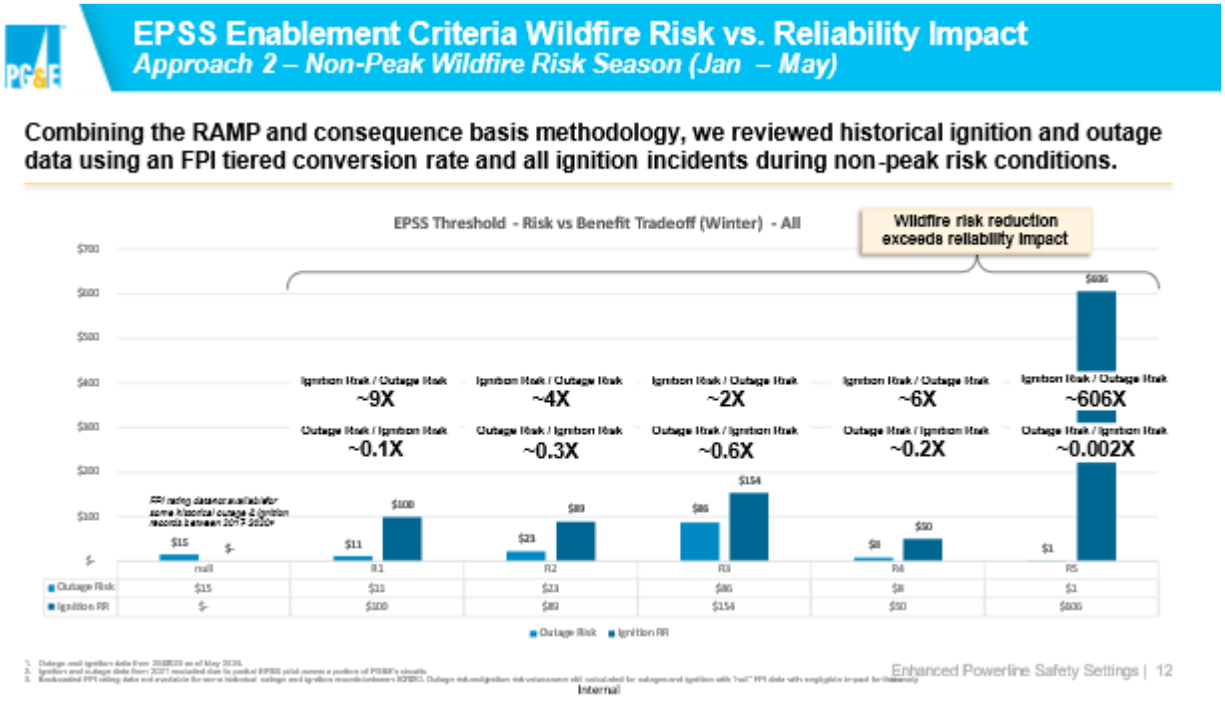
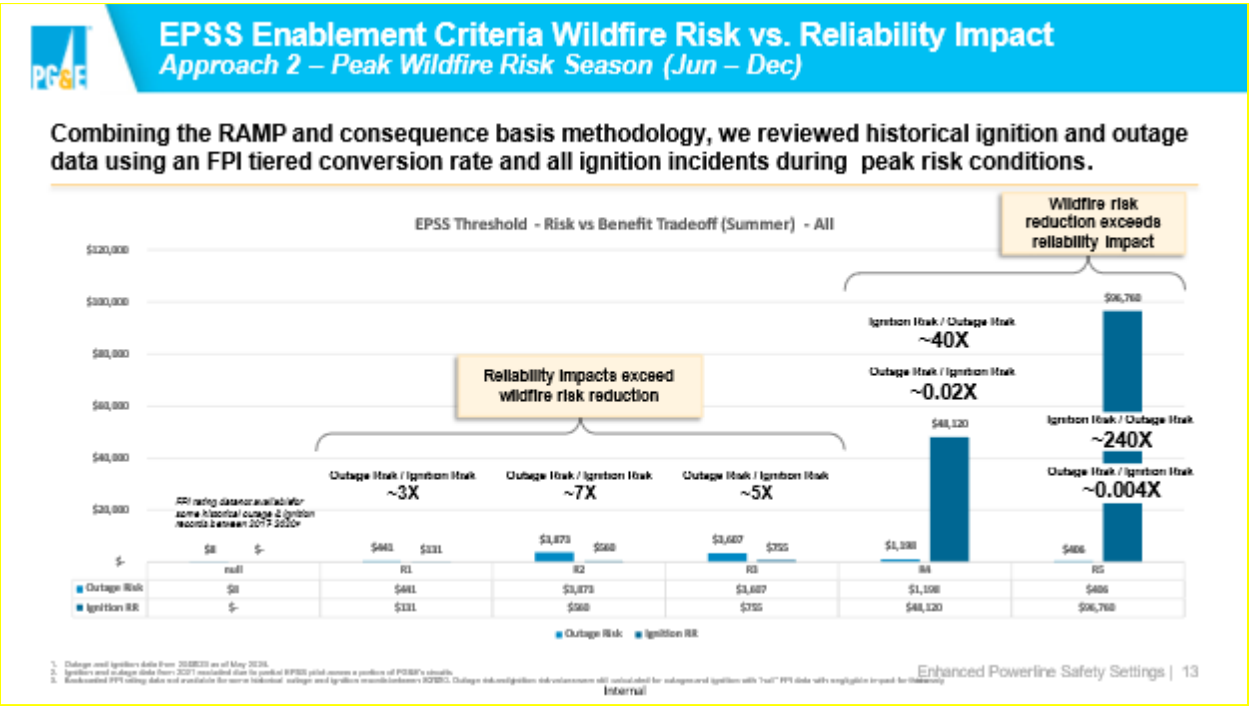


FIGURE PG&E-23-26-8:
EPSS ENABLEMENT CRITERIA WILDFIRE RISK VS. RELIABILITY IMPACT: APPROACH 2 PEAK WILDFIRE RISK SEASON (JUN – DEC)



Given the EPSS Program consistently enables during R3 conditions regardless of peak or non-peak season, as referenced previously in Figure ACI-PG&E-23-26-3 above, and the non-peak wildfire risk season analysis indicates a greater risk of ignition as compared to outages, it would be appropriate to enable EPSS settings at a minimum in R3+ conditions. Additionally, given EPSS enablement is driven by a forecasted basis, and it is possible FPI conditions may increase in rating day-of, it is prudent to enable EPSS settings prior to realization of escalated risk and ahead of need. Reviewing each analysis, it is also evident the transition at which ignition risk to outage risk becomes greater occurs at orders of magnitude higher than that of the outage to ignition risk, further signaling a prudency in enabling prior to realization of increased risk.

5. Summary

The analysis conducted as part of ACI PG&E-23-26 has provided PG&E with the opportunity to review ignition and reliability risk, leveraging multiple methodologies, to better understand the trade-offs between each relative to the EPSS Program enablement criteria and each Fire Potential Index. Reviewing the results, PG&E finds this analysis supportive of enabling EPSS settings in R3+ FPI conditions in both peak and non-peak wildfire risk seasons and some R2 and R1 FPI conditions throughout the year. While the analysis does indicate higher outage risk to ignition risk during R2 FPI conditions, this trade-off was observed at orders of magnitude lower than that of the ignition risk to outage risk at higher FPI conditions. As a prudent operator working with the relative uncertainty that comes with predictive weather and fuel modeling, PG&E believes the analysis provides support for continuing to enable EPSS during R2 FPI

conditions during peak wildfire risk season. It is also important to note that this analysis benefits from being in hindsight, having access to actual historical FPI conditions.

While PG&E believes it is appropriate to maintain our current EPSS enablement criteria, PG&E acknowledges any impact to reliability for our customers is an extremely important issue and presents an opportunity to improve and better serve our customers.

In 2024, the EPSS Program is overseeing the execution of a targeted proactive and reactive vegetation management program, animal mitigation, and circuit sectionalization efforts to support a reduction in all reliability impacts, including reliability impacts when EPSS settings are enabled, while remaining steadfast in its prudency to safely operate the system.

6. Opportunities

This analysis, in conjunction with PG&E's 2024 RAMP filing, has provided PG&E with the opportunity to evaluate the ignition risk as compared to reliability risks relative to EPSS settings enablement and the program criteria at each FPI rating including considerations for seasonality differences and differences in ignition to outage probability depending on FPI.

Moving forward, PG&E has the opportunity to further refine this analysis and the various assumptions made to produce additional potential scenarios, leveraging historical performance data. PG&E anticipates leveraging this analysis to consider such scenarios and identify opportunities to improve the program and continue to serve our customers.

PACIFIC GAS AND ELECTRIC COMPANY

2025 WILDFIRE MITIGATION PLAN UPDATE

APPENDIX A

Appendix A

ACI PG&E 23-25 Tables on List of Model Features

This section includes the complete tables supporting ACI PG&E-23-25 response:

- Table ACI-PG&E-23-25-3: List of Model Features Evaluated and Selected for FPI5.0.
- Table ACI-PG&E-23-25-5: List of Model Features Evaluated and Selected for OPW5.0.
- Table ACI-PG&E-23-25-8: List of Model Features Evaluated and Selected for IOPW.

TABLE ACI-PG&E-23-25-3:
LIST OF MODEL FEATURES EVALUATED AND SELECTED FOR FPI5.0.

Model Feature	Model Feature Group	Final Model Feature (1 = yes, 0 = no)
alignment_vector_avg	Terrain	0
TerrainRugged_Max	Terrain	0
TerrainRugged_Mean	Terrain	1
TerrainRugged_Min	Terrain	0
Slope_Degree_Max	Terrain	0
Slope_Degree_Mean	Terrain	1
Slope_Degree_Min	Terrain	0
Aspect_Most_Common_Angle	Terrain	0
Aspect_Flat_Percent	Terrain	0
Aspect_N_NE_Percent	Terrain	0
Aspect_NE_E_Percent	Terrain	0
Aspect_E_SE_Percent	Terrain	0
Aspect_SE_S_Percent	Terrain	0
Aspect_S_SW_Percent	Terrain	0
Aspect_SW_W_Percent	Terrain	0
Aspect_W_NW_Percent	Terrain	0
Aspect_NW_N_Percent	Terrain	0
Aspect_Southerly_Percent	Terrain	0
elevation_m	Terrain	0
canopy_ht_ft	Fuels	0
canopy_ht_pct_tile_20_ft	Fuels	0
canopy_ht_pct_tile_80_ft	Fuels	0
canopy_ht_std_ft	Fuels	0
canopy_cover_pct	Fuels	0
canopy_cover_std_pct	Fuels	0
canopy_cover_pct_tile_20	Fuels	0
canopy_cover_pct_tile_80	Fuels	0
dead_tree_pct	Fuels	0
dead_tree_std_pct	Fuels	0
dead_tree_pct_tile_20	Fuels	0
dead_tree_pct_tile_80	Fuels	0
enc1:Grass	Fuels	1
enc1:Grass-Shrub	Fuels	1
enc1:Non-burnable	Fuels	0
enc1:Shrub	Fuels	1
enc1:Timber Litter	Fuels	1
enc1:Timber Understory	Fuels	1
enc1:Urban-Roads-Agg Low Burnable	Fuels	1
enc1:Urban-Roads-Agg High Burnable	Fuels	1
enc2:Grass	Fuels	0
enc2:Grass-Shrub	Fuels	0
enc2:Non-burnable	Fuels	0
enc2:Shrub	Fuels	0
enc2:Timber Litter	Fuels	0
enc2:Timber Understory	Fuels	0
load_100h_lbperft2	Fuels	0

TABLE ACI-PG&E-23-25-3:
LIST OF MODEL FEATURES EVALUATED AND SELECTED FOR FPI5.0.
(CONTINUED)

Model Feature	Model Feature Group	Final Model Feature (1 = yes, 0 = no)
load_10h_lbperft2	Fuels	0
load_1h_lbperft2	Fuels	0
load_herb_lbperft2	Fuels	0
load_woody_lbperft2	Fuels	0
fuel_bed_depth_ft	Fuels	1
ave_fuel_complexity	Fuels	1
dfm_1000hr	Fuel Moisture	1
dfm_100hr	Fuel Moisture	1
dfm_10hr	Fuel Moisture	1
dfm_1hr	Fuel Moisture	1
lfm_chamise_new	Fuel Moisture	1
lfm_chamise_old	Fuel Moisture	1
lfm_manzanita_new	Fuel Moisture	0
LFMC_herb	Fuel Moisture	0
LFMC_woody	Fuel Moisture	0
ndvi	Fuel Moisture	1
smois_0	Soil Moisture	1
smois_1	Soil Moisture	0
smois_2	Soil Moisture	0
smois_3	Soil Moisture	0
rh_1500m	Weather-Dry	0
rh_1200m	Weather-Dry	0
rh_750m	Weather-Dry	0
rh_300m	Weather-Dry	0
rh_150m	Weather-Dry	0
rh_80m	Weather-Dry	0
rh_50m	Weather-Dry	0
rh_30m	Weather-Dry	0
rh2m	Weather-Dry	0
vpd_mb_1500m	Weather-Dry	0
vpd_mb_1200m	Weather-Dry	0
vpd_mb_750m	Weather-Dry	0
vpd_mb_300m	Weather-Dry	1
vpd_mb_150m	Weather-Dry	0
vpd_mb_80m	Weather-Dry	0
vpd_mb_50m	Weather-Dry	1
vpd_mb_30m	Weather-Dry	0
vpd2m_mb	Weather-Dry	1
Max(vpd_mb_30-1500m)	Weather-Dry	0
tdd2m_f	Weather-Dry	0
sfcdownshortwaveflux	Weather-Heat	1
temp_f_1500m	Weather-Heat	0
temp_f_1200m	Weather-Heat	0
temp_f_750m	Weather-Heat	0
temp_f_300m	Weather-Heat	1
temp_f_150m	Weather-Heat	0
temp_f_80m	Weather-Heat	0

TABLE ACI-PG&E-23-25-3:
LIST OF MODEL FEATURES EVALUATED AND SELECTED FOR FPI5.0.
(CONTINUED)

Model Feature	Model Feature Group	Final Model Feature (1 = yes, 0 = no)
temp_f_50m	Weather-Heat	1
temp_f_30m	Weather-Heat	0
temp2m_f	Weather-Heat	1
Max(temp_f_30-1500m)	Weather-Heat	0
pbl_height_m	Weather-Turbulence	0
tke_pbl_1500m	Weather-Turbulence	0
tke_pbl_1200m	Weather-Turbulence	0
tke_pbl_750m	Weather-Turbulence	0
tke_pbl_300m	Weather-Turbulence	1
tke_pbl_150m	Weather-Turbulence	0
tke_pbl_80m	Weather-Turbulence	0
tke_pbl_50m	Weather-Turbulence	1
tke_pbl_30m	Weather-Turbulence	0
Max(tke_pbl_30-1500m)	Weather-Turbulence	0
ustar_frc_vel	Weather-Turbulence	1
wg_cf_mph	Weather-Wind	0
wg_ec_mph	Weather-Wind	0
ws_mph_1500m	Weather-Wind	0
ws_mph_1200m	Weather-Wind	0
ws_mph_750m	Weather-Wind	0
ws_mph_300m	Weather-Wind	1
ws_mph_150m	Weather-Wind	0
ws_mph_80m	Weather-Wind	0
ws_mph_50m	Weather-Wind	1
ws_mph_30m	Weather-Wind	0
ws_mph	Weather-Wind	1
Max(ws_mph_30-1500m)	Weather-Wind	0
vector_wind_dir_f_avg	Weather-Wind	0
u_mph_1500m	Weather-Wind-Vector	0
u_mph_1200m	Weather-Wind-Vector	0
u_mph_750m	Weather-Wind-Vector	0
u_mph_300m	Weather-Wind-Vector	0
u_mph_150m	Weather-Wind-Vector	0
u_mph_80m	Weather-Wind-Vector	0
u_mph_50m	Weather-Wind-Vector	0
u_mph_30m	Weather-Wind-Vector	0
u10_ms	Weather-Wind-Vector	0
v_mph_1500m	Weather-Wind-Vector	0
v_mph_1200m	Weather-Wind-Vector	0
v_mph_750m	Weather-Wind-Vector	0
v_mph_300m	Weather-Wind-Vector	0
v_mph_150m	Weather-Wind-Vector	0
v_mph_80m	Weather-Wind-Vector	0
v_mph_50m	Weather-Wind-Vector	0
v_mph_30m	Weather-Wind-Vector	0
v10_ms	Weather-Wind-Vector	0
w_mph_1500m	Weather-Wind-Vector	0

TABLE ACI-PG&E-23-25-3:
LIST OF MODEL FEATURES EVALUATED AND SELECTED FOR FPI5.0.
(CONTINUED)

Model Feature	Model Feature Group	Final Model Feature (1 = yes, 0 = no)
w_mph_1200m	Weather-Wind-Vector	0
w_mph_750m	Weather-Wind-Vector	0
w_mph_300m	Weather-Wind-Vector	0
w_mph_150m	Weather-Wind-Vector	0
w_mph_80m	Weather-Wind-Vector	0
w_mph_50m	Weather-Wind-Vector	0
w_mph_30m	Weather-Wind-Vector	0
znt_roughness	WRF Paramteter	0
ps_mb_1500m	Weather-Pressure	0
ps_mb_1200m	Weather-Pressure	0
ps_mb_750m	Weather-Pressure	0
ps_mb_300m	Weather-Pressure	0
ps_mb_150m	Weather-Pressure	0
ps_mb_80m	Weather-Pressure	0
ps_mb_50m	Weather-Pressure	0
ps_mb_30m	Weather-Pressure	0
psfc_mb	Weather-Pressure	0
acc_precip_nc	Precipitation	0
acc_snow_mm	Precipitation	0
acc_snow_nc	Precipitation	0
snow_depth_m	Precipitation	0

TABLE ACI-PG&E-23-25-5:
LIST OF MODEL FEATURES EVALUATED AND SELECTED FOR OPW5.0

Model Feature	Model Feature Group	Final Model Feature (1 = yes, 0 = no)
avg_ws_mph	Weather-Wind	1
avg_ws_mph_50m	Weather-Wind	1
avg_ws_mph_300m	Weather-Wind	0
avg_ws_mph_750m	Weather-Wind	0
avg_ws_mph_1500m	Weather-Wind	0
avg_tke_pbl_50m	Weather-Wind	1
avg_tke_pbl_300m	Weather-Wind	1
avg_tke_pbl_750m	Weather-Wind	0
avg_tke_pbl_1500m	Weather-Wind	0
wind_dir_f_10m	Weather-Wind	0
wind_dir_f_50m	Weather-Wind	0
wind_dir_f_300m	Weather-Wind	0
wind_dir_f_750m	Weather-Wind	0
wind_dir_f_1500m	Weather-Wind	0
wind_alignment_10m	Weather-Wind	0
wind_alignment_50m	Weather-Wind	0
wind_alignment_300m	Weather-Wind	0
wind_alignment_750m	Weather-Wind	0
wind_alignment_1500m	Weather-Wind	0
avg_w_mph_50m	Weather-Wind	0
avg_w_mph_300m	Weather-Wind	0
avg_w_mph_750m	Weather-Wind	0
avg_w_mph_1500m	Weather-Wind	0
avg_znt_roughness	Weather-Wind	0
avg_ustar_frc_vel	Weather-Wind	0
maxof_avg_ws_mph_300m_750m	Weather-Wind	0
maxof_avg_tke_pbl_300m_750m	Weather-Wind	0
maxof_avg_ws_mph_50m_1500m	Weather-Wind	0
maxof_avg_tke_pbl_50m_1500m	Weather-Wind	0
avg_acc_precip_nc	Weather-Precipitation	1
avg_acc_snow_mm	Weather-Precipitation	0
avg_temp2m_f	Weather-Heat	1
avg_temp_f_300m	Weather-Heat	0
avg_temp_f_750m	Weather-Heat	0
avg_temp_f_1500m	Weather-Heat	0
avg_sfcdownshortwaveflux	Weather-Heat	0
avg_temp_f_50m	Weather-Heat	1
avg_vpd2m_mb	Weather-Dry	0
avg_vpd_mb_300m	Weather-Dry	0
avg_vpd_mb_750m	Weather-Dry	0
avg_vpd_mb_50m	Weather-Dry	0
avg_vpd_mb_1500m	Weather-Dry	0
avg_psfc_mb	Weather	0
avg_pbl_height_m	Weather	0
mean_canopy_ht_ft	Veg – Salo	1
sum_tree_overstrike	Veg – Salo	0
mean_tree_overstrike	Veg – Salo	0
std_canopy_ht_ft	Veg – Salo	0
pct_tile_20_canopy_ht_ft	Veg – Salo	0
pct_tile_80_canopy_ht_ft	Veg – Salo	0

TABLE ACI-PG&E-23-25-5:
LIST OF MODEL FEATURES EVALUATED AND SELECTED FOR OPW5.0
(CONTINUED)

Model Feature	Model Feature Group	Final Model Feature (1 = yes, 0 = no)
pct_tile_20_tree_overstrike	Veg – Salo	0
pct_tile_80_tree_overstrike	Veg – Salo	0
mean_canopy_cover_pct	Veg – Salo	0
std_canopy_cover_pct	Veg – Salo	0
pct_tile_20_canopy_cover_pct	Veg – Salo	0
pct_tile_80_canopy_cover_pct	Veg – Salo	1
mean_deadtree_cover_pct	Veg – Salo	0
std_deadtree_cover_pct	Veg – Salo	0
pct_tile_20_deadtree_cover_pct	Veg – Salo	0
pct_tile_80_deadtree_cover_pct	Veg – Salo	0
avg_tree_height	Veg – Lidar	0
sum_tree_ovr	Veg – Lidar	0
time_of_day	Time	1
weekend	Time	1
aspect_most_common_angle	Terrain	0
slope_degree_mean	Terrain	1
terrainrugged_mean	Terrain	0
avg_smois_0	Soil Moisture	1
avg_smois_1	Soil Moisture	0
avg_smois_2	Soil Moisture	0
avg_smois_3	Soil Moisture	0
percent_primary	Node	0
node_id_33mile	Node	1
point_per_node_33	Node	0
circuit_dominant_n33c	Node	1
node66_dominant_n33c	Node	0
node132_dominant_n33c	Node	0
avg_age_years	Asset – Poles	1
avg_percentatmcu	Asset – Poles	0
std_age_years	Asset – Poles	0
std_percentatmcu	Asset – Poles	0
percent_poles_greater_31pct_atmcu	Asset – Poles	0
percent_poles_less_31pct_atmcu	Asset – Poles	0
percent_poles_unknown_atmcu	Asset – Poles	0
avg_conductorcount	Asset – CC	0
avg_primary_use_size_area_mm2	Asset – CC	0
percent_hardened	Asset – CC	0
percent_treewire_non_hardened	Asset – CC	0
percent_ACSR	Asset – CC	0
percent_AL	Asset – CC	0
percent_CU	Asset – CC	0
dominant_primary_use_material_category	Asset – CC	0

TABLE ACI-PG&E-23-25-8:
LIST OF MODEL FEATURES EVALUATED AND SELECTED FOR IOPW

Model Feature	Model Feature Group	Final Model Feature (1 = yes, 0 = no)
dfm_1hr	Fuel Moisture	1
dfm_10hr	Fuel Moisture	1
dfm_100hr	Fuel Moisture	1
dfm_1000hr	Fuel Moisture	1
temp2m_f	Weather-Heat	1
temp_f_50m	Weather-Heat	0
temp_f_300m	Weather-Heat	0
temp_f_750m	Weather-Heat	0
temp_f_1500m	Weather-Heat	0
vpd2m_mb	Weather-Dry	1
vpd_mb_50m	Weather-Dry	0
vpd_mb_300m	Weather-Dry	0
vpd_mb_750m	Weather-Dry	0
vpd_mb_1500m	Weather-Dry	0
rh2m	Weather-Dry	0
smois_3	Soil Moisture	0
smois_2	Soil Moisture	0
smois_1	Soil Moisture	0
smois_0	Soil Moisture	1
sfcdownshortwaveflux	Weather-Heat	1
enc1:timber_understory	Fuels	0
enc1:timber_litter	Fuels	0
enc1:shrub	Fuels	0
enc1:grass-shrub	Fuels	0
enc1:grass	Fuels	0
enc1:urban-roads-agg_burnable	Fuels	0
enc1:urban-roads-agg_low_burnable	Fuels	0
canopy_ht	Fuels	0
pbl_height_m	WRF Parameter	0
ndvi	Fuel Moisture	1
lfm_herb	Fuel Moisture	0
lfm_woody	Fuel Moisture	0
lfm_manzanita_new	Fuel Moisture	0
lfm_chamise_old	Fuel Moisture	0
lfm_chamise_new	Fuel Moisture	0
ws_mph	Weather-Wind	1
ws_mph_50m	Weather-Wind	0
ws_mph_300m	Weather-Wind	0
ws_mph_750m	Weather-Wind	0
ws_mph_1500m	Weather-Wind	0
wind_dir_f	Weather-Wind	0
ustar_frc_vel	Weather-Turbulence	0
tke_pbl_50m	Weather-Turbulence	0
tke_pbl_300m	Weather-Turbulence	0
tke_pbl_750m	Weather-Turbulence	0
tke_pbl_1500m	Weather-Turbulence	0
terrainrugged_mean	Terrain	0

TABLE PG&E- ACI-PG&E-23-25-8:
LIST OF MODEL FEATURES EVALUATED AND SELECTED FOR IOPW
(CONTINUED)

Model Feature	Model Feature Group	Final Model Feature (1 = yes, 0 = no)
slope_degree_mean	Terrain	1
aspect_southerly_percent	Terrain	0
aspect_most_common_angle	Terrain	0
alignment	Terrain	0
psfc_mb	Weather-Pressure	0
epss_ind	Grid Operations	0
percent_treewire_non_hardened	Assest	0
percent_hardened	Assest	0
percent_cu	Assest	0
percent_al	Assest	0
percent_acsr	Assest	0
avg_primary_use_size_area_mm2	Assest	0
avg_percentatmcu	Assest	0
avg_conductorcount	Assest	0
avg_age_years	Assest	0
acc_precip_nc	Weather-Precip	0
hour	Time	0
weekend	Time	0
month	Time	0
year	Time	0
prob_vegetation	OPW Outputs	0
prob_equipment_structural	OPW Outputs	0
prob_equipment_electrical	OPW Outputs	0
prob_animal_3rdparty	OPW Outputs	0
prob_unknown	OPW Outputs	0
opw	OPW Outputs	0