Power Off for Safety

2022 SAFETY OUTAGE DECISION-MAKING GUIDE

Contents

1 Overview

Safety is our most important responsibility. As California continues to experience extreme weather and drought, we are seeing increased wildfire risk and longer wildfire seasons. To help prevent wildfires, we are using advanced safety tools. These may result in two types of wildfire safety power outages.

Public Safety Power Shutoffs (PSPS)

High winds may cause trees and debris to fall onto powerlines and cause a wildfire. That is why we may need to proactively turn the power off during dry, windy weather. **This is called a Public Safety Power Shutoff (PSPS).** A PSPS is a last resort safety measure taken by PG&E and other utility providers to help prevent wildfires.

Enhanced Powerline Safety Settings (EPSS)

Powerlines in and near high fire-risk areas are enabled with Enhanced Powerline Safety Settings (EPSS). When wildfire risk is high, these settings automatically turn off power within one-tenth of a second when something hits a powerline. This helps prevent wildfires. **Because power turns off automatically, unplanned outages may occur.**

Understanding safety outages

This document explores:

- How PG&E evaluates weather and environmental risks that may lead to a safety outage

- When we determine an outage is necessary for public safety

- How we support and protect our customers and communities

Improving the electric grid

We are also working year-round to make our system safer and more resilient by:

- **Undergrounding 10,000 miles of powerlines** in high fire-risk areas as part of a multiyear effort.

- **Strengthening the electric grid** with stronger poles and covered lines.

- **Installing microgrids** to keep the electricity on during a PSPS.

- **Managing trees and other vegetation** above and beyond state standards.

2 Tools and Technology to Support Safety Outage Decision-making

High-resolution weather forecasting

We partner with leading wildfire prediction experts to predict wildfire behavior. Using high-resolution weather and fuel moisture forecasting models, we are able to generate five-day lookahead fire potential forecasts.


How do we analyze wildfire risk?

Historical weather data can answer questions such as:

(?) What weather and fuel moisture values best predict if and when large fires will occur?

(?) Where do Diablo and Santa Ana winds most frequently develop?

(?) Have Diablo wind events increased over the past 30 years?

(?) At what wind speeds do we see an increase in outage activity?

Tracking weather in real time

PG&E has a dedicated meteorology team that continually monitors weather conditions and potential wildfire risks.

Using advanced weather modeling systems and data from our network of more than 1,400 weather stations, this team is able to forecast and track weather conditions in real time.

TEMPERATURE

WIND SPEEDS

HUMIDITY

WIND DIRECTION
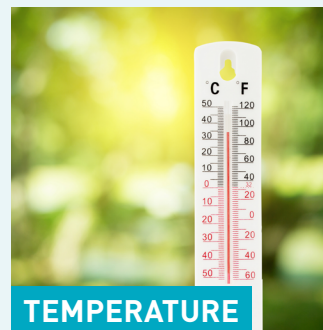
State-of-the-art weather forecasting:

- **Determines the historical potential for ignitions** from each analyzed weather event (Ignition Probability Weather - IPW)
- **Assists with fire model development** and calibration (Fire Potential Index - FPI)
- **Improves fire spread modeling** via data inputs (Technosylva)
- **Provides guidance** for operation decision-making (PSPS models, EPSS enablement)

Machine learning models

Our machine learning models provide a better understanding of historical weather events and improve our weather forecasting. These models use:

- **Precise location data points across our service territory** to conduct hourly weather analyses using high-resolution, historical data.
- **Over 100 trillion historical data points**.
- **Hourly weather data** such as temperature, relative humidity, wind speed, precipitation, pressure, and dead and live fuel moisture.
- **Data storage and processing** via the PG&E-Amazon Web Services Cloud.

Who makes up the PG&E team?

- Leadership from PG&E's Meteorology and Fire Science, Meteorology Operations, and Systems and Analytics teams
- Team members with backgrounds in meteorology, data science, fire weather analysis, high-resolution weather modeling, cloud computing and more

What do we do?

- Analyze historic weather patterns to inform future decisions
- Create high-resolution weather models
- Use our weather station and high-definition camera networks to monitor and forecast wildfire risks
- Inform PSPS and EPSS decision-making

Who do we work with?

- Our team regularly collaborates with San Jose State's Fire Weather Research Lab, the University of Madison Wisconsin Space Science and Engineering Center, Technosylva, the National Weather Service, the U.S. Forest Service, Atmospheric Data Solutions and others.

PSPS decision-making

PG&E has developed tools and models to better understand the impact of potential fire ignitions on communities. PG&E partners with Technosylva, an external expert in the wildfire modeling field, to test and deploy cloud-based wildfire spread model capabilities. This helps us better understand where we might need to turn off power.

Each day, PG&E delivers our wildfire conditions datasets to our partners at Technosylva, who then perform over 100 million fire spread simulations. These are done every three hours for the upcoming five days. These simulations provide fire spread scenarios that help to identify circuits that may be at risk during dry, windy weather.

Weather awareness

Our weather web page provides current weather conditions, an interactive weather map and tools to prepare for a PSPS.

- Learn about the role weather plays in a PSPS
- Find our seven-day PSPS potential forecast
- Review criteria to determine a PSPS
- Explore PG&E's real-time weather map
  - Wind gusts and speeds

Learn more at: **pge.com/weather**
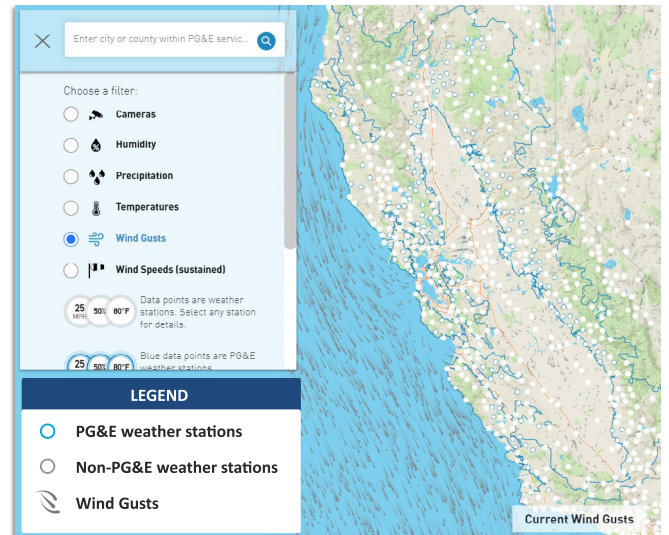
ended to further reduce the risk of wildfires. 1

EPSS decision-making

We use advanced tools and apply state-of-the-art machine learning models to determine when and where safety settings should be enabled. Based on the ongoing elevated risk for wildfire, we use our daily analysis of multiple weather models and operational flexibility to determine risk and whether settings can be safely disabled.

Ensemble forecasting

As of 2022, PG&E uses a range of forecast outcomes, called an ensemble, to make decisions for EPSS enablement. Ensemble forecasting uses eight different forecasts to help determine the range, spread and uncertainty of various weather predictions.

This improved modeling and location precision helps us better identify specific areas at an elevated risk of wildfire. It also helps identify lines at less risk. This assists us with determining if the lines can be excluded from potential safety shutoffs or EPSS enablement.

PG&E prioritizes customer safety as our guide in decision-making.

3 Safety Power Outage Criteria

PSPS criteria

PG&E carefully monitors data from multiple sources to confirm that conditions require an outage for public safety. These sources include weather data and federal forecasts, such as:

- **High-resolution forecasts** of the FPI Model, IPW Model and Technosylva fire spread simulations

- **Weather model forecast data** from external sources, including American, European and Canadian weather models

- **Red Flag Warnings** from the National Weather Service

- **Real-time data** from weather stations

- **Live feeds** from our Alert California wildfire cameras

- **High-risk forecasts** of Significant Fire Potential from the Geographic Area Coordination Center

- **Fire weather outlooks** from the Storm Prediction Center, which is part of the National Weather Service and National Oceanic and Atmospheric Administration

- **Information received on interagency conference calls** during high-risk periods

PSPS risk-benefit analysis

While we turn off power to protect public safety, we also recognize that losing power can be disruptive and create its own safety risks. To help us better assess the potential impact of a PSPS, we analyze:

- The potential safety risk of turning the power off
- The potential risk of wildfires that could occur on the circuits being considered for a PSPS

The analysis is driven by safety, with customer reliability and financial impact scores as secondary considerations. **This helps to ensure that PSPS is being used as a last resort to protect the safety of customers and communities.**

Steps for determining if a PSPS is necessary

When determining whether to turn off power for safety, we start with the distribution system. These powerlines are closer to communities and are generally more susceptible to dry, windy weather threats. We use 10 years of PG&E high-resolution climate data to help understand wildfire risk and potential customer impacts of PSPS.

STEP 1

If all of the minimum fire conditions are met...

High fire potential   Low relative humidity   High wind speeds   Low fuel moisture

STEP 2

...we conduct an in-depth review of fire risk using three separate measures:

A. **Catastrophic Fire Probability**
   PG&E uses machine learning to assess the likelihood of equipment failure during a given weather event and the risk of catastrophic wildfire if a failure occurs. This model uses a combination of the IPW Model and the FPI Model.

B. **Catastrophic Fire Behavior**
   Even if the probability of a powerline or equipment failure is unlikely, we may still turn off power where the consequence of a wildfire would be extreme.

C. **Vegetation and Electric Asset Criteria Considerations**
   We identify areas where tree or electric compliance issues may increase the risk of ignition.

STEP 3

If any of the three measures in Step 2 are met, we turn off power for safety.

Determining the power outage area

Each of the three measures is evaluated within a small geographic area (four square kilometers). If any of the measures are met, circuits within that area are de-energized. Because powerlines travel across long distances, customers outside the affected area may also be impacted.

The first step to determine the scope of a PSPS is evaluating the minimum fire potential conditions. This ensures that PSPS is only executed during wind events when atmospheric conditions and fuels are dry.

Criteria that meets the minimum fire potential conditions:
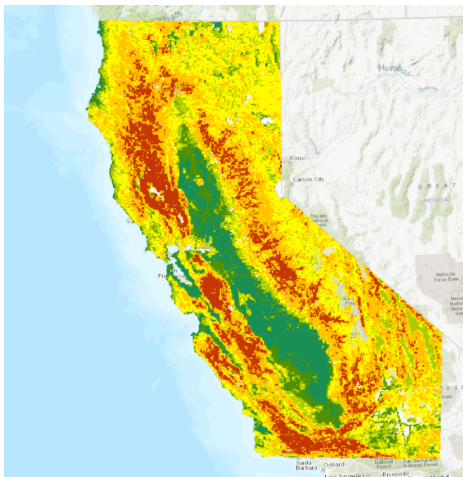
>0.7
Fire Potential Index

<30%
Humidity

>19MPH
Sustained wind speeds

<9-11%
Dead fuel moisture

Fire Potential Index (FPI) Model

The FPI Model shows the probability that a fire will become large or catastrophic, which is considered as part of the PSPS decision-making process.

FPI is used as a daily and hourly tool to drive operational decisions to reduce the risk of utility-caused fires. In 2019 it was enhanced, then again in 2021 with additional data and improved analytical capabilities.
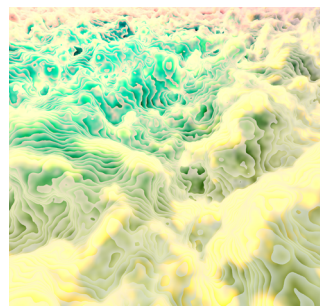
The current FPI Model combines the following to predict the probability of large and/or catastrophic fires:

Fire weather parameters
(wind speed, temperature, vapor pressure deficit)

Fuel moisture data
(**dead fuel:** dead grass, fallen branches; **live fuel:** grass, growing shrubs)

Topography
(terrain ruggedness, slope, wind-terrain alignment)

Fuel type data
(grass, shrub, timber, urban)

If all minimum fire conditions are met, we conduct an in-depth review of fire risk using three separate measures. If the criteria for any of these measures are met, we may need to turn off power for safety.

A. Catastrophic Fire Probability

The Catastrophic Fire Probability Model is the primary method used to determine the neccessity of a PSPS. This model combines the probability of fire ignitions due to weather impacting the electric system with the probability that a fire will be catastrophic if it starts. It is the combination of the FPI Model and the IPW Model.

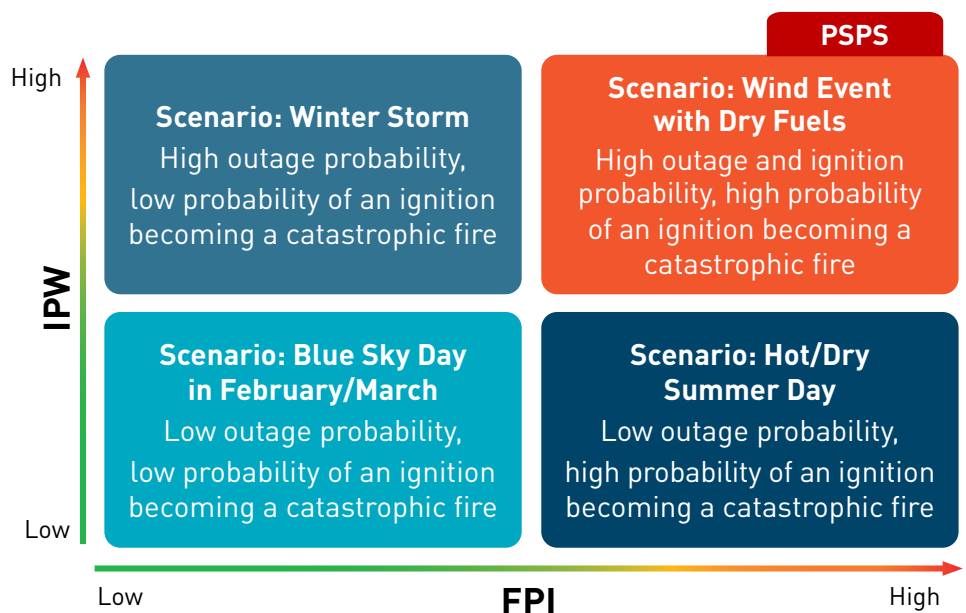### Ignition Probability Weather (IPW) Model

The IPW Model, a machine learning model, uses 10 years of weather data to provide the likelihood of an outage for specific circuits during past weather events. The model also uses historical data to identify the outage causes. Some tracked causes include vegetation, structural failures, electrical malfunctions and animal or third-party damage, among others.

The IPW Model analyzes the potential for several types of power outages in a given weather event. It also analyzes the potential for that outage to be the source of an ignition. IPW learns from and accounts for changes on the grid from year to year.

Tree considerations

Our PSPS protocols use a machine learning model to include the potential for trees to strike the lines. This helps our meteorology teams more accurately analyze risk posed by trees and how that translates to increased ignition probability.

PG&E ranks scenarios based on the IPW risk and the FPI value. **Scenarios with a high risk of an IPW and a high FPI value will always warrant a PSPS.** However, power may be turned off in other scenarios to avoid catastrophic wildfires.

High

IPW

Scenario: Winter Storm
High outage probability, low probability of an ignition becoming a catastrophic fire

PSPS

Scenario: Wind Event with Dry Fuels
High outage and ignition probability, high probability of an ignition becoming a catastrophic fire

Scenario: Blue Sky Day in February/March
Low outage probability, low probability of an ignition becoming a catastrophic fire

Scenario: Hot/Dry Summer Day
Low outage probability, high probability of an ignition becoming a catastrophic fire

Low

Low   **FPI**   High

B. Catastrophic Fire Behavior

In addition to using historical data and machine learning models, PG&E considers environmental conditions of significant wildfires, like dead and dying trees or drought conditions. This allows us to capture potential ignition events that are more rare and difficult to forecast, such as animal contact and external debris (e.g., metallic balloons) impacting the electric lines. These locations are only considered once the minimum fire potential conditions are met.

The U.S. Forest Service Rocky Mountain Research Station, a federal hub of wildfire research, has published documentation that relates the observed and modeled fire behavior to the type of fire suppression efforts that may be effective or ineffective. This includes a study of fireline intensity, which is an analysis of how wildfires can grow and spread.

Fireline intensity is determined by the size and components of flames. It is measured as the rate of heat energy released (Btu) per unit length of the fireline (ft) per unit time (s). It can also be calculated by estimating the flame length, which is the distance measured from the average flame tip to the middle of the base of the fire. We use probable fireline intensity to evaluate the potential need to turn off power.

For illustrative purposes only
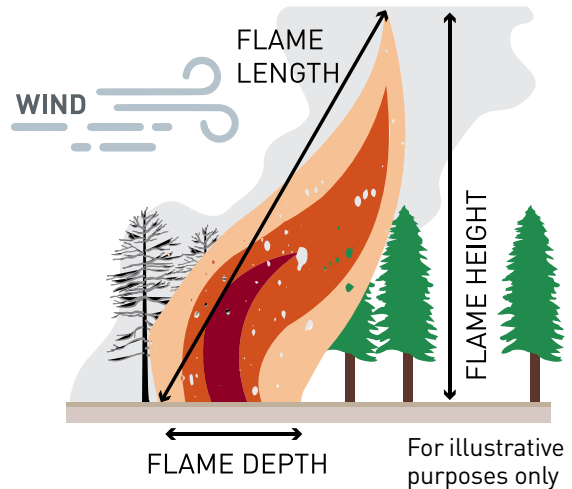
The two rows outlined are considered catastrophic fire behavior, which would necessitate a PSPS.

FLAME LENGTH (L)	FIRELINE INTENSITY	INTERPRETATION
ft	Btu/ft/s	
<4	<100	■ Fires can generally be attacked at the head by using hand tools ■ Hand line should hold the fire
4-8	100-500	■ Fires are too intense for direct attack on the head using hand tools ■ Hand line cannot be relied on to hold the fire ■ Equipment such as dozers, pumpers and retardant aircraft can be effective
8-11	500-1,000	■ Fires may present serious control problems — torching out, crowning and spotting ■ Control efforts at the fire head will probably be ineffective
>11	>1,000	■ Crowning spotting and major fire runs are probable ■ Control efforts at head of fire are ineffective

Andrews, et al. (2011)

C. Vegetation and Electric Asset Considerations

We review locations where high-priority trees or electric compliance tags may increase the risk of ignition. We will make every effort to address these conditions in advance so that turning off power is only initiated as a last resort.

Priority 1 or Priority 2 tree tags
We will turn off power if there are trees with open maintenance tags.

PRIORITY 1 TREES
Must be addressed within
24 hours

- **In contact or showing signs of previous contact** with a primary conductor

- **Actively or at immediate risk of falling**

- **Presenting an immediate risk** to PG&E's facilities

PRIORITY 2 TREES
Must be addressed within
30 days

- **Encroached** within the PG&E minimum clearance requirements

- **Having any other identifiable potential safety issues**, requiring expedited work

Electric asset criteria
We will turn off power if there is equipment with open high-risk safety-related compliance tags.

REPAIR TAGS

A TAGS	**B TAGS**	**E TAGS + F TAGS***
Must be addressed **immediately**	Must be addressed within **3 months** of identification	Are addressed based on **priority**

PG&E actively inspects for and schedules work to address these tags. To the extent possible, we fix these issues in the areas that may be within a severe weather footprint before a potential PSPS so we don't have to turn off power.

*Prioritized based on ignition risk

Transmission PSPS decision-making

In addition to analyzing distribution circuits, we also review the transmission lines and structures in areas experiencing dry, windy weather conditions. Transmission lines are like the freeways of the electric system, carrying high-voltage energy across long distances.

There is no single factor or threshold that will require turning off power to a transmission circuit. When determining whether to turn off power for safety on transmission lines, we review the same minimum fire potential conditions as with distribution lines. If these conditions are met, we will then look at the below criteria to determine whether a transmission line must be turned off.

Transmission line PSPS scoping criteria

Asset Health
Risk assessment based on FPI and Operability Assessment (OA) to determine probability of asset failure due to weather and Catastrophic Fire Probability (CFP)

+

Vegetation Risk
Risk assessment based on a Transmission Vegetation Risk Model and FPI to determine the probability of fire ignitions due to vegetation failure and CFP

+

Catastrophic Fire Behavior
Analysis of fire spread modeling from Technosylva to determine where intense and fast-spreading fires are possible

+

Additional Vegetation and Electric Asset Criteria
Transmission Asset Health Specialists review locations of known high-priority trees and electric compliance A Tags

+

Public Safety Impact
Grid stability and potential de-energization impacts considered (e.g., non-consequential loss, generation loss)

=

Safety Shutoff Decision
Decision is made on a transmission structure level that intersects within a weather footprint

During rare cases where weather conditions are so windy and dry that the chance of a wildfire starting would be extremely dangerous, we may need to turn off power to transmission lines even if the equipment is unlikely to fail. This is known as the Catastrophic Fire criteria.

Once PG&E identifies the initial scope, we work with the California Independent Service Operator (CAISO) to ensure the initial scope is appropriate. This includes analyzing whether it will compromise the power supply to other jurisdictions, utilities or facilities connected to our system. This important step can last several hours, which is why the potential scope of a PSPS may change as we get closer to the forecasted weather event.

Operational Assessment (OA)

The OA determines the probability that an asset (a tower or pole structure plus the equipment and conductors it supports) will fail during wind gusts of a given speed. While wind speed is the intensity measure used to determine this probability, the OA considers damage mechanisms, such as corrosion, fatigue, wear and decay, that could lower the capacity of an asset to resist extreme winds.

Power is turned off if any of the criteria listed above are met over a certain geographic area.

PG&E's high fire-risk area (HFRA) map

In 2021, PG&E enhanced its fire risk mapping to more closely align with the risk of catastrophic fire from offshore winds. PG&E re-examined the boundaries of the California Public Utilities Commission (CPUC) High Fire-Threat District (HFTD) map to be more reflective of current conditions in the service territory.
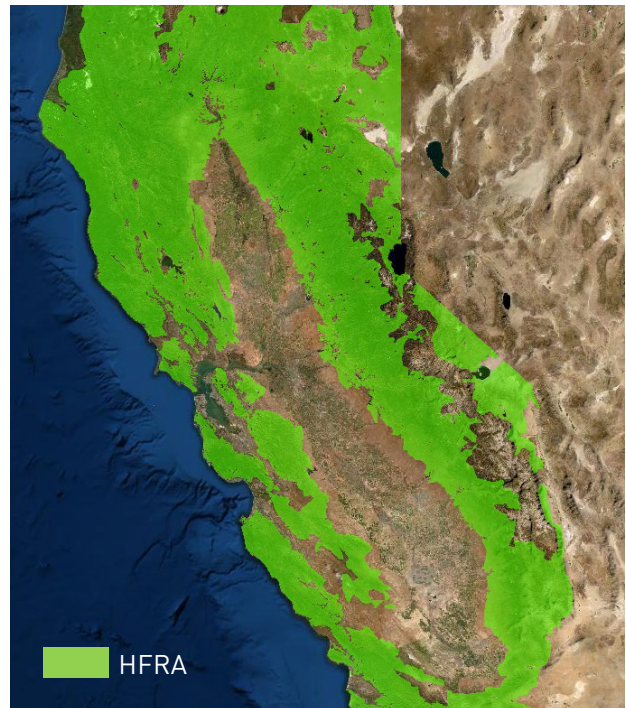
CPUC HFTD map

- HFTD Tier 2
- HFTD Tier 3
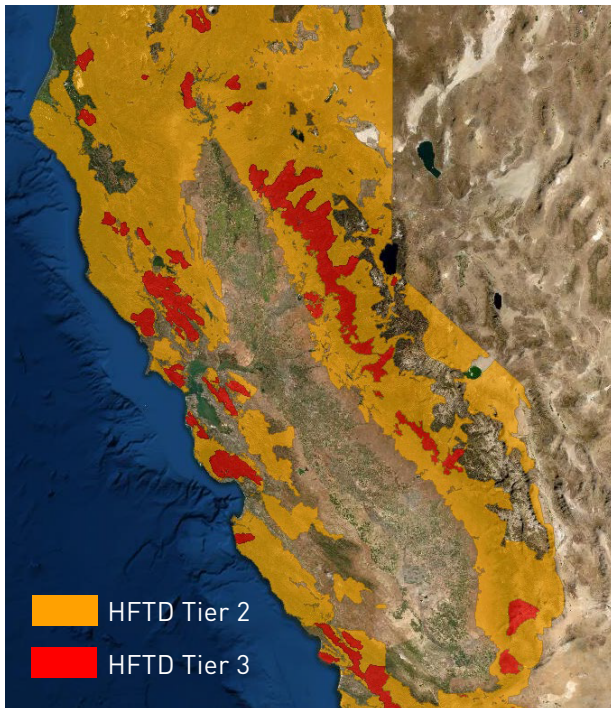
PG&E HFRA map

- HFRA

HFTD background:

- Built to categorize areas of fire risk, not utility assets – not intended to be used for PSPS scoping
- Since its release in 2018, the map has been used as a general reference guide for where PSPS may be necessary

HFRA background:

- Re-examination of HFTD to align catastrophic wildfire risk driven by offshore winds and to reflect the latest land use and fuel conditions
- Includes changes around the HFTD boundaries using both computer analysis and on-the-ground observations

Restoring power

As soon as it is safe to do so, PG&E will begin inspecting our lines and equipment to restore power to all customers within 24 hours. The first step in determining whether it is safe to begin inspections is confirming that weather conditions have passed. PG&E uses weather stations, high-definition cameras and real-time observations from our Safety and Infrastructure Protection Teams across our service territory to monitor weather conditions and fire risks.

We continue to build one of the largest utility-owned weather station networks in the world, which allows us to track temperature, wind speed and humidity in real time.
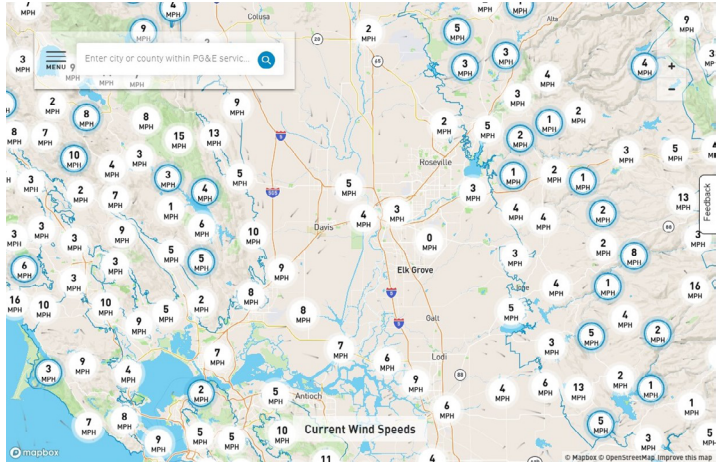

Weather station data is available through PG&E's weather map at: **pge.com/weather**

Sample weather damage in need of repair

Following a PSPS, we analyze damage to the system and hazards. Each hazard or instance of damage would have potentially been an ignition source. In 2021, we experienced **442 separate damages or hazards** to our electric equipment in areas that were de-energized over the course of five PSPS.
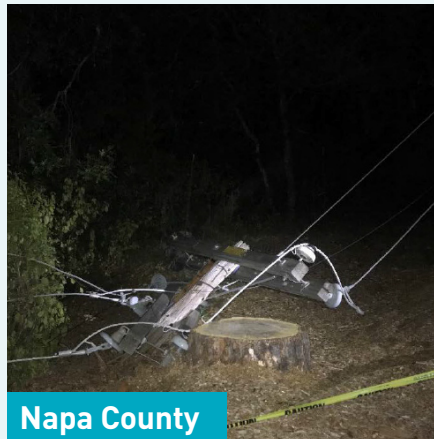
Napa County

Sierra County

EPSS criteria

EPSS is enabled throughout the year when conditions indicate an increased potential for wildfires. Although this is most likely to occur from May to November, in 2022 we saw an increased risk for wildfire in parts of our service territory as early as January due to the ongoing drought.

As wildfire conditions continue to evolve, our criteria for enabling the safety settings has also evolved to capture more potential for wildfire ignition reduction.

We use the FPI Model to guide EPSS. The FPI Model outputs the probability that a fire will become large or catastrophic. These factors combine to produce a one to five-plus scale of wildfire risk, or R1 to R5+.

EPSS may be disabled when wildfire risk meets R1 conditions and other wildfire risk weather conditions are not present.

Where are safety settings being enabled?

In 2021, we saw an 80% reduction in CPUC-reportable ignitions on the select number of high fire-risk area powerlines with safety settings enabled.* As a result, we expanded the EPSS program from the 45% (11,500) of line miles in high fire-risk areas implemented in 2021 to all 100% (25,500) of line miles in high fire-risk areas in 2022, as well as approximately 18,000-line miles in adjacent portions of the system. In total, approximately 44,300-line miles are EPSS-protected as of July 2022.

Maps of EPSS-capable circuits are available. These circuits are enabled during times of heightened wildfire risk.

pge.com/epss

Our Address Lookup Tool allows customers to see if their home or business is protected by an EPSS-capable circuit.

pge.com/addresslookup

Restoring power

If an outage on a safety setting-enabled line occurs, crews must patrol the de-energized area – and perform any necessary repairs – prior to restoring power.

The length of the outage and the portion of customers restored will vary depending on the time and location that it occurs, as well as the severity of any damage. For example, in rural and difficult terrain, crews may not be able to safely patrol the system at night. Additionally, patrols with limited access will take longer.

If customers are served by an EPSS-enabled circuit, they may see crews in their community patrolling the circuit and performing any necessary repairs prior to restoring power. In some cases, customers may see helicopters or drones performing aerial patrols. If customers have powerlines on their property, we may need access to restore power as quickly and safely as possible.

*Compared to the prior three-year average (as of December 31, 2021).

4 Notifying Customers and Communities

PSPS notifications

We aim to send customers PSPS notifications two days ahead, one day ahead, just before turning off power, once power is turned off and daily until power is restored.

Whenever possible, we also issue priority PSPS notifications to public safety partners, critical facilities and infrastructure, as well as transmission-level customers. These alerts are sent 48-72 hours in advance of a potential PSPS.

New

PSPS notifications will be provided via call, text and/or email both day and night, as needed, and include:

- "Warning"
- "Cancellation"
- "Power off"
- "Restoral"
- "All-clear"

PSPS direct-to-customer outreach

We will attempt to reach customers through automated calls, texts and/or emails.

- **72-48 HOURS BEFORE POWER IS TURNED OFF**
  Priority Notification: After PG&E's Emergency Operations Center is activated, direct contact is made to California's Office of Emergency Services (Cal OES), county OES and tribal contacts. We also provide an initial notification to public safety partner contacts.

- **48-24 HOURS BEFORE POWER IS TURNED OFF**
  PSPS Watch: We send a notification in advance of the planned de-energization.

- **4-1 HOURS BEFORE POWER IS TURNED OFF**
  PSPS Warning: We send a notification when the decision to de-energize has been made.

- **JUST BEFORE SHUTOFF**
  Shutoff: Customers are notified power is about to be or has been turned off for public safety.

- **FOLLOWING WEATHER "ALL-CLEAR"**
  Post-Weather Event: After weather has passed, we send notifications to customers daily until power is restored. We also notify agencies that system inspections are underway.

- **TIMING IS WEATHER DEPENDENT**
  Cancellation/Update: We send a notification if at any time weather conditions change, a PSPS is cancelled, the Estimated Time of Restoral changes or different areas will be impacted.

- **FOLLOWING POWER RESTORATION**
  Power Restoration: We send a notification once power has been restored.

We will also use our website (**pge.com/pspsupdates**), social media, community-based organizations and local news to keep customers informed and updated.

EPSS notifications

EPSS-enabled lines automatically turn off power if a fault is detected, which may result in an unplanned safety outage. Because power is turned off automatically, PG&E is unable to provide advance notification.
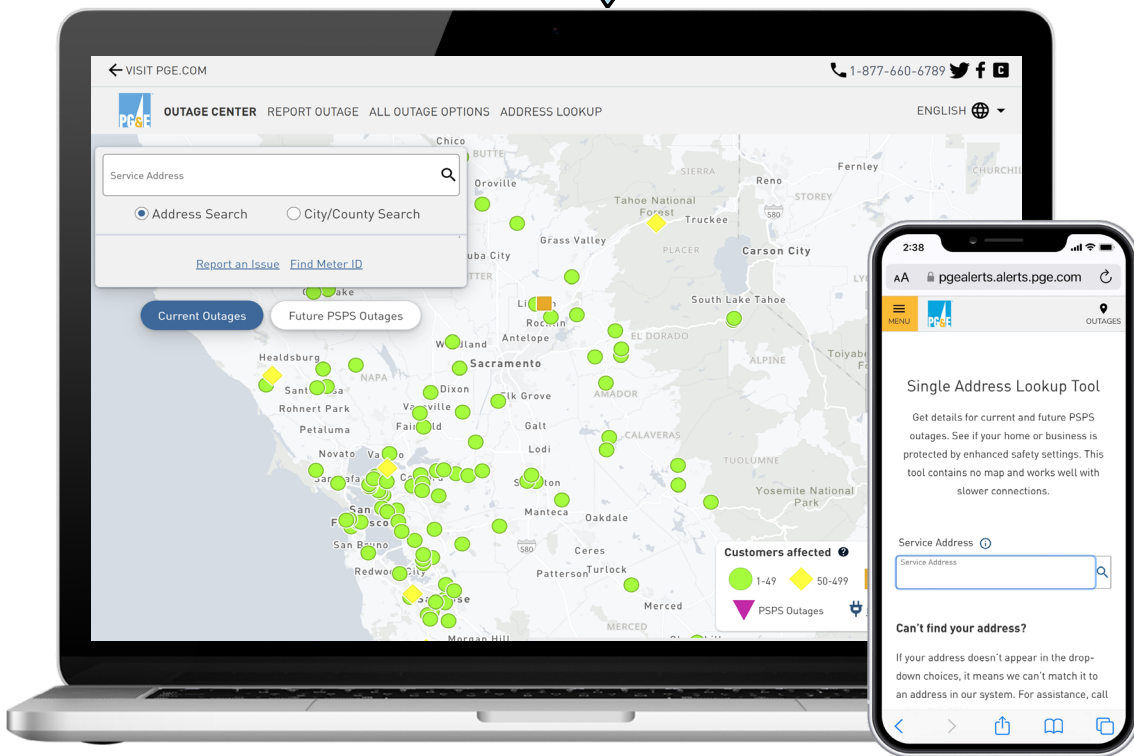
If power outages on EPSS-enabled lines occur, customers will receive notifications. These notifications will be sent via text, phone or email, depending on the customer's preferred contact method. Customers can review and update their contact information at:

pge.com/myalerts

Outage map
Find power outage updates at:

pge.com/outages

Address Lookup Tool
Customers can see if their home or business is protected by an EPSS-capable circuit at:

pge.com/addresslookup

5 Support for Customers and Communities

Customer support programs

We know losing power can be disruptive. That is why we have programs in place to help customers prepare in advance of a safety outage and ensure they have access to resources during these outages. We expanded eligibility for these programs in 2022 as the EPSS program expanded.

Portable Battery Program
Portable batteries are available for eligible Medical Baseline customers who live in high fire-risk areas or have experienced two or more PSPS since 2020.

Generator and Battery Rebate Program
Rebates are available for customers who rely on well water, those in our Medical Baseline Program and certain small businesses. Customers who live in Tier 2 and 3 High Fire-Threat Districts and/or are served by an EPSS-protected circuit and have experienced two or more PSPS are also now eligible.

Safety Action Center
Information and tools are available online to help customers stay safe before, during and after an emergency.

Backup Power Transfer Meter Program
Customers who live in a High Fire-Threat District or who are served by an EPSS-capable circuit can receive a free Backup Power Transfer Meter.

211 partnership
PG&E partners with 211 to provide local resources and 24/7 support before, during and after times of critical need, such as a PSPS.

Food Bank/Meals on Wheels support
We provide meal replacements to communities impacted by PSPS.
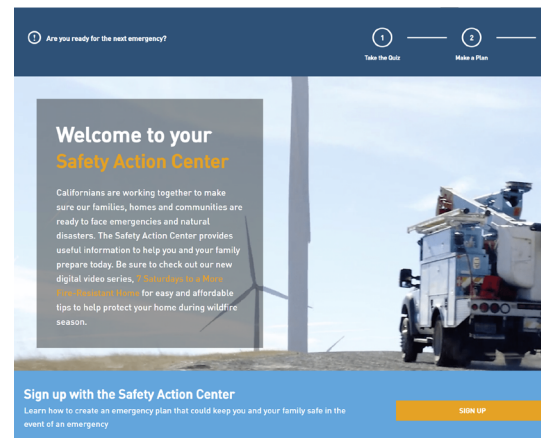
PSPS Portal and Outage Portal

PSPS Portal

The PSPS Portal is a secure site designed for cities, counties, tribes, critical service providers and some community-based organization partners to share planning and PSPS-specific maps and reports.

Information on the PSPS Portal includes:

- Maps of areas more likely to be impacted, to assist with planning efforts.
- PSPS-specific information, such as estimated time of shutoff and restoral and the total number of customers impacted.
- Outage area maps.
- Confidential lists with the critical facilities and Medical Baseline customers impacted, for eligible users that have accepted the online agreement.
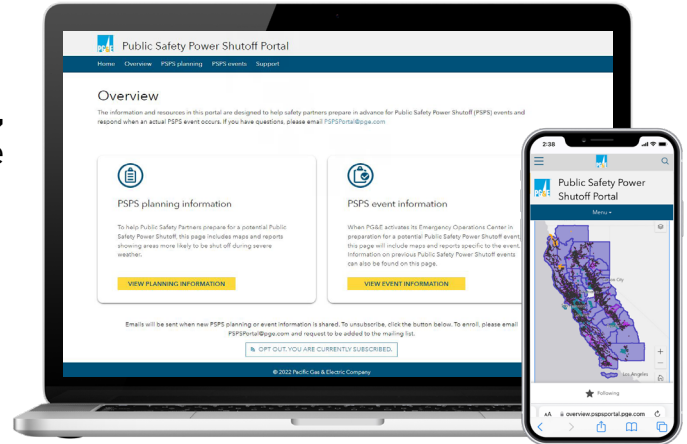
New

Outage Portal

Public safety partners and some community-based organizations have access to our secure online Outage Portal. This portal provides data focused on EPSS-enabled circuits and power outages occurring on powerlines protected by the safety settings.

The Outage Portal provides information on:

- The location of currently EPSS-enabled circuits.
- Details of active power outages on EPSS-enabled lines across the service territory.

Users have the option to view the Outage Portal on mobile devices and download outage data in real time.

Additional resources

To view informational videos, visit PG&E's YouTube Channel:

youtube.com/ user/pgevideo

To view webinar recordings and presentation materials, visit:

pge.com/ firesafetywebinars

Learn more

To find information about our wildfire safety efforts, visit:

pge.com/wildfiresafety

Customers can also call us at **1-866-743-6589** or email **wildfiresafety@pge.com**.