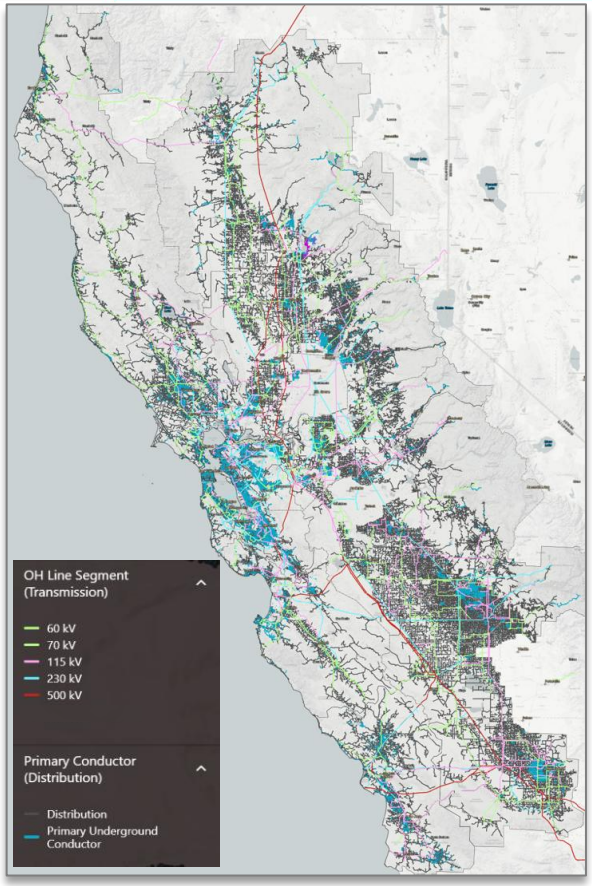
Predicting Risk, Preventing Impact: Fire Potential & PSPS Forecasting at PG&E

ESIG 2026

Together, Building a Better California

PG&E's Electric Infrastructure – Northern and Central CA

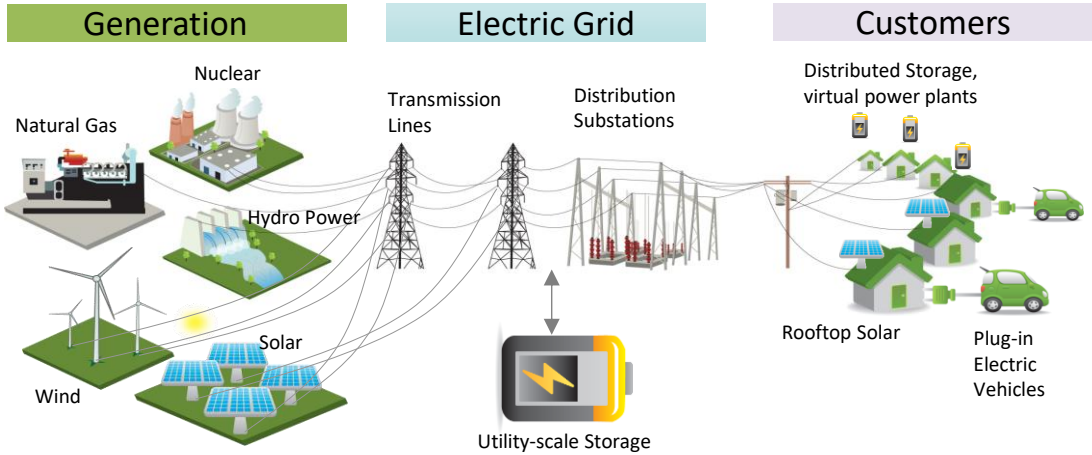


~202,000 km — **Electric lines** *Could wrap Earth 5x stacked end-end*

~170,000 km — **Distribution lines**
- **~137,000 km** Overhead
- **~33,000 km** Underground

~50,000 km — **Overhead Line Miles in High Fire Threat Districts (HFTD)**

>5 Million — **Trees that can strike lines in HFTD**



High Resolution Weather Model & 30+ Yr. Climatology

Carpenter *et al.*, 2024

Weather/fuel moisture forecasts and 30-year climatology

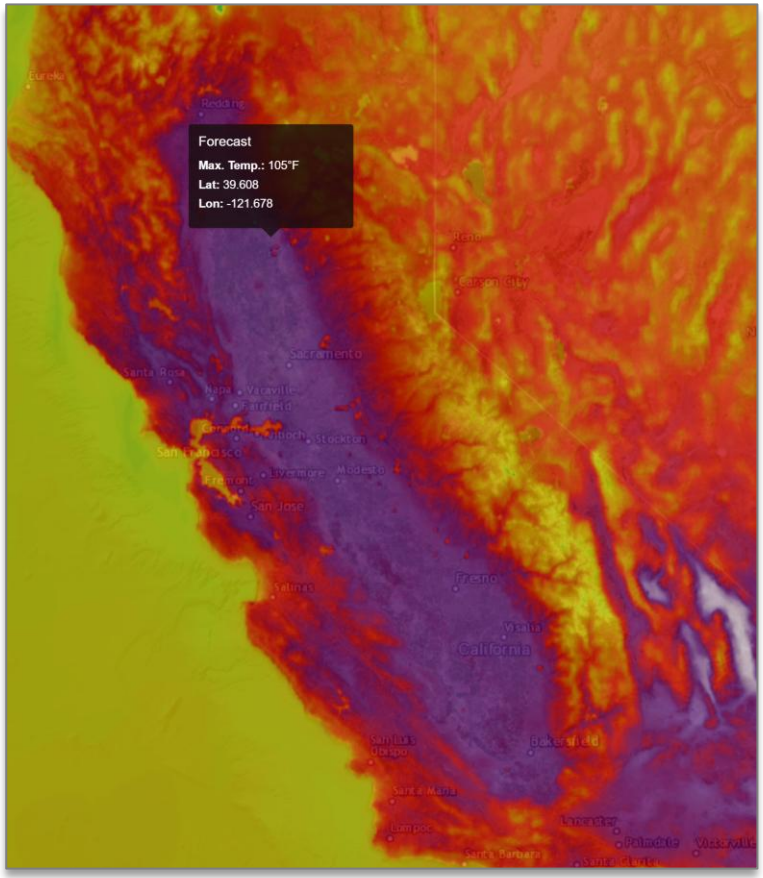
- Described in Carpenter *et al.,* 2024
- 129 hour forecast horizon **(~10B surface data points per day**)
- 2km^2 spatial resolution, hourly temporal resolution
- On demand numerical simulations at 0.67km^2
- ML/AI downscaling to weather stations and 0.7km^2 grid
- 9-member ensemble based on ECMWF
- **30+ year climo (~4.5 trillion data points)**

Applications

- Train weather-outage-ignition models (**OPW, IOPW, IPW**).
- Build Fire Potential Index (**FPI**).
- Build and execute PSPS models
- **Calibrate PSPS guidance for operational use**
- Climatology for long term planning decisions
- Input to dynamic fire spread models (*e.g.*, Technosylva)

Development Partners

technosylva DTN aws



PG&E Outage And Ignition Probability Models (OPW & IPW)

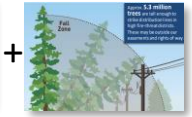
Model Features

Weather

Wind Speed
Turbulence
Temperature
Precipitation

+

Vegetation Exposure



Tree Height + Canopy Cover of Strike Trees from Planet Labs

+

Environmental

Slope
Soil Moisture

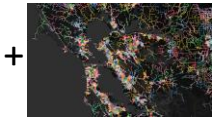
+

Asset Age

Pole Age

+

Local Performance



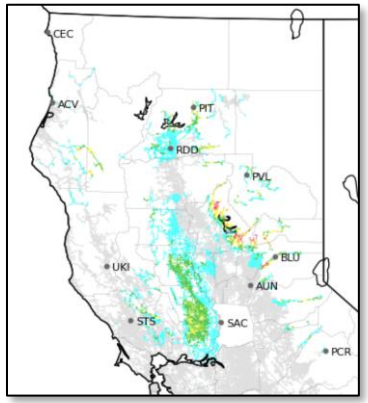
Outage trends specific to each location

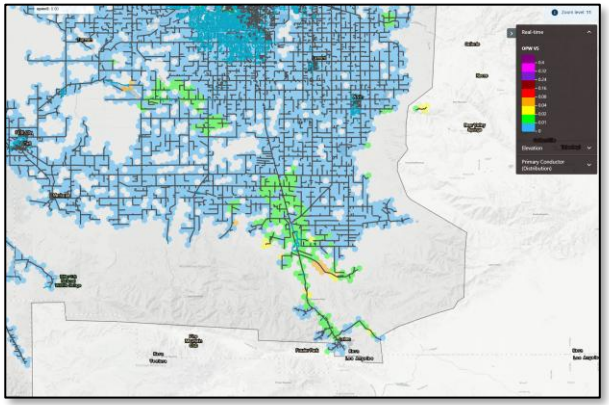
$$OPW = P(Outage_{cell,hour}) = \sum_{class}^{cause\ clases} P(Outage_{class,cell,hour})$$

Model Approach

- **Outage model (OPW)** trained on all hours since 2008 and whether an unplanned (momentary and sustained) outage was observed or not in each location. All outages and 270 billion data points were evaluated to develop model.
- **Model Output = p(outage)** at 0.7km^2 hourly (forecast & historical)
- **Verification** Macro AUROC = 0.72 | Vegetation = 0.84

Model Outputs





From Outages to Ignition

- We **translate from p(outage) to p(ignition)** using machine learning **predicts the probability of an ignition given an outage**
- Features such as weather (hot, dry, windy), fine dead fuels, herbaceous LFM, solar irradiance, and grid setting like EPSS
- The result is the **Ignition Probability Weather (IPW)** model:

$$IPW = P(\text{Ignition}) = P(Outage) * P(Ignition|Outage)$$

PG&E Fire Potential Index (FPI)

Key Insights

FPI Training Data

30+ year **weather and fuels** climatology.

Historical VIIRS satellite fire detection
https://www.publish.csiro.au/wf/WF22048

International Journal of Wildland Fire — International Association of Wildland Fire

Analysis & Results

New classification approach forecasts the **probability of large and catastrophic fires hourly per 0.7km² grid cells**

Applied state-of-the-art machine learning models to maximize predictive skill and **learn non-linearities in fire behavior.**

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Features of the PG&E Fire Potential Index Model

Weather

Wind Speed
Turbulence
Temperature
Vapor Pressure Deficit

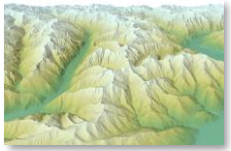
+

Fuel Moisture

Dead Fuel Moisture
Woody Live Fuel Moisture
Herbaceous Fuel Moisture

+

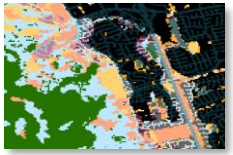
Topography



Ruggedness
Slope
Wind-terrain Alignment

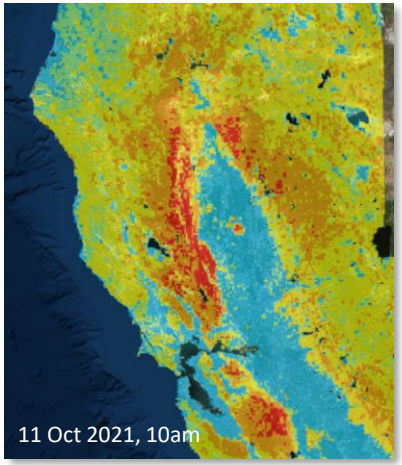
+

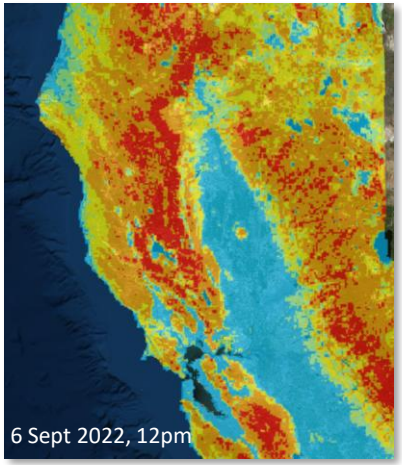
Fuel Type

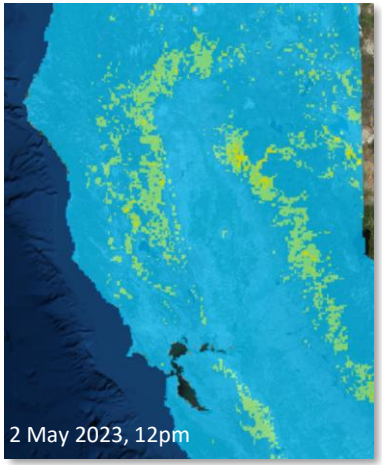


Grass
Shrub
Timber
Urban

Example 2 x 2km hourly output







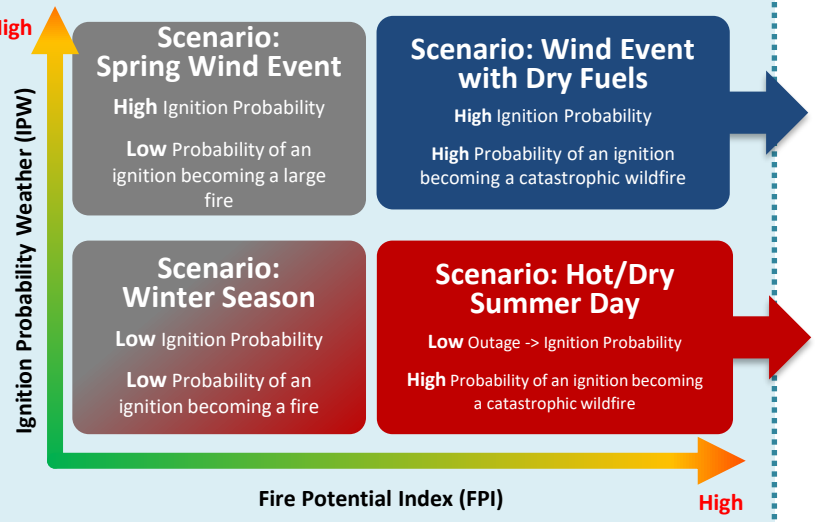
Using Data to Forecast Catastrophic Fire Risk

We combine FPI and IPW to forecast the probability of catastrophic wildfires

Catastrophic Fire Probability (CFP)

*CFP = Ignition Probability * Fire Potential*

*CFP = IPW * FPI*



Weather-Driven Response

Public Safety Power Shutoff (PSPS)

Turning off power during severe weather to prevent tree branches and debris from contacting energized lines during severe weather.

Enhanced Powerline Safety Settings (EPSS)

EPSS enabled powerlines allows power turn off within one tenth of a second if a tree branch or object strikes the line providing mitigation against high-risk ignitions.

PG&E PSPS Model and Machine Learning Model Construct

Catastrophic Fire Probability

A risk-based assessment of the probability of fire ignitions combined with the probability of catastrophic fires.

Catastrophic Fire Probability (CFP) = Ignition Probability (IPW) × Catastrophic Fire Probability (FPI)

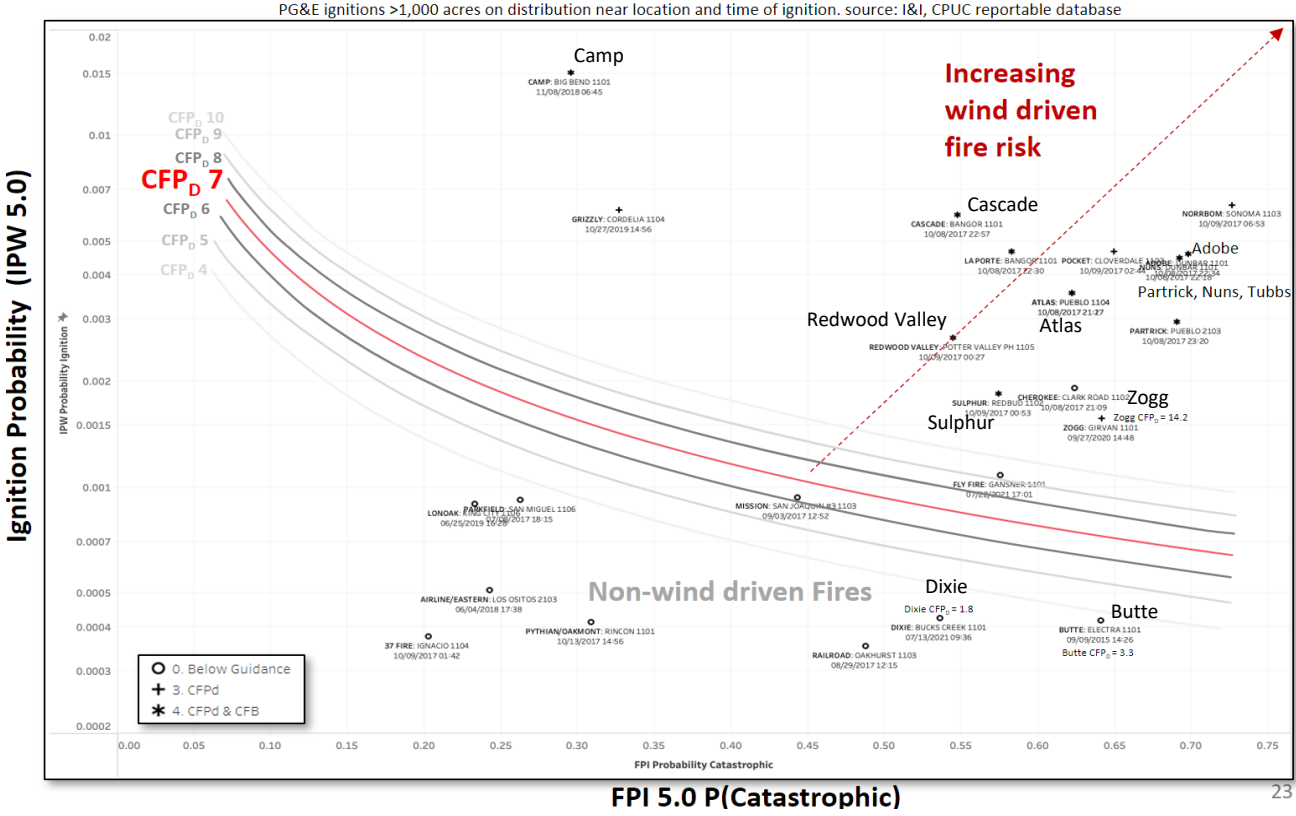
$$CFP_{h3,t} = IPW_{h3,t} * FPI_{h3,t}$$

Where h3 represents the h3 hexagon grid cell and t is hour. CFP is calculated for each location, each hour in forecast and historical mode.

PSPS Event Calibration

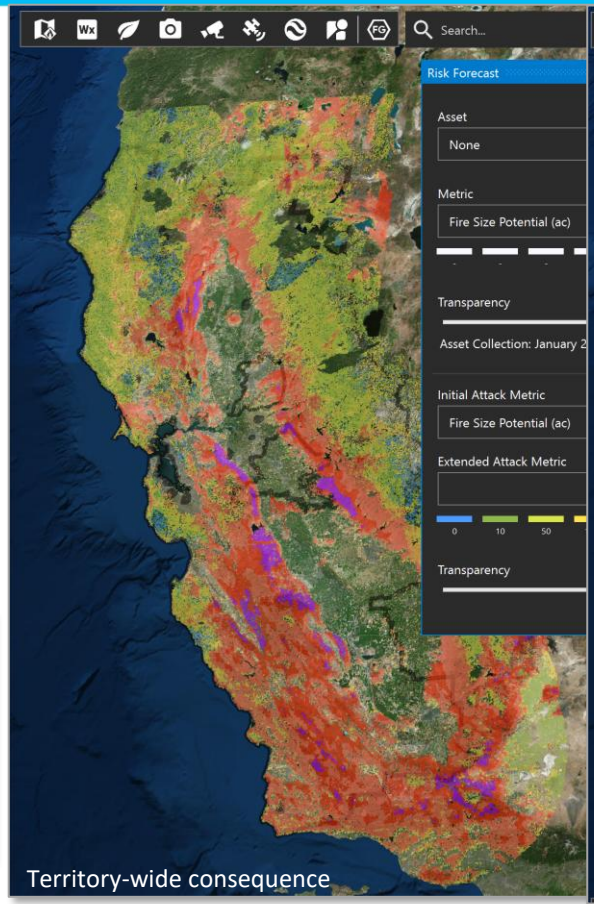
- CFP backcast through 30+ year climatology
- Allows **calibration of PSPS guidance** and evaluation of PSPS size, scope frequency versus historical fires captured
- Subject matter expertise applied every event

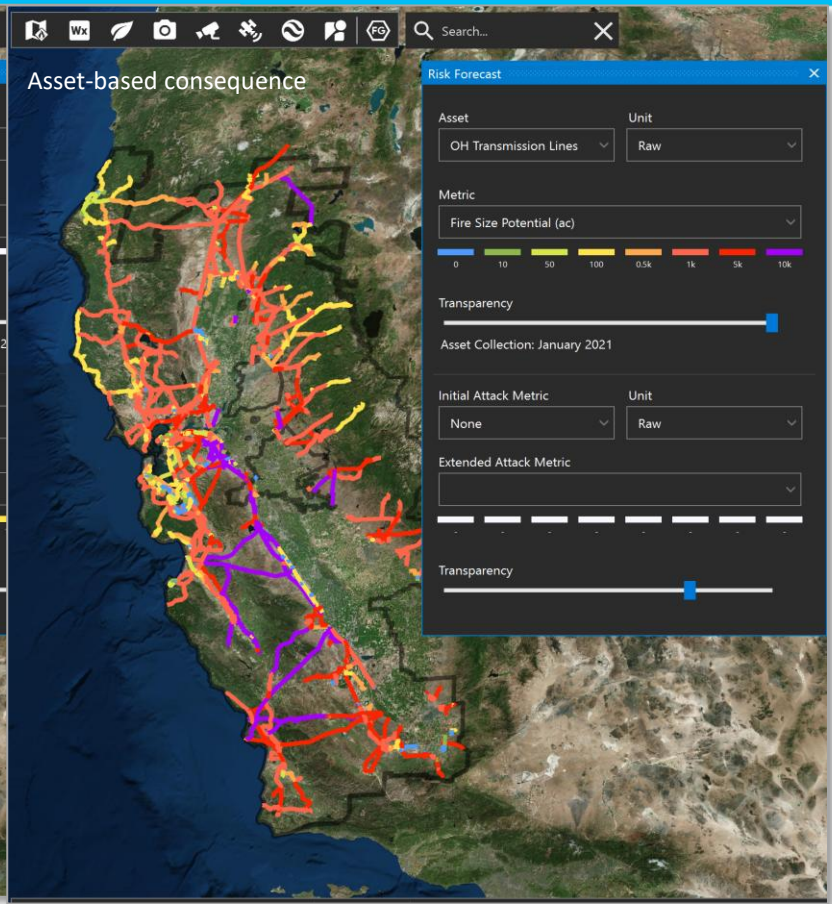
Catastrophic Fire Probability backcast through climatology for event calibration



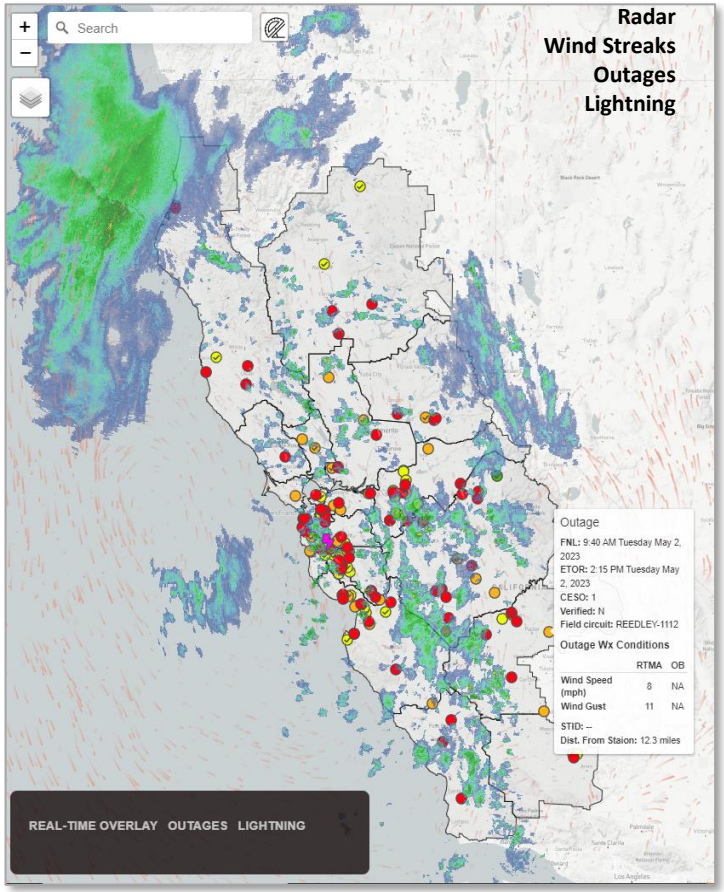
Fire Spread and Consequence Modeling

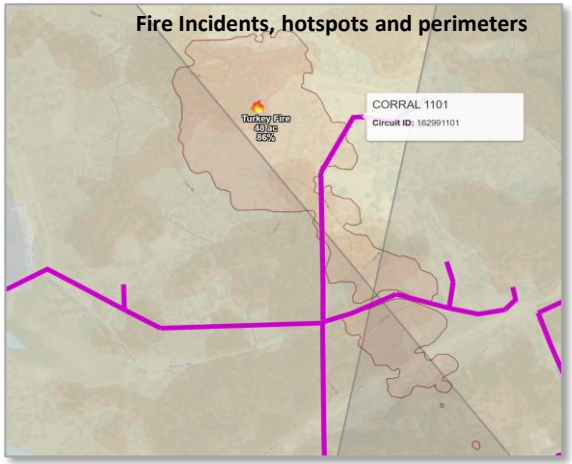
- ~100 million fire spread simulations daily
- Identifies highest risk circuits/areas from a spread and consequence (e.g., acres burned) perspective
- ‘what-if’ and ‘what-could-have-been’ fire spread analyses available
- Used in PSPS decision making

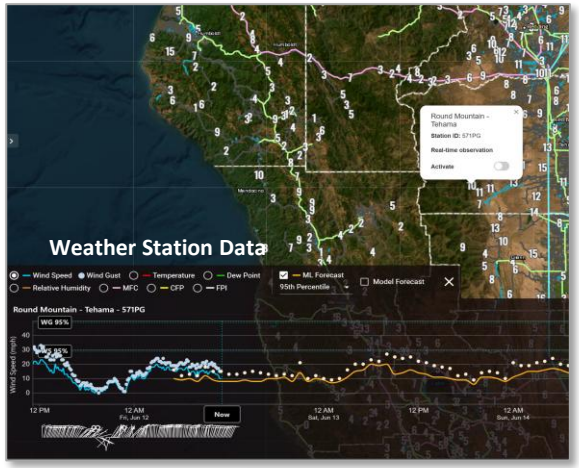




WxMap: PG&E Meteorological Visualizations in AWS

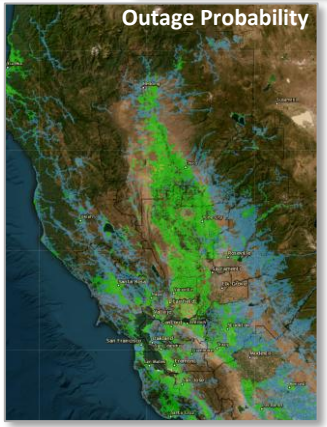


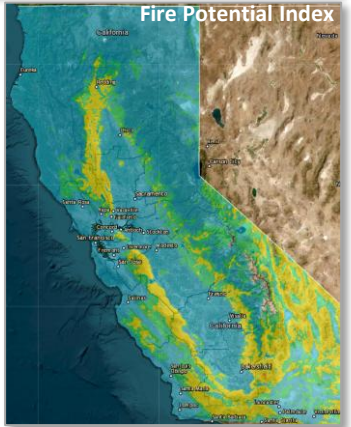


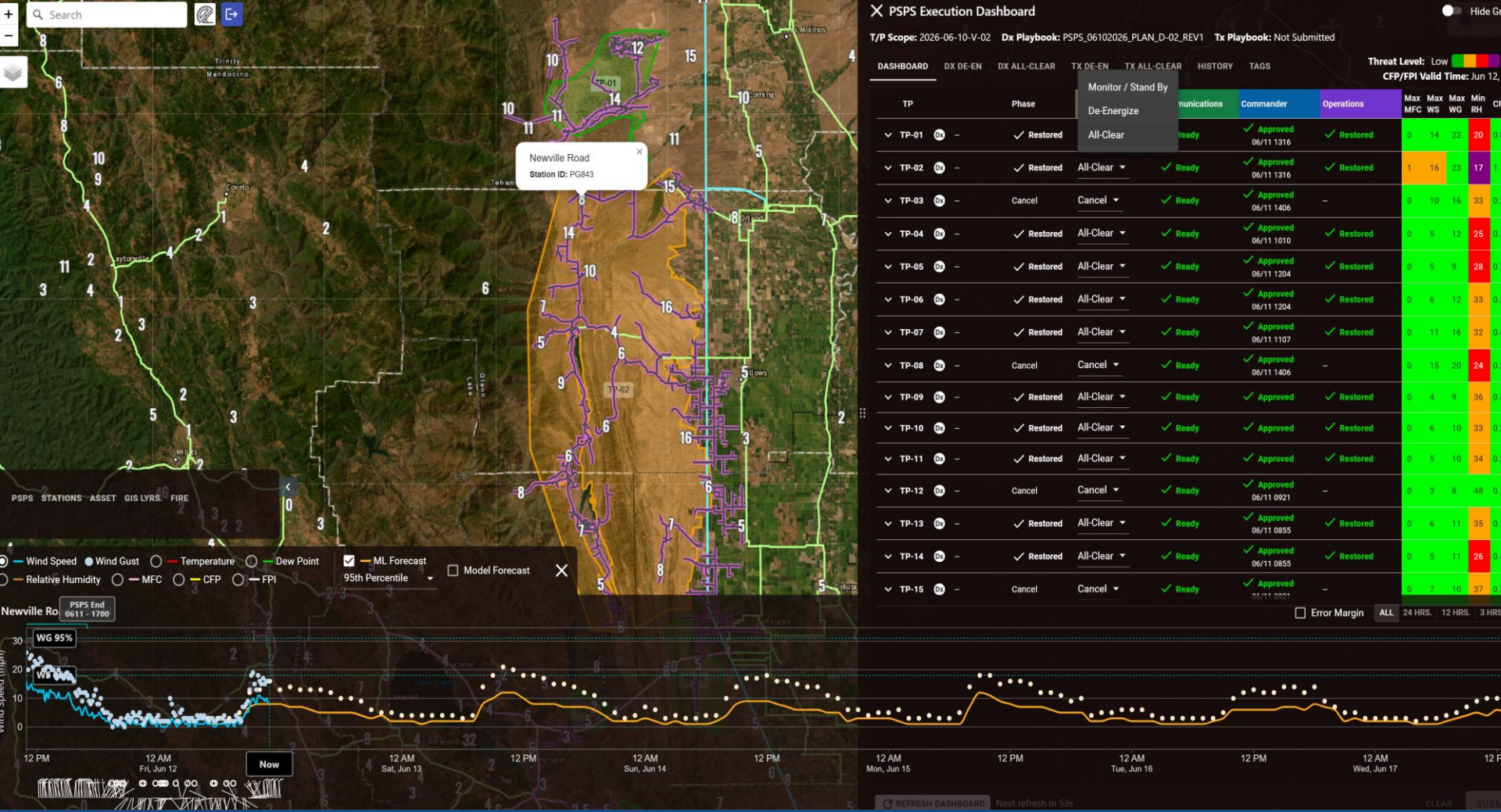


Data Overlays

- PSPS data and decision making
- Outages – Outage Probability
- Fire Potential Index
- Lightning
- Radar
- Weather Station data
- Utility Infrastructure Live Fuel Moisture
- Forecast data
- Fire detections, incidents







WxMap: PSPS Situational Awareness and Decision Platform

PG&E Weather Station Project

We have installed **1,637 weather stations** to date. 35 installed in 2025. 30 planned in 2026. 1500 stations equipped with machine learning forecasts.

- All data collected is available to the public via MesoWest, National Weather Service (NWS) and Meteorological Assimilation Data Ingest System (MADIS)
- >200,000 observations daily, >75M per year
- 30 second observations available on-demand
- To determine optimal site locations, PG&E collaborates with NWS offices, CAL FIRE, US Forest Service and others

If interested in further information contact: Rihaan.Gangat@pge.com

PG&E Mt. Diablo Weather Station

Station Coverage Area

Thank you!

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