PACIFIC GAS AND ELECTRIC COMPANY
Wildfire Mitigation Plans Discovery 2023-2025
Data Response

PG&E Data Request No.:	CalAdvocates_042-Q004		
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PG&E Witness:		Requester:	Holly Wehrman

QUESTION 004

Table PG&E-B.1.1-1 on page 8 of PG&E's 2025 WMP Update indicates that WDRM v4 includes wind direction in its vegetation models.

a) Describe how wind direction is incorporated in the vegetation models in WDRM v4.

b) List the data sources that PG&E uses to incorporate wind direction into its risk model.

c) Describe the benefits of incorporating wind direction into the risk model.

ANSWER 004

The basis for incorporating wind direction comes from the paper "Towards Simulation and Risk Assessment of Weather-Related Outages" by Rui Yao found here:

https://web.eecs.utk.edu/~kaisun/papers/2018-TSG_Yao_Weather.pdf

Within this paper, a probability density function is defined (equation 14) which quantifies the probability per angle that anything from a spatial location, in this case a tree's location, will project itself into a conductor given the conductor's normal vector and direction of the wind. This probability density is integrated along the conductor, via the angle, to calculate the total probability of strike given a wind's direction, the tree's location, and the location of the conductor segment.

Due to the unavailability of LiDAR for the distribution system, Planet's canopy height raster (Fall 2020) is used, the snapshot of the distribution grid (v4) and an average distribution line height of 8 meters to determine which of the pixels within the canopy height raster which can fall into a conductor and, approximately, which pixels kinematically have a chance of branches/debris from the tree falling into a conductor.

For wind vectors, Meteorology's POMMS system is used. The data is in 2 km by 2 km cells and communicates the wind vector components at 10m and the roughness length to easily calculate speeds at heights other than 10m. This data occurs in one-hour intervals and covers the years 2015 to 2021. Only the fire season and wind speeds above 6.7 meters per second is considered. Please note that the value 6.7 m/s was the value that the odds of a tree falling in a storm are equal to a tree falling not in a storm studied in the paper.

The covariate calculation is as follows:

The grid is divided into segments of 5 meters in length. For each 5-meter segment, and for each strike tree for that segment, the total probability along that 5-meter segment is calculated for all one-hour intervals of wind speeds greater than 6.7 m/s. All calculated probabilities are summed over that time for each tree-segment pair. A second quantity is calculated by weighting each hourly probability by the increased odds of wind damage during the storm by turning the log-odds (equation 13) into a probability, then multiply by the directional probability and finally multiplying by the inverse distance from the vegetation pixel to the 5-meter segment before summing over time. The total wind direction index is then found for each 5-meter segment by summing over all trees that influence it. Finally, each 5-meter segment is assigned to a pixel of the 100-meter-by-100-meter resolution raster used in the WDRM and all segment's indices found within a single pixel are summed. Two more indices are formed by taking the above two quantities and dividing by the total number of trees within the 100-meter pixel for a total of four new wind directional covariates.

Wind is a vector quantity and has magnitude and direction. Magnitude has been present in the WDRM before but has been a low-value covariate. The reason for this is that higher speeds don't necessarily mean higher risk when the wind direction is pointing away from an asset and the tree is oriented in location which is not impactful to the line.