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Public Safety Power Shutoff Maps: Methodology & Data Sources

PSE Healthy Energy

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The Public Safety Power Shutoff Map displays the frequency and duration of Public Safety Power Shutoff (PSPS) outages in California by aggregating and visualizing data from the State's six investor-owned utilities (Pacific Gas & Electric, SoCal Edison, San Diego Gas & Electric, PacifiCorp, Liberty, and Bear Valley Electric Service). This data is paired with selected economic, demographic, and climate vulnerability information for each census tract.

The Public Safety Power Shutoff Map is a free tool developed for community groups, citizens, and decision-makers that allows users to customize views of PSPS data. Viewers can focus on regions or populations of interest by filtering the data. It is important to note that while PSPS events are only one type of outage impacting communities, strong reporting requirements around these events allows for census-tract level mapping.

Methods

I. Public Safety Power Shutoff (PSPS) data aggregation and standardization

The Public Safety Power Shutoff Map includes data about circuits that have been de-energized during PSPS events. It uses the California Public Utilities Commission (CPUC) PSPS Rollup as its base for PSPS data, verifying against and supplementing with information from each utility's Post Event Reports [1-7]. The Rollup is an excel sheet with information from each utility's PSPS Post Event Report since 2013. Each row contains information about a circuit or a portion of a circuit de-energized during a PSPS event. But this initial dataset contained inconsistent, mismatched, and missing information that needed to be updated before analysis could begin.

To prepare this data for analysis and visualization we spot checked data in the CPUC Rollup and identified places where data was reported differently between utilities, data appeared incorrect, or information was missing. Where possible, we verified data against PSPS Post Event Reports and media coverage of events. We filled in missing data—such as PSPS start or end times—with information from Post Event Reports or data obtained via electronic data requests. Outages with no customer impacts listed and missing start or end times, for instance because the electrical line was already idle, were filtered to a separate list and not included in the final dataset

We then standardized the data between utilities. This included matching the format of reported circuit names to the format of circuit names in each utility integration capacity analysis map (more on this

below). We also created a unique identifier for each outage and ensured the formats for outage start and restoration times were consistent. Additionally, we split out start dates and times for each outage so that we could understand which years, months, days, and times were most likely to have PSPS events. We identified which circuits were likely to be transmission versus distribution lines based on cues within the data such as listed line voltages and name formats, verifying against grid data for each utility. We also assigned each row in the Rollup to a specific event by comparing the outage start information with the start dates of possible events for each utility. Finally, we identified if a circuit experienced multiple outages during the same PSPS event by noting whether a single circuit was de-energized, re-energized, and de-energized again within the time window for a single event.

To quantify both outage length and scope of impact within a single metric, we assigned an "Outage Customer Minutes" and "Outage Customer Hours" measure to each row. This metric is simply the outage duration multiplied by the number of customers impacted. "Outage Customer Hours" was also used as part of determining an average customer-weighted outage duration for each census tract later on.

For most PSPS events, the Post Event Reports and the CPUC Rollup included information about whether an impacted circuit was in a Tier 2, Tier 3, or outside of a High Fire Threat District. As listed in the Rollup, the data was standardized into discrete "Yes" or "No" indicators for each option. To verify and add additional granularity, we overlaid circuits and California census tracts with a map of High Fire Threat Districts in ArcGIS [8]. We then recorded the percentage of each impacted circuit and each census tract was within each Fire Threat District.

II. Geospatial circuit data aggregation and standardization

Prior to 2021, utilities did not report PSPS impacts by census tract. Instead, Post Event Reports included the name of impacted circuits, the number of people affected on each circuit, and information about the general area such as the county. This is still true about Post Event Reports. However, starting in 2021, investor-owned utilities were required to provide PSPS impacts at the census-tract level in their Post Season Reports. The CPUC Rollup does not include locational information for impacted customers at all.

To gain more geographic granularity for PSPS impacts, we assigned impacts by circuit to respective circuit locations. To do so, the standardized PSPS data was joined with information about the locations of circuits, where available.

This geospatial information about circuits was largely drawn from PG&E, SCE, and SDG&E Interconnection Capacity Analysis maps [9-11. Each of these maps is built on a dataset of circuit segments. These segments were aggregated to the circuit level in ArcGIS. In some cases, a utility's distribution lines were split between multiple shapefiles. We also merged these within ArcGIS to create the fullest picture possible for each utility. As SDG&E's circuits were represented by polygons while

PG&E and SCE circuits were represented by lines, the latter two were buffered slightly to match SDG&E's format. This allowed us to merge these datasets together, creating a single map of PG&E, SCE, and SDG&E distribution circuits. This process also required changing the datatypes for specific fields within ArcGIS. For privacy reasons, not all circuits within a utility's service territory are included in the ICA maps. This includes 46 circuits that were impacted by PSPS events.

Circuits in PacifiCorp's service territory were assigned a geographic location using a combination of information provided in PacifiCorp's Post Event Reports, PacifiCorp's Post Season Reports, and Census Bureau data [7, 12]. PacifiCorp's Post Event Reports contained PDF maps with circuit locations and information about which incorporated or census designated places were impacted while their 2021 Post Season report included information about which census tracts were impacted by outages on specific circuits. This data was compared to and combined with geospatial data from the U.S. Census Bureau about the location of relevant incorporated or census designated places. (As the outage impacting Weed City included the neighboring census tract, the polygon representing that area was expanded based on the Post Event Report map. And in one instance, an extra polygon was added to the map to represent a circuit that spanned two census tracts but did not align with a specific place included in the U.S. Census Bureau data.)

As Liberty Utilities and Bear Valley Electric Service have not reported any PSPS events and their service territories are comparatively small among California's six investor-owned utilities, their circuits are represented by their full utility service territories.

III. Assigning PSPS impacts and utilities to census tracts

This analysis uses 2010 census tract boundaries, taken from the 2019 Tiger Line Geodatabase files from the U.S. Census Bureau. This was done to ensure data aligned with economic, demographic, and environmental justice data that was available using the 2010 boundaries at the time of analysis.

To assign PSPS impacts to census tracts, we tabulated the intersection of census tracts and PSPS-impacted circuits and allocated impacts accordingly. For example, if a circuit was 40 percent in census tract A and 60 percent in census tract B and a PSPS outage on that circuit impacted 100 customers, 40 customers were allocated to tract A and 60 to tract B. Allocating customers this way assumes that outages always impact the full circuit and that customers are evenly distributed along that circuit. Early PSPS outages likely did impact the full circuit, though this changes for more recent outages where utilities only de-energize segments of certain circuits. It's also unlikely that customers are evenly distributed across each impacted circuit. Thus, some customers in this dataset are likely to be inaccurately allocated to census tracts. However, barring information about the locations of different circuit segments and census-tract specific customer allocations from the utilities, this population distribution acts as a reasonable stand in.

We took a similar approach to assigning utilities to census tracts—which allowed us to include census tracts with no reported PSPS impacts in our analysis. The location of all utility service territories was

downloaded from the California Energy Commission's GIS Data Portal [13]. Non-investor-owned utilities are not required to report on PSPS events to the California Public Utilities Commission, so these areas were given a "Non-reporting utility" label. We then overlaid census tracts and utility service territories and assigned each census tract a "Likely Utility" based on whichever utility covered the largest percentage of that census tract. The same was done for High Fire Threat Districts using the CPUC High Fire Threat Districts map.

To calculate the average annual frequency of PSPS events, we found the total number of PSPS events that a census tract had experienced and divided it by the number of years the utility responsible for those outages had been reporting on PSPS events. This was necessary to normalize the frequency of outages, because each utility started reporting PSPS in different years.

IV. Demographic data aggregation, analysis, and visualization

To understand more about those who may have been impacted by PSPS outages, we gathered demographic data from the U.S. Census Bureau, socioeconomic data from the American Community Survey (ACS), environmental justice data from CalEnviroScreen 4.0, and projected extreme heat data from the California Department of Public Health CalBrace project [14-17]. These data are reported at the census-tract level, allowing us to compare with the census-tract level PSPS data. Ultimately, this allows map users to see where PSPS events might be impacting communities that lack the resources to recover quickly from power outages.

Demographic data was drawn from the Office of Environmental Health Hazard Assessment's CalEnviroScreen 4.0 dataset and included population estimates for the percent of each census tract that identifies as Hispanic or Latino, white, African American, Native American, Native American, or as other or multiple races. Additionally, data on the location of tribal communities was taken from the Federal Bureau of Indian Affairs and the California Office of Emergency Services [18-19]. This was also overlaid with census tracts to indicate what percentage of a census tract may be a tribal community, and which tribal communities may live in a given census tract.

Socioeconomic data was included as an indicator for the ease with which households in that census tract would be able to cope with the potential costs incurred from losing power. This data included median household income and whether a census tract would be considered low income (e.g., below 60% of California's median income). It also included the percentage of households under the Federal Poverty Level (FPL), 1.5x below the FPL, and 2x below the FPL. These numbers were used because households below 60 percent of California's median income or below 150 percent of the FPL are eligible for the Federal Low Income Home Energy Assistance Program in California and households below 200 percent of the FPL may qualify for the California Alternative Rates for Energy Program. (While this data was not available, households up to 250% of the FPL may qualify for the Family Electric Rate Assistance Program.)

Environmental justice data includes each census tract's CalEnviroScreen 4.0 score and score percentile, and whether a census tract is considered a Disadvantaged Community (e.g., is within the top 25% of CalEnviroScreen Scores or above the 95th percentile for census tracts missing demographic scores.)

Data on the projected number of extreme heat days from 2060-2090 was also included to give a sense for where people would be most vulnerable to negative impacts from extreme heat if power outages cut off access to air conditioning.

V. Building and hosting the PSPS maps

The interactive maps, including "PSPS Frequency by Census Tract" and "PSPS Duration by Census Tract" were built in Tableau desktop and published to the Tableau Public site. Data for these two maps was pre-aggregated to the census tract level in Python.

The forthcoming "PSPS Lookup Table" will complement these maps, allowing users to see a breakdown of individual PSPS events impacting different census tracts and aggregate data to different geographic extents. This dashboard was also built in Tableau and will be published to the Tableau Public site. Data for this dashboard will be at the level of both the census tract and individual outages.

Data Sources

1. **Data:** CPUC PSPS Event Rollup
   Source: California Public Utilities Commission
   Available at:
   https://www.cpuc.ca.gov/consumer-support/psps/utility-company-psps-reports-post-event-and-post-season
   Most recent download: January 2023

2. **Data:** PSPS Post Season Reports 2021
   Source: California Public Utilities Commission
   Available at:
   https://www.cpuc.ca.gov/consumer-support/psps/utility-company-psps-reports-post-event-and-post-season/psps-post-season-reports-pge-2021
   Most recent download: December 2022
   Notes: These reports and associated PSPS Data By Census Tract (Geospatial) and PSPS Data by Census Tract (Non-Spatial) files are also available from each investor-owned utility.

3. **Data:** PG&E PSPS Post Event Reports
   Source: Pacific Gas & Electric Company
   Available at:
   https://www.pge.com/en_US/residential/outages/public-safety-power-shuttoff/psps-reports.page
   Most recent download: December 2022
   Notes: Many of these reports are also available from the CPUC here and here.

4. **Data:** Additional PG&E PSPS Data
   Source: Pacific Gas & Electric Company via electronic data request
   Available via email from ElectricDataRequests@pge.com
   Date obtained: October 2022

5. **Data:** SCE PSPS Post Event Reports
   Source: Southern California Edison
   Available at: http://on.sce.com/PSPSposteventreports
   Notes: The main SCE PSPS page is https://www.sce.com/wildfire/psps.

6. **Data:** SDG&E PSPS Post Event Reports
   Source: San Diego Gas & Electric Company
   Available at: https://www.sdge.com/wildfire-safety/psps-more-info

7. **Data:** PacifiCorp PSPS Post Event Reports
   Source: Pacific Power
   Available at:
   https://www.pacificpower.net/outages-safety/wildfire-safety/public-safety-power-shutoff.html

8. **Data:** Fire-Threat Maps & the High Fire-Threat Districts (HFTD)
   Source: California Public Utilities Commission
   Available at:
   https://www.cpuc.ca.gov/industries-and-topics/wildfires/fire-threat-maps-and-fire-safety-rulemaking
   Most recent download: September 2022

9. **Data**: PG&E Integration Capacity Analysis Data
   Source: Pacific Gas & Electric Company
   Available at:
   https://www.pge.com/en_US/for-our-business-partners/distribution-resource-planning/distribution-resource-planning-data-portal.page
   Most recent download: September 2022

10. **Data:** SCE Integration Capacity Analysis Data
    Source: Southern California Edison
    Available at: https://drpep.sce.com/drpep/
    Most recent download: September 2022

11. **Data:** SDG&E Integration Capacity Analysis Data
    Source: San Diego Gas & Electric Company
    Available at:
    https://www.sdge.com/more-information/customer-generation/enhanced-integration-capacity-analysis-ica
    Most recent download: September 2022

12. **Data:** 2019 Census Tract Boundaries; Incorporated Places; Census Designated Places
    Source: U.S. Census Bureau TIGER/Line Shapefiles
    Available at:
    https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.2019.html#list-tab-790442341
    Most recent download: April 2022

13. **Data:** Electric Load Serving Entities: IOU & POU
    Source: California Energy Commission
    Available at:
    https://cecgis-caenergy.opendata.arcgis.com/datasets/electric-load-serving-entities-iou-pou/explore?location=37.059572%2C-119.273187%2C7.01
    Most recent download: September 2022

14. **Data:** Projected number of extreme heat days 2040-2060
    Source: Climate Change & Health Vulnerability Indicators for California (CCHVIs) from the California Department of Public Health CalBrace Project
    Available at: https://skylab.cdph.ca.gov/CCHVIz/
    Date obtained: November 2022

15. **Data:** CalEnviroScreen 4.0
    Source: California Office Environmental Health Hazard Assessment
    Available at: https://oehha.ca.gov/calenviroscreen/sb535
    Most recent download: September 2022

16. **Data:** Median Household Income in the past 12 months (in 2019 inflation-adjusted dollars)
    Source: IPUMS NHGIS, University of Minnesota

Available at: https://data2.nhgis.org/
Most recent download: December 2022

17. **Data:** Ratio of Income to Poverty Level in the Past 12 Months (via 2019 American Community
Survey: 5-Year Data [2015-2019, Block Groups & Larger Areas])
Source: IPUMS NHGIS, University of Minnesota
Available at: https://data2.nhgis.org/
Most recent download: December 2022

18. **Data:** American Indian and Alaskan Native Land Area Representations (LAR)
Source: U.S. Department of the Interior Indian Affairs
Available at: https://biamaps.doi.gov/bogs/datadownload.html
Most recent download: May 2022

19. **Data:** Indian Lands and Native Entities
Source: California Office of Emergency Services
Available at:
https://gis-calema.opendata.arcgis.com/datasets/CalEMA::indian-lands-and-native-entities/about
Most recent download: May 2022
Notes: This dataset has since been updated to "Tribal Lands and Native Entities," available in point format here:
https://gis-calema.opendata.arcgis.com/datasets/tribal-and-native-entities/explore?location=37.223249%2C-119.345455%2C6.39