QUANTITATIVE AND QUALITATIVE FACTORS FOR PSPS DECISION-MAKING

Revision: November 6, 2023



As the severity and frequency of wildfires in California continues to grow,[1] the state's utilities, including Southern California Edison, have implemented Public Safety Power Shutoffs (PSPS) to reduce the risk of electrical infrastructure igniting a significant wildfire. SCE's core objective is to keep customers safely energized, which is why PSPS remains a tool of last resort. We forecast with as much granularity as possible and then work to reduce the number of customers impacted.

Customer impacts are reduced by de-energizing only when necessary, based on real-time weather reporting; isolating only those circuits that present significant risk; moving customers between circuits (sectionalization) and turning off specific segments while keeping other segments of the same circuit energized (segmentation).

We use preset thresholds for dangerous wind speeds, low humidity and dry fuels as the basis of our decision-making. These thresholds are set for each of the circuits in high fire risk areas (HFRAs) and are continuously reviewed to calibrate the risk of significant events against the potential for harm to customers from the loss of power.

In 2021, based on an examination of 26 years of historical fire activity, SCE updated its thresholds for all but one fire climate zone within our service area.

Simultaneously, grid hardening efforts, including replacing bare wire with covered conductor (see box, right), are reducing ignition risk and thereby allowing SCE to raise thresholds on many of the circuits most frequently impacted in the 2019 and 2020 fire seasons.*

REDUCING THE NEED FOR PUBLIC SAFETY POWER SHUTOFFS

Concurrent with the work that SCE is doing to reduce the number of customer impacts from PSPS, we are increasing grid resiliency in high fire risk areas through grid hardening measures. The more resilient grid (described in our Wildfire Mitigation Plan) will help reduce the risk of utility equipment sparking significant wildfires and the need for PSPS.

Since 2018, SCE has replaced more than 2,000 circuit miles of bare wire with covered conductor, with additional miles in progress. Covered conductor should prevent ignitions associated with objects or vegetation contacting power lines or conductor-to-conductor contact.

Additional grid hardening activities since 2018 include the installation of 100 sectionalizing devices, more than 7,500 fire-resistant poles and more than 13,000 fast-acting fuses.

* For simplicity, we are referring to the last fire season as the "2020 fire season" although it includes the PSPS event from Jan. 12 to 21, 2021.

DECISION-MAKING

PSPS decisions are based on quantitative analyses while accounting for qualitative factors such as societal and emergency management impacts.

SCE makes PSPS decisions predominantly at the distribution grid level. Decision-making for transmission-level de-energization is not covered in this paper.

THRESHOLDS

All circuits have an **activation threshold**, defined by the Fire Potential Index (FPI) and the wind speed at which they are considered at risk. Activation thresholds are computed for each circuit for the season. For each PSPS event, every circuit also has a **de-energization threshold**. De-energization thresholds are determined separately for each circuit to prioritize circuits for de-energization based on the specific risks of the event. This is particularly important for large events where many circuits must be evaluated simultaneously. The baseline activation thresholds for each of the high fire risk area circuits are included in the online appendix.

SCE PSPS TERMINOLOGY

Consequence score: Used to quantify risk in decision-making

Incident commanders: All decision-making in PSPS events is authorized by an incident commander, who represents the company and undergoes continuous training in PSPS response.

Incident Management Team: SCE follows principles of the National Incident Management System and components of the Standardized Emergency Management System during PSPS events. This includes using an Incident Management Team structure to execute PSPS events.

In-Event Risk Calculation: A decision-making tool that assesses and compares potential public safety risk (PSPS risk) and the benefit of de-energization (wildfire risk) 24 hours out from the start of the period of concern.

In scope: Circuits at risk are deemed to be in scope when they are at risk for reaching event risk thresholds.

Monitored circuit list: Circuits in scope are listed and prioritized and each circuit has a specific time range for which it is forecasted to be of concern.

Period of concern: The forecasted period, including start and end time, as measured in three-hour time blocks.

REST Service (Representational state transfer): A software architecture we use to share GIS maps with public agencies.

FIRE POTENTIAL INDEX

FPI estimates the likelihood of a spark turning into a major wildfire. FPI uses a whole-number scale with a range from 1 to 17 and are categorized as normal (1-11), elevated (12-14) and extreme (15+). Historical FPI and state and federal fire data shows that the most severe fires in terms of number of acres damaged occur at the higher levels of FPI (FPI is calculated using the following inputs (Figure 1):

- **Wind speed**—Sustained wind velocity at 6 meters above ground level.
- **Dew point depression**—The dryness of the air as represented by the difference between air temperature and dew point temperature at 2 meters above ground level.
- **Energy release component (ERC)**—"The available energy (BTU) per unit area (square foot) within the flaming front at the head of a fire … reflects the contribution of all live and dead fuels to potential fire intensity."[2]
- **10-hour dead fuel moisture**—A measure of the amount of moisture in ¼-inch diameter dead fuels, such as small twigs and sticks.
- **100-hour dead fuel moisture**—A measure of the amount of moisture in 1-to 3-inch diameter dead fuels, i.e., dead, woody material such as small branches.
- **Live fuel moisture**—A measure of the amount of moisture in living vegetation.
- **Normalized Difference Vegetation Index (NDVI)**—"… used to quantify vegetation greenness and is useful in understanding vegetation density and assessing changes in plant health."[3]

Dryness Level is a function of ERC and the 10-hour/100-hour dead fuel moisture time-lag.

Fuel loading modifier associated with low, moderate, and heavy fuel loading corresponding to 0.50, 0.75 and 1.00, respectively. This represents a measure of the amount of vegetation on the ground.

$$FPI = \left(\frac{DL}{LFM} + G\right) FLx + Wx$$

Moisture content of the living vegetation.

Degree of green-up of the annual grass based on the NDVI.

Weather component of the FPI, also known as the weather score, and references a lookup table of paired sustained wind speed and dew point depression values as in the figure below. The value range is 0 to 6.

Figure 1: *Fire Potential Index Equation*[4]

FPI Weather Component (Wx)

Dew Point Depression	Wind Speed (mph) <=5	6-10	11-16	17-22	23-28	>=29
>=50	2	3	3	4	5	6
40-49	2	2	3	3	4	5
30-39	1	2	2	3	3	4
20-29	1	1	2	2	3	3
10-19	0	0	1	1	1	1
<10	0	0	0	0	0	0

The variables used to generate the FPI score come from the Weather Research and Forecasting (WRF) model[5], which has been customized for SCE to replicate our specific geography and weather conditions. Individual components of the FPI score are forecast hourly for each 2 km by 2 km grid cell. The model is run twice a day and provides an hourly forecast for five days forward. The forecasts associated with each of the FPI components for each grid cell are then summarized by circuit for three-hour intervals.

The forecasted FPI is further refined and calibrated by integrating model guidance from multiple public sources such as sampling from fire agencies and proprietary data. These refined FPI values are used to determine which circuits are forecast to breach PSPS thresholds during the event, and the values are recorded on SCE's monitored circuit list. In many cases, SCE's meteorologists and operations experts further refine these initial estimated FPI values in real time during the period of concern, based on actual weather observations.

Initially, SCE set the FPI threshold to 12 for all circuits in SCE's high fire risk areas. Starting on Sept. 1, 2021, SCE raised the FPI to 13 for most areas and most events based on a risk analysis of historical fire data.

Exceptions where the FPI threshold continued to be set at 12 include:

- **Fire Climate Zone 1 (FCZ1) (Coastal region) —** The threshold for FCZ1 is staying at 12 because probability calculations indicated a significantly higher ignition risk factor at an FPI threshold of 13 for this FCZ than for the other FCZs (2, 3, 4, 9 and 10). (Figure 2)

- **Geographic Area Coordination Center (GACC) preparedness level of 4 or 5 —** The GACC coordinates multiple federal, state, and regional fire suppression resources. It provides daily fire preparedness levels on a scale of 1-5. A high score signals that there is significant resource drawdown which could negatively impact fire response.

- **Circuits located in an active Fire Science Area of Concern (AOC) —** AOCs are areas within FCZs that are at high risk for fire with significant community impact. This designation is based on factors that are part of FPI, as well as egress, fire history and fire consequence. Further details about AOCs can be found in SCE's Wildfire Mitigation Plan.[7]

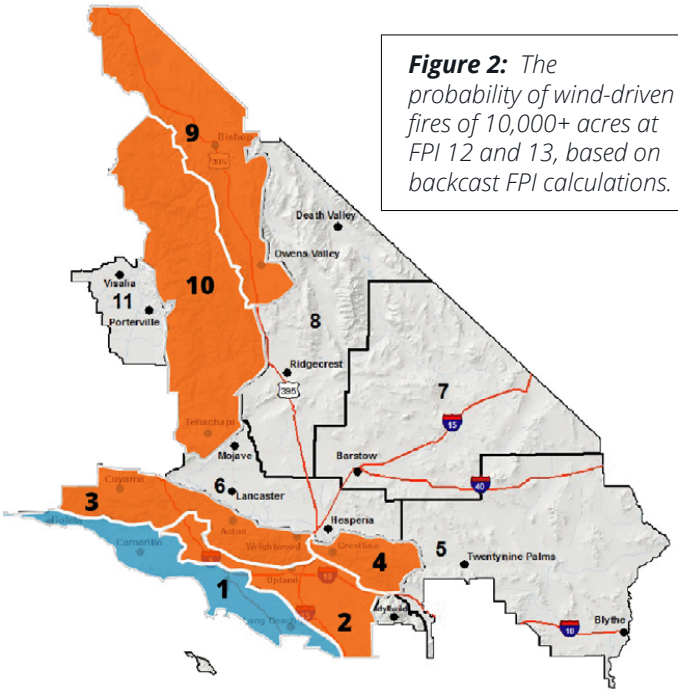
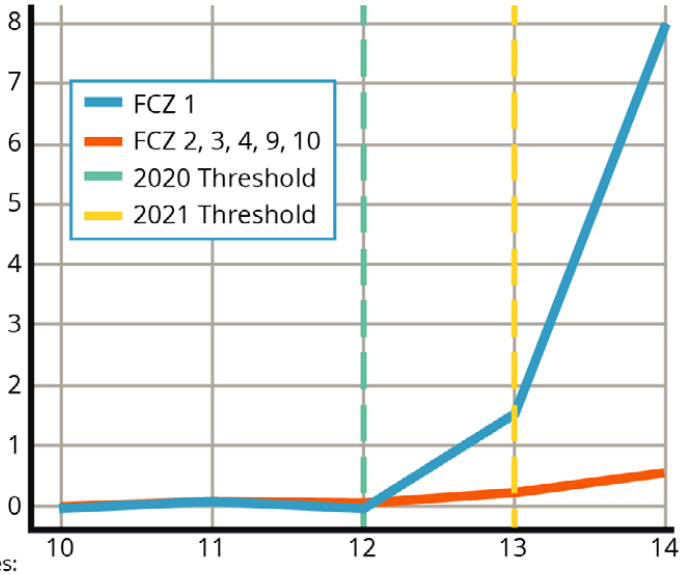


Figure 2: *The probability of wind-driven fires of 10,000+ acres at FPI 12 and 13, based on backcast FPI calculations.*



Notes:
1. Based on an analysis of fire data from 1992-2017.
2. FPI is calculated as a whole number (there are no fractional FPI values).
3. Fires of less than 10,000 acres are not represented on this graph.

In 2023, SCE identified certain remote and isolated areas (less than 1% of SCE's high fire risk area) where an FPI threshold of 11 may be appropriate to mitigate additional fire risk created by unique factors such as extremely limited egress and constrained fire suppression capability. SCE does not anticipate a significant increase in PSPS events as a result of lowering the FPI threshold in these areas.

WIND SPEED

SCE considers the lower of the National Weather Service's (NWS) wind advisory levels (defined as 31 mph sustained wind speed and 46 mph gust wind speed) or the 99th percentile of historical wind speeds to set activation thresholds for each circuit. The wind advisory level is chosen because debris or vegetation is likely to become airborne as described by the Beaufort Wind Scale,[8] while a circuit's 99th percentile wind speeds represent extreme and unusual wind activity for the area.* There are a handful of circuits that have legacy thresholds below the NWS advisory level because they have a history of local circuit outages at lower wind speeds.

CALCULATING DE-ENERGIZATION THRESHOLDS

De-energization thresholds account for circuit health, including any outstanding maintenance and issues identified through patrols,[9] and are also informed by a **consequence score** for each specific high fire risk area. The consequence score estimates the impact of an ignition on communities. The higher the score, the greater the risk to a particular location from wildfires. SCE's process for calculating de-energization thresholds is outlined in Figure 3 below.

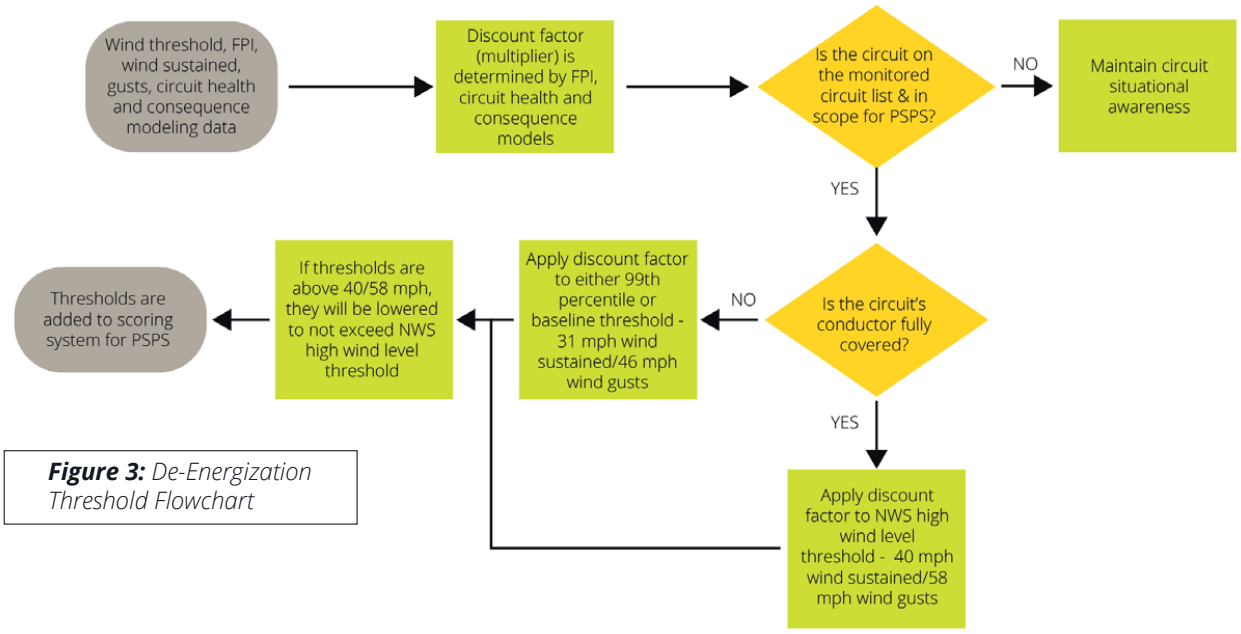


Figure 3: *De-Energization Threshold Flowchart*

If actual conditions suggest more risk, or in large-scale events when many circuits are under consideration for shutoffs, the de-energization thresholds may be lowered (discounted), meaning power on a circuit will be turned off at lower wind speeds. This step prioritizes the circuits that represent the highest risk to be evaluated for de-energization before circuits at lower risk.

* top 1% each year, based on 10 years of data

Conversely, de-energization thresholds are raised for segments or circuits that have had covered conductor installed. The de-energization threshold for segments with covered conductor is 40 mph sustained/58 mph gusts which aligns with the National Weather Service high wind warning level for windspeeds at which infrastructure damage may occur. Other factors, such as maintenance issues, could lower the thresholds for specific events.

TOOLS AND TECHNOLOGIES

To better inform PSPS decision-making, SCE has invested in tools, technologies and practices to improve forecasting. In 2020, two super computers produced twice-daily, high-resolution weather and fuel modeling forecasts for the more than 1,100 distribution circuits in SCE's high fire risk areas. (Two additional super computers and machine learning technology will improve forecasting accuracy in 2021.) The models resolve the complex flows that occur in California's mountainous topography.

PRE-PLANNING (PRIOR TO WILDFIRE SEASON)

PSPS preparedness activities take place year-round. Pre-planning work includes establishing circuit-specific FPI and wind speed thresholds for activation, reviewing circuits for fuel risk and developing process and tool enhancements, such as updating circuit switching plans for circuits in high fire risk areas.

CIRCUIT SEGMENT REVIEWS

We use an exception review process to remove circuit segments from consideration for PSPS when the wildfire risk is temporarily or permanently abated. An example would be a portion of a circuit traversing a recent burn scar where there is little or no vegetation remaining to pose an ignition risk. Circuit segment exceptions are identified when SCE begins preparing detailed designs for grid hardening activities or through specific feedback received from the field. This process is further informed by field teams who have current knowledge of changing conditions in specific areas.

A review team composed of SCE experts from PSPS operations, fire science and risk management evaluates each circuit segment's unique characteristics (e.g., construction type, outage history) and location characteristics (e.g., fuel quantity, fuel type, fuel dryness, fuel age and history of fires in the area) to assess the fire risks associated with that segment. Through the circuit exception review process, SCE has removed more than 31,000 customers on 26 circuits from consideration for PSPS in 2020 that had been at risk in 2019. We are continuing to review circuits to further reduce PSPS impacts as part of our PSPS Action Plan for 2021.

SWITCHING PLAN DEVELOPMENT

Every circuit in SCE's high fire risk area has ties to other circuits. This provides flexibility to potentially isolate customers from high fire risk areas to minimize customer impacts to the smallest extent possible. SCE develops switching plans to determine whether circuit segments could be transferred using field isolation devices. Individual circuits could have one or more switching plans to account for different weather conditions. These switching plans are used for all circuits under consideration in an event and customers can be switched both before and during events. Switching plans can be used in some situations to remove critical infrastructure from circuits under consideration for shutoff.

The switching plans include mapping the location of isolation devices, associated weather stations, mapping of any underground circuit sections and description of areas of the circuit where circuit exceptions may be applied where the conditions are not conducive to a fire start (e.g., area has covered conductor, paved roadways or no vegetation).

FUEL MOISTURE ANALYSIS

Live fuel moisture observations are obtained biweekly, year-round (weather permitting) to determine inputs for FPI calculations. Fifteen sites are sampled in four fire-prone geographic areas: the eastern Sierra (along Highway 395), the western Sierra, northern Los Angeles County and the Inland Empire (Figure 4).

Samples of native vegetation from each of the 15 sites are weighed, dried and then weighed again to determine the vegetation's moisture content. This field research targets the areas that have the greatest fire potential. The data from this fuel sampling program is used to develop and train machine-learning models to estimate live fuel moisture, which serves as one of the inputs into the FPI. SCE also uses the data to calibrate FPI by improving the accuracy of the high-resolution weather and fuel modeling output from weather vendor American Digital Systems.

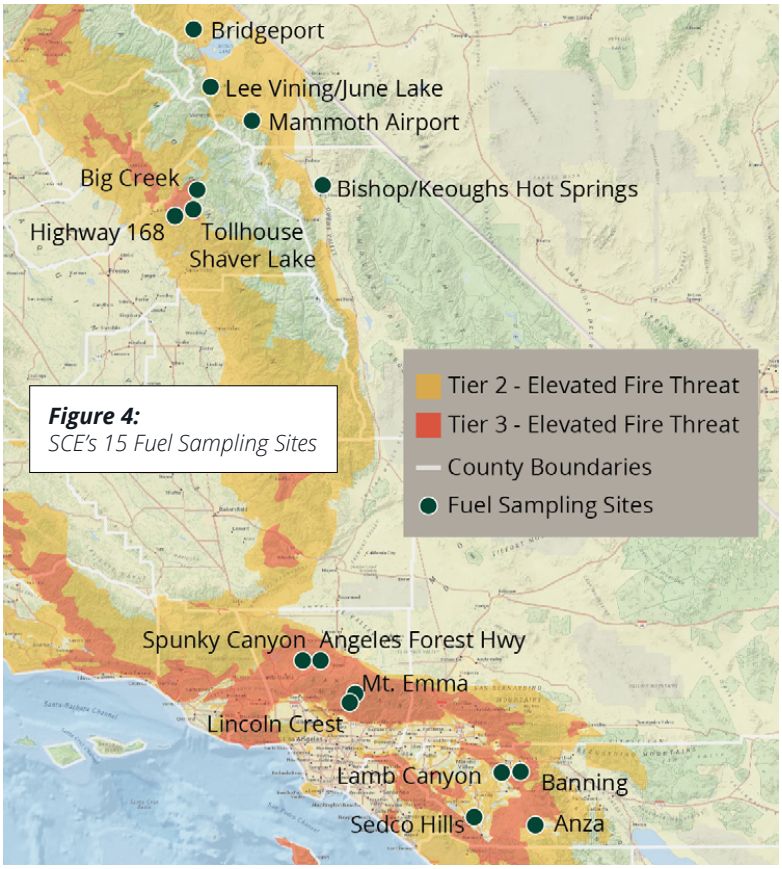


Figure 4:
SCE's 15 Fuel Sampling Sites

Dead fuel moisture factors into the dryness level in the FPI in both 10-hour and 100-hour measures. It is calculated twice daily using the field sample data and a series of mathematical algorithms that account for precipitation as well as the diurnal variability that occurs with temperature and relative humidity.

EVENT PLANNING (FOUR TO FIVE DAYS PRIOR TO POTENTIAL SHUTOFF)

At five days before potential weather events, the meteorologists and fire science team can review the first model run of twice-daily weather and fuel forecasts from SCE's super computers to determine if established thresholds are expected to be breached.

No customers are notified at this point, given the uncertainty of longer-range forecasting.

IMT ACTIVATION (ONE TO THREE DAYS PRIOR TO EXPECTED SHUTOFF)

If forecasts predict that thresholds will be breached within one to three days, the team facilitates a forecast weather call to activate the IMT under the authorization of the incident commander.

The meteorologists produce a monitored circuit list and an associated period of concern table. The table includes a specific forecast start and end time for each circuit, broken down in three-hour time blocks.

Additional quantitative and qualitative factors are monitored in real time once circuits are identified.

As the event gets closer, the initial monitored circuit list and period of concern table are validated by the meteorologists and the fire science team. They improve the raw model using forecasting experience, other weather models and pattern recognition.

The Advanced Circuit Evaluation (ACE) team — a team of SCE engineers and analysts — develops individual de-energization thresholds for each circuit segment for the event based on the pre-assigned activation thresholds. The team assesses circuit conditions and identifies any potential issues that need to be resolved.*

EVENT MANAGEMENT PLANNING

The IMT, under the incident commander, makes staffing and resource decisions (See Complexity Factors, Table 1) and develops a unique event management plan. The plan details the de-energization thresholds and cadence of decision-making based on the complexity of the event and situational information. Managing to the plan allows the PSPS team sufficient time to process simultaneous de-energizations when multiple circuits might approach de-energization thresholds in parallel. For small scale events (up to 30 circuits in scope and limited complexity), an event management plan allows us the flexibility to make individual segment decisions as late as possible.

Table 1: *Complexity Factors*

Criteria	Impacts
Number of distribution circuits in scope (primary circuits)	Increased number of customer and public safety partner notifications requires coordination to ensure alignment between functional groups.
Sub-transmission circuits in scope	De-energizing sub-transmission circuits could potentially create significant customer impacts and local SCE-system reliability issues.
Transmission circuits in scope	Potential for significant customer impacts and reliability issues.
Significant number of circuits forecasted to exceed de-energization thresholds	1. Requires additional staffing to support higher volume of individual de-energization decisions at the circuit segment level. 2. Stresses resource availability to manage restoration in the field.
Large number of counties/ large geographic spread	Increases resource needs. Overextends customer care resources.
Large customer count	Increases demand on customer care resources.
Customer demographics	A high number of access and functional needs customers and/or critical infrastructure providers increases level of support provided by SCE.
Complex/concurrent incidents	Intersecting impacts such as fires, extreme heat or wind-related outages require increased coordination with public safety partners.
Multi-day events	Multi-day events are a significant burden on impacted customers. Providing temporary relief requires planning and significant resources in the field.
Number of circuits close to (below) MCL criteria threshold	Risk of additional circuits that could potentially come into scope and rapidly.

* There is a small subset of circuits with 99th percentile wind speed values that are significantly higher than the NWS wind advisory cap. In instances where wind speeds are forecast to exceed the activation threshold but are not expected to come within proximity of the 99th percentile value, the incident commander may elect not to activate the PSPS protocol. We may dispatch field crews to observe the circuits for possible debris fly-ins but may not activate PSPS due to the low probability of reaching de-energization threshold values.

PRE-PATROLS IN THE FIELD

Where possible, every circuit in scope is patrolled before the arrival of the forecasted weather, unless it was already patrolled within the previous seven days. Crews visually inspect the entire length of each circuit to find any imminent hazards that require immediate remediation and provide additional up-to-date intelligence on field conditions. If maintenance concerns are discovered on a circuit in scope, repairs are expedited (if possible) before the impending wind event.

COORDINATION

SCE meets with local governments, the emergency management community and first responders to inform them about the event, including the location of circuits in scope in their jurisdictions, and to discuss any public safety concerns that should be taken into account.

Situational awareness notifications are sent to local and county jurisdictions, public safety partners and critical infrastructure providers starting at three days out.

CUSTOMER NOTIFICATIONS

Customer notifications begin 24-48 hours ahead of the forecasted weather event. Because these notifications are based on two-day-ahead forecasting at the circuit level, they lack the precision of later, in-event notifications, which will be based on real-time weather readings at the segment level. They also do not reflect in-event efforts to sectionalize circuits to reduce customer de-energizations.

"The wildfire risks that are reduced through PSPS must be balanced against the potential public safety risks that are introduced by a temporary loss of power. SCE maintains transparent coordination with emergency management officials and other public safety partners leading up to and during PSPS events."

IN-EVENT RISK CALCULATION

A new in-event calculator provides an event-based quantitative comparison of risk scores to inform de-energization decision making. The PSPS risk and the benefit of de-energization (wildfire risk) are modeled independently and provided to incident commanders 24 hours in advance of the period of concern. This calculator is also documented in the post-event reports required by Resolution ESRB-8.

IN-EVENT DECISION-MAKING

Three to six hours before the winds are forecasted to meet de-energization thresholds, the PSPS IMT moves from forecasting to real-time weather monitoring, using SCE's 1,050 field weather stations and other public weather stations. Every 10 minutes, SCE weather station readings are updated for each circuit. Meteorologists compare the forecast conditions to the actual conditions to identify trends that could suggest whether wind speeds are increasing or decreasing.

LIVE FIELD OBSERVATIONS

Live field observers are stationed at every circuit in scope, at least two hours before the forecasted start of the event (when feasible). Observers are trained SCE employees who monitor circuits for any possible signs of failure and for environmental conditions that could accelerate the need to turn off power, such as potential for damage from wind gusts, airborne vegetation or other flying debris. Field crews also use handheld weather stations to provide field condition readings to supplement information from fixed weather stations.

ACE TEAM DECISION-MAKING PROCESS

The ACE team activates circuit switching plans to reduce the number of customers who lose power.

In-event data is gathered on a master database populated with the de-energization threshold of each circuit segment and auto-populated every 10 minutes with updated wind speeds from circuit-specific weather stations. Field input is provided to the team in real time to inform decisions. As a circuit, or segment of a circuit approaches its de-energization threshold, this team will recommend shutoffs. The incident commander will review each unique recommendation and validate using additional data, such as field reports, if necessary, before approving the decision.

IMMINENT DE-ENERGIZATION NOTIFICATIONS

In addition to other notification requirements, CPUC guidelines require notifying all customers one to four hours in advance of power shutoffs, if possible. Predicting when this window will occur in advance of changing weather conditions can be challenging. Notifying customers too early may result in over-notification: customers may receive a warning of de-energization but not lose power if wind speeds do not reach forecasted conditions. Conversely, waiting until wind speeds pick up significantly can result in missing this window and not providing customers advance notice before a power shutoff. For the 2021 fire season, we continue to refine the timing and content of our notifications to be more effective.

ADDRESSING PUBLIC SAFETY CONCERNS

The wildfire risks that are reduced through PSPS must be balanced against the potential public safety risks that are introduced by a temporary loss of power. SCE maintains transparent coordination with emergency management officials and other public safety partners leading up to and during PSPS events. The PSPS team considers how best to manage de-energizations that may impact public safety and determines if any mitigating actions can be taken to reduce the associated risk. Mitigating actions may include sectionalizing lines to minimize the amount of the line that is de-energized or temporarily providing a backup generation source to a critical facility.

Information is provided to public safety partners through a notification sequence managed by the liaison officers and enhanced by access to REST service maps. Starting in June 2021, an online public safety partner portal will provide these partners with enhanced and simplified access to information. Public safety partners have been consulted on the development of the new public safety partner portal.

Requests to delay de-energization or re-energize circuits are addressed on a case-by-case basis. Potential reasons to delay the de-energization of a circuit could include the need to power water pumps for fire suppression, evacuations in progress and critical facilities that are not equipped with sufficient backup generation.* These requests may come from fire agencies or from other emergency management agencies during an event. The incident commander has the final authority to determine a response for SCE.

PATROL AND RE-ENERGIZATION

The ACE team continues to monitor all circuits that are de-energized and watches for winds to decrease below thresholds, which will trigger patrol for reenergization. For multiday events, with gaps of even a few hours, field crews will attempt to restore customers before the second period of concern begins, even if this will require a repeat de-energization.

In most cases, field crews are standing by for patrol, which is typically accomplished within eight hours (for more than 90% of circuits). Some circuits will require foot or helicopter patrol. If possible, customers on difficult-to-patrol circuits are switched to more accessible circuits for restoration, so that circuits with no customers on them will be the last in line for restoration.

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*Many critical infrastructure customers are required by law or industry standard to have back-up generation in place to sustain critical operations during a power outage, regardless of outage type. Other customers not required to have back-up generation are encouraged to consider adding this capability to meet critical needs that require electricity during a power outage.

NEXT STEPS FOR PSPS DECISION-MAKING

Lessons learned, customer feedback and the 2021 PSPS Action Plan are informing SCE's plans for improving decision-making to better serve our customers and our communities for the 2021 fire season. SCE will:

- Use fire spread predictions to estimate how large fires may grow and what their subsequent impact on nearby communities may be. Following evaluation, we will incorporate these estimations to clarify the PSPS geographic coverage to reflect true fire weather conditions more accurately.

- Improve in-house forecasting capabilities to reduce the variance between the customers who are notified of potential de-energization and the customers who are actually de-energized due to the onset of increased fire danger conditions, as well as the number of customers who lose power without prior notification.

- Acquire more computing power to increase resolution of weather and fire potential predictions. This will include doubling the forecast resolution from 2 km to 1 km, which will allow for more precise weather and fuels forecasts.

These improvements should result in adjustments to the activation and de-energization thresholds, resulting in fewer customers losing power because of PSPS. Grid hardening efforts should also reduce the number of customers who experience a PSPS outage assuming the same weather conditions as 2020.

REFERENCES

1. Cal Fire. 2020. "Top 20 Largest California Wildfires." ca.gov. Nov. 3. Accessed April 14, 2021. https://www.fire.ca.gov/stats-events/.

   Cal Fire. 2020. "Top 20 Most Destructive California Wildfires." ca.gov. Nov. 3. Accessed April 14, 2021. https://www.fire.ca.gov/media/t1rdhizr/top20_destruction.pdf.

2. U.S. Department of Agriculture. n.d. "Energy Release Component (ERC) Fact Sheet." Forest Service. Accessed April 14, 2021. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5339121.pdf.

3. U.S. Department of the Interior. n.d. Landsat Normalized Difference Vegetation Index. Accessed April 14, 2021. https://www.usgs.gov/core-science-systems/nli/landsat/landsat-normalized-difference-vegetation-index?qt-science_support_page_related_con=0#qt-science_support_page_related_con.

4. Fire Potential Index adapted from San Diego Gas & Electric (https://www.sdge.com/sites/default/files/regulatory/SDGE_Fire_Prevention_Plan_2018.pdf, pages 25-27) and modified to serve SCE's needs, including the insertion of the Live Fuel Moisture variable.

5. National Center for Atmospheric Research. 2021. WRF - Weather Research & Forecasting Model. Accessed April 14, 2021. https://www.mmm.ucar.edu/weather-research-and-forecasting-model.

6. Short, Karen C. 2017. Spatial wildfire occurrence data for the United States, 1992-2015 [FPA_FOD_20170508]. 4th Edition. Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2013-0009.4 Supplemented with 2016-2017 ignition data supplied directly by CalFIRE via email.

7. Southern California Edison. 2021. 2021 Wildfire Mitigation Plan Update. February 5. Accessed August 26,2021. https://www.sce.com/sites/default/files/AEM/Wildfire%20Mitigation%20Plan/2021/SCE%202021%20WMP%20Update.pdf.

8. National Weather Service. 2013. Beaufort Wind Scale. March 5. Accessed April 14, 2021. https://www.wpc.ncep.noaa.gov/html/beaufort.shtml.

9. California Public Utilities Commission. 2017. General Order 95 Rule 18. Dec. 21. Accessed April 14, 2021. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M215/K830/215830213.PDF.

Online appendix (including May 2021 draft) is available at SCE.com/PSPSDecisionmakingAppendices

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