PG&E Network Hardening – 2022 Update

By John Benson

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1. Introduction

My last post on this subject was almost a year ago and is described and linked below:

PG&E Distribution Hardening: *PG&E is my local utility for both my primary residence (Livermore, California) and my other residence (Arnold, California). My primary residence has minimal risk from wildfires, but my other residence is not so lucky, as it is in a Tier 3 (Extreme) High Fire Threat District (HFTD). Thus I have an interest in the subject of this post.*

PG&E's main wildfire document is their Wildfire Mitigation Plan, a detailed document that is updated every year.

On July 26 PG&E announced a major new initiative to expand the undergrounding of electric distribution power lines in High Fire Threat Districts (HFTD) to further harden its system and help prevent wildfires.

This post will cover two areas related to the above:

- *Why PG&E feels that undergrounding the distribution lines is now viable, and*
- *What their Wildfire Mitigation Plan (WMP) says about the subject of distribution line hardening*

https://energycentral.com/c/gr/pge-distribution-hardening

PG&E released an annual update to their WMP earlier this year. This post will be a summary of that update and includes information on efforts to harden PG&E's transmission and distribution networks, and thus reduce wildfire risk in their territory.

Unfortunately, much of California is still in a multi-year drought, although it isn't quite as severe as in past years. As I am writing this paper in mid July, the largest wildfire of the season for northern California is in progress (Electra Fire, about 50 miles northeast of Stockton, 4,478 acres, and about 85% contained as of now)[1].

2. 2022 PG&E Wildfire Mitigation Plan Update

Our stand is that catastrophic wildfires shall stop. In 2021, we made significant progress, but the wildfire risk continues to change and so our efforts must evolve also. Our 2022 Wildfire Mitigation Plan (WMP) reflects our learnings, new ideas and feedback from stakeholders including the Office of Energy Infrastructure Safety (Energy Safety), the California Public Utilities Commission (CPUC), our Federal Monitor, the Governor's operational observer, and other engaged stakeholders. Our WMP outlines our broad program to reduce wildfires, with many complementary parts that work together to address this risk.[2]

[1] CAL FIRE Incident Report, Electra Fire, https://www.fire.ca.gov/incidents/2022/7/4/electra-fire/

[2] PG&E, "2022 Wildfire Mitigation Plan Update", https://www.pge.com/pge_global/common/pdfs/safety/emergency-preparedness/natural-disaster/wildfires/wildfire-mitigation-plan/2022-Wildfire-Safety-Plan-Update.pdf

In 2020 and 2021, California had its 5th and 2nd driest water years, respectively, in the last century.[3] Climate scientists at the University of California, Los Angeles recently concluded that for the Western United States "2000-2021 [was] the driest 22-year period since 800 A.D., which is as far as the data goes back."[4] PG&E's entire service area experienced extreme and severe drought conditions through much of 2021 prior to the rainstorms that occurred in the latter part of the year.

California experienced unprecedented increases in the wildfire risk as a result of drought and the ongoing impacts of climate change. For example, on non-Red Flag Warning (RFW)[5] days in 2021, there was a more than 500 percent increase in acreage burned, as compared to the average acreage in the prior four years. Simply put, the wildfire threat is growing, and it is PG&E's mission to reduce the risk of this threat to keep our customers and communities safe. This means our programs must evolve with the risks.

As outlined in this 2022 WMP, we are deploying a comprehensive and multi-faceted wildfire safety strategy, utilizing programs and actions that have proven effective at reducing wildfire risk and expanding innovative programs and actions initiated in prior years, such as:

- ***Moving Forward to Underground Powerlines and Harden Our System** – Aggressively moving forward with our program to underground 10,000 circuit miles of distribution lines in High Fire Threat Districts (HFTD)—which effectively eliminates the ignition risk for overhead lines that have been placed underground and hardening additional miles with covered conductor or line removal using a risk-ranked approach to prioritize work. We will be working closely with federal, state and local agency partners, such as Cal Trans, as well as other stakeholders to build strong relationships and coordinate efforts for this innovative and bold program;*

- ***Expanding Enhanced Powerline Safety Settings (EPSS) to All Risk Areas** – Expanding the scope of EPSS, where we re-engineer electrical equipment settings to rapidly, automatically shut off power if an object comes into contact with a distribution line until we can patrol the line to ensure there is no wildfire ignition risk. These safety settings resulted in an 80 percent reduction in ignitions compared to the prior three-year average in our 2021 pilot program. In 2022, we will implement EPSS on all of our distribution lines in HFTD areas and High Fire Risk Areas (HFRA), as well as select non-HFTD areas that are adjacent to HFTD areas and HFRA. Like the work we have done to improve the PSPS program, we will continue to adjust these settings, undertaking a more surgical approach to only activate the settings in areas most at risk and limit reliability impacts to our customers;*

  Author's comment: Note that the "settings" referred to in the above bullet are those for distribution line protective relay settings. For more information on this subject go through the earlier paper linked below, Section 2.

  https://www.energycentral.com/c/pip/initial-resilience-%E2%80%93-part-2

[3] Water years run from October 1 to September 30. See Water Year 2021: An Extreme Year (ca.gov).

[4] https://www.nytimes.com/2022/02/14/climate/western-drought-megadrought.html?referringSource=articleShare

[5] A Red Flag Warning (RFW) indicates a level of wildfire risk from weather conditions, as declared by the National Weather Service

- ***Applying New Mitigation Technology*** *– Deploying equipment to reduce the potential for wildfire ignitions and mitigate wildfire impacts, such as Supervisory Control and Data Acquisition (SCADA)[6]-enabled automated sectionalizing devices, single phase recloser sets, and advanced system sensors;*

- ***Continuing Aggressive Vegetation Management Practices*** *– Continuing our extensive vegetation management that is above and beyond regulatory requirements, such as our Enhanced Vegetation Management (EVM) program;*

- ***Performing Enhanced Inspections and Risk Modelling*** *– Conducting enhanced detailed inspections (i.e., inspections that include significantly more detail than traditional detailed inspections completed prior to 2020) of our facilities in HFTD areas and deploying the most up to date risk modeling capabilities to support our data-driven, risk-informed approach to wildfire mitigation;*

- ***Improving Situational Awareness*** *– Maximizing the use of cameras and weather stations to identify potential wildfire ignitions and risk and expand the situational awareness capabilities of PG&E, the California Department of Forestry and Fire Protection (CAL FIRE), first responders and the public; and,*

- ***Utilizing PSPS as a Final Safety Action*** *– Continuing to implement as a measure of last resort our data-driven, model-based Public Safety Power Shutoff (PSPS) protocols that resulted in more targeted and smaller PSPS events in 2021.[7]*

The 2021 WMP included 53 commitments focused on wildfire mitigation activities such as risk modeling, system hardening, EVM, PSPS, and situational awareness. Despite the challenges posed by the COVID-19 pandemic, our team, including both PG&E coworkers and our contractor partners, was able to complete all of the commitments by year end 2021 and exceeded unit targets in a number of cases. From a timing perspective, 50 of the commitments were completed by the initial target date specified in the 2021 WMP. The remaining 3 commitments were completed later than the target date included in the 2021 WMP but were completed by the end of 2021.

In July 2021, we also took two steps to start programs that we believe will substantially reduce wildfire risks even further; one of which has already delivered dramatic results.

First, following an internal assessment and external benchmarking, we announced our 10,000-mile underground program to eliminate wildfire risk from overhead electric facilities. The undergrounding program is described in the subsection below.

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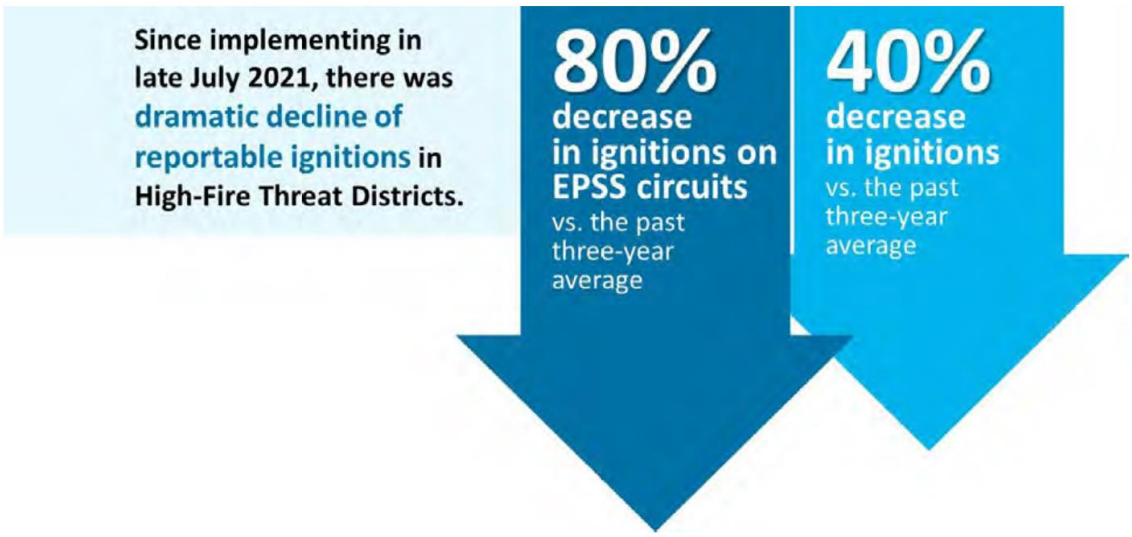
[6] For more information on SCADA systems, there is a six-part series on these that was posted several years ago. The link immediately below is the first part which may satisfy your requirements: https://energycentral.com/c/pip/supervisory-control-and-data-acquisition-scada-introduction If you want to drill deeper, part six liked below has brief descriptions and links to the other parts: https://energycentral.com/c/pip/scada-%E2%80%93-part-6-transmission-and-distribution-network-management

[7] For more information on Public Safety Power Shutoffs, see the brief paper linked below from a couple of years ago: https://www.energycentral.com/c/ec/public-safety-power-shutoffs

Second, we implemented EPSS[8] on approximately 11,500 miles of distribution circuits, or 45 percent of the circuits in HFTD areas. Through EPSS, we addressed the evolving wildfire risk and dramatically decreased CPUC-reportable ignitions, as indicated in Figure PG&E-ES-3 below:

FIGURE PG&E-ES-3:
IGNITION REDUCTION ON EPSS ENABLED CIRCUITS AND OVERALL DECREASES IN HFTD AREA CPUC-REPORTABLE IGNITIONS AFTER EPSS ENABLED



While EPSS resulted in fewer fire ignitions, increased public safety, and reduced the risk of a catastrophic wildfire, impacted customers in high fire threat areas also experienced more outages. To address outages and customer impacts, we re-engineered the sensitivity of devices to continue to provide ignition risk reduction while reducing the likelihood of an outage.

In addition, we improved coordination between our devices to reduce the size of outages and coordination of patrol crews for faster restoration times. As a result, average customer outage duration on EPSS-enabled circuits decreased by 40 percent after these changes were implemented. Despite reductions in customer outages, we appreciate that we can certainly do more.

Given the significant ignition reduction and the criticality of reducing ignitions that could cause a catastrophic wildfire, we are expanding the EPSS program in 2022 to all 25,500 distribution line miles in HFTD and HFRA areas, as well as select non-HFTD areas in our service area. We recognize that EPSS may result in increased outages in 2022 and so we will be continuing our efforts to engineer the best technical solutions including taking additional operational actions to reduce outages and expanding customer support offerings. We will also be evaluating integrating EPSS and EVM, as well as other wildfire initiatives, so that these programs together most effectively mitigate wildfire risks and reduce customer outage impacts. See the second subsection below for more information on the EPSS Program.

[8] EPSS = Enhanced Powerline Safety Settings, see second bullet above, and the author's comment under it.

2.1. Undergrounding

In July 2021, PG&E announced a multi-year program to underground 10,000 distribution circuit miles in and near high wildfire risk areas. PG&E's undergrounding efforts, and other wildfire safety measures, will make our system safer and more resilient to better serve customers and respond to the state's evolving climate challenges. Building and expanding PG&E's electric distribution system underground will not only help eliminate wildfires caused by overhead equipment failures, but it will also help to reduce the need for and/or frequency of PSPS outages and Enhanced Powerline Safety Settings (EPSS), improving system reliability under the full range of weather and fire risk conditions. Undergrounding will also help protect trees and the ecological, environmental, and other benefits they provide.

***Prioritization of Work within Initiative**: PG&E is prioritizing undergrounding in areas where it can have the greatest impact on reducing wildfire risk and PSPS outages for customers, including identified critical facilities. As risk models and conditions evolve, PG&E will adjust prioritization so that the highest wildfire risk areas continue to be addressed.*

PG&E also considers a variety of other factors for undergrounding prioritization including topography (including accessibility for ingress and egress of areas), geology, constructability (land rights/easements, community traffic/access impacts, etc.), existing infrastructure (such as the number of services and transformers), reliability, and the potential of trees falling into lines. When possible, we are prioritizing undergrounding efforts in areas that will address multiple areas of concern at the same time (e.g., wildfire risk, PSPS frequency, topography etc.)

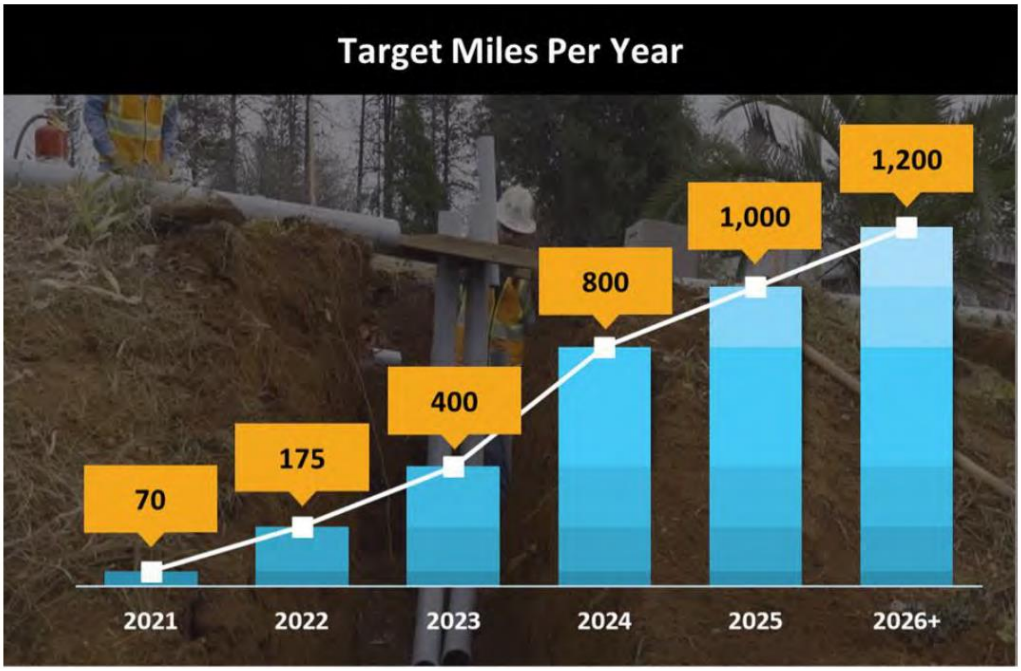
Engineering an underground electric system requires designing the system around existing water, natural gas and sewer / storm-water drainage systems, as well as planning for future road widening. PG&E is working closely with customers and local, state, federal, tribal and regulatory officials to address these issues as part of this program.

PG&E is currently developing scoping criteria that will more quickly and efficiently identify the highest risk areas, assess where undergrounding is a feasible and effective solution, and prioritize and sequence undergrounding work that is designed to reduce system risk based on several factors including:

The prioritization methodology for selecting underground projects will continue to evolve over time as PG&E assesses asset and area risk and as new risk models are approved and applied.

Our goal is to significantly increase underground miles annually, ramping up to 1,200 miles or more of undergrounding per year by 2026. Our current forecast for ramping up the undergrounding program is reflected in Figure PG&E-7.3.3-2 below.

FIGURE PG&E-7.3.3-2:
CURRENT UNDERGROUNDING FORECAST



2.2. Enhanced Powerline Safety Settings (EPSS) Program

Prior to 2021, most of the total acreage impacted by large wildfires in our service area resulting from electric facilities occurred as a result of ignitions that started during Red Flag Warning (RFW) weather conditions. In 2021, however, all of the acreage burned by large wildfires occurred as a result of ignitions that started on non-RFW days. Table PG&E-7.3.6-1 below highlights this significant change.

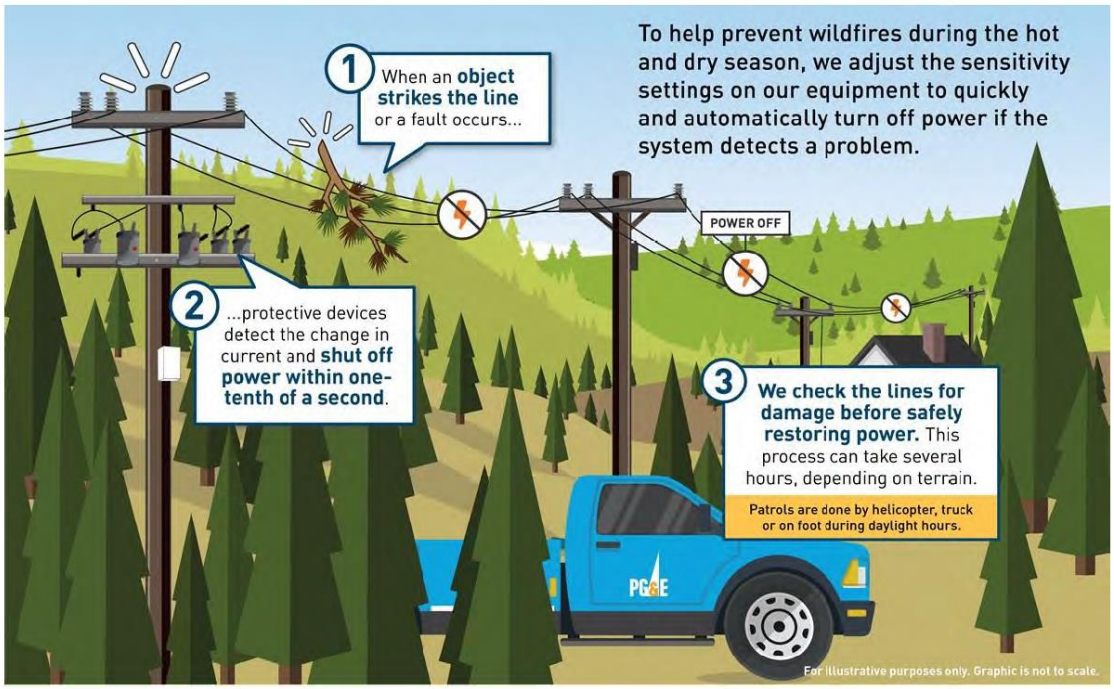
TABLE PG&E-7.3.6-1:
ACREAGE IMPACTED IN PG&E'S SERVICE AREA FROM LARGE WILDFIRES CAUSED BY ELECTRIC FACILITIES

Year	Red Flag Warning Ignition Acres Impacted	Non-Red Flag Warning Ignition Acres Impacted	Ratio of Non-RFW to RFW
2017	228,112	32,063	0.14
2018	243,624	0	0.00
2019	77,758	0	0.00
2020	56,338	696	0.01
2021	0	981,695	N/A

The risk of an ignition event occurs every time there is a fault of any magnitude (fault current), including failures that could emit sparks from overhead assets. Utilities have devices on their system to prevent prolonged fault current by de-energizing the relevant distribution line, much like a household fuse in an electric panel will de-energize for safety. The longer duration that a fault current event occurs, the more wildfire risk is present.

In July 2021, to address this dynamic climate challenge, we implemented the EPSS program on approximately 11,500 miles of distribution circuits, or 45 percent of the circuits in HFTD areas. With EPSS, we engineered changes to our electrical equipment settings so that if an object such as vegetation contacts a distribution line, power is automatically shut off within 1/10th of a second, reducing the potential for an ignition. EPSS-enabled settings provide a layer of protection on days when the wind speeds are low. EPSS is especially important during hot-dry summer days, when there are low winds but continued low relative humidity, low fuel moistures levels, and where the volume of dry vegetation, in close proximity to the distribution lines, increases the risk of an ignition becoming a large wildfire. Figure PG&E-7.3.6-1 below demonstrates how EPSS works.

FIGURE PG&E-7.3.6-1:
EPSS OVERVIEW



Our Public Safety Specialist (PSS) team, who have extensive public safety and fire-fighting experience, evaluated circuits which might have presented a potential catastrophic wildfire risk from an ignition with overhead assets; in collaboration with Division Superintendents, local District Storm room personnel, Electric Operations Maintenance & Construction, Restoration, Compliance, Meteorology staff and Vegetation Management personnel, with considerations of historical fire and weather data, terrain, potential ignition fuel, and ingress and egress factors.