2022 Wildfire Mitigation Plan

Grid Design & System Hardening

Christine Cowsert, Vice President
Jamie Martin, Vice President
March 10, 2022

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Overview

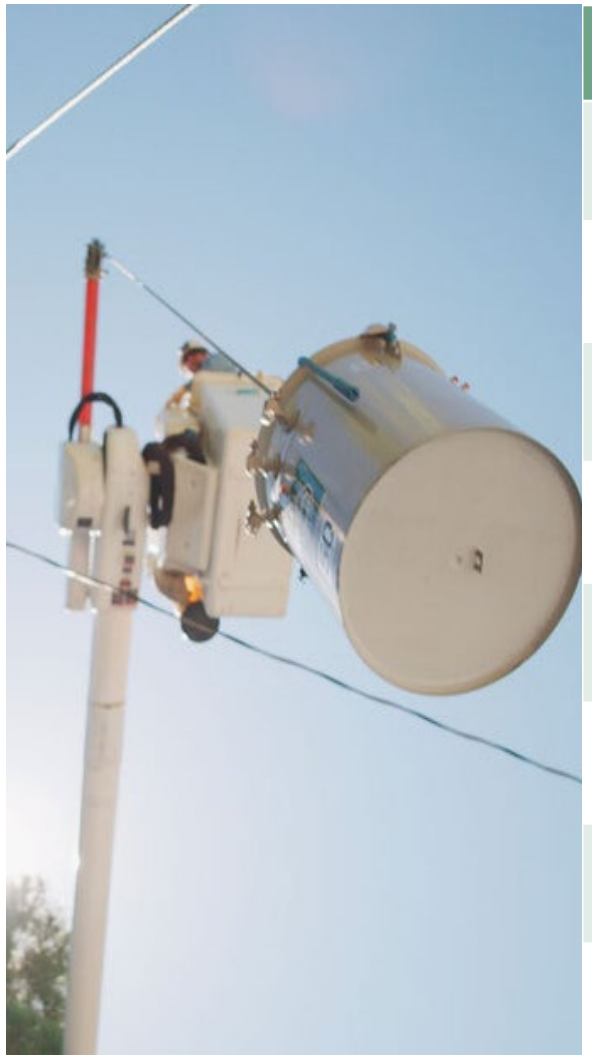
In 2021, we advanced our system hardening and grid design efforts by:

- **COMPLETING** 210 miles of distribution system hardening (which includes undergrounding, overhead hardening, line removal);
- **HARDENING** or removing 104 miles of transmission lines;
- **SYSTEMATICALLY REPLACING** equipment in HFTD areas that creates ignition risks, such as non-exempt fuses (more than 1,400) and surge arresters (more than 15,000); and,
- **LAUNCHING** our plan to underground 10,000 miles of overhead distribution lines in HFTD areas.

In 2022, we are rapidly expanding our system hardening efforts by:

- **COMPLETING** 470 circuit miles of system hardening work which includes overhead system hardening, undergrounding and removal of overhead lines in HFTD or buffer zone areas;
- **COMPLETING** at least 175 circuit miles of undergrounding work, including Butte County Rebuild efforts and other distribution system hardening work;
- **REPLACING** or removing 32 miles of transmission conductor to reduce ignition risk from those lines;
- **INSTALLING** additional automated devices which allow us to sectionalize our grid and reduce the impact of PSPS events; and,
- **REPLACING** equipment in HFTD areas that creates ignition risks, such as non-exempt fuses (3,000) and surge arresters (~4,500, all known, remaining in HFTD areas).

Initiative Targets



2022 Initiative Targets	Date
Replace the fuse with a circuit switcher on the Rincon Transformer Bank 1.	6/1/2022
Install and commission **100 new PSPS SCADA enabled Distribution Sectionalizing devices**.	9/1/2022
Install and SCADA commission **15 transmission line switches** on lines that traverse the HFTD areas.	9/1/2022
Replace 50 of the 104 remaining Motorized Switch Operators energizing HFTD or HFRA.	12/31/2022
Install 17 substation SCADA enabled reclosers on circuits serving line sections that feed into HFTD areas or HFRA, barring any exceptions due to connectivity issues	12/31/2022
Install 80 single phase recloser sets in HFTD areas or HFRA.	12/31/2022
Make operationally-ready **four additional Distribution Microgrid Pre-installed Interconnection Hubs** (PIHs).	12/31/2022
Remove 3,000 non-exempt fuses / cutouts identified on distribution poles in HFTD areas or HFRA.	12/31/2022

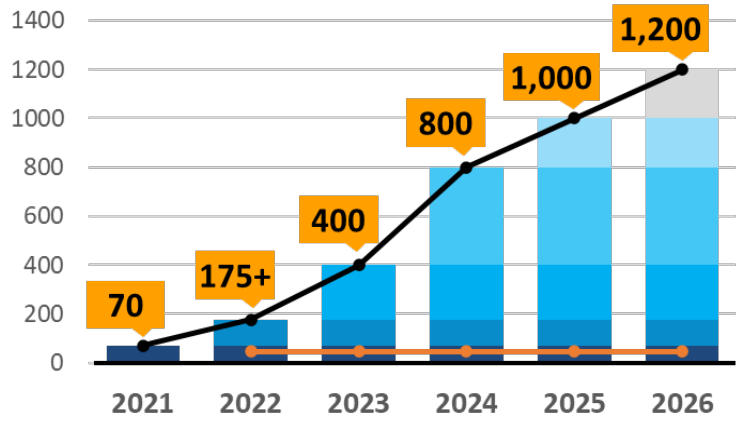
Initiative Targets *(continued)*

2022 Initiative Targets	Date
Equip 15 PG&E Service Centers or Materials Distribution Centers sites with **emergency back-up generation**	12/31/2022
Complete at least 175 circuit miles of undergrounding work.	12/31/2022
Complete at least 470 circuit miles of system hardening work which includes overhead system hardening, undergrounding and removal of overhead lines in HFTD or buffer zone areas with the exception of any mileage being undergrounded and tracked separately as part of our Butte County Rebuild efforts.	12/31/2022
Remove or replace 32 circuit miles of transmission conductor on lines traversing the HFTD areas or HFRA.	12/31/2022
Remove all the remaining non-exempt surge arrestors in HFTD areas (based on the known population of 4,590 surge arrestors as of January 1, 2022) through replacement with exempt equipment.	12/31/2022
Operate 2 new Remote Grid Standalone Power System (SPS) units	12/31/2022
Complete 55 circuit miles of undergrounding work as part of the **Butte County Rebuild** program.	12/31/2022

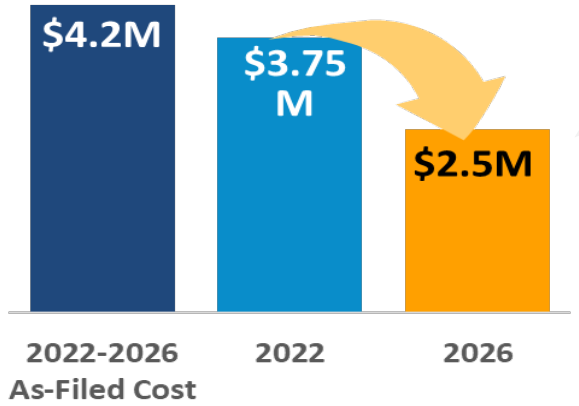
10k Undergrounding Program

PG&E is undertaking a major new initiative to underground approximately 10,000 miles of power lines in high fire risk areas.

Approximate Target Miles Per Year



Approximate Cost Per Mile



How?

- **Optimize** design and construction standards
- **Bundle** work strategically
- **Deploy** new technology and equipment

This commitment represents the largest effort in the U.S. to underground power lines as a wildfire risk mitigation.

Safe	Dependable	Sustainable
99% Risk Reduction & Long Term Resiliency	Reduces PSPS, EPSS and EVM Improves Reliability	Saves Trees

Questions & Feedback

Together, Building a Better California

2022 Wildfire Mitigation Plan

Risk Modeling & Assessment

Paul McGregor, Director

March 10, 2022

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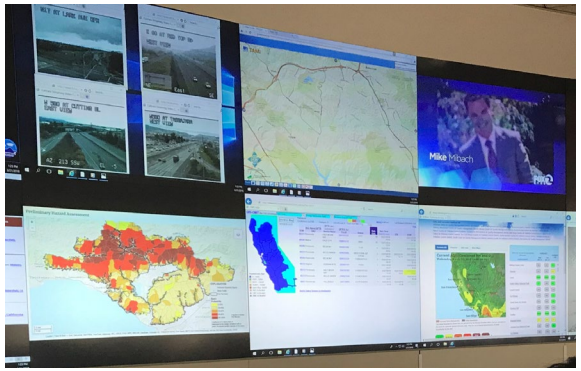
Overview



In 2021, we enhanced our risk modeling to inform our wildfire mitigation activities by:

- **EXPANDING** geographical coverage, adding input data sources, refining probability of ignition modules for our Wildfire Distribution Risk Model;
- **MODELING** critical components of our transmission assets through the Wildfire Transmission Risk Model;
- **DEVELOPING** an initial PSPS Consequence Model at a circuit level; and,
- **DEVELOPING** spatial model visualization in our enterprise data management platform to inform EVM and System Hardening programs.

In 2022, we will continue building on this foundation to effectively make risk informed decisions in the planning and execution of wildfire risk reduction activities by:

- **DEVELOPING** additional models for equipment failure and foreign object contact ignition risk;
- **UTILIZING** the PSPS Consequence Model;
- **DEVELOPING** an approach on how to incorporate ingress/egress into risk modeling; and,
- **ACTIVELY PARTICIPATING** in the risk modeling working group led by Energy Safety.

2021 Wildfire Distribution Risk Model (Version 2)

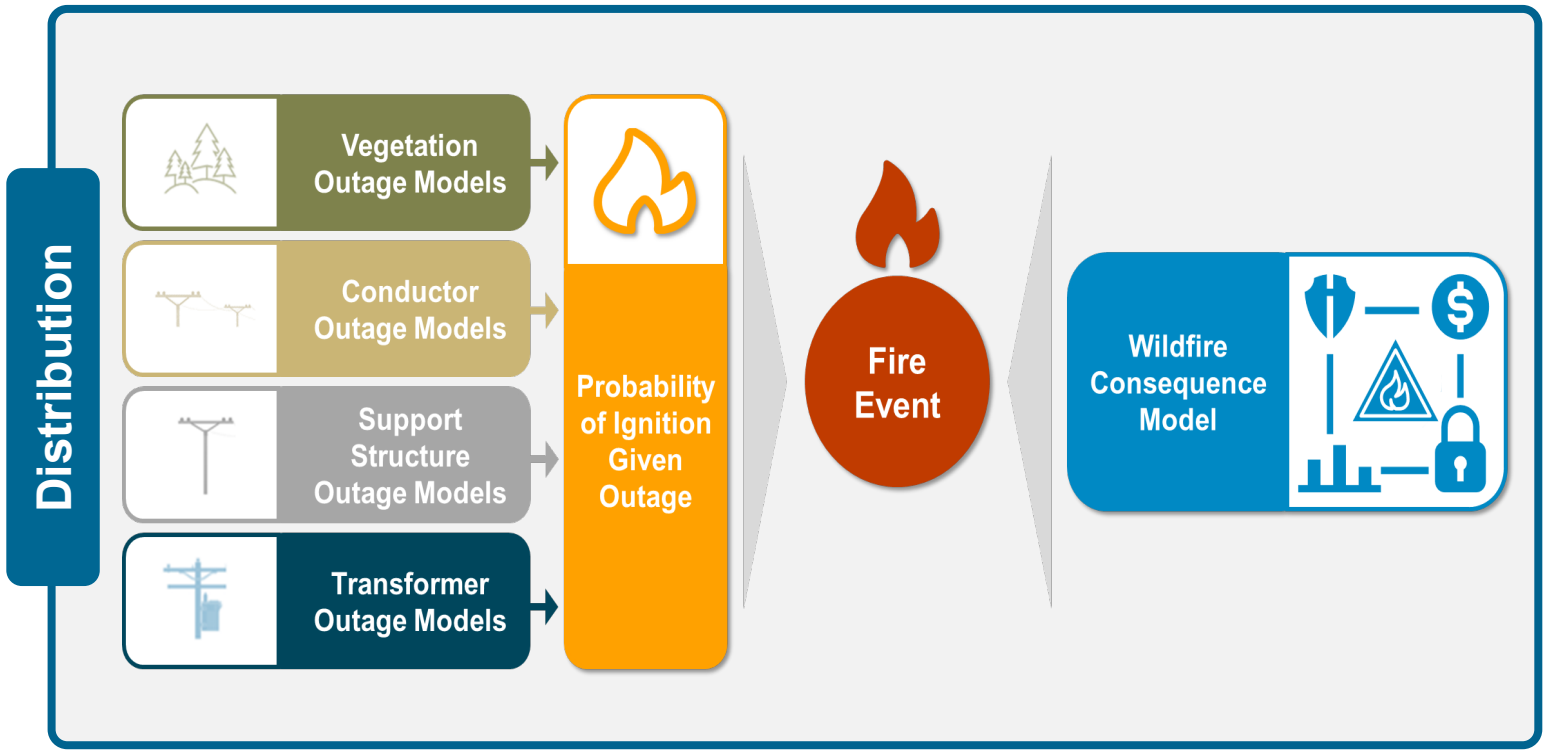
Our 2021 models quantified risk using the approach:

Risk = Probability (Ignition) x Wildfire Consequence

2022 Wildfire Distribution Risk Model (Version 3)

Our Version 3 models expand our analysis to include failures and their propensity to result in ignitions:

Risk = Probability(Outage) x Probability(Ignition Given Outage) x Wildfire Consequence



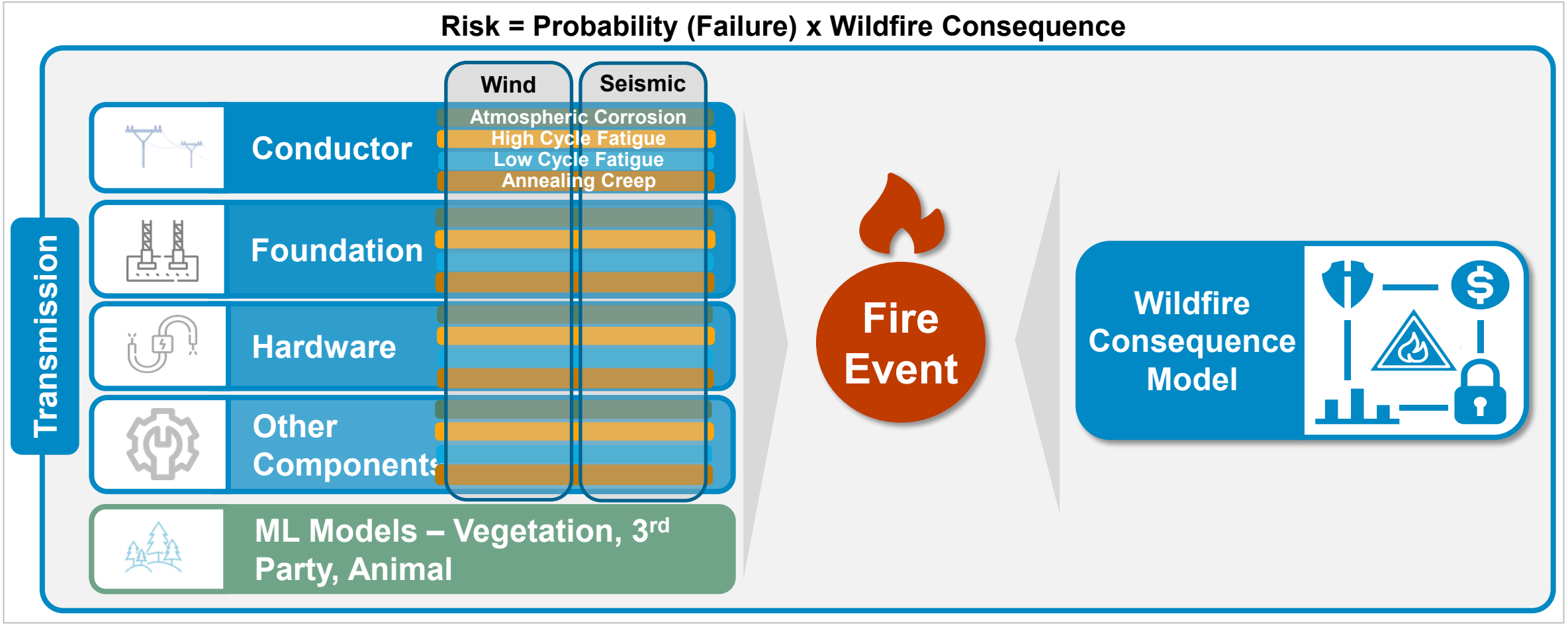
- Enhanced Vegetation Management Prioritization
- System Hardening Prioritization
- Undergrounding Prioritization
- EPSS Prioritization
- Repair Tag Prioritization
- Inspection Ordering & Cadence

Evolution of Wildfire Distribution Risk Models

		2019 WDRM v1	2021 WDRM v2	2022 WDRM v3
Probability	Exposure	HTFD T2/3	HTFD T2/3	**Service Territory**
	GIS Vintage	2018	2020	**2022**
	Risk Event	2015-2018 Ignitions	2015-2019 Ignitions	**2015-2020 Outages / Ignitions / Damages**
	Vegetation	Yes	Yes	Yes
	▶ LiDAR Data	No	No	**Yes**
	Conductor	Primary	Primary	Primary and Secondary
	Support Structures	No	No	**Yes**
	Transformers	No	No	**Yes**
	Compositing	No	No	Yes
	Mitigation Effectiveness	No	No	Yes
Consequence	Exposure	HTFD T2/3	HTFD T2/3	**HTFD + Burnable T1**
	GIS Vintage	2016	2019	**2022**
	Fuels	2012 LANDFIRE	2020 Fuels Snapshot	**2030 Forecast Growth**
	Simulation Duration	6 Hours	8 Hours	8 Hours
	Consequence Formulation	Reax Index	FBI >=2 and Acres >= 300 and Buildings >= 50, OR FBI >=3	**FPI >= R4, OR FL >= 5 and ROS >= 12**

2022 Wildfire Transmission Risk Model

Our Transmission Risk Models focus on the impact of Threats and Hazards on Failures related to Critical Component Groups:



Risk Spend Efficiency

Improving risk-based decision-making

- **EXPANDING** use of RSE for decision making to provide greater risk reduction per dollar invested, especially in system hardening mitigation selection;
- **MODELING** granular tranches based on the Wildfire Distribution Risk Model for RSE;
- **BENCHMARKING** with other CA IOUs with workgroups on risk scores and effectiveness used for RSE calculations;
- **DEVELOPING** RSE Governance team to standardize communications and application of RSE implementation;
- **ENGAGING** in ongoing developments in risk models and RSE calculations in WMP, S-MAP, RAMP, and GRC filings.

Mitigation Initiative Categories	RSE Scored
7.3.1 Risk Assessment and Mapping	2
7.3.2 Situational Awareness and Forecasting	10
7.3.3 Grid Design & System Hardening	19
7.3.4 Asset Management and Inspections	9
7.3.5 Vegetation Management and Inspections	4
7.3.6 Grid Operations and Protocols	6
7.3.7 Data Governance	-
7.3.8 Resource Allocation Methodology	-
7.3.9 Emergency Planning and Preparedness	1
7.3.10 Stakeholder Cooperation and Community Engagement	-
Grand Total	**51**

Initiative Targets

2022 Initiative Targets	Date
Develop additional Equipment/Facility Failure (EFF) and **Contract From Object (CFO)** sub-models and assess effectiveness to enhance the WDRM.	12/31/2022
Develop Threat and Hazard (risk drivers) sub-models and asses if sub-models are to be included in the WTRM.	12/31/2022
Conduct an assessment of the PSPS Consequence model to determine if it is fit for use to inform PSPS mitigation plans to minimize customer impact.	6/1/2022
Develop an approach on how to incorporate ingress/egress into the Wildfire Consequence Model.	12/31/2022
Evaluate an approach to incorporate "Resistance to Control" into the Wildfire Consequence Model.	12/31/2022
Evaluate running the FPI and IPW Models with the ensemble mean output of the POMMS-EPS.	9/1/2022
Develop and share RSE Governance Process with Energy Safety.	9/30/2022

Questions & Feedback

PG&E

Together, Building a Better California

2022 Wildfire Mitigation Plan

Vegetation Management

Sandra Blain, Director
April Schneider, Principal
March 10, 2022

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Overview

In 2021, in addition to the work performed in our Routine, Tree Mortality and Pole Clearing programs, we were able to reduce the potential for vegetation caused ignitions by:

- **COMPLETING** 1,983 miles of EVM work, 98 percent of which was focused on the highest 20 percent or risk-ranked Circuit Protection Zones
- **EXPANDING** 218 miles of transmission ROWs to reduce vegetation contact with our transmission facilities
- **ENHANCING** our vegetation management work verification and training to ensure the quality of work performed

In 2022, we will continue to perform our vegetation management programs by:

- **PERFORMING** 1,800 miles of EVM work
- **COMPLETING** detailed LiDAR inspections
- **CONTINUING** a pilot program to include an enhanced process to perform visual assessment of all sides of potential strike trees on routine vegetation management patrols in HFTDs. The pilot program will inform an implementation of this enhanced process on routine vegetation management patrols in HFTDs
- **UNDERTAKING** extensive work quality audits and reviews through our Quality Assurance Vegetation Management and Quality Verification Vegetation Management programs.

Initiative Targets

2022 Initiative Targets	Date
Complete EVM work on 1,800 risk ranked distribution circuit miles, barring External Factors.	12/31/2022
Complete work on at least 9,000 poles identified as needing work during pre-inspection in PG&E's Vegetation Management Database as of October 1, 2021, in HFTD areas or HFRA, not required by PRC 4292 and barring External Factors.	4/30/2022
Complete defensible space inspections in alignment with the guidelines set forth in PRC 4291 at **132 distribution substations** within HFTD areas or HFRA, barring External Factors.	12/31/2022
Complete defensible space inspections in alignment with the guidelines set forth in PRC 4291 at **55 transmission substations** within HFTD areas or HFRA, barring External Factors.	12/31/2022
Complete defensible space inspections at 61 Hydroelectric Generation Substations and Powerhouses within HFTD areas or HFRA, barring External Factors.	12/31/2022
Complete utility defensible space work on a minimum of 7,000 poles in the HFTD, barring External Factors.	12/31/2022
Perform vegetation management program quality audits prioritizing HFTD/HFRA areas. Statistically valid methodology parameters, such as a confidence level of 95%, will be utilized.	12/31/2022

One Veg Program

Strategic elements of the current EVM program scope are anticipated to integrate to our Routine program by 2023, supported by technology, process, and sourcing enhancements to be planned & executed through 2022

Scope	Current Scope Within HFTD *2021 Executed & 2022 Plan*			Future Scope Within HFTD (One Veg Scope) *2023 & Beyond*		
	Routine	Tree Mortality	EVM	Routine	Tree Mortality	EVM
Hazard Trees	✓		✓	Hazard Trees – Enhanced visual assessments of potential Strike Trees		
Strike Trees			TAT			
Record Creation			All **Strike** Trees	All Trees **Requiring Work**		
12' Radial Clearance	✓		✓	✓		✓
Priority Tree Mitigation	✓	✓	✓	✓	✓	✓
Dead Tree Mitigation	✓	✓	✓	✓	✓	
Overhang Removal			✓			✓
Overhang Maintenance	✓			✓		
Final Work Verification			✓	✓		✓

Routine / "One Veg" Program

✓ Continuation of existing routine maintenance scope

✓ Performing visual assessment of all sides of potential Strike trees, as well as record creation for any trees requiring work.

EVM Program

✓ Continuation of overhang removal work on remaining ~65% of HFTD mileage

✓Key Take Away

- Visual assessment from all sides of potential strike trees on Hazard Trees to be comprehensive in the determination of risk.
- Record creation will be focused on those trees which upon inspection will require work to be performed.

Questions & Feedback

Together, Building a Better California

2022 Wildfire Mitigation Plan

Public Safety Power Shutoffs

Shawn Holder, Director
March 10, 2022

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Year-Over-Year PSPS Overview

In 2021, we continued to evolve and improve, keeping our customers safe and reducing the impact of PSPS events.

Event Details	2019	2020	2021	Improvement
PSPS Events	7	6	5	**17%** fewer outages
Customers Impacted	2,014,000	653,000	80,400	**88%** fewer customers impacted
Average Number of Counties Impacted	17	17	10	**41%** fewer counties impacted
Average Outage Duration (hours)	43	35	31	**11%** less time without power
Average Outage Restoration Time (hours)	17	10	12	**20%** increase restoration time
Damage/Hazards	722	257	442	(13% decrease in restoration time when excluding January PSPS event)
Peak Wind Gusts	102 MPH	89 MPH	102 MPH	
Potential Impacted Acreage Prevented*	3.5M	912K	691K	
Potential Damaged Structures Prevented*	280K	196K	86K	

97% notification accuracy

98% Medical Baseline notification accuracy

ZIP Code Alerts expanded to both customers and non-customers

*According to studies prepared by Technosylva
Slide data is approximate

Post-PSPS Customer Survey Feedback

In 2021, we began to survey customers about their PSPS experience. This information is being used to guide programmatic improvements in 2022.

Methodology

- 3 online surveys (August, September and October 2021)
- Sent to customers deenergized and notified about events
- Topics included outage notifications, PSPS resources and suggested areas for improvement

Top Themes

- **October PSPS events showed significant improvement** compared to August and September events
- **Top issues identified across all surveys:**
  - Accurate restoration time estimates
  - Resources to those with disabilities, medical or other critical needs
- **Generally low awareness and usage of resources (e.g., CBOs)**
- **Most common verbatim comments about lost food and added costs (e.g., fuel for generators)**

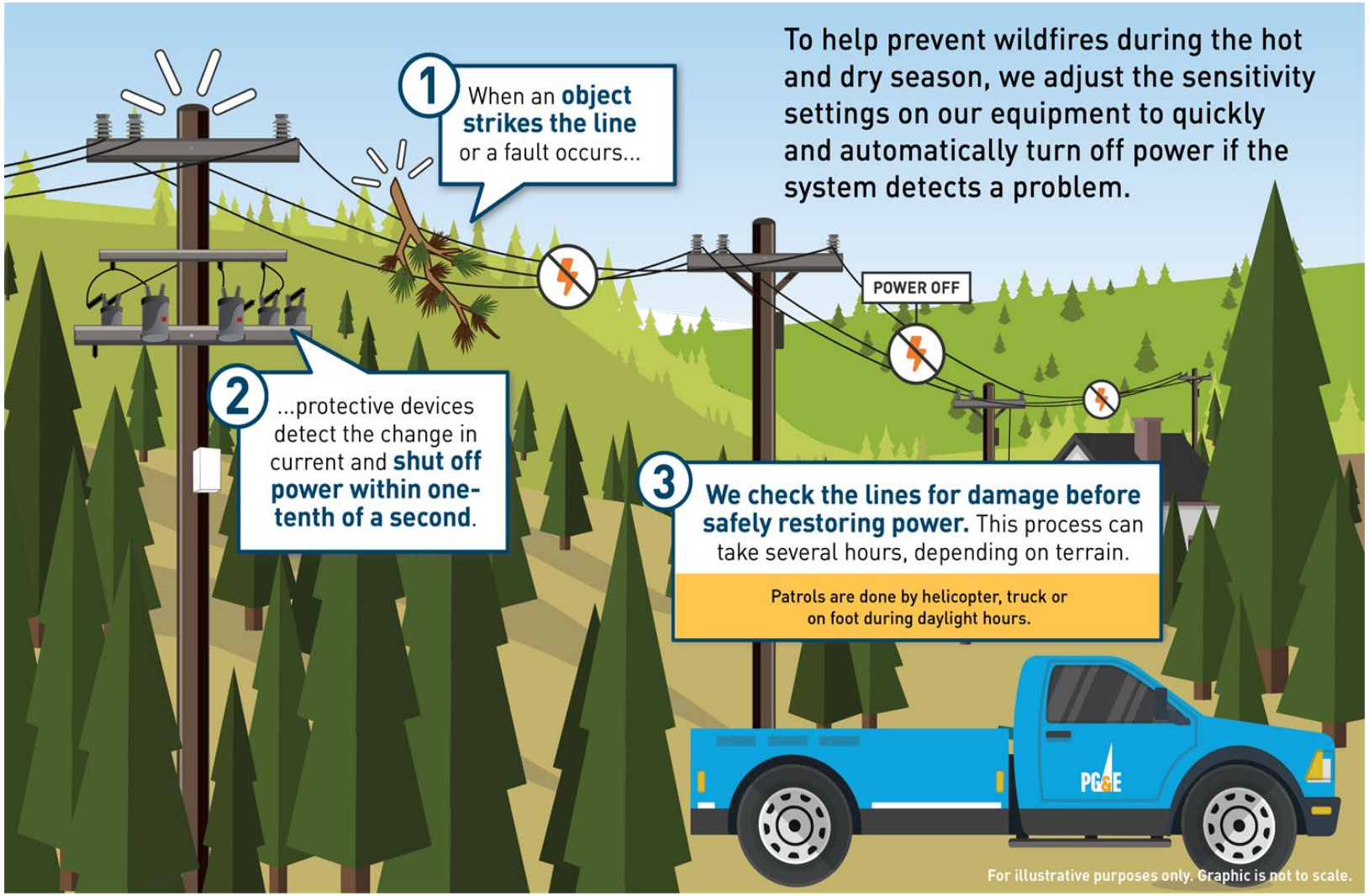
~9%
total response rate

34,542
surveys distributed

Actions To Address Feedback:

- **Improving awareness** of community-based organizations, food resource partnerships and more through increased outreach and education
- **Updating notifications** to be more clear, concise and accurate, working in coordination with our customers
- **Expanding access** to portable batteries and generator rebates
- **Increasing availability** of food banks, Meals on Wheels and grocery delivery
- **Reducing impacts** by installing more sectionalizing devices and distribution microgrids

Enhanced Powerline Safety Settings (EPSS)



EPSS IN 2021

~45% of HFTD circuit miles

~40% vs. the past three-year average*

~80% **on EPSS circuits** vs. the past three-year average*

*compared to 2020

EPSS IN 2022

Expanding to 100% of HFTD circuit miles

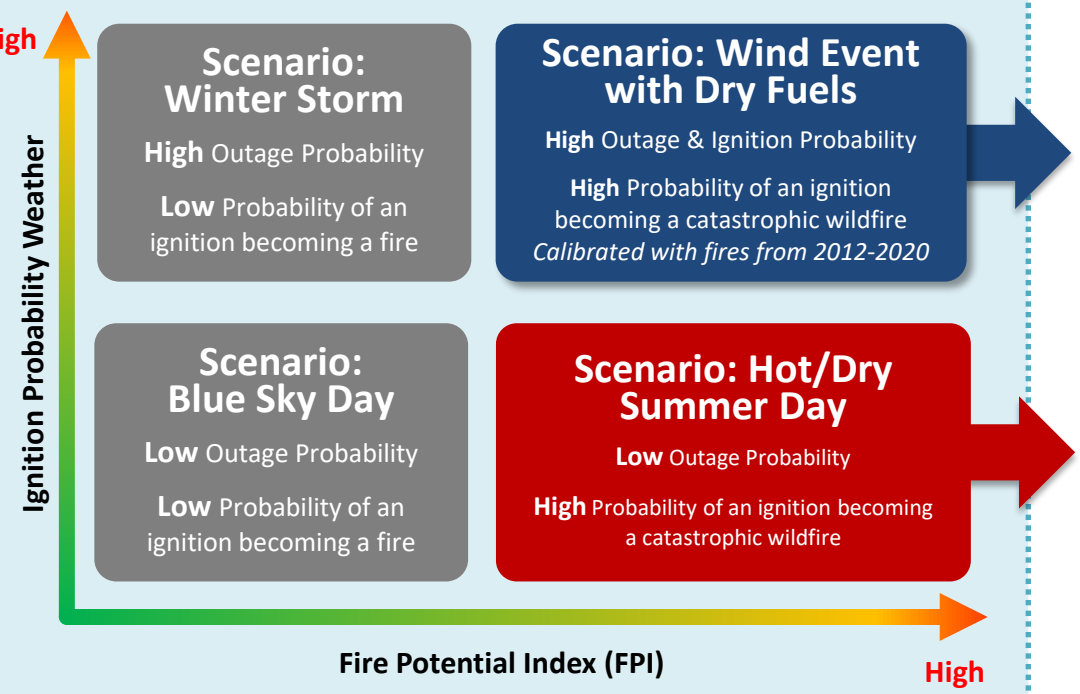
While focusing to minimize outages by

- Targeted vegetation, equipment and animal protection work
- Dedicated crews for faster restoration & readiness response

PSPS & EPSS: Differing Risk Mitigation Targets

Year-Round Wildfire Mitigation

- Undergrounding
- System Hardening
- Enhanced Inspection and Repair



Weather-Driven Response

Public Safety Power Shutoff (PSPS)

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

PSPS IN 2021

17% fewer outages[1]

88% fewer customers impacted[1]

2022 FOCUS

Continuing to refine program and reducing impacts in the areas at highest risk

Enhanced Powerline Safety Settings (EPSS)

Using equipment on powerlines that allows them to turn off power within one tenth of a second if a tree branch or object strikes the line.

EPSS IN 2021

In place on **~45%** of HFTD circuit miles

2022 FOCUS

Expanding to **100%** of HFTD circuit miles (Due to **80%** CPUC Reportable ignition reduction in 2021 for EPSS-enabled circuits)

Questions & Feedback

Together, Building a Better California

2022 Wildfire Mitigation Plan

Asset Management & Data Governance

Mark Esguerra, Sr. Director
Ali Moazed, Director
March 10, 2022

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Asset Management Overview

In 2021, we continued our enhanced inspection programs designed to reduce the potential for wildfire ignition from our electrical equipment by:	For 2022, our inspections and asset management programs will reduce wildfire ignition risk by:
• COMPLETING enhanced detailed inspections on all distribution poles and transmission structures in Tier 3 and Zone 1 HFTD areas and on ~33 percent of the Tier 2 HFTD and HFRA distribution poles and transmission structures; • COMPLETING supplemental ground and aerial inspections of 71 distribution substations, 33 transmission substations and 38 hydro substations; • USING infrared technology to identify potential risks not easily detectable, and LiDAR imaging to improve our knowledge about our assets; • UPGRADING our intrusive pole inspection Program's field hardware and software to enhance record keeping and data system integrations.	• CONTINUING our enhanced detailed inspection programs and intrusive pole inspections for distribution and transmission facilities; • COMPLETING supplemental ground and aerial inspections of 86 distribution substations, 43 transmission substations, and 52 hydroelectric substations to reduce potential ignition risks from these facilities located throughout HFTD areas; • CONTINUING to evolve the effectiveness of our inspection processes and procedures; • CONTINUING our infrared technology inspections to identify potential risks not easily detectable, • PERFORMING LiDAR data acquisition on distribution and transmission facilities.

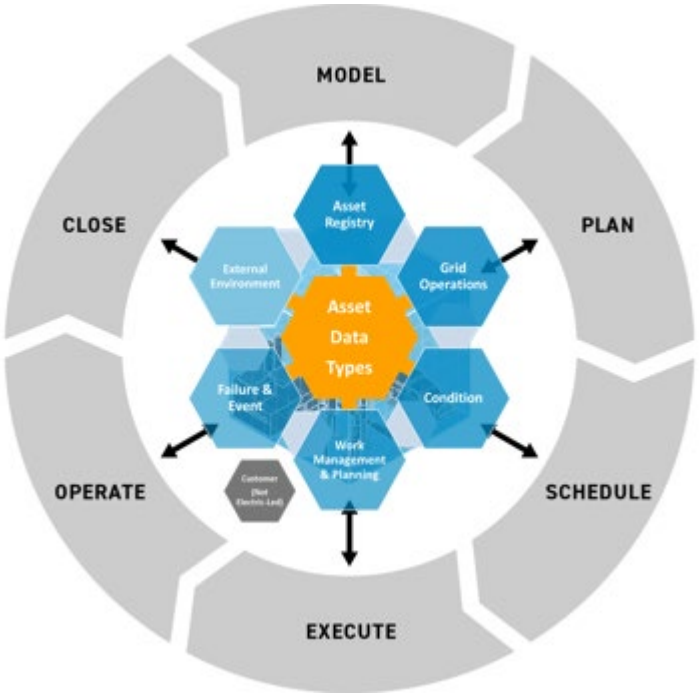
Initiative Targets

2022 Initiative Targets	Date
Complete detailed inspections on 396,000 distribution poles	7/31/2022
Complete detailed ground inspections on 39,000 transmission structures	7/31/2022
Complete detailed climbing inspections on 1,800 transmission structures	7/31/2022
Complete detailed aerial inspections on 39,000 transmission structures	7/31/2022
Complete infrared inspections on 9,000 distribution circuit miles	12/31/2022
Complete supplemental inspections on 86 distribution substations	7/31/2022
Complete supplemental inspections on 43 transmission substations	7/31/2022
Complete supplemental inspections on 52 Hydroelectric Generation Substations and Powerhouses	7/31/2022
Perform Transmission and Distribution system inspection quality audits	12/31/2022
Centralize High Priority Data including implementing a process to identify data gaps in Foundry for critical risk drivers; identifying and incorporating new high priority datasets into Foundry, and incorporating 20 new, foundational ontology objects into Foundry	12/31/2022

Data Governance Overview

In 2021, we continued to expand our data driven approach to wildfire mitigation by:	In 2022, we will be building on our data capabilities by:
Foundational Asset Registry Improvements • IMPROVING core Support Structure Asset Registry focused on wildfire areas including improvements to Asset Characteristics, Geospatial Accuracy, System Synchronization, Completeness • MATURING Data Governance processes including establishment of a Data Governance Forum to address cross-cutting data issues Centralized Repository for Data (Foundry) • INCREASING our capacity to deliver new, high-quality data objects into Foundry data platform – 50+ data source systems connected, 436 ontology objects • DEVELOPING eight new wildfire-related analytic and situational intelligence products	Foundational Asset Registry Improvements • EXPANDING data quality initiatives to additional high priority Asset Classes. • DEVELOPING and implementing standards to codify Asset Registry system and process governance Centralized Repository for Data (Foundry) • EXPANDING the electric operations data available in Foundry data platform; and, • DEVELOPING new analytic and situational intelligence products within the data platform, and maturing platform governance.

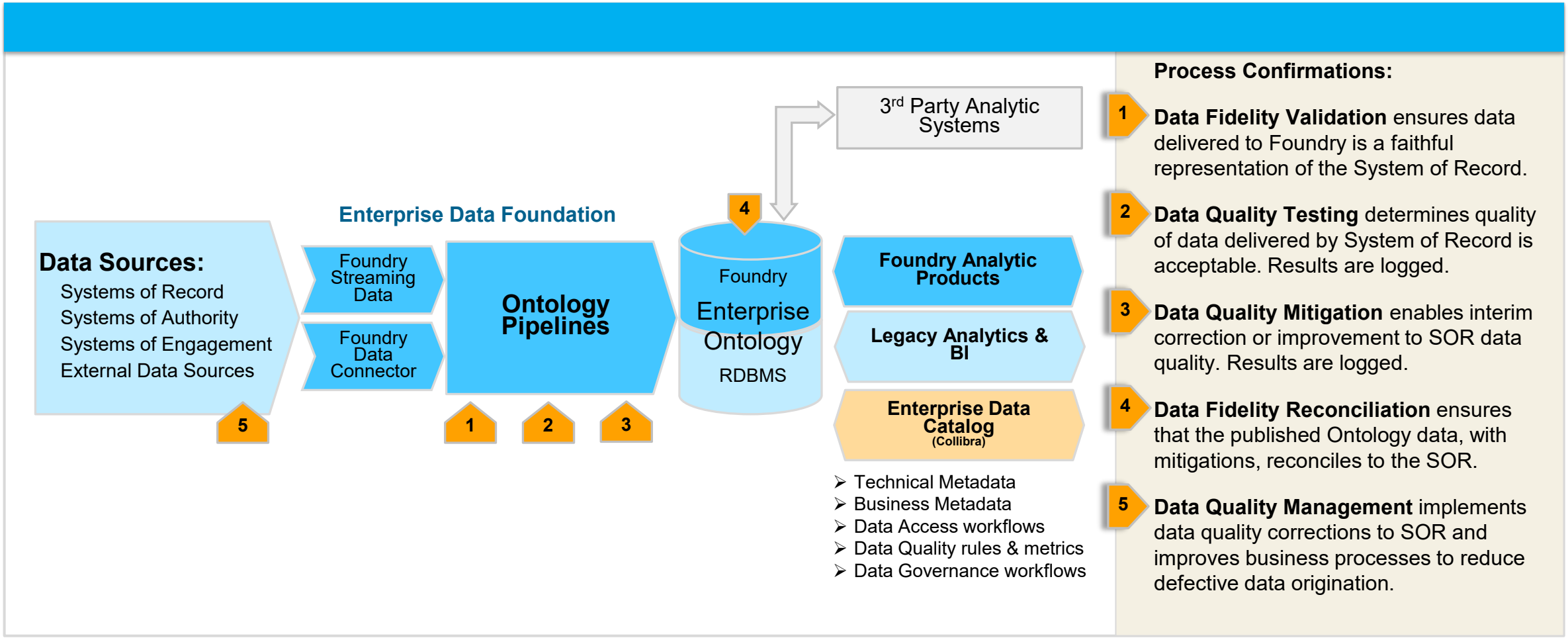
Foundry Data Products



Strategic Theme		Product / Purpose
Wildfire Risk Management and Operations	1	**PSPS Situational Intelligence Platform:** Provide timely, precise, accurate information to de-energizing the right lines; provide foundation for external data sharing and event documentation
	2	**Wildfire Risk Command Center:** Enable visibility and understanding of work plan status for 53 WMP commitments.
	3	**Grid Data Analytics Tool (GDAT):** Accelerate detection / resolution of unknown cause outages; set foundation for real time outage management and predictive analytics
Risk Modeling	4	**T-Line Operability Assessment:** Streamline PSPS scoping; composite Transmission risk model.
	5	**Transmission Composite Model:** Develop composite models to understand the fire ignition risk from Electric Transmission Assets
	6	**Wildfire Distribution Risk Model:** Ensure access to trusted risk scores for workplan creation.
Integrated Grid Planning	7	**Asset Maintenance & Compliance Platform :** Efficiently produce accurate asset inspection plans that address compliance requirements/ commits.
	8	**Integrated Planning Undergrounding Tool Development:** Develop effective, transparent, data driven decision process and tool to select which lines the company will underground.
	9	**Asset Failure Analysis**: Provide precise asset failure data for risk modeling and failure prediction models.
Reporting	10	**OEIS (WMP) GIS Data Standard & Automation:** Increase efficiency and completeness of data reporting to meet WMP requirements/ commitments; connect key assets and wildfire initiatives.

Target State Architecture – Palantir Foundry

Bringing foundational data sets from disparate data sources together in a central data platform for use in developing new situational intelligence and analytic capabilities to enable wildfire mitigation



Process Confirmations:

1. **Data Fidelity Validation** ensures data delivered to Foundry is a faithful representation of the System of Record.
2. **Data Quality Testing** determines quality of data delivered by System of Record is acceptable. Results are logged.
3. **Data Quality Mitigation** enables interim correction or improvement to SOR data quality. Results are logged.
4. **Data Fidelity Reconciliation** ensures that the published Ontology data, with mitigations, reconciles to the SOR.
5. **Data Quality Management** implements data quality corrections to SOR and improves business processes to reduce defective data origination.

Questions & Feedback

Together, Building a Better California

Documentation & Disclosure of Wildfire-Related Data Overview

	In 2021, we enhanced our quarterly reporting through the following:	In 2022, we will continue expanding our reporting capabilities by:
GIS Data Standard (Spatial QDR)	• **IMPLEMENTED** process improvements around the collection, curation, and organization of data inputs • **ADOPTED** revised requirements from the Energy Safety, as introduced in GIS Data Standard V2, V2.1, V2.2 • **ADDED** Metadata to help describe data inputs • **LEVERAGED** Foundry to drive connectivity between select source systems and data sets, enabling reporting of formerly distinct data	• **TRANSFORMING** PG&E's data to provide additional required fields to meet GIS Data Standard requirements • **REPORTING** on more WMP programs • **ADAPTING** automations and submissions to meet evolving revised version releases • **ALIGNING** with other wildfire data reporting (e.g., QDR, QIU)
Quarterly Data Report (QDR)	• **SUBMITTED** Q1-Q3 2021 Quarterly Data Reports and revised data as needed within the 12 data tables	• **ADOPTING** revised requirements as introduced from Energy Safety's Wildfire Mitigation Revised Guidelines released 12/15/21
Quarterly Initiative Update (QIU)	• **ADDED** four "Addressing Extreme Drought Conditions" initiatives under Category "Protocols on Public Safety Power Shutoff" and Initiative Activity "Strategy to Minimize Public Safety Risk During High Wildfire Risk Conditions." • **INCLUDED** all initiatives from the 2021 WMP in the QIU working file by adding all "Other" sections • **IMPLEMENTED** a pilot program in Foundry to build QIU reporting functionality	• **REPORTING** out on 51 targeted initiatives prioritized by impact of wildfire mitigation (PG&E's 2022 WMP section 7.3) • **IMPLEMENTING** all reporting functionality – including progress updates, approval process and uploading of supporting file within Foundry