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Wildfire Risk Model Improvements

Full Board

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Executive Sponsor(s): [REDACTED] (SVP and Chief Risk Officer)

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Topic Summary

Item Overview

- Purpose of Presentation: To provide an overview of the Wildfire Risk Model Improvements
- Advanced Vegetation Management (EVM) are the two key mitigation programs in use for the 25,000 circuit. The Wildfire Risk Models are the method used to target the right miles for risk
- None

to Revise after complete review

Key Takeaways

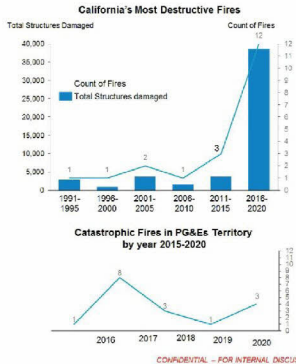
- The Wildfire Risk Models are built around the CPUC approved risk framework of "Likelihood of a risk event" combined with "Consequence of the risk event"
- The models were initially developed in 2018 and revamped in 2020, using more advanced machine learning methods for predicting ignitions and shifting from REAX Engineering simulations to Technosylva simulations for determining consequence
- The changes resulted in a major shift in which circuit locations have the highest risk
- The new risk models (Vegetation and Equipment) are used in conjunction with field information to determine the 2021 workplan for EVM and System Hardening

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Wildfires have become more frequent and destructive, highlighting the importance of understanding wildfire risk

Situation	<p>Catastrophic wildland fires have become a major threat throughout PG&E's service territory, and pose significant threat to the safety and economic future of the organization. PG&E recognizes our electrical equipment has been the ignition point for a number of these fires and is working to understand these catastrophic events to maximize planned risk reduction activities</p>
Complication	<p>The frequency and severity of these catastrophic fire events has increased dramatically over the last 10 years. PG&E's service territory has grown from 15% HFTD to over 50% from 2012 through 2020. The historical methods for managing fire risk need to evolve to manage the increasing population in the wildland urban interface and changing climatological conditions. To meet these challenges, PG&E has developed a series of models to identify areas of highest consequence and potential for ignitions. These models continue to improve as the available information and understanding improves.</p>
Objective	<ul style="list-style-type: none"> • Outline the process for assessing risk • Communicate the evolution of PG&E's risk modeling efforts • Identify the areas where risk modeling has been operationalized for risk reduction activities



From 2012 – 2020 HFTD went from 15% to 50%

The framework to assess wildfire risk examines the likelihood and consequence of a potential ignition event

LoRE

- The likelihood of a risk event (LoRE) is the relative frequency of a specific risk event occurring.
- In the case of **wildfire risk**, this is the relative **likelihood of an ignition occurring**.

CoRE

- The consequence of a risk event (CoRE) is the average impact of the risk should it materialize across key outcomes (Safety, Reliability, Financial).
- In the case of wildfire risk, **consequence contains serious injuries, fatalities, property damage**, and impacts to reliability.

Risk = LoRE X CoRE

- Risk is the product of the likelihood and consequence of a risk event.
- This method produces an expected value of impact across the consequence outcomes, and when combined results in a multi-attribute score that can inform risk-based decision making

Methodology

Ignition Model

Likelihood of Ignition

Ignition likelihood was determined based on 2021 modeling predicting ignitions at fire circuit protection zone (FCPZ)



Fire Spread Model

Likelihood of Spread

Spread likelihood was determined based on a study conducted by PQSE and Techosysve

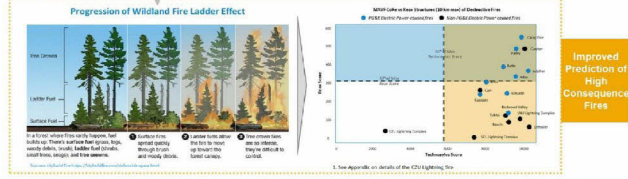
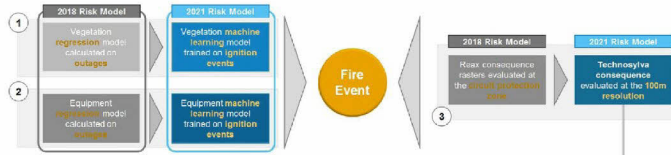
Consequence

Consequence considerations focused on the potential impact of a wildfire



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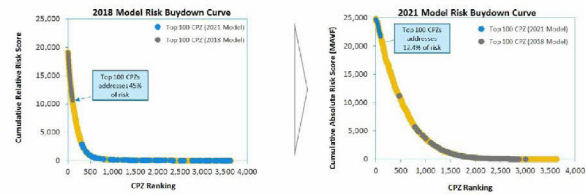
Enhancements implemented in 2021 Wildfire Risk Models



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Risk models provide risk buydown curves to guide workplan

The risk buydown curve shows *the amount of risk that can be addressed* with every subsequent mile within a Circuit Section (or referenced as Circuit Protection Zone, CPZ) that is mitigated. This view illustrates the relative magnitude of risk associated with the top 100 CPZs and the visualization highlights the consolidation of risk by CPZ as you move down the prioritization list.



Equipment (Conductor) Risk Buydown curves highlight the significant shift of where the top 100 CPZ's are between the two models primarily as a result of the shift in the consequence model

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Additional data and local field Information informs the workplan

EVM Workplan

- Vegetation Risk Model Segment Ranking determines the initial workplan
- LIDAR data on strike potential trees spanning the 25,000 miles of High Fire Threat Districts adjusts the plan
- Final identified list of EVM miles to be worked in 2021 are being checked by Public Safety Specialists for final confirmation

System Hardening Workplan

- Equipment Risk Model Segment Ranking determines the initial workplan
- Project by project review ensures appropriate mitigation method is selected
- Projects and mitigation selection are reviewed for effectiveness at reducing PSPS events
- Final identified list of System Hardening projects to be worked in 2021 are being checked by Public Safety Specialists for final confirmation

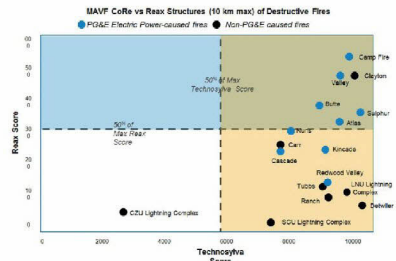
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Appendix

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Technosylva more accurately predicts high consequence fires as having high risk

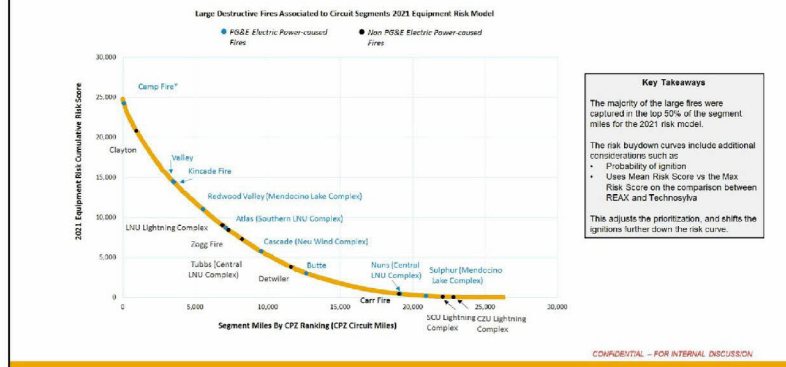
Technosylva based wildfire consequence data better identifies historical destructive fire locations



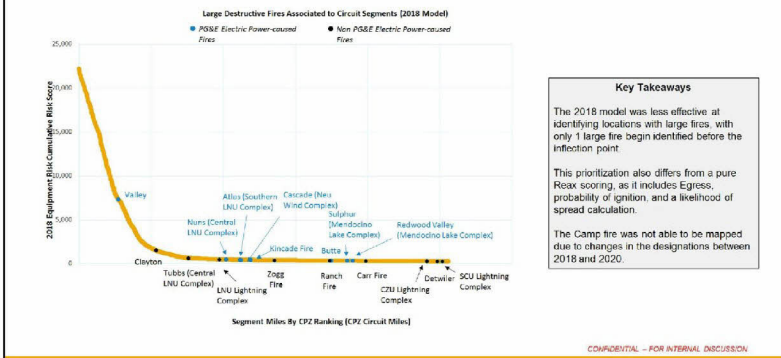
Fire Name	Cause	Circle Segment Name
Bull	Electrical Power	Bicota 11010CB
Valley	Electrical Power	Medetown 1101464G
Clayton	Arson	Highlands 110302E
Delaware	Shooting	Raker Valley 21011000D
Cascade (New Wind Complex)	Electrical Power	Bangor 1101195B
Tukey Central LNU Complex	Private Electrical System	Calistoga 11011734
Ranchwood Valley (Mendocino Lake Complex)	Electrical Power	Capella 1101542
Nuro (Central LNU Complex)	Electrical Power	Dunbar 110147964
Atlas (Southern LNU Complex)	Electrical Power	Pueblo 11041354
Sagehen (Mendocino Lake Complex)	Electrical Power	Redbud 11010CB
Cam	Vehicle	French Gulch 11021452
Ranch Fire (Mendocino Complex)	Human	Raker Valley PH 11051904
Camp Fire	Electrical Power	Circle 1101546590
Kingside Fire	Electrical Power	Capita 11440CB
Sagehen Lightning Complex	Lightning / Liner Investigation	Wesley 110207022
LNU Lightning Complex	Lightning	Shields 2102489B
CZU Lightning Complex	Lightning	Point Moorh 110112122

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Large destructive fires plotted on the 2021 equipment risk buydown curve



Where do the High Consequence Fires show up on the Risk Buydown Curve



CZU Lightning Complex Fire



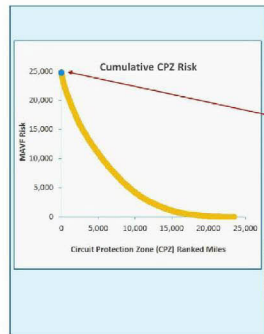
Fire Description and Observations

- The wildfires started at 6:41 AM on August 16, 2020 and was the result of a thunderstorm that produced close to **11,000 bolts of lightning** and started **hundreds of fires** throughout California.
- The lightning strikes initially started fires separately known as the Warnella Fire near Davenport and the Waddell Fire, near Waddell Creek, as well as three fires on what would become the northern edge of the CZU Complex fire.
- Two days after the fires began, a change in wind conditions caused these three northern fires to **rapidly expand and merge**, growing quickly to over 40,000 acres.
- This was not one fire but a **merging of small fires into one massive fire**. Our current **consequence models focus on potential fires growing from one ignition point** as compared to simulating the fire behavior of multiple ignition points combining into one fire.
- The modeling complexity of this wildfire is such that it would require taking into account the **hundreds of fires** that were started rather than treating this as a single wildfire.
- Also, the focus of our **consequence model evaluates the potential ignition points from our overhead electric distribution circuits** in HFTDs and several of the ignition points for this fire occurred where none of our assets existed.



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The top 50 highest risk-miles represent 1.4% of the total risk



Protection Zone Name	Miles	Cumulative Miles	Mean MAVF Score	Total CPZ MAVF	% total risk reduced
OREGON TRAIL	0.02	0.02	3.16	3.16	0.01%
CALPINE	0.01	0.03	1.88	1.88	0.01%
MARIPOSA	0.08	0.12	1.89	1.89	0.02%
SHIPPEN	0.01	0.13	1.44	1.44	0.02%
MIDDLETON	0.05	0.18	1.30	5.20	0.03%
UPPER LA	1.00	1.17	1.26	3.77	0.04%
KESWICK	6.66	7.83	1.25	48.04	0.17%
MIDDLETON	4.21	12.04	0.92	48.56	0.29%
110230281	5.61	17.65	0.88	51.70	0.42%
KONOCTI	0.64	18.29	0.77	13.03	0.44%
MARIPOSA	4.29	22.58	0.73	9.55	0.47%
BLUCKS CR	0.09	22.67	0.73	2.19	0.47%
DELMAR	0.42	23.08	0.72	8.72	0.49%
MIDDLETON	24.80	47.88	0.72	151.83	0.87%

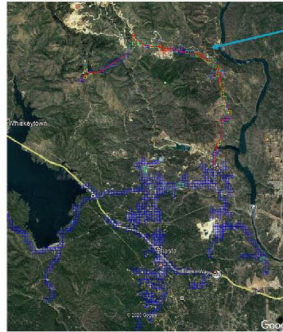
*Based on assuming an OH hardening risk mitigation (82% risk reduction effectiveness)

Key Takeaway

On each project a more granular risk spend efficiency evaluation will be performed on an NPV basis (total cost of ownership for the asset life) once the project is fully scoped similar to what is shown on the Keswick circuit protection zone on the next slide.

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Project Example: Keswick [REDACTED] Circuit Protection Zone



Keswick [REDACTED] Circuit Protection Zone

- 6.8 Miles in total, the 100m X 100m grid points are the absolute risk values for each section of this protection zone
- The total protection zone absolute risk score is 48.84 risk units (sum of all the 100m grid points along the circuit)
- Average risk score of all the grid points results in the CPZ mean risk score of 1.26

Network (B.R. Miles)	No System Hardening	Overhead Hardening	Under-grounding	50%-50% OH / UG
Total CPZ Risk Reduced After Mitigation	0	30.28	48.35	39.32
Total CPZ Residual Risk Value	48.84	18.56	0.49	8.52
Overall Miles Mitigated	0.0	6.6	6.6	6.6
OH System Hardening	[REDACTED] miles			
UG System Hardening	[REDACTED] miles			
Total Capital Cost	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
Average O&M Cost (per year)	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
NPV @ 7% discount rate	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
\$ NPV per unit of risk (\$/r)	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
Estimated Time to Complete		12 mos.	24 mos.	38 mos.

Assumptions:

- Discount Rate: 7%, Cost Escalation / Inflation: 3%
- Benefit Duration: 30 years for OH and 60 for UG
- Routine Tree Care: 1 Mile = \$6.2k
- FS&PS Cost of Reenergizing: [REDACTED] / mile
- Patrols and Inspections: [REDACTED] / mile for OH and [REDACTED] / mile for UG

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