PG&E WILDFIRE RISK MODELING

FEBRUARY 24, 2021

Safety

Earthquake

Duck, Cover, & Hold

Emergency Plan & Exit Strategy

Have a plan for yourself and your household

24/7 Nurse Care Line

If you experience a work-related discomfort or injury, call [redacted] and notify your supervisor.

Wash your hands!

Wear a Mask

Practice social Distancing

California can stop the spread

Add your phone today to California's exposure notification system

iPhone | Google Play

https://canotify.ca.gov/

Meeting Agenda

Date:	February 24, 2021
Desired Outcomes:	• Operational Observer gains an in depth understanding of the 2021 Wildfire Distribution Risk model. • Specifically, the MaxEnt algorithm and application of the Technosylva wildfire simulation, the predictive power of the models and how model views can be used to provide insights for the development of wildfire mitigation workplans.

Meeting Agenda

	What - Content	Who - Facilitator(s)	Slide(s)	Duration
1	Review Safety and meeting objectives			
2	Modeling objectives and methodology			
4	Ignition Probability Deep Dive			
5	Wildfire Consequence – Application of Technosylva			
6	Model Views			

Modeling Objectives and Methodology

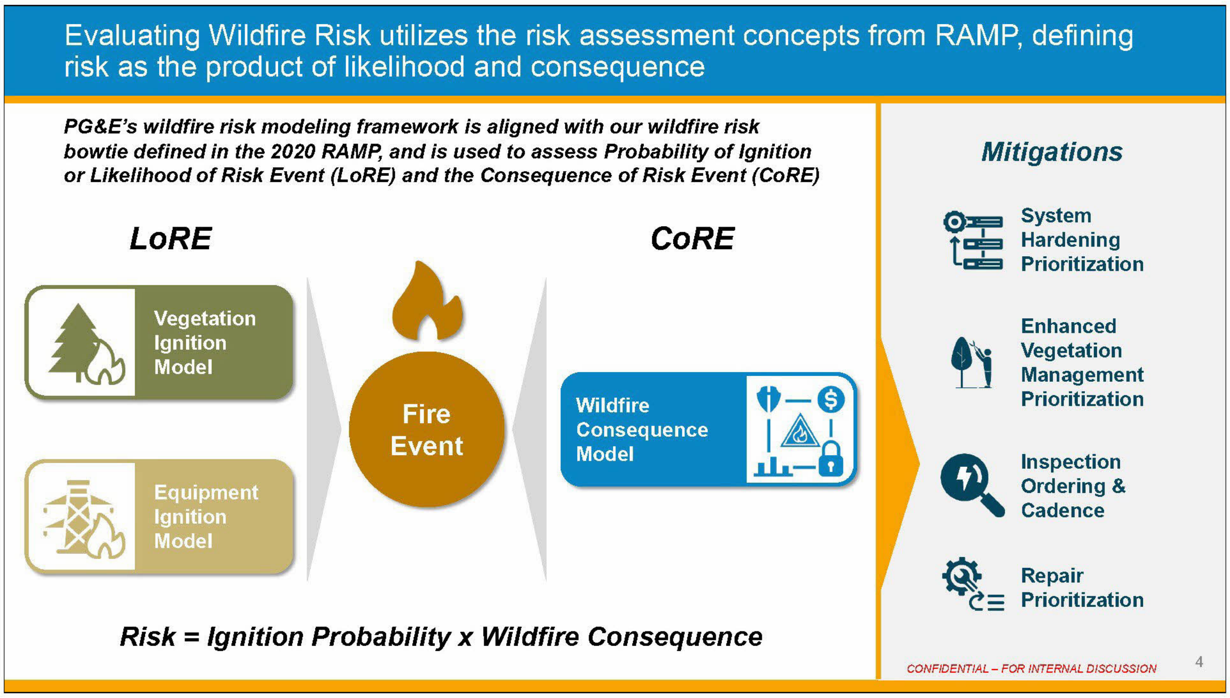
Risk Data and Analytics Team Objectives

(1) Provide situational awareness of risk,

(2) Enable risk-informed decisions making, and

(3) Enable PG&E to develop line-of-sight on risk reductions from wildfire risk mitigation initiatives

As outlined in the model documentation, approach these objectives through a systematic methodology


Evaluating Wildfire Risk utilizes the risk assessment concepts from RAMP, defining risk as the product of likelihood and consequence
PG&E's wildfire risk modeling framework is aligned with our wildfire risk bowtie defined in the 2020 RAMP, and is used to assess Probability of Ignition or Likelihood of Risk Event (LoRE) and the Consequence of Risk Event (CoRE)
LoRE
CoRE
Vegetation Ignition Model
Equipment Ignition Model
Fire Event
Wildfire Consequence Model
Risk = Ignition Probability x Wildfire Consequence
Mitigations
System Hardening Prioritization
Enhanced Vegetation Management Prioritization
Inspection Ordering & Cadence
Repair Prioritization
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Ignition Modeling Approach using MaxEnt

MODEL DETAIL

Methodology

- Divide Ignition Events into distinct categories of Vegetative or Conductor Caused
- Make vegetative or conductor ignition predictions with MaxEnt model at a scale of 100m x 100m "pixels" along the Dx grid
- Rolls-up pixels to Circuit Protection Zones
- For each pixel, assign risk score based upon the product of: LoRE X CoRE

Approach

- Use MaxEnt model technique due to its ability to predict rare and unique events in a given region and their probability of occurring both geospatially and under aggregated weather conditions
- Ignition probabilities calculated every 100m along conductor lines and then assigned to a pixel along Dx grid
- Ignition probabilities are combined with consequence (CORE) to determine overall risk

Ignition Probability

Likelihood:
via ignition prediction (Max Entropy)

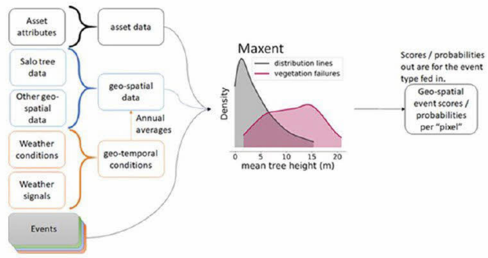
Effect: via :
(1) Ignition spread (Technolylva)
(2) Ignition consequence (Technolylva)

MAX ENT MODEL

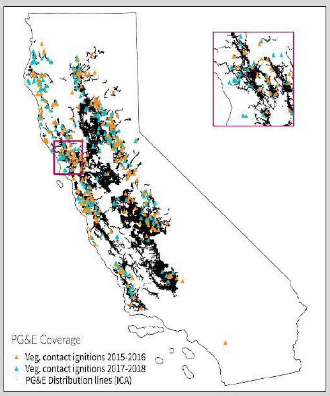
Training:
On reportable California Public Utilities Commission (CPUC) Ignition Events and related geospatial and temporal weather data

Vegetative/Conductor Ignition Model:
Two models were developed based on two specific risk mitigation priorities and their associated, relevant risk drivers – EVM and SH

Ignition likelihood:
The likelihood of ignition in 100m x 100m pixels determined by either Vegetative or Conductor



Maximum Entropy (MaxEnt) Approach



Locations and characteristics of areas where ignitions occur are collected and compiled

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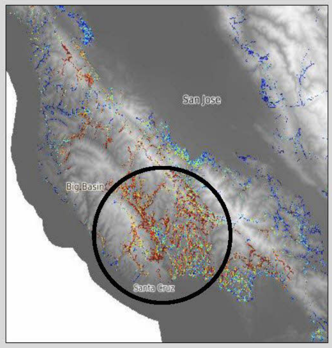

Similarities between the conditions at ignition points are identified, and evaluated for commonality

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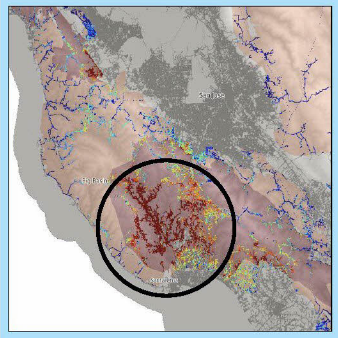


Places where there are similar conditions across the examined area are given a probability of the event occurring based on similarity to other ignition locations and a level of uncertainty

Identifying the right data

Covariate	Category	Source	Spatial resolution
100 hour fuels	Meterological data	gridMET	~4km
1000 hour fuels	Meterological data	gridMET	~4km
Burn index	Meterological data	gridMET	~4km
Energy release	Meterological data	gridMET	~4km
Precipitation average	Meterological data	gridMET	~4km
Specific humidity	Meterological data	gridMET	~4km
Vapor pressure deficit avg	Meterological data	gridMET	~4km
Temperature max average	Meterological data	gridMET	~4km
Wind avg	Meterological data	RTMA	~2.5km
Wind max	Meterological data	RTMA	~2.5km
Windy summer day pct	Meterological data	RTMA	~2.5km
Gusty summer day pct	Meterological data	RTMA	~2.5km
Tree height max	Tree data	Salo Sciences	100m
Tree height average	Tree data	Salo Sciences	100m
Impervious	Surface condition	NLCD	100m
Unburnable Location	Surface condition	LANDFIRE 2016	100m
Local topography	Surface condition	NED Database	100m
Age	Asset data	EDGIS Conductors	100m
Materials	Asset data	EDGIS Conductors	100m
Size	Asset data	EDGIS Conductors	100m
Splice count	Asset data	EDGIS Conductors	100m
Coastal indicator	Asset data	EDGIS Conductors	100m

Key Takeaways

- *Potential drivers of ignition probability were identified and collected to improve the model efficacy*
- *Data sources with reliable and consistent information were identified for key factors for the analysis to maintain high input quality*
- *Temporal and Geospatial data was required to accurately investigate the various conditions that exist in PG&E operational region*
- *Where data was limited, such as portions of asset condition, proxies like age and material were used*
- *All data was validated and missing or incomplete datasets were assed and mitigated*

Right side overall impression about data Left side all the covariates

Pool A

Had outside vendors look at all of California to get data that could potentially impact fire behavior

How data was obtained

Consequence Approach

MODEL DETAIL

Methodology

- Understand how a fire spreads in varying weather conditions and environments along PG&E resources
- Results tied back to Ramp model with MAVF Scores
- Predict Fire spread along all HFTD assets with an ignition event

Approach

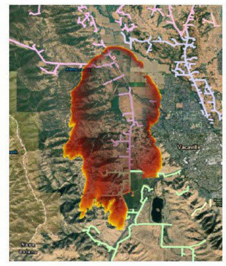
- Fire Spread simulations conducted at regular intervals along assets in HFTDs
- Utilize Technosylva Firesim – an industry standard for fire burn simulations taking into account environment and weather effects
- Consult with Fire Experts to review results

Ignition Probability

Spread: via 8 hour burn simulation (Technosylva Firesim)
Effect: via…
(1) Ignition Spread (Technosylva Firesim Acres Burned)
(2) Rate of Spread (Technosylva Firesim FBI)
(3) Burn Intensity (Technosylva Firesim FBI)
(4) Buildings Impacted (Technosylva Firesim Structures Impacted)

TECHNOSYLVA BURN SIMULATION

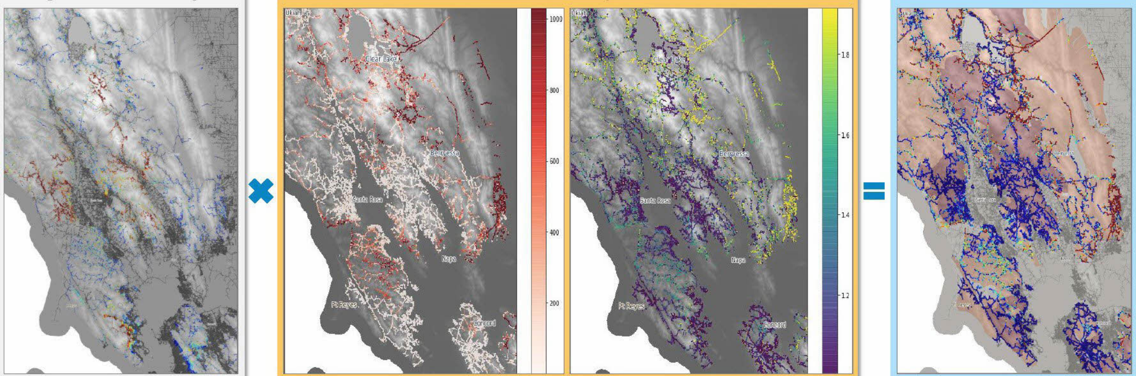
- Technosylva simulation of 8-hour burn every 200m along HFTD lines
- Simulations conducted with weather data from 452 worst historical fire weather days
- Outputs key consequence metrics: acres burned, population and structures impacted, and fire behavior index (FBI)
- FBI score based no flame length (burn intensity metric) and rate of spread (ROS)



FBI Class		Description
1	LOW	Fire will burn and will spread however it presents very little resistance to control and direct attack with firefighters is possible.
2	MODERATE	Fire spreads rapidly presenting moderate resistance to control but can be countered with direct attack by firefighters.
3	ACTIVE	Fire spreads very rapidly presenting substantial resistance to control. Direct attack with firefighters must be supplemented with equipment and/or air support.
4	VERY ACTIVE	Fire spreads very rapidly presenting extreme resistance to control. Indirect attack may be effective. Safety of firefighters in the area becomes a concern.
5	EXTREME	Fire spreads very rapidly presenting extreme resistance to control. Any form of attack will probably not be effective. Safety of firefighters in the area is of critical concern.

Creating a Risk Score

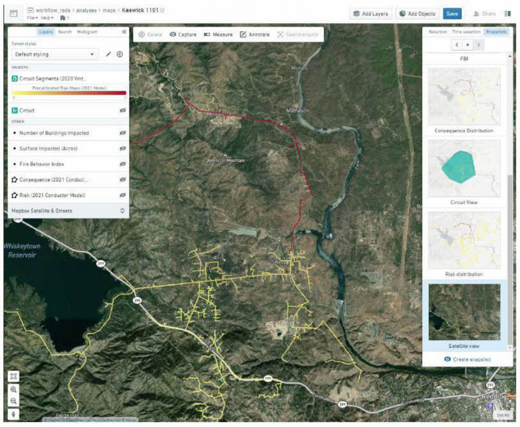
Ignition Probability | **Wildfire Consequence** | **Risk Score**



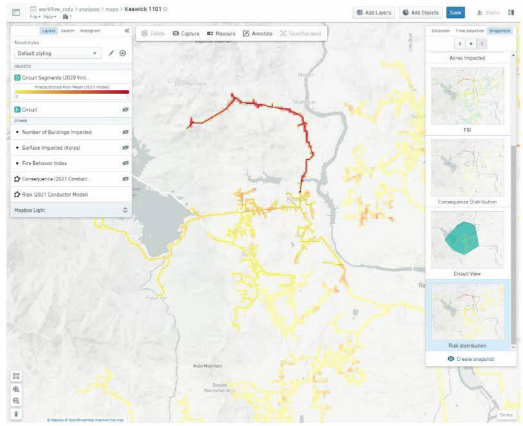
Probability of Ignition (Red High, Blue is Low) | Technosylva Burn Area Consequence | Technosylva Fire Behavior Index | Risk Units (MAVF) (Red High, Blue Low)

Risk = Ignition Probability x Wildfire Consequence

Model Visualization and Application



Circuit Segment View



Risk Pixel View

Future Model Enhancements

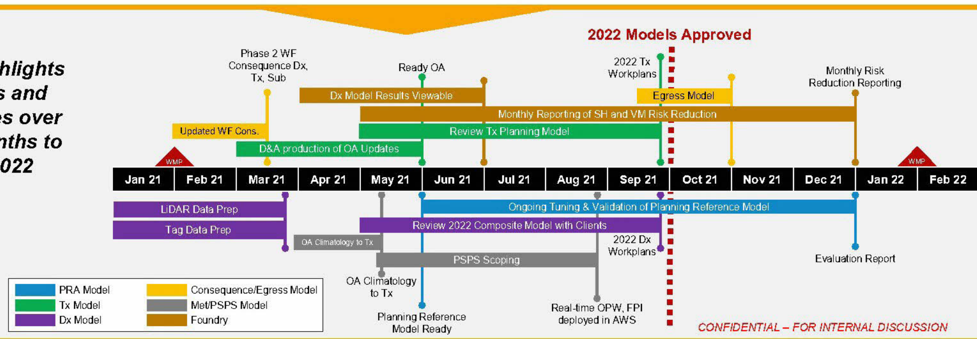
2018
- Senate Bill 901 outlines the process for filing the wildfire mitigation plan
- Safety model assessment proceeding (SMAP) provides guidance on how risk should be assessed
- SME opinion informs system hardening and mitigation decisions
- Initial risk modeling approach developed

2019
- Outage models are enhanced with random forest models to act as a proxy for ignitions
- Consequence model is enhanced with information from Reax Engineering

2020
- Enhanced Vegetation Model is enhanced with Maximum Entropy approach predicting ignitions
- Conductor model is enhanced with Maximum Entropy approach predicting ignitions
- Consequence is enhanced utilizing Technosylva to provide increased understanding of consequence

2021 +
- Incorporate additional data sources such as Vegetation LIDAR, EC Tag information
- Combined model for all ignition sources in development
- Additional consequence metrics (egress, population) considered for inclusion
- Additional granularity considered for model outputs

This timeline highlights key capabilities and model milestones over the next 12+ months to develop the 2022 models



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APPENDIX

Evolution of Risk Assessment and Modeling

2017 RAMP/ 2020 GRC

- First Generation RAMP Model using Probabilistic Modeling and Monte Carlo Simulation
- Multi Attribute Risk Score (MARS) & Risk Spend Efficiency (RSE)
- High Fire Threat Districts Definition

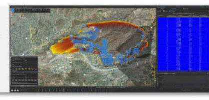
2019 WMP

- Community Wildfire Safety Program
- Enhanced Wildfire Safety Inspection Program
- Ignition Analysis for Distribution & Transmission Voltage Classes

- Initial Fire Propagation Modeling (Reax)
- First-of-a-Kind Circuit Prioritization Models for System Hardening & Enhanced Vegetation Management Programs

2020 WMP

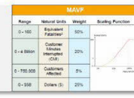
- Enhanced VM & SH
- Asset Inspection and Repair
- System Automation
- PSPS Improvements



- Improved Meteorology
- Inclusion of initial Egress methodology
- Fire Risk Model interaction between Outage Producing Winds (OPW) & Fire Potential Index (FPI)

2020 RAMP

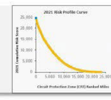
- Second Generation RAMP Model using Python
- Enhanced Multi Attribute Value Function (MAVF) in accordance with SMAP Settlement Agreement



- Enhanced Bowtie with Sub-drivers and Outcomes
- Exposure and Tranching performed various levels of granularity

2021 WMP

- Enhanced Risk Assessment and Prioritization Models for SH and EVM using:
  - — Probability of Ignition
  - — Fire Propagation & Consequence
- Risk Assessed at 100m grid-squares and aggregated to Circuit Segments



The information from the Technosylva fire simulations feeds the destructive fire probability calculations and ultimate risk score

Technosylva FireSim Results

Ignition Simulation #	Acres Burned	Buildings Destroyed	FBI Score		Destructive Fire Designation: True	Destructive Fire Designation: False
1	400	45	3	=	1	0
2	600	23	2		1	0
3	550	75	1		0	1
. . .	. . .	. . .	. . .		. . .	. . .
452	300	40	1		0	1
				Subtotal	85	340
				Destructive Probability	20%	

A fire simulation is considered destructive if:

Acres Burned > 300 **AND**
Buildings Impacted > 50 **AND**
FBI > 2

OR FBI > 3

Key Takeaways

- The Destructive Fire Probability takes into account multiple factors and outcomes from fire simulations and creates a singular usable score
- Probability scoring for destructive and catastrophic fires allow for the calibration of the outcomes to RAMP values for easier comparison to other risks