San Diego Gas & Electric

Wildfire Risk Modeling Workplan

October 13, 2021

Introduction

On September 29, 2021, the Office of Energy Infrastructure Safety (OEIS) issued guidance for the risk modeling working group which will focus on facilitating risk modeling alignment across the California utilities. The guidance requested additional details on each utility's risk modeling efforts to supplement the information provided during the utilities' presentations held during the October 5 – 6 risk modeling workshops. SDG&E provides its report herein, but respectfully emphasizes the very short period allotted for preparation. As evidenced at the workshop, risk modeling is a complex and technical process that requires time and thought. As such, this report represents SDG&E's efforts to respond to the requested information within the timeframe given as it relates to the 5 models covered during SDG&E's presentation, but SDG&E looks forward to the opportunity to continue to supplement its data as necessary. SDG&E's report is organized as follows:

- Section 1: Data used broken down by model
- Section 2: Model descriptions for ignition, consequence, and PSPS models
- Section 3: How model outputs are analyzed and utilized for each model
- Section 4: Description of any collaborations previously undertaken among the utilities, as well as details on consistency across utilities
- Section 5: Description of any collaborations previously undertaken and/or ongoing with other entities
- Section 6: Anticipated changes to any of the models between now and the 2022 WMP Update
- Section 7: Attachments of any internal or third-party validations completed, and description of any peer review utilized

Description of the 5 models presented during the workshop:

- Enterprise model: Multi-attribute value framework model, with weights and scales that allows for comparable risk scoring, Monte Carlo simulation for wildfire risk
- WiNGS: Multi-attribute value framework with weights and scales that allows for comparable risk scoring at the sub-circuit/segment level to inform its investment decisions by determining which initiatives provide the greatest benefit per dollar spent in reducing both wildfire risk and PSPS impact.
- CRI: Linear regression model predicts likelihood of conductor failure and likelihood of ignition given a failure. This model quantifies the conductor risk based on conductor type, conductor size, location, as well as other factors for a segment as a function of wind gusts.
- VRI: Relative model that compares and ranks vegetation risk across polygons tied to weather stations
- WiNGS-Ops: Multi-attribute value framework model with weights and scales that allows for comparable risk scoring, while leveraging linear regression modeling capability. This model

quantifies wildfire and PSPS risk and provides a range of wind gusts where fire risk is likely greater than the PSPS risk.

Section 1: Data used broken down by model:

Data Usage	Enterprise Model	WiNGS	CRI	VRI	WiNGS-Ops
Scale and geographical context	System-wide: San Diego County and South Orange County	High Fire Threat District: Tier's 2 and 3, as well as Wildland Urban Interface (WUI) boundary	System wide: San Diego County and South Orange County	HFTD and WUI	System-wide Electrical Distribution territories within San Diego County and South Orange County
Topography	HFTD and Non-HFTD Assessment of risk	HFTD and WUI wildfire (WF) and PSPS risk mitigation	Span and Segment level evaluation of severe wildfire type weather conditions, define wind thresholds when power needs to be shut off.	Taken into consideration by SMEs when developing polygons	Span/Pole and aggregated segment level evaluation of severe wildfire type weather conditions, define wind thresholds when power would be recommended to be shut off. Balance between PSPS and WF risk.
Quality of historical outage, fault, and ignition data	Outage Data: Good Historical reportable ignition data: Fair	Ignition Data: Fair Fault and ignition data: N/A	Outage/fault data: Good Weather data: Good Ignition data: Fair	Outage and vegetation data: Good. Fault and ignition data: N/A	Outage/fault data: Good Weather data: Good Ignition Data: Fair
Usage of outage and fault events to augment ignition data[1]	N/A	N/A	N/A	N/A	N/A

[1] SDG&E uses both outage and ignition data to predict ignitions in the CRI and WiNGS-Ops model. SDG&E maps ignitions to outages along with other datasets to better understand causes and circumstances surrounding ignition events.

Data Usage	Enterprise Model	WiNGS	CRI	VRI	WiNGS-Ops
Integration of potential ignitions avoided due to PSPS events (to account for bias in ignition data post during PSPS events)	N/A	N/A	N/A	N/A	N/A
Asset data (including asset age, health, inspection results, type, etc.)	Asset data used to account for system hardening.	Inputs: hardening state, pole age, conductor age, conductor lengths Source: Electric GIS database	Inputs: Primary Overhead Conductor (spans). Attributes include wire type, size, material, and more. Source: Electric GIS database and the Enterprise Asset Management Program reporting database (EAMP_REP)	N/A	Inputs: Primary Overhead Conductor (spans) and structures (poles). Attributes include wire type, size, material, and more. Source: Electric GIS database AND EAMP_Rep database
Impacts of system hardening and other initiative efforts	Impacted changes from historic likelihoods for wildfire risk	Impacts of mitigation are calculated based on risk scores of existing undergrounded and covered conductor	Characteristics of hardening projects are reflected in the wire attributes	Undergrounding may change polygon	Impacts of hardening initiatives are reflected in the Overhead Structure and Overhead Conductor asset attributes
Climate conditions (including historical wind conditions, relative humidity, temperature, etc.)	Climate conditions considered for the likelihood of ignition for wildfire risk	Max wind gust based on nearest/most relevant weather station	Historical/current weather and rainfall data as well as historical forecasts being utilized as inputs in the model	VRI polygons associated to weather stations	Historical/current weather and rainfall data as well as historical forecasts being utilized as inputs in the model

Data Usage	Enterprise Model	WiNGS	CRI	VRI	WiNGS-Ops
Vegetation (including type, density, height, etc.)	Vegetation is considered in the granular bottoms up approach to find failure and ignition rates.	Tree Strike count and length per segment	Vegetation and foreign contact are not included in this analysis	Inventory tree database- species, height	Number of Trees Source: PowerWorkz
Fuel characteristics (including load, size, continuity, vertical arrangement, moisture, etc.)	N/A	Fuel is integrated into WRRM conditional impact score	Fuel map used for predicting potential ignitions based on type of fuels	N/A	Fuel map used for predicting potential ignitions based on type of fuels as well as in the WRRM conditional impact score
Impacts of Routine and Enhanced vegetation management activities (including tree-trimming, tree-removal, inspections, etc.)	N/A	Impacts are reflected within ongoing Tree Strike data updates	Not included	May change VRI score	N/A
Frequency of updates to datasets and inputs, including any associated triggers to determine the need for updates	Annually	Quarterly	Daily	Annually	Daily
Accuracy and quality checks for data and inputs	QC process enacted prior to release	QC process enacted prior to release	Code-based automated tests	Conducted during annual updates	Code-based automated tests

Section 2: Model descriptions for ignition, consequence, and PSPS models:

Note: These algorithms and model details are based on current status but may change as model development continues to evolve based on new data and techniques.

Model Descriptions	Enterprise Model	WiNGS	CRI	VRI	WiNGS-Ops
Algorithms used and machine learning capabilities	Multi-Attribute Value Function (MAVF) framework for WF and PSPS Risk Score calculations	Multi-Attribute Value Function (MAVF) framework for WF and PSPS Risk Score calculations	Multiple Linear Regression (MLR) Random Forest	Algorithm developed in-house	Multiple algorithms utilized (e.g. Random Forest, XGBoost, Multiple Linear Regression, etc.)
Impact of climate change	Climate change considered for the likelihood of ignition for wildfire risk	Climate change is reflected based on enterprise model	N/A	N/A	N/A
Ingress and egress	N/A	N/A	N/A	N/A	N/A

Model Descriptions	Enterprise Model	WiNGS	CRI	VRI	WiNGS-Ops
Modeling components, linkages, and interdependencies	N/A	Inputs include complex electric GIS queries, SME meteorological input, consultant driven tree strike and WRRM GIS analyses	Failure Rate per Mile is dependent on Wind Gust, Wind Direction, Conductor Type, Elevation, and District. Span level probability is aggregated to segment assuming a constant probability of ignition and consequence	Vegetation-related linkages and interdependencies	Calculated span/pole level WF Risk is dependent on various data inputs from multiple failure mode models, including wire down, animal contact, vehicle contact, and others. Data inputs are varied and include Wind Gust, Wind Direction, Pole Age, Pole Material, Fuel density, etc. PSPS Risk is calculated at the segment level, utilizing data inputs such as downstream customer counts, customer types, average PSPS duration, and others.

Model Descriptions	Enterprise Model	WiNGS	CRI	VRI	WiNGS-Ops
Weight of each data components and inputs	MAVF Framework Weights: Safety: Index 0 – 20, Weight 60% Reliability: Index 0 – 1, Weight 23% Financial: Index $0 - 500M, Weight 15% Stakeholder Satisfaction: Index 0-100, Weight 2%	MAVF Framework Weights: Safety: Index 0 – 20, Weight 60% Reliability: Index 0 – 1, Weight 23% Financial: Index $0 - 500M, Weight 15% Stakeholder Satisfaction: Index 0-100, Weight 2%	N/A	Tree height and species weighted equally; historical outages weight doubled	MAVF Framework utilized for PSPS and Conditional Impact calculations Weights: Safety: Index 0 – 20, Weight 60% Reliability: Index 0 – 1, Weight 23% Financial: Index $0 - 500M, Weight 15% Stakeholder Satisfaction: Index 0-100, Weight 2%
Automatization implemented	N/A	Hybrid: manual and automated components. Model outputs calculated automatically with every data input refresh. Efforts underway to automate model in Python	Python workflow	Hybrid: manual and automated components	Python workflow
Frequency of updates to modeling, including the basis for updates	Approximately annually or as needed Basis: for filings, annual reporting needs, improvement opportunities etc.	Approximately annually or as needed in coordination with the Electrical System Hardening team's project scoping	Seasonally or as needed depending on weather conditions	SMEs review and update annually due to availability of new data and lessons learned	TBD – new model

Section 3: How model outputs are analyzed and utilized for each model:

Model Outputs	Enterprise Model	WiNGS	CRI	VRI	WiNGS-Ops
Confidences for each modeling component, including how such confidences were determined	N/A	N/A	PoF: 95% R^2 = 0.89 Based on OLS method PoI: Mean ROC AUC = 0.7 Based on 90/10 cross validation split	N/A	Builds on several models
Range of uncertainty for model outputs, including how those ranges are determined and how uncertainty is minimized	N/A	N/A	Range still being determined	Range still being determined through analysis by San Diego Supercomputing Center (SDSC)	Range still being determined
Systems used to verify the model outputs, including verifier (subject matter experts, third-party) and description of implementing lessons learned	SME	Electrical System Hardening (ESH) team's input and verification of model outputs is utilized. Feedback is utilized to help better inform model optimization and interpretability.	Subject matter expert review from Meteorology, Distribution Engineering, and Electric Regional Operations	Analysis through SDSC, subject matter expert collaboration to implement lessons learned	Subject matter expert review from Meteorology, Distribution Engineering, and Electric Regional Operations

Model Outputs	Enterprise Model	WiNGS	CRI	VRI	WiNGS-Ops
How uncertainty affects the interpretations of model outputs	N/A	Model outputs serve as base assessments of risks and optimal mitigations. Collaboration with the Electrical System Hardening (ESH) team is subsequently sought to consider additional factors not accounted for in the model, e.g. land right usage, mitigation feasibility, etc.	Uncertainty is implied in the recommended categorical H/M/L indices	TBD	Model output is used to help guide decision makers in making PSPS decisions in real-time, and are understood to represent a range of potential risk of wildfire vs PSPS comparisons, and not absolute predictions of outcomes
Determination of highest risk areas based on model outputs	N/A - System-level model	Utilizing Multi-Attribute Value Function (MAVF) framework for PSPS and WF risk at the segment, and subsequently circuit level.	Ranking of segments based on highest wind gust speed and conductor attributes	VRI polygons have different risk values (H/M/L)	Ranking of highest risk spans/poles, as well as aggregated highest risk segments.

Model Outputs	Enterprise Model	WiNGS	CRI	VRI	WiNGS-Ops
Use of subject matter expertise for inputs and further verification	Internal SME input considered	Electrical System Hardening (ESH) team's input and verification of model outputs is utilized	Meteorological input was greatly utilized to understand wind conditions and weather stations used to PSPS segments. Distribution Engineering expertise provided insight into PSPS operations and concerns.	Meteorology and Vegetation Management	Subject matter experts utilized include experts from Meteorology, Distribution Engineering, and Electric Regional Operations

Section 4: Description of any collaborations previously undertaken among the utilities, as well as details on consistency across utilities:

As described in SDG&E's October 5 – 6 workshop presentation, SDG&E, PG&E and SCE have conducted several benchmarking meetings covering various topics including risk modeling. See SDG&E's October 5-6 workshop presentation, slide 38:

- Since the 2019 WMP process, SCE, PG&E and SDG&E have conducted wildfire-related benchmarking sessions on various topics, including risk modeling, mitigation effectiveness, vegetation management activities, and PSPS operations.
- PG&E, SCE and SDG&E collaborated on at least 10 occasions in 2021 on risk assessment and modeling alignment opportunities.
- IOUs have evaluated elements of risk modeling where near-term alignment could be achieved.
- Currently developing a common vision (end-state) for long-term alignment on risk modeling, while recognizing differences.

To answer additional questions posed by OEIS in their guidance for the risk modeling workplan:

- What modeling approaches are already consistent:
  - Utilities use Technosylva model for assessing wildfire consequences
  - Utilities are building POI Models for different assets and risk drivers
  - Utilities use similar concepts to develop their multi-attribute value frameworks for enterprise risk assessments
- Which modeling approaches have the potential for more consistency and how approaches would benefit from consistency:
  - Utilities are working on aligning types of data used in models
  - Utilities are working on aligning on granularity of modeling efforts where applicable
  - Consistency in data collection where feasible can further enable comparability (e.g. basic attributes, granularity and quality of attributes, etc.)
- Where consistency is infeasible or not necessary:
  - Standardization of predictive models may not be feasible due to differences in the topography of the land, service territory, different assets and data, granularity of risk, historical outage and ignition information as well as weather patterns.
  - Standardizing data collection methods could be difficult given differences in operations and capabilities

Section 5: Description of any collaborations previously undertaken and/or ongoing with other entities

SDG&E continues to partner and collaborate with the IOUs and other entities via various forums (conferences, meetings, workshops, etc.) to discuss risk modeling capabilities, best practices, and knowledge sharing. Examples of such collaborations include:

- Participation in the International Wildfire Risk Mitigation Consortium. This has been an international platform for sharing best practices and ideas with other utilities regarding the challenge of safe operations with increasing wildfire risk.
- Joint Utility PSPS Working Group for PSPS Operations which Includes increased focus on identifying and quantifying PSPS risks and weighing benefits against harm.
- Working to enhance wildfire risk modeling with San Jose State University, in partnership with Technosylva, by incorporating more accurate and higher resolution fuel moisture data

Section 6: Anticipated changes to any of the models between now and the 2022 WMP Update

SDG&E's team continues to work on:

- Development of machine learning probability of ignition models for different risk drivers
- Model refinement to perform more accurately with its predictive capability
- Migration of risk modeling to the cloud environment to enable more dynamic updates to the models
- Improvement and addition of new data variables
- Modeling automation
- Exploration of risk visualization tools to enhance monitoring and risk information sharing across the company

Section 7: Attachments of any internal or third-party validations completed, and description of any peer review utilized

SDG&E does not have any attachments to share regarding validation efforts. In lieu of that, the table below outlines validation approaches applied for each of the 5 models:

Enterprise Model	WiNGS	CRI	VRI	WiNGS-Ops
Accenture	Accenture	Internal validation	San Diego Supercomputing Center is reviewing and analyzing methodology, though there have been no publications to date	Internal validation, SMEs

--- End of Report ---