PACIFIC POWER
A DIVISION OF PACIFICORP

825 NE Multnomah, Suite 2000
Portland, Oregon 97232

October 13, 2021

VIA ELECTRONIC SUBMISSION

Office of Energy Infrastructure Safety
300 Capitol Mall, Suite 500
Sacramento, CA 95814
info@energysafety.ca.gov

Docket #Risk-Model-Group

RE: PacifiCorp's Report on Current Wildfire Risk Modeling Practices

PacifiCorp d/b/a Pacific Power hereby submits its Localized Risk Assessment Model Overview (the "LRAM Overview") in accordance with the Office of Energy Infrastructure Safety's Wildfire Risk Modeling Working Group Workplan Guidelines.

PacifiCorp requests that the LRAM Overview marked confidential is treated as confidential under § 29200 of the draft process and procedures regulations for the Office of Energy Infrastructure Safety.

Please direct any questions regarding this filing to Pooja Kishore, Regulatory Affairs Manager, at (503) 813-7314.

Sincerely,

Shelley McCoy

Shelley McCoy
Director, Regulation

LOCALIZED RISK ASSESSMENT MODEL OVERVIEW

1. Project Background and Description

The goal of the Localized Risk Assessment Model (LRAM) is to understand the relative risk of a utility caused ignition leading to a wildfire at each zone of protection (ZOP) in PacifiCorp's distribution network. A ZOP is defined as the circuitry from one protective device, like a recloser or a fuse, to any downstream protective device(s) (or the end of the line). In general, a ZOP is the smallest subcircuit that can be controlled either programmatically, automatically, or manually. Accordingly, it is the subcircuit unit appropriately used to calculate localized wildfire risk scores. Each ZOP has a unique risk profile which consists of the environmental risks (like drought frequency, wind normals, vegetation, etc.) and utility risks (like outage frequency, arc energy risk, ignition history, etc.), and it is the goal of the LRAM to integrate both risk dimensions mathematically and logically into a final combined relative risk score.[1] There are two main model components within the LRAM. First, there is the Environmental Risk Component, which can be thought of as the layers of risk analysis aimed at quantifying the consequence of a wildfire event; second, there is the Utility Risk Component, which can be thought of as the layers of risk analysis aimed at quantifying the relative risk of an ignition related to utility equipment. When the two components are combined, using the weighting methodology discussed below, a final Combined Risk Score is calculated for each individual ZOP. This approach aligns with the traditional definition of risk (probability times consequence), and, as such, it represents the total relative risk of a utility-related ignition leading to a wildfire at the ZOP. The individual relative risk sub-scores are all calculated on a 0-1 scale and are combined using rationalized weighting factors where the total weight is split evenly between utility and environmental risks.

The final Combined Risk Score and the sub-scores are calculated for all ZOP's and are used for both targeted mitigation tactics and for long term wildfire mitigation planning. Because of certain design goals, access limitations, and other factors not specifically calculated, a higher combined score does not necessarily mean that the ZOP will always receive priority over a ZOP with a lower risk score. For example, it would often not make sense to prioritize a ZOP for certain types of mitigation in one year if the same ZOP was scheduled for conversion to covered conductor in the following year. Ultimately the LRAM enables the company to have a more refined understanding of the unique risk profile at each ZOP, which in turn informs our wildfire mitigation strategy both long and short term. It is to be stressed that these risk measures are not

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[1] All of the risk scores used in this risk assessment are length independent, because the length of a ZOP should not influence relative risk. The length of a ZOP may influence other wildfire mitigation considerations, but, if needed, ZOP length is considered separately, outside of the LRAM.

probabilities but in fact relative risk scores which allow the company to rank the ZOPs among the different dimensions of risk quantified.

The individual model elements used in the LRAM are identified and summarized in Section 2 and in Table 1 in the Appendix; model validation and sub-layer weighting is discussed in Section 3; climate chance consideration is discussed in Section 4; and, finally PSPS modeling is discussed in section 4. More details and specifics regarding the use of LRAM can be found in PacifiCorp's 2020 Wildfire Mitigation Plan Update.

2. Model Elements

A. Circuit Topology

1. **Purpose of element** – Circuit topology is the company's base data which details the spatial locations of facilities and equipment. The circuit topology is broken up into zones of protection (ZOP) which are defined as a section of lines from one protective device to any downstream protective device(s) (or the end of the line).
2. **Relevant terms** – Standard GIS terminology.
3. **Data elements** – GIS Point and line features, USGS GAP/LANDFIRE National Terrestrial Ecosystems dataset, US Census Data.
4. **Methodology** – PacifiCorp's base topology data is managed and mapped by the companies' GIS department which updates records based on work orders. We also integrate many system variables like conductor type, spacing, phases, and other equipment related information. We additionally tie in factors like elevation, slope, USGS /GAP landcover classification, and census data into the circuitry.
5. **Timeline** – Data is refreshed and maintained daily.
6. **Application and results** – The ZOPs are the smallest unit of circuitry that can be controlled and is what we will be assigning risk scores to.

B. Historical Climate Modeled Probabilistic Fire Spread (iUTI)

1. **Purpose of element** – Identify a wildfire consequence measure from historic fire weather days which are used to simulate wildfire magnitudes from random ignitions.
2. **Relevant terms** – Anderson fuel model, Fosberg Fire Weather Index, ELMFIRE wildfire model.
3. **Data elements** – LANDFIRE fuel data, Anderson fuel models, weather reanalysis data.
4. **Methodology** – Randomly ignited cells modeled fire spread based upon historic fire weather days (where FFWI >50), model run for six hours of fire weather days, with volume of acres burned from modeled ignitions accumulated for each 20 m grid. Data evaluated by SMEs and inference drawn reelevated areas, upon which iUTI

was subsequently founded. This gridded raster dataset was overlaid on circuit ZOPs and length-weighted for the ZOP iUTI score between 0-01.

5. **Timeline** – Data analysis will be refreshed based on updates to LANDFIRE dataset. In addition, major changes to PacifiCorp asset locations would require a refresh in analysis.
6. **Application and results** – The simulated wildfires quantify the relative risk of a location being burned and serve as a proxy for long-term wildfire risk. These results have been integrated into the model.

C. Fire Weather Risk

1. **Purpose of model** – Create a normalized relative ranking for the fire weather risk at a zone of protection using recent historical gridded outputs. The main goal is to use the High Resolution Rapid Refresh (HRRR) model (3km resolution) to identify zones that have a high frequency of strong winds, high Fosberg, and frequent droughts (measured by KBDI). We can then combine the weather component with the fuel density as quantified by the LANDFIRE 2020 remap to identify locations that have a coincidence of frequent fire weather and abundant fuel to sustain large wildfires. We call this combination of the fuel density and Fire Weather Risk Score the Wildfire Risk Score (discussed in greater detail below).
2. **Relevant terms** – The High Resolution Rapid Refresh is a NOAA hourly real time 3-km resolved weather forecasting model.
3. **Data elements** - This layer is composed of calculated risk metrics from the HRRR weather forecasting model.
4. **Methodology** – The first goal is to obtain a localized and accurate weather history for each zone of protection. Historically we have relied on weather stations for this task, but for many locations across PacifiCorp the density of weather stations in our service territory is not high enough to enable sub-circuit analysis. To remediate this, we used the hourly HRRR 3km data which provides high quality historical weather throughout the United States. We then overlay the zones of protection over the HRRR data and extract the hourly wind speed, wind gust, precipitation, relative humidity, and temperature going back to 2016. From this we can extract most fire weather indices that are utilized in industry, and importantly the ones used at PacifiCorp: Fosberg & KBDI. We now have a detailed weather history for each zone of protection from which we just need to extract a ranking.
    a. There are many complicated ways to do this, but we went with a straightforward solution that is easily explainable – take the sum of the weather indices during the wildfire season at each location normalized by the number of years. This is essentially an average exposure to each weather variable per year at each ZOP and creates an easy way to rank them relatively. We then apply a min-max scaling to put all the exposure measures onto the same 0-1 scale. Now for each

zone of protection we have a measure of the wind gust, Fosberg, and KBDI intensity.

b. Now that we have all the pieces, we must now combine the weather scores to get the final Fire Weather Risk Score. We chose to do a simple linear combination of each sub-score multiplied by its own respective coefficient shown as:

$$Fire\ Weather\ Risk\ Score = \sum_{i}^{Layers} x_i c_i$$

where x_i is the relative ranking between 0-1 for each sublayer (Fosberg, KBDI, gust, and fuel) and c_i is the respective chosen coefficient to each variable. There is subjectivity in choosing the coefficients, and, after a few iterations involving expert judgement and looking at edge cases, we settled on all the weather variables having a coefficient of 1. This set of weights effectively highlights locations that are often windy, dry, and often experience drought.

5. **Timeline** – We plan on updating the Fire Weather Risk layer after each wildfire season is concluded. The metrics are calculated on a per year basis and as a result we can identify trends across our service territory as they emerge. Additionally, the company is working on obtaining a 30-year weather reanalysis dataset which will allow us to analyze historical weather at our circuits in a much more granular manner.

6. **Application and results** – Using the Fire Weather Risk Score, we can identify zones of protection that have a high frequency of fire weather. The Fire Weather Risk Score is also used an input in calculating the more comprehensive Wildfire Risk Score.

D. Wildfire Risk Score

1. **Purpose of model** – This layer is the combination of the Fire Weather Risk Score and the LANDFIRE 2020 Fuel Characteristic Classification System Fuelbeds (FCCS) dataset. The purpose of this layer is to identify the locations that have a coincidence of frequent fire weather with sufficient fuel to sustain a wildfire.

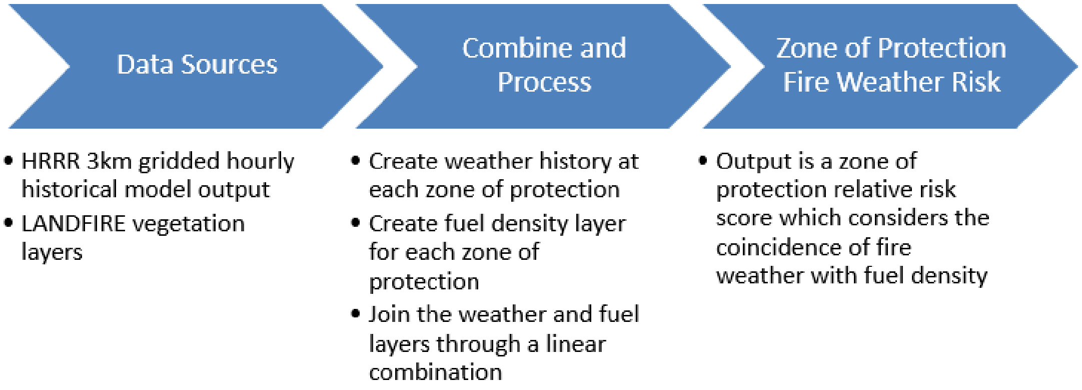
2. **Relevant terms** – Wildfire Risk, PSPS Risk, HRRR Weather Data.

3. **Data elements** - Fire Weather Risk Score, LANDFIRE Fuel Characteristic Classification System Fuelbeds.

4. **Methodology –** First the total available fuel density for combustion is obtained from the FCCS for each ZOP (average under the lines). Next the fuel densities are mapped to a 0-1 scale so that they can be joined with the Fire Weather Risk Score. We combine the two through a linear combination in an analogous method to the Fire Weather Risk Score calculation. Again, the weighting selection required expert judgement, and we settled on the Fire Weather Risk Score having a coefficient of 1 and the fuel component having a coefficient of 2. Thus, the fuel component has

~66% of the weight and the weather component has ~33%. If the fuel component is too small, the scores tend to highlight desert environments that are frequently hot dry and windy but lack the vegetation density which correlates with catastrophic wildfire. This set of weights is not final and is still a work in progress.

Figure 2-1: Outline of creating the Wildfire Risk layer.



- HRRR 3km gridded hourly historical model output
- LANDFIRE vegetation layers

- Create weather history at each zone of protection
- Create fuel density layer for each zone of protection
- Join the weather and fuel layers through a linear combination

- Output is a zone of protection relative risk score which considers the coincidence of fire weather with fuel density

5. **Timeline** – We plan on updating the Wildfire Risk Score after each wildfire season is concluded. The metrics are calculated on a per year basis and as a result we can identify trends across our service territory as they emerge.
6. **Application and results** – The Fire Weather Risk Score reflects the total risk of a wildfire ignition occurring in a given area. The Wildfire Risk Score is a part of the Environmental Risk Component and used as a core layer in calculating the Combined Risk Score for each ZOP.

E. Fire Area Score

1. **Purpose of element** – Identify the ZOPs which are in environments conducive to large wildfire growth.
2. **Relevant terms** – USGS Combined Wildfire Perimeters, Wildfire Frequency.
3. **Data elements** – USGS Combined Wildfire Perimeters, circuit topology.
4. **Methodology** – A 30-mile buffer was created for each ZOP in our service territory and intersected with the wildfire perimeters to tabulate the total acres burned within the buffer. The burned areas are then mapped to a 0-1 scale to create the Fire Area Score which is then used in the Environmental Risk Score.

   Large wildfire events are extremely complicated phenomena and highly dependent on the availability of fuel, weather (both short & long term), terrain, accessibility, and a variety of other factors. Instead of trying to model each one of those factors we are instead using the actual fire occurrence (as measured through burned acres) to identify the locations which are susceptible to these catastrophic events. This is of course an approximation to a very complex problem and this layer serves to highlight the locations where large wildfires are part of the environment.
5. **Timeline** – This layer will be updated after each wildfire season.

6. **Application and results** – The fire area layer has been integrated into the model and behaves as expected.

F. Tree Canopy Coverage

1. **Purpose of element** – Find locations with highest demands for vegetation maintenance by determining the extent of tree coverage along circuits and circuit segments. Additionally, this risk score serves as a proxy for fall in or blow in risk which could lead to an ignition event.
2. **Relevant terms** – Point layer: GIS layer consisting of individual points with location information and vegetation attributes.
3. **Data elements** – NLCD Tree Canopy coverage and internal distribution GIS data. NLCD data has 30m^2 resolution and extracted data layers maintain that resolution.
4. **Methodology** - A point layer was created from distribution line GIS files with 30m spacing. The point layer was clustered to avoid oversampling at line intersections. Data was extracted from the NLCD Tree Canopy Cover raster layer at each point, then aggregated per circuit or sub-circuit segment on a 0-1 scale. This provided distribution functions and statistical values for the tree canopy cover along each segment.
5. **Timeline** – Data analysis will be refreshed based on updates to the NLCD Canopy Cover Layer, which is anticipated at 3 to 5-year intervals. In addition, major changes to PacifiCorp asset locations would require a refresh in analysis.
6. **Application and results** – The tree canopy coverage layer has been integrated into the fire risk model. The model results have also been incorporated into vegetation trimming cost forecasts. Layer validation efforts compared coverage to historic vegetation outages and historic vegetation maintenance records. These showed weak, but non-negligible, correlations. Limitations from the NLCD data resolution and techniques result in lower accuracies in developed areas.

   In upcoming versions, additional elements will be combined with the tree canopy coverage layer to form a new vegetation score. These will include strike tree locations developed from remote sensing vegetation mapping (currently in pilot stage), and vegetation management activities from a newly implemented vegetation management field records collection system.

G. Utility Outage Rates

1. **Purpose of element** – Identify the ZOPs and circuits which have the highest relative ignition risk due to outages.
2. **Relevant terms** – PROSPER outage record database, CPUC Fire Incident Data**.**
3. **Data elements** – Historic outage records, circuit topology, CPUC Fire Incident Data.

4. **Methodology** – PacifiCorp records outages in our PROSPER database which has direct and contributory cause categories. We are calculating outage rates for five major categories: vegetation, equipment failure, animal, interference, and other. The first step in this process is to calculate length normalized outage rates for each circuit for each of these five categories. With these outage rates in hand, we then map them to a 0-1 distribution just like the other risk layers, and at this point we are now able to rank the circuits based on their outage rates.

   The final step is to identify their relative weighting of each of these outage risk scores in the Combined Score. While we have a rich outage database the same cannot be said for our ignition database, and as a result, we are not able to draw significant statistical correlations between outages and ignitions with our data alone. To remediate this issue, we are going to incorporate the CPUC Fire Incident Data to identify the relative proportion of ignitions counted in each of the five outage categories. While this is not a perfect solution, it gives us an approximation of the ignition risk by outage category and serves as a basis for the weights for each outage risk layer in the Combined Score.

5. **Timeline** – The outage rates will be updated annually, with an expectation that wildfire mitigation initiatives, particularly grid hardening efforts, will continue to positively impact outage rates.
6. **Application and results** – Outage rates in each of the five categories normalized by line length have been incorporated into the risk model.

H. Available Probabilistic Arc Energy Risk

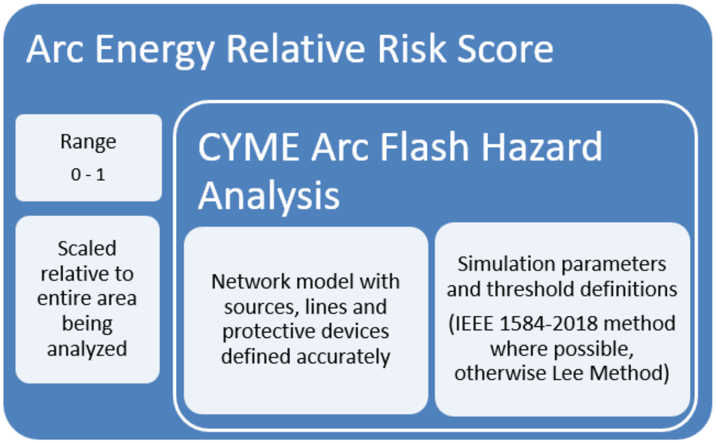
1. **Purpose of model** – The layer uses simulations of the distribution system model to arrive at arc energy values for studied locations. Higher arc energy from short circuit events is associated with an increased risk of ignition. Arc energy is calculated from the available fault current (amps) and the time required for a protective device to clear the fault event. Available fault current varies across the system due circuit topology, length, and materials used. Line sections, and ultimately protective zones and circuits, were scored based on arc energy values and line length (exposure). The score is a gauge of relative ignition risk and can be used for the purpose of identifying locations where system improvements or operational changes can be proposed to reduce said ignition risk.
2. **Relevant terms**
   - Arc flash analysis**:** Any of several engineering methods (IEEE 1584, NFPA-70E, CSA Z462, Lee Method, Wilkins Method) used to analyze electrical safety in power systems. The methods typically use heat transfer models, heat flux calculations and/or prescribed tables to assess risk level and help determine adequate safety procedures. A variety of parameters, including source impedance, equipment type, equipment location and clearing device are used to calculate total energy from an arc associated with a short circuit event.

- CYME model: A software representation of a given power system, where simulations can be run to gain insight on system capability and behavior.
- Load current: The current (Amperes) normally flowing through an energized power system to deliver power.
- Protective device details: The applicable TCC curves for a protective device, together with logic-based settings.
- Short circuit event: An occasion when one or more components of an electrical system contact one or more circuit return paths. Commonly used for arc flash analysis: a phase conductor contacting earth or system neutral. The result is typically a current value higher than load current.
- Time current characteristic (TCC): The specified relationship between applied current and operating time for a protective device such as a fuse, recloser or relay-controlled breaker. TCCs are often represented visually by curves for the purpose of studying device coordination, or for developing new settings. For example, a 100 Amp T-speed fuse will take more time to operate for a given current magnitude than will a 25 Amp T-speed fuse.

3. **Data elements –** CYME PacifiCorp Distribution System Model.
4. **Methodology** - The pilot simulation evaluated short circuit scenarios where 5 Ohms of impedance was assumed for all short circuit events, and applied voltage at the low end of ANSI A range (95% nominal). These values were chosen to represent an event whose arc energy was reasonably high. Simulating voltage higher than 95% nominal, or with fault impedance lower than 5 Ohms, generally results in faster clearing times and may result in lower total arc energy. A higher impedance value would generally result in slower clearing times and may result in higher total arc energy. The pilot results used relative, not absolute, arc energy value for final scores.

   For each protective device, downstream overhead lines in its zone of protection were evaluated for composite scoring by arc flash results and line length. That score was also aggregated to the circuit level. The result is a metric that helps the company focus on arc energy high-risk areas for remediation, and that can be used as a component within a more comprehensive score that accounts for risk from other categories.

Figure 2-2: Overview of Probabilistic Arc Energy Risk Calculation.



5. **Timeline** – PacifiCorp completed the pilot in PSPS areas described in the WMP. Based on a review of the pilot results and system records, certain equipment has been updated. PacifiCorp expanded the pilot to all of California during 2020, with long term adoption intended over the next five years, including incorporation as a standard aspect of cyclical study processes.
6. **Application and results** – The results of the pilot were used to identify locations where the potential fault (based on the similarity to modeled configurations) reflected a higher risk of damaged conductor or ignition. PacifiCorp used the modeling results to identify locations where there was a higher risk of ignition from a fault condition. Use of this information allows for system network changes to preempt such a risk condition.

I. Component Damage or Mechanical Failure from Short Circuit Current

1. **Purpose of model** – Identify areas where system improvements (including but not limited to additional protective devices, neutral extensions, reconductors) are warranted to reduce ignition risk associated with component damage or mechanical failure from short circuit current. Available fault current varies across the system due circuit topology, length and materials used, and changes over time as system improvements and configuration changes are implemented. This metric may or may not be combined directly with other composite scoring methodologies.
2. **Relevant terms**

   Conductor damage**:** The material properties of overhead bare conductors include melting point, temperature coefficient, hardness and tensile strength. When performing engineering analysis on various sizes of conductors comprised of copper, aluminum and steel, these properties can be modeled in a two-dimensional damage curve, where the axes are current and time (TCC). This curve can be used to show the duration in time that a conductor can sustain a given current without degradation of its material properties (softening, etc.). Beyond this duration, the conductor is said to have incurred damage.

Protective device details**:** The applicable TCC curves for a protective device, together with logic-based settings.

Source details**:** A numerical representation, typically at the head of a circuit or substation, of the upstream configuration and equivalent impedance to all connected current contributors (e.g. generation). A low impedance suggests that generation is relatively close and available fault current is relatively high.

Short circuit event**:** An occasion when one or more components of an electrical system contact one or more circuit return paths. Commonly used for arc flash analysis: a phase conductor contacting earth or system neutral. The result is typically a current value higher than load current.

Time current characteristic (TCC): the specified relationship between applied current and operating time for a protective device such as a fuse, recloser or relay-controlled breaker. TCCs are often represented visually by curves for the purpose of studying device coordination, or for developing new settings. For example, a 100 Amp T-speed fuse will take more time to operate for a given current magnitude than will a 25 Amp T-speed fuse.

3. **Data elements -** CYME PacifiCorp Distribution System Model.
4. **Methodology** - Throughout the distribution system, identify components where high current flow and/or heat from a short circuit event is predicted to damage overhead components based on simulation results. Initially the focus will be on overhead conductor, but insulators and other devices may be included in the future. The metric will initially be associated with spans of overhead conductor and their protective devices. Simulations will be performed in CYME and possibly other tools yet to be determined.

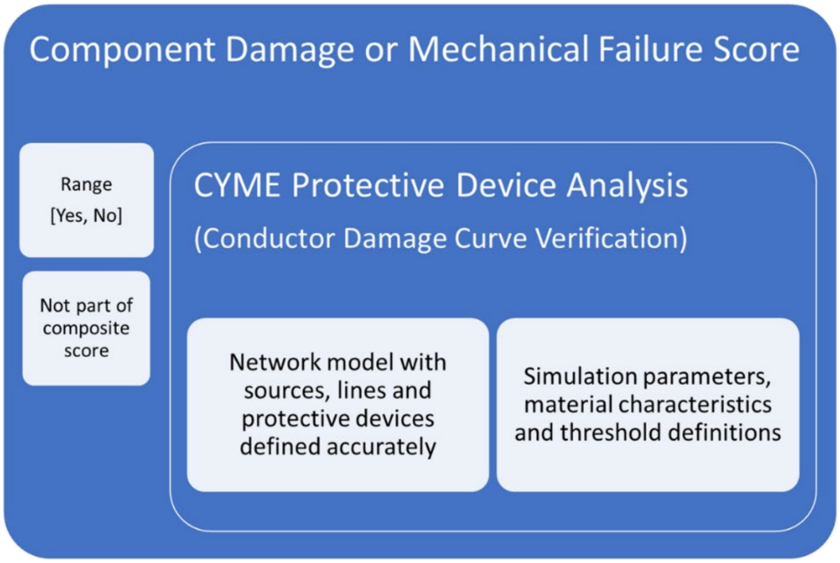
   Available short circuit current magnitude varies throughout the distribution system and can be estimated by the CYME model. The time for a clearing device (fuse, recloser, breaker, etc.) to clear a given fault can also be determined from the CYME model. Materials used for conductor, insulators and other devices have temperature withstand ratings, and when they sustain too high a temperature for sufficient time duration, mechanical damage and/or failure can result. Consequences can include a line down event, risking ignition.

   Small overhead conductors are expected to present the greatest risk for two reasons. First, their original material capacities (represented visually by a time-current-characteristic damage curve) are more susceptible to high current than are today’s standard conductors. Second, by virtue of their vintage and service life, they are more likely to have sustained some annealing or loss of life from operational events. This further degrades their ability to sustain high current without damage. In most locations, fast operating fuses provide adequate protection for small conductors, but the power system is constantly growing. System improvements can increase available fault current, and this metric will help to identify components whose protection is no longer adequate.

The pilot simulation evaluated short circuit scenarios where 10 Ohms of impedance was assumed for all short circuit events, and applied voltage at the high end of ANIS A range (105% nominal). These parameters were found to better represent worst case damage than the 95% nominal voltage scenario.

This metric will be measured as a simple yes or no – is the component likely to sustain damage from the fault events studied? Mitigation will be pursued for areas where the result is “yes.” Consequently, the identified high-risk lines are assigned a risk score of 1, while the lines without an elevated probability of failure have a risk score of 0.

Figure 2-3: Component damage or mechanical failure from short circuit current methodology.



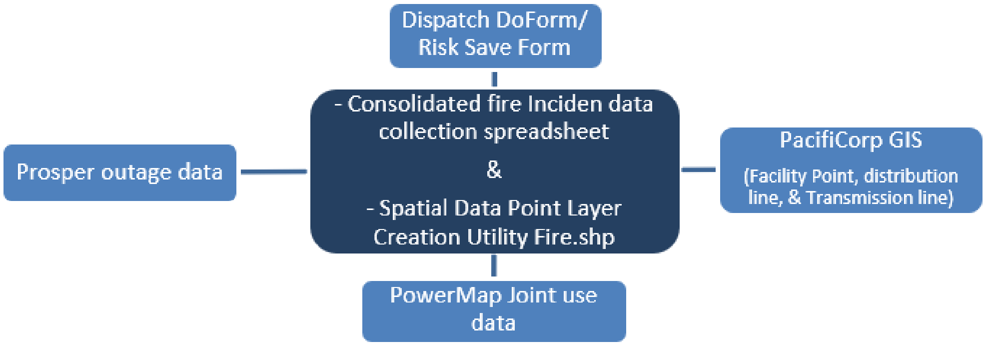
5. **Timeline** – PacifiCorp completed the pilot CYME analysis for bare overhead conductors in its California service territory in 2021. Other components were not simulated for damage risk, but they may be added in the future. The yes/no output is not expected to be combined directly with other measures for composite risk scoring, but it may be used to prioritize improvements related to the composite scores. Over the next five years the conductor analysis is intended to be incorporated as a standard aspect of cyclical study processes in California.
6. **Application and results** – The results of the pilot were used to identify locations where the potential fault (based on the similarity to modeled configurations) created a risk of damaged bare overhead conductor. Use of this information allows for

system network changes to preempt such a risk condition.

J. Utility-Related Fires

1. **Purpose of model** – To review and compare utility-related wildfire ignition details and locations, to determine what types of equipment failures and outages more closely correlate with wildfire risk.
2. **Relevant terms** – PROSPER, Outage record database. PowerMap, internal company mapping system. Dispatch Do Form/Risk Save, internal form created at the onset of a fire risk event.
3. **Data elements** – Dispatch log, PROSPER outage records, risk save event forms, equipment location and asset details, in addition to event response personnel details and environmental drivers at the time of the event.
4. **Methodology** – All the above data elements are combined to create a recorded dataset of utility-related fires. In addition, a detailed review of the various data sources is preformed to consolidate the data into a single source. Data location based on GIS equipment location at the time of the incident. The current database of ignitions is relatively small and as such does not currently have a strong statistical significance. Thus, it is difficult to calculate an ignition frequency across most ZOPs. Until the dataset becomes statistically significant, we designate the ZOPs that have had ignitions a utility fires risk score of 1 while those without ignitions have a score of 0.

Figure 2-4: Process graphic for consolidation of Fire Ignition events.



5. **Timeline** – Data records are reviewed monthly.
6. **Application and results** – Implement wildfire mitigation strategy in areas where at risk equipment exists. The information can be used to determine any trends which may occur when analyzed with additional fire risk influencers. This data will help to determine where addition system and equipment risk exist to drive facility locations upgrades and placements for protective equipment.

3. Model Validation and Combined Risk Score Weighting

Each of the above-described risk scores are all on a 0-1 scale, where 0 is the lowest risk and 1 is the highest risk. To get the final combined score we perform a simple linear combination analogously to how the fire weather risk score is calculated. Essentially each risk score (x_i) is multiplied by it's respective relative weighting coefficient c_i and the product is summed across all risk layers. Upon completion of the detailed framework the company conducted stress testing for the weightings of each of the sub layer risk scores. It chose "boundary condition" locations, specifically circuits within three areas it served having various fuel, fire weather, equipment characteristics and outage rates and performed comparisons of the model results. The final LRAM risk score layers and their associated weights are summarized in Table 3-1 below.[2]

Table 3-1: Risk Layers and Their Weighting Coefficients.

Risk Layer	Weight Percent
iUTI	[redacted]
Wildfire Risk Score	[redacted]
Fire Area Score	[redacted]
Tree Canopy Risk	[redacted]
Vegetation Outage Risk	[redacted]
Equipment Failure Outage Risk	[redacted]
Animal Outage Risk	[redacted]
Interference Outage Risk	[redacted]
Other Outage Risk	[redacted]
Arc Energy Risk	[redacted]

In this table the iUTI, Wildfire Risk, and the Fire Area layers represent the Environmental Risk Component, and they comprise half of the Combined Risk Score. The remaining risk layers represent the Utility Risk Component as they are risks related to utility equipment. The current risk layers and their weights should not be viewed as final. As experience prompts learning, including through sharing with other utilities and stakeholders, and more data becomes available, the company expects to iteratively improve the LRAM modeling approach, by

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[2] It is worth noting that the majority of ZOP's (>99%) do not have an ignition history or an increased risk of equipment failure due to short circuiting. As a result, only a small fraction of ZOPs receive a small score boost from those two layers.

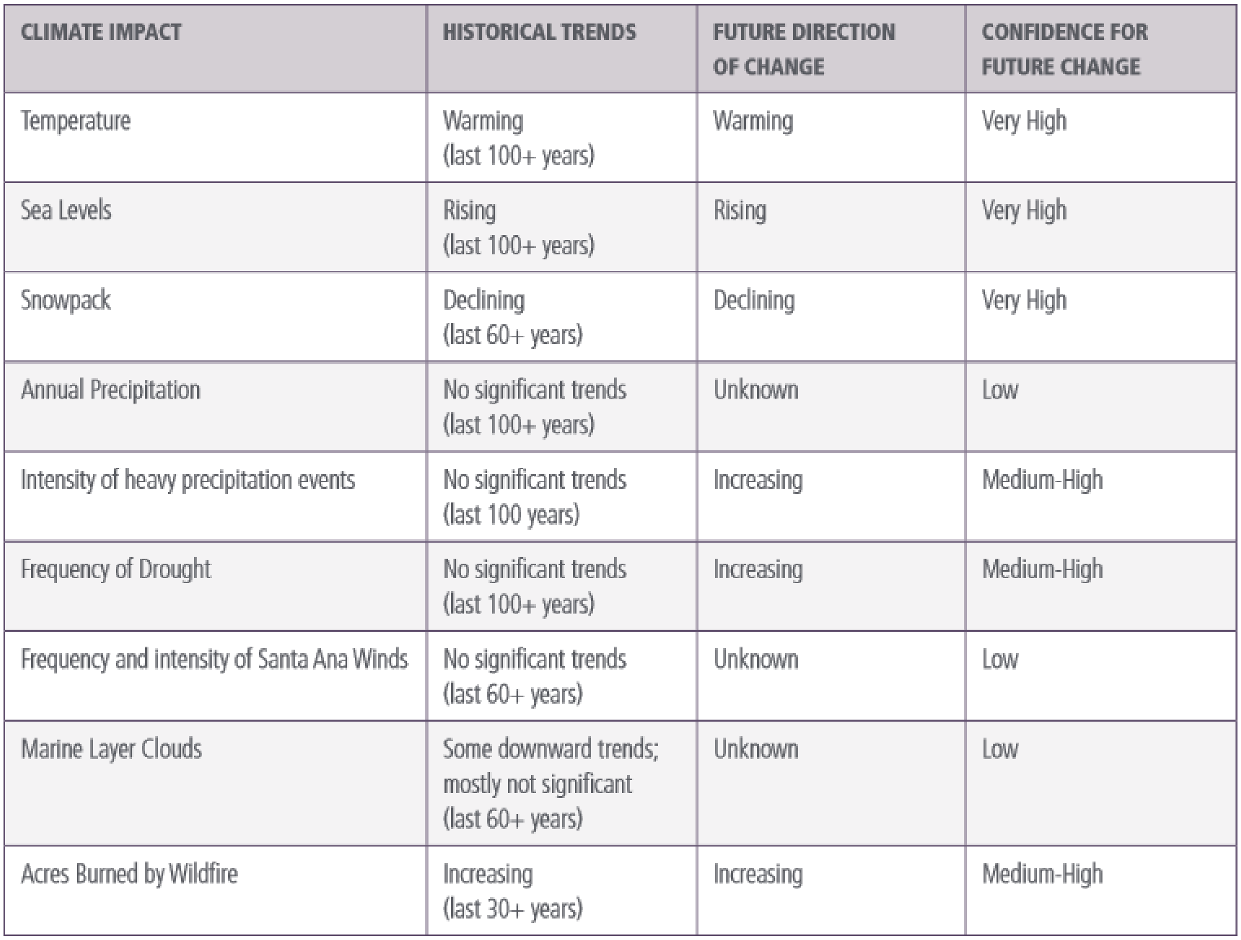
changing the weighting discussed above or even potentially modifying, removing, or adding certain risk layers.

Now that the LRAM model is functional, PacifiCorp can use these products, notably the Combined Risk Scores for specific ZOP's, to strategically guide our wildfire mitigation activities going into the future.

4. Climate Change Consideration

PacifiCorp has utilized materials prepared by California's 4th Climate Change Assessment through Cal-Adapt to assess the impacts of climate change throughout the service territory. A general summary of the climate impacts, historical trends, and future projections are summarized in Table 4-1 below. One of the primary metrics that is used at PacifiCorp to gauge wildfire risk and the necessity of a PSPS event is KBDI, and it increases based on the lack of rainfall and the increase is more rapid during higher temperatures. If we reference Table 4-1 below, we can see that the temperature is projected to increase with a very high confidence and the drought frequency is also projected to increase with a medium-high confidence. Based on these two macro trends we can confidently say that we expect the KBDI intensity to increase over the long term throughout our service territory. Consequently, if wind intensity stays the same or increases, the company expects that environmental risk scores will worsen; moreover, as a result, the risk of utility caused catastrophic wildfires will increase absent the positive influence of ongoing wildfire mitigation initiatives.

Table 4-1: A qualitative summary of historical and expected future climate trends.



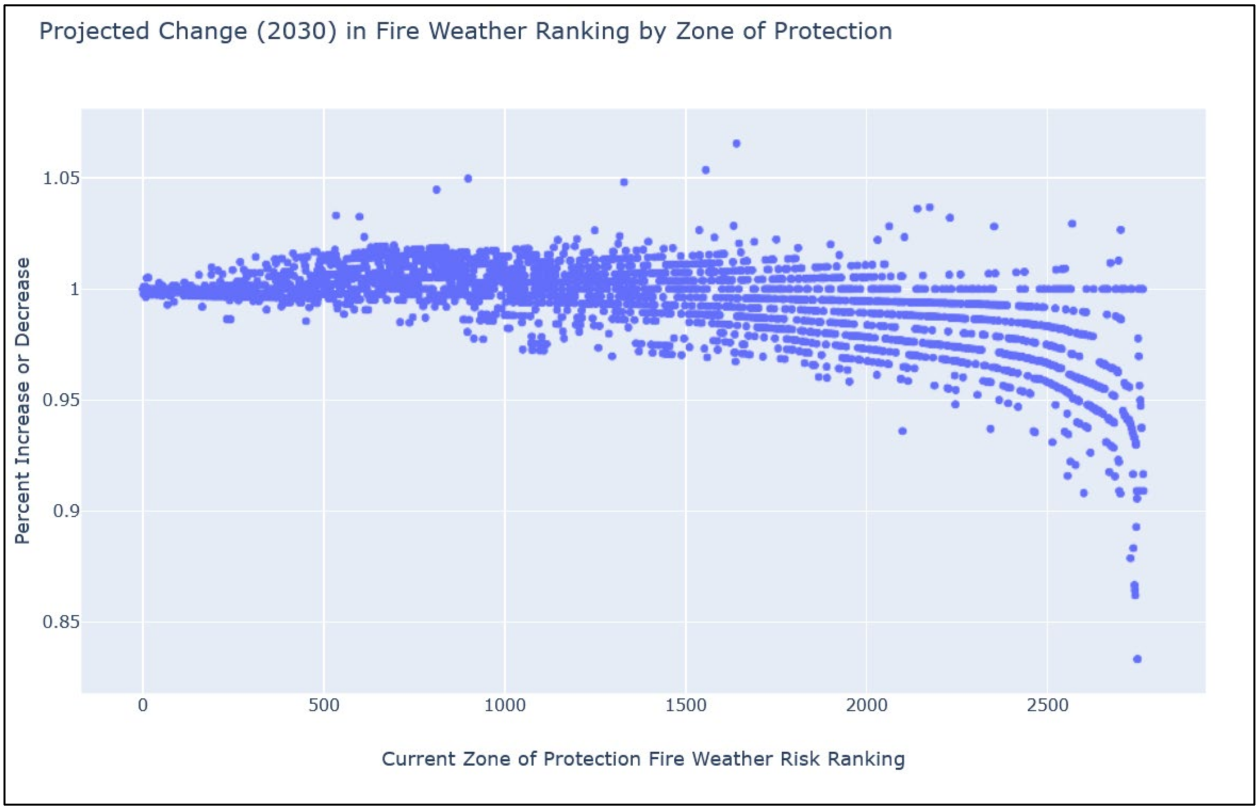
CLIMATE IMPACT	HISTORICAL TRENDS	FUTURE DIRECTION OF CHANGE	CONFIDENCE FOR FUTURE CHANGE
Temperature	Warming (last 100+ years)	Warming	Very High
Sea Levels	Rising (last 100+ years)	Rising	Very High
Snowpack	Declining (last 60+ years)	Declining	Very High
Annual Precipitation	No significant trends (last 100+ years)	Unknown	Low
Intensity of heavy precipitation events	No significant trends (last 100 years)	Increasing	Medium-High
Frequency of Drought	No significant trends (last 100+ years)	Increasing	Medium-High
Frequency and intensity of Santa Ana Winds	No significant trends (last 60+ years)	Unknown	Low
Marine Layer Clouds	Some downward trends; mostly not significant (last 60+ years)	Unknown	Low
Acres Burned by Wildfire	Increasing (last 30+ years)	Increasing	Medium-High

Now that these macro trends have been considered it is important to dive into the data and analyze these climate trends at a more refined scale. This is accomplished by overlaying circuitry (broken up by zone of protection) over the downscaled projected climate forecasts provided through the Cap-Adapt website. Now each zone of protection has a climate projection of temperature, precipitation, wind, and rainfall from which we can extract the fire weather indices that we rely on - namely Fosberg and KBDI. This was done for both climate scenarios, RCPs 4.5 and 8.5, and used the HadGEM2-ES, CANESM2, CRNM-CM5, and MIROC5 models which address the largest possible variability in the future climate.

For each zone of protection and climate scenario PacifiCorp then took the average of the four models and created an average forecasted KBDI and Fosberg forecast to 2030. Thereafter PacifiCorp performed a linear regression fit to these average fire weather indices between May and October. From the linear regression fit we obtain the slope, grab the fitted intensity in 2020 and 2030, and calculate a percent increase or decrease by 2030 at each zone of protection. At this time the company propagated the percent change of KBDI/Fosberg though the LRAM model to identify how the Fire Weather Risk Score and the Combined Risk Score will be impacted by 2030. Using these modeled risk scores we can identify zones of protection that are forecasted to cross the identified thresholds from non-tier to Tier 2, or Tier 2 to Tier 3 which in in turn will help inform the company's long term prioritization strategy.

A figure summarizing the projected change to the Fire Weather Risk Score at the zone of protection can be seen summarized below. On the y-axis is the percent change to the Fire Weather Risk Score by 2030 and on the x-axis is the current Fire Weather Risk Score ranking. From this figure one can see that the zones of protection with the lowest Fire Risk Score (right side of figure) are projected to continue decreasing in fire weather. We can also see that the higher risk zones have more variability where some increase and some decrease, and there are some zones that increase by as much as 5%. This is PacifiCorp's first pilot into incorporating the Cap-Adapt climate data, and we expect to integrate it into our long-term wildfire mitigation strategies. This aspect is particularly noteworthy as the company continues the future of mitigation efforts beyond those that were targeted toward Tier 3 and PSPS reduction.

Figure 4.1: Current Fire Weather Risk Score ranking for the zone of protection is on the x-axis and the y-axis has the projected change in the Fire Weather Risk Score by 2030.



5. Leveraging LRAM for PSPS Risk

The company uses the Combined Risk Score to gauge overall PSPS risk with respect to any given ZOP. Moreover, individual LRAM layers help inform the PSPS decision-making process. The Wildfire Risk Score incorporates gust, FFWI and KBDI intensity at any given location along with the fuel density, and those are the factors we look at when evaluating the necessity of a PSPS event. Consequently, the Wildfire Risk Score can be thought of as a relative frequency (or probability) of the coincidence of extreme fire weather with sufficient fuel which would lead the company to deenergize a circuit. The layers reflecting the Utility Risk Component provide important information about circuit resiliency. This information is considered in conjunction with other components of the PSPS assessment, including the impact on customers and other members of the public who would be affected by a PSPS event.

From a longer-term perspective, LRAM helps reduce the potential for PSPS by facilitating more targeted mitigation efforts based on a localized risk assessment at the ZOP level. LRAM allows the company to logically identify the circuits that need to be prioritized for system hardening. To best reduce the impact of PSPS, the company is in the process of using LRAM to target circuits that have both a high Wildfire Risk Score and have many downstream customers connected. In general, this approach allows us to align the work prioritization schedule with the PSPS risks that the company is facing.

Going forward we plan to dive further into PSPS risk by analyzing historical fire weather days where the conditions were above our PSPS thresholds to calculate the recurrence interval of these storms, their durations, and the customer impacts from the de-energization. This analysis once integrated into the LRAM model will further empower the company to perform data driven system hardening.

6. Appendix

Table 6-1: LRAM data elements.

Model Element	Influencer Type	Level of Granularity	Assumptions in the Model	Validation Method	Future Improvements
Circuit Topology	Utility Base Case	Spatially, approximate 10' accuracy	Conductor types, spacing, etc. are accurate.	Review by engineering team.	Better locational precision; more hardware detail in GIS.
Historic Climate/ Probabilistic Fire Spread (iUTI)	Fire Climate Risk	30 m pixels rendered on circuit topology	Locations where climate has favored fire spread will continue to favor fire spread.	Review by stakeholders/fire professionals	Better integration of contemporary fuel situation; utility focus on ignitions rather than agnostic to source.
Wildfire Risk	Fire Climate Risk	3 km gridded	Climatology can generally be inferred with limited measured assets, i.e. weather stations; models can be used to gauge local climate patterns.	Calibration using company and external weather sources to gauge local terrain impacts.	Machine learning application to fine tune locational precision when coincident to weather assets.
Tree Canopy Coverage	Fire Spread Risk/ Utility Risk Event	30 m gridded	Position errors are random and can be removed through statistical sampling. Techniques used by the NLCD base layer are consistent and accurate. Higher tree canopy density correlates to more trees and more risk.	Comparison to historic vegetation outages and historic vegetation maintenance records.	Augmenting NLCD cover data with higher resolution datasets in developed areas.
Outage Rates	Utility Risk Event	Reconciles outage events to zones of protection; granularity in certain areas of model may not be particularly precise	Outages with reference to outages (whether by sustaining or contributory causes) may not be as accurate as ideal; weather-influenced outages may mistake vegetation impactions.	Subject matter expertise	Reconciliation of tree canopy/vegetation performance would result in greater accuracy with causal relationship.

Model Element	Influencer Type	Level of Granularity	Assumptions in the Model	Validation Method	Future Improvements
Utility Fault Rate Ignition Risk	Utility Risk Event	Reconciles outage events to zones of protection; granularity in certain areas of model may not be particularly precise	Historic fault rates and locations have relationship to future risk events; circuit topology from year to year is relatively stable to enable translating history forward onto zonal expectations.	Quality checked by central engineering subject matter experts.	Finer detail on locations of damaged equipment when risk events occur, i.e. which span was the location at which vegetation contact occurred?
Available Probabilistic Arc Energy Risk	Utility Risk Event	Sub-second time analysis overlaid on circuit topology	Requires accurate conductor registry in TCC/arc flash models.	Quality checked by local engineering subject matter experts.	Cyclic process to validate modeling and performance as part of annual readiness check.
Component Damage or Mechanical Failure from Short Circuit Current	Utility Risk Event	Device clearing time analysis overlaid on circuit topology	Requires accurate source and conductor representation in Protective Device Analysis models.	Quality checked by local engineering subject matter experts.	Cyclic process to validate modeling and performance as part of annual readiness check.
Utility Fires	Utility Ignition Event	GPS accuracy from field resource	Requires manual reporting processes instituted since 2019.	Quality checked by risk, operations and engineering subject matter experts.	Centralized database with information augmented by risk event investigation team.