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COMMENTS OF THE GREEN POWER INSTITUTE ON WILDFIRE RISK MODELING AND THE RISK MODELING WORKSHOP

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The Green Power Institute, the renewable energy program of the Pacific Institute for Studies in Development, Environment, and Security (GPI), provides these *Comments of the Green Power Institute on Wildfire Risk Modeling and the Risk Modeling Workshop*.

GPI appreciates the OEIS decision to host a Wildfire Risk Modeling workshop on October 5-6, 2021, and the Utilities presentations on their granular wildfire risk modeling efforts to date. Unless otherwise noted, our comments address what SDG&E terms "Investment Planning models," especially baseline (e.g. existing) wildfire risk models intended to guide annual and granular risk mitigation planning and initiative implementation (Figure 1). This is in contrast to what SDG&E terms "Operational models," models intended to guide situational awareness and other real-time decision making.

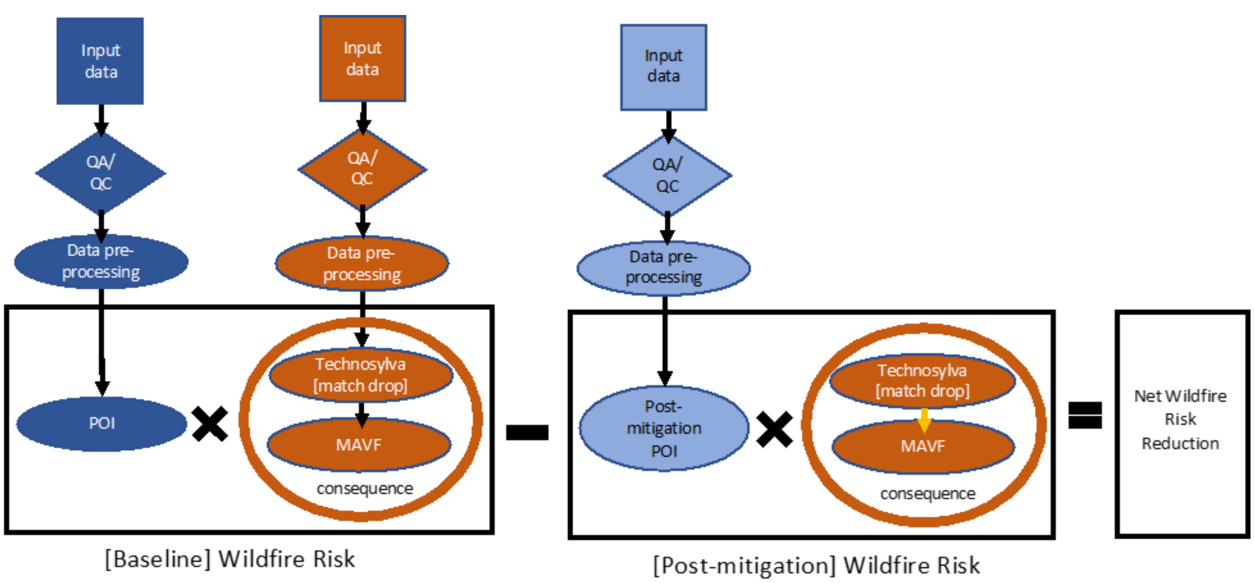

Figure 1. General schematic of granular wildfire risk investment planning models. Progress on Post-mitigation wildfire risk models and results are not as advanced as utility progress on baseline wildfire risk models and terms.

We further focus our comments on the Probability of Ignition (POI) component of the granular baseline risk models, where the risk score equals POI x wildfire consequence (Figure 1). Wildfire consequence is instrumental to understanding granular risk and guiding where to deploy mitigation activities. It is, however, especially difficult to change fuel type, load, and moisture across a potential burn zone, or alter population density and dynamics in a given consequence zone. Identifying specific ignition risk drivers and where near misses and ignitions are most likely to occur based on POI is paramount to preventing an ignition event before any consequences are incurred by efficiently deploying the "right" mitigations in the "right" places. Mitigating ignition risk drivers generally constitutes a more controllable risk reduction strategy for utilities compared to ignition consequence. For example, trimming trees, installing covered conductor, and removing flammable biomass in the immediate area to prevent a "near miss" event from occurring or escalating to an ignition.

Models developed for both large IOUs and smaller SMJUs present many novel methodologies for risk ranking circuits and circuit segments according to combined ignition and consequence risk. Given the novelty of these modeling approaches, and underlying assumptions, GPI supports the decision to host a Wildfire Risk Modeling working group and associated deep dive into the models and methodologies. GPI submits these comments on both the wildfire risk modeling working group work plan and Utility risk models.

The overarching hypotheses and goals driving risk models are clear. Objectives and activities should be refined to provide additional specificity and clarity regarding how the models are intended to guide utility planning and risk mitigation activities

GPI frames the current overarching purpose of wildfire risk modeling in term of wildfire mitigation planning hypotheses, goals, and objectives. The primary hypotheses driving the push to develop more granular wildfire risk models is that variability in wildfire risk is more granular than HFTD zones, modeling more granular risk is possible, and these granular model outputs can direct more surgical mitigation efforts that more effectively and rapidly reduce wildfire risk, all at a more economical cost. This is predicated on the understanding that current HFTD zones, while able to direct wildfire mitigation planning on a regional scale, are a low-granularity guidance largely based on environmental conditions and population distributions. HFTD do not take into account other wildfire risk factors such as the type of electric infrastructure, equipment condition, and more granular environmental conditions (e.g. fuel load, moisture content, wind, etc.). Taking these additional more granular risk factors into account, it follows that wildfire risk within a given HFTD zone is likely variable on a more granular scale and includes factors that are not accounted for in regional HFTD designations. Developing granular models that take into account additional granular risk drivers with predictive power for anticipating near-misses and ignitions based on granular risk outputs can direct more economical and impactful risk mitigation efforts. GPI agrees with this hypothesis as an adequate justification for developing and refining granular investment planning wildfire risk models.

The overarching goal of the developing wildfire risk planning models is to determine wildfire risk on a more granular level and to use the model output to guide specific and localized risk mitigation activities that improve risk mitigation efficiency in terms of time, local and total risk reduction, and risk buy-down cost. Together the overarching hypothesis and goal are adequate to justify and initiate the current wildfire risk modeling efforts. However, this goal encompasses multiple objectives from quantifying risk and risk drivers to evaluating mitigation activity efficacy on an individual and layered basis (e.g. grid hardening and EVM separately, or in the same location). It is therefore important to recognize that achieving this goal will likely require an iterative and evolving set of actionable objectives that span a variety of near- to long-term timelines.

GPI recommends developing an initial set of clear objectives and activities during the risk modeling working group in order to guide model development that animate the goal and adequately answer the driving hypothesis. These objectives should constitute near-term (e.g. 1- 5 year) and longer-term (5-10 year) objectives for granular wildfire risk models and output informed planning. For example, objectives may include:

- Modelling capability objectives and activities
    - Quantify equipment near-miss and ignition risk based on risk drivers and identify additional nuanced risk drivers (e.g. asset type and age, operating conditions, wind thresholds) at the asset or line segment level. Achievement timeline: 1- 3 years.
    - Quantify vegetation related near-miss and ignition risk at a square, or linear mile granularity, or better, and identify additional nuanced risk drivers (e.g. species, height, wind thresholds etc.). Achievement timeline: 1- 3 years.
    - Account for near-term climate change impacts or trends such as trending drought conditions that point to near- to mid-term wildfire risk increases and that can inform risk mitigation efforts prior to high-risk onset. Achievement timeline: 3- 5 years.
    - Account for long-term climate change trends that can inform general electrical infrastructure planning and design standards. Achievement timeline: 5- 10 years.
    - Establish standardized risk model evaluation reporting metrics that include model predictive power and a review of near-misses and ignition events that the model(s) fail to predict. Achievement timeline: 1- 3 years.
- Ongoing and iterative model improvement objectives and activities
    - Establish a framework for annual model development/refinement that supports external and academic input. Make models, inputs, assumptions, and results publicly available on a data portal. Achievement timeline: 1- 3 years, ongoing.
    - Develop a regular modeling review cycle supported by independent evaluators. Achievement timeline: 1- 3 years, ongoing.
    - Evaluate data input quality and QA/QC methods; establish a data validation method to guide data quality in perpetuity. Achievement timeline: 1- 3 years.
- Risk model application objectives and activities
    - Develop a transparent framework and process which establishes how model outputs are used in Utility annual mitigation planning and implementation in conjunction with other information (e.g. infraction tags, SME input etc.). Achievement timeline: 1- 3 years.

- Quantify the risk mitigation value of specific mitigation activities that are currently available (e.g. covered conductor installation, EVM, Figure. 1 Post-mitigation risk model). Notably this objective requires multiple evaluation steps beginning with risk modeling that can quantify baseline risk at a given location and can identify the primary risk drivers. While a related process, it is important to acknowledge that quantifying the ability of a mitigation activity to reduce risk at a given location will likely require additional focused investigations that include supplemental data and/or data-subsets, and modelling efforts (e.g. Figure 1, inputs to POI term of post-mitigation risk model).

  That is, baseline risk and the risk-reduction potential of a mitigation activity or solutions are both required to quantify the net remaining risk and constitute related yet different analytical and investigative objectives (Figure 1). A third aspect of this objective is quantifying the net negative impacts of a given mitigation (e.g. PSPS), which likely requires another dataset/sub-set and alternate evaluations/models. GPI recommends developing a parallel track, or second working group round, that addresses and drives progress towards quantifying risk mitigation potential as well as negative impacts. Achievement timeline: 1- 5 years, likely dependent on/ constrained by available data.

It is important to recognize that there are challenges with delineating a comprehensive set of objectives in this early stage of model development. As with any novel investigation there are limitations on existing knowledge and the “Catch 22” of not knowing what we don’t know. GPI therefore advocates for establishing frameworks and regulatory cycles that ensure iterative objective development that in turn guides ongoing model and application advancements. For example, as baseline POI risk machine learning models are built and refined, future model insights may include specific risk drivers that call for otherwise unforeseen focused objectives such as the ability to inform the pre-emptive maintenance or replacement of specific assets.

GPI supports comments advocating for increased model alignment between utilities.

We support party and stakeholder comments calling for improvements to utility wildfire risk modeling alignment. This includes MAVF model alignment, especially linear versus logarithmic risk multipliers. With respect to the multiple parallel, granular wildfire risk models designed by IOUs and SMJUs, these multiple modeling approaches can be leveraged to compare and contrast data inputs, model selection and methods, and the resulting predictive power and accuracy of the model outputs. We agree with OEIS that an initial set of risk modeling best practices based on current progress can improve and align utility models and inform appropriate model approaches for the spectrum of utility sizes.

The dichotomy between IOUs and SMJU size will require substantially different modeling approaches and/or greater collaboration between utilities.

GPI has raised concerns regarding data constraints for small SMJUs compared to the more expansive IOUs. Statistical constraints are a product of the territory size combined with the relative infrequency of near misses and electric infrastructure-related ignition events. The spread of utility data ranges from effectively zero ignitions for the smallest SMJU, Bear Valley Electric Service (BVES), up to 100+ ignition events since 2015 for IOUs. Based solely on these data the risk exposure of BVES and PGE cannot be directly compared, nor should the wildfire risk in SMJUs with small data sets be downplayed. Similarly, modeling methods used to assess Utility-wide ignition risk between large and small utilities must take different approaches if assessed separately. GPI is particularly concerned that the data limitations of small utilities such as BVES, may negatively affect the ability to predict and mitigate wildfire risk and occurrence.

GPI recommends exploring whether large utility machine learning models can be expanded to neighboring SMJU jurisdictions and systems. If this is possible for some, or all SMJUs, it may be prudent to simultaneously leverage and expand IOU risk models and data-sets (with SMJU data) to also model granular SMJU wildfire risk. This would also reduce the number of parallel risk model methodologies employed across California, leading to better model alignment. It could also create some cost-share and saving opportunities for SMJUs and IOUs.

If IOU model extension to SMJUs is deemed infeasible, GPI recommends addressing risk modeling methods for large and small utilities (e.g. IOUs versus SMJUs) separately, since they will necessitate substantially different model approaches that are suitable based on data availability and size. SMJU wildfire risk modeling should not be overlooked based on small data sets that can present a misleading gauge of wildfire risk.

GPI advocates for a complete review of the utility modeling processes from data collection to model refinement approaches

A proper assessment of utility risk modeling requires a review of (*i*) utility data inputs, (*ii*) model selection, (*iii*) model outputs, and (i*v*) the ability of the output to inform action.

Data inputs – Models are only as good as the data they are provided. The adage "garbage in, garbage out" applies to the granular wildfire risk models under review. Data inputs must be accurate, meaning data has passed a quality assessment and quality control review that ensures the "raw" input data collected in the field is complete (e.g. all planned data collection fields are filled in) and correct (e.g. location data accuracy, quantitative versus relative descriptions of attributes). GPI recommends requiring all utilities to develop a data validation plan that includes data QA/QC. We further recommend establishing best practices that will serve as a baseline for comparing, ranking (e.g. maturity model), and ultimately approving utility wildfire risk modeling data validation plans. The working group should also explore parallels and disparities between utilities' available data types and the temporal and spatial granularity of input data (e.g. physical wind measurements per square mile, outage event time and location granularity). For example, is utility A able to pinpoint a near-miss/outage event to the line segment while utility B can only trace an outage to the circuit level.

Modeling based on near-miss (outages) versus ignition datasets also has implications that include dataset size and underlying drivers. GPI recommends investigating the pros and cons of using these datasets independently and together to inform more robust wildfire risk models. Near miss events are more frequent and therefore provide additional data for model training. Both near miss events and ignitions also include a plethora of implied and underlying risk drivers. A near miss may imply adequate preventative measures (e.g. flammable fuels were removed), coincidental conditions (recent rain), or basic probability despite high risk conditions (sparks landed on dry grass but did not manifest in a wildfire). The probability of a risk driver leading to an ignition event is also related to many underlying and parallel factors. That is, a risk driver causing a near miss event in a given location versus an ignition in another is linked to a wide range of variables. Delineating the underlying drivers for near misses versus ignitions is important for developing, training, and interpreting granular wildfire risk models that inform mitigation activities, spatial deployment, and their efficacy.

Other input data factors that will impact model output include data pre-processing. For example, modelers during the October 5-6 risk modeling workshop mentioned using wind, max, min and average – these values require data pre-processing such as interpolation of wind speed over an area (between physical weather stations) that is further constrained to a temporal window. The area and timeframe over which the data is interpolated and processed will impact granular max, min and average values that could in turn alter model predictive power and implications (e.g. covered conductor safe operating thresholds). Differences in data selection methods between utilities may affect model predictive power and outputs. GPI recommends requiring model sensitivity testing to better understand how data selection and pre-processing methods affect model output. In short, input data constitute many "levers to pull" in terms of model capability, predictive power and output usability, and should therefore be a major focus of the wildfire risk modeling working group.

Previous IOU presentations have shown that outage datasets include outage events that occur during low wildfire risk, for example wires down or other outage event that occurs during wet, winter storm conditions. Multiplying a localized POI based on an outage frequency associated with wet winter storms by the worst-case ignition consequence for that same area (i.e. dry, hot, high-risk fuels) may result in misleading risk scores if the outage events do not coincide with high fire risk conditions. The working group should explore whether utilities do and/or should filter out outage events that take place during the wildfire "off-season" (e.g. cold, wet winter storms).

Model Selection – Model selection will be partially driven by dataset size. GPI recommends comparing and contrasting model pros and cons in the working group as well as model output fit in order to guide model selection best practices. The multiple machine-learning based models currently used in IOU's granular wildfire risk planning modelling (e.g. MaxEnt and Random Forest) provide a starting point from which to compare model suitability. Given data constraints, alternate modeling approaches are likely needed for SMJU granular wildfire risk models. However, the predictive power of input data (e.g. wind, power cycling, asset age) in IOU models may be capable of guiding the variables that SMJUs should consider in their wildfire risk ranking approaches.

Model outputs – Model outputs that are actionable are paramount to achieving granular wildfire risk modeling objectives. IOUs began including wildfire risk model output fit curves (AUC-ROC) in their 2021 Updates and the October risk modeling workshop. Model fit transparency is a start to vetting model input data, model selection and output usability. GPI recommends exploring additional model success parameters including a deep dive into the near-miss (outage) and ignition data that the machine learning models are unable to predict. This will help guide adjustments and/or additions to the input dataset that improve model predictive power. Model output shortcomings should also inform wildfire mitigation actions that acknowledge and can address wildfire risk not captured in the granular risk models.

In addition to model accuracy, the output format and information must be adequate to inform actionable risk mitigation activities. For example, in the instance of an area designated as high wildfire risk due to contact from vegetation, what are the predictors (e.g. asset age/condition, tree genus, species, height, wind max?) and are they specific enough to inform a mitigation activity such as replacing the asset and/or remove and trim trees of a specific species and/or height. Models that address equipment versus contact from vegetation risk drivers may also require different granularities, such as asset or line segment versus larger areas of integration, respectively. GPI recommends the working group explore not only output predictive power and shortcomings but also its ability to inform the available "toolbox" of specific and implementable risk mitigation activities. Data input, model selection, output accuracy and application are all interconnected and will therefore require an ongoing iterative development process. GPI advocates for baking this iterative development process into the wildfire mitigation plan requirements. At this early stage of development, it is impossible to answer if or when granular wildfire risk models will have achieved a "good-enough," or steady state status. However, making the data, models and model outputs open access to the maximum extent possible will support third party, academic and peer-review engagement that can advance the process of model refinement.

OEIS should establish an independent evaluator process as well as standard model reporting metrics for wildfire risk modeling

External peer-review is a valuable tool for the complex, granular wildfire risk modeling method development at hand. Input from wildfire specialists, data scientists, climate/weather modelers, and utility/electrical equipment experts, among others, will benefit the model development and refinement process. While utilities employ SMEs across many of these fields, external review that welcomes outside perspectives and expertise is paramount for eliminating potential conflicts of interest and implicit biases. Developing complex models such as the granular wildfire risk planning models is also a highly technical endeavor that requires proficiency in data science and statistical analysis, which are best vetted by industry experts.

The working group should explore how Utilities apply the results of the wildfire risk models, and should glean a set of current best practices as a guidance for risk model application going forward

The link between granular risk assessment, mitigation implementation, and mitigation efficacy is not well developed in the Utility wildfire mitigation plans. The WMPs generally lacked clear and explicit descriptions on how risk modeling results and other related metrics, such as RSEs, were factored into decisions regarding specific mitigation selection and locational deployment. One example of this disconnect was PG&Es failure to clearly and consistently risk rank and implement enhanced vegetation management work on risk-ranked high wildfire risk circuits (February 8, 2021, WSD CPUC EVM Audit letter). This instance suggested a disconnect between wildfire risk assessment, mitigation planning, and mitigation deployment. GPI recommends that the working group delve into how each utility is applying granular risk model outcomes in their decision-making process. This includes delineating the systems in place to compile and weigh all relevant information, including risk modeling results, used to determine when, where, and how much of each wildfire risk mitigation activity is deployed in a given year. These methods should be clearly explained in the WMP Updates and backed by transparent internal documentation.

Mitigation efficacy and RSE are key metrics in wildfire risk planning that will require additional modeling objectives informed in part by granular baseline risk modeling outcomes.

Utility granular, investment planning risk models to date have largely focused on identifying the variability of baseline (i.e. existing) risk within HFTD zones. This in and of itself is a substantial undertaking requiring a plethora of environmental and electric system considerations. Our comments above are largely focused on the challenges and work still needed to vet and iteratively improve the data inputs, models, and model results used to determine existing, or baseline, wildfire risk, especially concerning granular POI models. Modeling general and granular risk reduction potential of a given mitigation measuer (e.g. enhanced vegetation clearances/trimming), while part and parcel to the larger task of risk modeling informed mitigation, will likely require a separate set of risk modeling objectives, models, and datasets (and/or data sub-sets).

It is our understanding that the granular wildfire risk planning models developed to-date will help point to general or specific risk drivers (depending on the input data and results) that inform mitigation selection for a given location. For example, palm trees along distribution system line sections with wind speed average or max above a given threshold contribute to *n* percent of the POI risk along a given line section. This example of baseline risk model output is actionable, pointing to the general risk driver(s) (e.g. palm trees and wind) in identifiable locations (e.g. locations that experience the threshold wind velocities and have palm trees) that can be mitigated. However, determining the effectiveness and RSE of a given mitigation activity, for example trimming palm trees to 25' clearances around distribution lines, will require additional datasets and quantitative analyses. These analyses will require an entirely separate set of analytical and planning objectives. The WMP requirements and utility WMP filings have just scratched the surface of data driven RSE quantification through pilot projects and preliminary data analyses (e.g. tree species risk assessments).

The results of mitigation specific analyses can then be applied to the granular baseline/existing risk models to calculate the risk reduction potential. For example, if a 25' palm tree trim clearance around distribution lines in locations with at-or-above threshold winds reduces palm frond-caused near miss events by *n* percent (or as a function of wind speed), then the anticipated percent reduction in contact from vegetation after the mitigation would be fed into the POI risk model. The difference between granular baseline risk and the mitigated risk value (i.e. the post-mitigation POI x consequence, e.g. Figure 1) defines the mitigation's efficacy and informs the granular RSE.

GPI recommends using the results of the present working group to inform a set of forward-looking objectives that initiate more quantitative RSE evaluations. These objectives should be informed based on the wildfire risk modeling working group findings such as what data are available, how actionable are the granular baseline risk model outputs (e.g. able to guide specific mitigation actions), what are the specific factors causing the most risk, do we already have sufficient information to inform how to mitigate those drivers, and if not, what is needed in terms of data and modeling to determine the appropriate mitigation and its RSE. Objectives may also include evaluating the RSE of layered mitigations, for example implementing EVM and installing covered conductor in the same location.

We also suspect that there is a wealth of existing utility generated data that could begin to answer more nuanced questions and hypotheses about both existing risk and risk mitigation effectiveness. Extracting actionable interpretations from these data is at least partially limited based on Utilities' personnel, time, and financial resources. Making utility wildfire risk related data publicly available through data access portals would create opportunities for external review by WMP parties, stakeholders, and academics. The combination of tapping into additional resources and broad expertise outside utility personnel can expand our understanding of utility wildfire risk and mitigations, and can affect how quickly we develop new knowledge.

Near-term (e.g. 2- 5 years) wildfire risk forecasting should be explored in order to get ahead of changing risk due to climate change and to account for the time it takes to implement wildfire risk mitigations before the risk is fully manifested

The Utilities and their WMPs are currently trying to "catch up" in terms of mitigating accrued and increasing wildfire risk that was previously not addressed or perhaps in some instances, not realized. Environmental conditions, population growth, and equipment-related risk will continue to evolve over time. Fire season is expanding to include nearly year-round risk, drought is persisting, and environmental conditions continue to change with our changing climate. As population expands so to do cities, suburbs, and the WUI, resulting in changes to population density, demographics, and public infrastructure (e.g. schools, hospitals, etc.) distributions. Equipment also continues to age and utility standards that were once acceptable in a given location may contribute to increased wildfire risk over the next decade (e.g. bare versus covered conductor, overhead versus undergrounding). The advent of data-driven granular and quantitative baseline wildfire risk modeling presents an opportunity to track wildfire risk trends. Supplemental and input data showing ongoing and deepening drought conditions, decreasing dead and live fuel moisture content, and/or tree die-off trends could be used to preemptively update the electrical infrastructure before the onset of a wildfire risk threshold.

Wildfire risk mitigation upgrades and activities inherently take time to implement and Utility WMP plans are only able to address risk in a small proportion of the highest risk circuits. For example, tree trimming and risk-tree felling across entire HFTD zones is a massive undertaking and is limited by available personnel and resources (e.g. equipment, funding etc.). Antiquated fuse replacements are scheduled to take upwards of a decade. Covered conductor installations are in the 100s of circuit miles per year while total HFTD distribution circuit miles total 1,000s of circuit miles. Undergrounding is an even slower installation process. Utilities do not have unlimited resources to implement many different mitigations in addition to infrastructure replacement projects in locations that have burned in recent wildfires.

Failing to address future near-term increases in wildfire risk will perpetuate a cycle of catch-up after a given location reaches an "unacceptable" or threshold risk level. For example, locations with trending drought conditions and decreasing fuel moisture could signal the onset of an elevated wildfire risk state in the next 1-3 years. If identified at the time when wildfire risk thresholds are met, this parcel has already entered a high-risk state that may take years to mitigate through VM and equipment replacements or upgrades. Alternatively, identifying these trends and future near-term wildfire risk (e.g. 1-5 years ahead) would afford utilities the time to schedule and implement risk mitigations prior to, or at the time of, high risk onset, versus long after. Near-term wildfire risk projections can also inform updated distribution planning standards. For example, projecting high wildfire risk areas in the next 3 years could inform a wide range of utility decisions from distribution investment deferral framework (DIDF) project selection (e.g. microgrid or DER installations that provide local backup power under PSPS conditions) to preemptively scheduling the replacement of aging high risk equipment, or selecting alternate risk reducing solutions (e.g. undergrounding) in place of like-for-like infrastructure replacements.

While granular wildfire risk associated with long-term climate change trends (e.g. 10 to 20 years out) likely contain substantial uncertainty, near-term trends on the timescale of utility distribution grid planning activities and wildfire mitigation implementation timelines (e.g 1- 5 years) may reflect greater certainty and can inform wildfire mitigation planning that takes a pro-active verse reactive approach. GPI recommends exploring how granular wildfire risk models and data trends (e.g. fuel moisture, drought index, tree mortality rates) can inform which locations will experience wildfire risk thresholds in the near term. Establishing clear objectives and deliverable timelines for wildfire risk forecasting will support progressive development of granular existing/baseline risk models, mitigation risk reduction metrics (e.g. RSE), and near-term risk forecasts.

Conclusions

Quantifying risk and risk mitigation needed to inform action and optimize risk buydown is a complex and massive issue with many facets that will require stepwise developments akin to the development of a new field in an academic setting. Immediate next steps include vetting data inputs and models needed to create granular and actionable baseline risk maps. Holes in our understanding of risk drivers based on model outputs and their inability to predict only some near-miss and ignition events should drive investigations regarding unidentified risk drivers/predictors. Actionable risk drivers and thresholds gleaned from the baseline risk models should drive focused investigations of mitigation activity effectiveness that can then be used to justify and implement mitigations in other similar locations according to baseline risk maps. The combination of these two components, baseline wildfire risk model outputs (e.g. granular risk maps) and risk mitigation efficacy studies, will inform RSE quantification, risk buydown optimization, and total system risk reduction metrics. Near-term wildfire risk forecasting based on granular baseline risk and extrapolated based on risk driver trends (e.g. fuel moisture) can get ahead of the risk in the distribution planning timeframe and inform preemptive action versus reactive mitigation. These steps will take years to manifest and refine, akin to establishing a new field of study, but can be expedited by making data publicly available to stakeholders and researchers.

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