7.3.1 Risk Assessment and Mapping

7.3.1.1 A Summarized Risk Map Showing the Overall Ignition Probability and Estimated Wildfire Consequence Along Electric Lines and Equipment

WSD Initiative Definition: *Development and use of tools and processes to develop and update risk map and simulations and to estimate risk reduction potential of initiatives for a given portion of the grid (or more granularly, e.g., circuit, span, or asset). May include verification efforts, independent assessment by experts, and updates.*

1) ***Risk to be mitigated/problem to be addressed:***

   Risk maps and tools can be useful for identifying the potential risk reduction associated with initiatives for specific geographic areas or portions of the electrical grid. This can help focus initiatives on the areas where the potential risk reduction is the greatest. For its electric distribution system, Pacific Gas and Electric Company (PG&E) has created distribution maps for our System Hardening and Enhanced Vegetation Management (EVM) programs that combine ignition probability and wildfire consequences to estimate the risk reduction potential of these initiatives.

   For its electric transmission system, PG&E can produce various maps by asset, but none offer a fully comprehensive risk view of ignition probability and wildfire consequences for transmission lines. PG&E does have modeling capabilities for transmission facilities, but these capabilities do not yet include multiple consequences (e.g., public safety, wildfire, environment, etc.) and multiple failure modes (e.g., wind, third party, asset failure, etc.). PG&E does have a full asset failure probability model for windy conditions (*i.e.*, the Transmission Operability Assessment Model or "OA Model"), which it has combined with the wildfire consequence model. We intend to develop additional risk maps and tools for transmission lines in 2021, as described below in response to Question #5 regarding future improvements.

2) ***Initiative selection ("why" engage in activity)****: –* ***include reference to a risk informed analysis on empirical (or projected) impact of initiative in comparison to alternatives****.*

   Risk ranking using a risk map allows for prioritization within system-wide workplans and potential areas of risk. For example, it allows inspections to be focused more frequently in riskier areas, repairs to be done in order of highest risk (rather than first in, first out), controls and mitigations to be set up in order to address risk, and capital upgrades and replacements to be prioritized based on risk.

3) ***Region prioritization ("where" to engage activity)****:* ***– include reference to a risk informed analysis in allocation of initiative (e.g., veg clearance is done for trees tagged as "high-risk")***

Risk modeling and mapping has been focused on High Fire Threat District (HFTD) areas, which allows PG&E to prioritize areas that have a pre-determined higher fire risk by geographical location. The models/maps then allow higher risk areas to be identified, to target the best areas for specific programs.

4) ***Progress on initiative (amount spent, regions covered) and plans for next year***

Distribution models have changed in the approach to model ignition probability, with more sophisticated modeling techniques than in previous years. PG&E's risk modeling approach for distribution lines is described in detail in Sections 4.3 and 4.5.1. PG&E's risk models and existing modeling approach for the transmission system, including the OA Model, are described in more detail in Sections 4.2.A and 4.5.1.

5) ***Future improvements to initiative***

Distribution: In June 2021, PG&E intends to focus on understanding and better quantifying risk reduction of implemented mitigations on the distribution system and refining the 2021 Wildfire Distribution Risk Model. Refinements will include the added ability to compare wildfire risks for different risk drivers as well as measuring the risk reduction of specific mitigations. These refinements in 2021 will be represented in the 2022 Wildfire Distribution Risk Model.

Transmission: In 2021, the Technosylva wildfire consequence information will be combined with the OA Model asset failure probability information to provide more standardized wildfire risk mapping/ranking between the various controls and mitigations.

For both distribution and transmission, the key to future improvements will be the understanding of how various mitigations (regardless of primary driver) reduce wildfire risk in a quantitative measure. Ideally, the combined impact of multiple mitigations or controls should be understood to provide for efficient work planning.

ACTION PGE-25 (Class B)

1) Integrate discussion on long term planning within the respective section of each individual initiative.

Response:

PG&E's long-term plan for developing and using risk maps and simulations to estimate the risk reduction potential of initiatives centers around refining data inputs, creating more integrated models, and improving granularity in model outputs. Steady improvement in these areas will serve to better localize areas and mitigations that efficiently reduce the risk of grid related ignitions. With more data being captured internally as well by outside parties, PG&E will continue to evaluate these vast amounts of available data to increase the granularity and performance of its models. Following the risk framework

outlined in Section 4.5.1(c), as modeling capabilities are improved from relative risk models at the circuit level with system level risk reduction and Risk Spend Efficiencies (RSE) capabilities, to automated quantitative risk models that include risk reduction and RSE evaluations all at the asset level, these improvements over the next three years will place PG&E at a steady state where improvement will focus on continually improving the data and granularity of the risk models. PG&E expects to reach a semi-automated level to update risk mapping by 2026, where risk reduction is shown as work is completed.

7.3.1.2 Climate-Driven Risk Map and Modelling Based on Various Relevant Weather Scenarios

WSD Initiative Definition: *Development and use of tools and processes to estimate incremental risk of foreseeable climate scenarios, such as drought, across a given portion of the grid (or more granularly, e.g., circuit, span, or asset). May include verification efforts, independent assessment by experts, and updates.*

1) ***Risk to be mitigated / problem to be addressed:***

Changes in climate can have significant impacts on the risks associated with electrical facilities, as well as the effectiveness of wildfire mitigations and initiatives. To address this risk effectively, it is important to develop tools to consider changes in future operating conditions as a result of climate change. PG&E has used and/or developed the following two resources for climate-informed risk mapping and modeling:

- 30-Year Historical Climatology Model: A 30-year historical climatology analysis to help prioritize near-term (zero to five years) wildfire mitigation measures based on historical weather patterns.

- Long-Term Climate Projections: California Public Utilities Commission (CPUC)-approved forward-looking climate data from California's Fourth Climate Change Assessment to consider long-term trends in risk due to climate change.

In addition to these resources, PG&E's Climate Resilience Team specifically evaluated whether the High Fire Risk Area (HFRA) Map (described in Section 4.2.1) that is used to inform some near-term Wildfire Mitigation Plan (WMP) initiatives is consistent with projected increases in wildfire risk due to climate change. PG&E found that the HFRA Map is consistent with expected wildfire risk intensification and spread patterns as a result of climate change, increasing the likelihood that WMP investments guided by the HFRA Map are prudent from both a near-term and long-term perspective.

Finally, PG&E has also initiated research on a study known as the Long-Term Grid Architecture Study to determine the longer-term impacts on grid architecture from various external factors including, but not limited to:

- Climate Change
  - Agricultural changes and impacts on load
  - Wildfire threat
  - Rising sea levels
- Population Migrations
  - Urbanization (e.g., inability to acquire fire insurance in rural areas)
  - Ruralization (e.g., increase in cost of living for urban landscapes)
- Technology
  - Reduction in costs for current generation/storage technologies
  - Introduction/maturation of newer generation/storage technologies
  - Increase in electric vehicle quantity and capability
- Policy Changes
  - Senate Bill 100 – 100% renewable energy by 2045
  - Executive Order N-29-20 – 100% new vehicles to be zero-emissions

The Long-Term Grid Architecture Study aims to identify how these externalities will impact load and capabilities in ascertaining what a theoretical green-field optimal grid design should look like to safely and reliably provide electricity to customers in a 30-year lookahead. In support of this study, PG&E is undertaking an Electric Program Investment Charge project, 3.10 - Grid Scenario Engine, that will investigate whether a grid architecture can be automatically modeled based upon a variety of inputs that can help inform the longer-term grid architecture study.

2) ***Initiative selection ("why" engage in activity) – include reference to a risk informed analysis on empirical (or projected) impact of initiative in comparison to alternatives.***

The 30-Year Historical Climatology Model was developed to help PG&E determine where wildfire and related contributing weather events are most likely to occur in the near-term, which supports planning and prioritization of near-term mitigation activities. PG&E uses CPUC-endorsed climate projections from the Fourth California Climate Change Assessment for an increasing number of applications as climate change is expected to alter operating conditions in unprecedented ways. We have used climate data to validate the use of the HFRA Map in wildfire mitigation planning and decision-making.

It is important to note that while climate change has and will continue to contribute to the increased risk of wildfire in California, considering future trends in wildfire risk may or may not be warranted for every wildfire mitigation initiative depending on the nature and timeframe of the work in question.

The Long-Term Grid Architecture study may allow PG&E to understand what potential grid architectures need to be applied in a targeted fashion throughout its service territory based upon the many external factors that may affect its ability to safely and reliably serve electricity to its customers. This can help inform PG&E on what longer-term decisions may be required to transition between grid architectures, and what policies may need to be enacted in order to support the transition.

3) ***Region prioritization ("where" to engage activity) – include reference to a risk informed analysis in allocation of initiative (e.g., veg clearance is done for trees tagged as "high-risk").***

The analyses described above are intended to allow PG&E to focus on where there will be potential climate change impacts, and to evaluate our mitigations and initiatives based on these potential impacts. The 30-Year Historical Climatology Model helps us predict and prepare for wildfire risk events and indicates where these events are most likely to occur. The Long-Term Climate Projections can help validate geographic prioritization of work given future expected conditions. The HFRA Map evaluates areas outside of HFTD areas for potential higher wildfire risk. Finally, the Long-Term Grid Architecture Study will be localized based upon local load profiles and external risk factors that can be generated based upon a variety of assumptions. An attempt to utilize these profiles in identifying the best-fit grid architecture will be studied and has the potential to inform future grid planning.

4) ***Progress on initiative (amount spent, regions covered) and plans for next year***

PG&E will refresh any relevant forward-looking wildfire risk analysis once new relevant climate projections become available, such as with the release of California's Fifth Climate Change Assessment.

The Long-Term Grid Architecture Study is in the very beginning stages of conceptualization and planning, and therefore current plans and spend amounts forecasted for this effort are still unknown. It is anticipated that this work will occur in phases, with various parallel initiatives that may branch out from this work which can be defined in future WMPs.

5) ***Future improvements to initiative:***

As new climate modeling and research becomes available, for example upon release of California's Fifth Climate Change Assessment, PG&E will evaluate whether near-term mitigation action and long-term planning is consistent with expected changes in wildfire risk due to climate change.

ACTION PGE-25 (Class B)

1) Integrate discussion on long term planning within the respective section of each individual initiative.

Response:

30-year climatology model

We plan to continue building our high resolution weather and fuels climatology every year. This climatology is used to better understand the environmental conditions that lead to outages and large fires; thus, we expect the climatology dataset to continue to grow over the next ten years. At some point in the future, we may decide to make the operational weather model more granular, and at that time, it would require re-running the historical climatology at the new granular configuration. At this time, however, there are no plans in place to make the operational weather model or climatology more granular.

General usage of forward-looking climate data

The use of long-term climate data to inform decision-making is primarily driven by PG&E's Climate Resilience Team.[1] The Climate Resilience Team provides input into WMP as requested and appropriate depending on the evolving efforts of the CWSP. It is important to note that operational risk models and mitigations often are focused on a one-to-five year time horizon, while climate projections are most useful for understanding trends on a decadal scale. Misapplication of climate data may result in overprediction of future conditions, skewed results, and misinformed decision-making.

Long-Term Grid Architecture study

As the Long-Term Grid Architecture study is intended to identify potential grid architecture changes over a longer time horizon. It is anticipated that any changes to the expense and capital investments required to meet recommendations that come from this study would occur in the 3-10 year window or even beyond. However, as the study is currently in the beginning stages, no findings have yet been determined.

7.3.1.3. Ignition Probability Mapping Showing the Probability of Ignition Along the Electric Lines and Equipment

WSD Initiative Definition: *Development and use of tools and processes to assess the risk of ignition across regions of the grid (or more granularly, e.g., circuits, spans, or assets).*

1) ***Risk to be mitigated / problem to be addressed:***

Ignition probability models, in conjunction with the Wildfire Consequence Model, can be used to determine and identify wildfire risk at specific grid locations. This information can also be used to identify which locations

[1] More information about the previous and planned activities of the Climate Resilience Team, which include many foundational work activities designed to integrate climate data into PG&E decision-making in appropriate cases, can be found in PG&E's 2020 Risk Assessment and Mitigation Phase Report (Chapter 20, Attachment A, Section A-4).

should be prioritized for specific initiatives and wildfire mitigations.

2) ***Initiative selection ("why" engage in activity)**: – include reference to a risk informed analysis on empirical (or projected) impact of initiative in comparison to alternatives*.

The ignition probability of distribution and transmission lines is a critical component to addressing and mitigating wildfire risk. While PG&E's mapping effort to date related to electric distribution facilities has been focused on risk where probability and consequences are combined, PG&E has the capability to create an ignition probability map. PG&E has developed a Vegetation Probability of Ignition Model and an Equipment Probability of Ignition Model. These models are described in more detail in Section 4.3 and PG&E's risk modeling in general is described in Section 4.5.1.

For transmission lines, predicted asset failure during windy conditions is modeled using the OA Model. Although this is not a direct ignition probability analysis for transmission lines, the asset failures modeled have the potential to cause an ignition. The OA Model is described in more detail in Section 4.5.1.

3) ***Region prioritization ("where" to engage activity) – include reference to a risk informed analysis in allocation of initiative (e.g., veg clearance is done for trees tagged as "high-risk"):***

The ignition probability data provides information that helps identify and delineate areas of increased probability of ignition. Once these areas are identified, PG&E can better plan and coordinate activities in those areas.

4) ***Progress on initiative (amount spent, regions covered) and plans for next year:***

The development of PG&E's Vegetation Probability of Ignition and Equipment Probability of Ignition Models in 2020 is described in detail in Section 4.3. Plans for the refinement of these models, as well as development of new transmission models and the 2022 Wildfire Distribution Risk Model and 2022 Wildfire Transmission Risk Model, are described in Section 4.5.1.

5) ***Future improvements to initiative:***

In 2021, PG&E's Vegetation Probability of Ignition and Equipment Probability of Ignition Models will see more improvements with another year of data (2020) to be incorporated.

ACTION PGE-25 (Class B)

1) Integrate discussion on long term planning within the respective section of each individual initiative.

Response:

The same long-term plan from Section 7.3.1.1 is applicable to this initiative

because ignition probability modeling is a subpart PG&E's wildfire risk modeling.

7.3.1.4 Initiative Mapping and Estimation of Wildfire and PSPS Risk-Reduction Impact

WSD Initiative Definition: *Development of a tool to estimate the risk reduction efficacy (for both wildfire and Public Safety Power Shutoff (PSPS) risk) and risk-spend efficiency of various initiatives*

1) ***Risk to be mitigated / problem to be addressed:***

Tools and models can be used to determine both the risk reduction effectiveness of wildfire mitigation initiatives and the use of PSPS to reduce wildfire risk, as well as the RSE of proposed initiatives. It is difficult to determine the impact of wildfire mitigation initiatives and the effectiveness of utilizing PSPS events without these types of tools and models.

2) ***Initiative selection ("why" engage in activity) – include reference to a risk informed analysis on empirical (or projected) impact of initiative in comparison to alternatives.***

For wildfire mitigation programs and initiatives, such as System Hardening or EVM, PG&E has developed the 2021 Wildfire Distribution Risk Model, which is described in detail in Section 4.5.1. PG&E is currently working on developing a 2022 Wildfire Distribution Risk Model which will provide the capability to compare wildfire risks for additional risk drivers as well as measuring the risk reduction for specific mitigation. As failure models for conductors, vegetation, poles, and other risk drivers are added to the 2022 Wildfire Distribution Risk Model, subject matter expertise can be developed to estimate the impact of the mitigation in reducing the ignition probability or the wildfire consequence portion of the wildfire risk at a given location. These general risk reduction values can be combined with general or specific cost estimates to determine the RSE for a given mitigation option at a given location. RSE values can provide valuable insights for improved risk informed decision making and program development. The 2022 Wildfire Distribution Risk Model will add the ability to estimate the reduction in the ignition probability due to a new or hardened conductor. This will provide improved insights for aligning the right mitigation for locations on the distribution grid.

For PSPS events, PG&E uses weather, fuel moisture, and Outage Producing Wind and Utility Fire Potential Index (FPI) Models which inform the decision as to whether a PSPS is necessary. These models are described in more detail in Section 4.2.A. These high-resolution historical datasets and forecasts are utilized in outage potential and fire potential index models, which are the main inputs into the framework PG&E utilizes to make the decision to execute a PSPS event.

For RSE scores for initiatives in the 2021 WMP, PG&E used its Enterprise Risk Model, as described in more detail in Section 7.1.A.

3) ***Region prioritization ("where" to engage activity) – include reference to a risk informed analysis in allocation of initiative (e.g., veg clearance is done for trees tagged as "high-risk")***

The prioritization and location of EVM and System Hardening initiatives is informed by the 2021 Wildfire Distribution Risk Model for the distribution system. For PSPS, PG&E does not prioritize by region as we use forecasts from models for the whole service territory and consider the appropriate scope for PSPS events.

4) ***Progress on initiative (amount spent, regions covered) and plans for next year***

The progress and development of PG&E's risk modeling is described in detail in Sections 4.3 and 4.5.1. The 2022 Wildfire Distribution Risk Model, expected to be finalized in 2021, will also add wildfire risk values for distribution line locations beyond the HFTD and HFRA areas to include all of PG&E's distribution lines.

5) ***Future improvements to initiative***

Future improvements to wildfire mitigation and PSPS risk models are described in Sections 4.2.A, 4.3, and 4.5.1.

ACTION PGE-25 (Class B)

1) Integrate discussion on long term planning within the respective section of each individual initiative.

Response:

While there is no formal long-term plan at this time, we have outlined a detailed approach in Sections 4.2A, 4.3, and 4.5.1 for future improvements in the next 2 years, which will focus on building out the modeling of risk drivers, improving the granularity of the model results, and providing risk reduction values for mitigation alternatives. As these focus areas are achieved, the continuous improvement of the wildfire risk models will shift to a more steady-state improvement driven by improvements in input and training data. These data improvements will enable model granularity to reach a span and asset level.

7.3.1.5 Match Drop Simulations Showing the Potential Wildfire Consequence of Ignitions That Occur Along the Electric Lines and Equipment

WSD Initiative Definition: *Development and use of tools and processes to assess the impact of potential ignition and risk to communities (e.g., in terms of potential fatalities, structures burned, monetary damages, area burned, impact on air quality and greenhouse gas, or GHG, reduction goals, etc.).*

1) Risk to be mitigated / problem to be addressed:

In addition to determining whether an ignition is likely to occur or not, it is

also critical to understand the impact and potential consequences of an ignition. Some ignitions may have minimal impact on the surrounding area and communities, while other ignitions could create significant risks including loss of life and property damage, as well as other wildfire related impacts such as air quality impacts. Tools and models can be developed to analyze these potential ignition impacts.

2) ***Initiative selection ("why" engage in activity) – include reference to a risk informed analysis on empirical (or projected) impact of initiative in comparison to alternatives.***

PG&E has undertaken the development of tools and models to better understand the impact of ignitions on surrounding areas and communities. In late 2019 and 2020, PG&E partnered with an external expert, Technosylva, in the wildfire modeling field to test and deploy cloud-based wildfire spread model capabilities to better understand the technology and to test integration into current decision support framework, such as PSPS. Each day, PG&E delivers its high-resolution 2 x 2 Kilometer (km) weather and fuels model data sets to Technosylva, which performs over 100 million fire spread simulations every three hours out 3 days. These simulations provide fire spread outputs (e.g., potential number of acres burned, and population impacted) and can be visualized per overhead circuit in forecast mode to determine the highest risk circuits every 3 hours. In Figures PG&E-7.3.1-1 and PG&E-7.3.1-2 below, PG&E provides an example output from the fire spread model application and example output from the fire spread model application.

PG&E also has the ability, through a Technosylva application called Wildfire Analyst Enterprise (WFA), to simulate fires on-demand. This involves selecting a location on a map, the start time of ignition and the simulation duration in hours. The Technosylva wildfire spread model uses the dynamic weather forecast of wind and fuel moisture to model how the wildfire may spread. This model framework and technology is also being utilized by other Investor-Owned Utilities in California, as well as California Department of Forestry and Fire Protection (CAL FIRE). This technology allows PG&E to forecast ~100 million virtual fires daily across the PG&E territory in forecast mode, simulate fires on demand as they start, simulate hypothetical fires based on PSPS damage and hazard reports, as well as simulate fires in past weather scenarios.

Finally, PG&E has also developed a Wildfire Consequence Model using the Technosylva fire simulations. This model, in combination with wildfire ignition probability models described above, are used in the 2021 Wildfire Distribution Risk Model for producing Multi-Attribute Value Function (MAVF)-calibrated risk scores. These scores can then be used to inform initiatives such as EVM and System Hardening.

3) ***Region prioritization ("where" to engage activity) – include***

reference to a risk informed analysis in allocation of initiative (e.g., veg clearance is done for trees tagged as "high-risk")

The Technosylva wildfire spread model results are available across all HFTD areas and the HFRA areas identified by PG&E.

4) Progress on initiative (amount spent, regions covered) and plans for next year

In 2020, PG&E and Technosylva made considerable improvements to the Technosylva wildfire spread model, which are outlined below.

1. Detailed Fuels Mapping for PG&E Service Territory
    - The fuel model map utilized in the fire spread model was significantly enhanced to fix known issues in the United States Forest Service LANDFIRE dataset; provide more granularity in the Wildland Urban Interface; and include recent fire scars through 2020.

2. Updated Weather Forecast 2km Data Integration
    - The PG&E Operational Mesoscale Modeling System (POMMS) 2 km weather forecast data was fully integrated into the wildfire spread model.

3. Territory wide risk
    - Another mode was developed to evaluate the fire risk not just as it pertains to PG&E's assets but the risk across the entire footprint of PG&E's territory.

4. Woody and Herbaceous Live Fuel Moisture (LFM) Remote Sensing Methods Analysis and Integration
    - Technosylva developed and integrated new LFM models that simulate the moisture available in the LFM woody and herbaceous fuels.

5. Climatological Risk Assessment
    - Technosylva completed a historical analysis from 2000 – 2019 and simulated over a billion fires over the worst >450 fire risk days. This analysis will help inform where the highest risk areas are across PG&E's service territory.

6. Integration with PG&E Fire Detection and Alert System
    - Data generated from PG&E's fire detection and alert system are delivered to Technosylva via an API and are now integrated into WFA. These detections are being shared with multiple parties including CAL FIRE and the utilities that also use WFA in California.

7. Integration with PG&E Amazon Web Services (AWS) cloud
    - Results from each Technosylva simulation are available on the PG&E cloud. This allows PG&E scientists to evaluate

the results of every single simulation out of the millions produced daily.

5) Future improvements to initiative:

In 2021, PG&E will continue to evaluate and test a methodology to incorporate fire spread model outputs into PSPS decision making and expand the forecast horizon from three to four days. We will also work with Technosylva to update the fuel model layers on an annual basis. This includes modeling new vegetation growth in recently burned areas as well as accounting for recent fire disturbances.

ACTION PGE-25 (Class B)

1) Integrate discussion on long term planning within the respective section of each individual initiative.

Response:

PG&E plans to evaluate developments in fire spread simulation technology that occur during the next 3 to 10 years. The technology used PG&E, described above, will likely updated with incremental improvements made by external vendors such as Technosylva and experts. We will also continue to evaluate how we use the output of these simulations internally. Improvements may include updates to fuel layer mapping, fuel moisture models, and risk outputs.

FIGURE PG&E-7.3.1-1 EXAMPLE OUTPUT FROM THE FIRE SPREAD MODEL APPLICATION – COLOR CODING REPRESENTS THE MAXIMUM FIRE SIZE SIMULATED FROM EACH OVERHEAD CIRCUIT

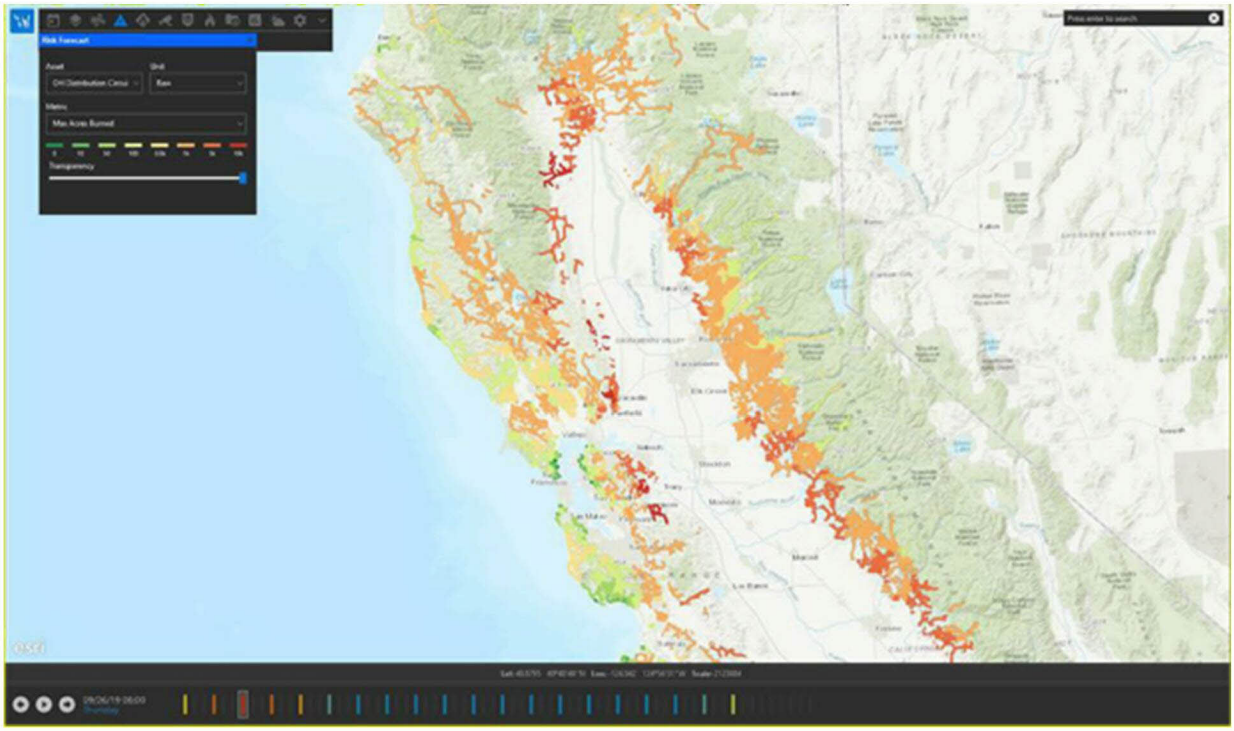
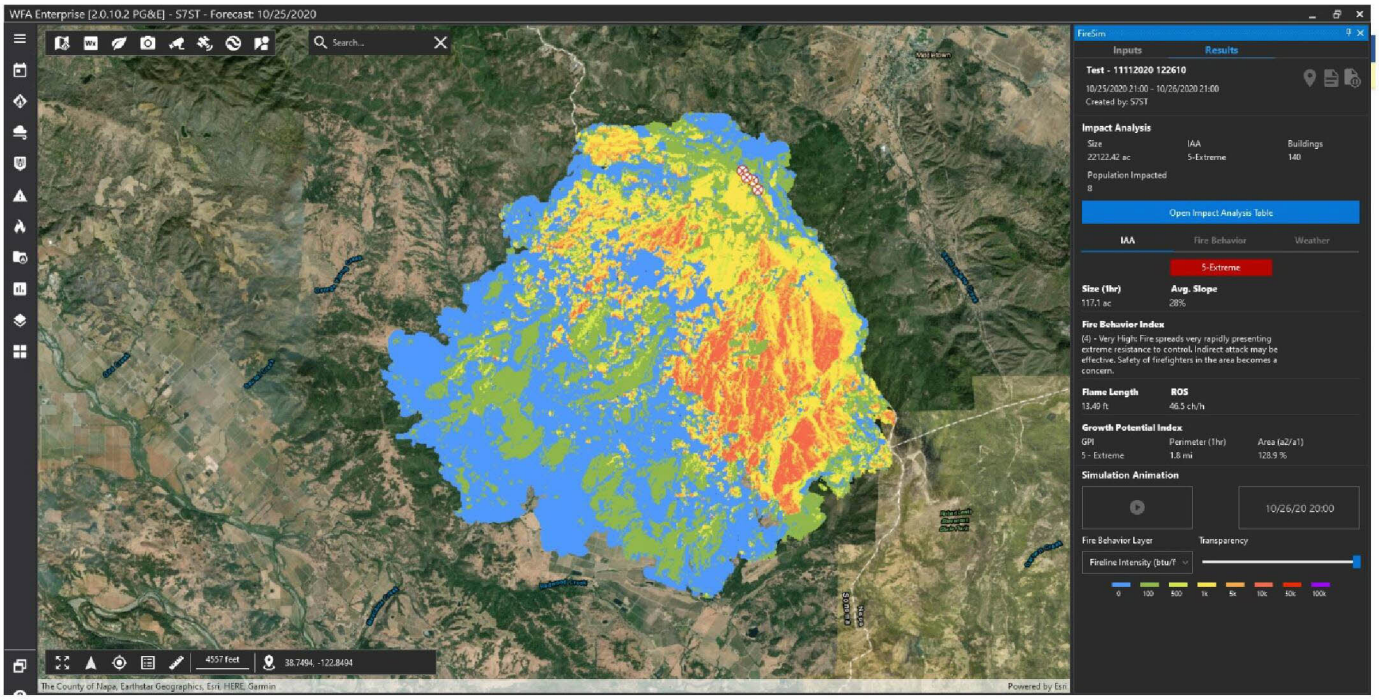


FIGURE PG&E-7.3.1-2: EXAMPLE OUTPUT FROM THE FIRE SPREAD MODEL APPLICATION



7.3.1.6 Weather-Driven Risk Map and Modelling Based on Various Relevant Weather Scenarios

WSD Initiative Definition: *A definition was not provided for this initiative in the WSD guidelines and templates. PG&E has provided a narrative to cover the scope of this initiative.*

1) ***Risk to be mitigated/problem to be addressed:***

   To gain better understanding of historical events as well as situational awareness of forecasted and real-time weather events, PG&E needs the ability to display weather model and risk information for model and data interpretation by subject matter experts.

2) ***Initiative selection ("why" engage in activity) – include reference to a risk informed analysis on empirical (or projected) impact of initiative in comparison to alternatives***

   PG&E has developed numerous historical, real-time and forecast weather-driven risk maps and visualizations that help inform operational decisions, including:

   - Weather model data output visualizations from PG&E high resolution weather model, POMMS at 2 x 2 km resolution.
   - Dead and Live Fuel Moisture model data available at 2 x 2 km resolution.
   - The Fire Potential Index internal web application, which shows the R1 to R5 FPI index rating for geographic area.
   - Weather model data output visualizations from external models including:
     - European Centre for Medium-Range Weather Forecasts
     - Global Forecast System
     - North American Mesoscale Model
     - High Resolution Rapid Refresh
     - Desert Research Institute California and Nevada Smoke and Air Committee Weather Research and Forecast model
   - North American Regional Reanalysis (NARR) weather plots from 1995 – 2020 accessible every 3 hours to visualize historic storms.
   - Real-time weather station data from over 1000 PG&E, National Weather Service (NWS) and Remote Automatic Weather Stations (RAWS) weather stations:
     - External visualizations from the National Oceanic and Atmospheric Administration-NWS Weather and Hazards Data Viewer and Mesowest
     - Internal Fosberg Fire Weather Index (FFWI) Page that shows the live FFWI for weather stations
   - Visualizations of PG&E's Large Fire Probability (LFP) Models in Tableau and ArcGIS Pro.
   - Visualizations from Technosylva Wildfire Analyst software, which

display wildfire spread consequence metrics.

- Near real-time lightning detection data from the PG&E Lightning Detection Network.
- GOES-West satellite views that show visible and infrared satellite data.

PG&E's weather modeling and risk mapping is described in more detail in Section 4.2.A.

3) ***Region prioritization ("where" to engage activity) – include reference to a risk informed analysis in allocation of initiative (e.g., veg clearance is done for trees tagged as "high-risk")***

There is no regional prioritization associated with this work. Weather maps and models are created for the entire PG&E service territory.

4) ***Progress on initiative (amount spent, regions covered) and plans for next year***

In 2020, PG&E deployed the latest version of its operational weather model, POMMS at 2 x 2 km resolution. This was built to be processed entirely on the AWS cloud. To that end, PG&E developed a model output visualization page where operational meteorologists can review forecast model data from each of the 4 model runs daily. These include maps of temperature, relative humidity, dewpoint, wind speed, winds gusts, precipitation, etc. Visualizations of Dead Fuel Moisture and LFM are available as well.

In 2020, PG&E also completed a 30-year historical weather and fuels climatology at 2 x 2 km resolution as well. This data was processed hour-by-hour by grid point to develop distribution functions that are used to put the forecast in perspective by translating forecasted wind speeds into percentiles based on these unique distributions.

PG&E also routinely updates its NARR archive maps once they become available from NCAR. These maps assist with storm forecasting as similar historical storm events can be studied in detail, as the impacts are known quantities, and compared against a forecasted event. This technique is called analog forecasting.

In 2020, PG&E also built visualizations of its LFP in Tableau and ArcGIS Pro. This allows operational meteorologists to visualize the LFP output across the entire PG&E territory.

5) ***Future improvements to initiative:***

PG&E will continue to leverage its current weather driven risk maps and modeling data to inform wildfire mitigation activities.

ACTION PGE-25 (Class B)

1) Integrate discussion on long term planning within the respective section of each individual initiative.

Response:

PG&E will continue to enhance our capabilities to visualize forecast and historical data over the long term. This includes creating interactive map displays where forecast data can be integrated with an interactive map platform as well as standard meteorological plots created using Python. We also plan to migrate our visualization platforms to the AWS cloud for scalability and redundancy. The risk maps are critical for our meteorologists to interpret and communicate the weather-related risks to internal and external stakeholders.