California Energy Commission

Draft Report

Product Management Plan

Project ID#: CEC EPC-18-026

October 28, 2019

Prepared for California Energy Commission
Prepared by Spatial Informatics Group, LLC

PYREGENCE™

Spatial Informatics Group

STATE OF CALIFORNIA
ENERGY COMMISSION

Primary Author:
Jean-Pierre Wack
Spatial Informatic Group
2529 Yolanda Court
Pleasanton, CA 94566

Contract Number: EPC-18-026
Prepared for: California Energy Commission

David Saah
Principal Investigator

Shane Romsos
Project Manager

Alex Horangic
Commission Agreement Manager

Laurie ten Hope
Deputy Director - Energy Research and Development Division

Drew Bohan
Executive Director

Gavin Newsom
Governor, State of California

Table of Contents

Acronyms and Abbreviations

CAWFE	Coupled Atmosphere-Wildland Fire Environment
CALFIRE	California Department of Forestry and Fire Protection
CAM	Commission Agreement Manager
CEC	California Energy Commission
Fire Lab	Missoula Fire Sciences Laboratory
GPL	General Public License
LANDIS-II	A Forest Ecosystem Computer Model for Simulating Growth, Succession, and Disturbance Effects
LUCAS	Land Use and Carbon Scenario Simulator – state and transition model for landuse, land cover, land management, and disturbance and their impacts on ecosystem carbon storage and flux.
REAX	Reax Engineering
SIG	Spatial Informatics Group
UC	University of California
UCB	University of California - Berkeley
UCAR/NCAR	University Corporation for Atmospheric Research/National Center for Atmospheric Research
UCM	University of California - Merced
USFS	United States Department of Agriculture – Forest Service
USGS	United States Geological Survey

Section 1. Introduction

Plan Purpose

The purpose of this Product Management Plan (PMP) is to detail how project products will be shared to the public over the duration of the CEC EPIC grant funding project - Comprehensive Open Source Development of Next Generation Wildfire Models for Grid Resiliency, EPC-18-026. The PMP addresses the requirements set out in Task 2 of the Scope of Work, (see Appendix 4). Table 1 summarizes how PMP addresses each of the requirements.

Table 1: Summary of Project Management Plan requirements and where they are addressed in this document

PMP Requirements in Task 2	**How the PMP addresses each requirement**
Address and describe all products in scope of work	Appendix 1 provides a comprehensive list and brief description of each product
How products are shared and made publicly available	Section 2: Table 2 details accessibility, hosting and archiving for categories of products, as set out in Appendix 1
How code will be made available through open source platform(s)	Section 3: Table 4 lists all code that will be developed and how it will be licensed open source
How code will not result in proprietary derivative works	Section 3: Table 4 confirms all code to be released under a GNU GPLv3 license
Potential tools to host on Cal-Adapt	Section 2: Discussion on potential tools to host on Cal-Adapt
Additional Information Covered	**How the PMP addresses each item**
Estimated size and type of file	Appendix 1 describes type of files for products, further information to be provided on potential size
Potential hosting sites aside from Cal-Adapt	Section 2: lists potential hosts and a brief summary of potential products to transfer

Project Background

The impacts of wildfires in California have intensified in the past decades. Community development patterns near wildlands has increased the amount of wildland-urban interface (WUI) in the state. Climate change and past forest management has led to wildland fuel conditions that have increased the likelihood of fire behavior that exceed the predictive power of existing wildfire models (i.e., existing fire models underestimate the intensity and spread characteristics of wildfires observed in recent years). Additionally, the impacts of wildfire on the investor-owned utilities' (IOUs) electric grid have resulted in

increased costs, reduced safety and weakened reliability to ratepayers — a situation that will likely worsen in a changing climate without improved mitigation strategies.

Wildfire science currently lacks sufficient information to forecast risk to natural and developed landscapes across California and are not able to predict extreme fire behaviors resulting from prolonged heat release by large woody fuels and deep duff layers typical of modern California forests. The current near-term risk fire-weather forecasts underestimate extreme weather events, surface fuel loads in elevated tree mortality areas and fire-spread dynamics due to omission of novel driving factors. For long-term planning, there is a lack of a comprehensive modeling framework to make mid- to late-century projections of fire risk. Consequently, IOUs, State agencies and stakeholders relying on the electric grid lack scientifically robust information and actionable insights to make effective near-term tactical and long-term planning decisions.

In Phase 1 of the project, the project team will advance wildfire science by incorporating the dynamics of tree mortality and weather information into next-generation wildfire models. The project team proposes to develop computationally efficient wildfire risk models to demonstrate the potential of the technologies to reduce the impacts of wildfire on the electricity grid. At both near- and long- term time horizons, the project team will compare different wildfire risk modeling approaches to converge on the best approach to developing the next generation of wildfire models. In Phase 2, the project team will integrate risk forecast models at IOUs and support the Fifth Climate Change Assessment with future fire projections. The wildfire risk models developed as part of the project will be deployed on an open-source platform providing free access to IOUs and other stakeholders. Figure 1 provides a simplified overview of the project's workflow.

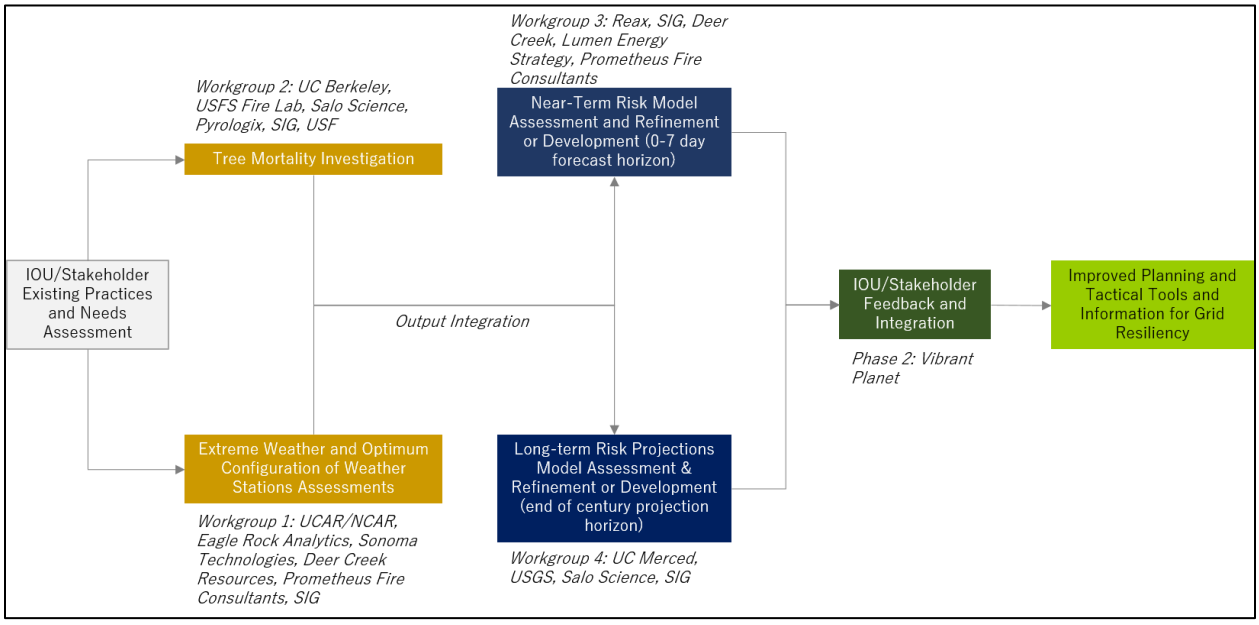

Figure 1. Overview of project workflow.

Section 2. Product Sharing and Access

The section addresses how products will be shared and made publicly available. The project team's intention is for all products to be made easily accessible to all interested parties. The various products are categorized in Table 2 along with how they will be hosted, accessed and archived. At a minimum, the project team will host products on public access servers for at least one year after project completion. Additional opportunities for hosting products are described in Table 3. For a list of products, description and category, see Appendix 1. Note that products will be further outlined for Phase 2 (as approved by CEC CAM), and similar sharing and access principles will be adopted at that time.

Table 2: Categories of products and explanation of how they be shared.

Product Category	Description	Access Type	Hosted	Duration of Archiving
Data Archives	All products from a Task, created at end of Task, including dataset, model, docker container, reports and user guide documentation	Public access	Hosted on an open access server	1-year post Task end date
Datasets	Typically, geospatial data layers or tabular data for model inputs, created at the outset of a Task	Primarily CEC and project team; public access as appropriate	Hosted on a server	For project duration
Models	A conceptual analysis framework, or process supported by programming or script code. In general, for this project, computer models are designed to simulate wildfire risk that will likely be experienced under different weather, environmental, landscape, an/or climate situations or scenarios.	Public access	Hosted on open access server, Github and code.ca.gov	1-year post Task end date; Permanently on Github and code.ca.gov
Model Outputs	Tabular and geospatial data resulting from Task model runs and analysis such as databases or maps	Public access	Hosted on an open access server	1-year post Task end date
Docker Containers	Executable package to install and run a model or program	Public access		
User Guides	Manuals to operate the analysis	Public access		
Reports	Documents, in pdf, types include report, summary, factsheet, briefings	CEC and/or public access	Direct to CEC	

Task 3 through Task 7 in the project's scope of work provide for a "dataset" to be produced at the beginning and a "data archive" at the end. The "data archive" will include the Task products and

relevant material to be able to replicate/reproduce the analysis, such as code and model inputs. The "dataset" is typically limited to the model inputs or outputs. The Project Team proposes that the initial "dataset" is given access to only CEC remotely via a weblink and the latter "data archive" be hosted for access by a wider audience as appropriate. For each "dataset" the Project Team will issue a schedule of the contents along with a brief description and source (e.g., fire perimeter maps from 2000 to 2019 from MTBS).

Where information can be accessed at an external source, guidance on how to access the information will be provided as part of the "Data Archive". For example, the weather data for near-term risk forecasts is available via National Weather Service and guidance on how to access it will be provided as part of the data archive and in the corresponding user guide documentation.

Opportunities to Host Data for Public Access

The following additional organizations have been identified as key organizations to further discuss hosting data for public access.

Table 3. Additional platforms for product access.

Organization	Name of Data Initiative	Type of Data and Link	Notes
California Energy Commission	Cal-Adapt	Tools: cal-adapt.org/data Datasets: cal-adapt.org/data Reports: cal-adapt.org/research	Further discussions required on types and size of data to be hosted
	Data Repository	Datasets: cal-adapt.org/data Reports: cal-adapt.org/research	
California Department of Technology / GovOps	California Open Data Portal	Datasets: Data.ca.gov	Instructions available online on how to access or host
	California Open Source Portal	Code: code.ca.gov	

Additional opportunities include, but are not limited to, the following:

- CALFIRE - Fire Resource Assessment Program (FRAP): Initial discussions underway for potential overlap or cross-link with FRAP.
- California Forest Observatory (https://salo.ai/observatory/): is a platform under development (project funded by the Moore Foundation) to host wildfire risk data. Initial discussions underway with Vibrant Planet and Salo Sciences (project team partners) are underway. Estimated timeline is June 2020 for an operational platform.
- California Fifth Climate Change Assessment: Further discussions with collaborators are needed to understand how data will be shared during preparation of the Fifth Climate Change Assessment and beyond.

Section 3. Code Licensing

All code developed with funding from this project will be made available under an open source GNU General Public License version 3 (GPL) license and further modifications of the code made under this agreement will be re-released under the GPL license. GPL is a widely used free software license that guarantees end users the freedom to run, study, share, and modify the software. The distribution terms of open-source program code will generally comply with the following opensource.org criteria:

Free Redistribution **-** The license shall not restrict any party from selling or giving away the software as a component of an aggregate software distribution containing programs from several different sources. The license shall not require a royalty or other fee for such sale.

Source Code **-** The program must include source code and must allow distribution in source code as well as compiled form. Where some form of a product is not distributed with source code, there must be a well-publicized means of obtaining the source code for no more than a reasonable reproduction cost, preferably downloading via the Internet without charge. The source code must be the preferred form in which a programmer would modify the program. Deliberately obscured source code will not be allowed. Likewise, intermediate forms such as the output of a preprocessor or translator are not allowed.

Derived Works **-** The license must allow modifications and derived works and must allow them to be distributed under the same terms as the license of the original software.

Integrity of The Author's Source Code - The license may restrict source-code from being distributed in modified form *only* if the license allows the distribution of "patch files" with the source code for the purpose of modifying the program at build time. The license must explicitly permit distribution of software built from modified source code. The license may require derived works to carry a different name or version number from the original software.

No Discrimination Against Persons or Groups - The license must not discriminate against any person or group of persons.

No Discrimination Against Fields of Endeavor - The license must not restrict anyone from making use of the program in a specific field of endeavor. For example, it may not restrict the program from being used in a business, or from being used for genetic research.

Distribution of License - The rights attached to the program must apply to all to whom the program is redistributed without the need for execution of an additional license by those parties.

License Must Not Be Specific to a Product - The rights attached to the program must not depend on the program's being part of a particular software distribution. If the program is extracted from that distribution and used or distributed within the terms of the program's license, all parties to whom the program is redistributed should have the same rights as those that are granted in conjunction with the original software distribution.

License Must Not Restrict Other Software - The license must not place restrictions on other software that is distributed along with the licensed software. For example, the license must not insist that all other programs distributed on the same medium must be open-source software.

License Must Be Technology-Neutral - No provision of the license may be predicated on any individual technology or style of interface.

For addressing code developed under this project, the project team has identified the following cases to differentiate how code is licensed:

- *New code developed for the project* - The new code would not be part of any declared pre-existing or pre-funded work by project team members. For example, the development of MaxEnt modelling to analyze optimal location of weather stations under Task 3.
- *Modifications and/or enhancements to pre-existing code* - New code developed as a modification/enhancement of pre-existing code declared in the Master Agreement. For example, the enhancement of GRIDFIRE and ELMFIRE to provide near-term risk forecasts in Task 6. Pre-existing code declarations were made as part of the Master Agreement and are included in Appendix 2, for reference.

Table 4 provides a list of code being implemented or developed during the program. For each instance, the table summarizes how the code is/will be licensed. Code that is shared for public access is addressed in Section 2. Note that code produced under the project will be characterized into:

- Programs: a self-enclosed set of code which can be executed independently. For example, GRIDFIRE and ELMFIRE run as independent programs
- Scripts: a set of code that runs on a third-party platform. For example, the modelling for LANDIS-II is a set of code that gives tasks/processes to the LANDIS-II program

Products from Pre-existing Intellectual Property

Several products will be delivered using software that was developed by the Project Team before EPIC grant funding or was separately funded to this project. In these instances, the software will remain proprietary to the existing owners and the outputs will be owned by the CEC. For example, Task 3 will use the CAWFE model to output fine-scale weather patterns for historical fire events. The CAWFE model will retain the pre-existing ownership and license and the outputs will be part of the Products for Task 3. The instances where software developed outside of the agreement is being used to generate products include:

- CAWFE to generate fine-scale weather patterns
- Salo to generate contemporary tree mortality maps

See Appendix 2 for the pre-existing IP declared as part of the Agreement.

Table 4. List of program or script code and associated licenses organized by workgroup that is expected to be implemented as part of this project.

Name	Pre-existing IP declared	Program (P) or Script (S)	License	Developed By	Comments
Workgroup #1					
Coupled Atmosphere-wildland Fire Environment (CAWFE)	Yes	(P)		UCAR	Only the product of the model to be funded by the program, the model has already been developed with external funding.
MaxEnt		(S)	GPL	CEC	
Workgroup #2					
UCB #1		(S)	GPL	UCB	Scripts developed for fuel projections over 20 years
NetMortality	Yes	(P)	Closed source	Salo	Only the product of the model to be funded by the program, the model has already been developed with external funding.
WG#2 fuel model(s)		(P) or (S)	GPL	USFS Fire Lab	The final product has not yet been determined.
Workgroup #3					
Weather pipeline		(P)	GPL	CEC	Program to be developed based on pre-existing work by Reax/SIG
ELMFIRE	Yes	(P)	GPL	REAX	Pre-existing program to be enhanced with CEC funds
GRIDFIRE	Yes	(P)	GPL	SIG	Pre-existing program to be enhanced with CEC funds
Workgroup #4					
Projections in LUCAS		(S)	GPL	USGS	Scripts to be developed under CEC funding. Scripts run on a proprietary platform
Projections in LANDIS-II		(S)	GPL	UNM	Scripts to be developed under CEC funding. Scripts run on an open source platform
USGS – Machine Learning		(S)	GPL	USGS	The final product is not yet determined
WG#4 – Long-term projection model		(P) or (S)	GPL	UC Merced	The final product is not yet determined

Trademarks

Trademark with existing products, such as ELMFIRE and GIDFIRE, will be owned and maintained by the current owner(s).

Use of Proprietary Platform

For Workgroup #4, the LUCAS model will process data on a proprietary platform. All code developed under the project will be released under a GPL and published on GitHub. However, to re-produce the analysis, individuals will have to access this proprietary platform.

Appendix 1 - Product Descriptions by Project Workgroup or Team

Workgroup #1 Products

Product	Description	Due Date	Product Category	Product Sub Category	Task	Lead Workgoup
Upper-air Profiler Test Plan	Is a workplan that includes: Objectives of the test; Site location; and Procedures for sharing data collected	9/30/2019	Report	Plan	3	WG1
Site Recommendation Methodology Framework and Baseline Needs Assessment Summary	A summary report that includes: relevant information or data assembly needed (includes: meetings with IOUs to gather information see Task 8); Process for evaluating information; Description of the evaluation outcomes; Description of considerations to identify priorities; Analysis of the existing weather station(s) and utility-planned network(s); Analysis of expected budget for weather stations at two-year and ten-year cycle; and Assessment of the data gaps and needs.	4/3/2020	Report	Summary	3	WG1
Weather Station Network Dataset	A dataset that includes - Atmospheric analyses and surface data; Data on fuels; Topography; Access (administrative boundaries and property rights); Electric utility assets at risk (public data from Cal-Adapt and information shared by the utilities); Existing weather/telecom/detection towers; and Weather stations.	4/3/2020	Dataset		3	WG1
Extreme Weather Historical Pre-Analysis Spatial Dataset	A dataset of historical weather data for major California weather and fire events. Analysis will include the various fuel types found in the three IOUs, e.g. chaparral, coastal forest, and Sierra conifer forest. Emphasis to be placed on wildfires that have damaged electricity system to find regional patterns.	9/25/2020	Dataset		4	WG1
Guidance on Using Upper-air Profiler Report	A document that includes guidance on: Leveraging upper-air profiler data to improve weather forecasts; Enhance situational awareness of high-wind events; Designing, deploying, and maintaining profiler networks; Integrating upper-air profiler into a data management system, similar to current operating practices in IOUs; and Comparison of	4/5/2021	Report		3	WG1

Product	Description	Due Date	Product Category	Product Sub Category	Task	Lead Workgoup
	data with other meteorological studies on upper-air profilers use in wildfire risk areas.					
Weather Station Network Optimization Data Archive	A data archive that includes: Data layers showing the optimal locations for weather stations; Data layer showing identified 'warning areas' and 'danger sites'; Source code for the MaxEnt or similar modeling; Atmospheric (re)analyses and surface data; Data on fuels; Topography; Access (administrative boundaries and property rights); Electric utility assets at risk through collecting public data from Cal-Adapt and from IOUs; Existing weather/telecom/detection towers; and Weather stations.	6/25/2021	Archive		3	WG1
Optimal Location of Weather Stations Report	A report that includes: Recommendations for improvements to the weather station network; Description of 'warning areas' and 'danger sites'; Cost evaluation of surface weather station locations for capital, maintenance and bandwidth costs; and Guidance for expanding the recommended sites.	6/25/2021	Report		3	WG1
Extreme Weather Historical Data Archive	The data archive will include: Dataset of outputs that identifies environmental conditions associated with major fires in the past overlaid with areas of heightened risk for different types (e.g. wind-driven vs. plume-driven) of fires; and Complete source code, database and analysis outputs.	6/25/2021	Archive		4	WG1
Extreme Weather Historical Analysis Report	a Report that summarizing the findings from Task 4, including the factors influencing wind-driven and plume-driven events for major historical fires in the State.	6/25/2021	Report		4	WG1

Workgroup #2 Products

Product	Description	Due Date	Product Category	Product Sub Category	Task	Lead Workgoup
State of Wildfire Science Report	A summary report that includes: A description of the state of wildfire science and its application for forecasting fire risk in California; and A summary of research objectives and outcomes of Task 5 and how they relate to the development of the next generation of wildfire risk models.	1/17/2020	Report		5	WG2
Contemporary Tree Mortality Dataset	A dataset that includes a spatially explicit data layer of areas of elevated tree mortality (observed and modelled)	4/9/2021	Dataset		5	WG2
Tree Mortality Fuel Projection Dataset	A dataset that includes: An analysis of fuel conditions for plots in Sequoia and Kings Canyon National Parks, or other locations as approved in advance by the CAM, combining ground-based and aerial LiDAR with field-based analysis; and A description of fuel strata as a set of distributions that specify cover, patch size, departure from randomness, and overlap among vertical strata.	6/25/2021	Dataset		5	WG2
Tree Mortality Data Archive	A data archive that includes a set of data layers describing areas of elevated tree mortality and current/projected fuel loads.	6/25/2021	Archive		5	WG2
Tree Mortality Evaluation Summary	A summary report that includes: A qualitative evaluation of the impacts of elevated tree mortality and surface fuel buildup on fire risk over 20 years; An evaluation of the opportunities for enhancing near-term and long-term fire risk forecasts and projections using the knowledge developed under Task 5; A description of a new fuel measurement and mapping system and models of non-steady fire spread and behavior; A summary of the findings of the laboratory simulations; and recommendations on the next research steps for advancing knowledge, tools and technologies for assessing fuel loads, fire spread and locations of elevated tree mortality.	6/24/2022	Report	Summary	5	WG2

Workgroup #3 Products

Product	Description	Due Date	Product Category	Product Sub Category	Task	Lead Workgoup
Near-Term Risk Forecast Baseline Needs Assessment Summary	A report that summarizes the IOU and stakeholder needs related to Near-Term Risk Forecast modeling outputs	1/17/2020	Report	Summary	6	WG3
Near-Term Risk Forecast Data Archive	Includes a data archive and web-based platform that can be used to distribute project outputs to IOUs and collect IOU electric asset and analysis information. The web-based platform will include the following features: A function to upload GIS data, source code, outputs and analysis; A function for IOUs to upload pertinent data and view Task outputs; and A function for separating proprietary and public domain data; Near-Term Risk Forecasts Outputs for 1) examples of forecasted risk to electric grid assets on a near-term time horizon and 2) estimated fire threat from ignitions from electric assets; Near-Term Risk Forecasts Docker Container which will include a single package to deploy the version 2 near-term risk forecasts on conventional High Performance Computing (HPC) resources; Near-term Risk Forecasts User's Guide to provide guidance on deploying, running, analyzing and visualizing the Near-Term Risk Forecast outputs; and Set of open-source code for models.	1/17/2020	Archive		6	WG3
Near-Term Risk Forecast Dataset	A dataset that includes: Data for fuels, topography and weather across the State; Data for a sample of major historical fires including ignition location, fire progression maps and downscaled weather conditions; Maps of electricity assets and damage to electricity assets from wildfire that are publicly accessible; Data on building footprints; and Source code and guidance documentation for existing open-source risk forecast models GRIDFIRE and ELMFIRE (or similar models approved by the CAM)	4/3/2020	Dataset		6	WG3
Near-Term Risk Forecast Modelling Framework Summary	A summary report that describes the steps and components that will be used for Near-Term Risk Forecast Modelling.	6/26/2020	Report	Summary	6	WG3
Decision-support Tool Brief	A briefing document that describes how the project team will integrate Task 6 products into operating practices at IOU and stakeholder institutions during Phase 2 of the project.	9/17/2021	Report	Summary	6	WG3

Product	Description	Due Date	Product Category	Product Sub Category	Task	Lead Workgoup
Near-term Risk Forecast Integration Workplan - Phase II	A workplan that describes activities needed to integrate risk forecasts into IOU operating practices that minimally includes: Summary of the current products available; and Objectives, outcomes and schedule to integrate near-term forecasts at each of the IOUs.	3/17/2022	Report	Plan	9	WG3
Near-term Risk Forecast Cost Benefit Analysis Fact Sheet	A summary document that highlights the potential cost and benefits of implementing the Near-term Forecast model/tool at IOUs or otherwise.	4/8/2022	Report	Factsheet	6	WG3
Near-term Risk Forecasts User's Guide	A guidance document on deploying, running, analyzing and visualizing the Near-Term Risk Forecast outputs; and Set of open-source code for models.	6/27/2022	Report	User Guide	6	WG3
Near-term Risk Forecast Outputs	Outputs from the near-term forecast models that includes: 1) examples of forecasted risk to electric grid assets on a near-term time horizon and 2) estimated fire threat from ignitions from electric assets	6/27/2022	Dataset		6	WG3
Near-term Risk Forecast Cost-benefit Analysis Factsheet	A summary document that highlights the potential cost and benefits of implementing the Near-term Forecast model/tool at IOUs or otherwise.	2/3/2023	Report	Factsheet	9	WG3
Near-term Risk Forecast: Evaluation of Performance and Recommendations Summary	A summary document that minimally includes: A review of gaps, needs and potential next steps for developing near-term risk forecasting and the wildfire science that supports the forecasts; and A summary of lessons learned and recommendations.	4/5/2023	Report	Summary	9	WG3
Near-term Risk Forecast Data Archive - Phase II	A data archive that minimally includes: A revision of the Near-term Risk Forecast Outputs; An update of the Near-term Risk Forecast Docker Container; Update the Near-term Risk Forecast User's Guide Documentation; and A set of open-source code for models.	6/26/2023	Archive		9	WG3

Workgroup #4 Products

Product	Description	Due Date	Product Category	Product Sub Category	Task	Lead Workgoup
Long-term Risk Projections Baseline Needs Assessment Summary	A report that summarizes the IOU and stakeholder needs related to Long-Term Risk Projection scenarios and modeling outputs	1/17/2020	Report	Summary	7	WG4
Long-term Risk Projections Modeling Framework Summary	A summary report that describes the steps and components that will be used for Long-Term Projection Modelling.	6/26/2020	Report	Summary	7	WG4
Long-term Risk Projections Dataset	A dataset that minimally includes: A database of major historical fires including ignition location, fire progression maps and downscaled weather conditions; and A dataset of electricity assets, building footprints and climate projections.	6/26/2020	Dataset		7	WG4
Planning Support Tool Design Brief	A briefing document that describes how the project team will integrate the Task 7 products into State Agency and stakeholder planning practices during Phase 2.	9/17/2021	Report	Summary	7	WG4
Long-term Risk Projections Workplan - Phase II	A workplan that described the activities relating to supporting the Fifth Assessment collaborators with wildfire risk projections that minimally includes: A summary of the current products and a specification of the scenarios to be run for each of the collaborators; and A specification of the web-based planning support tool.	3/17/2022	Report	Plan	10	WG4
Long-term Risk Projections Data Archive	A data archive that can be used to distribute Task 7 outputs that minimally include: A dataset containing the modeling outputs from the comparative analysis, baseline projections and iterations as an exemplar of the model outputs; A feature for Recipient to upload information and stakeholders to view project outputs; and A set of open-source code for models. Where datasets produced by third parties are available and accessible, guidance on how to access the dataset to be provided, instead of stored in the dataset.	6/27/2022	Archive		7	WG4

Product	Description	Due Date	Product Category	Product Sub Category	Task	Lead Workgoup
Long-term Risk Projections Planning Support Tool	A web-based planning tool that user can use to show different wildfire risk scenarios	4/10/2023	Tool	Website	10	WG4
Long-term Risk Projections Planning Support Tool Docker Container	A docker that will allow Cal-Adapt or other organizations to deploy the next generation Long-term Risk Projections (version 2) on conventional HPC resources.	6/26/2023	Tool	Docker	10	WG4
Long-term Risk Projections Planning Support Tool User's Guide Documentation	A user guidance document that describes deploying, running, analyzing and visualizing the planning support tool outputs	6/26/2023	Report	User Guide	10	WG4
Long-term Risk Projections Data Archive - Phase II	Update version of the Phase 1 long-term data archive that includes 10 output scenarios	6/26/2023	Archive		10	WG4

Outreach Team

Product	Description	Due Date	Product Category	Product Sub Category	Task	Lead Workgoup
User Engagement Workshops; Stakeholder Workshops, IOU meetings (Phase 1)	Meeting notes that capture the input and outcomes of User Engagement meetings	Dates to be confirmed by Project Team	Meetings	Notes	8	Outreach
User Needs Assessment Summary (Phase 1)	A report that summarizes the outcomes of User Engagement meetings	6/26/2020	Report	Summary	8	Outreach
User Integration Workshops; Stakeholder Workshops (Phase 2)	Meeting notes that capture the input and outcomes of User Integration meetings	Dates to be confirmed by Project Team	Meetings	Notes	11	Outreach
Integration Workshop Summary (Phase 2)	A report that summarizes the actionable outcomes from integration meetings	4/10/2023	Report	Summary	11	Outreach

Administration Team

Product	Description	Due Date	Product Category	Product Sub Category	Task	Lead Workgoup
Kick-off Meeting Benefits Questionnaire	Project team responses to CEC benefits questionnaire	7/8/2019	Report	Questionnaire	12	Admin
Draft Initial Fact Sheet	Draft initial project factsheet - containing salient project elements	7/26/2019	Report	Factsheet	13	Admin
Final Initial Fact Sheet	Final initial project factsheet - containing salient project elements	10 working days after comments from CAM	Report	Factsheet	13	Admin
Draft Technology/Knowledge Transfer Plan	Draft plan that includes: An explanation of how the knowledge gained from the project will be made available to the public, including the targeted market sector and potential outreach to end users, utilities, regulatory agencies, and others: A description of the intended use(s) for and users of the project results; Published documents, including date, title, and periodical name; Copies of documents, fact sheets, journal articles, press releases, and other documents prepared for public dissemination. These documents must include the Legal Notice required in the terms and conditions. Indicate where and when the documents were disseminated; A discussion of policy development. State if project has been or will be cited in government policy publications or used to inform regulatory bodies; The number of website downloads or public requests for project results; Additional areas as determined by the CAM.	9/30/2019	Report	Plan	13	Admin
Final Technology/Knowledge Transfer Plan	Final version of the Technology/Knowledge Transfer Plan	10 working days after comments from CAM	Report	Plan	13	Admin
Draft Product Management Plan	Draft report describing how the products will be shared and be accessed by the public, including licensing terms for code	10/28/2019	Report	Plan	2	Admin

Product	Description	Due Date	Product Category	Product Sub Category	Task	Lead Workgoup
Final Product Management Plan	Final report describing how the products will be shared and be accessed by the public, including licensing terms for code	10 working days after comments from CAM	Report	Plan	2	Admin
CPR Report #1	A report that 1) discusses the progress of the Agreement toward achieving its goals and objectives and 2) includes recommendations and conclusions regarding continued work on the project.	10/1/2020	Report	Summary	1	Admin
Mid-term Benefits Questionnaire	Project team responses to CEC benefits questionnaire	2/10/2021	Report	Questionnaire	12	Admin
CPR Report #2	A report that 1) discusses the progress of the Agreement toward achieving its goals and objectives and 2) includes recommendations and conclusions regarding continued work on the project. The CPR meeting #2 will be the "Go or No-Go" decision point on whether Phase 2 proceeds.	10/1/2021	Report	Summary	1	Admin
CPR Report #3	A report that 1) discusses the progress of the Agreement toward achieving its goals and objectives and 2) includes recommendations and conclusions regarding continued work on the project.	3/10/2023	Report	Summary	1	Admin
Draft Final Report Outline	Draft report outline for comprehensive final report - need to be approved from CEC CAM.	5/30/2023	Report	Outline	1	Admin
Final Report Outline	Final report outline for comprehensive final report that has to be approved by CEC CAM.	As determined by the CAM	Report	Outline	1	Admin
Draft Final Report	Draft comprehensive final report based on final report outline. Needs to be approved by CEC CAM	8/31/2023	Report		1	Admin
Draft Technology/Knowledge Transfer Report	A draft report that summarizes the technology/knowledge transfer activities	9/26/2023	Report	Summary	13	Admin
Final Technology/Knowledge Transfer Report	A report that summarizes the technology/knowledge transfer activities	10 working days after comments from CAM	Report	Summary	13	Admin
Final Report	Final comprehensive report that has been approved by CEC CAM.	10/27/2023	Report		1	Admin

Product	Description	Due Date	Product Category	Product Sub Category	Task	Lead Workgoup
Draft Final Project Fact Sheet	Draft final project factsheet - containing salient project elements and findings	10/31/2023	Report	Factsheet	13	Admin
Final Project Fact Sheet	Final project factsheet - containing salient project elements and findings	10 working days after comments from CAM	Report	Factsheet	13	Admin
Final Meeting Benefits Questionnaire	Project team responses to CEC benefits questionnaire	1/8/2024	Report	Questionnaire	12	Admin

Appendix 2 - Pre-existing Intellectual Property

The following information is copied directly from the Master Agreement sections addressing pre-existing Intellectual Property.

Project-Relevant Pre-Existing Intellectual Property and Project-Relevant Independently Funded Intellectual Property

The Recipient has identified the following items as "project-relevant pre-existing intellectual property" and/or "project-relevant independently funded intellectual property," as defined in Sections 20 (Pre-Existing and Independently Funded Intellectual Property) and 25 (Definitions) of these terms and conditions. The Commission makes no ownership, license, or royalty claims to this property, and may only access it for the purposes described in Section 20.

Name/Title of Intellectual Property	**GridFire**
Type of Intellectual Property	☒ Project-relevant pre-existing intellectual property ☐ Project-relevant independently funded intellectual property
	☐ Invention ☐ Process ☐ Technology ☐ Technique ☐ Design ☐ Work of Authorship ☐ Drawing ☐ Trademark/ Service mark ☐ Data ☐ Logo ☒ Software ☐ Formula
Registered or Pending Intellectual Property (i.e., copyrights, patents, or trademarks that are registered or pending with the U.S. Copyright Office or the U.S. Patent and Trademark Office)	☐ Copyright ☐ Patent ☐Trademark/ Service mark Name of owner:
	For pending applications Name of applicant: Application number and date:
Unregistered Intellectual Property	☒ Copyright ☐ Trademark/ Service mark ☐ Trade Secret of owner: Gary Johnson, Spatial Informatics Group er and date: Not applicable
Description of how the property will be or has been used to support a premise, postulate, or conclusion referred to or expressed in any product under the Agreement	GridFire is a high performance, cluster-scalable, monte-carlo wildland fire behavior simulator. Computes fire spread rates, burned areas, flame lengths, and fire line intensities of individual fires grown in the simulation and calculates aggregate statistics for each monte carlo run. This software is written and distributed as a Literate Program, which fully documents the entire modelling process in English, including all mathematical equations and literature cited.

	GridFire will be used in Task 5 to enhance wildfire risk models and Task 8 to provide near-term risk forecasts to Independent Owned Utilities (IOUs). GridFire is currently licensed under a GNU General Public License v3 and available on GitHub. Any changes to source code that is currently being licensed under the GNU General Public License (GPL) will be made through a Contributor's Agreement with joint copyright ownership being assigned to the CEC and the author of the pre-existing source code that is being modified.

Name/Title of Intellectual Property	**CAL FIRE MAP 1**
Type of Intellectual Property	☒ Project-relevant pre-existing intellectual property ☐ Project-relevant independently funded intellectual property
	☐ Invention ☐ Process ☐ Technology ☐ Technique ☐ Design ☐ Work of Authorship ☐ Drawing ☐ Trademark/ Service mark ☐ Data ☐ Logo ☒ Software ☐ Formula
Registered or Pending Intellectual Property (i.e., copyrights, patents, or trademarks that are registered or pending with the U.S. Copyright Office or the U.S. Patent and Trademark Office)	☐ Copyright ☐ Patent ☐Trademark/ Service mark Name of owner:
	For pending applications Name of applicant: Application number and date:
Unregistered Intellectual Property	☒ Copyright ☐ Trademark/ Service mark ☐ Trade Secret Name of owner: Gary Johnson, Spatial Informatics Group Number and date: Not applicable
Description of how the property will be or has been used to support a premise, postulate, or conclusion referred to or expressed in any product under the Agreement	CALFIRE MAP 1: All data, documentation, and scripts related to computing maps of extreme fire risk and severity for the state of California using WRF-derived extreme fire weather values and LANDFIRE topography and fuels layers. The fire behavior data generated for these maps was created by running GridFire in a large monte-carlo simulation. CALFIRE MAP 1 outputs will be used in Task 5 to enhance wildfire risk models and Task 8 to provide near-term risk forecasts to Independent Owned Utilities (IOUs).

Name/Title of Intellectual Property	Coupled Atmosphere-Wildland Fire Environment (**CAWFE)**
Type of Intellectual Property	☒ Project-relevant pre-existing intellectual property ☐ Project-relevant independently funded intellectual property
	☐ Invention ☐ Process ☐ Technology ☐ Technique ☐ Design ☐ Work of Authorship ☐ Drawing ☐ Trademark/ Service mark ☐ Data ☐ Logo ☒ Software ☐ Formula
Registered or Pending Intellectual Property (i.e., copyrights, patents, or trademarks that are registered or pending with the U.S. Copyright Office or the U.S. Patent and Trademark Office)	☐ Copyright ☐ Patent ☒Trademark/ Service mark Name of owner: University Corporation for Atmospheric Research (UCAR)/National Center for Atmospheric Research (NCAR)
	For pending applications Name of applicant: Application number and date:
Unregistered Intellectual Property	☒ Copyright ☐ Trademark/ Service mark ☐ Trade Secret Name of owner: University Corporation for Atmospheric Research/ Number and date: Not applicable
Description of how the property will be or has been used to support a premise, postulate, or conclusion referred to or expressed in any product under the Agreement	CAWFE is a coupled numerical weather prediction - fire behavior computer modeling software system. CAWFE computes the changing atmospheric state variables (air velocities, temperature, pressure, humidity, etc.), the advancement of a wildland fire, the heat release rate produced by the fire, and how these in turn change the atmospheric state. The system includes preprocessing software that gathers and projects weather analyses or forecasts, terrain elevation data, fuel data, and fire mapping data onto the model computational grid. It also includes post-processing software used for analysis and visualization of model output. For this project, the National Center for Atmospheric Research (UCAR/NCAR) anticipates using pre-existing IP including the CAWFE modeling system and previously completed simulations, analyses, animations, and publications of wildland fire events that occurred in

	California, including the 2017 North Bay Fires, the Thomas Fire, the Camp Fire, and Esperanza Fire, the Simi Fire, and the King Fire. Simulations of other events, to be completed for other sponsored projects, may be leveraged for this project. UCAR/NCAR will use CAWFE in Tasks 3 and 4 to simulate fine-scale airflows in complex terrain to identify areas at risk of extreme wind speeds and siting of weather stations and in Task 3 and 4 to identify the causes underlying a sample of large fire events. CAWFE is open source software that is released by UCAR/NCAR under the BSD 3-Clause License.

Name/Title of Intellectual Property	**ELMFIRE**
Type of Intellectual Property	☒ Project-relevant pre-existing intellectual property ☐ Project-relevant independently funded intellectual property
	☐ Invention ☐ Process ☐ Technology ☐ Technique ☐ Design ☐ Work of Authorship ☐ Drawing ☐ Trademark/ Service mark ☐ Data ☐ Logo ☒ Software ☐ Formula
Registered or Pending Intellectual Property (i.e., copyrights, patents, or trademarks that are registered or pending with the U.S. Copyright Office or the U.S. Patent and Trademark Office)	☐ Copyright ☐ Patent ☐Trademark/ Service mark Name of owner:
	For pending applications Name of applicant: Application number and date:
Unregistered Intellectual Property	☒ Copyright ☐ Trademark/ Service mark ☐ Trade Secret Name of owner: Chris Lautenberger, Reax Engineering Number and date: Not applicable
Description of how the property will be or has been used to support a premise, postulate, or conclusion referred to or expressed in any product under the Agreement	ELMFIRE is a high performance, cluster-scalable, monte-carlo wildland fire behavior simulator. Computes fire spread rates, burned areas, flame lengths, and fire line intensities of individual fires grown in the simulation and calculates aggregate statistics for each monte carlo run. ELMFIRE will be used in Task 6 to enhance wildfire risk models and Task 9 to provide near-term risk forecasts to Independent Owned Utilities (IOUs).

	ELMFIRE is currently licensed under a MIT Opensource license and available on GitHub.

Name/Title of Intellectual Property	**NetMortality**
Type of Intellectual Property	☒ Project-relevant pre-existing intellectual property ☐ Project-relevant independently funded intellectual property
	☐ Invention ☐ Technology ☐ Design ☐ Drawing ☒ Data ☒ Software ☐ Formula
Registered or Pending Intellectual Property (i.e., copyrights, patents, or trademarks that are registered or pending with the U.S. Copyright Office or the U.S. Patent and Trademark Office)	☐ Copyright ☐ Patent ☐Trademark/ Service mark Name of owner:
	For pending applications Name of applicant: Application number and date:
Unregistered Intellectual Property	☒ Copyright ☐ Trademark/ Service mark ☐ Trade Secret Name of owner: Salo Sciences, Inc. Number and date: Not applicable
Description of how the property will be or has been used to support a premise, postulate, or conclusion referred to or expressed in any product under the Agreement	NetMortality is a deep learning-based algorithm that automatically identifies standing tree mortality in satellite imagery. It delineates individual dead tree crowns in high resolution imagery and estimates the density of dead trees (i.e. the proportion of area covered) in moderate to low resolution imagery. The NetMortality system includes both software and the derivative data produced by the software. NetMortality will be used in Task 5 to quantify the extent of current mortality, parameterize fuels models, and forecast future mortality. NetMortality is currently licensed under a Creative Commons 4.0 BY-NC-SA license, and is hosted and run on Salo Sciences, Inc.'s cloud computing infrastructure.