CALIFORNIA ENERGY COMMISSION

Energy Research and Development Division

Comprehensive Open-Source Development of Next Generation Wildfire Models for Grid Resiliency

Phase II - Near-term Risk Forecast Cost-benefit Analysis Factsheet

PYREGENCE™

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Gavin Newsom, Governor
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Introduction

The following provides a Phase II update to the April 2022 "*Near-term Risk Forecast Cost-benefit Analysis Factsheet"* based on study team achievements and stakeholder feedback since then. This document follows the CEC's factsheet template dated February 2020.

Appendix A presents a case study, first developed in April 2022, of the net benefits of reduced data latency on utility pole pretreatments made possible by the Pyregence near-term fire forecasting tool (PyreCast) and associated models. Some descriptions of inputs and assumptions to the case study are refined for clarity based on comments and feedback from the CEC.

Cost/Benefit Factsheet

Comprehensive Open-Source Next Generation Wildfire Science and Models for Grid Resilience

The Issue

Today's prevailing wildfire behavior and risk models are in urgent need of scientific advancement in order to support effective wildfire risk mitigation decisions and safe, reliable, and cost-effective electricity service. Notably, these models (a) are built upon on a 1972 Rothermel fire surface spread equation not originally intended for mitigation activities and emergency response as it is used today, (b) have no basis for predicting extreme fire behavior we observe in the state, and (c) rely on outdated landscape data. Furthermore, the prevailing models are developed behind intellectual property walls that create barriers to interagency coordination on wildfire risk management, and to a broad and common understanding of this major threat to safe, reliable, and cost-effective electricity service.

Project Innovation + Advantages

The Pyregence consortium formed under the CEC's EPIC grant EPC-18-026 with a mission to advance wildfire science and build next-generation wildfire forecasting tools. Guided by an open-source philosophy, the consortium is making the tools free and available to all, while also providing access to all underlying model inputs and datasets. The consortium is composed of leading researchers from 18 institutions across industry, academia, and government, as well as software developers and designers.[1]

The "Pyregence study," funded by EPC-18-026, includes two working groups to advance underlying science and data used in wildfire behavior and risk models, two working groups to integrate science and data advancements into open source near-term (intra-week) and long-term (to end-of-century) wildfire behavior and risk models, and stakeholder engagement teams to ensure work products are useful to wildfire risk analysts and decision-makers. Specific advancements beyond the status quo include new algorithms for detecting the signatures of upcoming extreme or unusual wind and weather conditions, post-Rothermel fire spread equations, and open source, publicly vetted wildfire simulation and scenario tools.

Members of the consortium actively seek public/private partnerships outside of EPC-18-026 to complement and expand upon tools developed for the Pyregence study, and to ensure the realization of benefits from the Pyregence study. This fact sheet includes examples of those partnerships.

Anticipated Benefits for California

<u>General benefits</u>: Data, models, and tools developed by the Pyregence study can help the electric utilities, wildfire responders, and other stakeholders engaged in wildfire risk management to: (a) anticipate the drivers of some of the most difficult to manage and destructive wildfires; (b) anticipate the potential for rapid fire runs and more unusual fire propagation behaviors that are particularly difficult to contain and respond to; and (c) better understand the distribution and dynamic nature of their fire risks—in real-time and for planning purposes. This decision support

[1] Consortium members can be viewed here: https://pyregence.org/our-team/.

can help utilities (and responders and other stakeholders) make more informed and effective wildfire adaptation and mitigation decisions, leading to safer, more reliable, and more cost-effective electricity service.

Specific Benefits

- *Lower costs*

  Advancements in fire science, contemporary data accessibility, and wildfire spread equations yield more accurate and informative wildfire risk forecasts that will support more cost-effective mitigation activities. An example of how reduced data latency in wildfire forecasts can improve real-time response to an active fire and reduce asset damage is demonstrated in the supplement to this fact sheet (Appendix A).

- *Greater reliability*

  The Pyregence near-term wildfire forecast model, and its accompanying data and analytical tools (i.e., PyreCast) can support more effective Public Safety Power Shutoffs, with fewer false positives and unnecessary outages. PyreCast can also help utilities avoid significant infrastructure damage and associated outages due to active fires, as is demonstrated in Appendix A of this fact sheet.[2]

  The Pyregence long-term wildfire forecast model, and its accompanying data and analytical tools (to be developed as a planning support tool called "PyreClimate") can support more effective vulnerability assessments and adaptation planning for electricity grid infrastructure. PyreClimate can help utilities, state agencies, and local authorities better understand both long-term trends in wildfire risks and the range of wildfire risk outcomes conceivable by the scientific community. PyreClimate will also inform California's Fifth Climate Change Assessment, currently in progress.[3]

- *Increase safety*

  With improved information on extreme weather and fire behavior and on long-term shifts in wildfire risks, utilities, residents, and wildfire responders can develop more effective safety measures, both in real-time and in longer-term investment and local development decisions.

- *Economic development*

  Improved wildfire risk models can help California residents and business owners better understand and manage their risks. In 2022, members of the Pyregence consortium partnered with First Street Foundation to publish a novel property-level wildfire risk

[2] PyreCast can be viewed here: https://pyrecast.org/.

[3] For more information please see: https://opr.ca.gov/climate/icarp/climate-assessment/.

mapping tool, Fire Factor, to better inform private property owners, government agencies, and the insurance community on wildfire risks both now and over the next 30 years.[4]

As California ramps up its workforce for fuels reduction wildfire mitigation treatments, improved wildfire risk models can help the state's vegetation management planners better target priority treatment areas that also create jobs for disadvantaged communities.

- *Environmental benefits*

  More effective wildfire risk management can reduce the environmental shocks of megafires and other extreme wildfire situations—to the extent those extreme situations are the product of risky human activities (e.g., fuels mismanagement, human activity, and infrastructure in high wildfire risk areas) rather than wholly naturally-occurring.

- *Public health*

  PyreCast includes an interactive smoke forecast model that can be used to inform users of impending wildfire smoke exposure and related health impacts to communities in California.

- *Consumer appeal*

  Pyregence study data, models, and tools are being developed for open access and use by a variety of wildfire risk managers and may make wildfire risk analysis more appealing to a broader audience. More recently, through a different grant funding source, Pyregence modelers and software developers have teamed up with the UCSD WIFIRE Program to integrate Pyregence models into their FireMap tool[i]—extending the use and application of Pyregence models and demonstrating the value of shared open-source science.[5]

- Energy security

  PyreCast includes several interactive risk and fire weather forecasts that can aid users in understanding spatially explicit wildfire related vulnerabilities to the electricity grid. Similarly, PyreClimate populated with high resolution downscaled projected climate data, will better reveal vulnerabilities to critical infrastructure which can inform state and local resilience planning processes.

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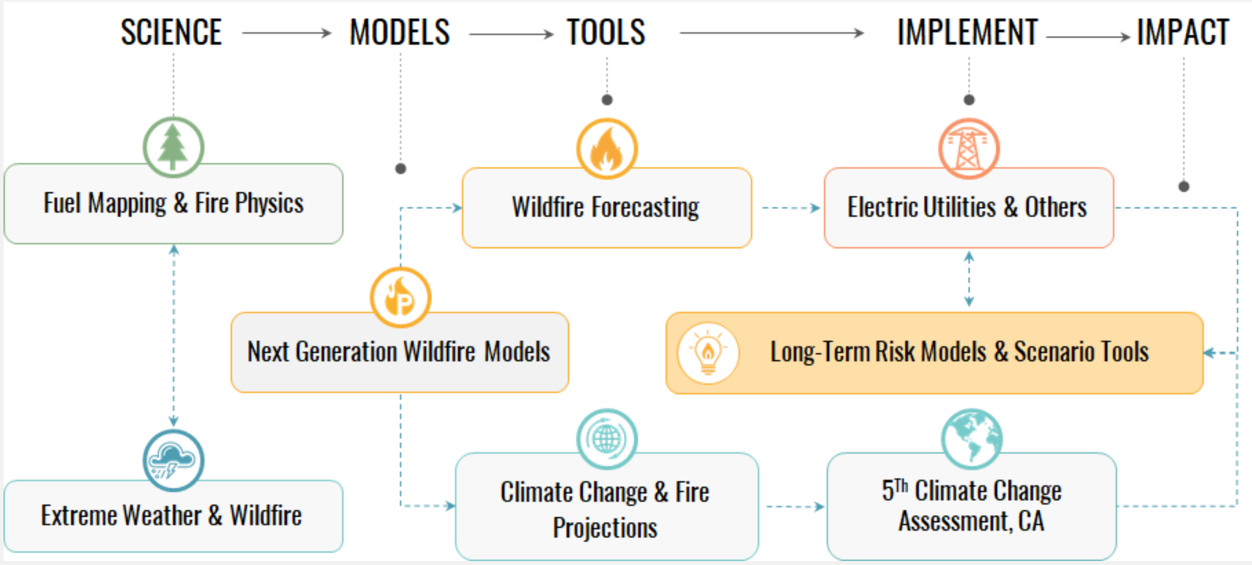
[4] For more information on Fire Factor, please see: https://firststreet.org/risk-factor/fire-factor/#:~:text=What's%20Your%20Fire%20Factor%3F,that%20risk%20changes%20over%20time.

[5] See description of UCSD WIFIRE FireMap at https://wifire.ucsd.edu/firemap.

The Pyregence Framework



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Appendix A: Case Study of the Net Benefits of PyreCast Reduced Data Latency on Utility Pole Pretreatments

Overview. PyreCast and long-term wildfire risk forecast development is still in-progress and most of the next-generation features that will distinguish these decision support tools from the status quo are not yet in place. However, the PyreCast development team has already implemented one important advancement that would not be available under status quo: reduced data latency (i.e., increased data refresh) in the form of sub-daily wildfire spread simulations. As a result of improved weather data integration and web tool development PyreCast can now produce up to four meaningfully updated wildfire risk simulations per day. This compares to one simulation per day under the status quo. We developed a benefit calculation for this model feature that demonstrates one specific mitigation activity: how reduced data latency can enable and improve utility emergency pole pretreatments ahead of an active fire.

Benefit result. Using the 2020 Glass Fire as a case study, we estimate PyreCast can save ratepayers $0.5 million in net pole replacement costs caused by an 80,000-acre wildfire. Roughly generalizing and scaling this result to 10-year annual average burn areas across all IOU service territories yields $5.0 million in annual benefits to all IOU ratepayers. Scaling further to all California service territories yields $5.9 million in annual benefits to Californians. These benefits accrue year over year although we expect them to decrease over time as the utilities' longer-term mitigation strategies—and benefits from those longer-term strategies—unfold. This benefit demonstration represents a very small subset of the full suite of benefits we expect to flow from the Pyregence study. Therefore, we believe this result supports our intuition that ratepayer benefits gained by funding the Pyregence study will far exceed the study's total cost of $5.0 million.

Our choice of pole pretreatment mitigation, the Glass Fire as a case study, and inputs and assumptions to this calculation are explained in detail below.

Status Quo framework. We define Status Quo as the suite of prevailing wildfire risk data and decision support tools as of 2020, including the operationalized version of Technosylva's Wildfire Risk Reduction Model (WRRM-Ops), prior to any possible influence by the Pyregence study, and considering the expected trajectory of development of those tools at that time. We assume the Status Quo data and tools would ultimately be fully integrated with utility operations and mitigation decision-making state-wide, but that they would not include certain key features and advancements the Pyregence study is tasked to develop.

Why pole pretreatments? A prudent emergency pole pretreatment mitigation strategy would first ensure crew safety by maintaining, in real time, a significant geographic buffer between the active fire areas and the treatment areas. This would require real-time data on the active fire area, weather conditions, and worst-case forecasted fire progression paths. We assume crews would be dispatched a day ahead of the worst-case forecasted burn areas (e.g., sent to areas that are not projected to burn in the next day under any scenario) and dispatched only if the forecast is not showing signs of significant under-forecast (i.e., actual burn is accelerating and exceeding even the worst-case forecast).

With limited resources, an effective emergency pole pretreatment mitigation strategy would also aim to identify and prioritize the highest-risk poles for treatment. Subject to crew safety constraints described above, we assume the dispatcher responsible for minimizing pole damage would target treatments within projected burn areas of a multi-day fire spread forecast.

Because of this reliance on a multi-day fire outlook—and because of the dangers to treatment crews of lagging fire spread forecasts—forecast model data latency of up to 24 hours under Status Quo can be extremely problematic to a real-time pole pretreatment strategy. That degree of latency can even inhibit this type of mitigation altogether. If the forecast is not frequently updated as a fire accelerates, for example, the model may systematically under-forecast to the point the model cannot provide dispatchers any confidence in a safety buffer for treatment crews.

Why the 2020 Glass Fire? The Glass Fire (9/27/2020–10/20/2020) burned about 70,000 acres in the northern Napa and Sonoma Valley areas, approaching the City of Santa Rosa on its western flank. Most of the fire's progression was within its first week, with final containment after 24 days. The burn area was a mix of populated areas, farmland, and state park terrain. PG&E had 2,500–5,500 wooden poles exposed to the fire (depending on burn area data source) and the utility replaced 1,191 of the damaged poles.[6] Because of these fire characteristics and the extent of pole damage we believe the 2020 Glass Fire to be a reasonable case study for an emergency utility pole pretreatment mitigation strategy.

The Status Quo mitigation decision-making process. We assume the dispatcher has two key decision points.[7] The first decision point is the night before treatment day when the dispatcher observes actual burn areas and a once-daily fire spread forecast to come up with a treatment plan for the next day. The second decision point is the next morning of the treatment day when the dispatcher observes real-time actual burn progression (not a forecast) to reassess if the treatment plan puts treatment crews in jeopardy, i.e., whether the forecast model has significantly under-forecasted fire spread.

To develop a treatment plan, the Status Quo dispatcher considers the following:

- Exclusion area: The actual observed burn area + worst-case forecasted burn area through the end of the treatment day is considered an exclusion area where crews will not be sent. This is essentially a safety buffer for the treatment crews.
- Treatment area: Beyond the exclusion area, the incremental forecasted burn areas out to the end of the 4-day forecast is considered the potential treatment area. This puts treatment crews 1–3 days ahead of the fire. In other words, they will aim to treat poles that are forecasted to burn 1–3 days after they apply treatments.
- Selected pole pretreatments: Given a resource limitation of 250 pole treatments per day, the dispatcher selects specific poles for pretreatment first by highest burn probability, then by age (with priority given to newest poles).

[6] https://www.pgecurrents.com/2020/10/06/in-response-to-glass-fire-nearly-500-pge-employees-focus-on-our-customers-in-the-north-bay/

[7] This is an assumption for illustrative purposes and not based on any particular company's real-time dispatch procedures.

- Real-time adjustments: The next day—treatment day—the dispatcher observes actual burn area in real-time. If actual burn areas start exceeding the day's worst-case fire spread scenario (i.e., the fire encroaches on the treatment crew's safety buffer) then the day's treatment plans are cancelled. Under this situation the forecast model is not sufficiently keeping up with the fire's progress for the dispatcher to have confidence in crew safety.

PyreCast mitigation decision-making process. The decision-making process with PyreCast is the same as described above for Status Quo, except with reduced forecast data latency plus an additional opportunity to update the treatment plan within the treatment day. The PyreCast dispatcher develops two half-day treatment plans based on PyreCast data and forecasts timed (1) in the morning of the treatment day and (2) at around noon during the treatment day. As under Status Quo, the dispatcher observes fire spread in real-time to ensure crew safety, but treatment cancellations are for a half day instead of the full day, and reduced data latency reduces the probability of treatment cancellations.

Summary of Pole Treatments Under 2020 Glass Fire Case Study

Treatments on 9/28/2020 through 10/4/2020

		Status Quo	PyreCast	**Improvement (PyreCast minus Status Quo)**
Total treatments planned	(250 poles per day x 7 days)	1,750	1,750	
Treatments canceled due to forecast error	(# poles)	508	3	
Treatment capacity used	(% of capacity)	71.0%	99.8%	**28.9%**
Poles treated	(# poles)	1,242	1,747	
Poles saved in final burn area	(# poles)	64	252	
Treatment accuracy	(% of treated poles in burn area)	5.2%	14.4%	**9.3%**
Replacement rate	(% of burn area poles)	22%	22%	
Avoided pole replacements	(# poles)	14	55	**41**
Avoided pole depreciation	(pole-years remaining life)	464	1,933	
Depreciation rate	($ per pole-year)	$333	$333	
Total avoided cost	($ per year)	$154,558	$644,220	**$489,662**

Assumptions to monetize benefits. Gross benefit of emergency pole pretreatment is calculated as the avoided cost of pole replacements. For any given pole within the final/actual Glass Fire burn area, we assume a 22% probability of extensive damage requiring pole replacement if treatment is not applied. This is based on PG&E's pole replacement rate of 1,191 out of 5,500 poles in the Glass Fire burn area. Pole replacements are assumed at a cost of $20,000 per pole.[8] Since it is standard practice for utilities to replace poles at the end of their useful life, the avoided pole replacement cost is not the full $20,000 but the avoided financial impact (i.e., additional depreciation) of advancing a $20,000 investment from its normal end-of-life replacement year up to 2020. We assume a simplified 60-year straight-line depreciation of wooden utility poles which yields an avoided cost of $333.33 per year per successfully treated

[8] We found several sources that indicate pole replacements cost on the order of $20,000 each. See, for example, https://www.pgecurrents.com/2017/07/25/pge-partners-with-fire-responders-enhancing-public-safety-ahead-of-detwiler-fire/

pole ($20,000 ÷ 60 years). So, for example, successful treatment of one 40-year pole in our case study would avoid a utility investment of $20,000 in 2020 rather than in 2040. This would equate to an avoided pole replacement cost of $6,666.67 ($333.33 × (2020-2040)). All dollars are expressed in constant (2020) real dollars.

Gross cost of emergency pole pretreatment is assumed at $100 per pole and represents both the materials and labor costs for crews to spray a fire-retardant coating in real-time ahead of an active fire. Note that gross cost does not affect our final benefit result because we assume cost is incurred based on planned treatments rather than executed treatments (the difference is canceled treatments which would require crews and materials to remain on standby). Thus, our costs under Status Quo are the same as with PyreCast.

Net benefit is calculated separately under the Status Quo scenario ($0.155 million per year) and under the PyreCast scenario ($0.644 million per year). Then net benefit of PyreCast minus net benefit of Status Quo ($0.5 million per year) is our benefit result for a representative 80,000-acre fire.

Scaling benefits to IOU ratepayers and California. The 2020 Glass Fire burned about 70,000–80,000 acres (depending on data source). Compared to a 10-year average statewide burn area of 970,835 acres, our case study represents 8.24% of expected annual burn area in California.[9] We scaled our $489,662 in annual net benefits to represent statewide expected burn areas accordingly (statewide $5.9 million per year = $0.489662 million per year ÷ 8.24%). This scaling assumes a similar average density of poles in the statewide annual burn area, which could include rural areas with relatively low pole densities and more populated areas with relatively high pole densities.

The geographic area of IOU service territories represents 84.93% of total (IOU + POU) utility service territories in the state.[10] We scaled the California total benefits down to the IOU service territories and the IOU ratepayers accordingly (IOU $5.0 million per year = $5.9 million per year × 84.93%).

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[9] To derive 970,835 acres, we relied on the multi-agency statewide database of fire history through 2020 compiled by CalFIRE, excluded fires under 10,000 acres, and calculated an annual average burn area for the years 2011–2020 (inclusive). See https://frap.fire.ca.gov/mapping/gis-data/#panel-1ebde4fb-3ee8-41bb-a1ea-4c3159294a26.

[10] To derive 85%, we relied upon the CEC's geospatial data on electric load serving entities. See https://gis.data.ca.gov/datasets/CAEnergy::electric-load-serving-entities-iou-pou/about.