Discussion of the Climate Vulnerability Assessment Methodology

Presentation to IEEE DRES Taskforce

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PG&E

Together, Building a Better California

Climate Vulnerability Assessment Timeline and Scope

Infrastructure | Operations | Services

Methodology

Climate Risk Exposure + Sensitivity + Adaptive Capacity

IOU vulnerability

Proposed adaptation projects presented in GRC filing

Exposure

Which PG&E assets and systems are potentially exposed to future hazards, and to what degree?

Impact Function

What are the thresholds (e.g. flood height) or hazard levels at which exposure could result in damage or operational impacts?

Consequences

Based on exposure and impact function, what impacts (e.g. customer outages, accelerated aging) are expected, absent adaptation?

Adaptive Capacity

What adaptation options are available or should be explored to mitigate impacts and consequences?

Classification of Risk Levels and Vulnerability Exposure

Goal: Accurately identify high-risk issues that require further attention

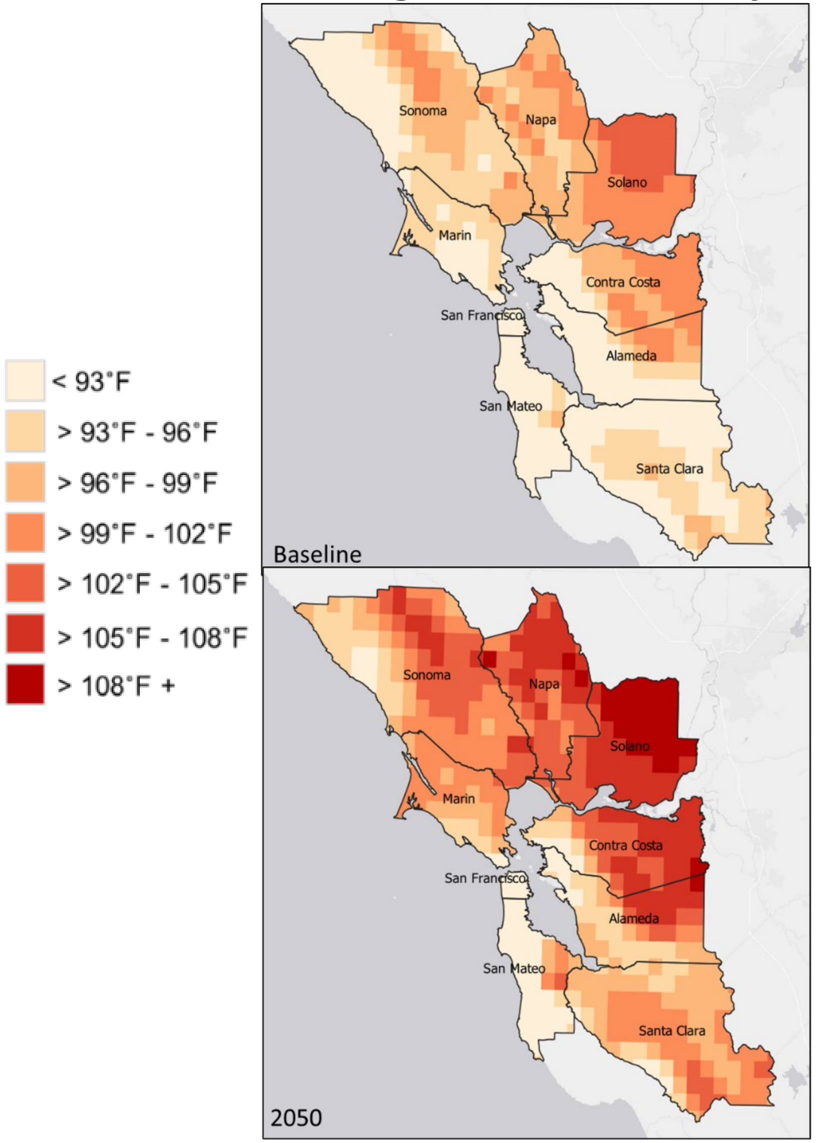
- Geospatial and quantitative analyses underlies this assessment however to avoid false precision, we are taking a qualitative approach to vulnerability and risk rankings.
- Currently not looking to quantitatively cross-compare among vulnerabilities/risks

	Vulnerability Definition	Risk Definition
Low	No assets or very few assets face projected exposures to which they have meaningful sensitivities. Vulnerability is not significant enough to warrant further analysis at this time.	Minimal to minor for adverse consequences to PG&E and its customers are projected from this hazard. Risk is not significant enough to warrant prioritized mitigation at this time.
Moderate	A small-to-moderate proportion of assets face exposures to which they are at least moderately sensitive.	Potential financial, safety, and/or customer outage consequences are significant enough to warrant near-term mitigation analysis.
High	A large proportion of assets are at least moderately vulnerable to projected climate hazards, or a meaningful minority of assets is highly vulnerable.	Potential financial, safety, and/or customer outage consequences could be of a severity with little to no precedent and with major significance to the company and/or customers. Risks pertain to assets with high criticality, are systemic/widespread, and/or carry significant public safety risks. These risks are a priority for immediate mitigation analysis.

Climate Hazards: Exposure in the Bay Area by Climate Variable

Temperature	Average and extreme temperatures are projected to increase over the course of the 21st century; coastal areas will remain cooler than inland areas.
Coastal Flooding	Sea level rise and storms are a concern for the region.
Precipitation	More intense and a greater number of large storm events are expected. For example, in Sonoma County, by 2050, the chances of a large rain event increases by 50%. Droughts are likely to become longer and more severe due to increases in temperature and decline in Sierra Nevada mountain snowpack.
Wildfire	Much of the region is within HFRAs. By 2050, average annual burn areas could increase by 31% to the Baseline Years (1976-2005).
Drought-driven subsidence	Not a priority concern for this region.
Cascading events	Wildfire scarred landscapes are more susceptible to precipitation-driven landslides, especially in Marin, Sonoma, and Santa Clara counties. Extreme heat may occur during wildfire-driven outage events.

Average of 7 Hottest Days



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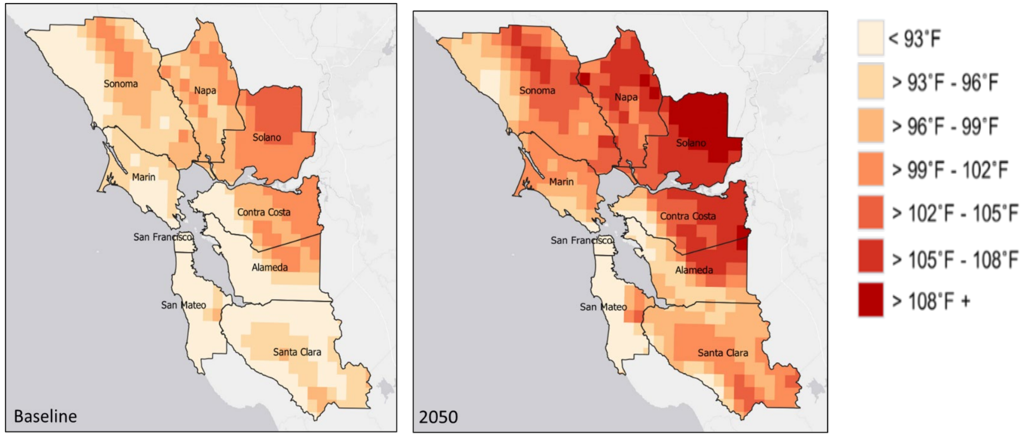
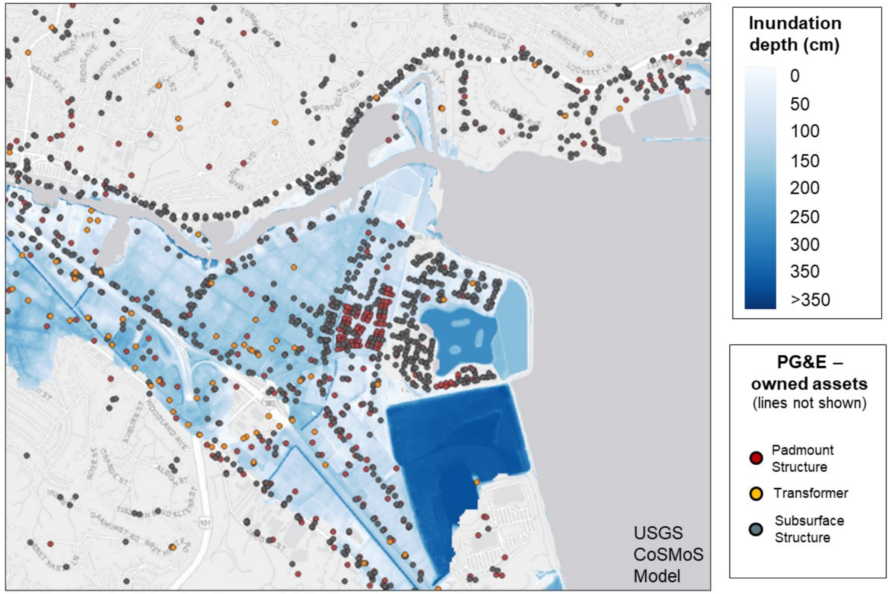
Climate Hazard Mapping Examples: Exposure in the Bay Area



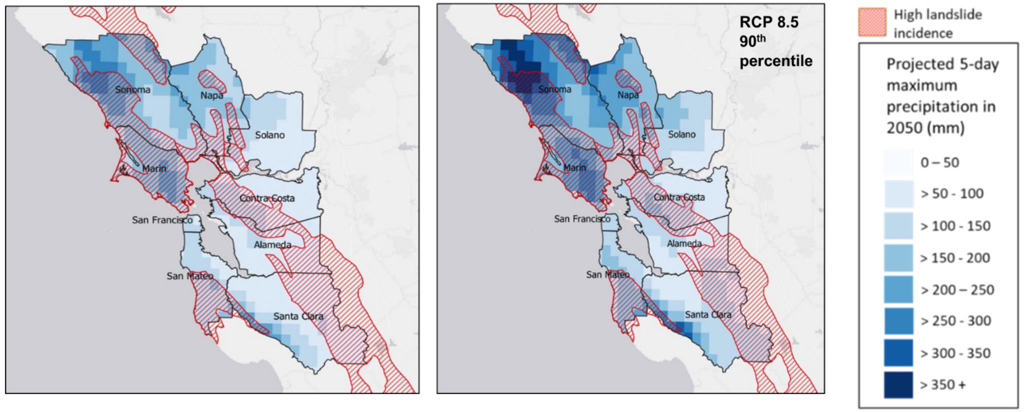
Temperatures are increasing, especially in East Bay. Coastal areas are relatively cooler but will also see increasing temperatures

Projected inundation under 0.5m sea level rise and 100-year storm

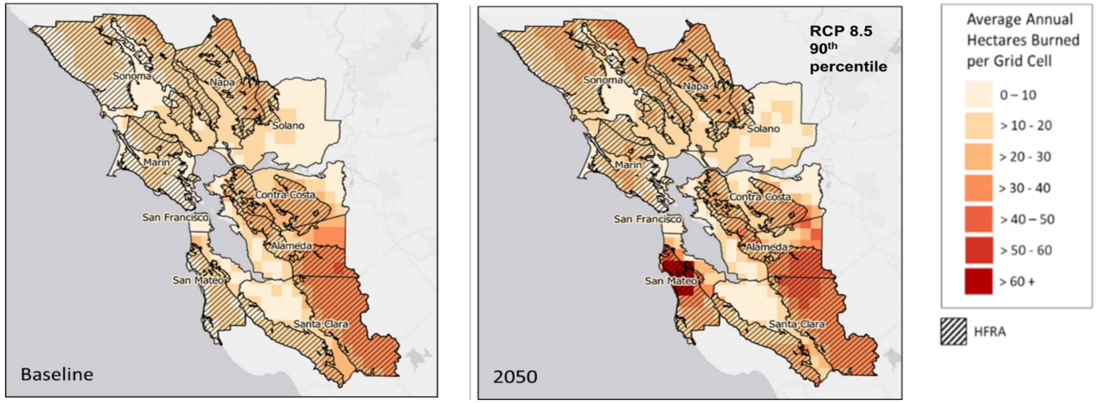


SF Bay is highly vulnerable to sea level rise – especially in San Pablo Bay, San Mateo and Alameda coastlines.

**Results represent preliminary hazard exposure data for discussion purposes only*



Large rain events will increase in severity, especially in North Bay counties. Areas of landslide risk are of high concern



Much of the Bay Area region is within HFRAs. By 2050, average annual burn areas could increase by 31%.

Summary of Climate Change Exposure – Bay Area

Electric Operations

Hazard	Asset group	Vulnerability	Risk / Impact
Heat	Substation	Moderate	Moderate
	Transmission	Moderate	High
	Distribution	High	High
Flooding	Substation	High	High
	Transmission	Moderate	Moderate
	Distribution	Moderate	Moderate
Wildfire	Substation	Low	High
	Transmission	High	High
	Distribution	High	High
Drought-driven subsidence	All assets	Low	Low

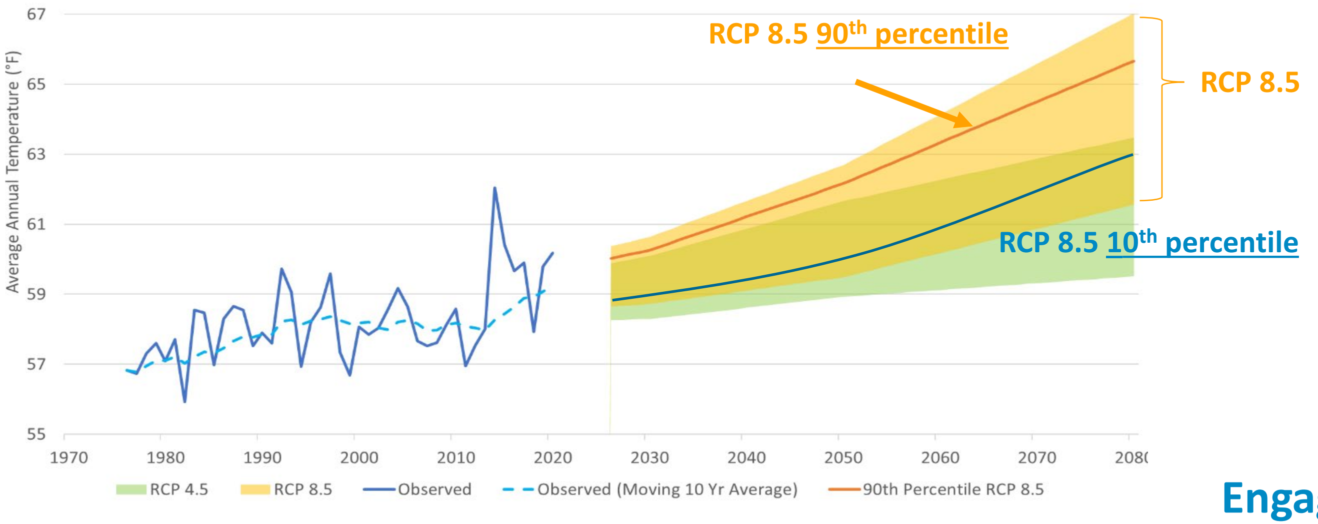
High heat is the primary climate risk in the Bay Area in the short term and will also increase in intensity over time. Electric assets are most vulnerable to high heat and extended heat waves.

Sea level rise will exacerbate coastal flooding during large storms. 10 substations in San Francisco Bay are currently or will be vulnerable to flooding by 2050 during a 100-year storm. Flooding can damage electrical equipment, assets are at risk to landslides, and operations are impacted.

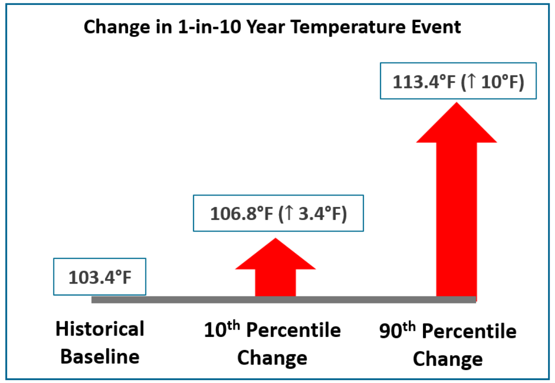
Wildfire is a priority concern for PG&E both in starting ignitions and damage from wildfire.

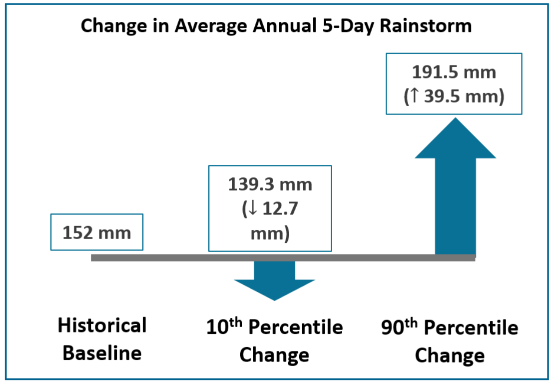
Integrating Climate Data is Not a Straightforward Exercise

Climate projections offer a range of possible outcomes – raising challenges to our engineering teams to implement if the data is not historically validated or approved for use



2050 Projections at Pioneer Substation, Amador County





Pathway selection criteria includes:

1. Risk aversion
2. System sensitivity and criticality
3. Implementation costs
4. Climate science
5. Potential co-benefits
6. External benchmarking

Engagement and communications with SMEs are needed to fully develop an implementation plan.

We can help with the integration of climate projection data but lack clear guidance on how to have these conversations.

Ask: Leadership 'guidance statement' to make this a part of the conversation and to build SME acceptance.

The use of climate projections is recommended where appropriate….

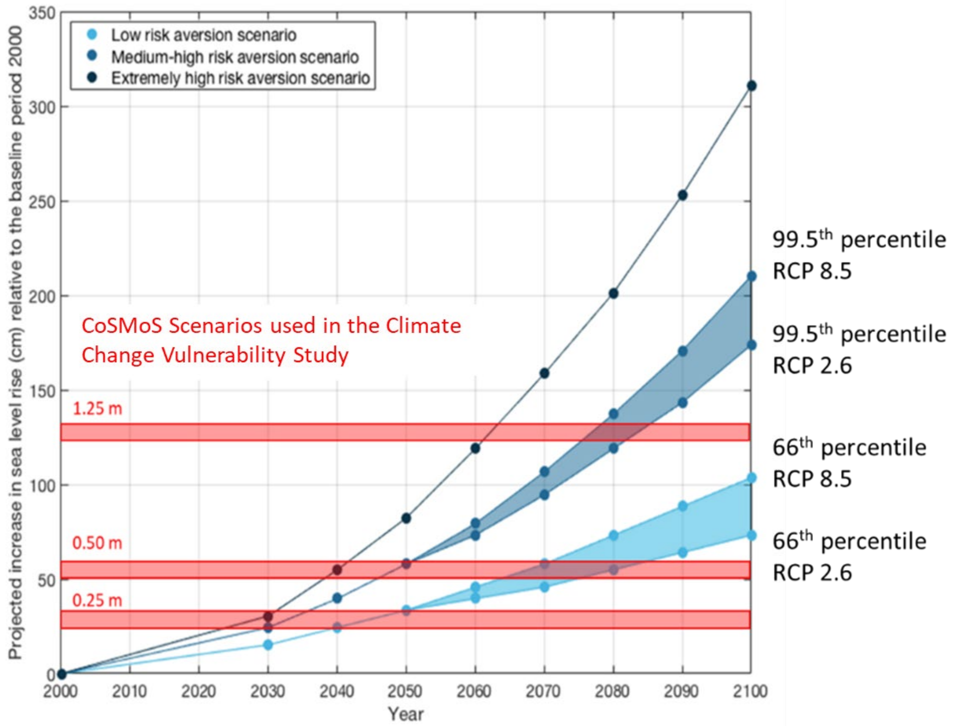
Types of Climate Data Used in CVA Analysis

Temperature and precipitation variables analyzed from LOCA data for Climate Change Vulnerability Assessment.

Variable	Definition
Temperature	
Annual Average Temperature	Average annual temperature in the average year, calculated by the average of the daily maximum and minimum temperatures across all days.
98th Percentile Temperature	Temperature exceeded by top 2% of maximum temperatures in the average year; approximately 7 days in the average year exceed this temperature threshold.
1-in-2 Year Weighted Daily Maximum Temperatures	PG&E uses weighted average temperatures to account for the heat that accumulates in equipment over the course of several hot days. This metric weights the hottest day at 70%, with the preceding two days at 20% and 10%, respectively. The 1-in-2 daily maximum is the annual high temperature (i.e. hottest day of the year) that can be expected to occur every other year on average (50% annual chance). 50% of years will be hotter, and 50% of years will be cooler.
1-in-10 Year Weighted Daily Maximum Temperatures	See above for description of "weighted temperature." The 1-in-10 daily maximum is the annual high temperature (i.e. hottest day of the year) that can be expected to occur once every ten years on average (10% annual chance).
Precipitation	
1-day Annual Maximum	The maximum 1-day precipitation event per year in the average year (mm).
5-day Annual Maximum	The maximum 5-day precipitation event per year in the average year (mm).
Annual longest period of consecutive dry days	Greatest number of consecutive days with no precipitation per year in the average year.

CoSMoS sea level rise scenarios used in the Climate Change Vulnerability Assessment and corresponding future time horizons

Time Horizon	Corresponding CoSMoS Sea Level Rise Scenario (Base sea level rise)
2010-2015	0 meters
2030	0.25 meters
2050	0.5 meters
2080	1.25 meters



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