

Building a climate resilient energy system

A Presentation for Engineering Change Lab

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The need for climate resilience

Using climate data in decision-making

PG&E's vulnerability assessment: some initial results

A new decision-making framework example: design standards





PG&E overview

PG&E is focused on providing safe, reliable, affordable and clean energy to nearly 16 million Californians.



24,000
employees

5.3 million
electric customers

~80%
GHG-free energy

126k
Circuit miles of
lines

70,000
square mile
service area

4.4 million
gas distribution
customers

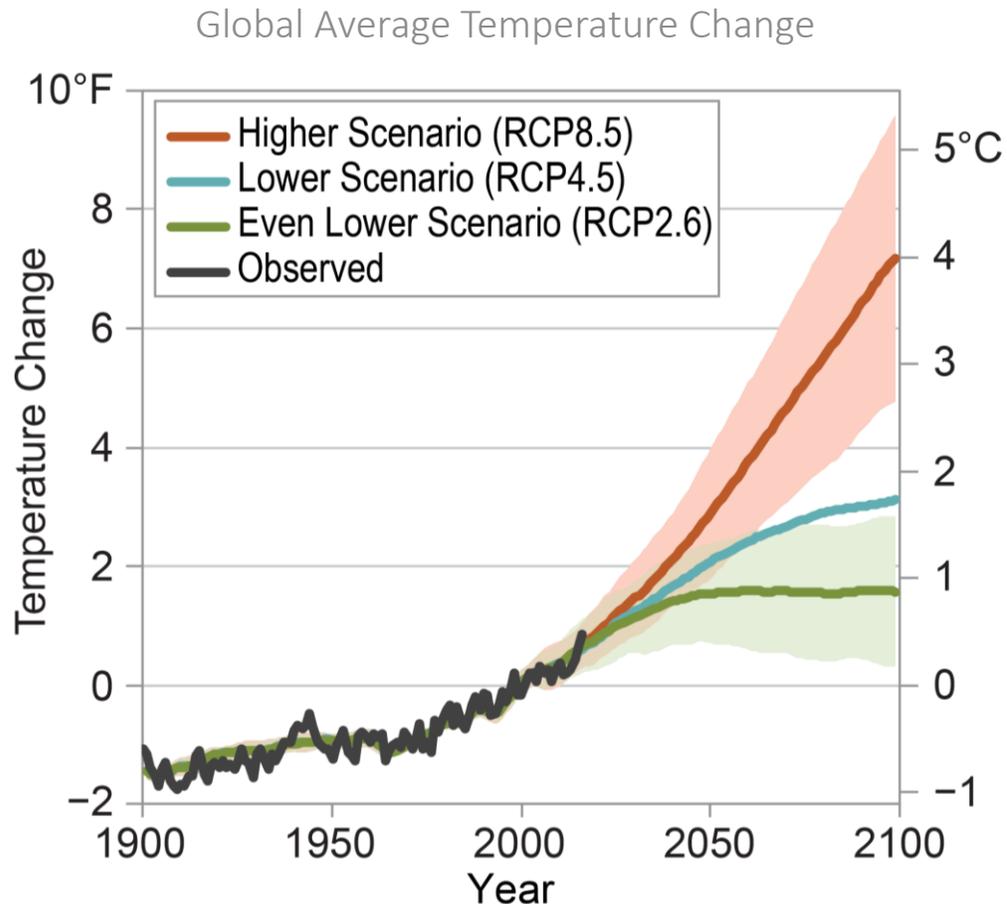
7,700
MW of owned electric
generation capacity

49k
Miles of gas
pipeline



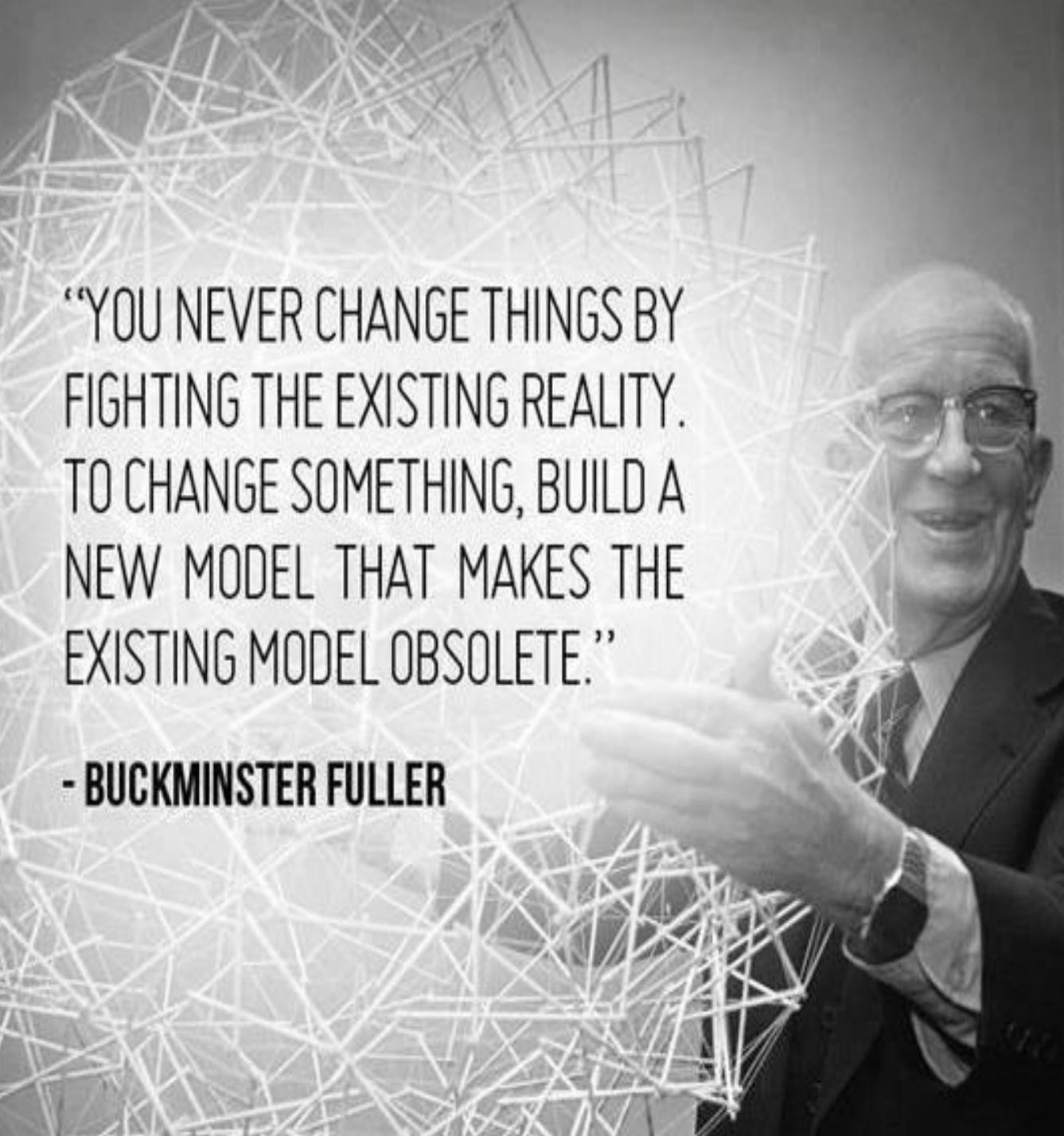
Climate Adaptation: As crucial as GHG mitigation

Global emissions trends and current observations are clear: we must act now to preserve the safety and quality of life of all Californians in the face of climate-driven natural hazards while we continue to reduce emissions within the state.



Source: 2018 National Climate Assessment

- Paris Climate Accord Goal: 1.5 Celsius
- Global warming trajectory with current global emissions policies: >3 Celsius
- Global average temperature deviation from pre-industrial average in 2020: 1.2 Celsius
- 2020 was among the three hottest years in history, with record-breaking wildfire, hurricane, and ground temperature conditions.
- If net zero emissions were achieved today warming would continue. Climate impacts are “baked in” already.



“YOU NEVER CHANGE THINGS BY
FIGHTING THE EXISTING REALITY.
TO CHANGE SOMETHING, BUILD A
NEW MODEL THAT MAKES THE
EXISTING MODEL OBSOLETE.”

- **BUCKMINSTER FULLER**

We must no longer think
of extreme weather as
unprecedented, but as expected.

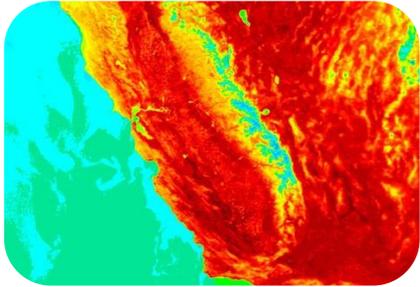
The models of the past
are not reflective of our future.

We must learn to use
forward-looking data
in our decision-making.



What does climate resilience look like for PG&E?

We safely, reliably, and affordably provide energy to our customers and manage impacts to our communities during:



10 five-day heat waves in Fresno a year



Flooding during an extreme storm in Sacramento



Sea level rise in San Mateo



Wildfire in the Sierra Foothills

Our goal is to plan for and adapt to conditions *before* they change.

Using climate data in decision-making: the PG&E View

Forward looking climate risk data



System wide
Climate
Vulnerability
Assessment

Updating design
standards to
account for
future conditions

Integration of
forward-looking
climate data into
risk models

Integration of
climate data into
Asset Management
Plans

Project design
considers
climate
risks



Climate-Informed Decision-Making

- Asset management
- System hardening
- System redundancy
- Microgrids
- Distributed generation
- Resilience zones
- Enhanced response and recovery capabilities
- Stockpiling spare equipment
- Physical and green infrastructure



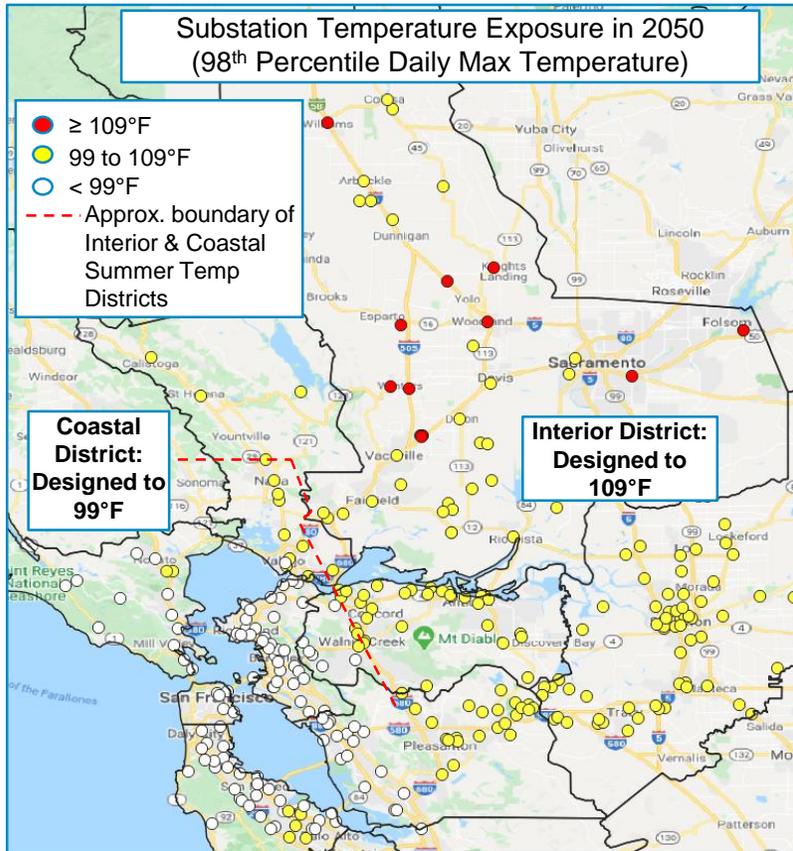
Outcomes:

- Customer, Community, and Shareholder Return**
- Reliability
- Safety
- Affordability
- Reputation
- Environmental impact



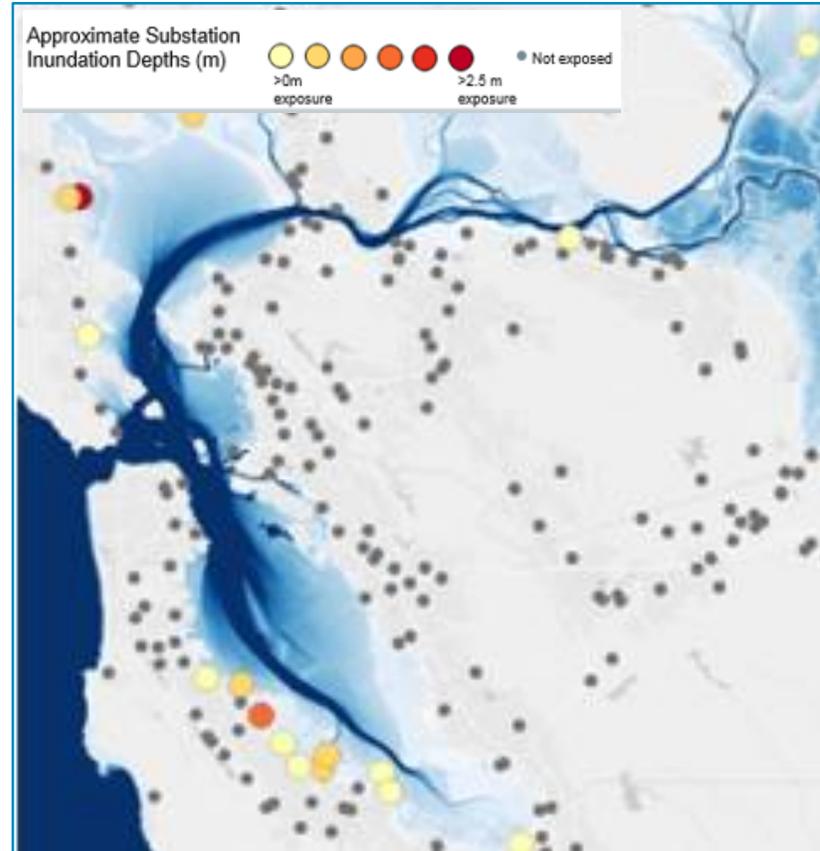
Climate risk in California is increasing over time

Heat Events: Increasing in Frequency and Intensity



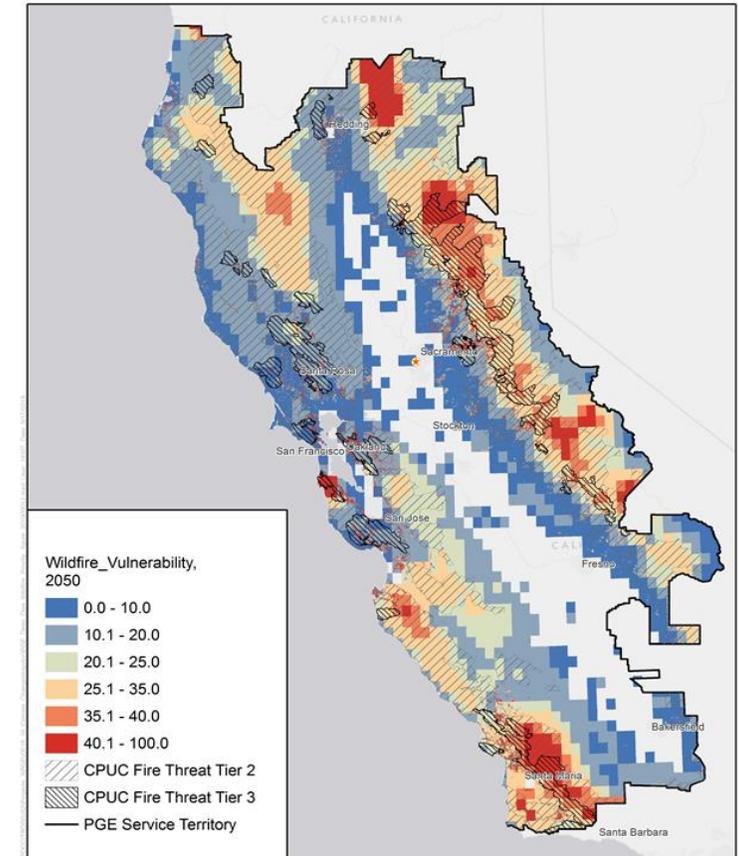
The frequency of extreme heat events will vary across PG&E's service territory. By 2050, the most disadvantaged quartile of CA's census tracts will experience ~32 additional days/year of 95°F or higher temperatures. In comparison, the least disadvantaged quartile will experience an increase of 16 days.

Flood Risk: Increasing Risk in SF Bay and Delta



PG&E assets exposed to sea level rise and flooding include electric substations, electric transmission towers, and gas pipelines. Assets with lifespan beyond 2050 may experience sea level rise of 3 feet or higher.

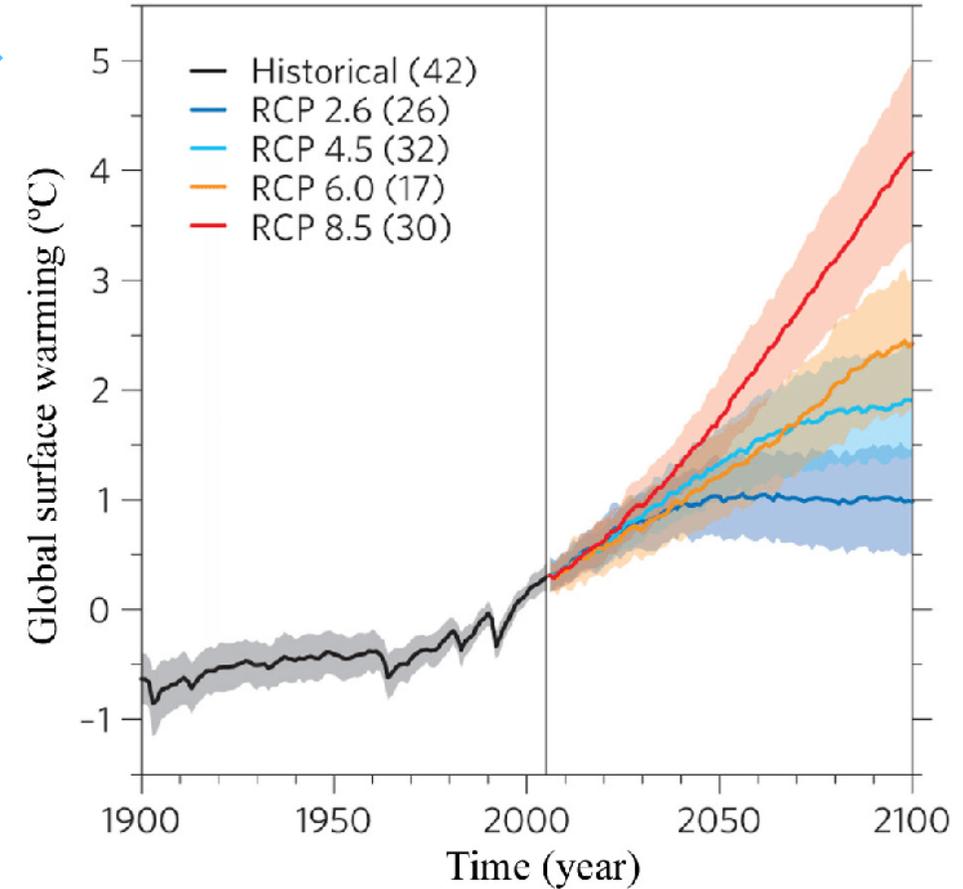
Wildfire Risk: Increasing Risk Beyond and Within Today's HFTD Zones



By 2050, average annual burn areas in PG&E's service territory could increase by 43% relative to a recent historical baseline (1986- 2005).

An example: Design standards for the future

- 1 What do I believe the future to be? ➔
- 2 What data is relevant for my project?
(Heat, sea level rise, extreme cold, drought, precipitation patterns, subsidence)
- 3 What risk tolerance do I have for my infrastructure/building/project? ⬇



Probabilistic Projections (in feet) (based on Kopp et al. 2014)

		MEDIAN	LIKELY RANGE	1-IN-20 CHANCE	1-IN-200 CHANCE	<i>H++ scenario (Sweet et al. 2017) *Single scenario</i>
		<i>50% probability sea-level rise meets or exceeds...</i>	<i>66% probability sea-level rise is between...</i>	<i>5% probability sea-level rise meets or exceeds...</i>	<i>0.5% probability sea-level rise meets or exceeds...</i>	
				Low Risk Aversion	Medium - High Risk Aversion	Extreme Risk Aversion
High emissions	2030	0.5	0.4 - 0.6	0.7	0.9	1.1
	2040	0.7	0.5 - 0.9	1.0	1.3	1.8
	2050	0.9	0.7 - 1.2	1.4	2.0	2.8
Low emissions	2060	1.0	0.7 - 1.3	1.7	2.5	3.9
High emissions	2060	1.2	0.9 - 1.6	1.9	2.7	3.9
Low emissions	2070	1.2	0.9 - 1.6	2.0	3.1	5.2
High emissions	2070	1.5	1.1 - 2.0	2.5	3.6	5.2

State of California Sea-Level Rise Guidance (2018)