Regional Climate Change Science and Energy Implications to California

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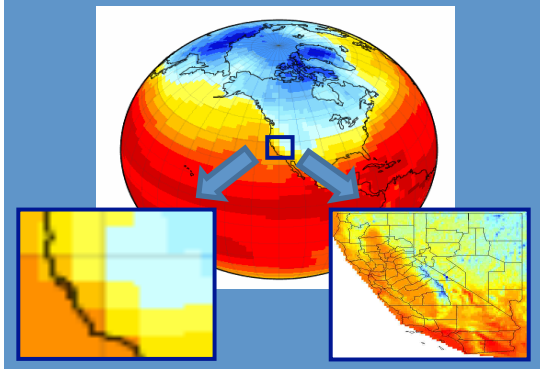


Technical Workshop on Efficiency, Renewables, and Grid Management
August 19, 2015

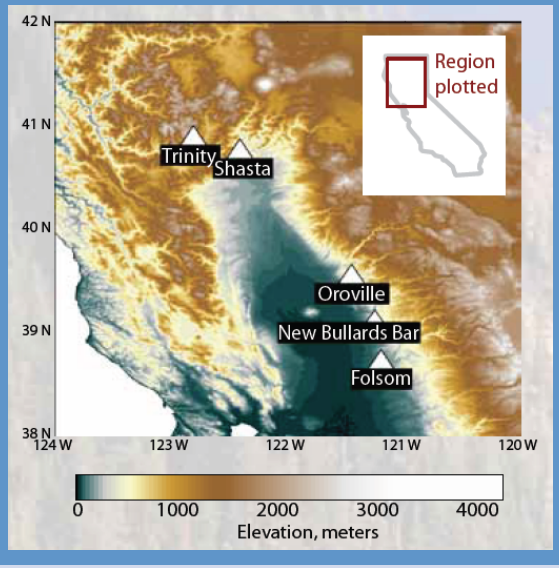
Outline

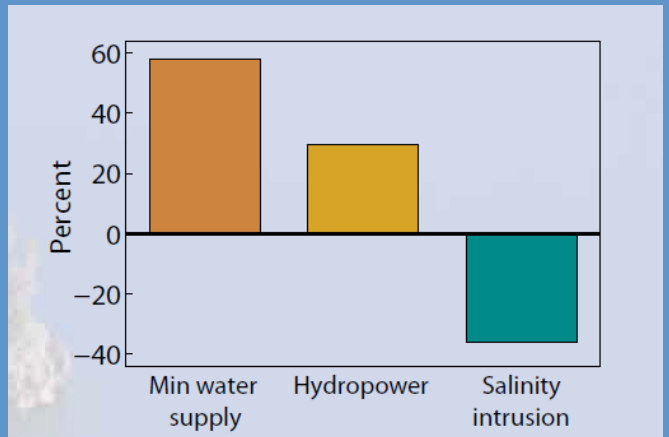
- Examples of potential impacts
- Potential adaptation options
- Linking mitigation and adaptation
- Conclusions

Examples of Potential Impacts

Low Elevation Hydropower Units

- Associated with large reservoirs (e.g., Folsom Dam)
- Provide about 25% of hydro generation
- Main functions are flood protection, water supply, and recreation.
- Multiple studies since 2001
- Using probabilistic forecasts and a modern decision support system (e.g., INFORM) is a win-win strategy; but regulatory, institutional, and legal requirements may impede the implementation of this adaptation option.



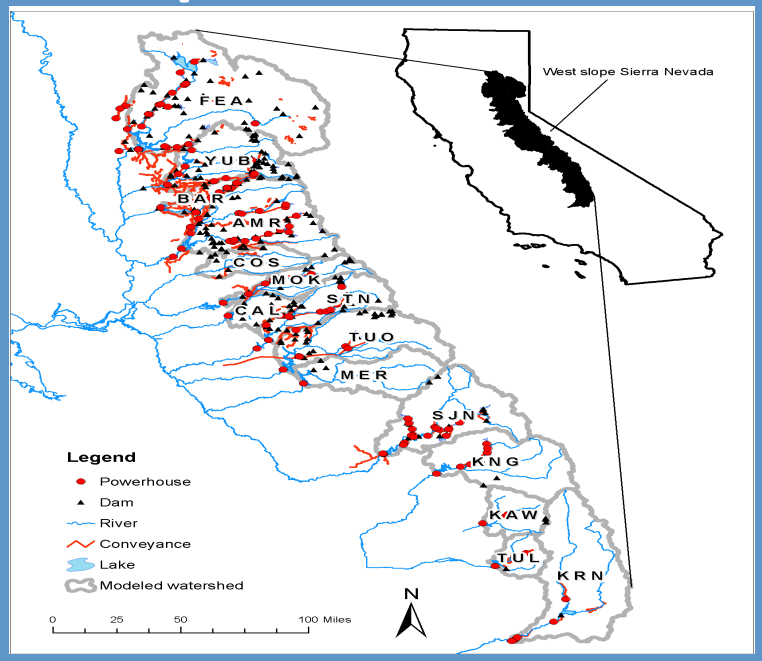


Compared to current practice, under future simulated climates INFORM gives a larger minimum water supply, more hydropower, and less salinity intrusion from the SF Bay.

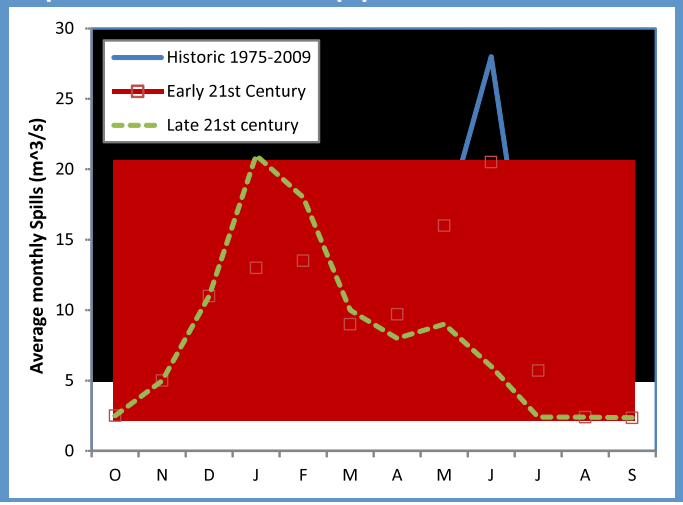
High Elevation Hydropower Units

- Provide about 75% of hydro generation. Snowpack is the main "reservoir."
- Four studies by UC Davis and UC Berkeley since 2006.
- Even without changes in precipitation, generation goes down due to loss of water due to evapotranspiration.
- Less generation in the hot months of the year.
- Increased flows in the winter time discharged to low elevation hydro units (risk of flooding?).
- Lack of detailed data has hampered more realistic simulations.

Source: Joshua Viers (UC Davis)



Simulated Operations for Upper American River Project



Source: Vicuña et al., 2011

Electricity and High Temperatures

LONG-TERM IMPACTS

Need for More Generation on Hottest Days

- Decreased Thermal Power Plants Generation Efficiency
  - Need additional GW (8%)
- Peak Period Demand
  - 21% higher cooling demand
  - Need additional GW (27%)
- Substation Loss
  - 2.7% higher losses
  - Need more GW (3.6%)

Total Required Generation Capacity

- Need 39% more capacity GW

Need for More Transmission Capacity

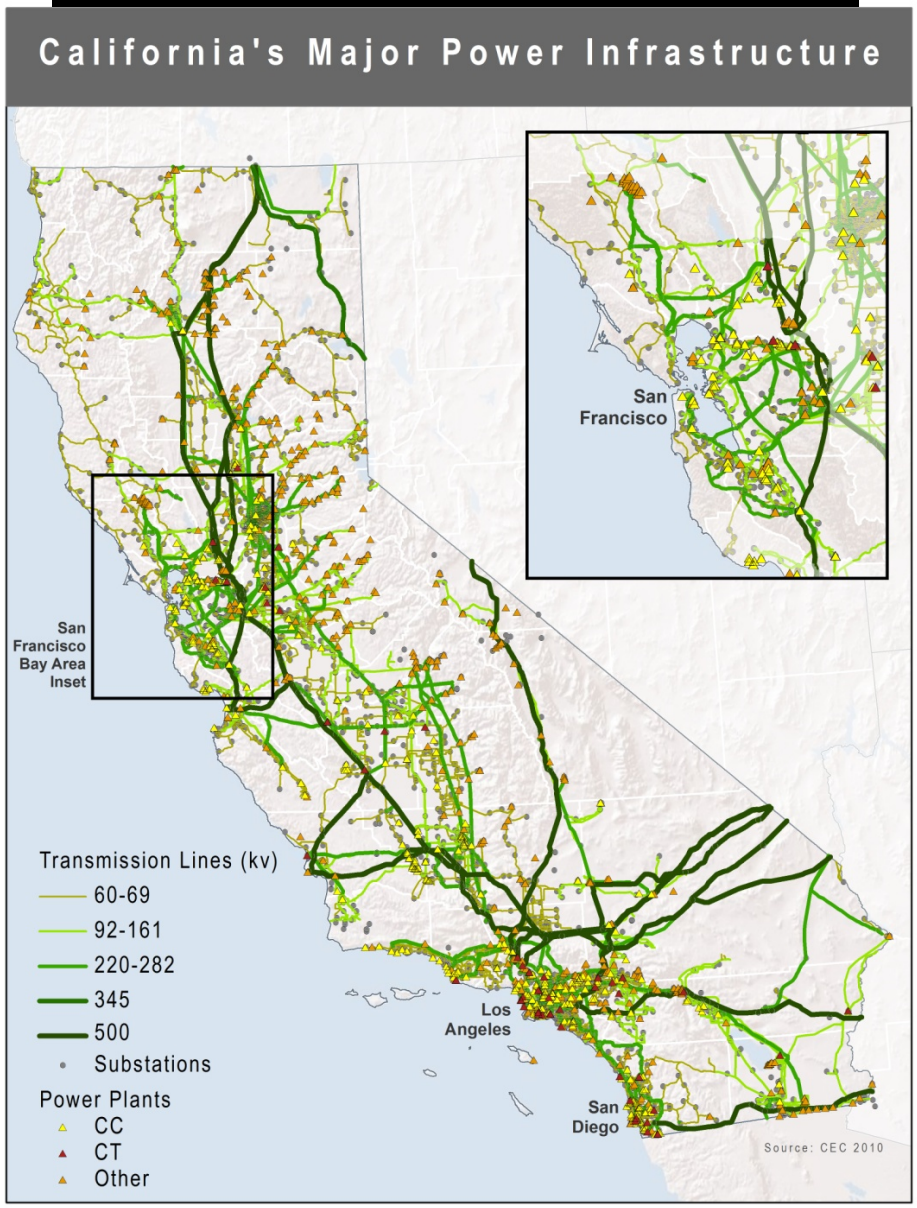
- Transmission lines
  - 7-8% loss of peak period capacity (static rating)

NEAR-TERM IMPACTS

Same as long-term but at a lesser degree. For example:

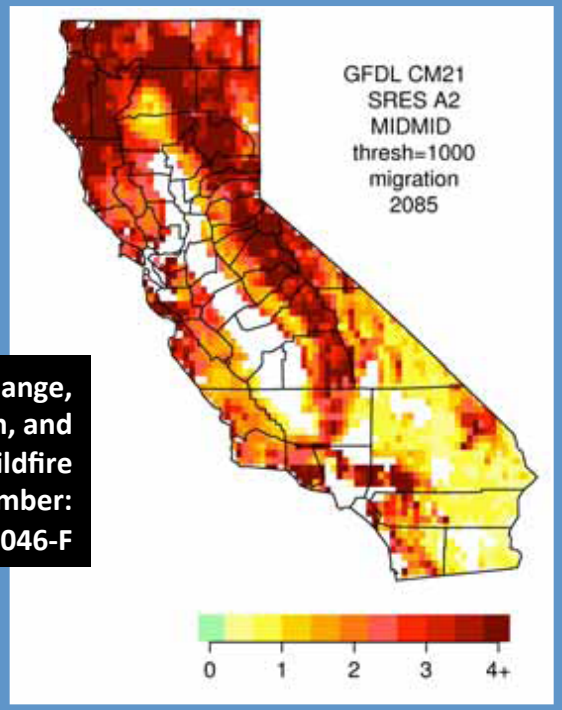
- Need additional capacity of 1.6 GW in the next 10 years (2013 IEPR)

Current Infrastructure & Future Climate

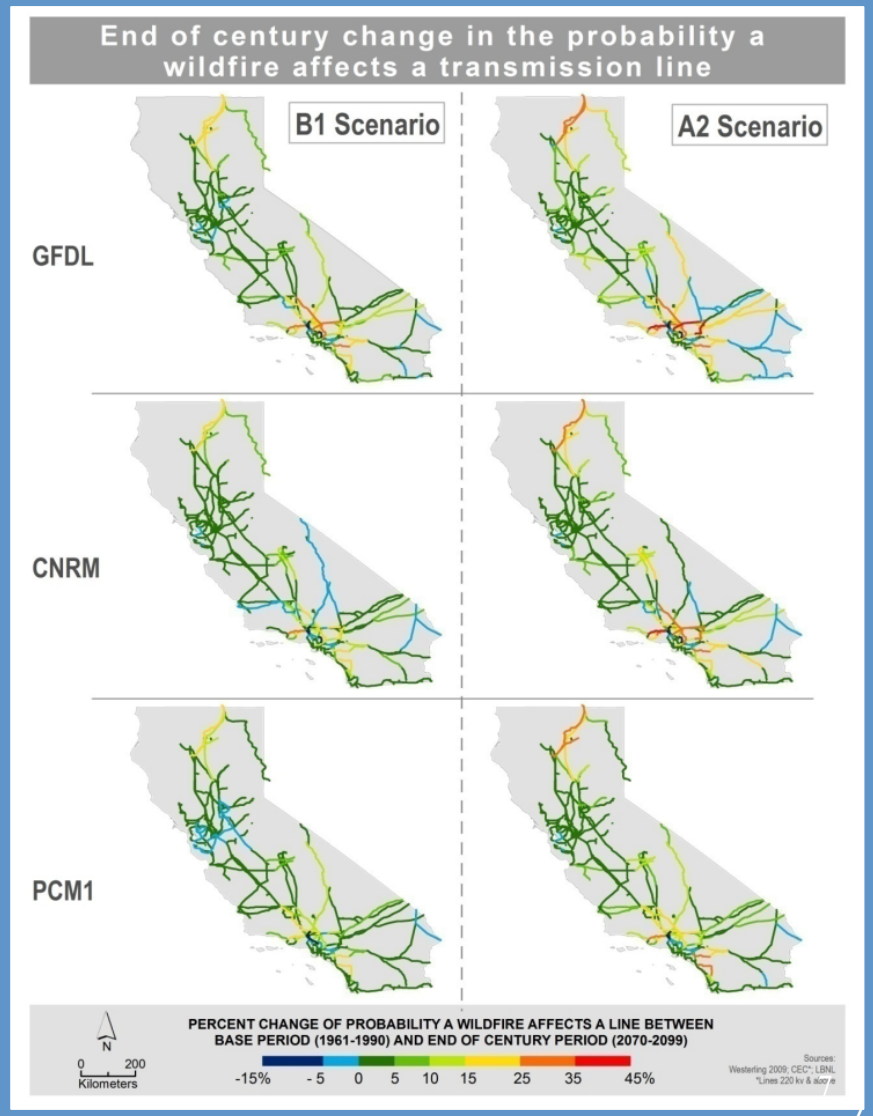


Source: Sathaye et al., 2013

Wildfires and Transmission Lines



Climate Change, Growth, and California Wildfire
Publication Number: CEC-500-2009-046-F



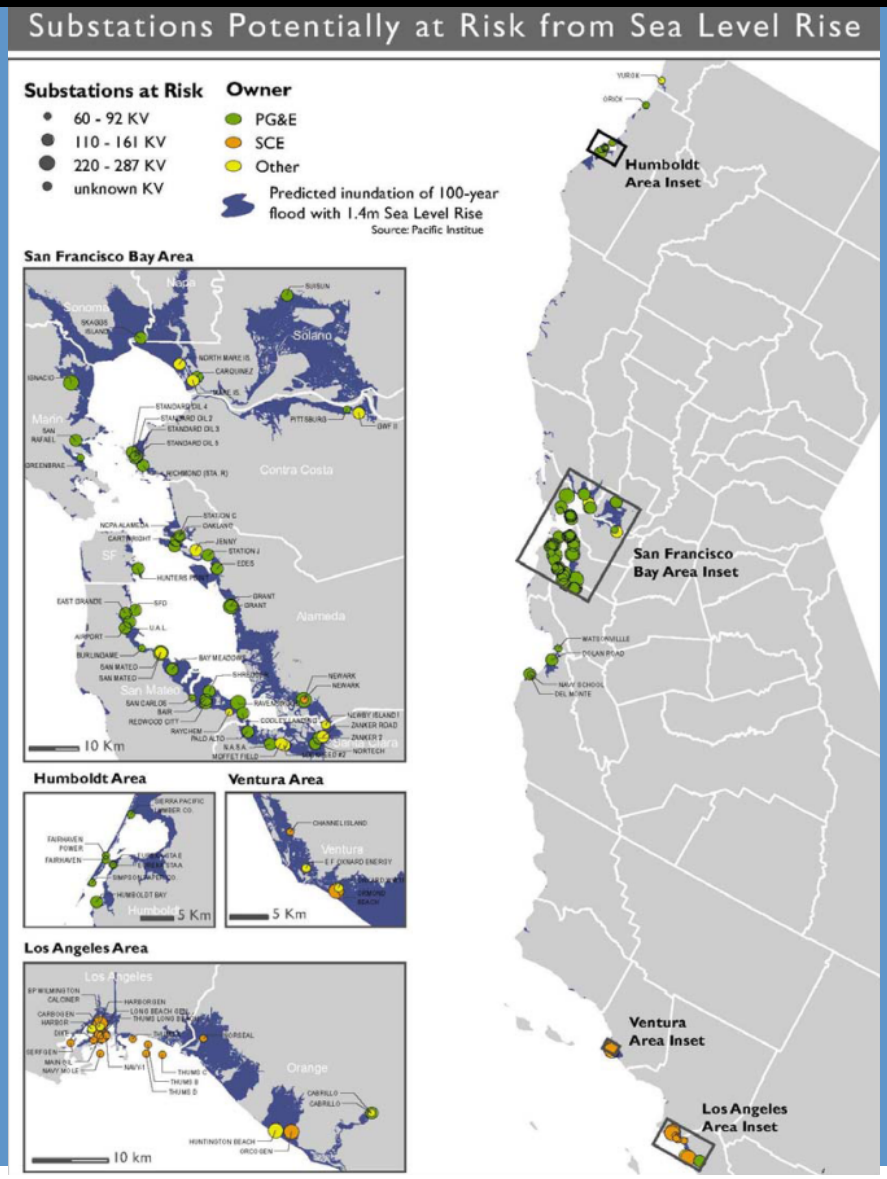
Study was hampered by the lack of access to historical data.

Estimating Risk to California Energy Infrastructure from Projected Climate Change
Publication Number: CEC-500-2012-057

Coastal Impacts

- Potential exposure of coastal power plants and substations to sea level rise.
- The study did not consider existing protection measures such as levees and coastal armoring.
- Available GIS data may have been distorted for security reasons.

100-year coastal flood with 1.4m sea-level rise

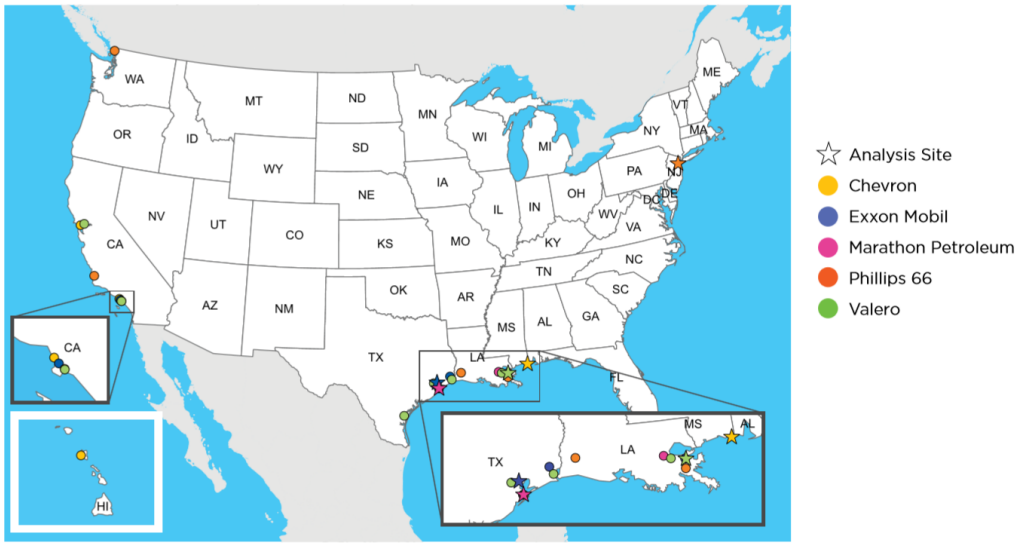


Source: Heberger et al., 2012

Petroleum Sector

- Some new preliminary work by US DOE and UCS
- Some refineries are at risk from sea level rise and coastal storms.
- Very little work on cascading effects (e.g., supply of electricity, natural gas, and water to refineries).

FIGURE 3. Map of U.S. Coastal Refineries of the Five Companies Analyzed



The five companies analyzed have refineries along the Gulf, East, and West Coasts, as well as in Hawaii. Some of these facilities face risks, now and in the future, from sea level rise and storm surge. The oil and gas infrastructure in the Gulf of Mexico is especially vulnerable because of rising seas, sinking land, and frequent tropical storm systems.

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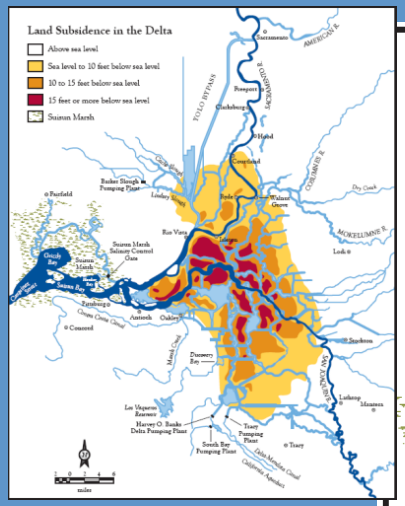
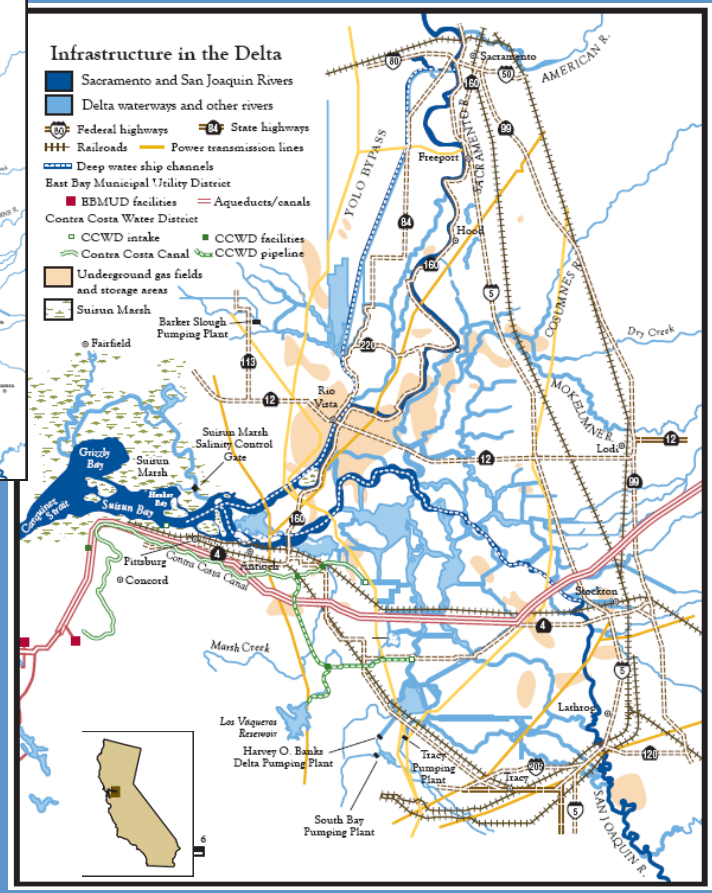
Energy Facilities in the Delta

- The Sacramento-San Joaquin Delta is protected by levees. Delta islands are below sea level
- Energy Facilities:
  - Underground natural gas reservoirs
  - Transmission lines
  - Natural gas pipelines
  - Power plants on the west side of the Delta
- Report from UC Berkeley will be available in the next few months.





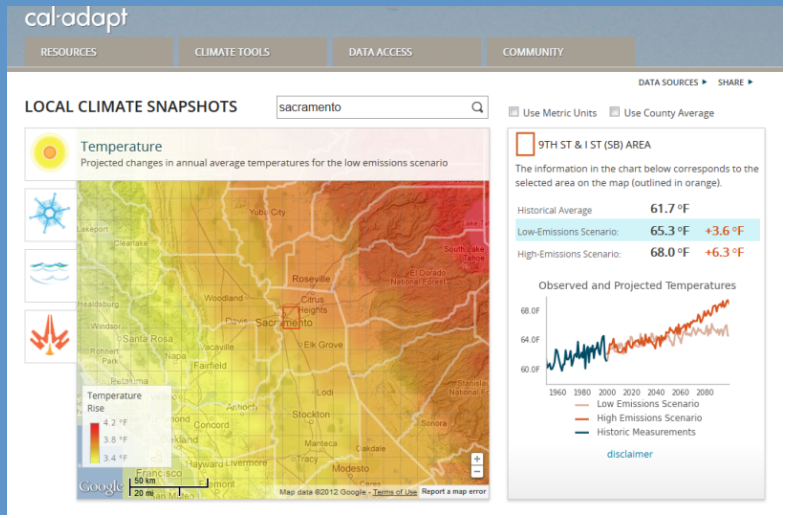
Source: PPIC 2007

Adaptation Opportunities

“Win-Win” Opportunities must be Identified

- Improved operation of hydro units using probabilistic hydrologic forecasts and modern decision support systems.
- CEC Demand forecast to consider climate change (done)
- Microgrids to reduce vulnerability of critical assets.
- Seasonal and decadal forecasts for the electricity and natural gas systems.
- Making information available to decision makers, research managers, and the public in general (e.g., Cal-Adapt) in a usable form.

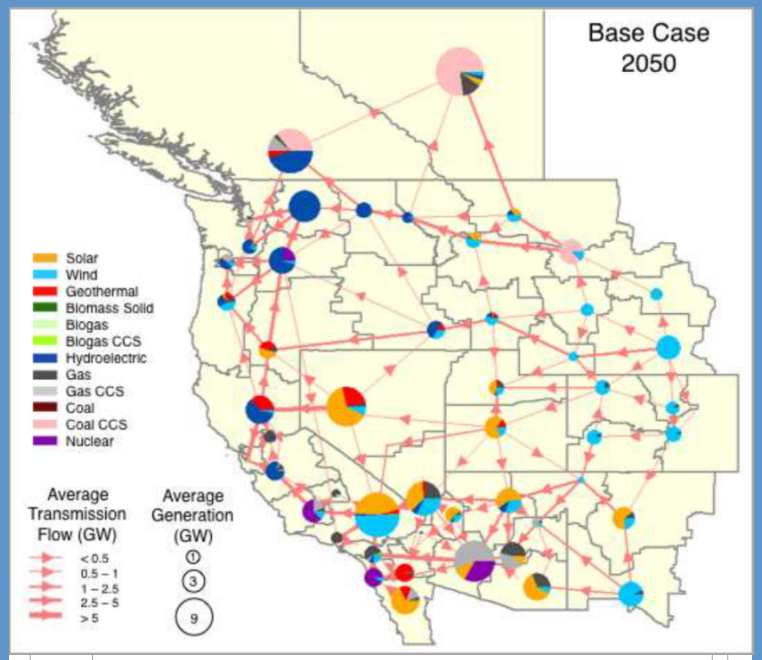
SDG&E’s Microgrid powered the community of Borrego Springs during planned grid maintenance, avoiding a major outage in June 2015.



Linking Mitigation and Adaptation

Energy System

- The electricity system is changing very rapidly
- This represents an opportunity to develop a more climate resilient system (2013 IEPR).
- A research project on this topic is starting with E3, LBNL/Berkeley, UC Irvine.



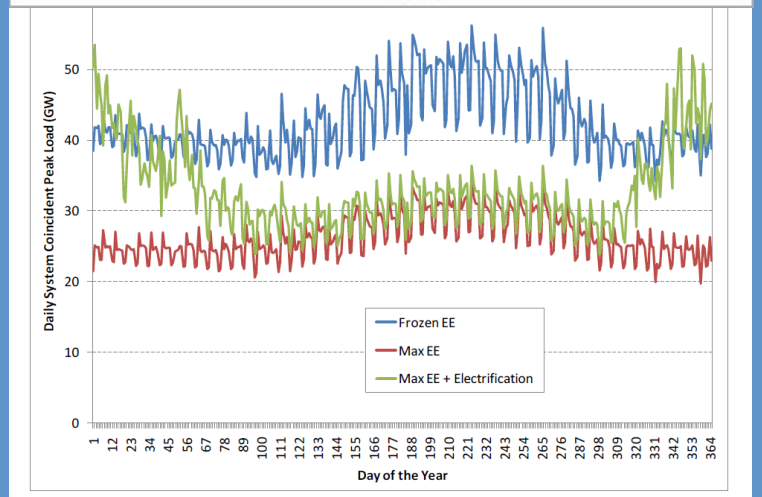


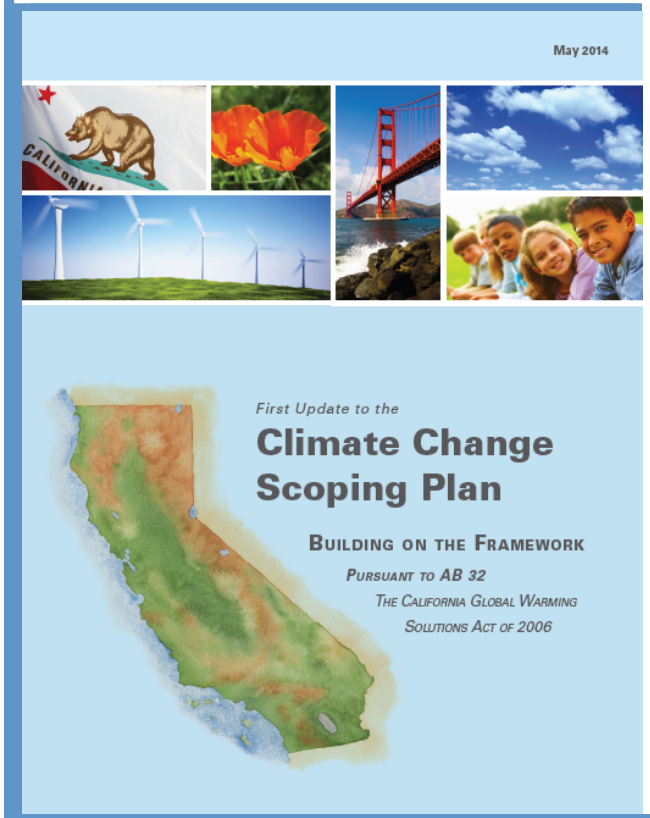
Figure 4-13. *Daily system coincident peak load from buildings in 2050 in California.*

Source: Wei et al., 2012

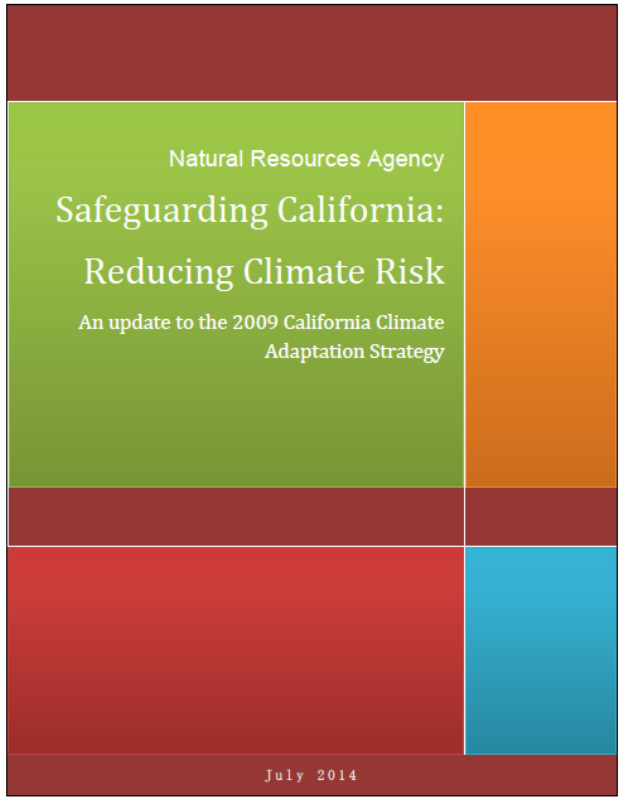
California's Fourth Climate Change Assessment

California's Comprehensive Climate Policy

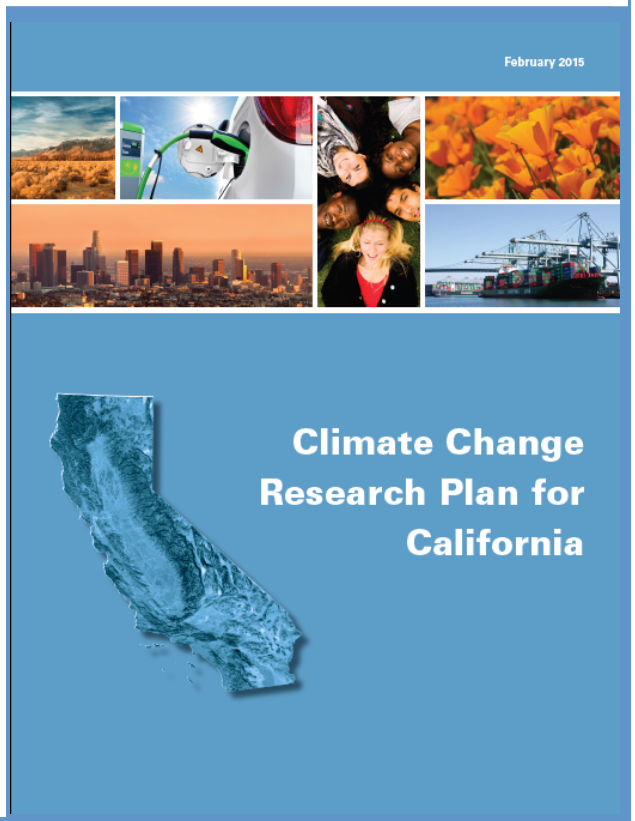
Reducing Emissions



Preparing for Impacts



Research



Conclusions

- Without proper planning impacts can be severe.
- Good adaptations options are available.
- Need to consider mitigation and adaptation simultaneously.

Thank you!

Panchito Franco

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