CALIFORNIA'S FOURTH CLIMATE CHANGE ASSESSMENT:
OVERVIEW OF PROPOSED ENERGY SECTOR STUDIES, PART B

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Proposed Studies

PART A (already presented)

- Socioeconomic and urban projections for the energy sector
- Climate, hydrological, and sea-level rise scenarios to support energy sector planning and management (*ongoing research*)
- Wildfires and the transmission and distribution system
- Sea-level rise and electricity infrastructure

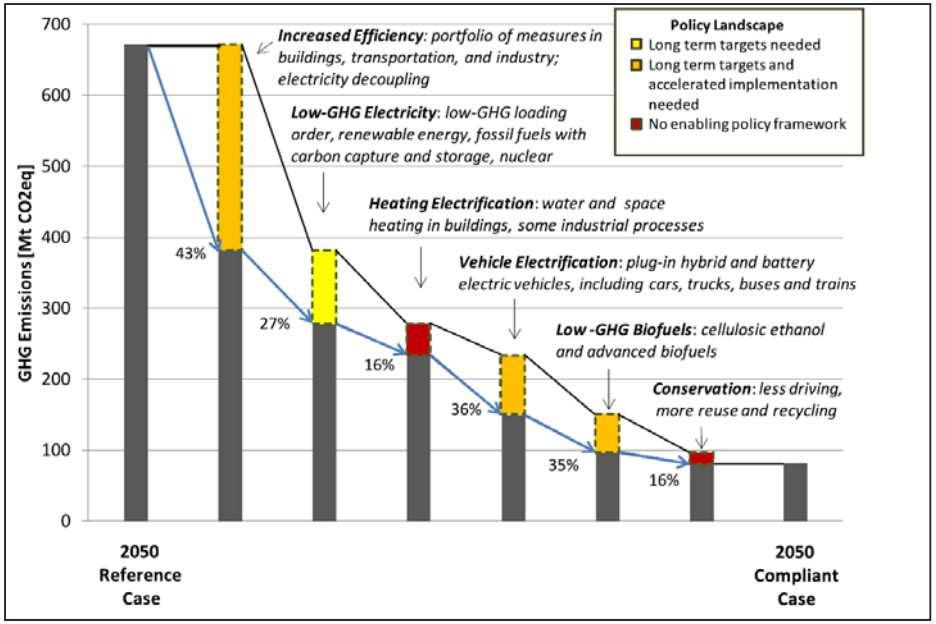
PART B (this presentation)

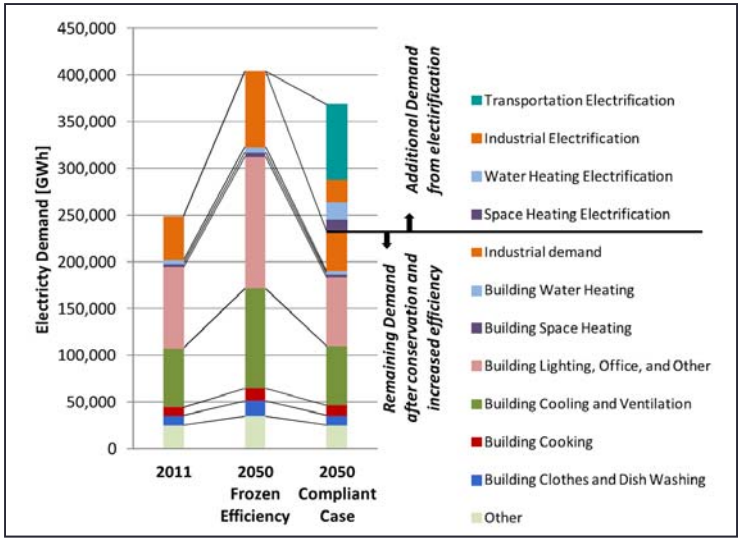
- Long-term scenarios for the energy sector
- Improved characterization of the urban heat islands
- Regional adaptation studies for the natural gas sector
- Electricity sector strategies to foster resilience
- … *related* studies supported by the CEC

Long-term scenarios for the energy sector

Simone Brant

- **Objective:** Explore potential energy scenarios that would drastically reduce GHG emissions while at the same time reducing vulnerability of the electricity system to climate impacts.
- **Prior work:** CEC supported study by UC Berkeley and LBNL to model the entire energy system (electricity, transportation, residential, etc.) for the WECC. Additional modeling work by others including E3.
- **Limitations of prior work**: Climate impacts to electricity sector not considered (e.g., reduced efficiency of thermal power plants with increased temperatures). Energy efficiency projections assumed technical potential.

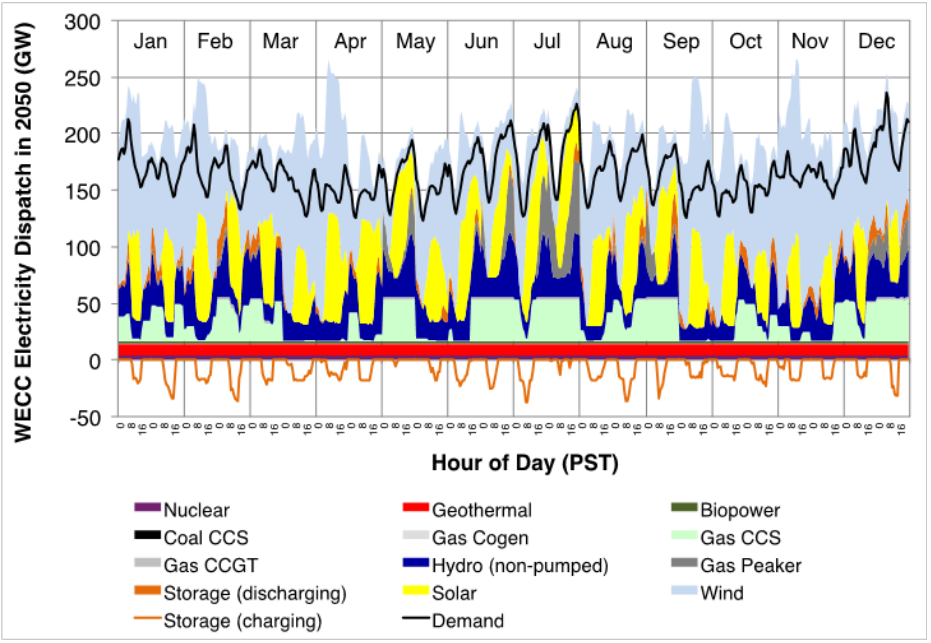




source: Wei et al., 2013. *Env Res. Letters*. (**8**) 1. http://iopscience.iop.org/1748-9326/8/1/014038

Proposed work will expand research capabilities in areas such as:

- Integrating climate change and its impacts on energy demand and generation (e.g., hydropower units) into scenarios.
- Investigating the magnitude of path dependence created by designing and operating the California energy system for intermediate targets (2020, 2030, etc.) while eventually reaching 2050 climate targets.
- Quantification of the impacts of misestimating future costs and technological availability in order to provide policy recommendations that are robust to a diverse set of futures.
- Improving abilities to more realistically model distributed generation and microgrids over the long-term modeling horizon.
- Preliminary investigation of how to reduce the vulnerability of the electricity system to climate impacts.
- Are there other elements that should be considered in long-term energy scenarios?

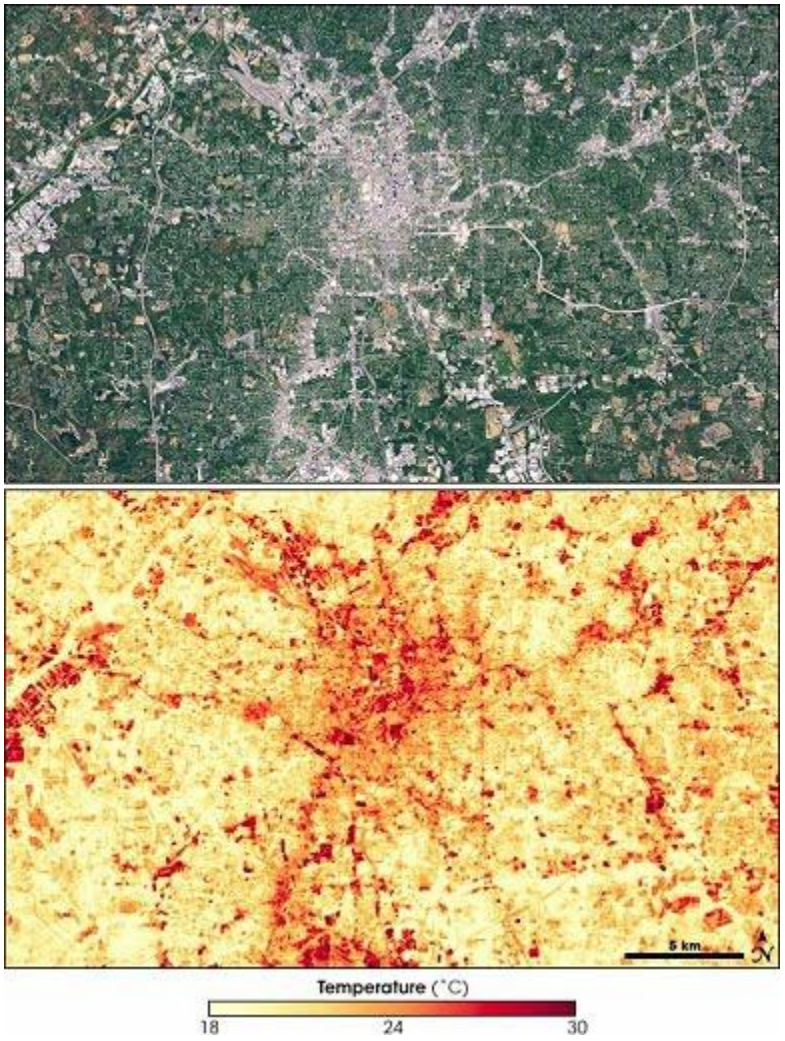


source: Nelson et al., 2014. Draft final report, CEC 500-10-047.

Improved characterization of urban heat islands

Susan Wilhelm

- **Issue:** Urban environments (e.g., low-albedo surfaces) and activities that discharge heat into the environment (e.g., use of A/C, manufacturing) can elevate ambient temperatures by several degrees.
  - City of 1M+ people can be, on average, 1.8–5.4°F warmer than its surroundings (USEPA).
  - This difference can be as high as 22°F in the evening (USEPA).
- **Consequences:** Increased peak energy use, greater greenhouse gas and other pollutant emissions, poor air and water quality, heat-related illness and mortality.
- **Measure to Cool Urban Heat Islands**: Cool surfaces (e.g., roofs, pavements, cars), use of vegetation (for shade, evaporative cooling), are being examined to mitigate the urban heat island (UHI) effect.



NASA satellite image showing elevated temperatures concentrated in heavily urbanized areas of Atlanta, Georgia. *source*: http://heatisland.lbl.gov/coolscience/cool-science-urban-heat-islands

- **Objectives:** Improve understanding of distribution and determinants of temperature within urban heat islands in California. Results will support impacts assessment of climate change on the electricity sector, may also aid social vulnerability mapping.
- **Recent work:**
  - Modeling studies: Possibility that “cool” cities can substantially reduce ambient temperatures and offset some of the expected increase due to climate change (Georgescu et al, *Proc. Nat. Academy of Sci*., 2014.);
  - Satellite studies: “Skin” temperature distribution rather than temperature in zone inhabited by people;
  - Field studies: Recent advances in low-cost, high-res, portable monitoring equipment enable improved characterization of spatial, temporal temperature distribution (Stewart & Oke, 2012; Brandsma & Wolters, 2012; Cassano 2013).
- **Research gap**: Dearth of high-resolution measurements to validate UHI models for California.

Brandsma and Wolters, 2012. *J. Appl. Meteor. Climatol*., **51**, 1046-1060. http://journals.ametsoc.org/doi/abs/10.1175/JAMC-D-11-0206.1

Proposed work:

- Improve characterization of UHI in California using mobile monitoring and/or a high-density network of fixed monitors.
- Use empirical factors (e.g., distance to parks, fraction of impervious surfaces, sky view) to support rigorous interpretation of data.
- Support/complement ongoing research to develop an UHI index.
- Support/complement ongoing research to develop robust, quantifiable strategies that reduce energy consumption and protect environmental justice (EJ) communities in heat islands.

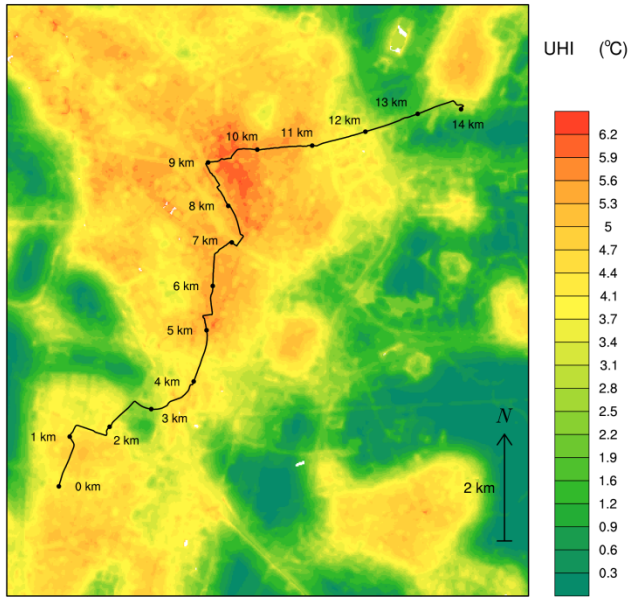


Figure: Spatial distribution of the maximum nighttime UHI intensity for the city of Utrecht and its surroundings

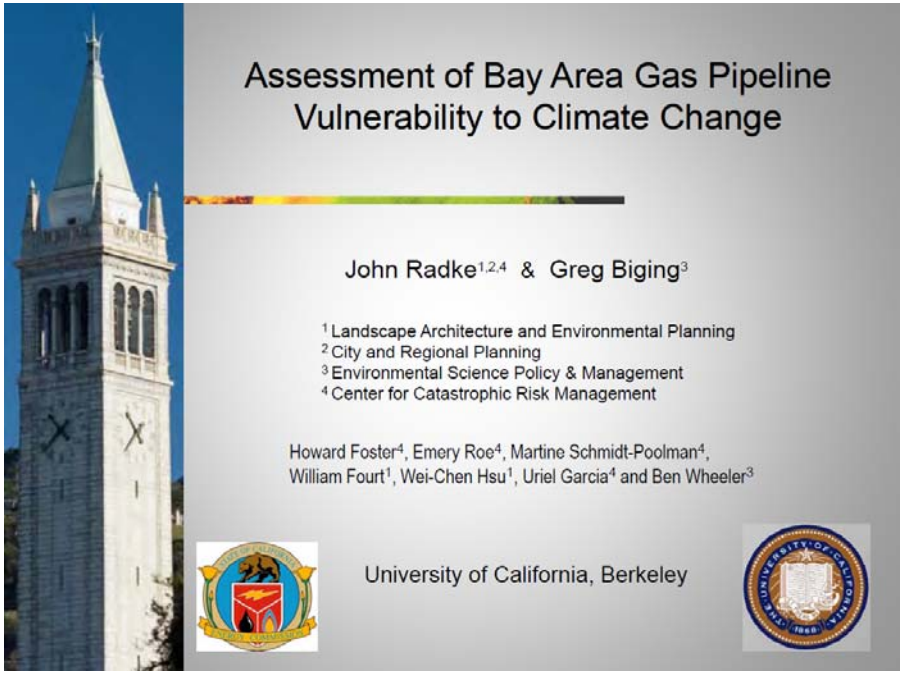
source: Brandsma and Wolters, 2012.
http://journals.ametsoc.org/doi/abs/10.1175/JAMC-D-11-0206.1

Regional adaptation studies for the natural gas sector

Susan Wilhelm

Objective: Enhance capacity to build resilience by supporting several "bottom-up", regional level vulnerability studies that consider regional impacts to the natural gas system due to a climate-mediated changes, such as sea level rise, inland flooding, temperature extremes, wildfires, drought, and mudslides.

Prior work: Very little prior work. Ongoing CEC study for the natural gas system in the Sac/SJ Delta (J. Radke and G. Biging, UC Berkeley).



2013 and 2014 IEPR Workshops on Climate Change

Proposed work:

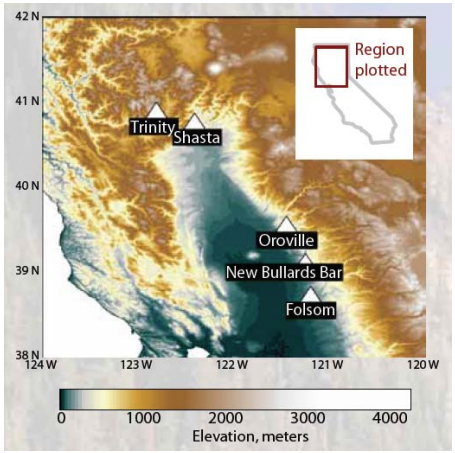
- Three “bottom-up”, regional level studies within territories of investor-owned utilities will be supported.
- Ideally, funds from CEC (for natural gas sector only) will be used as seed funding to be leveraged in support of more comprehensive studies.
- Possible areas of inquiry:
  - Vulnerability of coastal natural gas storage, transmission, and distribution facilities to sea level rise and storm events.
  - Exploration of other climate-mediated changes or events, e.g., inland flooding, mudslides, wildfires, and drought, that could affect the natural gas system.
  - Exploration of adaptation options to climate-related processes threatening the natural gas infrastructure (e.g., corrosion of pipes and tanks, prolonged pressure from floodwaters).
  - Exploration of regionally appropriate management options to increase climate resilience.
- …other natural gas sector climate vulnerabilities that merit investigation?
- Coordination between research teams and IOUs will be critical.

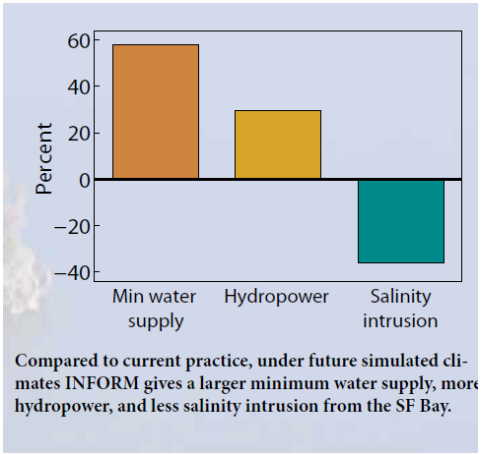
Fostering resilience in the California electricity sector

Guido Franco, Simone Brant

- **Objective:** To identify and document win-win strategies to make the electricity sector more resilient to climate impacts.
- **Prior Work:** Very little research to date. A demonstration project funded by NOAA and the CEC known as INFORM has shown that using probabilistic hydrologic forecasting and a modern decision support system could substantially improve the integrated management of water reservoirs (including hydropower production) and can be an excellent climate adaptation tool (Georgakakos et al., 2011). However, institutional and, perhaps, legal barriers are impeding its implementation.

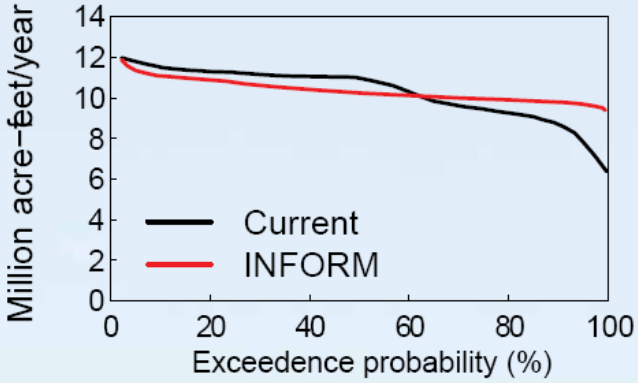
Present Conditions





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.

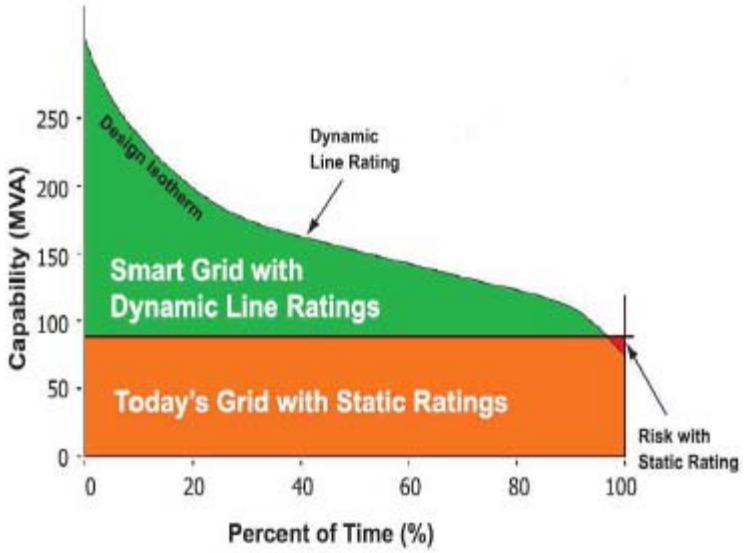
Future Scenarios

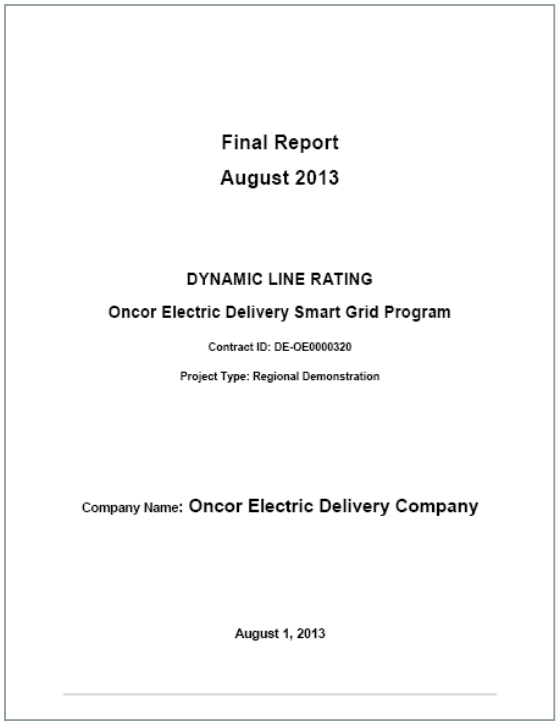


Using simulations of future climate, INFORM (red) maintains more uniform water deliveries year-to-year and higher deliveries in the driest years, compared to current methods (black).

source: Georgakakos et al., 2011. *Implications of Climatic Changes for Northern California Water Resources Management for the Latter Part of the 21st Century*. PIER Project Report, CEC-500-2010-051.

- **Proposed work:** This is a wide open request for ideas to identify options that may work well under current and future climate conditions (win-win strategies). An important element of this work will involve active interaction with decision makers to increase the likelihood of the adoption of research results. The following is only an illustrative example of a potential topic:
  - Dynamic rating of transmission lines could increase the ability to transfer more electricity in congested areas. However, its track record in CA is not good. At the same time, a demonstration project in Texas seems to have been very successful. This project included a seamless integration of dynamic rating with the computer system controlling the flow of electricity in Texas.
  - A study done in the United Kingdom (Craddem and Harrison 2013) suggests that dynamic rating could also be an excellent adaptation tool.





Final Report
August 2013

DYNAMIC LINE RATING
Oncor Electric Delivery Smart Grid Program
Contract ID: DE-OE0000320
Project Type: Regional Demonstration

Company Name: Oncor Electric Delivery Company

August 1, 2013

Final report from demonstration project in Texas.

Craddem and Harrison, 2013. Adapting overhead lines to climate change: Are dynamic ratings the answer? *Energy Policy* **63**:197 - 206.

Related CEC Studies

Guido Franco, Susan Wilhelm, Simone Brant, Lillian Mirviss

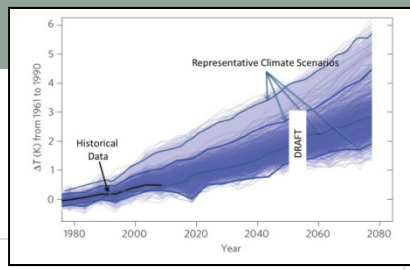
On-going and Planned Projects

- Use of portable LiDAR instrument to better estimate subsidence rates of levees critical to the energy infrastructure in the Sac/SJ Delta (Susan Wilhelm)
- Short-term, seasonal, and decadal probabilistic forecast for the electricity and natural gas systems (Guido Franco)
- Snow water equivalent (SWE) measurements in high elevation remote areas in the Sierra Nevada to improve hydrologic forecasts for hydropower units (Lillian Mirviss)
- Cal-Adapt*: Provide information to support climate resilience in the electricity and natural gas sectors (Susan Wilhelm)

* see www.cal-adapt.org

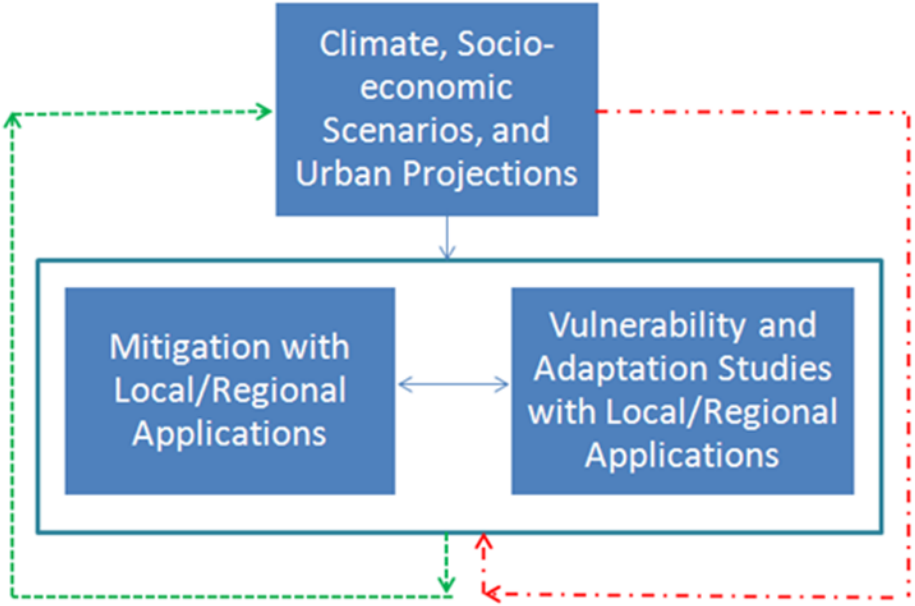
Figure: Truck driving along levee with baloon-mounted light detection and ranging (LiDAR) instrument gathering data to measure subsidence.

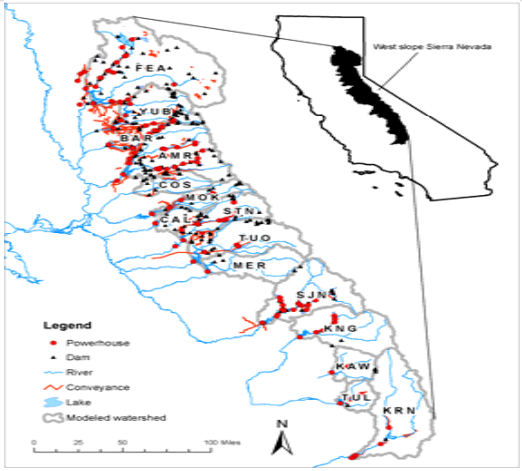
Potential Projects



The draft second EPIC investment plan includes the following relevant projects:

- Developing new downscaling techniques and additional climate scenarios for California (Guido Franco)
- Developing scenarios informed by the paleorecord (Guido Franco)
- Climate change and renewable sources of energy (David Stoms)
- Integrated view of impacts to high and low elevation hydropower units (Lillian Mirviss or Sonya Ziaja)

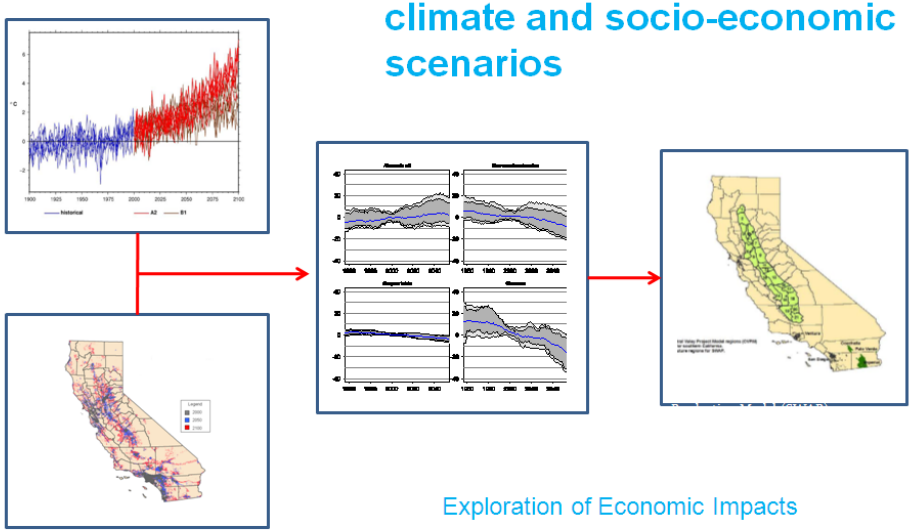




One more slide about integration

- All of the energy studies will be very well coordinated during the research phase and integrated in a final synthesis
- Meetings/conference calls with the PIs every quarter
- Strong coordination with the non-energy part of the Assessment (e.g., common set of wildfire scenarios)

Using an integrated framework with common climate and socio-economic scenarios



Exploration of Economic Impacts

Discussion Questions

- Are these high priority climate research areas for the energy sector?
- What coordination with utilities is needed to help leverage EPIC and Natural Gas funds and/or support production of “actionable” results?
- Are there security issues that would preclude in-depth studies of the electricity system?
- Should other potential stressors should be considered for the different studies? For instance, some believe that poles loaded with communication-related equipment are at greater risk of toppling.
- Other comments?

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