



Climate Change and Advanced Energy Generation

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Outline



- Background Information
- Implications of Climate Change to Advanced Electricity Generation Systems
- Related PIER-Climate Change Projects
- Final Remarks



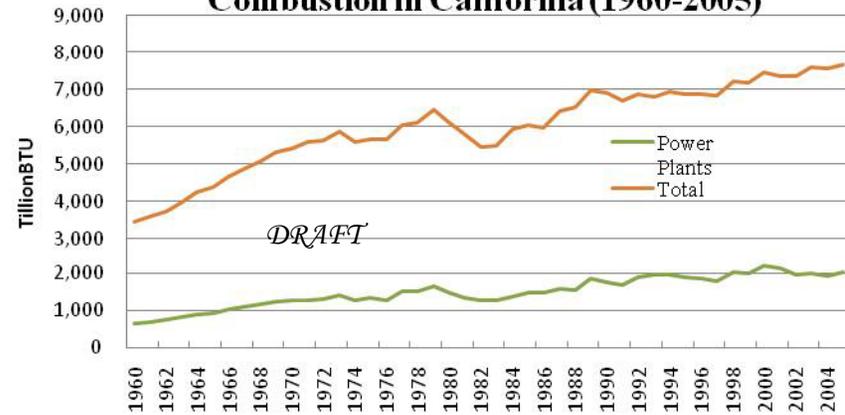
Background Information

Historical CO₂ Emissions



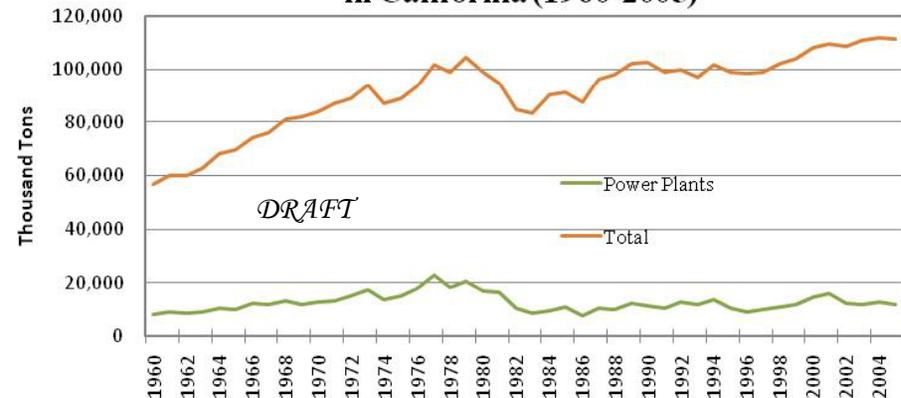
- Energy consumption from the combustion of fossil fuels has almost doubled in the last 40+ years
- CO₂ emissions from in-state generation had a peak in the late 1970s (residual oil combustion)
- What are the CO₂ emissions associated with electricity imports?

Energy Consumption from Fossil Fuel Combustion in California (1960-2005)



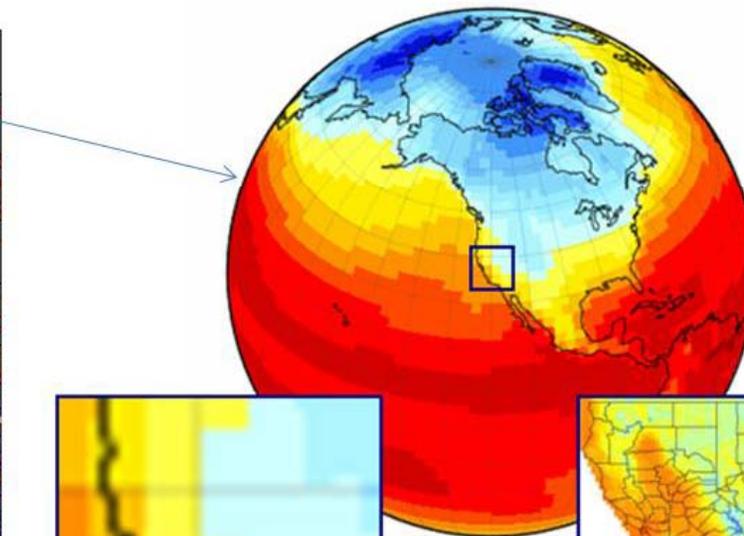
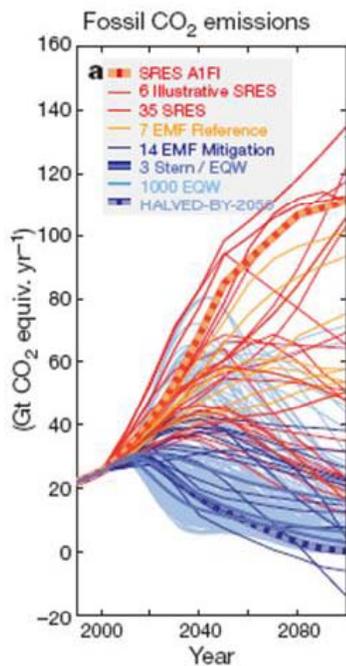
Data Source: EIA

Carbon Emission from Fossil Fuel Combustion in California (1960-2005)

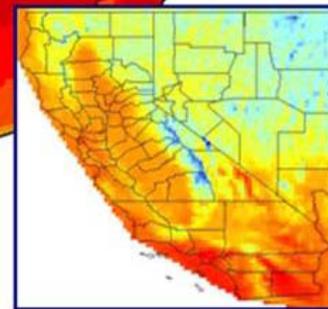
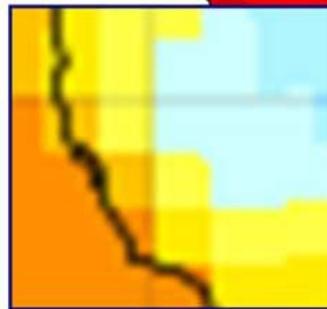


Shen and Franco, 2009

Climate Projections for California



About 16 global modeling groups in the world



7 x 7 miles

Statistical Downscaling

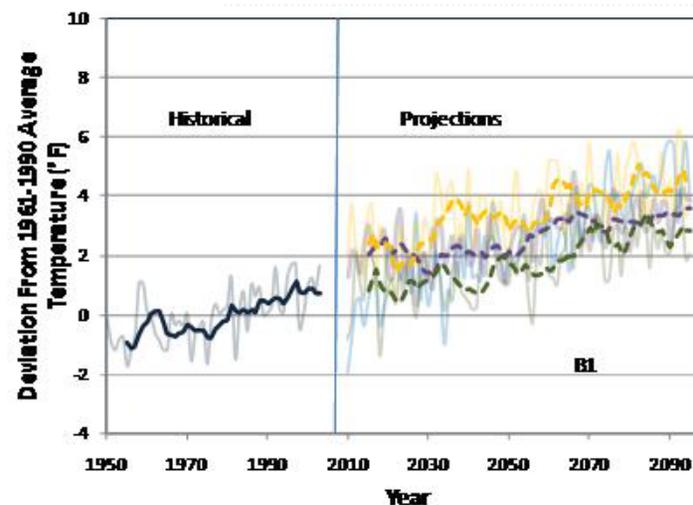
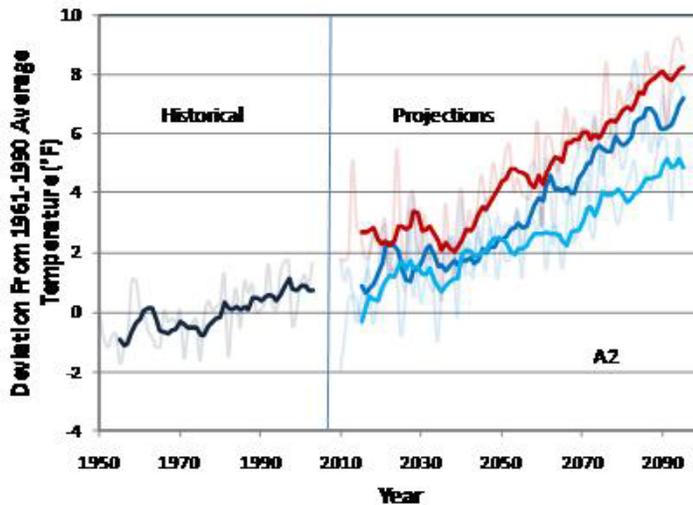
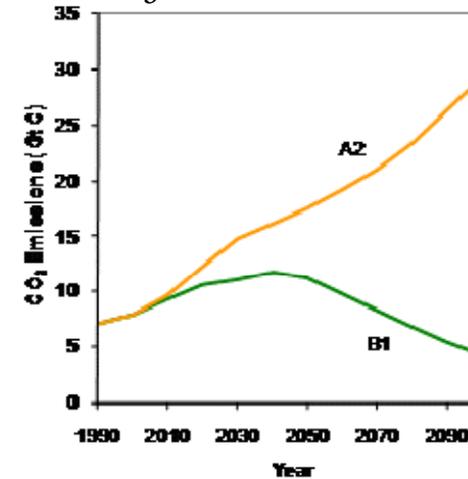
Source: Franco and Pittiglio, 2008.
Data provided by Scripps

Historical and Projected Average Temperatures for California



- Average Temperatures will go up in California as a function of global GHG emissions

Global C Emissions



Source: Moser, Franco, Pittiglio, Chou, 2008

Warming will not be uniform

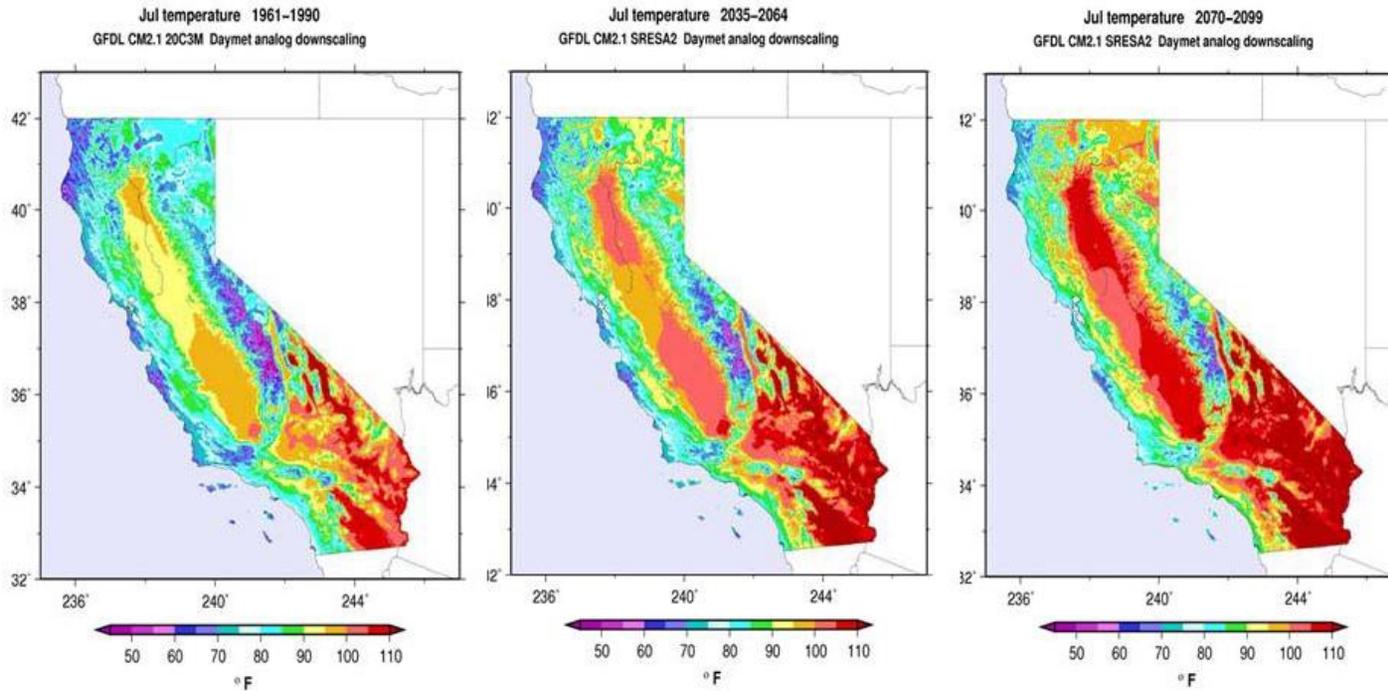


DRAFT

Current Conditions

Middle of the Century

End of the Century



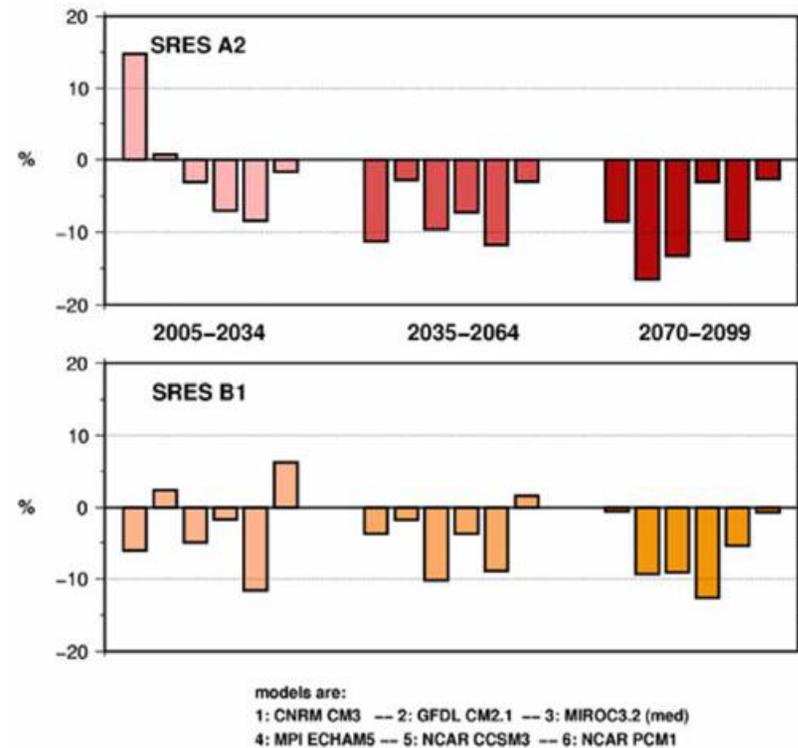
Source: *Cayan et al., 2009. PIER Report*

Drying Trend?



- Most of the global climate models suggest a drying trend for the Southwest and for California in particular

Percent Change in Precipitation Levels in Northern California in Relation to the 1961-1990 Water Year Average Precipitation

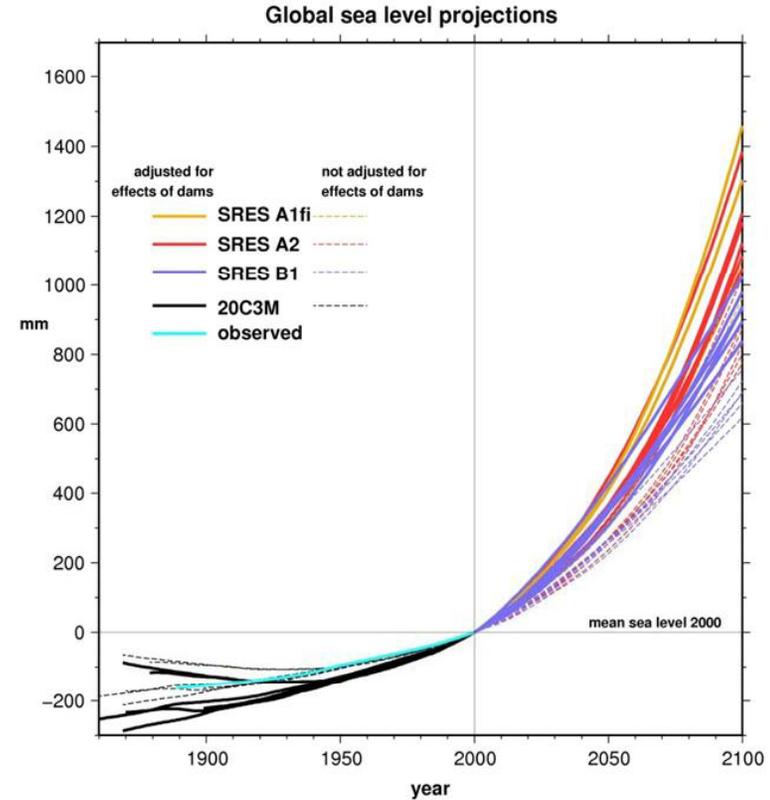


Source: *Cayan et al., 2009*

Sea Level Projections



- In the “worst” case scenario sea levels will go up by ~ 1.4 meters (55”) by the end of this century
- Even if global emissions are reduced drastically sea levels will go up and will continue this trend for centuries



CNRM CM3 GFDL CM2.1 MIROC3.2 (med)
MPI ECHAM5 NCAR CCSM3 NCAR PCM1

after Rahmstorf (2007) Science VOL 315 pp 368-370
Chao et al. (2008) Scienceexpress 13 March 2008 10.1126/science.1154580

Source: Cayan et al., 2009



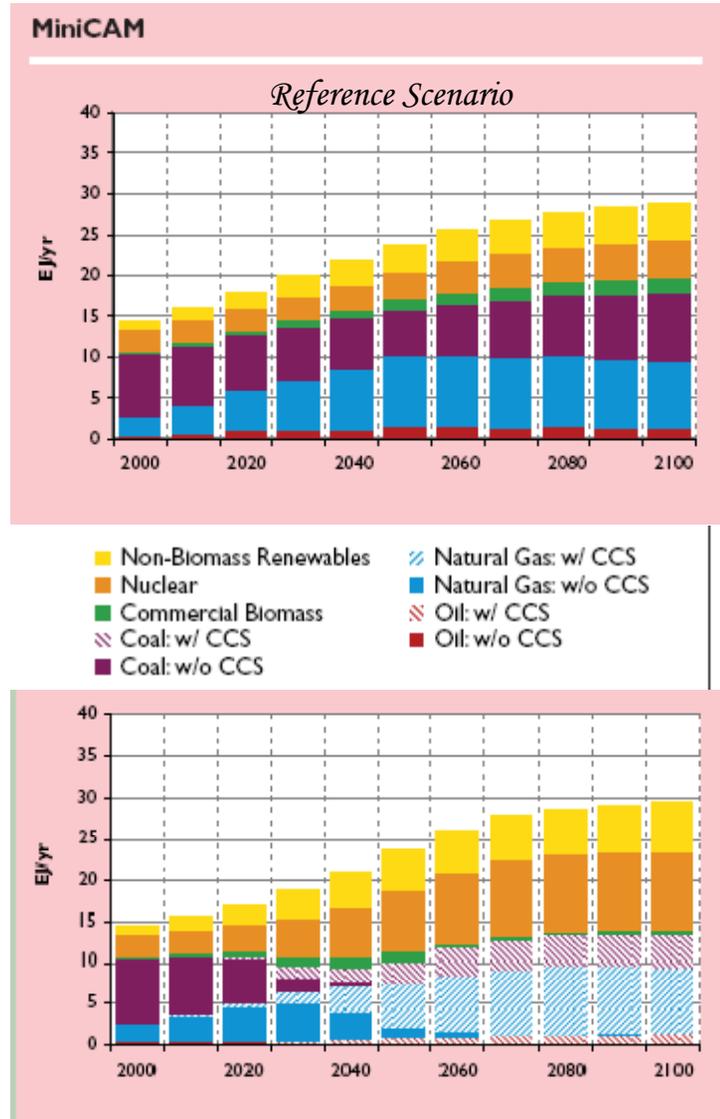
Implications of Climate Change to Advanced Energy (Electricity) Technologies

Results from Integrated Assessment Models



- Rapid electrification of the energy system under a carbon constrained world
- By 2050 an 80% reduction from “developed” countries requires the deployment of zero or close-to-zero GHG emitting technologies. Remember the CA 2050 target
- Be cautious with “silver bullets” (CCS?)

US Electricity – Reference case and one stabilization scenario



Source: US Climate Change Science Program. Synthesis and Assessment Product 2.1a. 2007



Related PIER-Climate Change Projects

Potential Energy Pathways for California through 2050

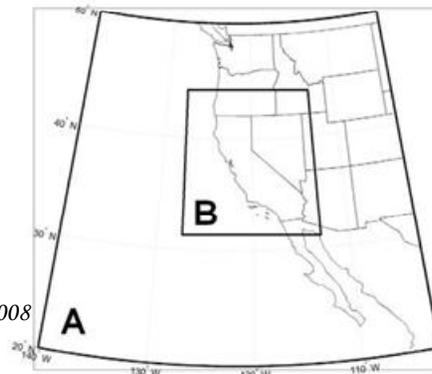


- LBNL, UC Berkeley, UC Davis are studying potential energy pathways for California integrating what we know about the potential for energy efficiency, renewables, etc.
- PNNL is developing a version of the MiniCAM model for California embedded into the US/Global model

Climate Change and the Energy Infrastructure and Renewable Sources of Energy



- Study of the potential effect of climate change on energy infrastructure in CA (LBNL)
- Study of the potential effect of climate change on renewable sources of energy



Source: Millet et al., 2008



Power plants vulnerable to a 100-year coastal flood with a 1.4 meter sea-level rise

Data sources: USGS/Scriptps Institution of Oceanography, California Energy Commission, CaSIL, ESRI. http://www.pacinst.org/reports/sea_level_rise





Final Remarks



Advanced energy generation technologies are technologies with zero or near-zero net greenhouse gas emission profiles