Clean Energy and Climate Change Response in California: The Intersection of Policy and RD&D

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California's Long Path to Clean Energy 1970-2007

- **1967 – California Air Resources Board established**
- **1971 – CARB automotive NO_x standards**
- 1978 – No new nuclear power without permanent storage
- **1977 – Building and Appliance efficiency standards created with updates every three years**
- **1982 – IOU rates of return decoupled from volumes; utility efficiency incentive programs established**
- 1991 – CARB establishes specifications and properties of reformulated, low emission gasoline.
- 1996 – PUC recommends electricity deregulation plan.
- 1997 – SB 90 deregulates IOUs and creates Public Interest Energy Research (PIER) program.
- **2003 – The CPUC and the CEC establish "the Loading Order" following 2001 Deliverability crisis. Deliver on new demand with 1) Efficiency and Demand Response, 2) Renewables, and 3) Clean Fossil Generation and Distributed Generation.**
- **2003 – Renewables Portfolio Standard enacted.**
- 2005 – PUC orders $2.2B, 3 year Efficiency procurement for the IOUs.

An Abbreviated Chronology

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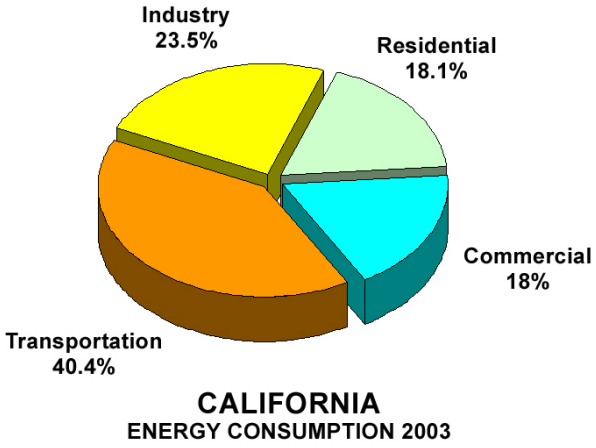
Where is California's Energy Used



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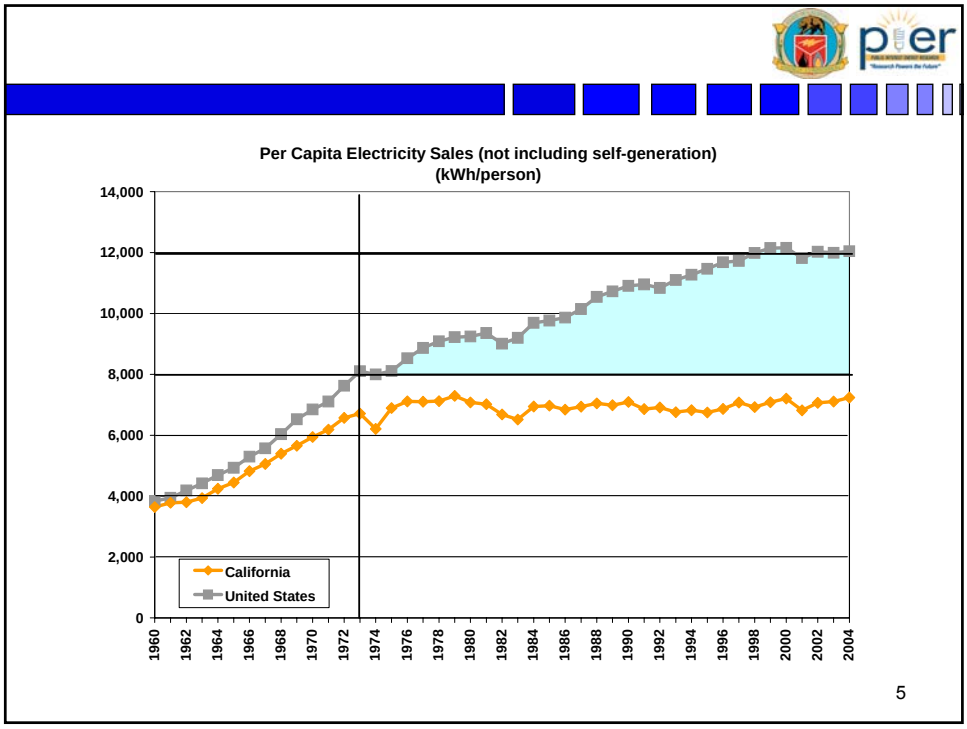
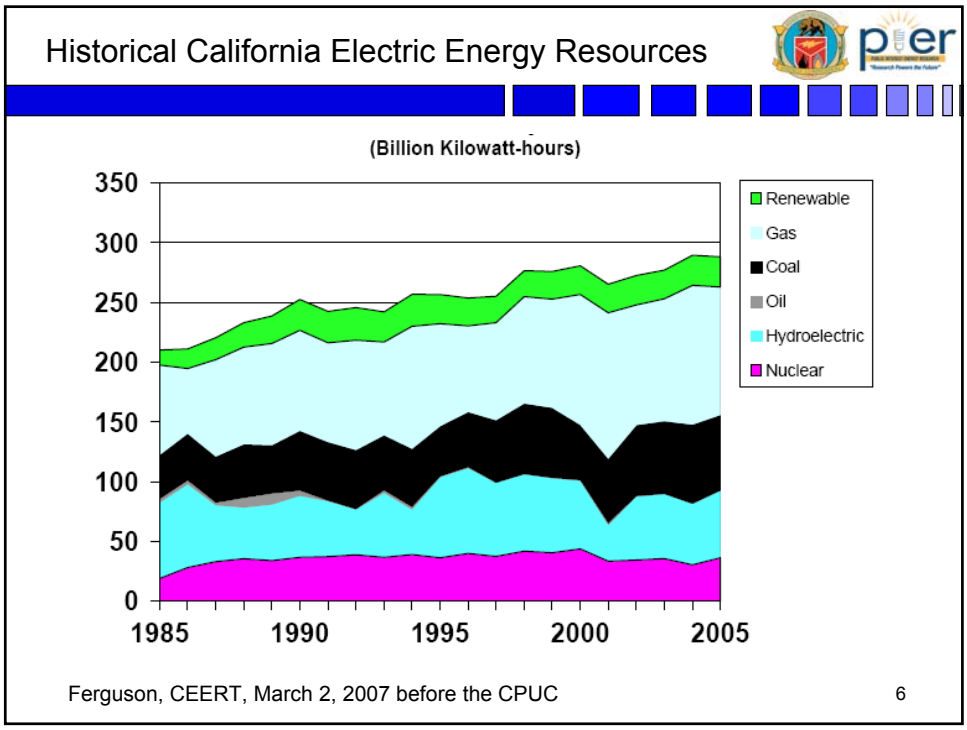
California – Electricity Overview

- Population: *>34 million, 1.1% per year growth*
- Multiple Utility Service Territories
- 2004 Electricity Use: *262,000 GWH*
- 2004 Peak Demand: *54,500 MW*
- Annual growth: *Consumption - 1.4%* *Peak - 1.65%*


Per Capita Electricity Sales (not including self-generation)
(kWh/person)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
California
United States
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
5


Historical California Electric Energy Resources
(Billion Kilowatt-hours)
350
300
250
200
150
100
50
0
1985
1990
1995
2000
2005
Renewable
Gas
Coal
Oil
Hydroelectric
Nuclear
Ferguson, CEERT, March 2, 2007 before the CPUC
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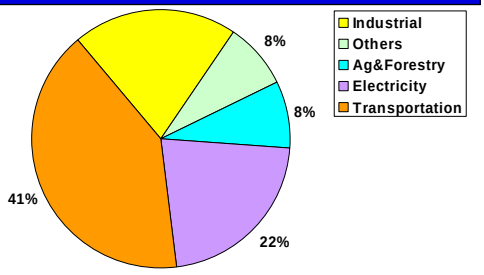
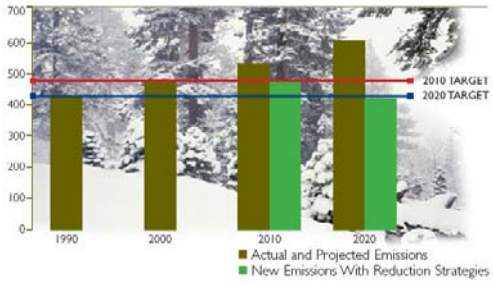
California Responds to Global Warming 2000 - 2007



California Carbon Dioxide Emissions by Energy Sectors, 2004
~400 million metric tons carbon dioxide



- In 1988 GHG impacts review mandated
- In 2000, the California Greenhouse Gas Registry was established
- In 2002 AB1493 (Pavley) mandates 30% reduction GHG emissions in new light duty vehicles by 2016
- In 2005, AB 1007 requires plan to replace gasoline use with low carbon alternatives.
- **AB 32 – Global Warming Solutions Act of 2006; aggressive goals for 2020**
- **SB 1368 – GHG Emissions standards for IOUs and POUs**
- **AB 2021 – Energy Efficiency for POUs**
- **AB 2160 – Green Building Acquisition Financing for State Facilities**
- **SB107 – Accelerated RPS Goals – 20% by 2010**
- **SB1 – Renewables Goals for New and Existing Residential and Commercial Structures**
- **AB 2778 – Self-Generation Incentive Program for Fuel Cells and Wind**
- **SB 1250 – PIER and Renewables Incentive Programs Reauthorized**
- In 2007, Governor mandates development of Low Carbon Fuel Standard.
- AB 118 (Nuñez) establishes incentives for Development and Deployment of new technologies for alternative fuels and vehicles

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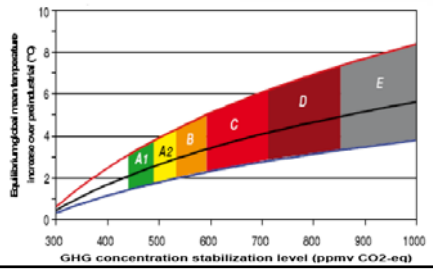
IPCC Fourth Assessment – Mitigation WG3

- **In order to stabilize the concentration of GHGs in the atmosphere, emissions would need to peak and decline thereafter. The lower the stabilization level, the more quickly this peak and decline would need to occur. Mitigation efforts over the next two to three decades will have a large impact on opportunities to achieve lower stabilization levels** (*high agreement, much evidence*).

Mitigation and Adaptation Required

Temperatures Will Rise

Stab level (ppm CO2-eq)	Global Mean temp. increase at equilibrium (°C)	Year CO2 needs to peak	Reduction in 2050 compared to 200
445 – 490	2.0 – 2.4	2000 - 2015	-50
490 – 535	2.4 – 2.8	2000 - 2020	-60 to -30
535 – 590	2.8 – 3.2	2010 - 2030	-30 to +5
590 – 710	3.2 – 4.0	2020 - 2060	+10 to +60
710 – 855	4.0 – 4.9	2050 - 2080	+25 to +85
855 – 1130	4.9 – 6.1	2060 - 2090	+90 to +140



550ppm concentration CO2eq Represents 2X Pre-Industrial Levels

To Maintain 550ppm Requires that Emissions Peak between 2010 and 2030

The World Would Be Committed to Significant Temperature Increases of ~ 3ºC

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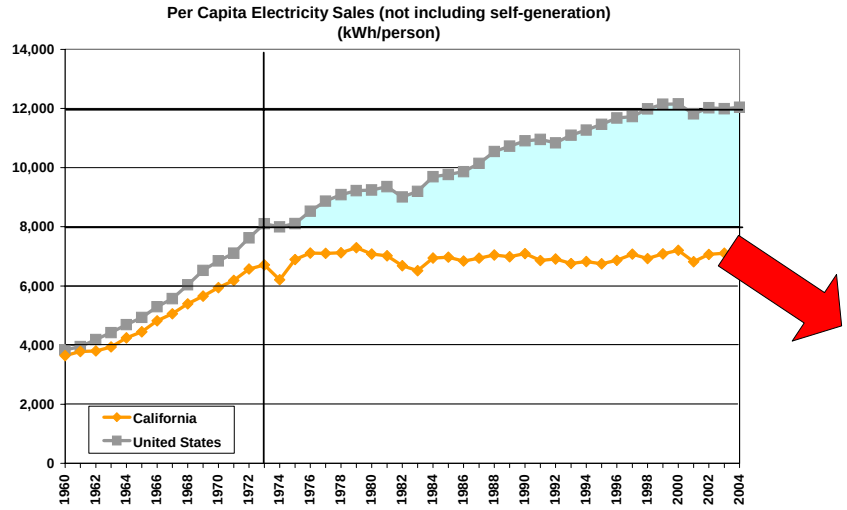
Per Capita Electricity Use Needs to Decline *Even In California*



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Near-Term Technical Challenges and Opportunities in Efficiency and Fuel Displacement

- Transportation
  - Vehicle Efficiency – Cool colors, auxiliary load
  - Batteries
  - Plug-In Hybrid Vehicles
  - Cellulosic ethanol, biodiesel
  - Regional Transit/Goods Movement Systems
- Efficiency – Buildings/Industry/Agriculture
  - Siting/ Design/ Installation/ Commissioning Protocols/ Monitoring and Evaluation
  - Building Envelopes/Fenestration
  - Lighting
  - Appliances
  - Furnaces/Boilers
  - Pumps
  - Back-up / Non-Uninterruptible Power Supplies
  - Combined Heat and Power
  - Integrated Renewables with Efficiency
- Water Efficiency

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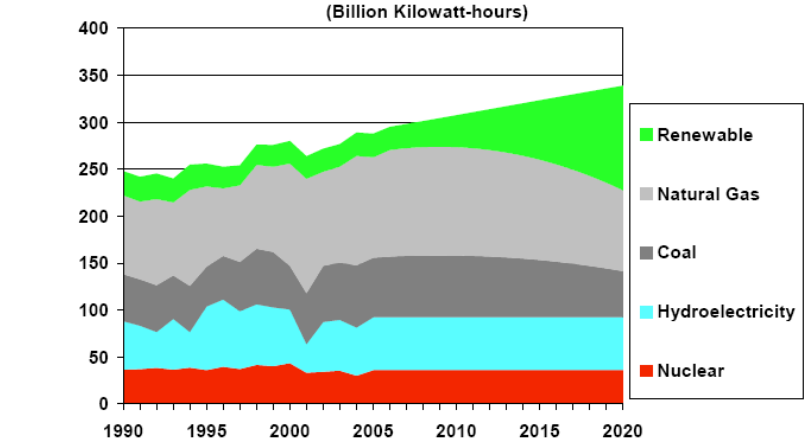
California Electricity, All Resources

Possible AB 32 scenario - equal CO2 emissions from coal and gas



Ferguson, CEERT, March 2, 2007 before the CPUC

Meeting California's 2020 Emissions Goals in the Electricity Sector Will Present Major Technical and Institutional Challenges

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Renewable Electricity – The Challenges

- The Renewable Portfolio Standard (33% by 2020) Means 'Big' Solar
  - 4,500 MW of Wind from the Tehachapis
  - 2,000 MW of Geothermal from the Imperial Valley
  - New Transmission Lines to Connect the Power to the North and South
  - Repower Existing Wind Resources
  - Large Solar Thermal Installations
  - Resource Prediction – Reliable Day Ahead
  - Variable Resource Firming
    - Storage
  - Variable Resource Integration with Transmission System
- The California Solar Initiative could provide as much as 3,000 MW from photovoltaics, solar hot water and solar thermal technologies
  - Reduce cost of installation
  - Net Metering
  - Interconnection with the Distribution System
- Biomass
  - 4,000 MW technical resource
  - Interconnection with the Distribution System
  - Resource Collection
  - Conversion Systems

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Systems Challenges

- **Future System Complexity**
  - **Distributed, Variable Generation Sources**
  - **Distributed Loads**
  - **Congestion and Peak Load Management**
  - ***System Controls & Planning***
  - ***Storage***
  - ***Smart Grid Tools***
  - ***Demand Response***
- **Climate Driven Impacts**
  - **Hydroelectric resources**
  - **Wind and Biomass Resources**
  - **Summer Peak Management**
  - **Water Supply and Use**
  - ***Risk Assessment, Management, Communication***
  - ***Intergovernmental Coordination***
    - ***Federal-State-Local***
    - ***Interagency Coordination/Cooperation***
- **Land Use Planning**
  - **Regional**
  - **Local**
  - **Energy Efficiency, Distributed Generation, Transportation, Water**
  - ***Consumer Behavior***
  - ***Behavior of Public and Private Organizations***
    - ***Integration of New Technologies***

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Clean Fossil Electricity – The Challenges

- Natural Gas Efficiency
  - Fuel Cells
  - Packaged Distributed Generation/ CHP Systems to Meet 2007 CARB Standards
  - Self-Generation Incentive Program
- Out-Of- State Coal/Petroleum Coke
  - Integrated Gasifier Combined Cycle
  - Oxyfuel Combustion
  - Carbon Sequestration

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Assembly Bill 1925 requires a report assessing California's readiness for commercial geologic sequestration

- Assembly Bill 1925 introduced by Blakeslee and passed unanimously
- Requires the California Energy Commission, with the Dept of Conservation, to prepare a report containing:

  …recommendations for how the state can develop parameters to accelerate the adoption of cost-effective geologic sequestration strategies for the long-term management of industrial carbon dioxide.
- First report due in 2007 to be followed by a second report in 2010 after WESTCARB Phase II is completed

Sam Blakeslee

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Goals for the first report were to assess technical readiness and implementation barriers

- Technical readiness:
  - Site characterization
  - Risk assessment
  - Monitoring and verification
  - Mitigation and remediation
- Barriers/uncertainties in:
  - Regulatory frameworks
  - Statutory frameworks
  - Economics
- Make recommendations for further actions prior to 2010 report

Findings:

CCS is technically ready but data from demonstration and early projects are critical to inform policy

Developing regulatory and statutory frameworks will require integrated agency efforts

Cost estimates need refining to define best early opportunities in the state and regionally and to set a proxy for long-term value of carbon reduction

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Thank You

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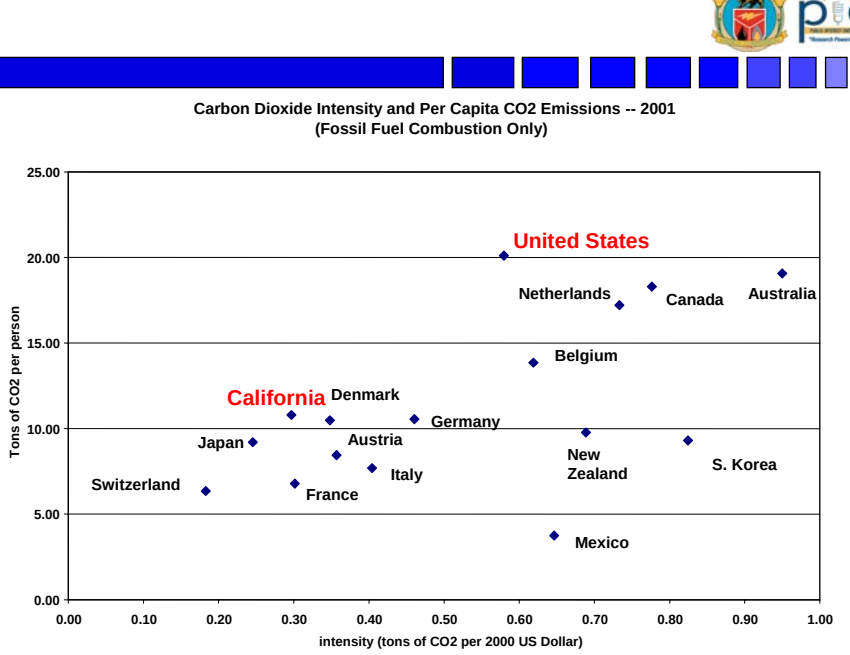

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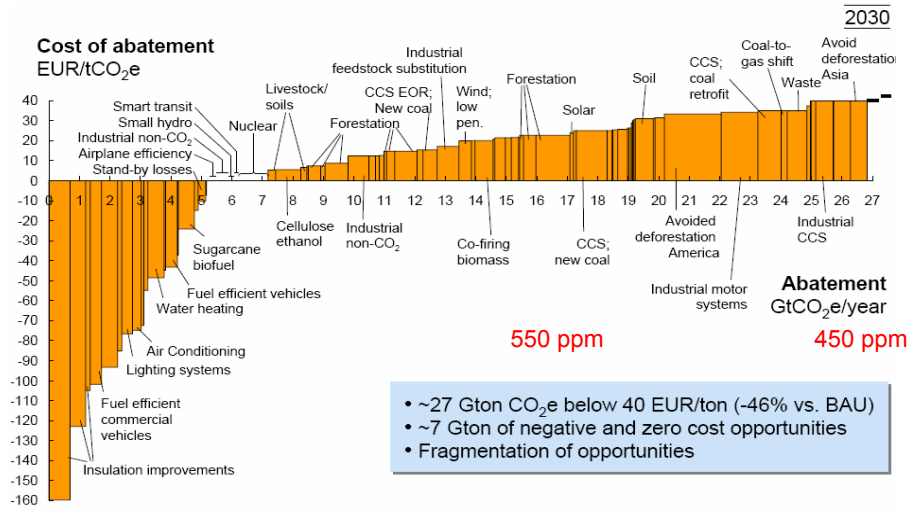
California's Water-Energy Nexus

- 70% of Precipitation in North
- 75% Demand in the South
- Water Demand: *43 maf*
  9 maf Urban
  34 maf Agricultural
- Energy Use:
  19% of Electricity
  33% of Natural Gas
- Population by 2030:
  48 million
- 2030 Water Demand:
  43-50 maf

	Northern California kWh/MG	Southern California kWh/MG
Supply & Conveyance	150	8,900
Water Treatment	100	100
Distribution	1,200	1,200
Wastewater Treatment	2,500	2,500
Regional Total	3,950	12,700

Global cost curve of GHG abatement opportunities beyond business as usual



Vattenfall

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California's Climate Action Plan