California's Air Pollution and Climate Change Policies

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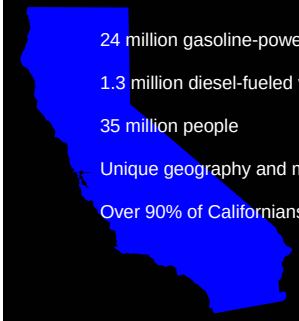
California Air Resources Board
California Environmental Protection Agency

Control policy drivers ...

California's Air Quality Problem



- 24 million gasoline-powered vehicles
- 1.3 million diesel-fueled vehicles and engines
- 35 million people
- Unique geography and meteorology confine air pollutants
- Over 90% of Californians breath unhealthy air

Unique, Adverse Meteorology

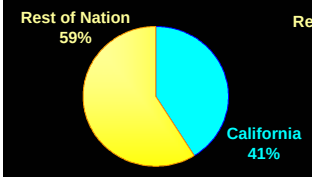
Lowest Per Capita Emission Targets

Onshore circulation pattern, high temperatures, stagnant air masses, and mountain ranges that trap pollutants lead to ...

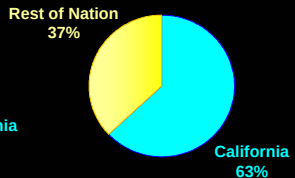
	Population (million)	Carrying Capacity (VOC+NO_X) (tpd)	(lb/person/yr)
Los Angeles	16.9	840	36
San Joaquin Valley	4.1	630	69
Houston	5.5	1360	181

California's Disproportionate Air Pollution Exposure

8-Hour Ozone
(NAAQS = 80 ppb)



Annual PM2.5
(NAAQS = 15 µg/m³)



Population-weighted and minus national ambient air quality standard (NAAQS), based on 2000-2002 data

Air Pollution and Premature Death

Sample Calculations for California

Pollutant	Averaging Time	Increased Risk in All-Cause Death (per 10 µg/m³) [a]	Threshold or Background (µg/m³) [e]	Annual Exposure (µg/m³) [f]	Annual Deaths [a]
PM2.5	Annual	10% [b]	2.5 to 7	13.5	13,000 to 22,000
PM10	24-hour	0.25% [c]	5	22.3	1000
Ozone	8-hour	0.27% [d]	80	--	800

[a] At least a factor of two uncertainty
[b] Median value from "An expert judgment assessment of the concentration-response relationship between PM2.5 exposure and mortality", Industrial Economics, Inc. (2006)
[c] "Revised analysis of time-series studies of air pollution and health", HEI Special Report, p. 21 (2003)
[d] Ostro, Tran and Levy "The health benefits of reduced tropospheric ozone in California", *JAWMA* (2006)
[e] Background for PM2.5 is 2.5 µg/m³ while threshold of 7 µg/m³ is the lowest measured PM2.5 level in American Cancer Society studies showing an association with premature death (Pope 2002)
[f] 2003-2005 air quality data, population-weighted

California Climate Impacts
over the past 100 years

1.3ºF (0.7°C) higher temperatures

7 inch sea level rise

12% decrease in fraction of runoff between April and July

snowmelt and spring blooms advanced 2 days/decade since 1955

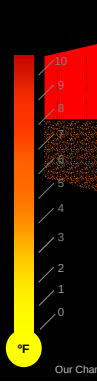
Cal/EPA-OEHHA, "Environmental Protection Indicators for California" (2002)
www.oehha.ca.gov/multimedia/epic/Epicreport.html

Lyell Glacier
Yosemite National Park

1903

2003

Projected Climate Impacts on California, 2070-2099
(as compared with 1961-1990)



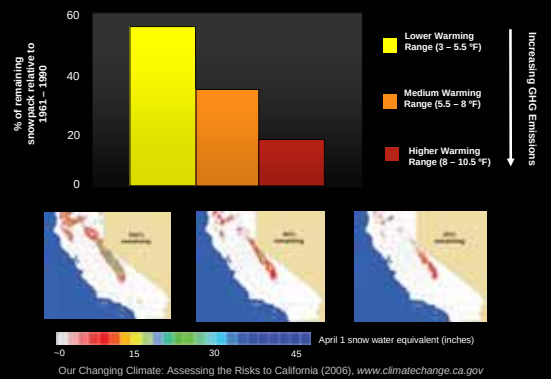
Higher Warming Range (8 – 10.5 °F)
3 - 4 times as many heat wave days
22 - 30 inches of sea level rise
90% loss in Sierra snowpack
20% increase in energy demand

Medium Warming Range (5.5 – 8 °F)
2.5 - 4 times as many heat wave days
14 - 22 inches of sea level rise
70 - 80% loss in Sierra snowpack
30% decrease in forest yields (pine)
55% increased risk of large forest fires
10% increase in energy demand

Lower Warming Range (3 – 5.5 °F)
2 - 2.5 times as many heat wave days
6 - 14 inches of sea level rise
30 - 60% loss in Sierra snowpack
7 - 14% decrease in forest yields (pine)
10 - 35% increased risk of large forest fires
3 - 6% increase in energy demand

Our Changing Climate: Assessing the Risks to California (2006), *www.climatechange.ca.gov*

Decrease in Sierra Nevada Snowpack

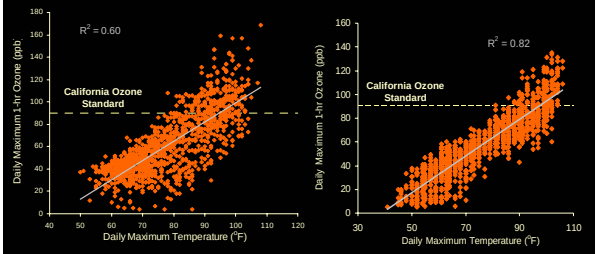


Our Changing Climate: Assessing the Risks to California (2006), *www.climatechange.ca.gov*

Implications of Climate Change for Air Quality

California's Major Air Basins

Ozone versus Temperature

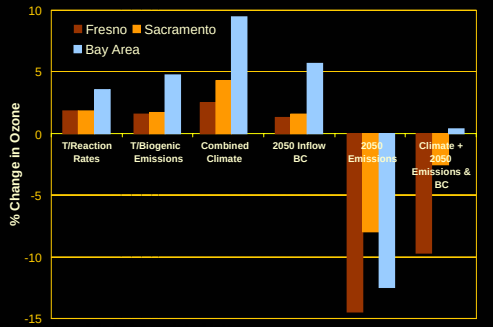


Riverside, 2003-2005

Fresno, 2003-2005

Projected Ozone Response to Climate

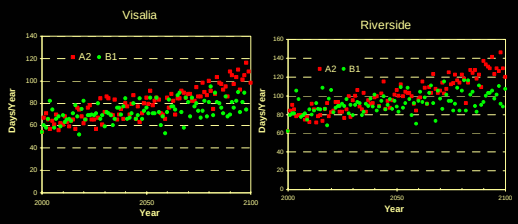
Central California, 2050



Steiner et al., "Influence of future climate and emissions on regional air quality in California", *JGR* (2006)

Projected Episode Response to Climate

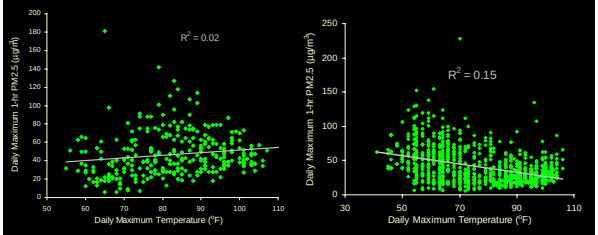
days per year > 90 ppb ozone



Stagnation events related to temperatures aloft. All other factors assumed to remain stay constant while global emissions follow IPCC projections A2 and B1.

Kleeman and Cayan, "Impact of Climate Change on Meteorology and Regional Air Quality In California", Interim Report to CARB (2006)

PM2.5 versus Temperature



Riverside, 2003-2005

Fresno, 2003-2005

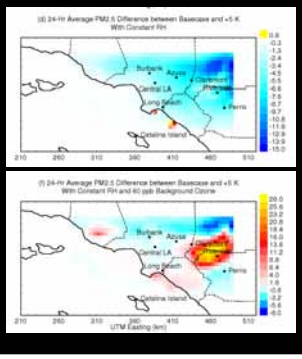
Projected PM2.5 Response to Climate

South Coast Air Basin

Base-case episode features
September 25, 1996 (125 µg/m³)
Elevated temperature inversion
Cool nights, warm days

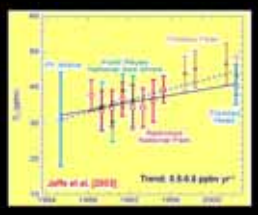
Sensitivity study
Limitations: No accounting of future controls or the effect of temperature on emissions and meteorology

1. Increase temperature by +5°C, constant relative humidity
2. Also increase background ozone to 60 ppb

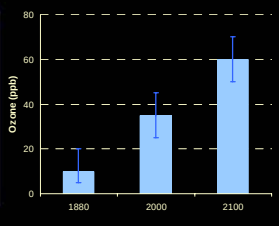


Kleeman, "A Preliminary Assessment of the Sensitivity of Air Quality in California to Global Change", *Climatic Change*, in review.

Increase in Background Ozone



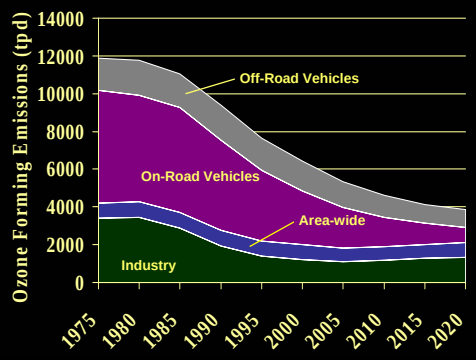
Observed trends in background ozone levels in California (Jaffe et al., 2003)



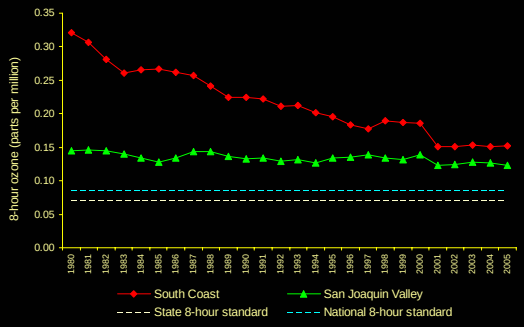
Background ozone levels in the Northern Hemisphere (Vingarzan et al., 2004)

Policy response ...

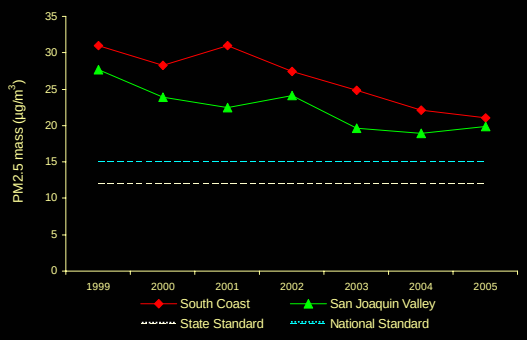
Statewide Emissions Trends



8-Hour Ozone Trends



Annual-average PM2.5 Trends



Governor Schwarzenegger's Environmental Targets

50% improvement in air quality from 2003 to 2010

Diesel Engines
75% below 2000 levels by 2010, 85% below by 2020
Replace or retrofit every diesel engine in California

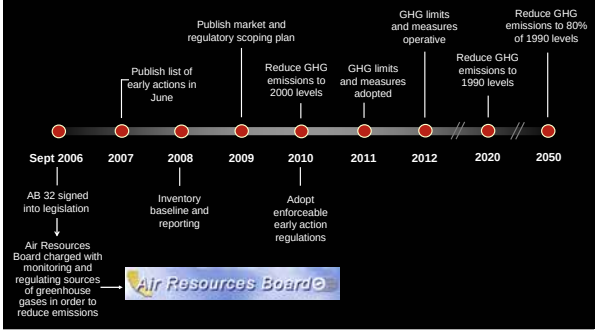
Goods Movement
2001 emission levels by 2010
Diesel PM risk 85% below 2000 by 2020

Greenhouse Gases
By 2010, reduce to 2000 levels (60 MMT, 11% below BAU)
By 2012, cap and trade market linked with EU-ETS and RGGI
By 2020, reduce to 1990 levels (174 MMT, 30% below BAU)
By 2050, reduce to 80% below 1990 levels

Hydrogen Highway

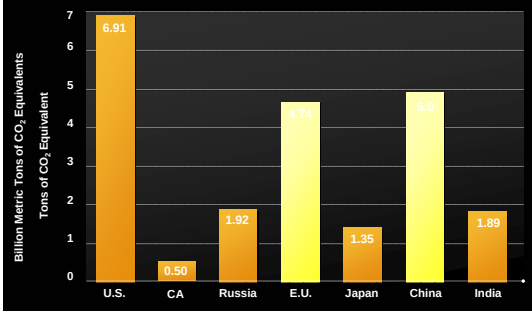
Green Government Buildings

California Global Warming Solutions Act of 2006 (Assembly Bill 32)



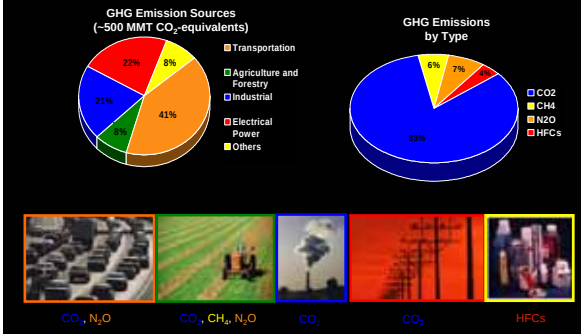
GHG Emissions Per Country / Region

2001-2002



Climate Analysis indicators Tool (CAIT US Version 1.0, CAIT version 4.0), World Resources Institute (2007), data includes CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6 with out-of-state electricity generation for California

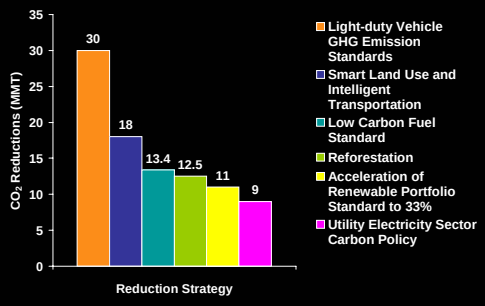
California Greenhouse Gas Emissions



CEC, "Inventory of California Greenhouse Gas Emissions and Sinks: 1990-2004" (2006)
www.climatechange.ca.gov/policies/greenhouse_gas_inventory/index.html

Current GHG Reduction Strategies

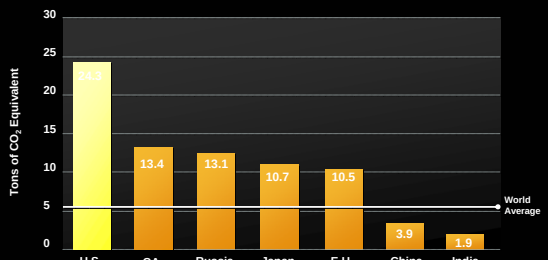
Annual reductions in CO_2 equivalents (million of tons) by 2020



2006 Climate Action Team Report to the Governor and Legislature
climatechange.ca.gov/climate_action_team/reports/index.html

GHG Emissions Per Person

2001-2002



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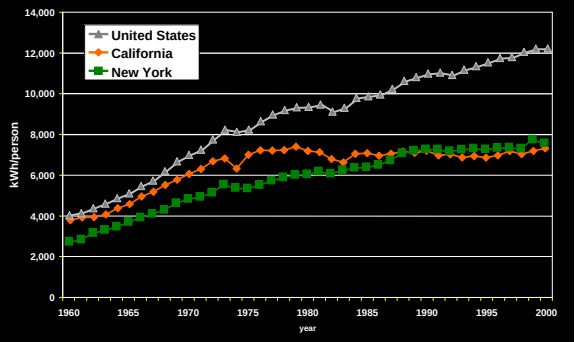
Per Capita Electricity Consumption



www.eia.doe.gov/emeu/states/sep_use/total/csv/use_csv

Non-Kyoto Climate Forcers in California

Sample Calculations

Climate Forcer	100-year Global Warming Potential [a]	MMT [b]	$MMTCO_2E$
CO	1.0 – 3.0	4.56	5 – 15
VOC	1.1 – 6.2	0.81	1 – 5
NO_X	-10 – 5	1.07	-10 – 5
Diesel PM	500 – 1,200	0.029	15 – 35
Other PM	unknown	--	likely negative
CFC and HCFC	100 – 10,000	0.014	10 – 100

[a] Fossil fuel soot GWP range from Hansen et al. (2007) and Jacobson (2005), all others from IPCC
[b] CFC and HCFC estimate from USEPA Vintaging model, all others from CARB emission inventory

Summary

Public health is the most important control policy consideration – especially premature deaths due to PM2.5

California already affected by climate change – future warming threatens water supply and agriculture

Climate change makes ozone standards more difficult to attain – overall impact on PM2.5 and PM10 is unclear

California greenhouse gas reduction policies

- Adopted: light-duty vehicle standards, energy efficiency measures
- Jan. 1, 2010: low carbon fuel standard, other early actions
- Jan. 1, 2012: cap and trade market, other regulations