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09-IEP-1M

DATE AUG 10 2009

RECD. SEP 30 2009

2009 IEPR Staff Workshop
RD&D of Advanced Generation Technologies
August 10, 2009
Carbon Capture and Sequestration in California



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Main Points

- **Assembly Bill 1925 required reporting to policy makers on key parameters to accelerate CCS adoption**
- **With little in-state coal use and ambitious GHG reduction goals, California's approach to CCS will be different than that of most other states**
- **Process to develop policies, regulations and statutes for accelerating CCS adoption will be rely heavily on early demonstration projects, involve multiple agencies, and will need to be regional**



AB 1925 is part of California's policy strategy to address GHG emissions reductions



Executive Order S-3-05 established three target reduction levels for GHG emissions in California

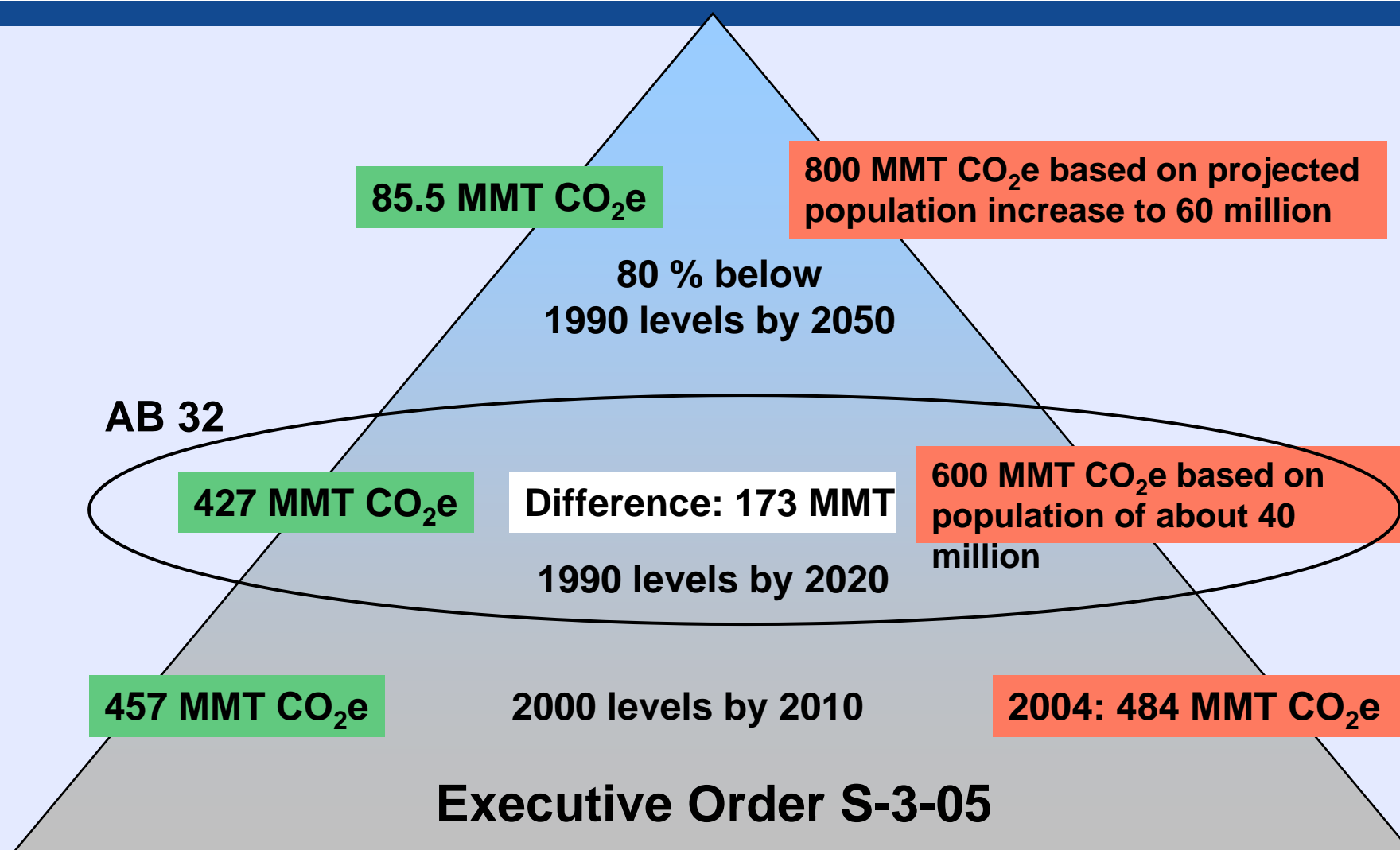
- 2000 levels by 2010
- 1990 levels by 2020
- 80% below 1990 levels by 2050.

AB 32 requires the Air Board to adopt regulations to report and verify greenhouse gas emissions and to adopt limits at 1990 levels to be achieved by 2020

SB 1368 sets an emission standard (1100 lbs CO₂/MWh) and prohibits long-term power purchase agreements for baseload power with emissions greater than that standard



California's GHG Reduction Goals

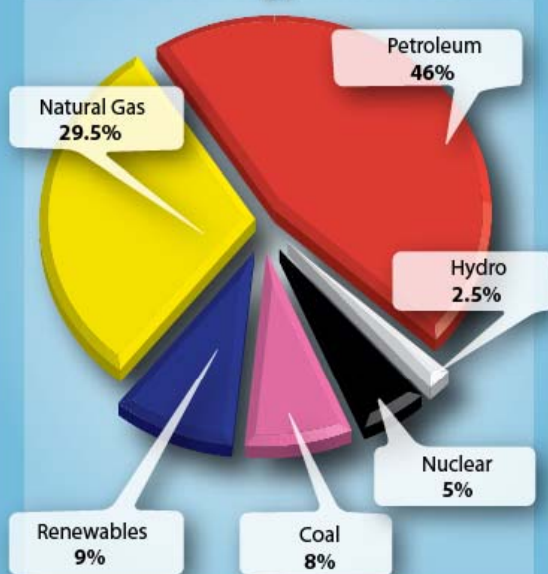


Numbers from CARB, Staff Report: California 1990 Greenhouse Gas Emissions Level and 2020 Emissions Limit, November 16, 2007



Energy sources, sector energy use and emissions for California

**Figure ES-5:
California Energy Sources - 2006**



**Figure 1-5:
Energy Use by Sector - 2006**

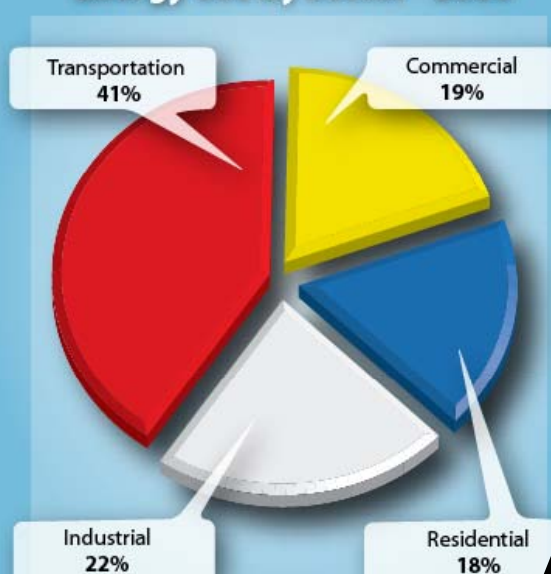
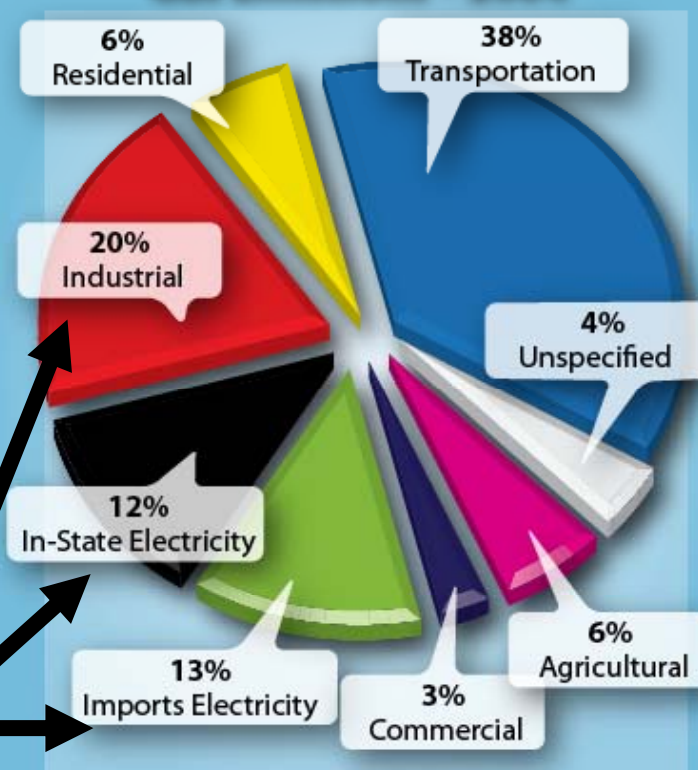


Figure 1-3: California Greenhouse Gas Emissions – 2004*



* Numbers may not add to 100% due to rounding.

CCS is a potential application for up to 45% of California's emissions

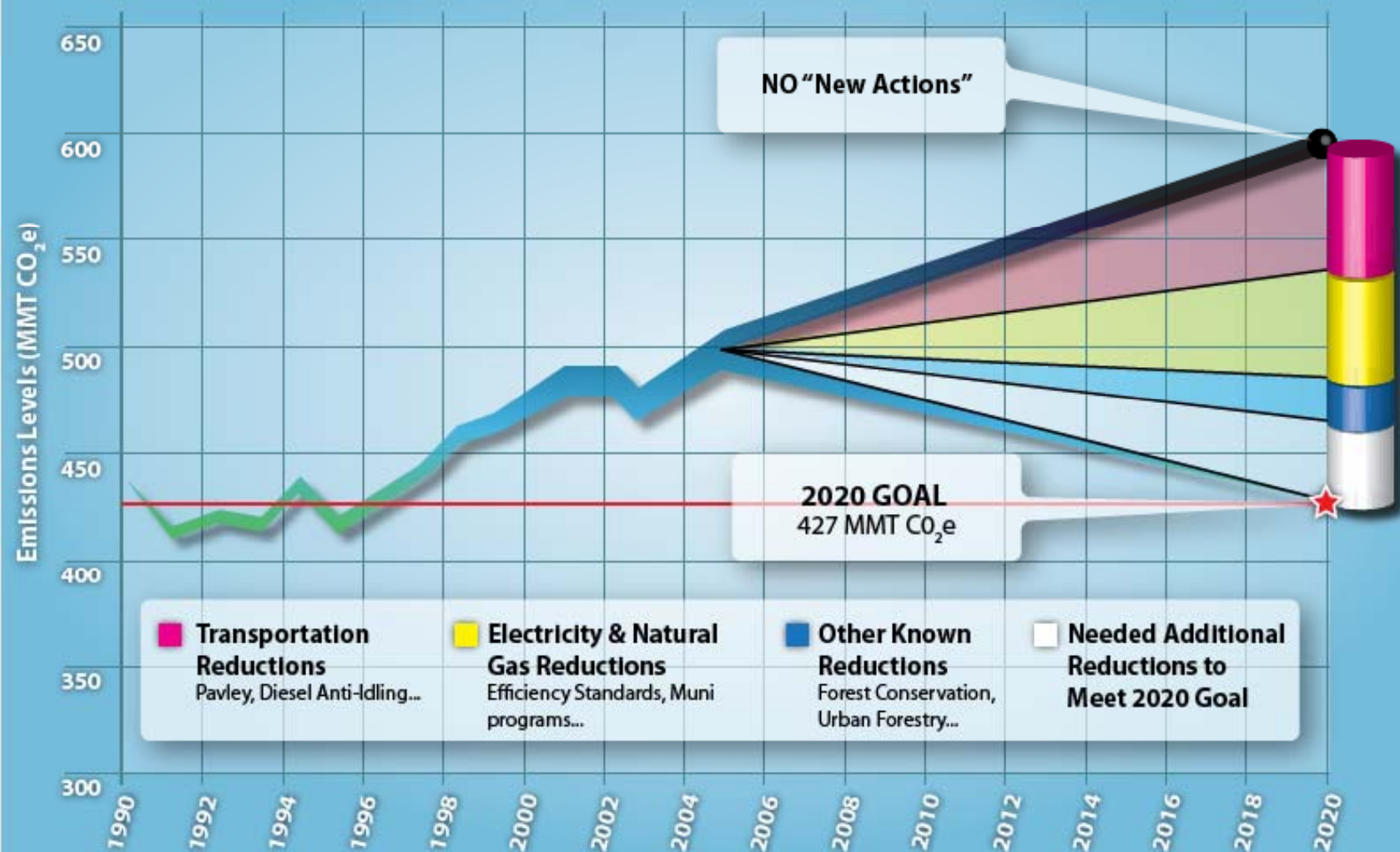
Sector proportions for 2020 and 2050 goals illustrates the deep cuts required

Sector	2004	1990 (2020 goal)	2050 goal
Agriculture	27.9	23.4	4.7
Commercial	12.8	14.4	2.9
Electricity generation	119.8	110.6	22.1
in-state	58.5	49	9.8
imports	61.3	61.6	12.3
Industrial	96.2	103	20.6
cement	9.8	8.1	1.6
landfills	5.6	6.3	1.3
petroleum refining	34.9	32.8	6.6
Residential	29.1	29.7	5.9
Transportation	182.4	150.7	30.1
Forestry	0.2	0.2	0.0



“Wedges” so far proposed for California to reach 2020 goal of 1990’s level of GHG emissions leave a substantial gap

Figure ES-1: California’s CO₂ Emission Reduction Strategies



First report focused on technical and economic feasibility

1. Role of CCS in California
 2. Key implementation issues
 3. California's sequestration capacity — large
 4. Capture technologies
 5. Site characterization and certification
 6. Monitoring and verification
 7. Risks and risk management
 8. Remediation and mitigation
 9. Economics — It's expensive
 10. Statutory and regulatory frameworks — Ambiguous and messy
 11. Recommendations
- Diagram illustrating the focus of the first report on technical and economic feasibility. The report covers 11 items, with specific annotations for items 3 through 10:
- Item 3: California's sequestration capacity — large
 - Items 4 through 8: Capture technologies, Site characterization and certification, Monitoring and verification, Risks and risk management, Remediation and mitigation — existing technology supports moving forward, but need proof-of-concept
 - Item 9: Economics — It's expensive
 - Item 10: Statutory and regulatory frameworks — Ambiguous and messy



Summary of first report's recommendations

1. Synthesis and analysis of data from sequestration projects worldwide, including the Partnerships, and especially from WESTCARB
2. Consideration of geologic sequestration within the energy-carbon framework of the western region
3. Further examination of early opportunities within the state
4. Development of improved cost estimates and inclusion of carbon sequestration as a GHG reduction strategy in state planning
5. Potential options for addressing existing regulatory and statutory ambiguities and providing protocols as needed to inform drafting of new regulations and statutes



Recommendation 1. Learnings from pilots are critical

- **No substitute for learning by doing**
- **DOE partnerships include practical experience as well as address many of the research elements identified by AB 1925**
- **WESTCARB Phase II pilots and early Phase III work can provide lessons-learned specific to California**
- **Early industry experience (e.g., Hydrogen Energy project) will be especially relevant**

Recommendation 2. Energy and carbon flow regionally

- Electricity flows into California
 - 22-32 % of electricity used
 - 39-57 % of GHG emissions
- Transportation fuels are exported from California's refineries to neighboring states—
 - 100% of Nevada's
 - 60% of Arizona's
 - 35% of Oregon's
- Does the carbon flow with the energy?



Recommendation 3. Early in-state opportunities: Offset CCS cost through advancing CO₂-EOR opportunities



Types of Oil Field Storage Reservoirs	Number of Fields	Estimated Total Storage Capacity (MMT CO ₂)
Oil fields with CO ₂ storage potential	176	3,563
Oil fields with miscible CO ₂ -EOR potential	121	3,186
Oil fields with immiscible CO ₂ -EOR potential	18	178
Oil fields with CO ₂ storage capacity but no EOR potential (fields lacking API data also included)	37	199

80% of large emissions sources are within 50 km of a potential EOR site



Recommendation 4. CCS costs remain problematic without a value for carbon



- Market Advisory Committee to the CA Air Resources Board: 2007 Recommendations for design of a cap-and-trade system
- Work beginning on CCS inclusion in cost of electricity generation studies and scenario planning at the Energy Commission



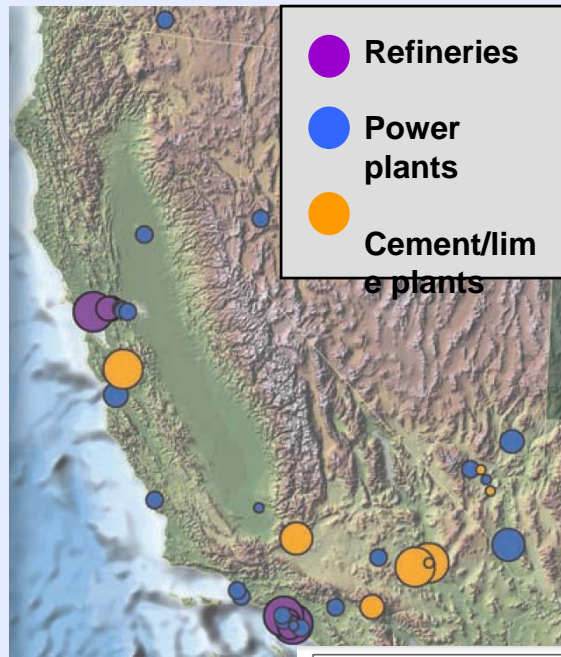
Recommendation 5. Various agencies with jurisdiction must work together toward integrated an regulatory framework



- CA Dept of Conservation (DOGGR) –underground injection, power plant siting
- CA Air Resources Board—climate
- Office of the State Fire Marshal--pipelines
- EPA Region 9—underground injection control
- Energy Commission—power plant siting (CEQA)
- Local agencies, etc....

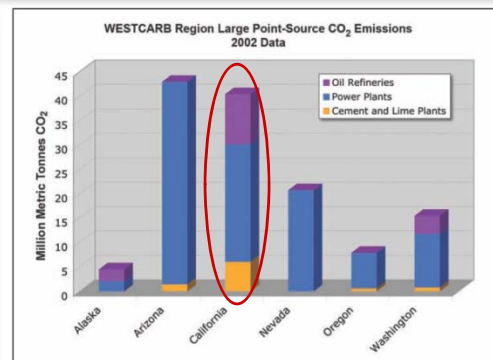


Early WESTCARB analysis suggests large potential for geologic CCS in California



CO₂ sources

- Substantial CO₂ storage capacity
- Large point sources
- Technical capability
- Market interest

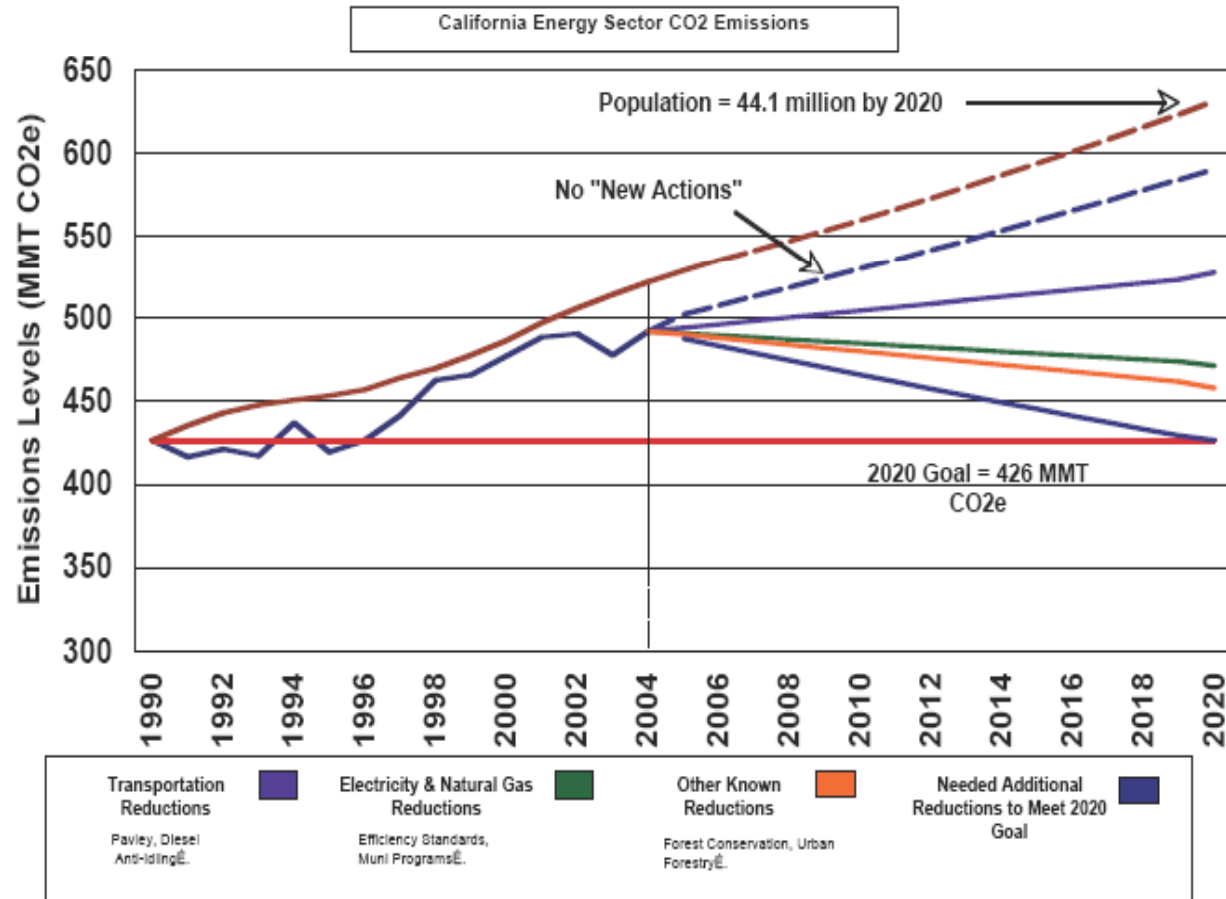


Saline formations

Oil and
gas
reservoirs

All figures from
“Carbon
Sequestration
Atlas of the
United States
and Canada”,
DOE 2007

Wedges for California's 2020 goals



By 2050:

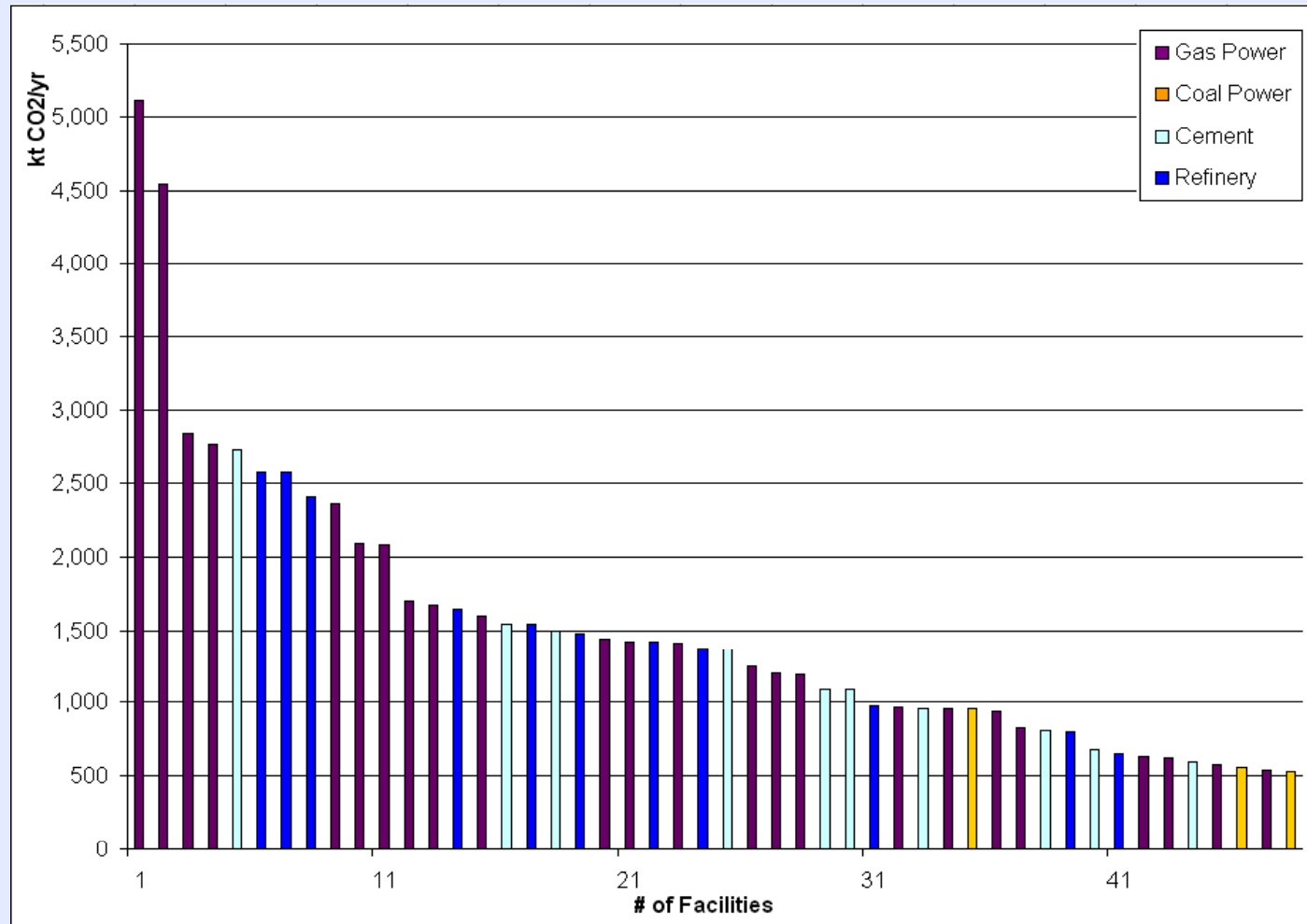
- 60 million people
- about 800 MMT CO₂e with no "new actions"

Source: California Energy Commission, Climate Action Team data

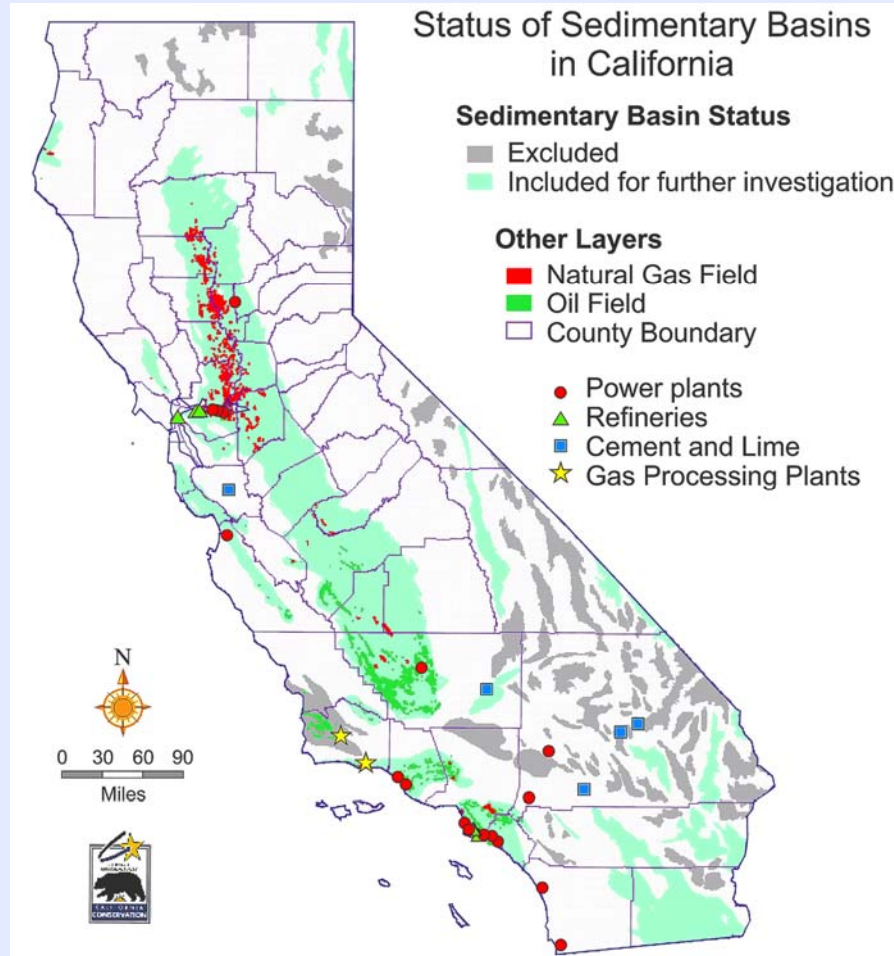
(figure taken from 2007 IEPR)



Geologic sequestration neutralizes emissions from industrial and power point-sources



California has large, conveniently located, sequestration capacity



- **Largest in-state sources**

- natural gas power plants
- refineries
- cement plants

- **90% with 50 km of potential sequestration site**

Energy and carbon are transboundary issues

- Electricity flows into California
 - 22-32 % of electricity used
 - 39-57 % of GHG emissions
- Transportation fuels are exported to neighboring states—
 - 100% of Nevada's
 - 60% of Arizona's
 - 35% of Oregon's
- Does the carbon flow with the energy?
 - Inventory
 - Credits
 - Actual
- How does each state meet its individual carbon emissions goals in this context?

