



*California Energy Commission*

# **CO<sub>2</sub> Capture and Geologic Carbon Sequestration Technology Development and Demonstration Overview**

**Martha Krebs, Ph.D.**  
**Director, Public Interest Energy Research Program**  
**Deputy Director, Research and Development**  
**California Energy Commission**

**at the**

**IEPR Staff Workshop on  
Commercial-Scale Geologic Carbon Sequestration  
Sacramento, CA  
May 18, 2009**

# 2009 Integrated Energy Policy Report Development



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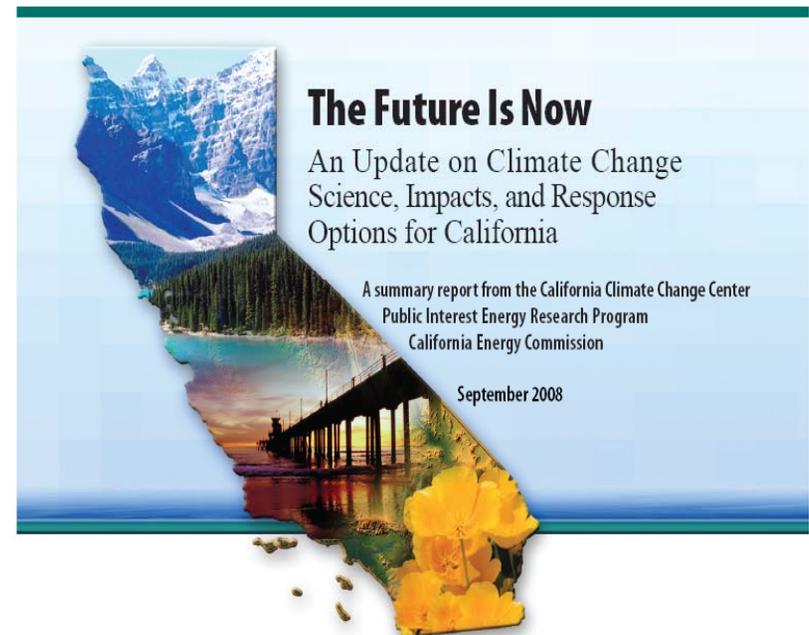
- Biennial report on all aspects of energy industry supply, production, transportation, delivery and distribution, demand, and prices
- Foundation document for development of policies that
  - conserve resources
  - protect the environment
  - ensure energy reliability
  - enhance the state's economy
  - protect public health and safety
- 30+ workshops from May–September 2009

# Defining California Climate Change Challenges and Solutions



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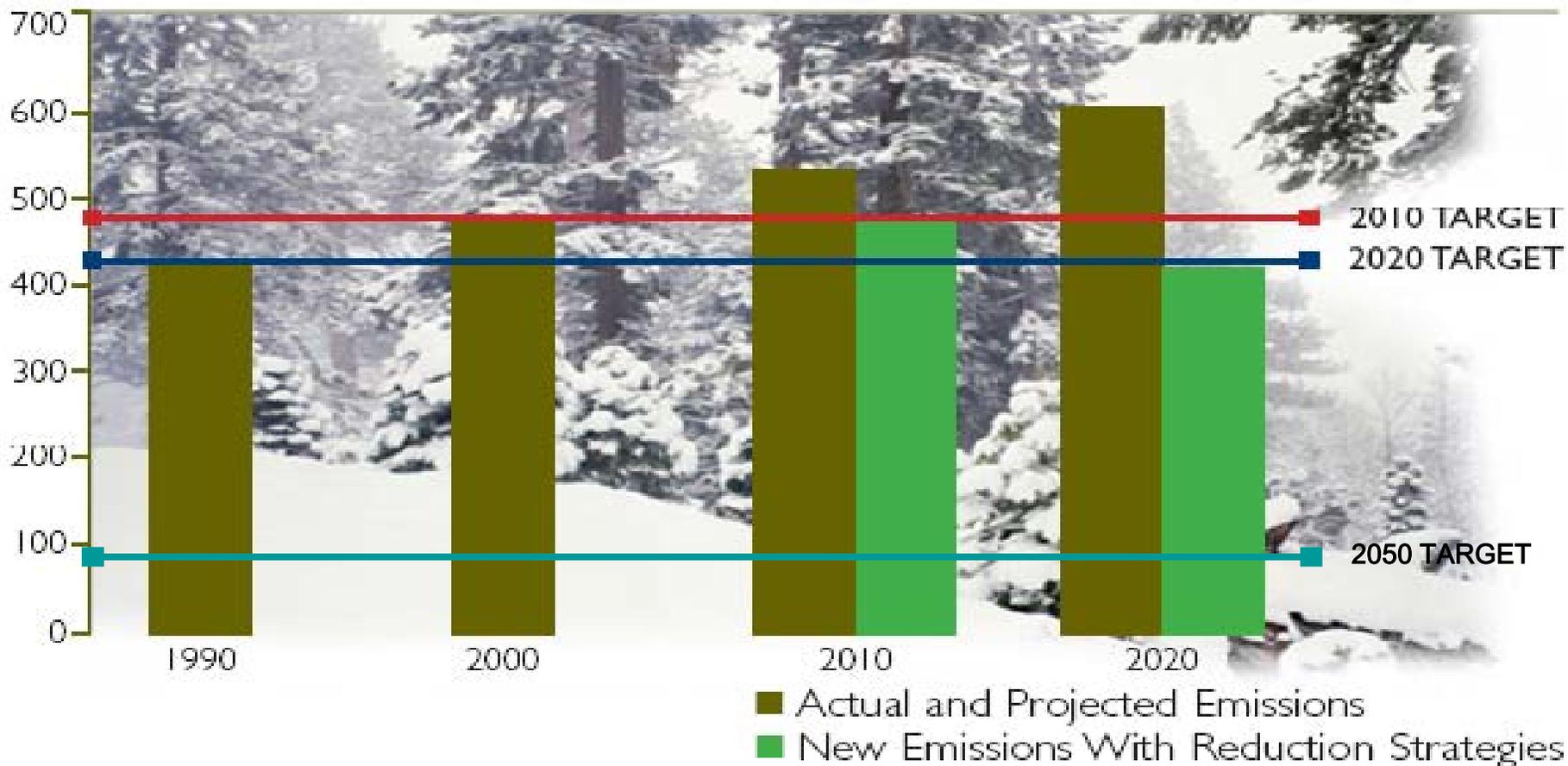
- Gov. Schwarzenegger and policymakers rely on Energy Commission's authoritative analyses of impacts and mitigation and adaptation opportunities
- Mitigation approach relies on a robust portfolio of technologies, including geologic carbon sequestration
  - Capture of CO<sub>2</sub> from process or exhaust gases at large industrial facilities, with secure long-term storage away from the atmosphere in deep geologic formations
  - Enables orderly transition from fossil fuels to alternative fuels/electricity (long-term climate change solution)
  - Combined with bio-refineries for fuels and chemicals, it may improve sustainability in the transportation sector



# California Has Aggressive Goals for Greenhouse Gas Reduction



Annual GHG emissions, million metric ton-CO<sub>2</sub>-equivalent  
(includes imported electricity)



# What's New Since the 2007 IEPR Workshop?



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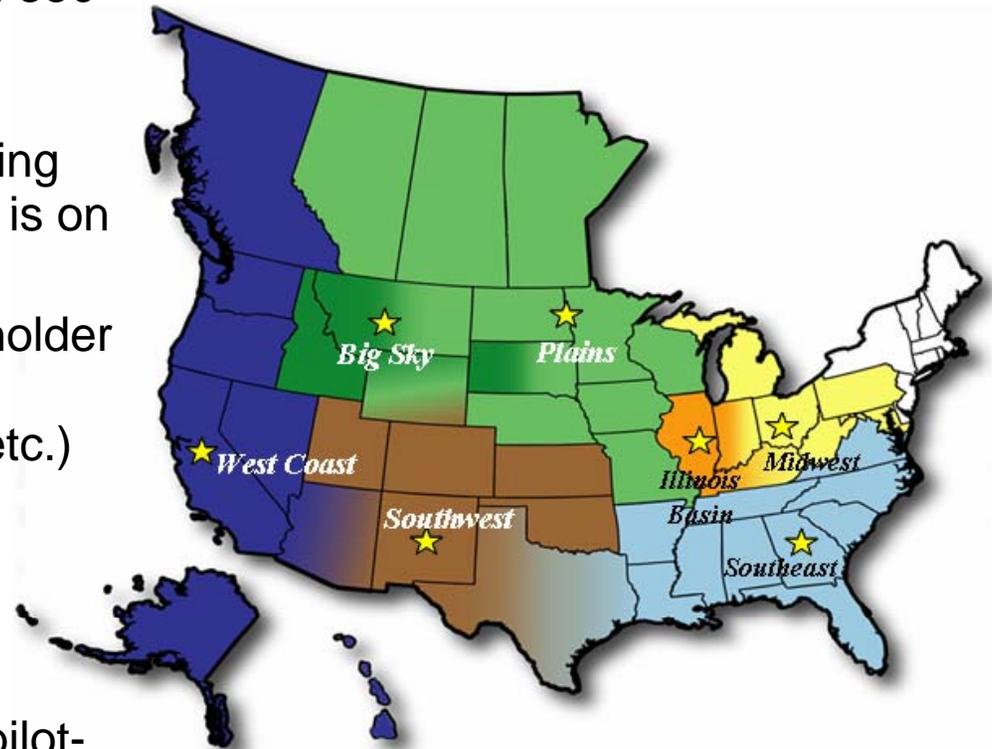
- Commercial power project with CCS being brought to Energy Commission for “certification” (permitting)
- AB 32 Scoping Plan adopted; regulatory measures in active development
- Low-Carbon Fuel Standard adopted
- Federal climate/energy legislation gaining momentum
- State/regional cap-and-trade programs growing
- DOE launches Regional Partnerships’ “Phase III”
- ARRA (“Stimulus Bill”) provides funds for multiple large-scale CCS projects; widens emphasis from coal power plants to other industries (NGCC, oil refineries, etc.)
- States are tackling CCS-related legal issues (WY, MT, KS)
- Boom in CCS technology development and demonstration projects internationally

# DOE “Regional Partnerships” Program Addresses Technical *and* Institutional Issues



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- Launched in 2003, the 7 “regional carbon sequestration partnerships” now represent 42 states and more than 350 partner organization
- Terrestrial and geologic carbon sequestration opportunities are being evaluated/validated, but emphasis is on long-term geologic storage
- Public education and broad stakeholder engagement (industry, regulators, insurers, NGOs, K-12 educators, etc.) are key program elements
- Phase I (complete)—focus was on regional capacity assessments, source-sink mapping, and costs
- Phase II (under way): focus is on pilot-scale technology validation tests
- Phase III (just starting): focus is on large-volume geologic storage tests



# WESTCARB Features Strong Partner Network



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- Researchers from more than 80 organizations comprising:
  - Resource management and environmental protection agencies
  - National laboratories (LBNL, LLNL) and research institutions (EPRI)
  - Conservation nonprofits and climate registries
  - Oil and gas companies
  - Power companies (including California IOUs)
  - Pipeline companies
  - Colleges and universities
  - Trade associations and policy coordinating bodies
  - Vendors and service firms
  - Consultants
- California Energy Commission is prime contractor

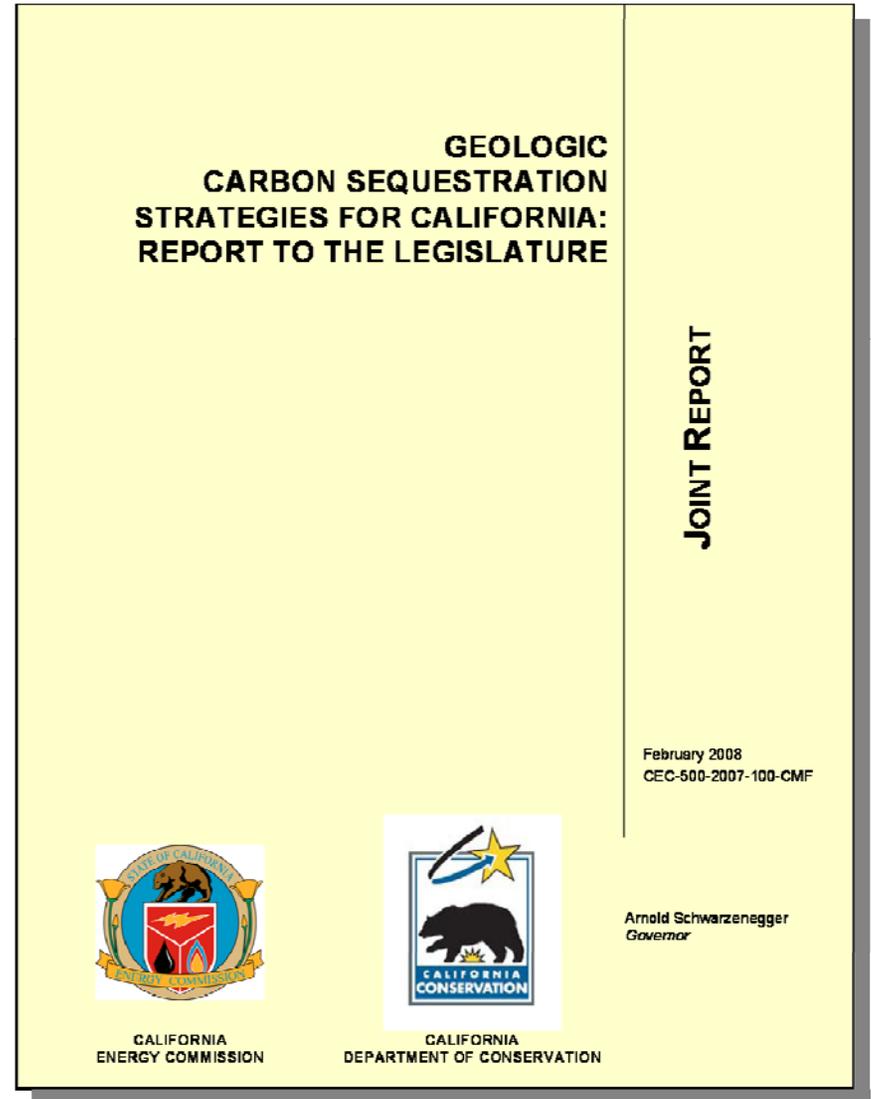


# WESTCARB Has Helped Inform Policy



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- AB 1925 Report to the Legislature (joint with Dept. of Conservation), *Geologic Carbon Sequestration Strategies for California*
  - Public workshops held with stakeholders
  - Report and PIER white papers
  - Follow-up workshops and report planned
- Integrated Energy Policy Report
  - 2005 workshop and report subsection
  - 2007 workshop and report subsections
- AB 32 Economic and Technology Advancement Advisory Committee
- AB 32 Environmental Justice Committee
- Support to other WESTCARB states

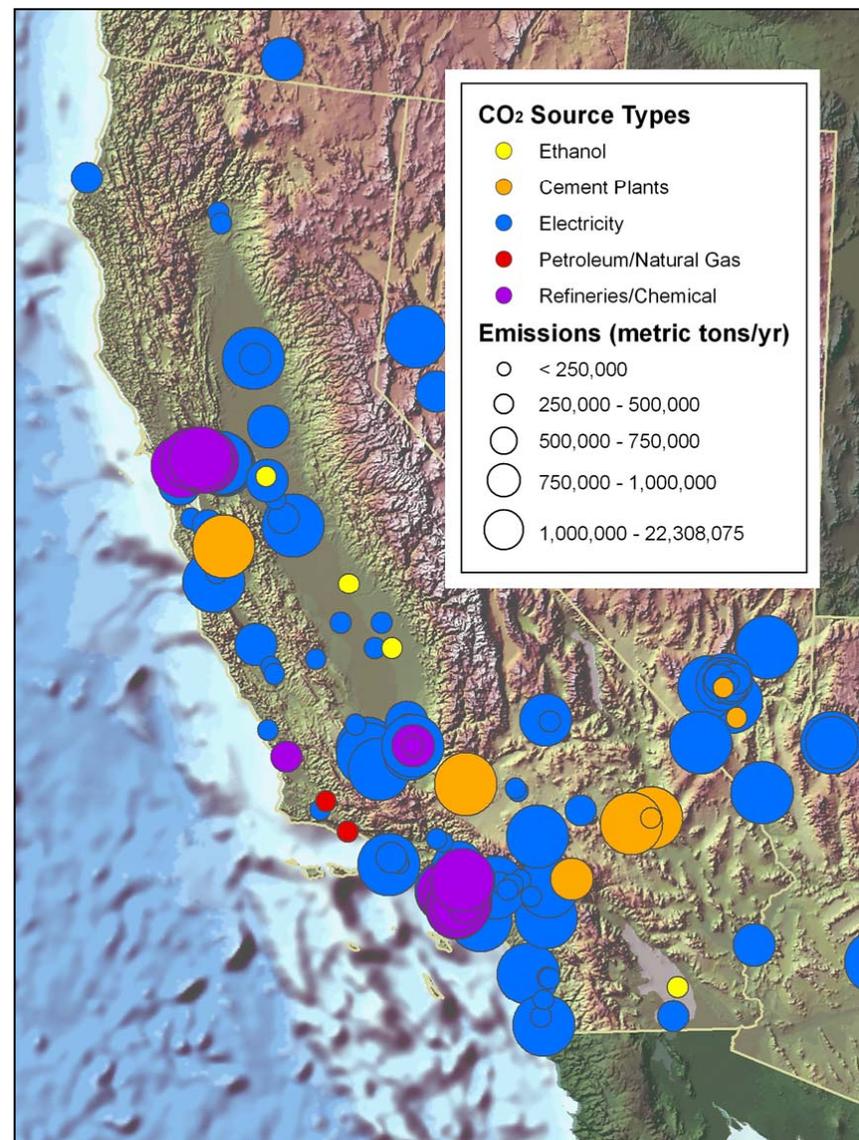


# WESTCARB Has Mapped California's Major Industrial CO<sub>2</sub> Point Sources

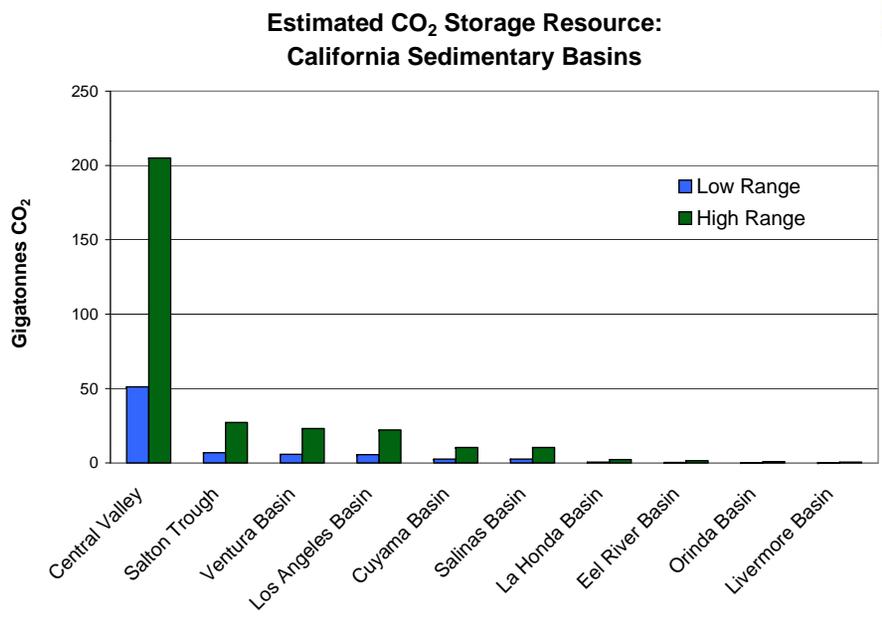


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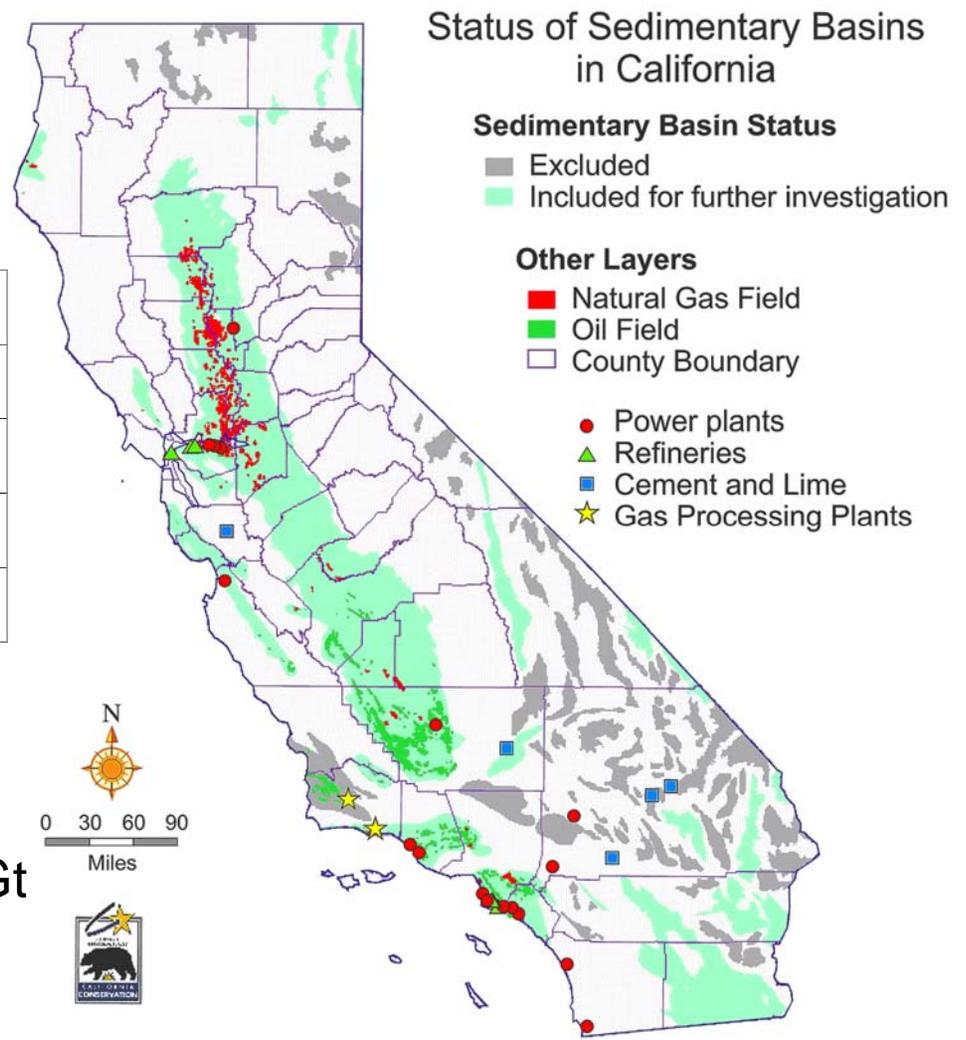
- Power plants represent largest point source type
  - In-state plants predominantly fueled by natural gas
  - Imported power predominantly from coal-fired plants
  - Most proposed new plants are gas-fired, but some have been proposed using CA petroleum coke and CO<sub>2</sub>-EOR
  - SB 1368 performance standard will curtail increase in imported coal power w/o CCS
- Oil refineries are a major source in coastal urban areas
- Cement and ethanol plants predominantly in Central Valley and Inland Empire
- Biofuels plants could be an important new source (amenable to CCS)
- CO<sub>2</sub> sources generally coincide with storage-suitable geologic formations



# WESTCARB/CGS Has Mapped Major Geologic Storage Opportunities in California



Saline formation capacity: 75–300 Gt  
 Gas reservoir capacity: 1.8 Gt  
 Oil reservoir capacity: 6.2 Gt  
 (Gt = billion metric tons)



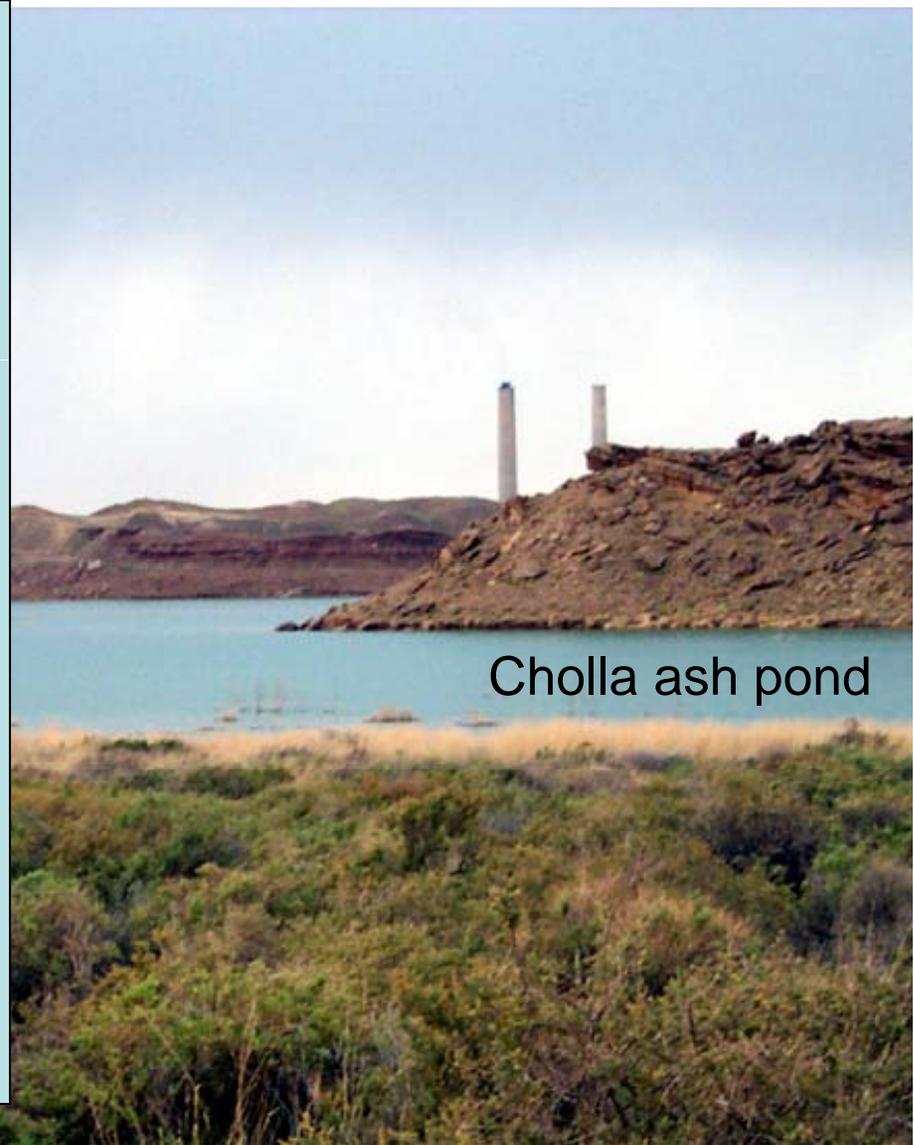
# WESTCARB Is Conducting a Pilot-Scale Field Test with Arizona Utilities Operating Coal Plants



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- Industrial partners include four major Arizona power producers
- Drilling and CO<sub>2</sub> injection permits in hand; drilling to begin soon
- Single well test about 3800 feet deep, adjacent an ash storage pond near the APS Cholla power plant
- Truck in 2000 tons of food-grade CO<sub>2</sub> for injection into the well
- Monitor the CO<sub>2</sub> in the subsurface using wire-line log, fluid sampling, pressure and temperature, and pre- and post-injection vertical seismic profile (VSP) measurements
- If possible, produce the CO<sub>2</sub> back out of the well (additional data collection)



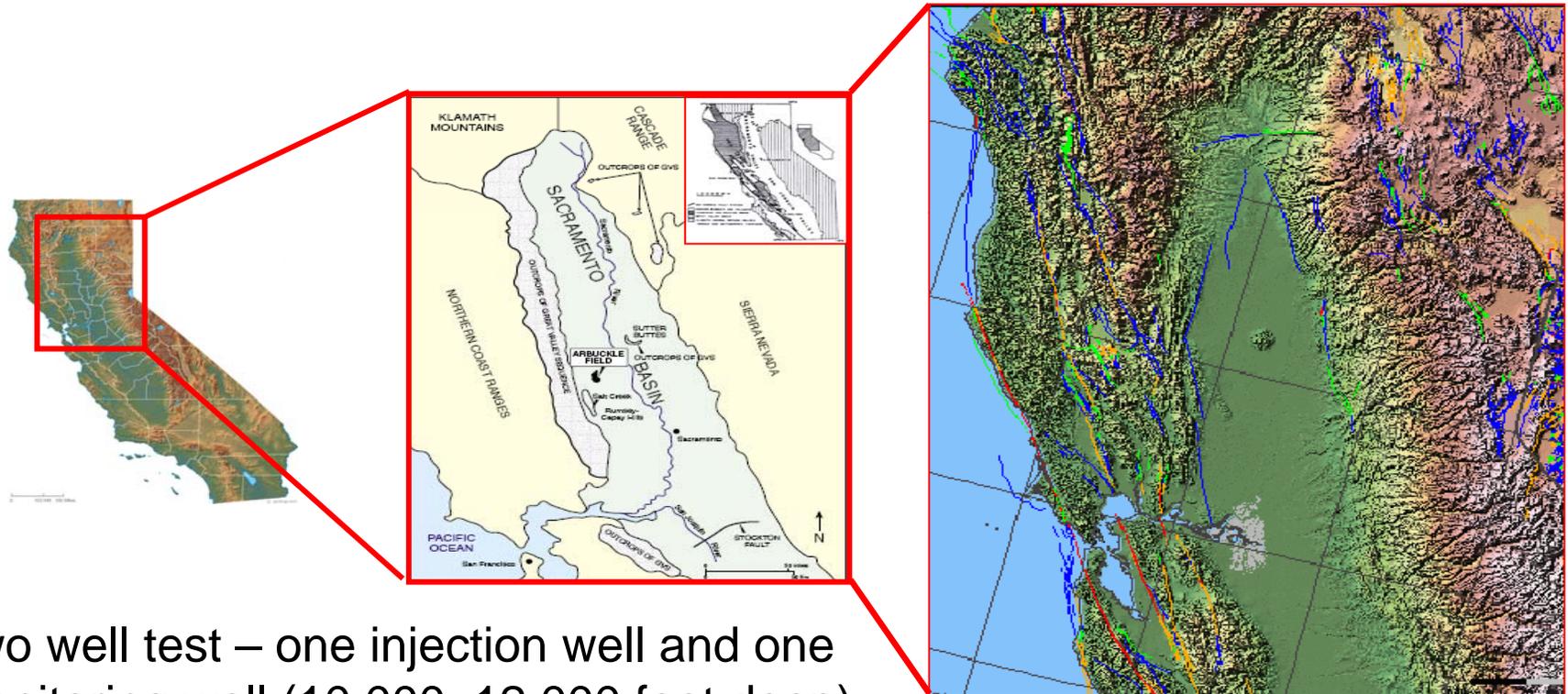
Cholla ash pond

# WESTCARB Is Conducting a Pilot-Scale Field Test in California with a Major Oil Company



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- Lead industrial partner: Shell Oil
- Assess sequestration potential of western Sacramento Valley



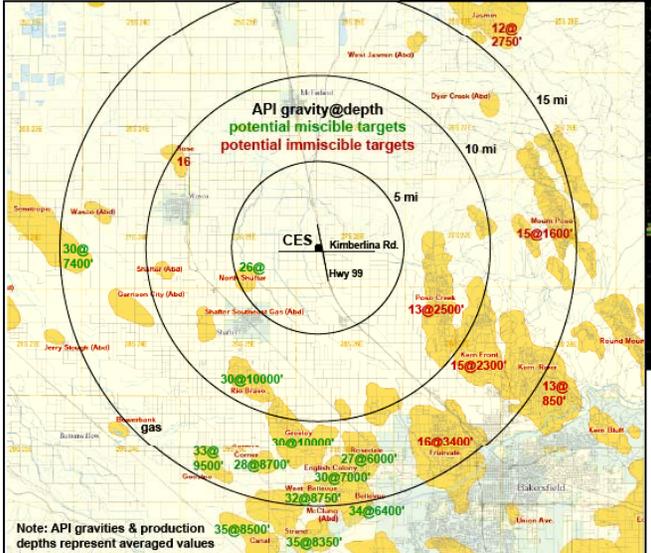
- Two well test – one injection well and one monitoring well (10,000–12,000 feet deep)
- Truck in 2000–6000 tons of commercial-grade CO<sub>2</sub> for injection
- Monitor CO<sub>2</sub> in the subsurface using industry-proven techniques and innovative methods at research stage

Source: Shell

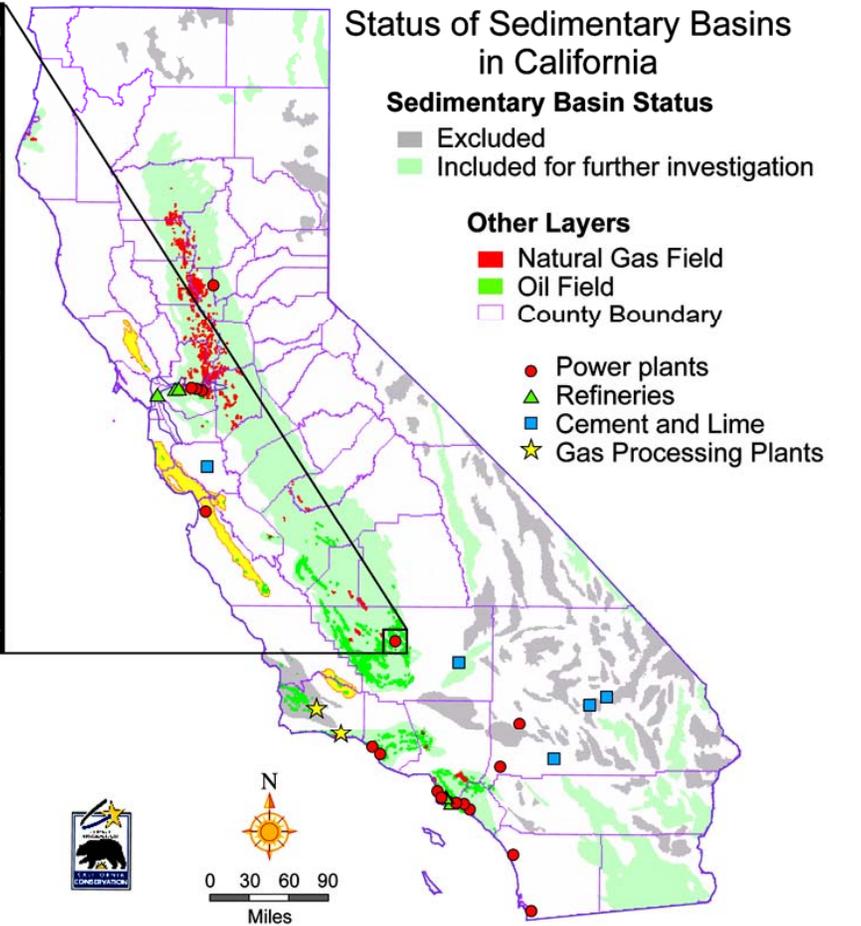
# WESTCARB Is Also Characterizing Sites for Large-Scale California Projects and CO<sub>2</sub>-EOR



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Many nearby oilfields are EOR-suitable (J. Johnson, LLNL)



Source: California Geological Survey

# WESTCARB Stakeholder Engagement



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- Public meetings and testimony
- Reports, fact sheets, website
- Legislative and media briefings
- Partner and scientific peer meetings

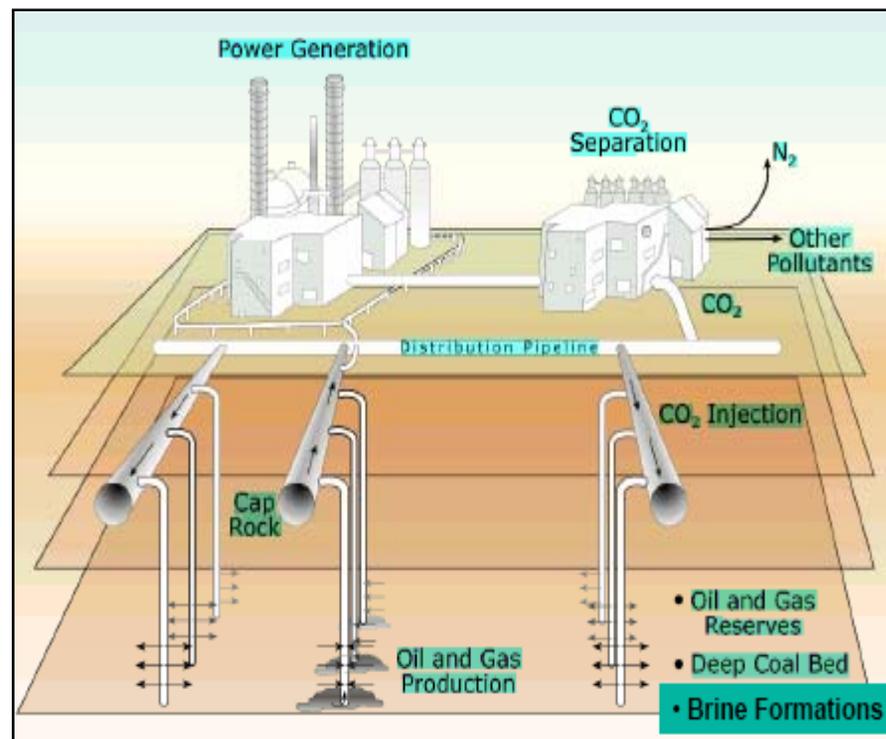


# Key Technical Challenges for CCS



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- Fundamentally, CCS represents a new application for existing technology, albeit with a different scale and time horizon
- Cost—primarily surface systems
  - Retrofit post-combustion CO<sub>2</sub> capture systems: natural gas combined cycle power plants, refinery-gas-fired furnaces
  - Gasification with pre-combustion capture; oxy-combustion with inherent capture
  - Other industrial sources: high-purity CO<sub>2</sub> streams; cement plant options
- Consensus on methodologies to assure health, safety & environmental protection
  - Impacts of leakage of CO<sub>2</sub>
  - Brine migration and pressure
  - Seismicity
- Storage capacity—incorporate technical and economic feasibility in estimates
- Infrastructure
  - Linking CO<sub>2</sub> sources, sinks, and the electric grid
  - Scale of construction effort



# Key Policy Challenges for CCS



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- Legal issues related to long-term CO<sub>2</sub> storage
  - Pore space ownership and severability unclear, especially for saline formation storage
  - Issues related to subsurface trespass also unclear
  - Long-term liability for stored CO<sub>2</sub> unresolved
- Regulations for geologic sequestration wells
  - EPA has proposed new UIC well class (VI) to regulate injection of CO<sub>2</sub> for long-term storage
  - Final EPA and other federal rules must be reconciled with state regulations
  - Potential for state implementation?
- Low-carbon fuel standard
  - Uncertainty over credit for refinery on-site CO<sub>2</sub> capture or other GHG reductions
- Financial uncertainty
  - Project financing and investor risk
  - Uncertainty in incentives for early movers
  - Value of CO<sub>2</sub> avoided—potential distortion of allowance markets by command-and-control regs





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Thank You!

mkrebs@energy.state.ca.us  
(916) 654-4878