



# ***CCS in California***

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# *Outline*

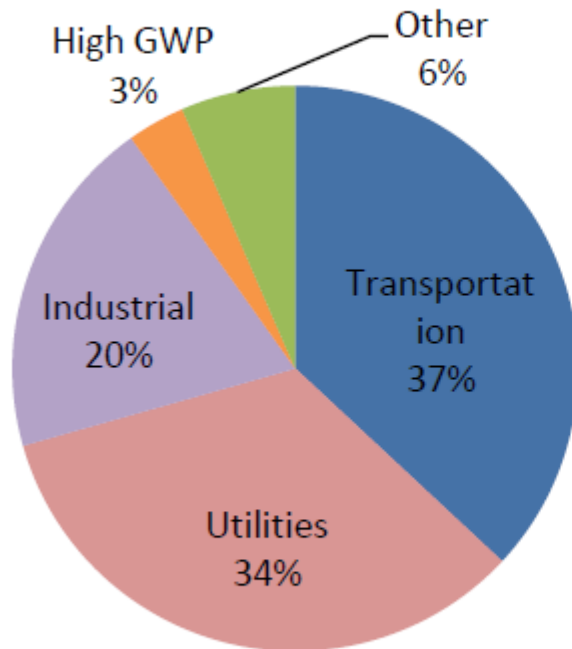


- Emissions and climate policies in CA
- Achieving the climate goals
- The potential role for CCS
- Policies and regulations
- Projects
- WestCarb NGCC/CCS study

# Emissions and goals

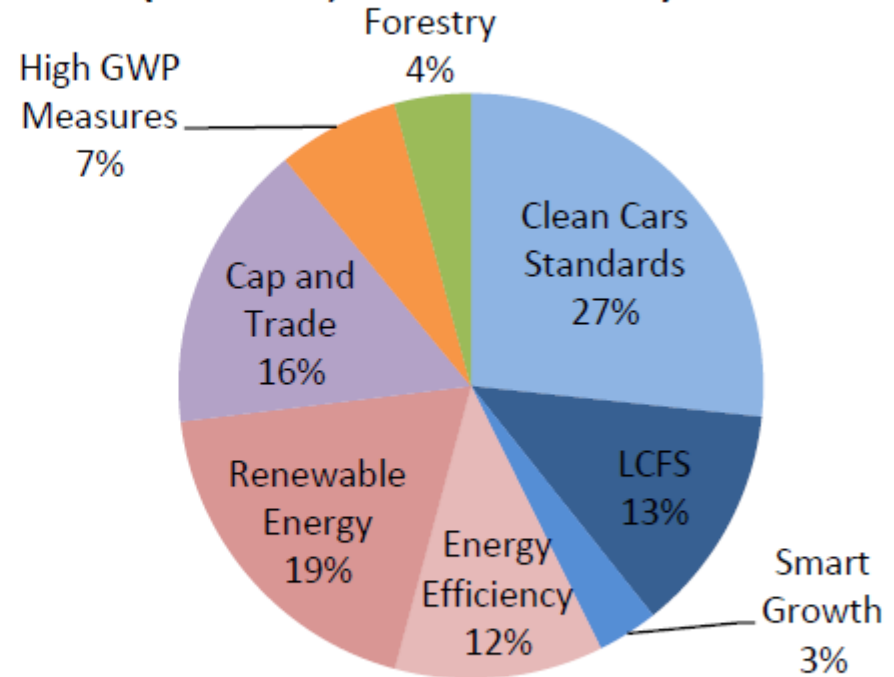
- AB 32: reduce to 1990 levels by 2020, and 80% below 1990 levels by 2050

California Emission Sources (2008)  
(Sector, Percent of Total)



Source: CARB, California GHG Inventory for 2000-2008

AB 32 Emission Reduction Strategies  
(Measure, Percent of Total)



Source: CARB, Emissions Reductions from Scoping Plan Measures; 2020 GHG Emissions Forecast

# AB32 milestones



Jan/May 2007	CPUC and CEC adopt SB 1368 regulations, establishing an emissions performance standard for new long-term commitments in baseload power
April 2008	CEC updates Title 24 building energy efficiency code
October 2008	CARB adopts mandatory GHG reporting regulations
November 2008	CPUC directs investor-owned utilities (IOUs) to help more than one million low income households become more energy efficient from 2009-2011
December 2008	CARB adopts Scoping Plan
April 2009	CARB approves Low Carbon Fuel Standard (LCFS)
September 2009	CPUC approves 2010-2012 IOU energy efficiency programs expected to achieve savings equivalent to avoiding three large power plants
September 2009	CARB finalizes Clean Car standards
November 2009	CEC adopts landmark TV energy efficiency standards
March 2010	California's public utilities commit to energy efficiency programs that will achieve savings equivalent to avoiding two large power plants by 2020
September 2010	CARB sets regional GHG targets under SB 375
December 2010	CARB approves cap and trade regulation
March 2011	Legislature passes 33% Renewable Portfolio Standard
July 2011	In conjunction with CARB, federal agencies and major automakers, President Obama announces agreement to increase fuel economy standards for passenger vehicles to 54.5 MPG by 2025
October 2011	CARB adopts final cap and trade regulation
January 2012	Cap and trade program goes into effect
December 2013	CARB updates the Scoping Plan

**On track!**

# How to get there?



## California's Energy Future - The View to 2050

Summary Report

California Council on Science and Technology  
May 2011

- “California can achieve emissions roughly 60% below 1990 levels with technology we largely know about today if such technology is rapidly deployed at rates that are aggressive but feasible”
- “We could further reduce 2050 greenhouse gas emissions to 80% below 1990 levels with significant innovation and advancements in multiple technologies that eliminate emissions from fuels. All of these solutions would require intensive and sustained investment in new technologies plus innovation to bridge from the laboratory to reliable operating systems in relatively short timeframes”

# CCST report in more detail



- Getting to 60%:
  - Four key actions:
    - Efficiency measures
    - Electrification
    - Decarbonizing electricity supply and zero-emissions load balancing
    - Decarbonizing the remaining required fuel supply where electrification is not feasible.
  - “If electric generation is predominantly intermittent renewable power, using natural gas to firm the power would likely result in greenhouse gas emissions that would alone exceed the 2050 target for the entire economy”
  - “CCS would modify an existing electricity pathway to provide a transition to the future, but relies on the large-scale development of a system of underground CO<sub>2</sub> storage”

# CCST report in more detail



- Achieving 60%:

Strategy	Assumed Plant Size	Total Plant Capacity Needed in 2050	Build Rate 2011-2050 (Plants/Year)
Nuclear	1.5 GW	44 GW	0.73
Fossil/CCS	1.5 GW	54 GW*	0.90
<b>Renewables Mix total</b>		165 GW**	
- Wind	500 MW	59 GW	3.0
- Central Solar (CSP and PV)	500 MW	65 GW	3.3
- Distributed Solar PV	5 kW	22 GW	110,000
Biomass/CCS	500 MW	1.5 GW	0.77
CA Biofuels	50 Mgge/yr	5.5 bgge/yr	2.8
Hydrogen		8.0 bgge/yr	
- Natural Gas Reforming	0.5 Mgge/yr	0.8 bgge/yr	40
- Central Plant	440 Mgge/yr	7.2 bgge/yr	0.41

Table 5. Summary of supply build rates required.

\*Gross capacity, assuming 10% parasitic loss from CCS (net capacity = 49 GW)

\*\*Includes geothermal and hydropower not included in this table

# *CCST report in more detail*



- Achieving 80%:
  - “CCS is likely to be an important part of several possible schemes to provide hydrogen, low-carbon fuels or offsets that allow continued fossil fuel use. For California, the utility of CCS in achieving a low carbon fuel portfolio could be as important as the utility of CCS for electricity production per se”



# CCS Review Panel



- Appointed by CPUC, CEC and CARB to:
  - Identify, discuss, and frame specific policies addressing the role of CCS technology in meeting the State’s energy needs and greenhouse gas emissions reduction strategies for 2020 and 2050
  - Support development of a legal/regulatory framework for permitting proposed CCS projects consistent with the State’s energy and environmental policy objectives

# CCS Review Panel (cont.)



- Among the key recommendations (Dec. 2010):
  - Recognize CCS (appropriately regulated) as a mitigation measure and devise protocol
  - Apportion regulatory roles to specific agencies
  - Consider a trust fund for post-injection stewardship
  - Evaluate incentives for early projects and consider implementing those that are most cost-effective
  - Others: pipeline siting, pore space ownership, outreach, sharing of burdens and benefits

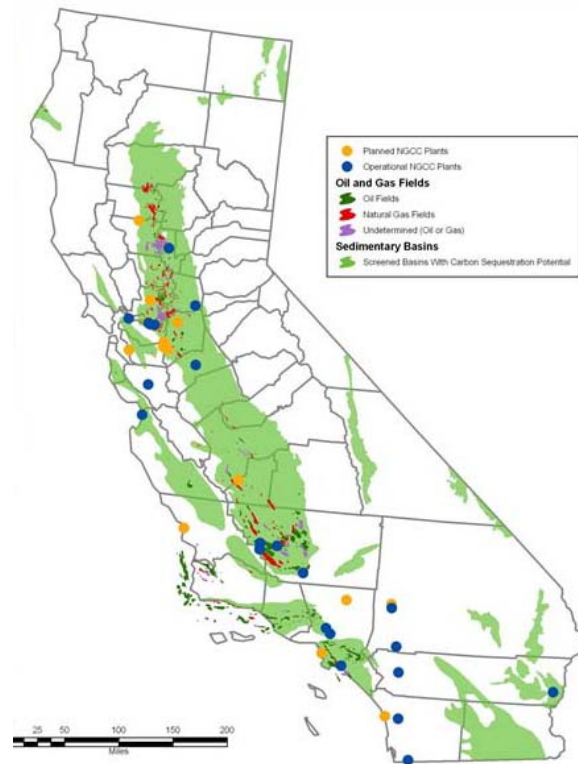
# Projects



- HECA I:
  - Carson: bad choice of location
- HECA II:
  - Too expensive
- HECA III:
  - New siting challenges?
- Martinez refinery:
  - Plans shelved in favor of tar sands project
- Other projects?

# Gas in CA

- Accounts for ~50% of generation
- NGCC plants among the largest point sources
- High capacity factors, high remaining life



# WestCarb NGCC/CCS study



- Partners: CEC, PG&E, Stone&Webster, LLNL, LBNL, BKI, NETL
- Screen candidate CCS technologies for new and existing NGCC plants
- Examine: permitting, HSE, water use
- Screen CO<sub>2</sub> storage options and build static geomodels
- Build engineering-economic models and evaluate selected CCS technology and NGCC unit combinations
- Develop a conceptual design for a pilot-scale CCS test on a California NGCC unit or cogeneration unit

*Credit: Rich Myhre, BKi*

# References



- CARB Emissions Trading Program (factsheet):  
[http://www.arb.ca.gov/newsrel/2011/cap\\_trade\\_overview.pdf](http://www.arb.ca.gov/newsrel/2011/cap_trade_overview.pdf)
- California's Energy Future – The View to 2050 (CCST):  
<http://www.ccst.us/publications/2011/2011energy.php>
- CA CCS Review Panel:  
[http://www.climatechange.ca.gov/carbon\\_capture\\_review\\_panel/index.html](http://www.climatechange.ca.gov/carbon_capture_review_panel/index.html)
- Engineering-Economic and Geologic Assessment of CCS Application to California NGCC Power Plants:  
[http://www.westcarb.org/pdfs/2011\\_CCS\\_NGCC\\_study\\_Myhre.pdf](http://www.westcarb.org/pdfs/2011_CCS_NGCC_study_Myhre.pdf)

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