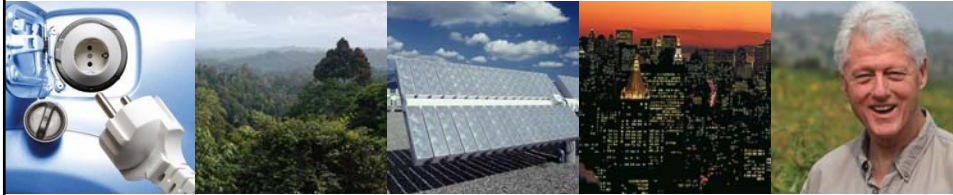


## CALIFORNIA CARBON CAPTURE AND STORAGE



26 OCTOBER 2011



CLINTON CLIMATE INITIATIVE

## CLINTON CLIMATE INITIATIVE BACKGROUND

- The Clinton Climate Initiative (CCI) works in collaboration with private sector sponsors and government partners, to develop and implement large-scale projects that directly reduce greenhouse gas emissions and serve as replicable and scalable models for others to follow
- CCI's three main focus areas are: cities, clean energy, and forestry
- CCI staff include people with backgrounds in finance, consulting, industry, engineering, policy development, and politics
- CCI is completely independent and has no financial ties to any company, technology, or project
- CCI is currently advising governments on utility scale CCS programs in Australia, Malaysia, the Netherlands and the USA. Also participating in CCUS Action Group and CSLF Finance Taskforce
  - Focus on removing near term commercial/financial barriers to enable the development of commercial-scale CCS projects

### CASE FOR CCS IN CALIFORNIA

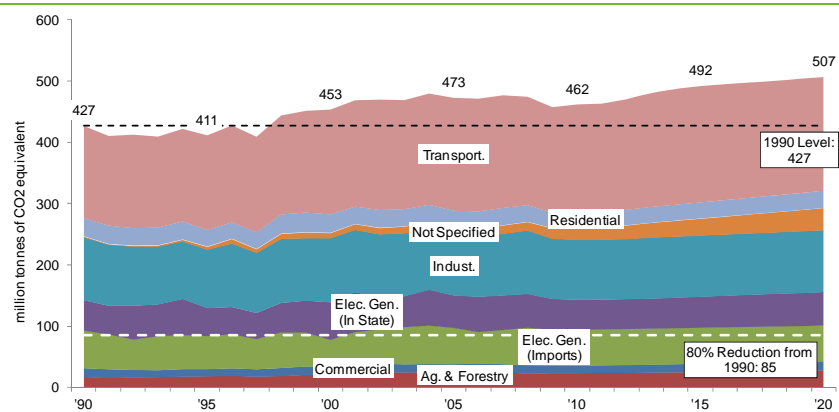
- California has been a leader in providing appropriate level of attention to issues of environmental protection
  - In case of CO<sub>2</sub> - state has aggressive 2050 goals for reduction
  - CCS will be a necessary component if these goals are to be achieved
- California has put forth regulations that support its quest for CO<sub>2</sub> reduction in form of Assembly Bill 32
  - Cap & Trade is key to implementation
- The location of stationary sources of CO<sub>2</sub> creates a possibility of at least three “natural” CCS network systems in California
  - These are East Bay, Bakersfield, and Los Angeles area
- The economics are likely to justify implementation of CCS networks in the long term
  - Possible use of CO<sub>2</sub> for EOR would provide additional revenue

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### EMISSIONS REDUCTION TARGETS ARE PROBABLY ACHIEVABLE IN EARLY YEARS WITHOUT CCS...



Sources: California Environmental Protection Agency Air Resources Board, federal agencies, international organizations, and industry associations.

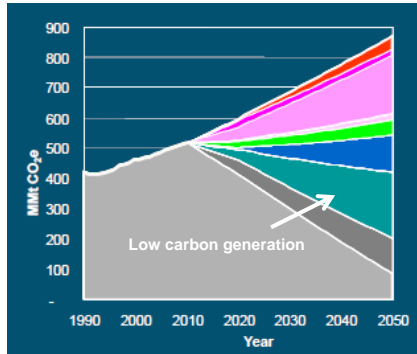
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### ... BUT CCS WILL BE NECESSARY TO MEET LONG-TERM GOALS

Greenhouse Gas Reductions



- Meeting California's Long-Term Greenhouse Gas Reduction Goals report of 2009 suggests:
  - Blend of nuclear, renewables, & CCS will be needed
  - Capital costs higher in nuclear and renewables pathways but fuel costs lower
  - High nuclear and renewables cannot provide dispatchable generation with current technology
  - All CCS components demonstrated at scale
- California's Energy Future – The View to 2050 report
  - Current transmission technology/infrastructure cannot balance intermittent renewable generation load
  - Renewables-heavy strategy would require 3x generation capacity versus fossil fuels
  - Reductions in the transportation sector place additional strains on electricity generation needs
- CCS may not be needed in very near term, post 2020 goals effectively require such technology

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### CALIFORNIA HAS REGULATIONS THAT SUPPORT CO2 REDUCTIONS

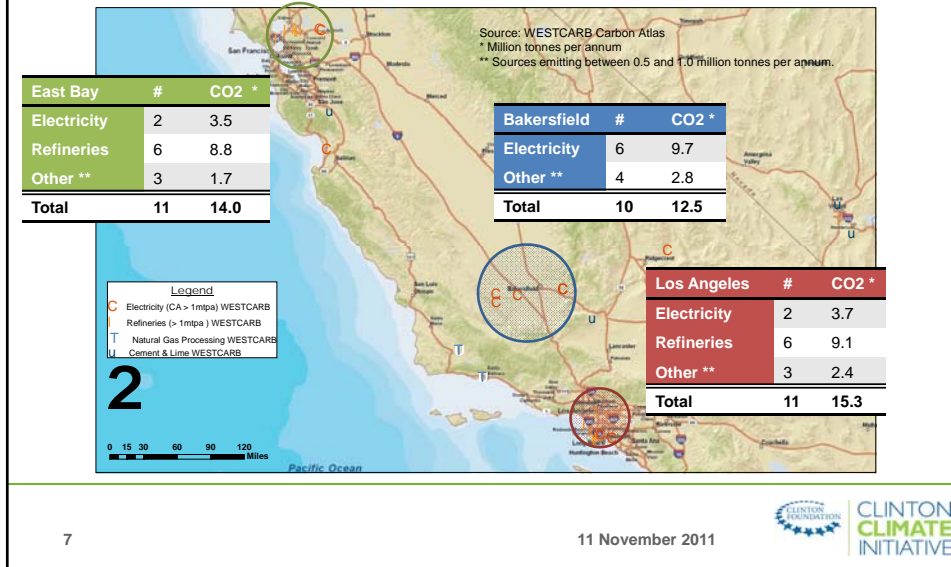
- California has put forth regulations that support its quest for CO<sub>2</sub> reduction in form of assembly Bill 32
  - Reduction of state-wide emissions to 1990 level by 2020
  - Implementation through a mix of reduction measures, including cap & trade
- California will be the first in implementing large cap & trade program in the United States
  - The experience and learnings will contribute to programs elsewhere
  - Advocates of CO<sub>2</sub> pricing locally, nationally, and globally will strive to see a positive impact in California in the form of
    - Real, cost-effective reductions in emissions
    - Support to growth in regional business and economy
- As the energy industry contributes significantly to the state (\$46B to GDP and 304K jobs, directly and indirectly), their investment in clean energy will signal confidence in local economy

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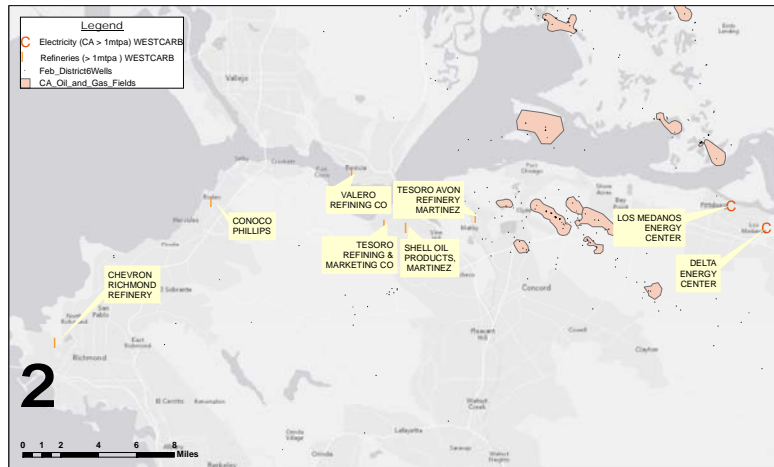
## CALIFORNIA IS WELL POSITIONED TO EMPLOY CCS NETWORK STRUCTURE



## EAST BAY AND BAKERSFIELD ARE ATTRACTIVE FOR CO2 NETWORKS

- East Bay
  - Concentration of emission sources creates network opportunity
  - Potentially lower capture cost at some CO2 sources (pure CO2)
  - Industrial sources demonstrate utility of CCS beyond power
  - Potential refinery expansion(s) provide context for CCS projects
  - Secure geologic storage available
  - Public amenable to sequestration
  - Need for economic growth will drive interest in infrastructure projects
  - Opportunity to drive action at refineries through LCFS regulation
  - Substantial work already done
- Bakersfield area
  - Concentration of emission sources creates opportunity for network benefits, stability
  - CO2 valuable in enhanced oil recovery - potential revenue stream
  - Use of steam in current oil production may be replaced by CO2 – lower emissions
  - Regional economy supportive to industrial infrastructure projects
  - Substantial federal government support for foundation project (HECA)
  - General public support for industry

## EAST BAY REGIONAL LAYOUT



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## LARGE VOLUME (> 1 MTPA) POINT SOURCES IN EAST BAY

Type	Facility	Owner	Capacity	Unit	CO2 *	Hydro CO2 **
Electricity	Delta Energy Center	Calpine	944	MW	2.0	n/m
	Los Medanos Energy Center	Calpine	678	MW	1.4	n/m
<b>Subtotal</b>					<b>3.5</b>	
Refineries	Chevron Richmond Refinery	Chevron Texaco	225,000	BPD	1.7	1.0
	Conoco Phillips	n/a	n/a	BPD	1.1	0.5
	Shell Oil Products, Martinez	Royal Dutch Shell Gp	159,250	BPD	1.2	0.6
	Tesoro Avon Refinery Martinez	n/a	166,000	BPD	1.3	0.6
	Tesoro Refining & Marketing Co	n/a	n/a	BPD	1.8	0.6
	Valero Refining Co	n/a	n/a	BPD	1.8	0.8
<b>Subtotal</b>					<b>8.8</b>	<b>4.0</b>
<b>Total (known)</b>					<b>12.3</b>	<b>4.0</b>

Source: WESTCARB Carbon Atlas

\* Million tonnes per annum

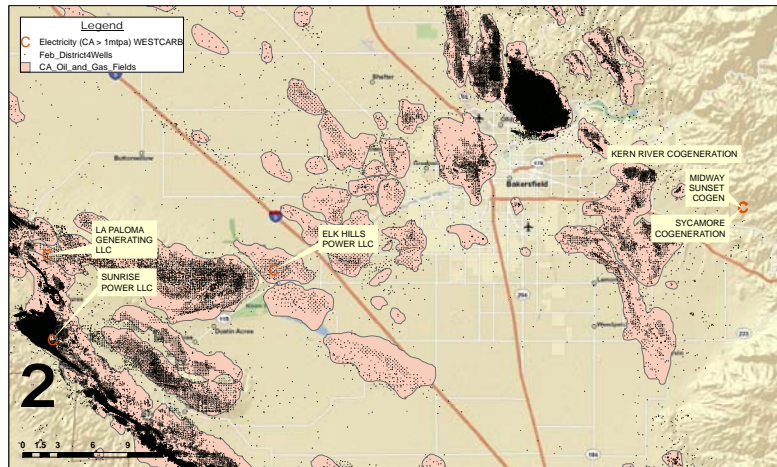
\*\* Million tonnes per annum. CO2 from hydrogen cracking.

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## BAKERSFIELD REGIONAL LAYOUT



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## LARGE VOLUME (> 1 MTPA) POINT SOURCES IN BAKERSFIELD

Type	Facility	Owner	Output Capacity	Unit	CO2 *
Electricity	Elk Hills Power Llc	Occidental Chemical	623	MW	1.3
	Kern River Cogeneration	Kern River Cogeneration Co	300	MW	1.5
	La Paloma Generating Llc	TCW	1,200	MW	2.0
	Midway Sunset Cogen	Chevron Corp., Edison Mission Energy	234	MW	1.2
	Sunrise Power Llc	Chevron Corp., Edison Mission Energy	605	MW	1.9
	Sycamore Cogeneration	Chevron Corp., Edison Mission Energy	300	MW	1.8

**Total (known) 9.7**

Type	Operator	Wells	Production **
Oil & Gas Production	Aera Energy LLC	16,559	46.6
	Chevron U.S.A. Inc.	20,608	61.6
	Occidental of Elk Hills, Inc.	3,873	14.3

**Total Top 3 41,040 122.4**

Sources: WESTCARB Carbon Atlas, DOGGR website

\* Million tonnes per annum

\*\* Million barrels per annum of oil production in District 4 (includes Bakersfield).

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**THE NETWORK CONCEPT COULD BE ECONOMIC UNDER CERTAIN CONDITIONS**

Ranges of Estimated Costs of CCS		Ranges of Estimated Revenue from CO2	
Component	\$/ tonne CO2	Source	\$/ tonne CO2
Capture & Compression	30-115	Cap & Trade	10-74
Transport (50 miles)	2-5	E.O.R.	25-40
Storage	10-20	<b>Total</b>	<b>35-114</b>
<b>Total</b>	<b>42-140</b>		

Costs in USD  
Sources: IEA, NETL, Rubin 2011, WESTCARB, CARB.

**INITIAL CCS DEPLOYMENT SHOULD BE WITH A LONG-TERM VIEW TOWARDS NETWORK BENEFITS**

- Deployment of CCS network provides for significant benefits to stakeholders through sharing of transport infrastructure and sharing of storage location(s)
  - Capital costs reduced through larger scale pipeline and common storage
  - Risk shared and reduced by operation by skilled entities (transport and storage)
  - Lower operating risk will reduce risk to individual investors, reducing capital costs
  - Commercial arrangements among emitters, transporters, and providers of storage will support market related pricing
  - Emitters properly responsible for capture only
- Initial deployment may need to be small in scale given the need for demonstration of integrated CCS approach and large capital needs associated with CO2 capture
  - But should be planned with long view in mind as infrastructure that can be expanded will reduce capital costs to subsequent entrants
- Long-term view to commercial viability will improve policy decisions and allow for better public support of initial projects

### STATE AND PRIVATE SECTOR MUST WORK TOGETHER TO BRING CCS NETWORK CONCEPT TO REALITY

- The relatively new approach to CO<sub>2</sub> containment – in form of CCS - requires that all stakeholders work collaboratively to make the idea a reality:
  - Details of regulations supporting CCS and cap & trade still being developed
  - Full scale capture technology in early stages of application
  - Network requires partnering across the supply chain – source, transport, sink
- The state must provide clear support, especially in early stages of CCS deployment
  - Clarify/develop regulations following on recommendation of CA CCS review panel
  - Support to finding funding alternatives, given high level of capital investment
  - Ensure that application of CCS will allow industry to meet regulatory requirements - through discussion with stakeholders
- The private sector must work towards longer term objectives of CO<sub>2</sub> mitigation
  - Recognize that CCS will be necessary to address long term CO<sub>2</sub> reduction goals
  - Work to demonstrate integrated use of existing technologies at commercial scale
  - Develop a business model that will support application of capture, transport & storage at commercial rates

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### NEXT STEPS: WE ARE READY TO WORK WITH YOU.....

- We believe that network approach is key to application of CCS technologies in California
  - Most effective and economic way to sequester large quantities of CO<sub>2</sub>
  - Large concentration of CO<sub>2</sub> sources in three areas
- We are prepared to work with all stakeholders to develop a business case for a CCS network in California, starting with two attractive opportunities, East Bay and Bakersfield
  - Approach all stakeholders individually: industry (both CO<sub>2</sub> sources and users), state government bodies (PUC, CEC, ARB) and academics to understand their interest
  - Bring stakeholders together to agree needs, program of work and way forward
  - Support development of “case for CO<sub>2</sub> network in California” including:
    - Assessment of network benefits and preliminary evaluation of economics
    - Articulation of potential business models to accommodate various stakeholders interest and support finance requirements
    - Identification of hurdles to deployment and potential mediation
- Learnings from the first two network examples can be utilized to fast forward other opportunities

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