WESTCARB Regional Partnership

WESTCARB Story 2010

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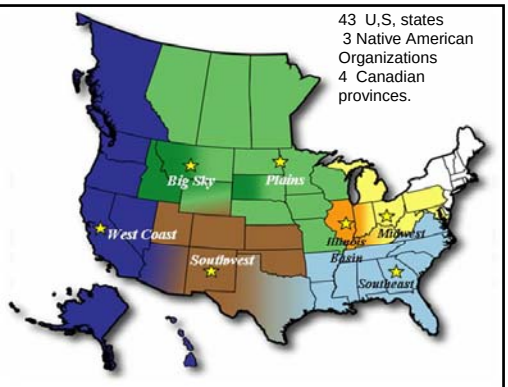
Overview of this talk and the meeting

- What WESTCARB is
- What WESTCARB does
  - Informing Policy
  - Technology Validation and Development
- What WESTCARB should do in the future (Quo Vadis?)
  - Vision for CCS technology adoption in the region (RTIP)
  - Development Phase efforts
    - Characterization
    - Field projects
    - Policy /Outreach

Regional Carbon Sequestration Partnership Program

- Three phases :
  - Characterization Phase (2003-2005) opportunities for carbon sequestration
  - Validation Phase (2005-2010) small-scale field tests
  - Development Phase (2008-2017) large-volume carbon storage tests
- Seven partnerships with 350+ members (state agencies, national labs, universities, NGOs, and private companies)
- Six countries from the Carbon Sequestration Leadership Forum participating in Validation Phase



Government/ industry effort tasked with determining the most suitable technologies, regulations, and infrastructure needs for CCS in different areas of the country. Geographical differences in fossil fuel use and sequestration sinks across the U.S. dictate regional approaches.

WEST COAST REGIONAL CARBON SEQUESTRATION PARTNERSHIP 3

Policy is critical to enabling technology development

State/Province	Terrestrial	Geologic	Mandatory GHG reduction
Alaska	No	No	No
Arizona	No	Yes	No
British Columbia	?	?	?
California	Yes	Yes	Yes
Hawaii	No	No	Yes
Nevada	No	No	No
Oregon	Yes	No	No
Washington	Yes	Yes	Yes

WEST COAST REGIONAL CARBON SEQUESTRATION PARTNERSHIP 4

Specifics of the California case

- Governor's Executive Order, S-3-05, in 2005, established target GHG reduction levels:
  - 2000 GHG emissions levels by 2010
  - 1990 levels by 2020 *(~436 million metric tons)*
  - 80 % below 1990 levels by 2050 *(~90 million metric tons)*
- Global Warming Solutions Act (AB 32) in 2006 put second goal into law:
  - AB 1925 in 2006: recommendations to accelerate geologic sequestration of industrial CO_2
  - SB1368 specified a GHG performance standard for long-term electricity contracts, allows geologic CCS
  - Low carbon fuel standard allows CCS for high-carbon fuel stocks

(Prop 23—makes AB 32 implementation conditional on unemployment rate)

In 2010, three agencies took action to form the California CCS Review Panel

- **Panel is to develop recommendations that could help guide CCS legislation and regulations in California**
- **Formed by**
  - Energy Commission
  - California Public Utilities Commission,
  - Air Resources Board
  - Other state agencies involved:
    - Department of Conservation
    - State Water Resources Control Board
- **Final report by the Panel is due at year-end 2010**

WESTCARB has played a pivotal role in the creation and operation of the Panel

Panel website:
http://www.climatechange.ca.gov/carbon_capture_review_panel/meetings/index.html

WESTCARB works with policy developers throughout its region and nationally

- **Western Climate Initiative:**
  - Arizona, California, Montana, New Mexico, Oregon, Utah, and Washington; British Columbia, Quebec, and Manitoba
  - Identify, evaluate, and implement ways to reduce greenhouse gas emissions: regional cap-and-trade program
- **Western Governor's Association**: Initiative on Climate Change and Adaptation
  - Forest and rangeland health:
  - Carbon sequestration: working with four RCSPs on outreach
- **Interstate Oil and Gas Compact Commission (IOGCC)**
  - Report providing recommendations and model rules for a geologic CCS regulatory framework.
- **Etc…**

Recognition of CCS role (geologic, beneficial use, and terrestrial) remains low

Technology validation: terrestrial

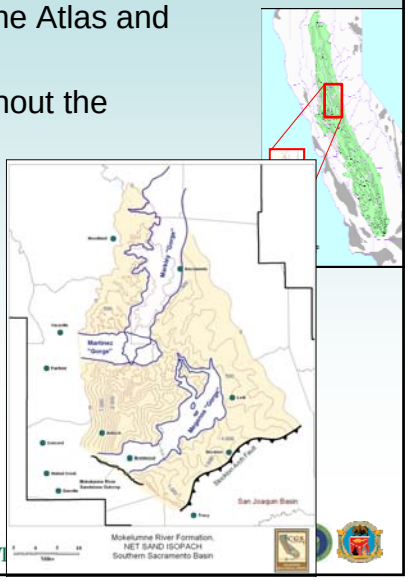
- Pilot projects
  - Lake County, OR
  - Shasta County, CA
- Characterized regional potential for riparian restoration, fast-growing tree species, fire management, and conservation activities
- Updated regional characterization with results from pilots and new data layers from public sources
- Identified candidate sites for future pilots in Washington and Arizona

Afforestation project in Shasta County

Monitoring crew from the Lake County Resources Initiative conduct a survey in Lake County, Oregon

Technology validation: geologic characterization

- Produced reports and data for the Atlas and NATCARB
- Engaged state agencies throughout the WESTCARB region
- Laid foundation for site selection for pilots and development phase projects
- Results:
  - California: Central Valley select formations
  - Nevada: Basin and Range
  - Alaska: Cook Inlet, North Slope, Offshore
  - Arizona: Colorado Plateau (NE corner of the state)



Example: Arizona characterization

Sources: Arizona Power Plants

Annual Emissions: ~ 45 million tons CO_2

Potential Storage:

Depleted Oil & Gas Fields: 15 million tons CO_2

Unmineable Coal Seams: no potential

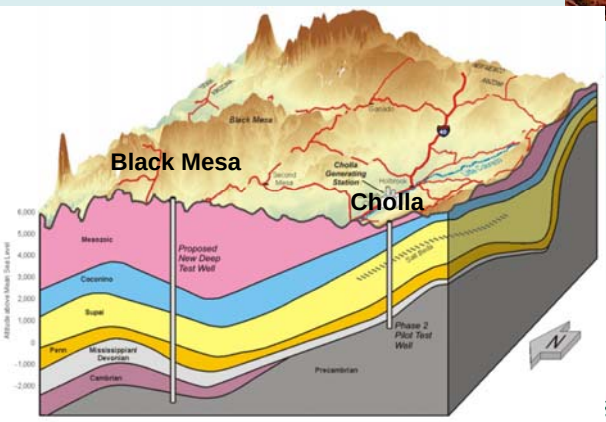
Deep Saline formations: 30,000 million tons CO_2

The Colorado Plateau is the most promising region for saline formation storage and contains several large sources

Data from Arizona Geological Survey

Technology validation: geologic tests in Arizona

Colorado Plateau is data-poor; one goal of testing is to improve characterization



- Criteria:
  - High salinity
  - High storage capacity
  - Good seals

SHIP

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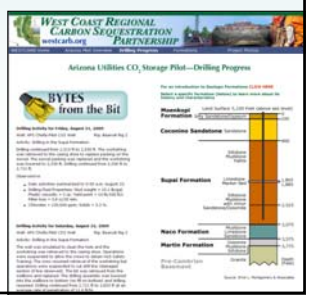
Geologic characterization and test well at the Cholla site, Arizona

- **Goal:** Installation and testing of a well near the fly ash pond at Arizona Public Service's Cholla Power plant; drilled into saline formations at a depth of nearly 4,000 feet
- **Methods:**
  - Mud logs (0–3,853 ft)
  - Rotary side-wall cores (25)
  - Open-hole logs (Schlumberger)
  - Drill-stem tests of Martin and Supai target formations
  - Fluid sampling
- **Results:** Saline formation water; good cap rock, poor reservoir permeability



WEST COAST REGIONAL CARBON SEQUESTRATION PARTNERSHIP

Proposed Black Mesa Basin Pilot

- Geologic storage zones are much deeper beneath the Black Mesa Basin (7000–9000 feet)
- Project plan includes:
  - Permitting (NEPA, EPA UIC, tribal)
  - Drilling a deep well to basement rock (7000 feet)
  - Logging and testing formations
  - Sampling of formation fluids
  - Water injection test (no CO_2 injection planned)
- Project contingent on receiving Hopi tribal approvals
  - 80% of tribal revenues from coal
  - Opportunity to scope potential for a clean-coal technology
  - Option to later convert and recomplete well for groundwater

Black Mesa Water Coalition photo
Black Mesa Mine coal mine before it was closed

Black Mesa pilot: results

- July 19: Hopi Council approved the project concept
- August 4: Inter-Tribal COALition sponsored protests
- August 12: Navajo Nation's Resources Committee opposes Hopi project
- August 23: Navajo Intergovernmental Relations Committee opposes Hopi project
- Sept 14: Hopi Council rescinds approval

The Inter-Tribal COALition Sponsors

A Public Forum On

Carbon Capture Sequestration &

Snow Bowl

August 6, 2010

Hotevilla Youth & Elderly Center
Hopi Indian Reservation
9:30 a.m. to 4:30 p.m. (PST)

Hopi Tribal Council recently approved an experimental Carbon Capture Sequestration (CO2 Sequestration) project on Hopi lands without consultation with tribal members. This project will also impact Navajo lands. The U. S. Department of Agriculture, Forest Service recently approved the use of affluent water to make artificial snow at the Snow Bowl Ski Resort on the San Francisco Peaks in Flagstaff, AZ. The COALition invites everyone to come learn about these issues and how our lands and environment may be affected by these projects. This is an opportunity for everyone to share their comments that we can take to our tribal councils.

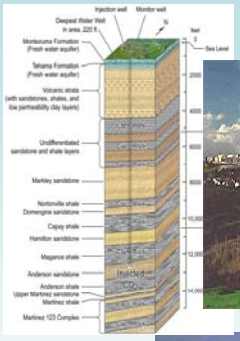
Topics will include:

- What is Carbon Capture Sequestration?
- What is the project that Hopi Tribal Council approved?
- If allowed to proceed, what are the potential impacts on our lands and our water?
- What is the effect of artificial snow making on the San Francisco Peaks?
- Discussions on Environmental Effects, Cultural Effects & Economic Impacts
- What options are available to Hopi and Navajo Nations to address these issues?
- Open Microphone – **All Public Testimonials Welcome.**

Everyone is Welcome!

California pilot test: Montezuma Hills, Solano County

- Linked to C6 Resources ARRA ICCS Phase I award:
- Project concept: capture and transport by pipeline approximately one million tons per year of CO_2 streams from industrial facilities located in the Bay Area



- Injection target is more than two miles underground in a saline formation
- Project designed to enable refinery compliance with AB32 and future caps
- However, no business case to pursue project given current policy status

Aerial view of the Montezuma Hills

Technology validation: capture

- Nexant prepared and later revised a draft report of the PC-fired power plant retrofit case based on the comments received from the plant operator
- Final Report completed by Nexant and EPRI: “Siting Future Power Plants Integrated with CO_2 Capture – A site Evaluation Methodology”
- Final Report completed by Nexant and EPRI: “New/Emerging CO_2 Capture Technologies for WESTCARB Region”
- Conducting an assessment of CO_2 capture process suitability and retrofit costs for a representative coal-fired plant and a natural gas combined cycle (NGCC) plant within the WESTCARB region
- Assessment of capture technologies for retrofitting NGCC plants with CO_2 capture and storage options in California’s gas-dominated electricity market

Beneficial Use Roadmap

- Building products
- Enhanced geothermal
- Desalination of saline groundwater
- Chemical or biologic conversion of CO_2 to fuels
- Direct fuel cell conversion of CO_2 to power
- EOR/EGR

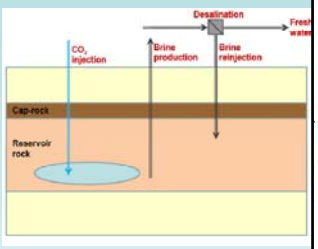
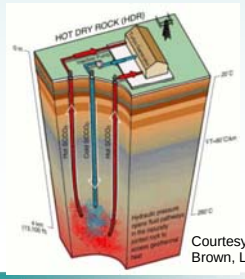


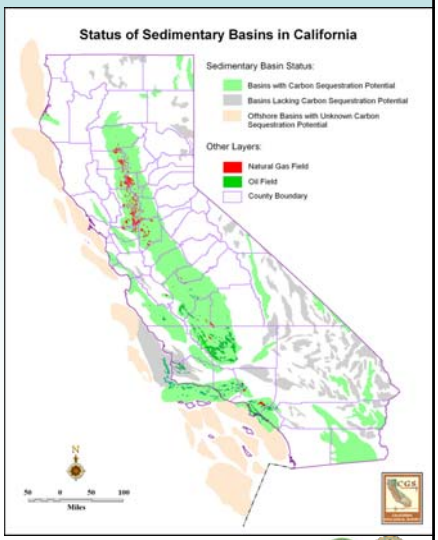
Figure Desalination of aquifer brines displaced by CCS to create fresh water. Source William Bourcier, LLNL.



Courtesy of Donald Brown, LANL

Technology development: geologic and terrestrial characterization

- Arizona: Tertiary and Paleozoic saline formations; salinity screening
- Hawaii: basalts and terrestrial
- California: offshore resources, salinity screening
  - Synergize with Terralog Technologies ARRA funding to characterize Pliocene and Miocene Formations in the Wilmington Graben, offshore Los Angeles
- Seismic risk issues

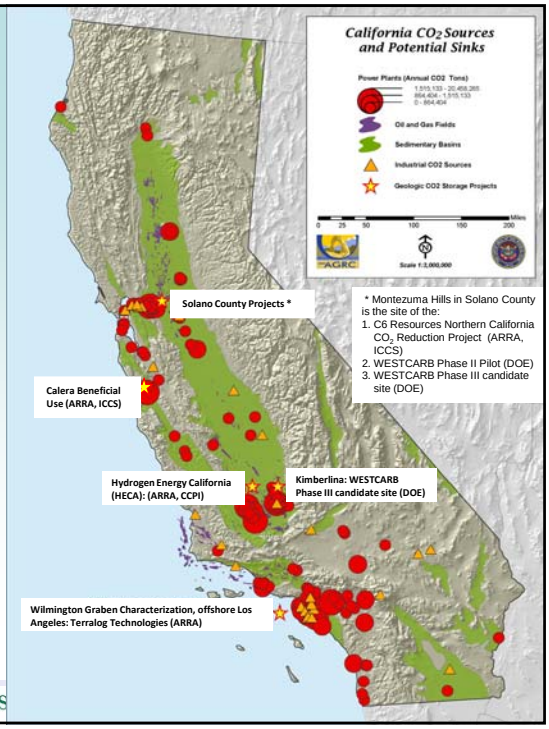


Seismic issues are an important consideration throughout most of the WESTCARB region

- California Geological Survey recently issued Seismic Hazard Map classifying faults according to age of activity
- LBNL and LLNL addressed seismic hazard issues for Solano County for proposed CCS project
- LBNL/WESTCARB established baseline seismic network for Solano County site
- WESTCARB working group to examine public perception and protocols

Technology development: industrial-scale focused California projects

- HECA (ARRA-CCPI)
- C6 Resources (ARRA-ICCS)
- Calera beneficial use (ARRA-ICCS)
- Terralog-Wilmington Basin (ARRA)
- Clean Energy Systems (ARRA)



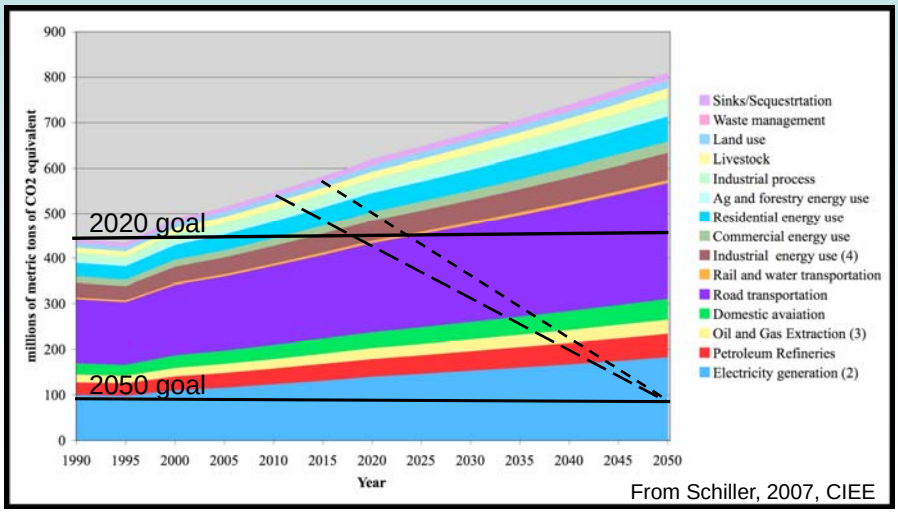
Quo Vadis?
CCS required to meet 2050 goals across the WESTCARB Region

California Scenario	Projected baseline in 2050 (avg. ann. growth 1990)	Reduction as percent of 2050 baseline	Reduction from 2050 to meet 20% of 1990 baseline
High Growth	~990 (1.2%)	~900	~91%
Moderate Growth	~800 (1.0%)	~710	~89%
Low Growth	~630 (0.6%)	~540	~86%

Values in million metric tons of CO_2 (eq)/yr)

E3 study of alternatives to achieve the 2050 goal

Rapid rates of adoption of CCS and other GHG reduction measures are necessary



From Schiller, 2007, CIEE

Regional Technology Implementation Plan (RTIP)—our approach seeks to link technical vision and policy out to 2050

- Input from stakeholders via breakout sessions
  - Capture and transportation
  - Geologic
  - Beneficial use
  - Terrestrial
- Post-meeting: integrate technical vision into state and regional energy and climate policy frameworks
  - Studies on infrastructure constraints
  - Carbon and energy flow
  - Regional policy initiatives

Summing Up

Your job is to write the rest of the story over the next day and a half.

Conclusion: Tomorrow at lunch

WESTCARB field projects

- Terrestrial field pilots in California and Oregon
  - Afforestation
  - Forest conservation
  - Fuels/fire management
- Four geologic site characterization pilots
  - ECBM/saline in Centralia, WA
  - EOR/saline in Kern County, CA (Kimberlina site)
  - Saline in Solano County, CA
  - Saline in Arizona's Colorado Plateau