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WEST COAST REGIONAL  
CARBON SEQUESTRATION  
PARTNERSHIP

# Developing Sequestration Baselines for the West Coast

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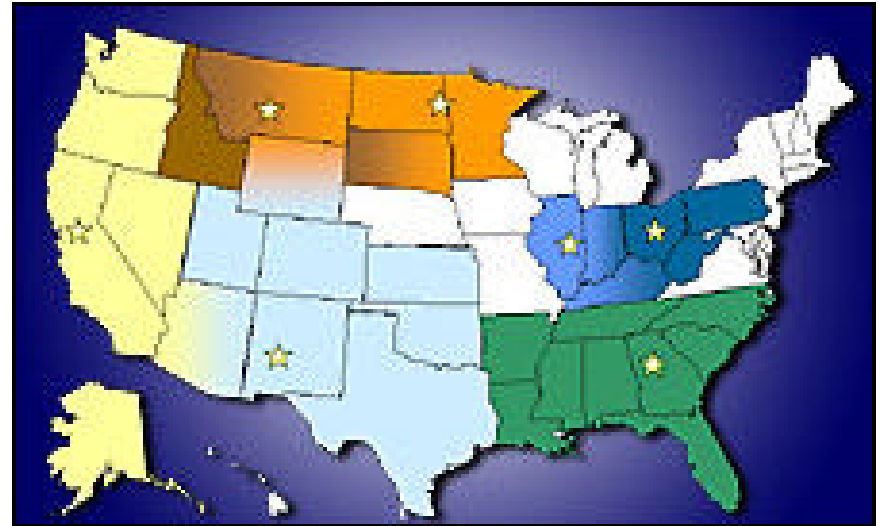
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**California Energy Commission**



# WESTCARB Is One of Seven in DOE Program

- Partnership is evaluating terrestrial and geologic options for CO<sub>2</sub> sequestration in the region
- Partnership has broad stakeholder representation

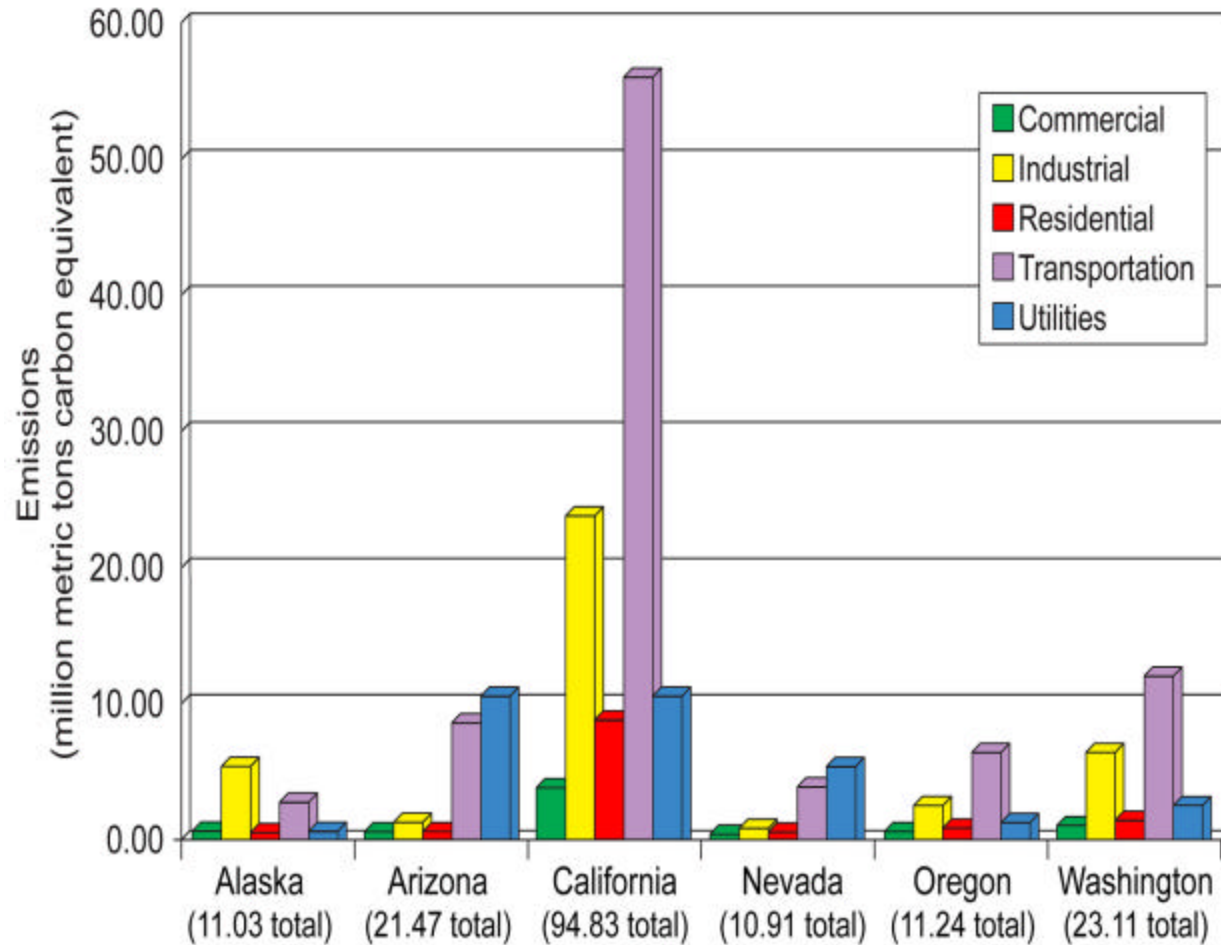


# Partnership Has Been Designed to Advance Practical Applications of Carbon Sequestration

- Capture, transport, and geologic storage options
- Terrestrial sequestration opportunities
- Regulatory analysis and permitting
- Monitoring and verification
- Economic and environmental efficacy
- Public outreach and education
- Develop geologic and terrestrial validation projects for Phase II

# WESTCARB Accounts for 11% of U.S. CO<sub>2</sub> Emissions

- Within region, breakdown by sector:  
transportation 53%,  
utilities 13%,  
industry 23%.
- California is second in nation in CO<sub>2</sub> emissions

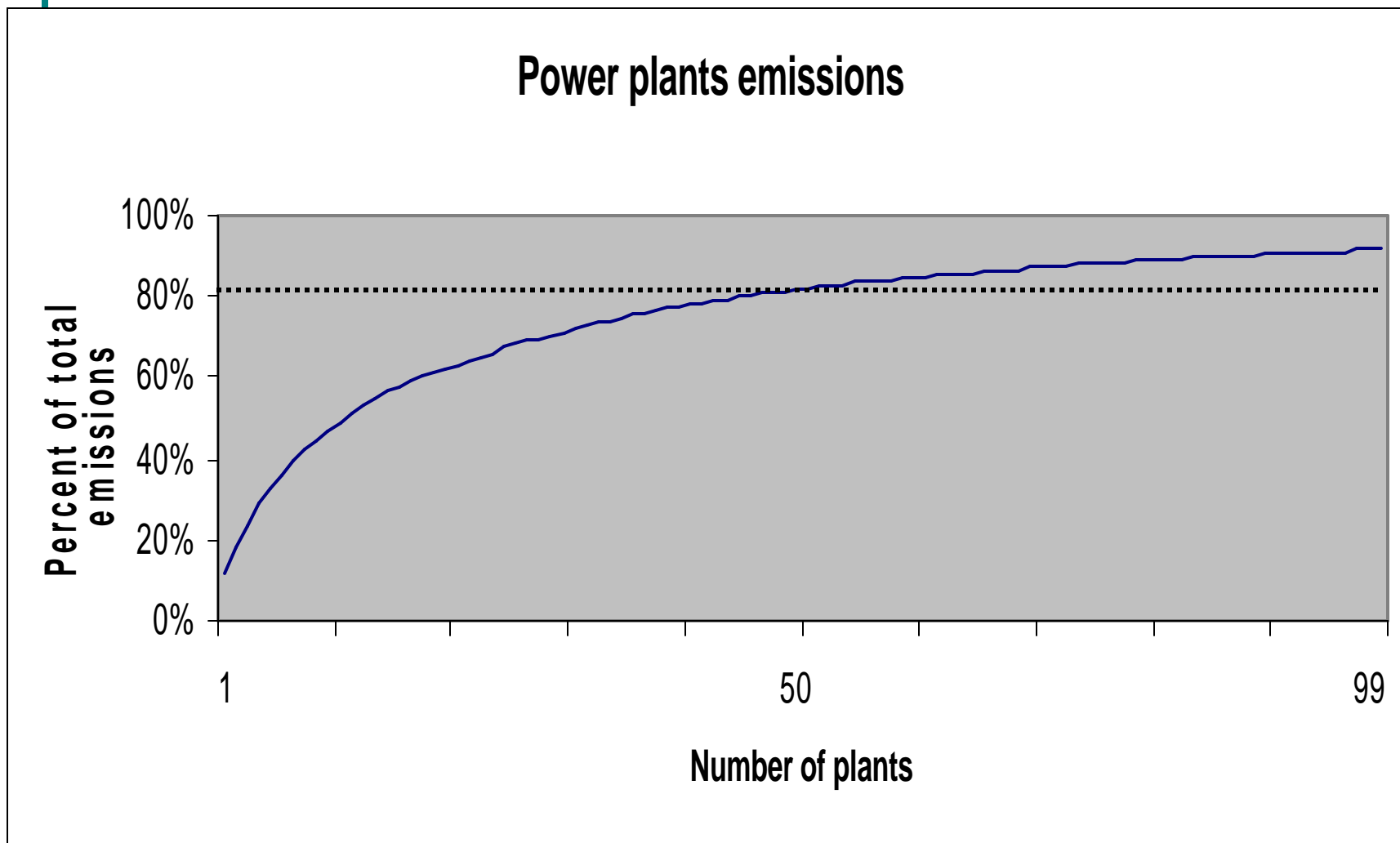


# Power Plants Are the Most Numerous Point Sources

	Alaska	Arizona	California	Nevada	Oregon	Washington	Total
	No. facilites	No. facilites	No. facilites	No. facilites	No. facilites	No. facilites	
Ammonia (2000)	0	1	0	0	1	1	3
Cement (1996)	1	2	13	2	1	2	21
Ethylene (2001)	0	0	0	0	0	0	0
Ethylene Oxide (varies)	0	0	0	0	0	0	0
Hydrogen (no date)	1	0	15	0	0	2	18
Iron & Steel (2001)	0	1	1	0	3	1	6
Oil & Gas (2000)	3	0	31	0	0	0	34
Refineries (1999)	6	0	21	1	0	6	34
Power (2000)	117	23	267	21	12	21	461

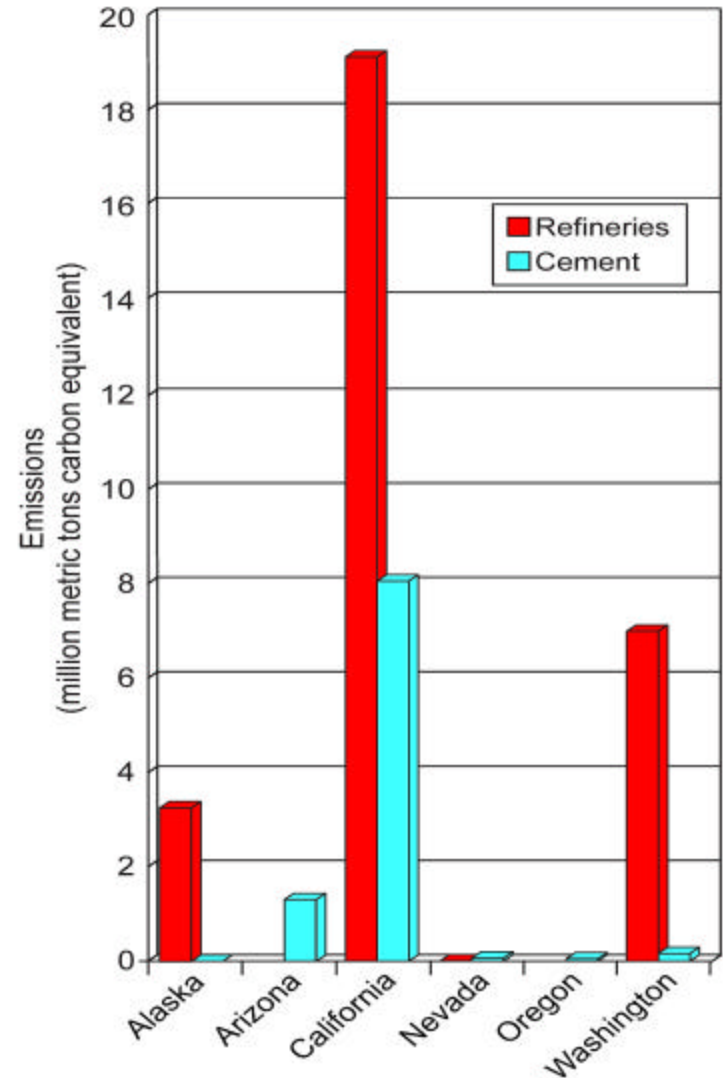


# 50 Power Plants Generate Most Emissions



# Most Industrial Emissions from Oil and Gas Production

- Refineries are major point sources in California and Washington
- About 4 MMTCE related to North Slope of Alaska oil and gas activities



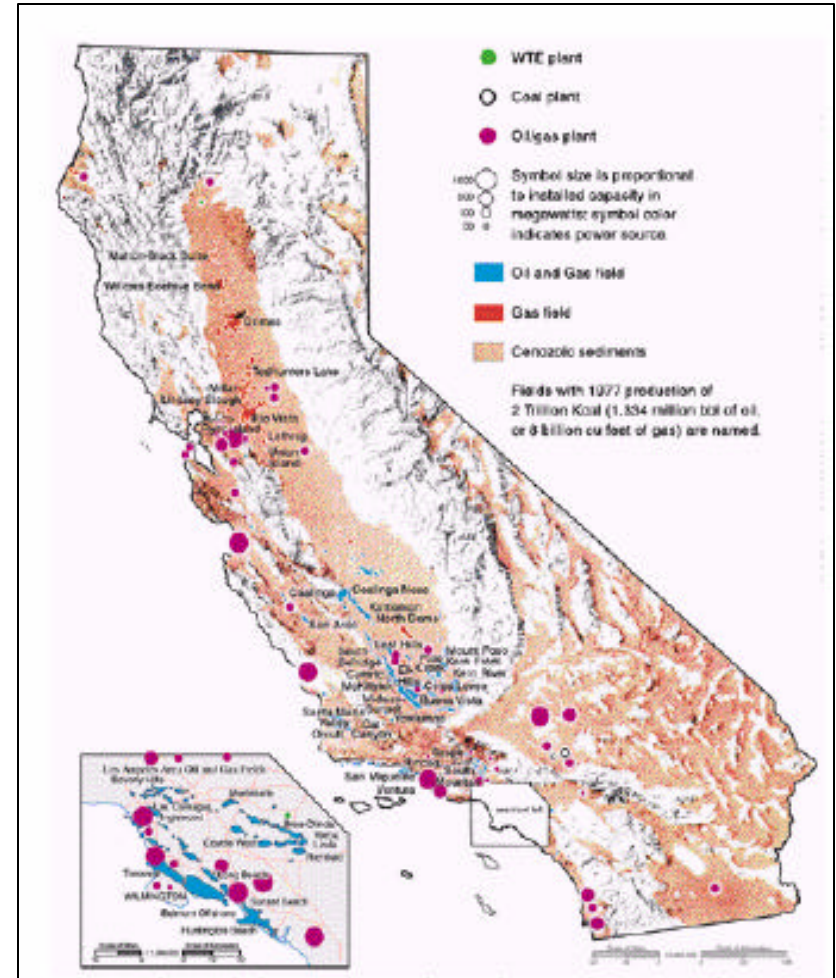
# Large Sedimentary Basins Are Potential Sinks

- Large capacity in oil and gas fields in California and Alaska
- Coal beds are potential sinks in Alaska and Washington
- Potential for offsetting costs with EOR, EGR, and ECBM
- Many basins have complex structure



# Geologic Storage Requires Characterization of Sources and Sinks

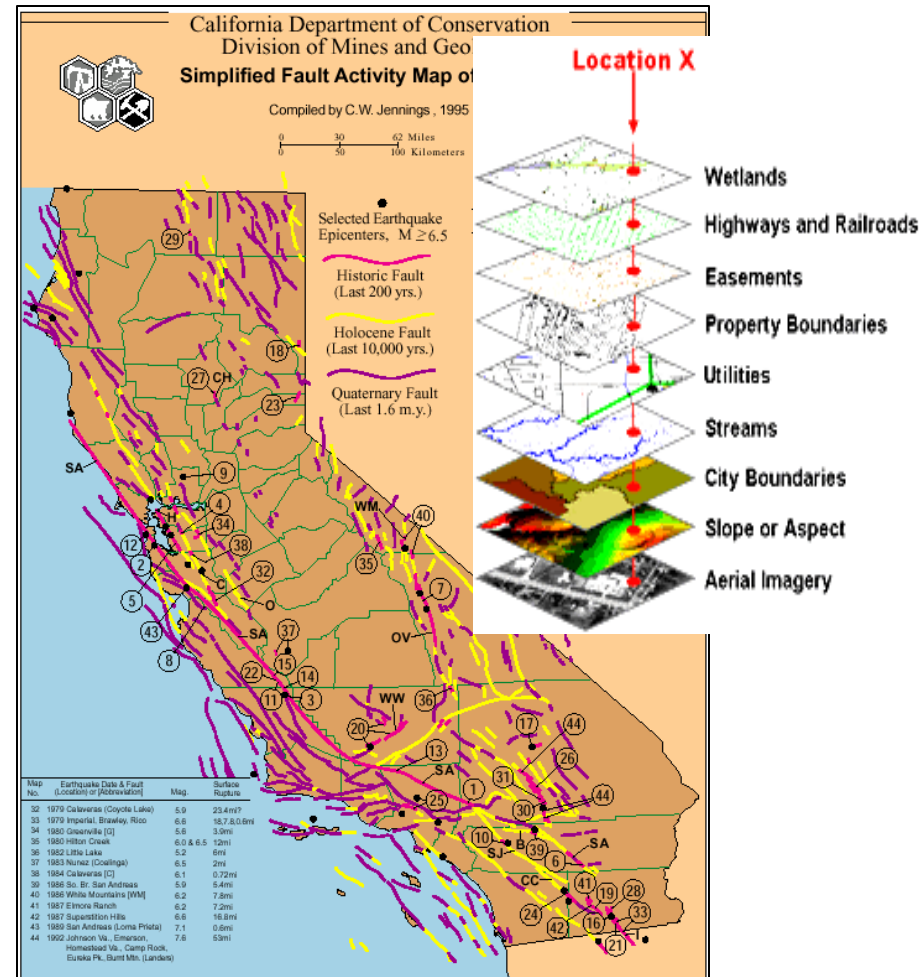
- Collect data on large utility and industrial sources
  - CO<sub>2</sub> and other emissions
  - Plant operating characteristics
- Characterize candidate sedimentary basins
  - Available rock and fluid properties of reservoirs
  - Gross sand thickness and shale thickness maps for basins



Power plants and oil/gas fields in California

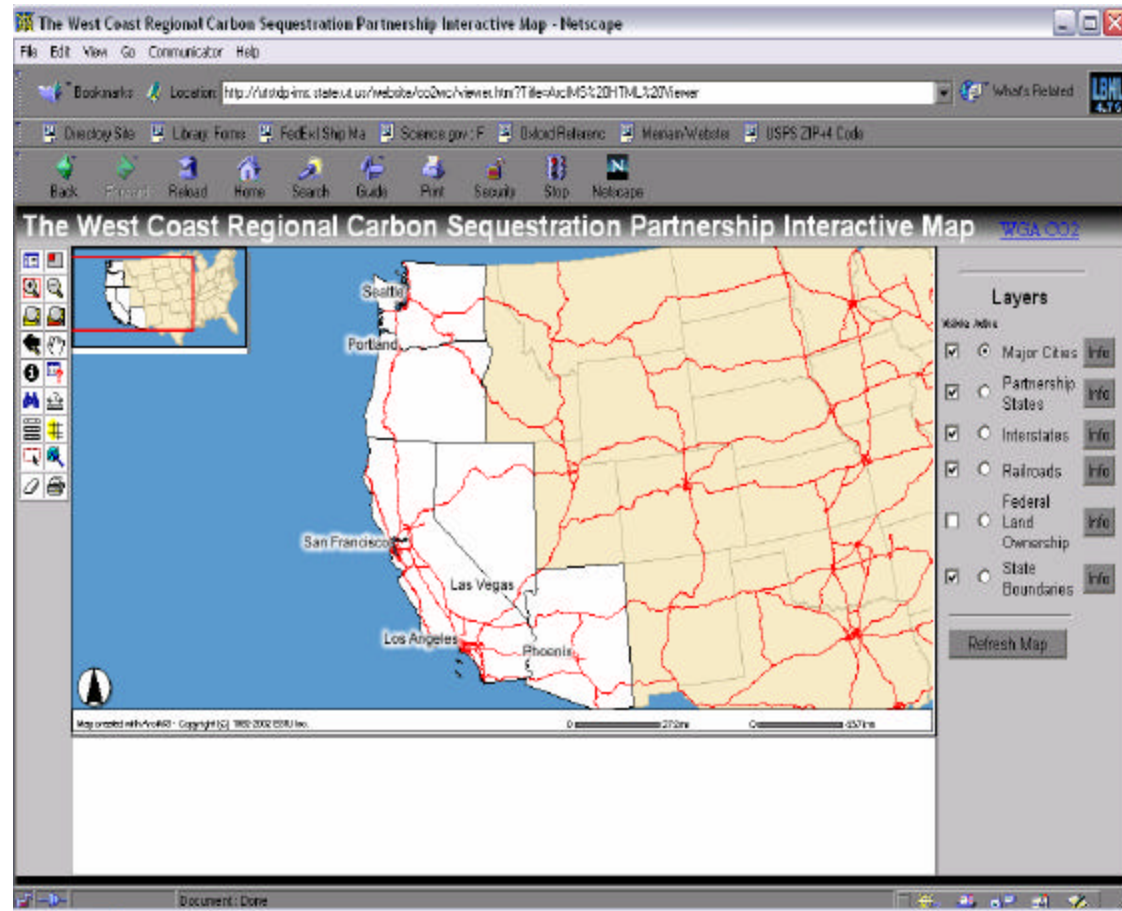
# GIS Layers Contain the Characterization Data

- Layers contain outline of basins and reservoirs; location of sources
- Reservoirs and sources are attributed by properties
- Other layers for transportation, faults, population centers, parks, mines, etc.



# Consolidated GIS – Based Database Will Be Regional and National Resource

- Public access through Internet Mapping Site at Utah AGRC
- Linking of Partnerships within WGA
- Link with National Atlas proposed by DOE
- Clearinghouse for data for Partnership work



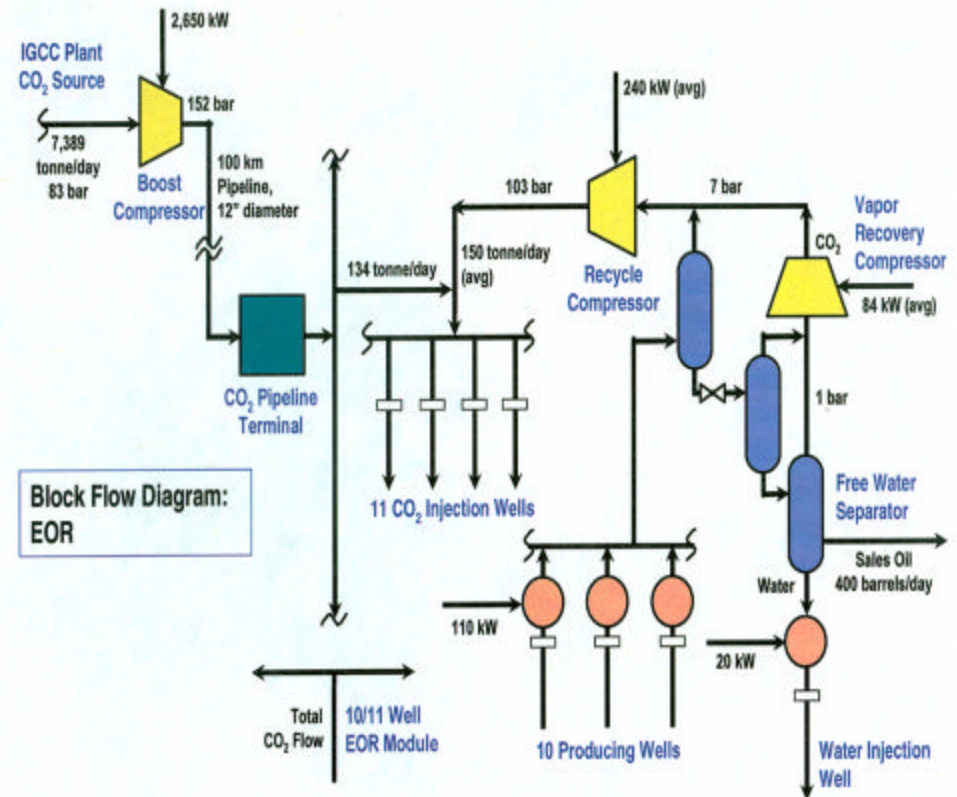
# Regional Geologic Sequestration Options Will Be Identified

- Perform economic, transportation, geologic screening and other analyses on GIS database

- Consider about five transport storage options for each source
- Consider short-term as well as long-term options

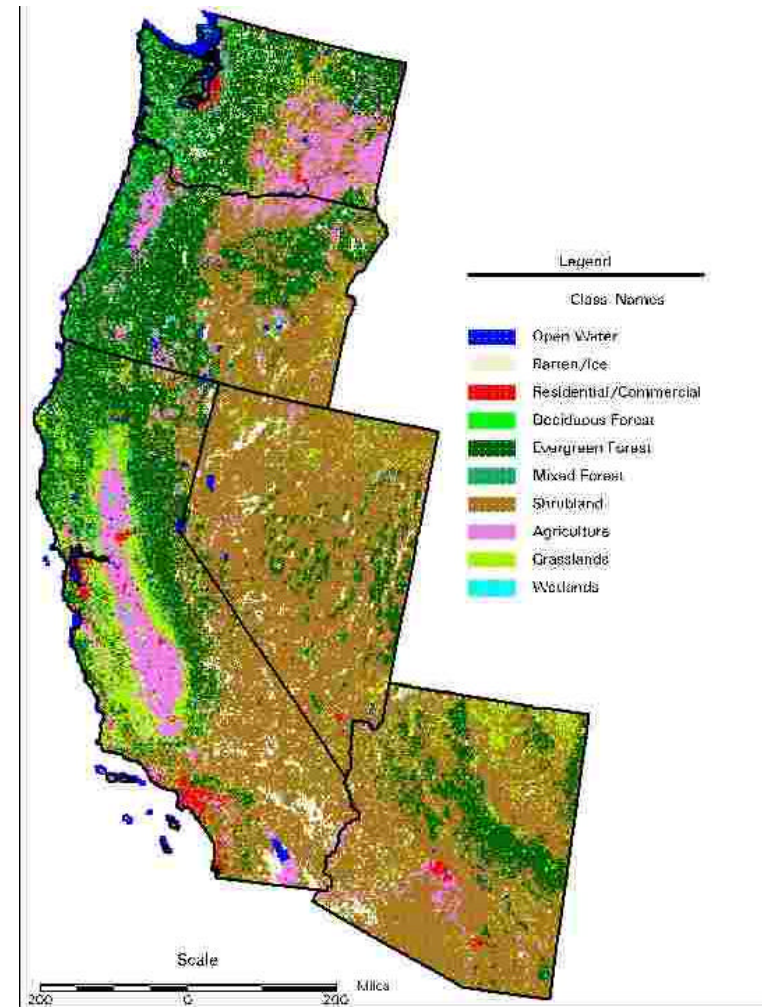
- Decision analysis techniques applied to selection of options

- Risk, public opinion, other externalities
- Terrestrial versus geologic options



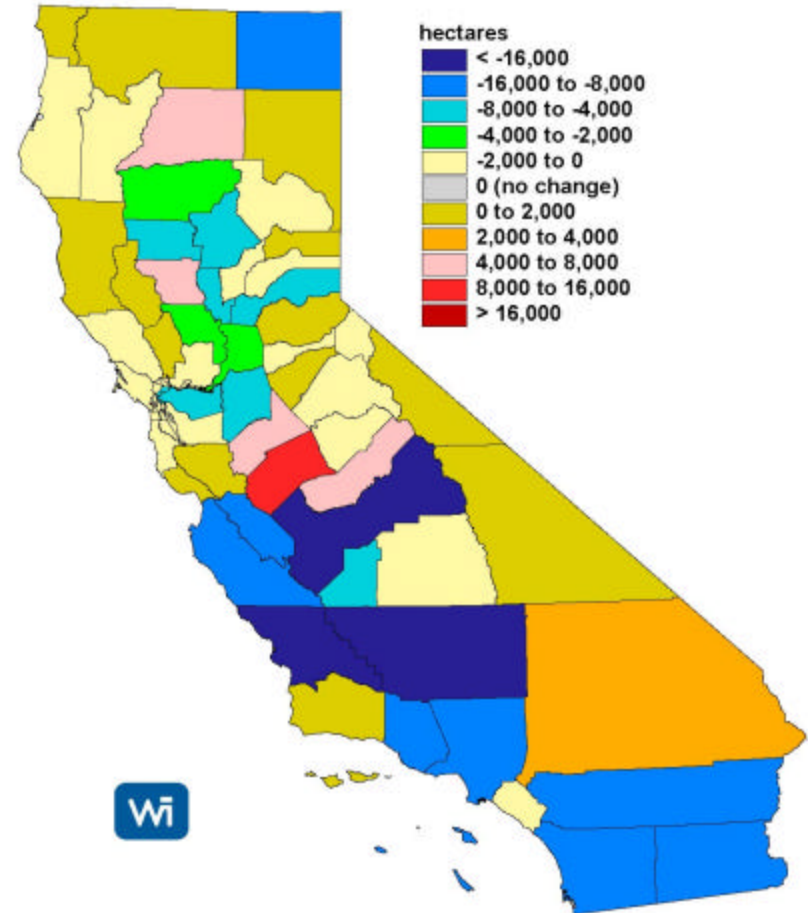
# Forests and Agricultural Soils Are Potential Terrestrial Sinks

- Region has evergreen, deciduous, mixed forests; rangeland; agricultural soil resources
- Forest sequestration activities include riparian management, conversion of rangeland/marginal land, enhancement of large wood, fire management
- 2.6 times more carbon in agricultural soil than vegetation
- Changes in farming practices, including tillage, fertilization, crop rotation are evaluated



# The Partnership Benefits from Ongoing R&D at the California Energy Commission

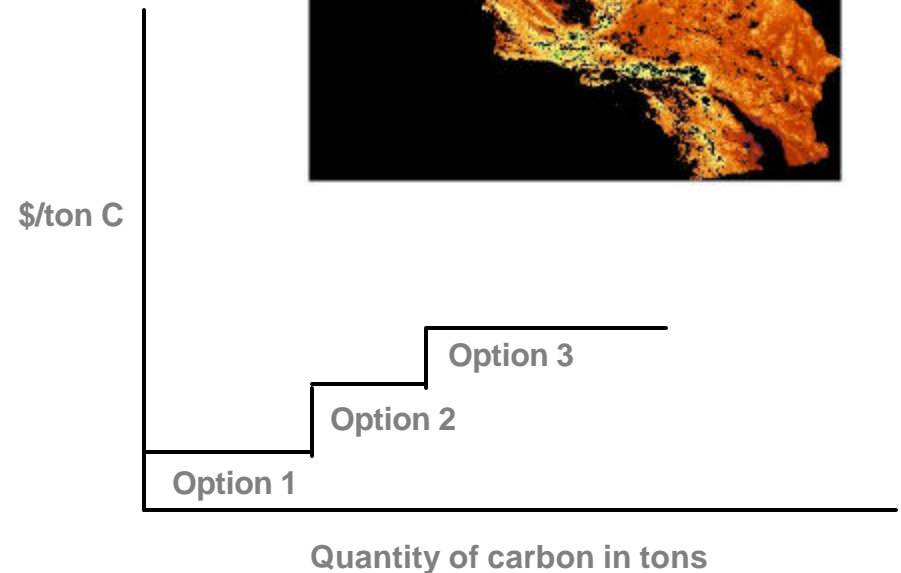
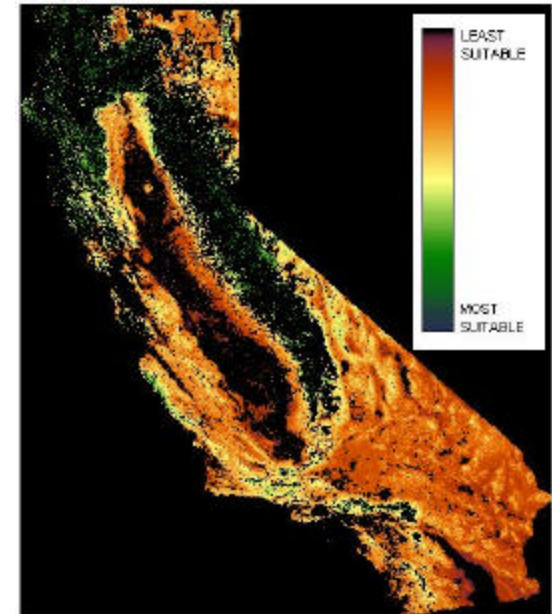
- Kearney Foundation (Soils)
  - Consideration of CO<sub>2</sub>, N<sub>2</sub>O, and CH<sub>4</sub> emissions
  - Scoping study using process-based model
- Winrock International (Forestry)
  - Development of two-point carbon baseline
  - Development of supply curves for major classes of land use and forest activities



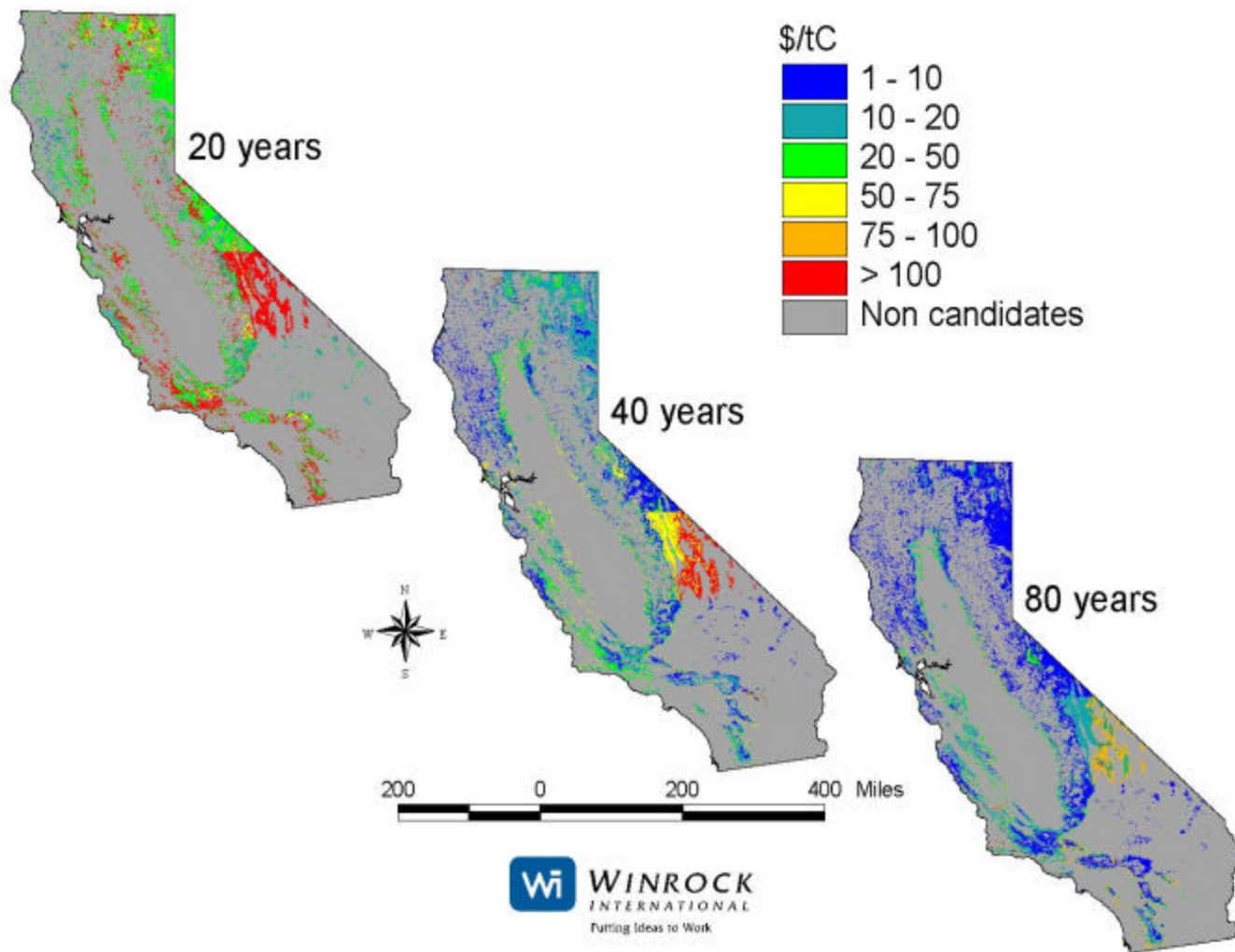
Distribution of area change in non-woody cropland

# Supply Curves Quantify Major Storage Options

- Use GIS framework for analyses
- Identify areas of current use
- Determine areas suitable for change
- Estimate additional carbon stored
- Include risk, environmental impacts, other externalities
- Estimate opportunity, conversion, MMV costs
- Field check estimates of carbon stored in different types of projects



# Carbon Quantity and Cost of Converting Rangeland to Forest



**Wi** WINROCK  
INTERNATIONAL  
Putting Ideas to Work

[westcarb.org](http://westcarb.org)

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# Developing Public Acceptance Is Key

- Create Partnership web site [www.westcarb.org](http://www.westcarb.org)
- Use existing channels, e.g., state forestry depts.
- Develop educational materials; work with other partnerships
- Hold stakeholders' meeting
- Advice from NGOs, other stakeholders

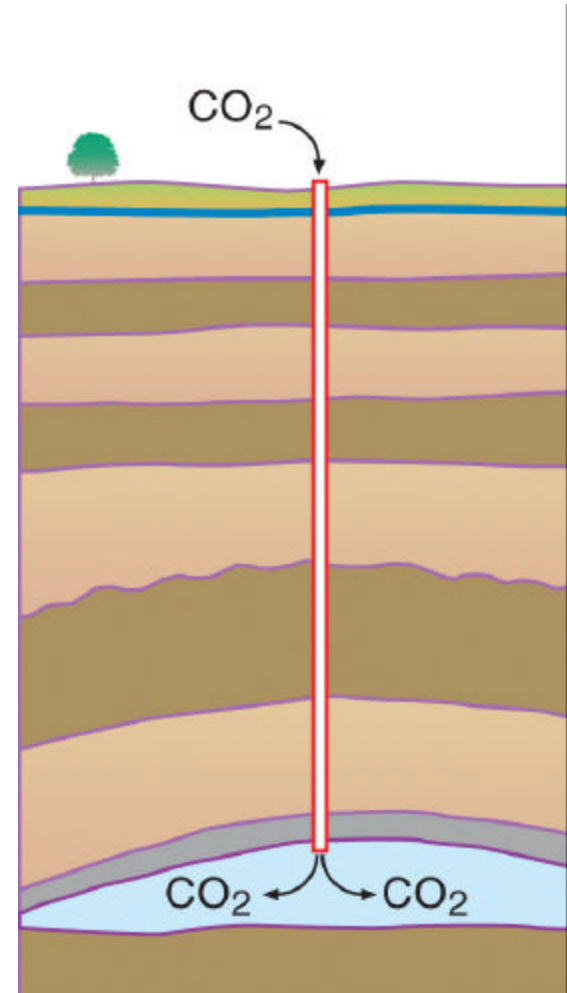


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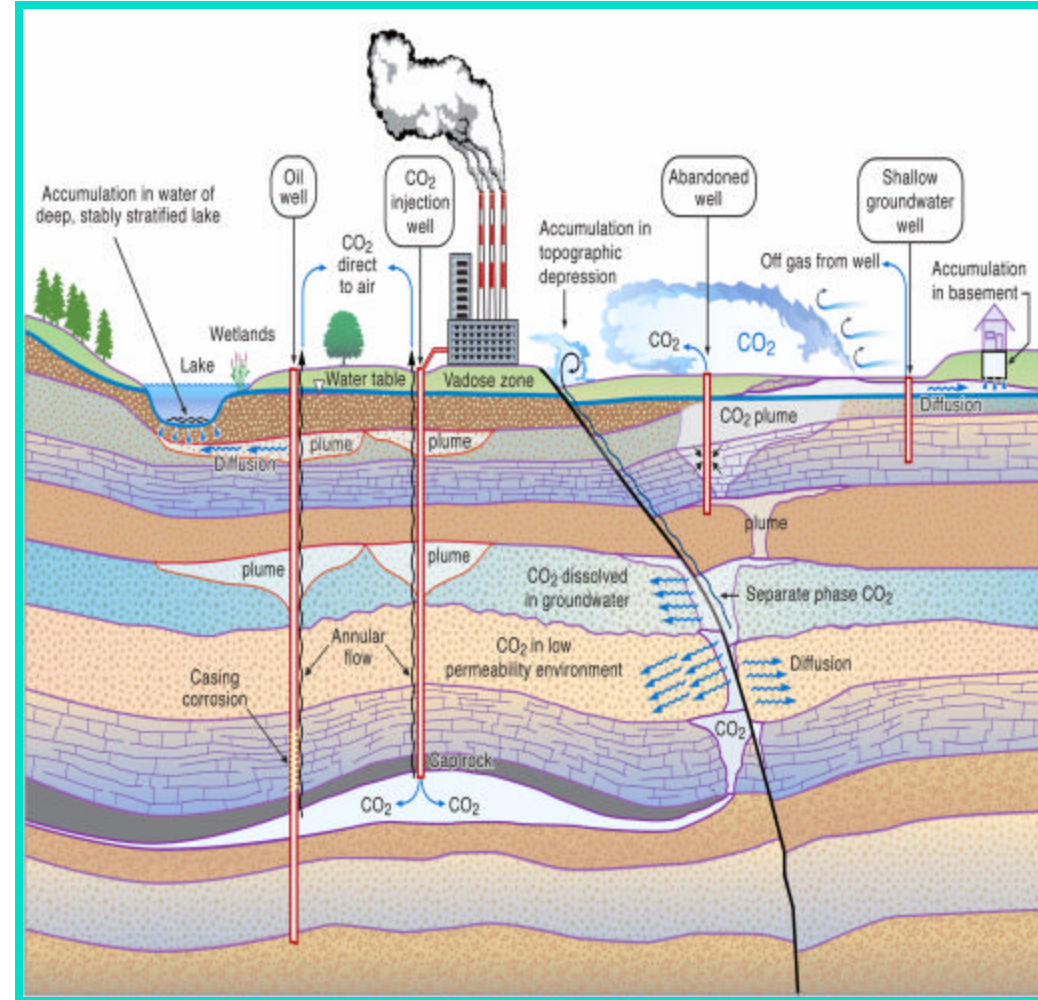
# Regulatory and Monitoring Issues Are Addressed

- Regulations and permits will be compiled and assessed
- Comparative assessment of regulations for enhanced oil recovery, natural gas storage, and underground waste injection
- Develop protocols for monitoring and verification
  - Use potential pilot sites; perform simulations and assessment



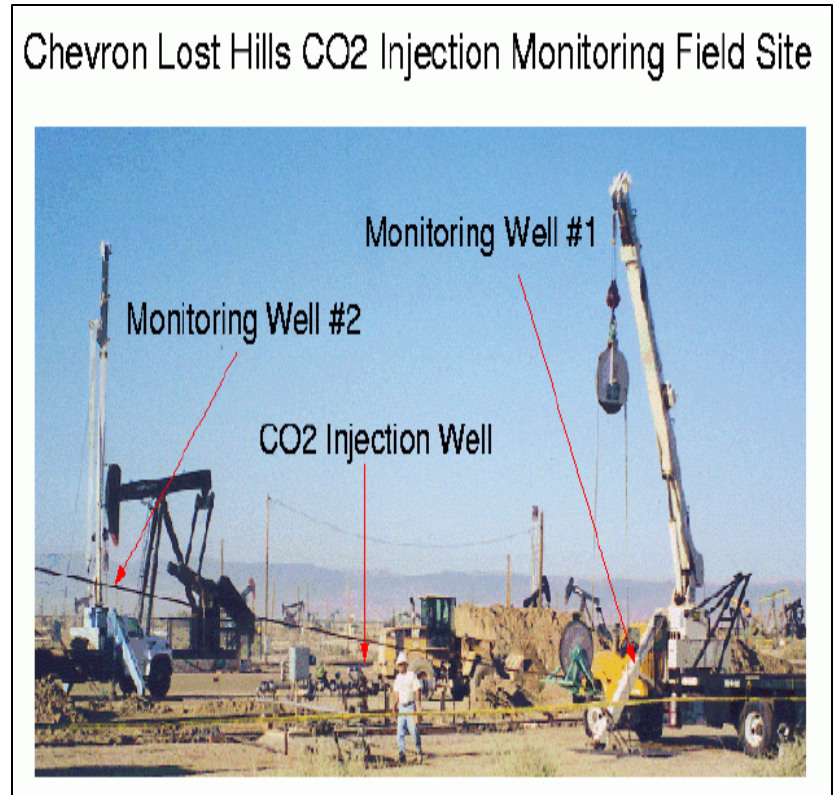
# Methodology for Assessing Risk Is Needed

- Focus on risk of leakage from geologic storage projects
- Approach uses simulations based on identified FEPs (features, events, processes)
- Use results in screening sinks



# Action Plans for Field Pilot Testing Will Be Developed

- Target one terrestrial pilot each in CA, OR, WA, AZ
- EOR projects are best geologic opportunities, candidates are:
  - Elk Hills (Occidental), Ventura and Huntington Beach (Shell/Aera), and Prudhoe Bay (BP)
- Action plan will address:
  - Technology validation
  - Monitoring and verification
  - Risk assessment
  - Regulatory definitions
  - Public outreach and education



# Regional Source/Sink Information Is an Important Basis for Decision-Making

- Provide data and analyses needed for informing state and national policy
- Assessing options and positioning team for conducting Phase II pilot validation tests