West Coast Regional Carbon Sequestration Partnership

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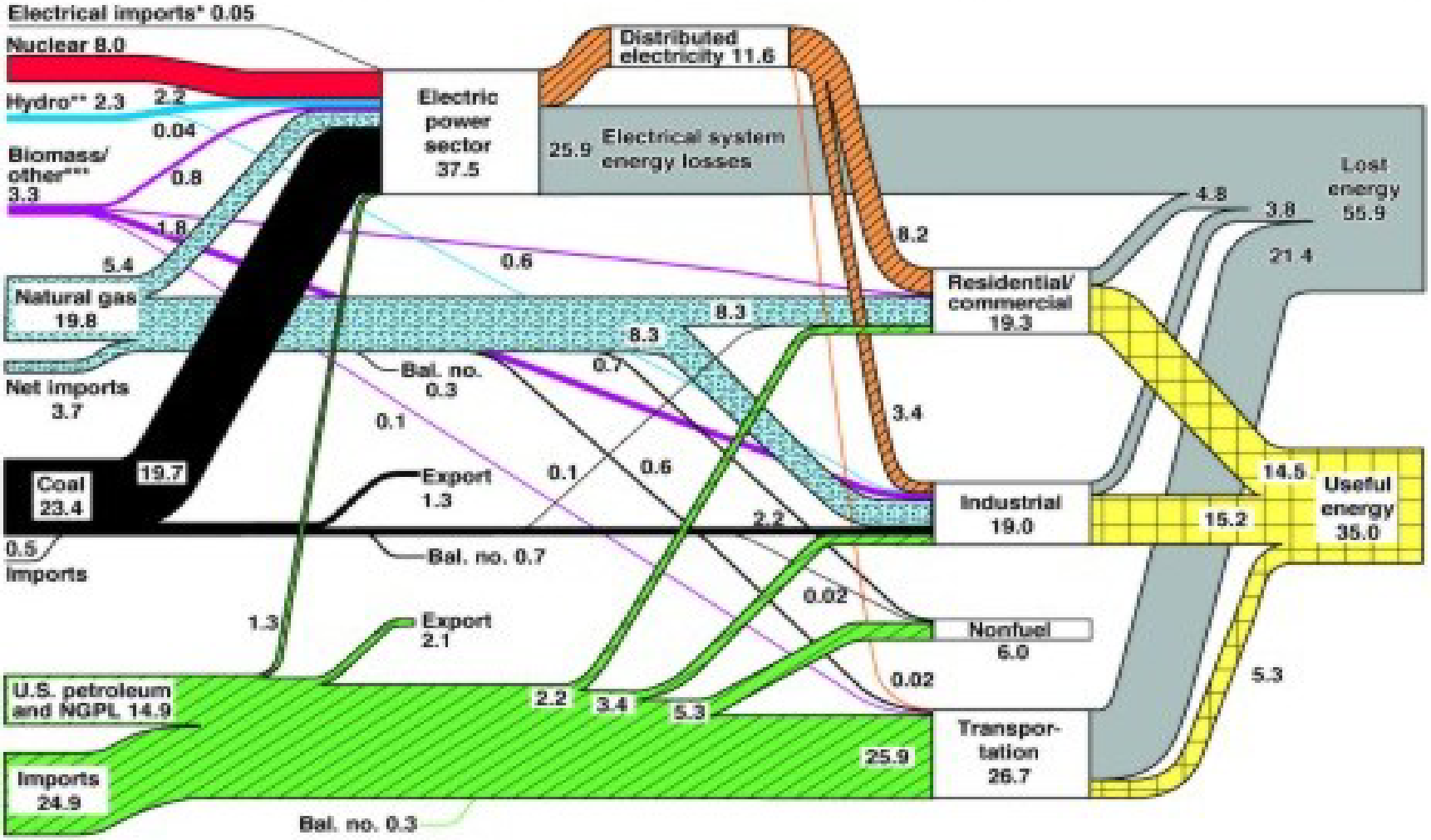
California Energy Commission (CEC)

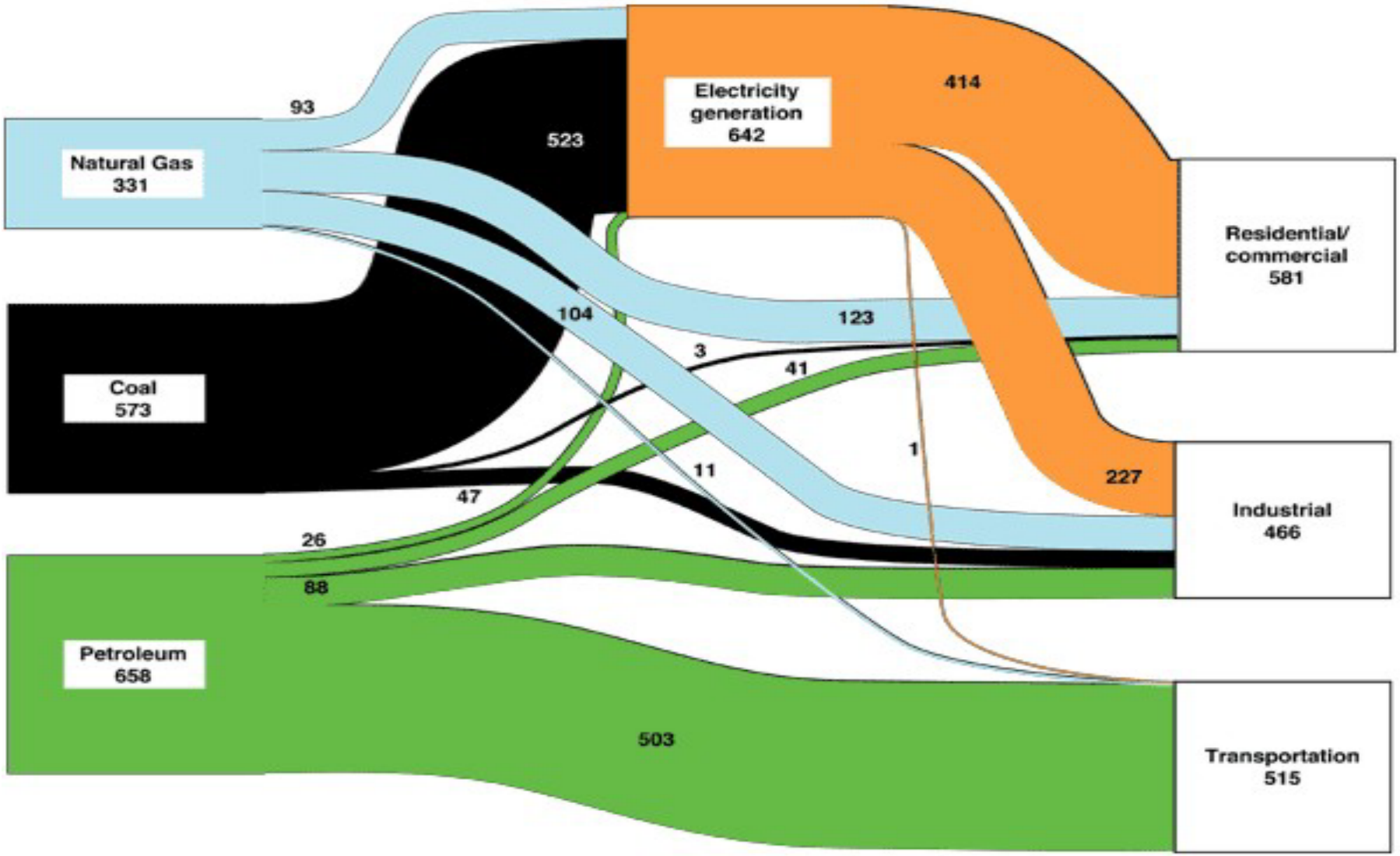
U.S. Energy Flow Trends – 2001
Net Primary Resource Consumption ~97 Quads



Source: Production and end-use data from Energy Information Administration, *Annual Energy Review 2001*
*Net fossil-fuel electrical imports
**Includes 0.2 quads of imported hydro
***Biomass/other includes wood, waste, alcohol, geothermal, solar, and wind.

Lawrence Livermore National Laboratory
http://eed.llnl.gov/flow

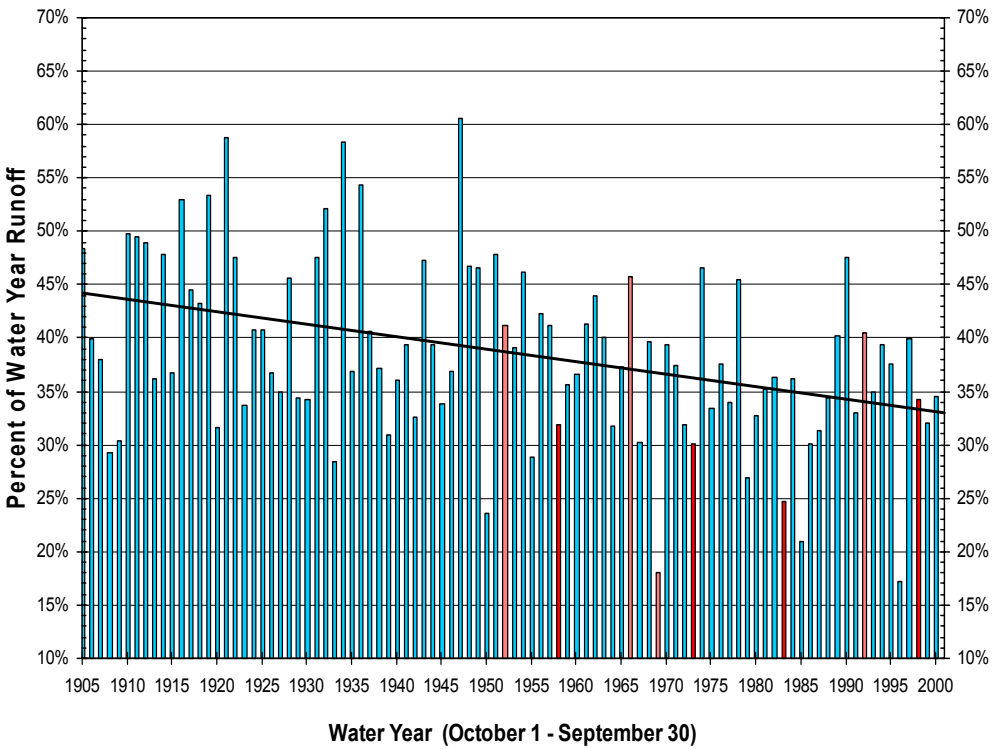
US 2000 carbon emissions from energy consumption — 1547* MtC



Source: Energy Information Administration
*Includes adjustments of 14 million metric tons of carbon from U.S. territories, less 28 MtC from bunker fuels

Lawrence Livermore National Laboratory, April 2002
http://en-env.llnl.gov/flow/

Our Principal Reservoir -
The Sierra Snow Pack - Is Shrinking



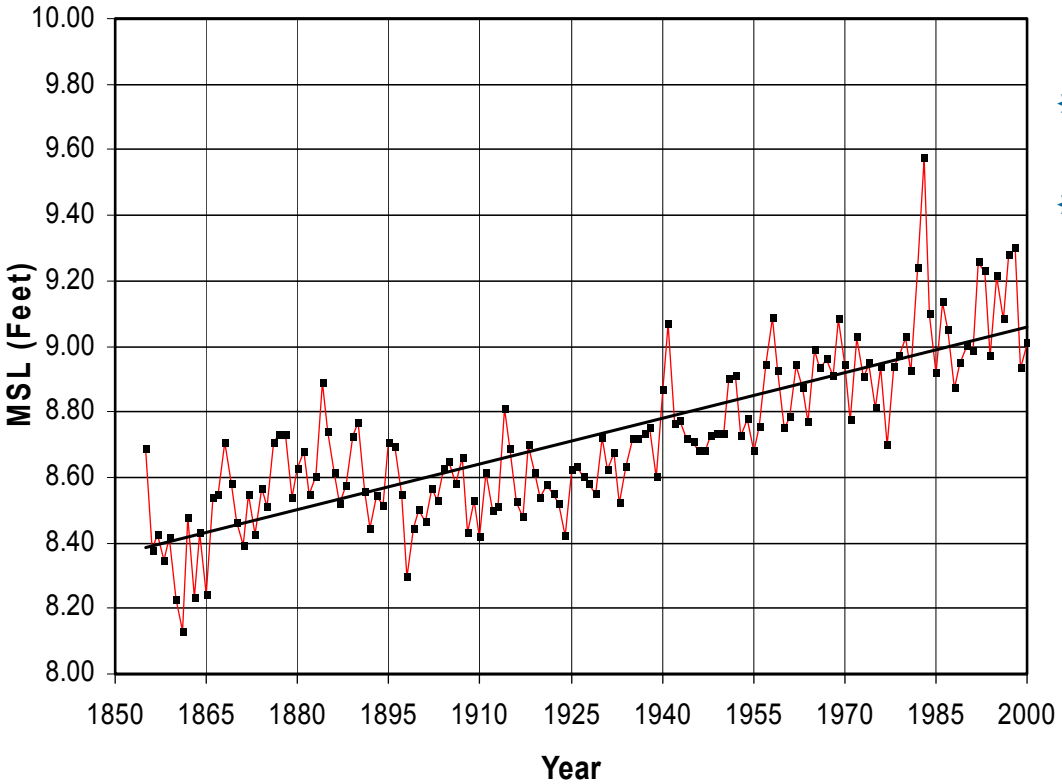
Sacramento River Runoff (1906-2001)
April to July as a Percent of Total Runoff

Warmer Winters Have:

- **Reduced snow pack**
- **Earlier snow melt**
- **Decreased Spring runoff by 10%**

Source: California Protection Agency, Environmental Protection Indicators for California, 2001

Sea Level Is Rising Along The West Coast



Golden Gate Gauge Yearly Mean Sea Level (1855-2000)

- Rise of 7" in 150 years
- IPCC projects 4-35" sea level rise by 2100

Source: California Protection Agency, Environmental Protection Indicators for California, 2001

The Region Forms a Coherent Study Unit

- Significant CO_2 source - over 11% of US anthropogenic emissions
- Commonality in terrestrial sinks in WA, OR, and Northern CA
- Commonality and large potential capacity in geological sinks in CA, NV, and AZ
- Significant potential for offsetting costs with EOR and EGR in California and Alaska North Slope

Partnership Has Been Designed to Advance Practical Applications of Carbon Sequestration

- Capture, transport and geological storage options
- Terrestrial sequestration opportunities
- Regulatory analysis and permitting
- Monitoring and verification
- Economic and environmental efficacy
- Public outreach and education
- Information on regional source/sink relationships

A Strong Multi-Sectoral Team Has Been Assembled for This Program

- **Policy and Coordination** (Western Governor's Association)
- **State Resource Management, Environmental Protection, and Regulation** (CA Dept. of Forestry and Fire Protection, CA Dept. of Oil, Gas and Geothermal Resources, CA Geologic Survey, CAL EPA, OR Dept. of Forestry, Nevada Bureau of Mines and Geology, WA Dept. of Natural Resources)
- **Oil and Gas Companies** (AERA, BP, Chevron Texaco, ConocoPhillips, Occidental Petroleum, Shell)

A Strong Multi-Sectoral Team Has Been Assembled for This Program

- **NGO's (Pacific Forest Trust, Natural Resources Defense Council)**
- **Utilities (Pacific Corp., Salt River Project, Sierra Pacific Resources, TransAlta)**
- **National Lab and Research Institutions (Electricity Innovation Institute, Kearney Foundation, LBNL, LLNL, MIT, Stanford-GCEP, Winrock, U of Alaska)**
- **Engineering Companies (Advanced Resources International, Clean Energy Systems, KinderMorgan, Nexant, SFA Pacific, Terralog)**
- **Public Outreach/Education (Cal State Bakersfield, Cal Poly, SF Dept. of Environment, Science Strategies, Western State Petroleum Association)**

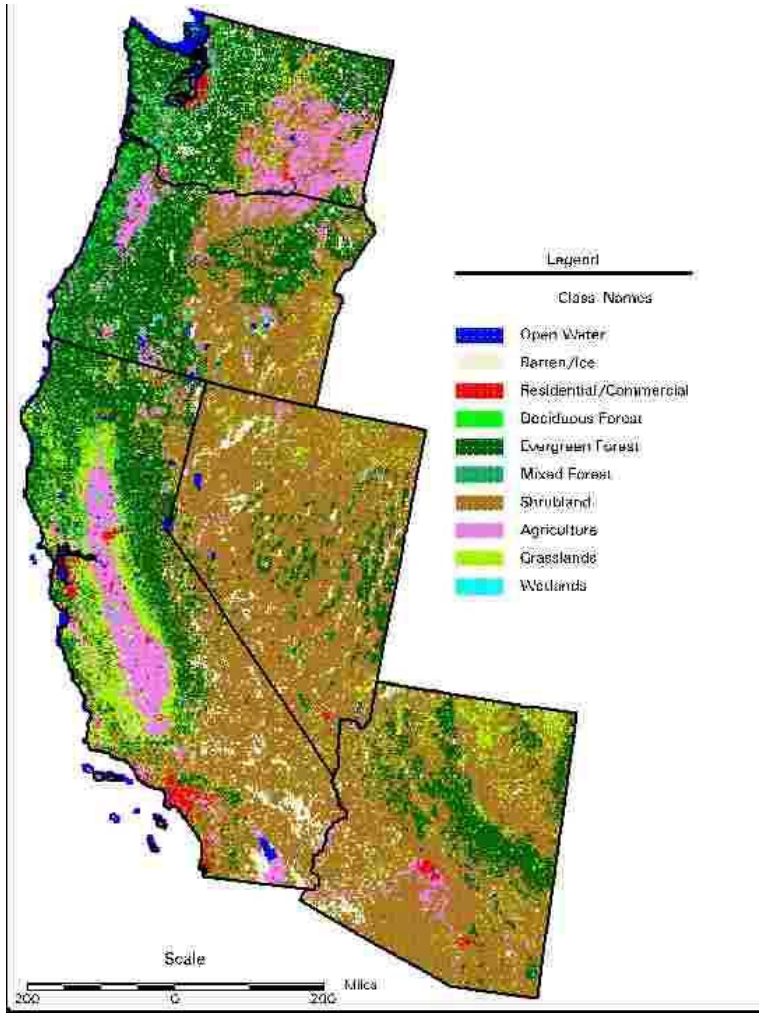
Phase I is Organized into Four Task Areas for Achieving Our Goal

- **Regional characterization and data integration**
  - Point source information
  - Terrestrial data and characteristics
  - Geologic data and characteristics
  - Transportation information
- **Technology deployment**
  - Environmental regulations, impacts
  - Life cycle analyses
  - Geological risk assessment
  - Monitoring and verification
- **Public outreach**
  - Action plan for outreach
  - Education and training
  - Sensitivity to unique stakeholder needs
- **Options and opportunities**

Regional Characterization:

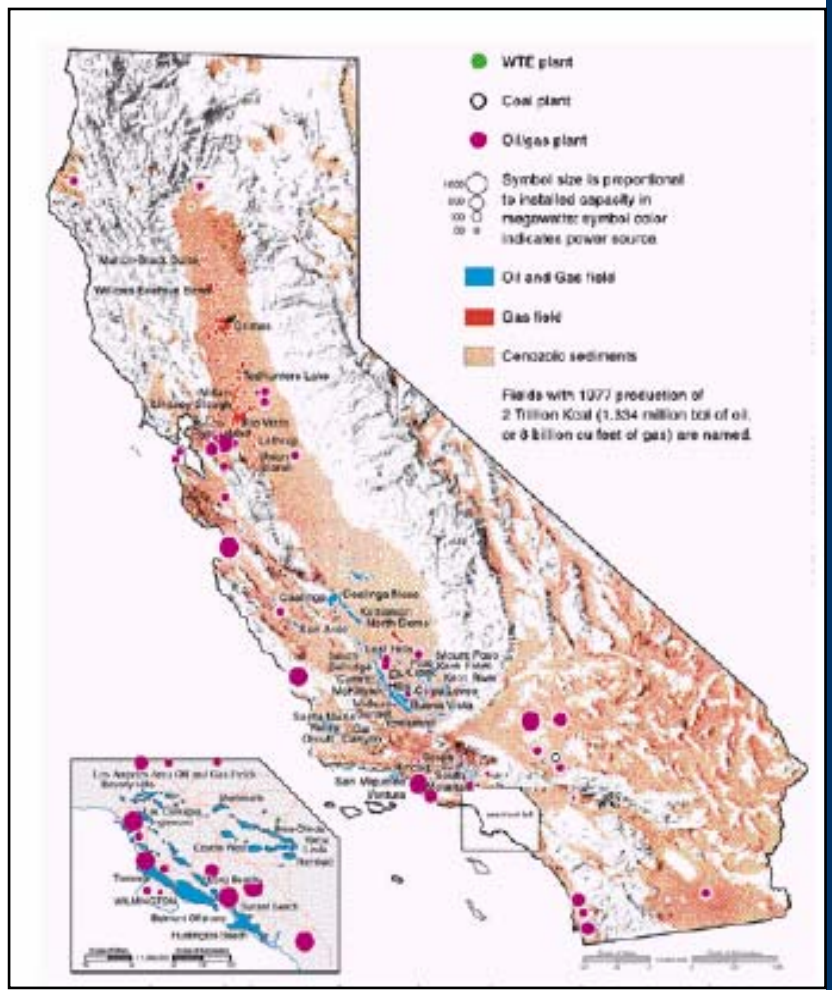
Data Collection is Already Underway

- Terrestrial data includes land use, land cover, hydrology, soil maps, crop yields, land ownership, etc.
- Point source data for power plants and major industrial sources; location, amount, processes
- Transportation data with focus on pipelines, including right-of-ways and topography
- Geologic data includes location, depth, formation properties, etc.



Regional Characterization: Data Integration Activities Are Already Underway

- Winrock will develop two point terrestrial baselines for WA, OR, AZ, and CA
- Complementary effort by Kearney Foundation on soil carbon storage in California
- Consolidated GIS-based geologic sequestration database to be developed
  - Source, transport, and site data
  - Cooperative effort with WGA, Utah AGRC, MIT, and CA Geologic Survey



Power plants and oil/gas fields in California

Technology Deployment Must Consider Life Cycles

- Life cycle analysis of impact of CO_2 capture, transport and storage options
  - Overall economics
  - Other emissions
  - Policy considerations

Technology Deployment Covers A Number of Regulatory Issues

- Develop an action plan to address environmental efficacy and regulations; focus on strategy for pilot projects and larger-scale deployments
- Compile and assess regulations and permits; current and future

Technology Deployment Issues: Develop Risk Assessment Framework for Geologic Sequestration

- Builds on previous work for the Carbon Capture Project and others
- Develop features, events and physical processes for failure analysis
- Quantify failure probability and consequence

Technology Deployment Issues: Also Builds on Previous CCP Work

- This allows a considerable head start for planned efforts
- Utilize potential pilot sites for stimulation
- Perform simulations to assess monitoring technique sensitivities

Public Outreach Will Be A Critical Component and Serve to Inform Public Policy

- Create Partnership web site
- Use existing channels, e.g.. State forestry depts.
- Develop University and K-12 curricula; work with WGA
- Hold stakeholders' meeting
- Advice from NGOs,other stakeholders
- Prepare action plan

California State University Bakersfield ...it's your university

CAL POLY

SF Environment

NRDC The Earth's Best Defense

Natural Resources Defense Council

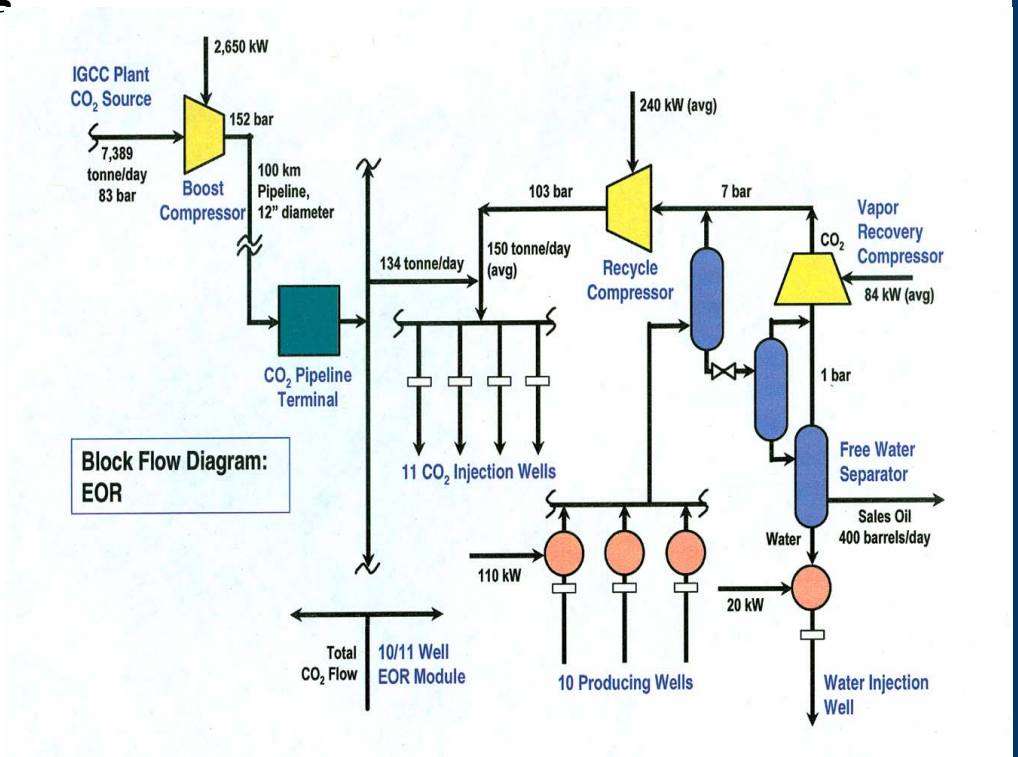
THE PACIFIC FOREST TRUST Preserving Productive Forestlands

Identify Terrestrial Sequestration Options and Opportunities

- **Prepare supply curves for major classes of regional land use and forest activities**
- **Evaluate potential pilot projects**
  - Increasing mass of large trees and dead wood
  - Reducing large fires
  - Reforesting riparian zones
  - Foresting marginal lands
  - Changing commercial practices to increase carbon stocks
- **Winrock will coordinate with Arizona Dept. of Forestry, California Dept. of Forestry and Fire Protection, Oregon Dept. of Forestry, Washington State Dept. of Natural Resources, Pacific Forest Trust**

Identify Geologic Sequestration Options and Opportunities

- **Perform economic, transportation, geologic screening and other analyses on GIS database to obtain best geologic options**
  - Consider about five transport - storage options for each source
- **E2I/EPRI to lead team**
  - MIT (scenario analyses on GIS data)
  - SFA Pacific (capture economics)
  - ARI (EOR, EGR engineering and economics)
  - LBNL (geologic screening)
  - Coordinate input from utilities, oil companies, others

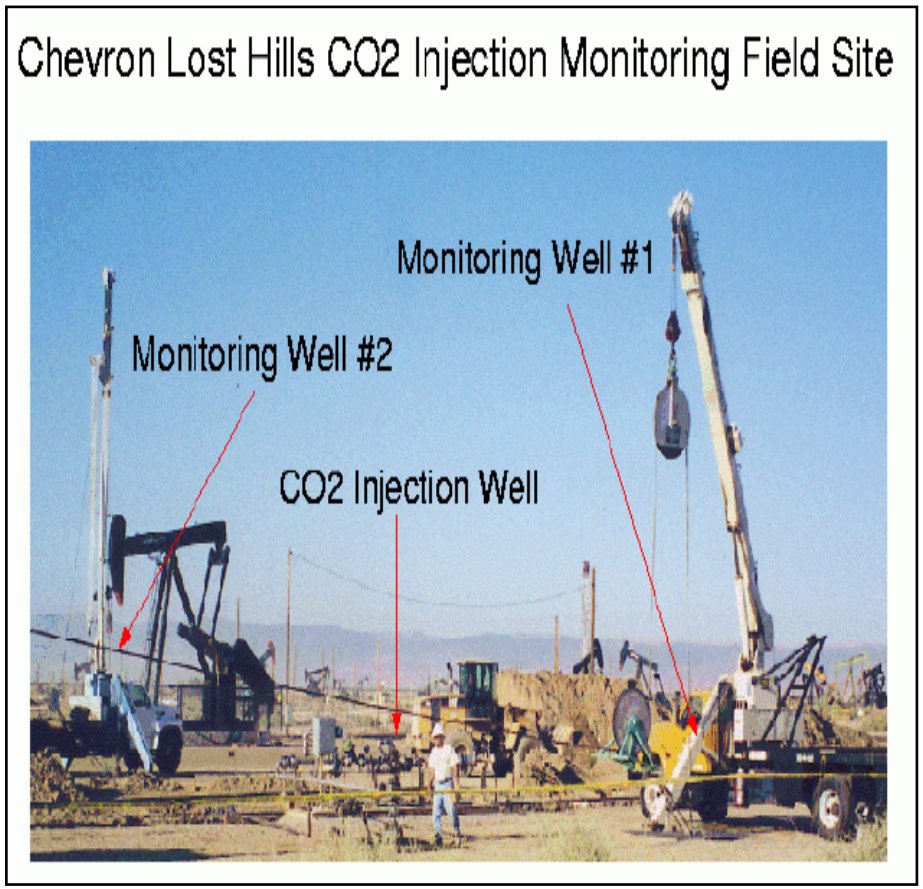


Field Pilot Demonstrations Will Emphasize All Program Components

- **Action plan will ensure proper evaluation of all possible activities within region and provide focus**
  - Technology demonstration
  - Monitoring and verification
  - Risk assessment
  - Regulatory definitions
  - Public outreach and education

Action Plan for Geologic Field Pilot Demonstrations

- EOR projects are best opportunities:
  - Elk Hills (Occidental)
  - Ventura (Shell/Aera)
  - Huntington Beach (Shell/Aera)
  - Prudhoe Bay (BP)



Action Plan for Terrestrial Pilot Demonstrations Will Target One Each In:

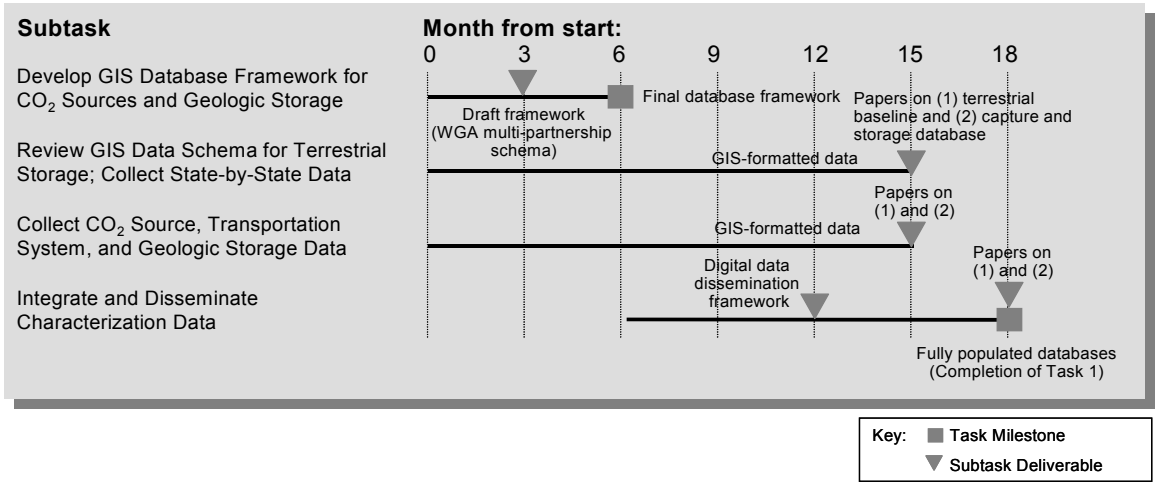
- **Oregon**
- **Washington**
- **Arizona**
- **California**

Phase I: Projected Deliverables

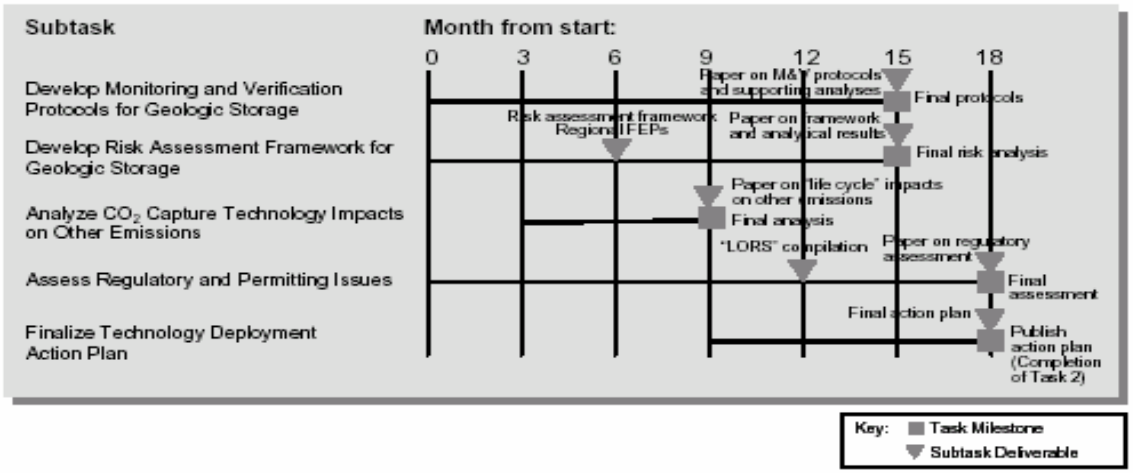
- Consolidated database of information on carbon sequestration, including sources, terrestrial and geologic sinks, and infrastructure
- Compilation and assessment of regulations
- Geologic risk assessment framework
- Assessment of impacts on other emissions
- Protocols for monitoring and verification
- Materials for a public outreach program
- Framework for comparison and selection of sequestration options, including economics (supply curves), capture technology, risk, etc.
- Selection and plans for demonstrations in Phase II

Task Schedules

Schedule, Milestones, and Deliverables for Task #1

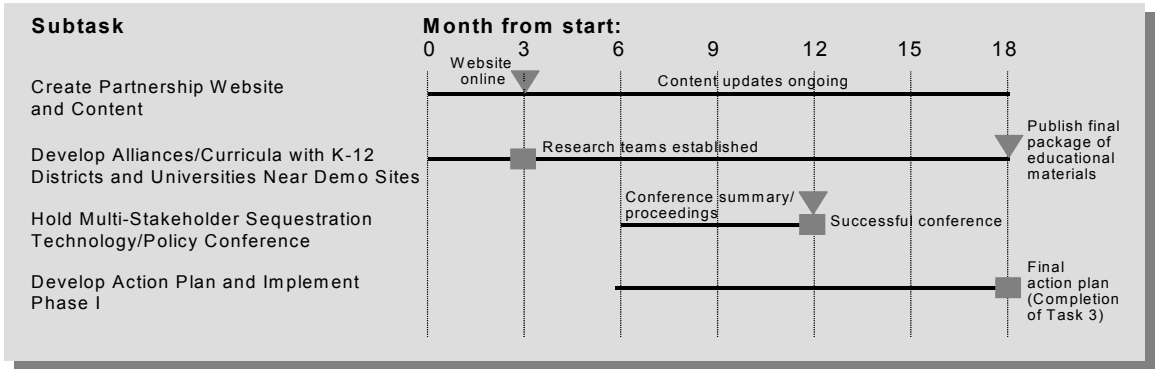


Schedule, Milestones, and Deliverables for Task #2



Task Schedules Cont'd

Schedule, Milestones, and Deliverables for Task #3



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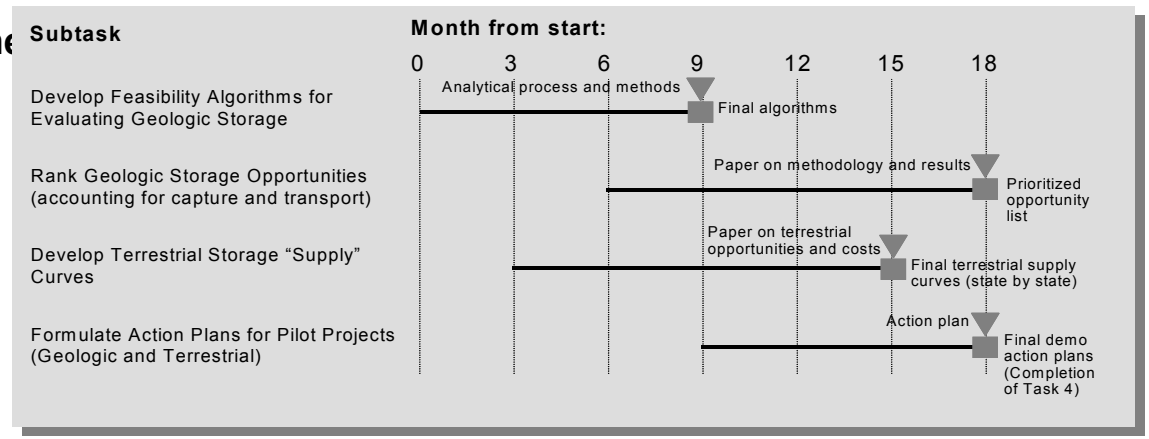

West Coast Regional Partnership Will Be A Springboard for Deployment of Technologies and Practices

- Determine suite of technologies best suited for region based on sources, sinks, and infrastructure
- Address regulatory issues and infrastructure needs for technology deployment
- Address public concerns proactively and develop educational materials to enhance public acceptance of technologies
- Identify least cost options associated with sequestration alternatives
- Evaluate environmental and public health risks and develop mitigation strategies

Our Commitment to the Team is Consistent With Explicit USDOE Goals

- Development of regional source/sink information will have intrinsic value to many organizations
- Work effectively with DOE and other regional partnerships to share information that enhances sequestration opportunities
- Development of a robust action plan can effectively support possible Phase II pilots

A Number of West Coast Partnership Members Are Here to participate in the Breakout Groups

Session 1: Regulation

Kelly Birkinshaw - CEC

Session 2: Outreach

Martha Krebs - Science Strategies

Session 3: Capture & Separation

John Ruby - Nexant

Session 4: Geology

Larry Myer (Facilitator) - UCOP

Session 5: Terrestrial

John Kadyszewski - Winrock

Session 6: GIS/Database

Richard Rhudy - EPRI

Dennis Goreham - Utah AGRC