

# Geologic Carbon Sequestration as an Approach to Emissions Reduction & Benefit to Utah

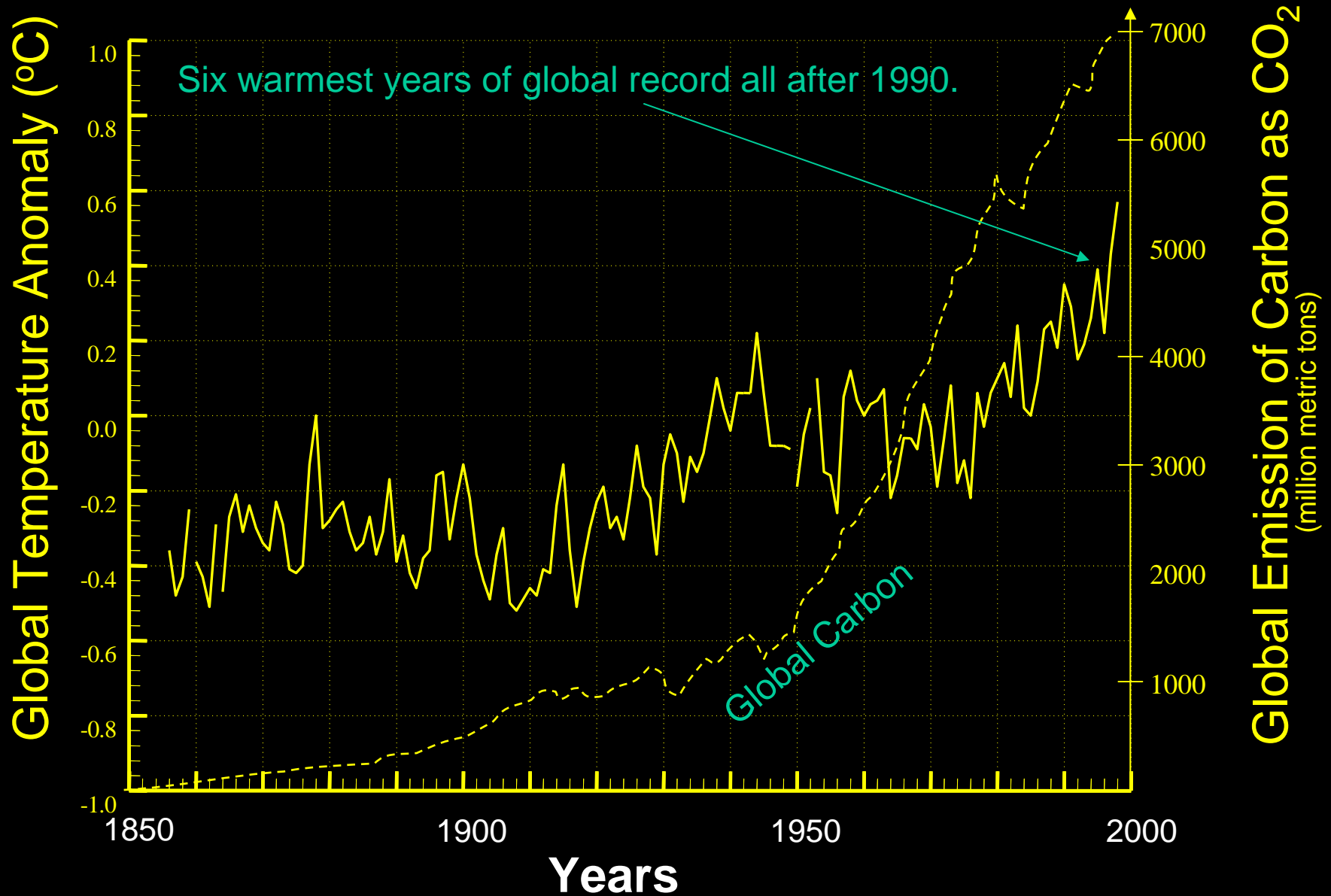


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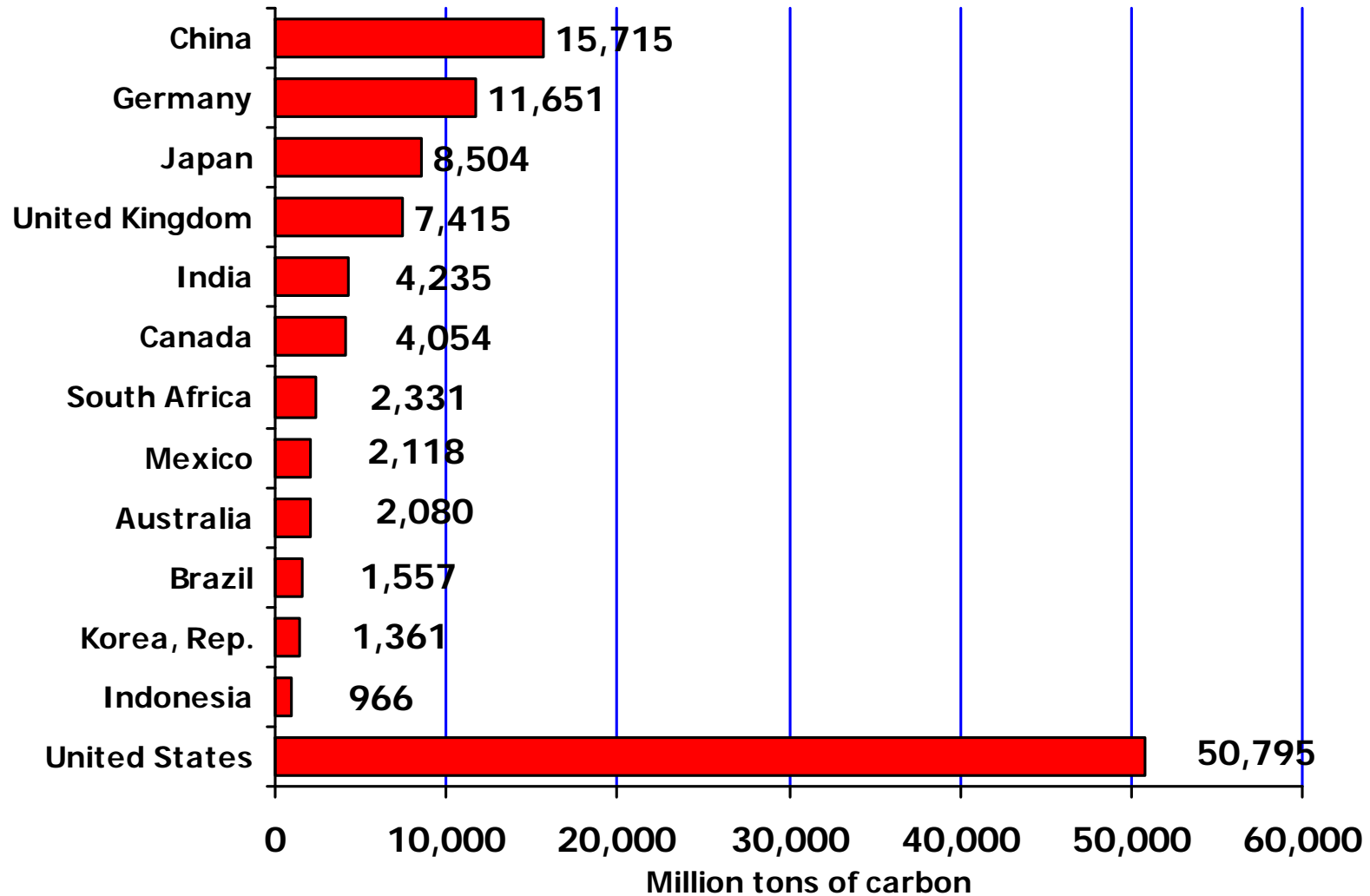
Acknowledgements:  
U.S. Dept. of Energy & NETL  
University of Utah



# Premise: Enhanced Greenhouse Effect



## Context: Cumulative carbon emissions, 1950-1996



Data Source: Marland et al, 1999. Carbon Dioxide Information Analysis Center.

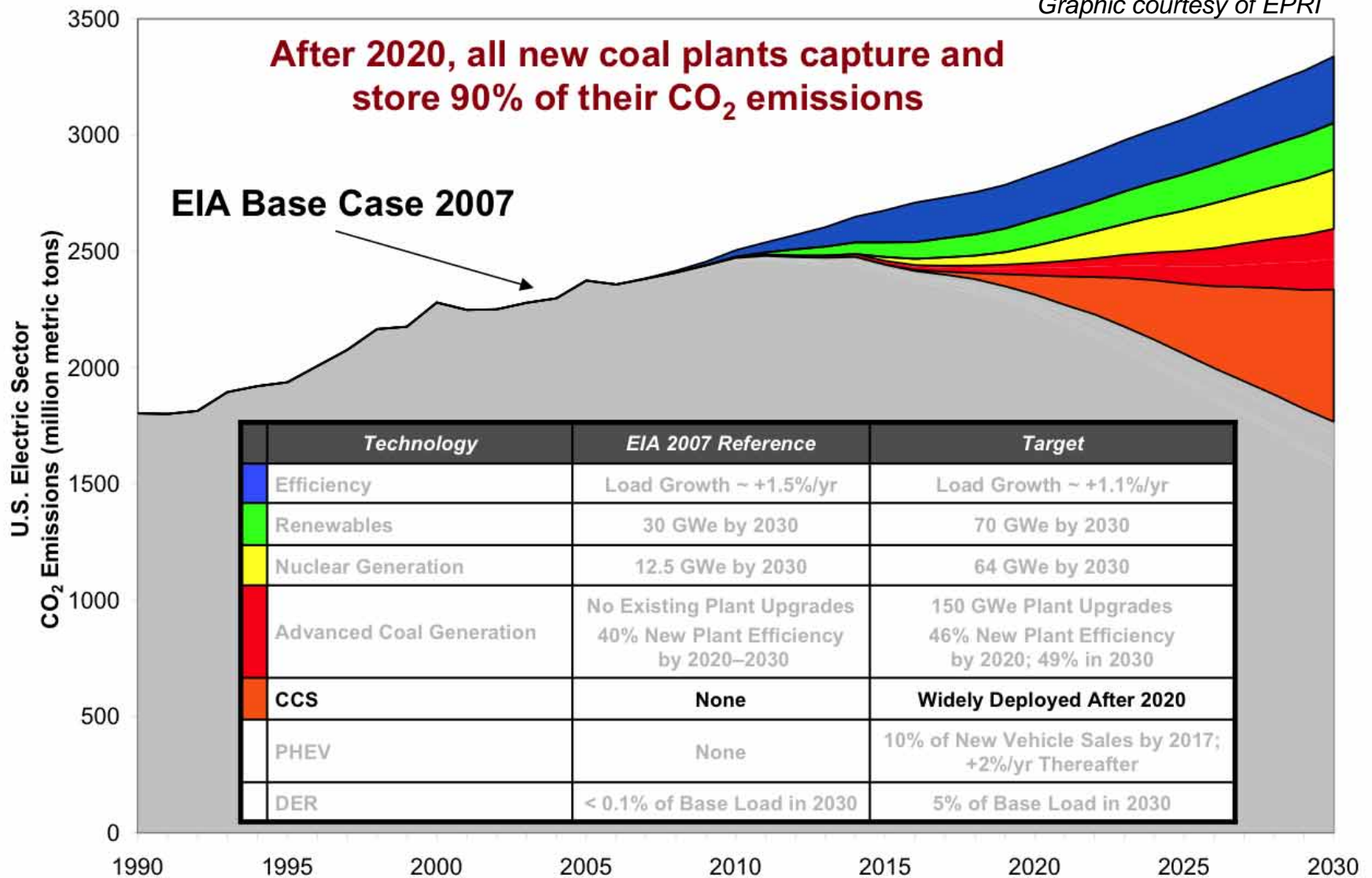
# Technology Deployment Targets: Electric Power Research Institute (EPRI)

<b>Technology</b>	<b>EIA 2007 Base Case</b>	<b>EPRI Analysis Target*</b>
<b>Efficiency</b>	<b>Load Growth ~ +1.5%/yr</b>	<b>Load Growth ~ +1.1%/yr</b>
<b>Renewables</b>	<b>30 GWe by 2030</b>	<b>70 GWe by 2030</b>
<b>Nuclear Generation</b>	<b>12.5 GWe by 2030</b>	<b>64 GWe by 2030</b>
<b>Advanced Coal Generation</b>	<b>No Existing Plant Upgrades 40% New Plant Efficiency by 2020–2030</b>	<b>150 GWe Plant Upgrades 46% New Plant Efficiency by 2020; 49% in 2030</b>
<b>Carbon Capture and Storage (CCS)</b>	<b>None</b>	<b>Widely Available and Deployed After 2020</b>
<b>Plug-in Hybrid Electric Vehicles (PHEV)</b>	<b>None</b>	<b>10% of New Vehicle Sales by 2017; +2%/yr Thereafter</b>
<b>Distributed Energy Resources (DER) (including distributed solar)</b>	<b>&lt; 0.1% of Base Load in 2030</b>	<b>5% of Base Load in 2030</b>

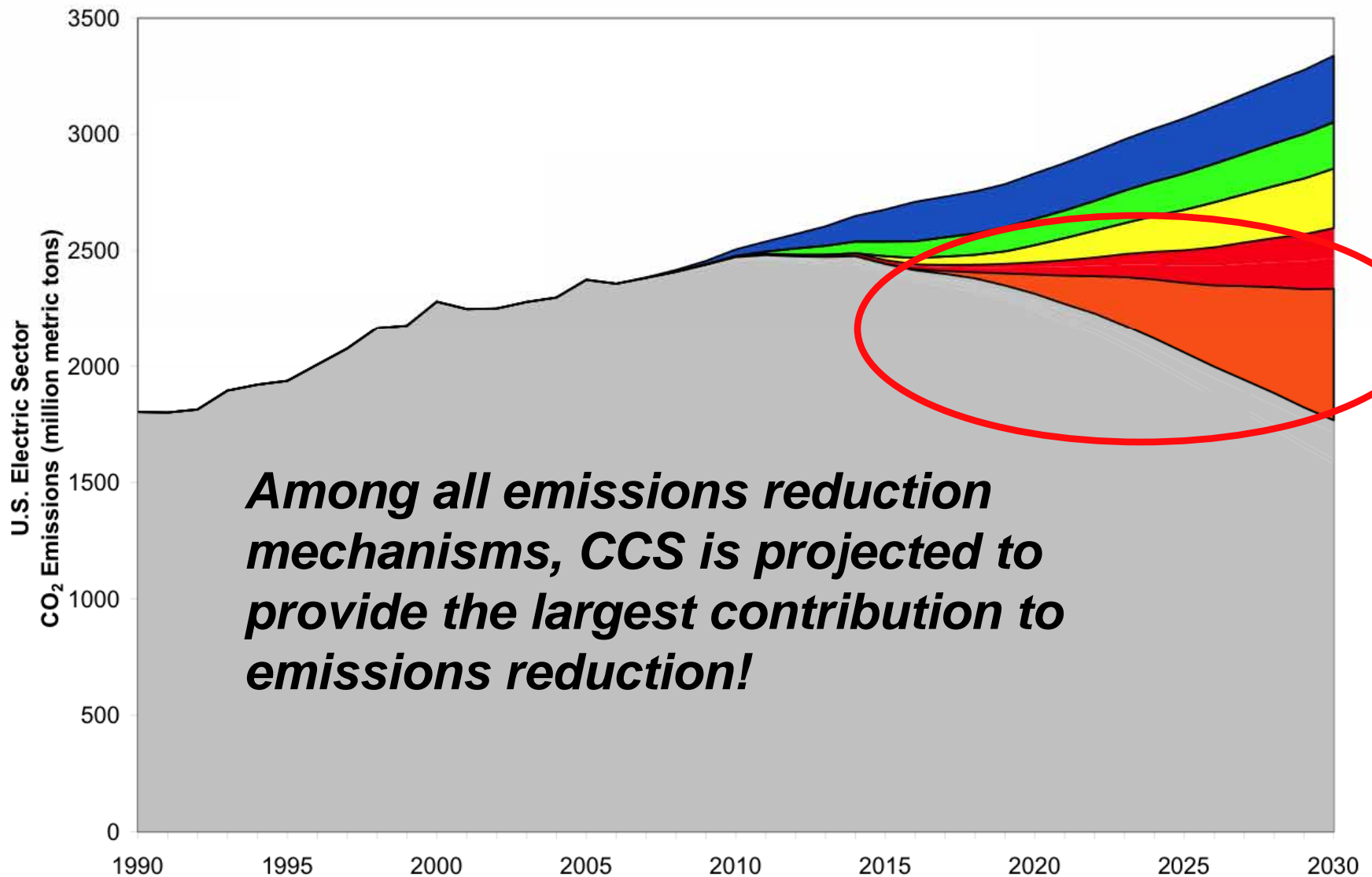
- EPRI analysis targets do not reflect potential regulatory and siting constraints. Additional economic modeling in progress

# Benefit of Achieving the CCS Target

Graphic courtesy of EPRI

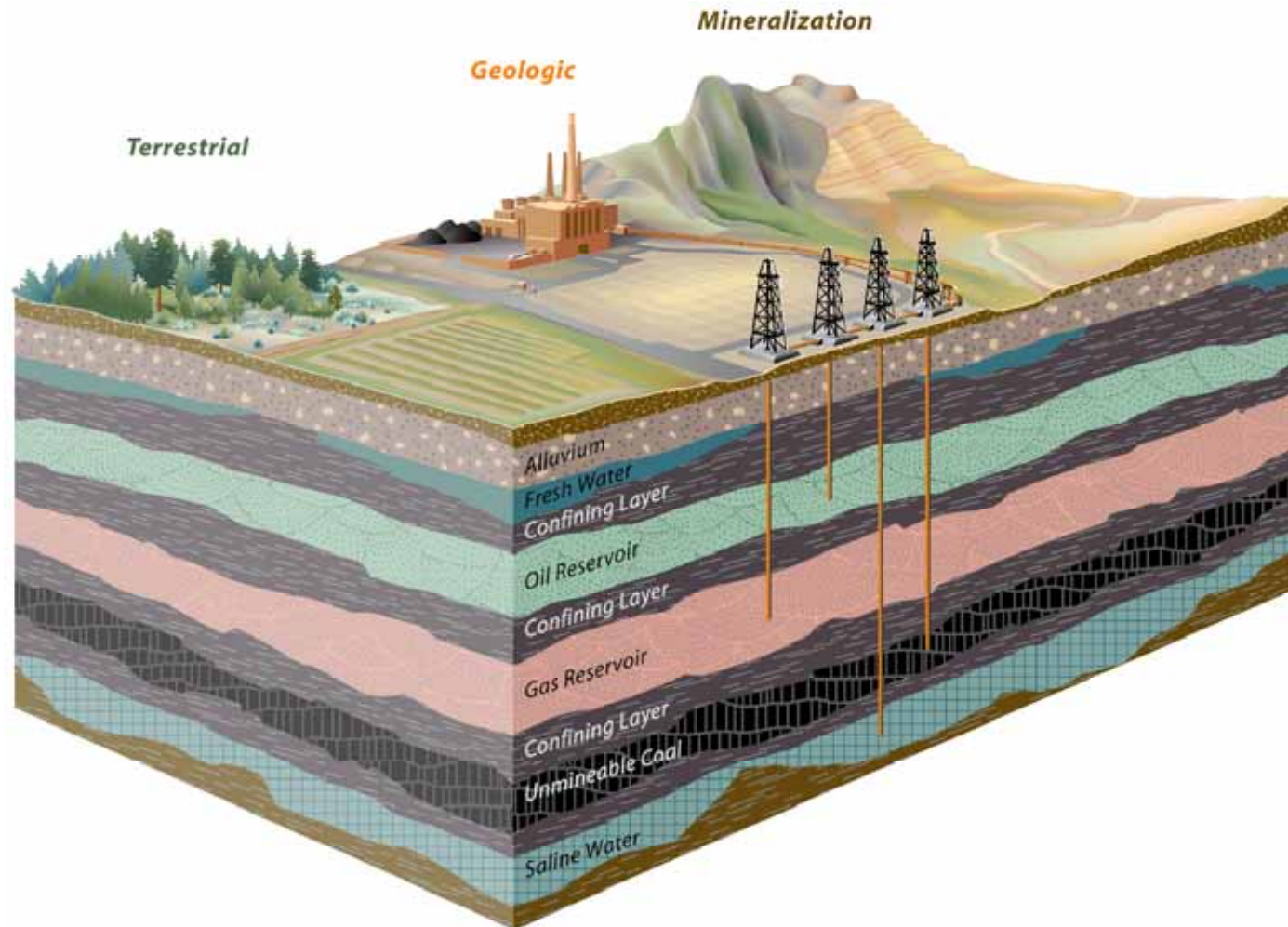


# Benefit of Achieving the CCS Target



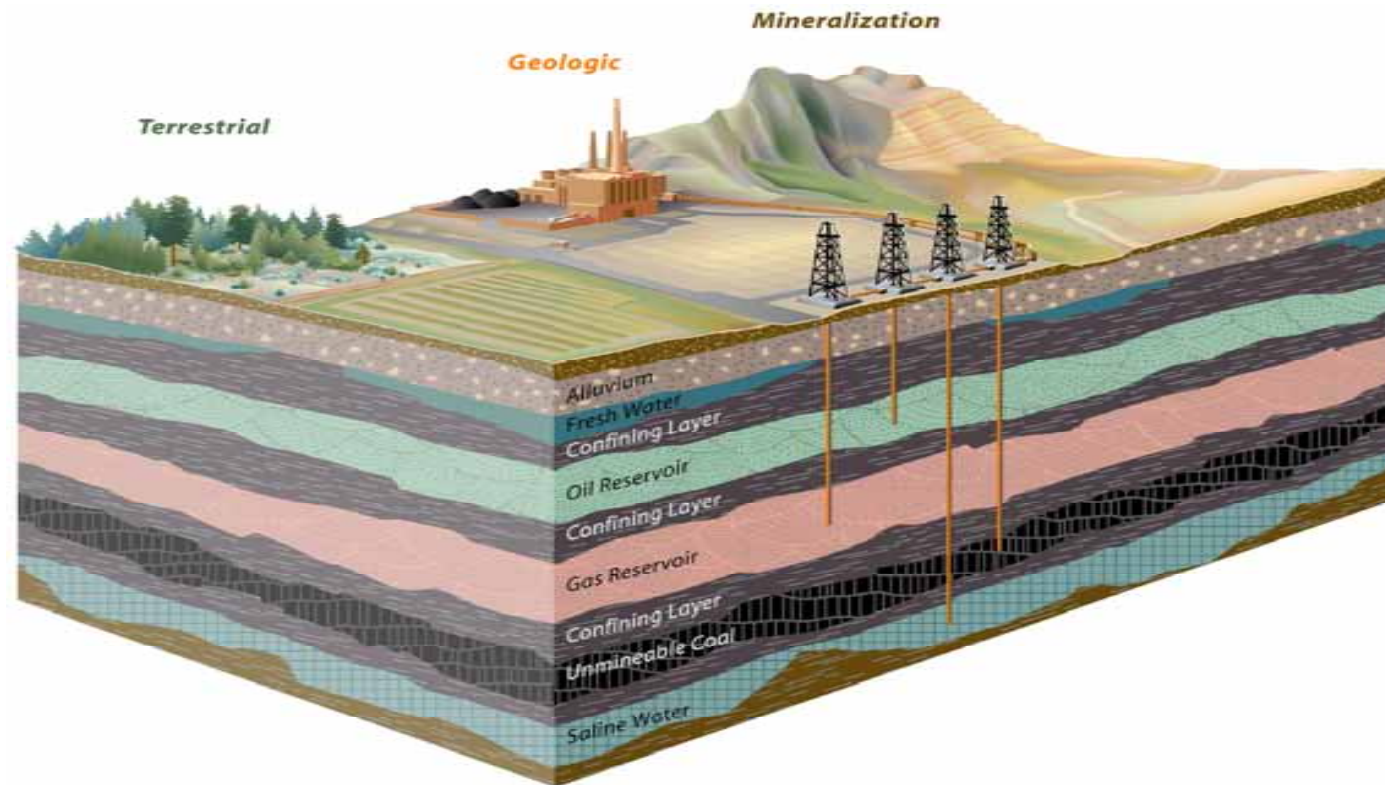
# Approach: CO<sub>2</sub> Storage or “Sequestration”

***Fossil fuels are here to stay for the next several decades...***



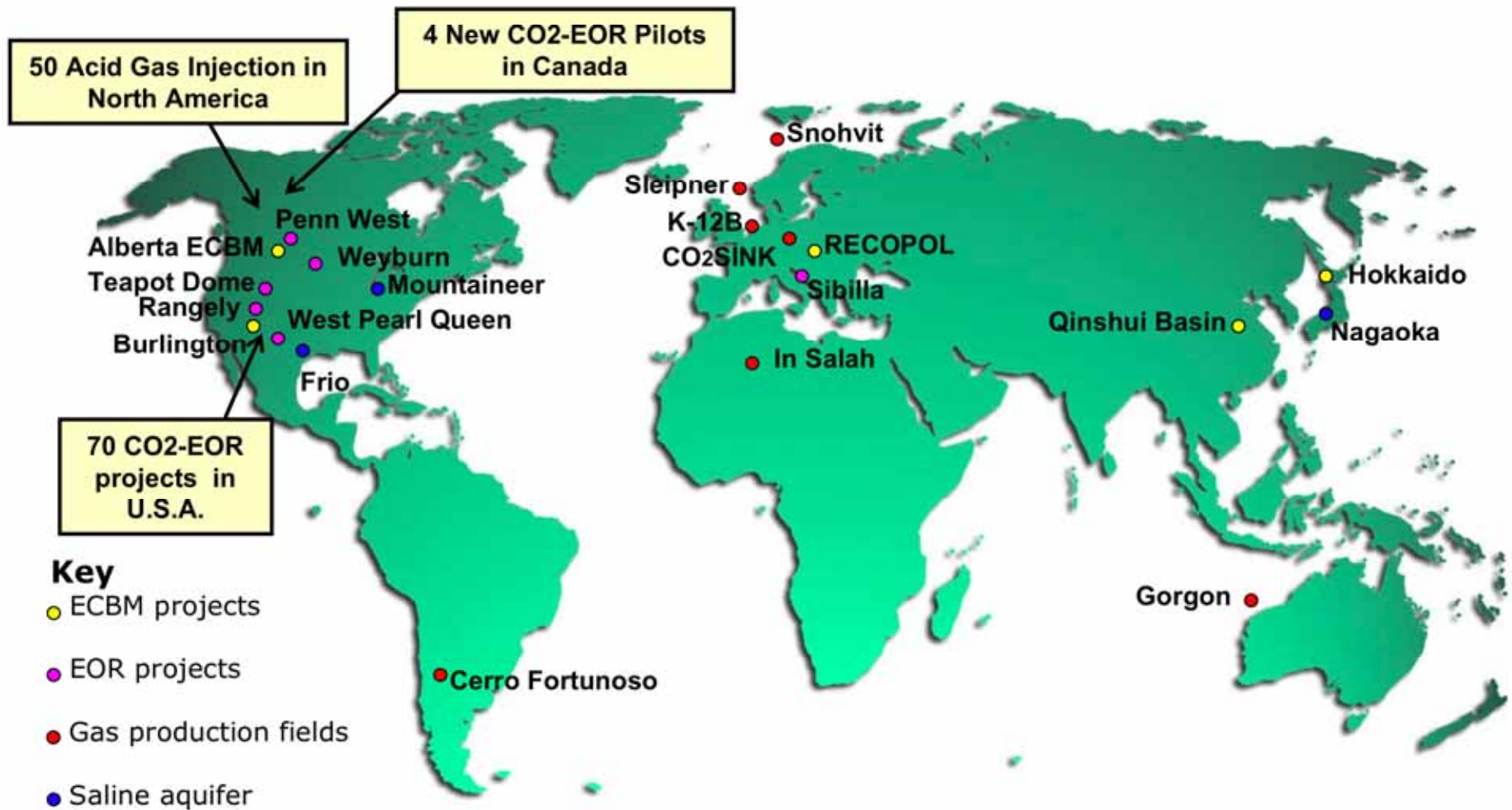
What is sequestration? Capture CO<sub>2</sub> at sources and store it permanently away from the atmosphere.

# Approach: CO<sub>2</sub> Storage or “Sequestration”



- In U.S., the state of California just passed legislation (AB 32) that limits carbon emissions from new power plants to 1100 tons/MW hour.
- Following this law, many utilities and other companies initiated sequestration programs.

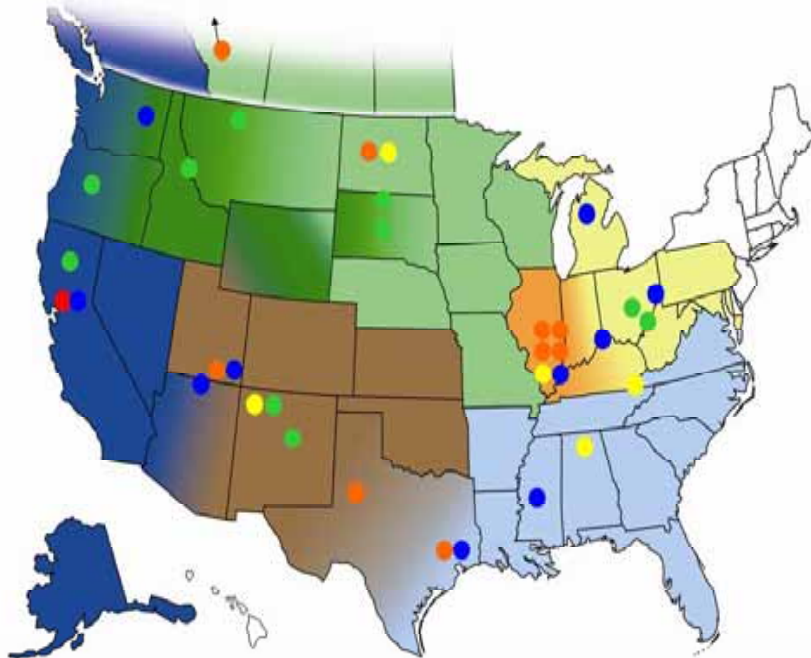
# Worldwide CO<sub>2</sub> Storage Demonstration Projects



Map Courtesy of IEA Greenhouse Gas R&D Programme

# U.S. Carbon Sequestration Partnerships

## 7 Partnerships:



## 3 Phases:

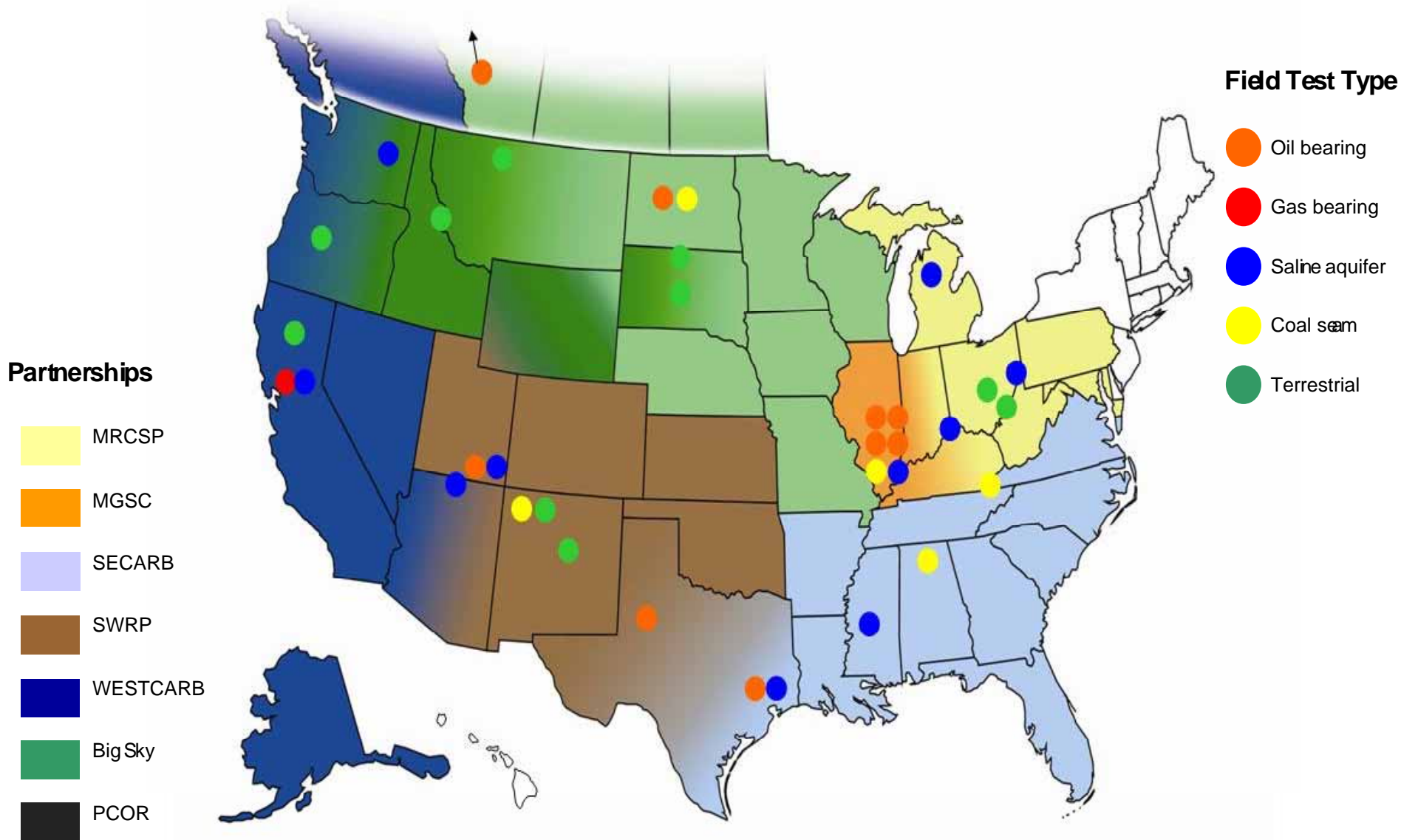
**Phase I: Characterization (2003 – 2005)**

**Phase II: Validation Testing (2005 – 2009)**

**Phase III: Deployment (2007 – 2017)**



# U.S. CO<sub>2</sub> Sequestration Projects Under Way



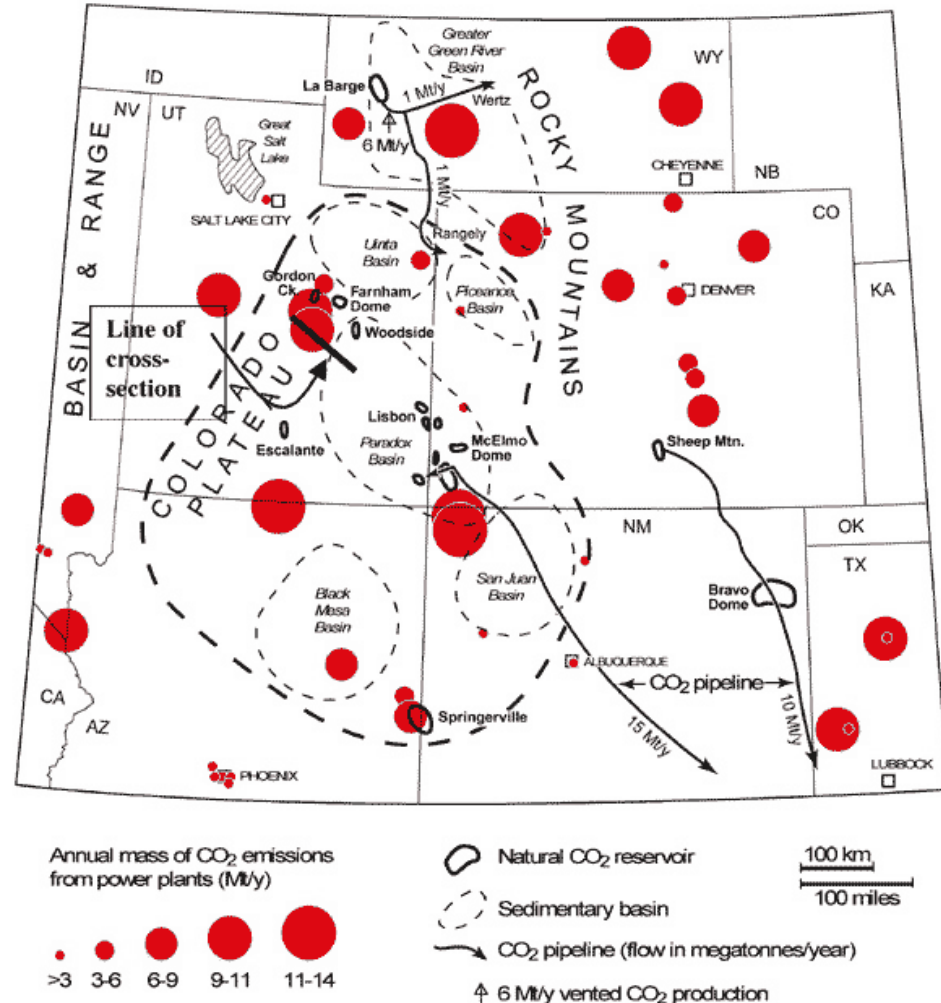
# CO<sub>2</sub> Sources in the Southwest

- electrical power plants
- cement & other plants
- urban centers
- non-point sources  
(agriculture, automobiles, etc.)

**Total regional point source emissions**  
**Over 350,000,000 tons/year**

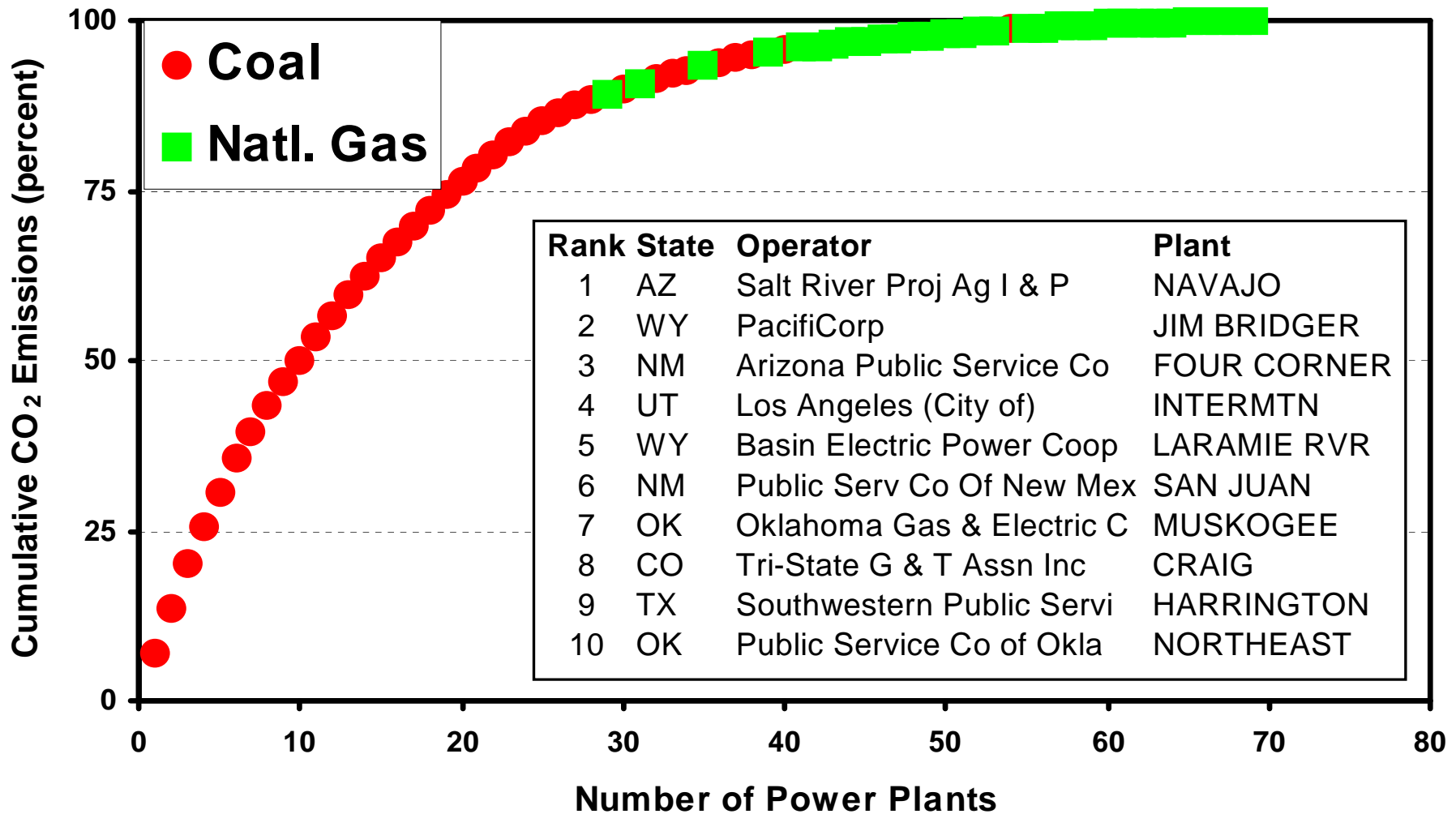
**In Utah, the amount of point source emissions is**  
**40,000,000 tons of CO<sub>2</sub> per year.**

Graphic courtesy of XXXXX



# A unique aspect of the region:

## 10 largest power plants in region contribute 50% of emissions!



# CO<sub>2</sub> Sinks in the Southwest: Deep Saline

Southwest Region Saline Formations

## Southwestern U.S. Inventory of Sources and Sinks (National Atlas)

### Minimum Deep Saline Field Capacities:

Arizona 92 Mtons

Colorado 3.8 Gtons

Kansas 10.6 Gtons

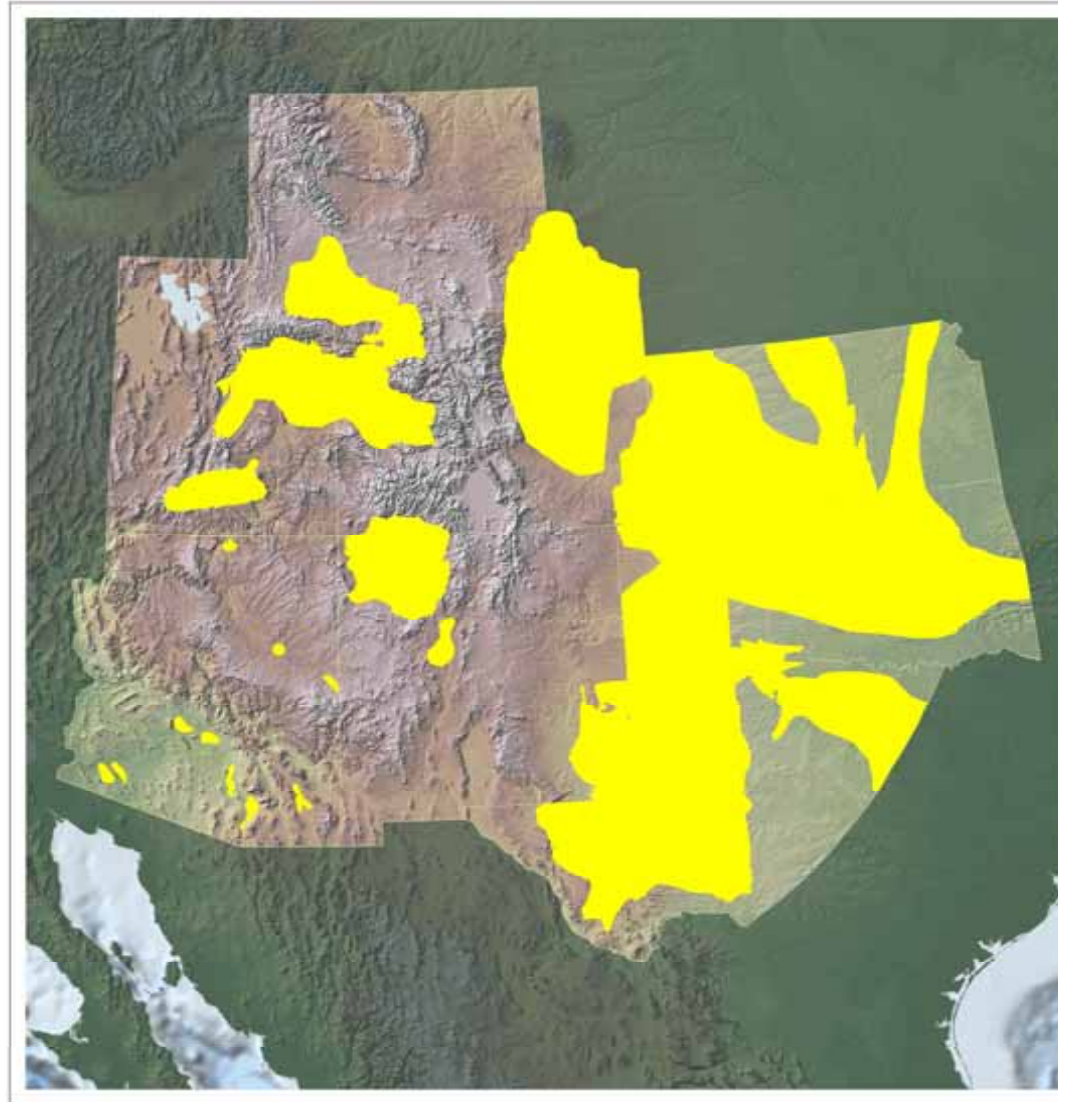
New Mexico 10 Gtons

Oklahoma 9 Gtons

Texas 48 Gtons

Utah 508 Mtons

Wyoming 507 Mtons



# CO<sub>2</sub> Emissions vs. Sequestration Capacity

## EXAMPLE: Utah Emissions & Capacity

Sources : **40 million tons** CO<sub>2</sub> per year

### Utah's CO<sub>2</sub> Sinks and Capacities:

Oil and Gas Reservoirs

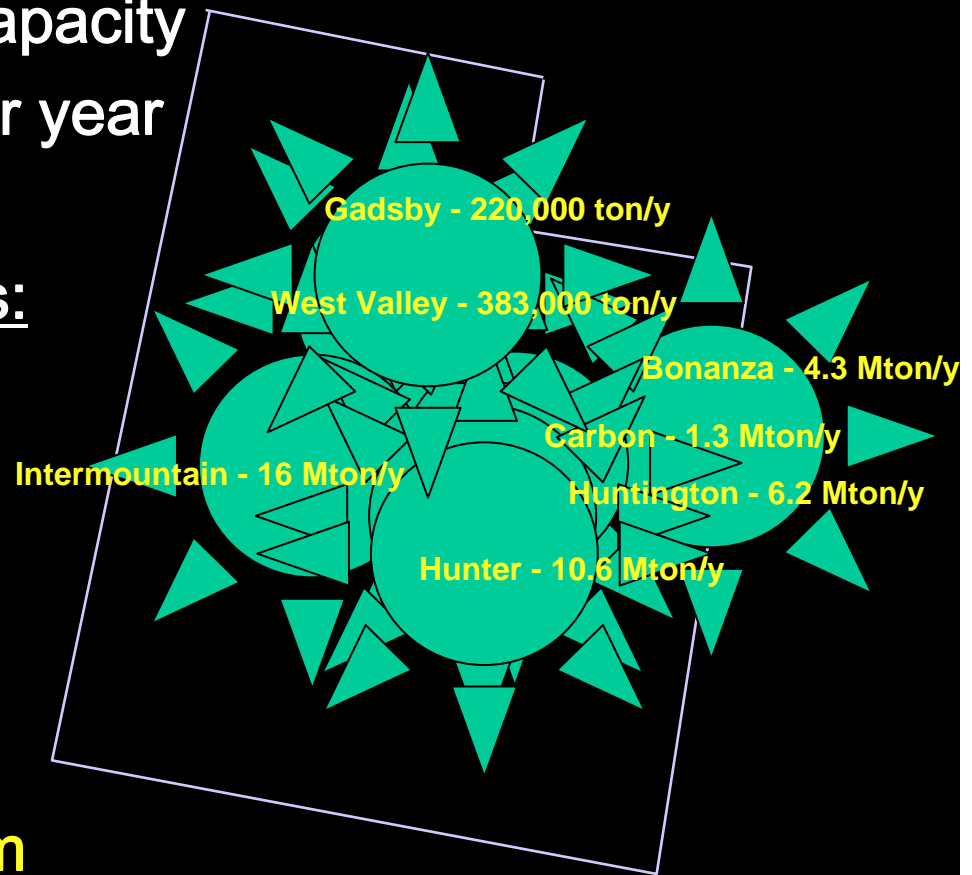
**1400 million tons minimum**

Un-mineable Coal Seams –

**120 million tons minimum**

Deep Saline

**Over 500 million tons minimum**



**Thus, the minimum storage capacity  
in Utah is equivalent to over  
50 years of its emissions!**

# Recommendation

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A recommendation for sequestration in western states:

***The best opportunities are deep saline formations underneath oil and gas fields.***

- in most cases, regulatory requirements are already established
- surface and subsurface ownership and mineral & water rights established
- the infrastructure of oil and gas fields provides tremendous monitoring options
- reduces concerns associated with leakage from abandoned wells, because few wells penetrate these deeper formations

# Challenges: What will CCS cost?

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- I. Cost – whether taxes or cap-and-trade market – of sequestration must be factored in.
  
- II. What will it cost the consumer?
  - For a traditional coal-fired power plant, cost-of electricity (COE) is ~5 cents per kilowatt-hour.
  - Add capture and sequestration to this plant, and COE increases to ~8 cents/kilowatt hour.
  - For a new coal gasification plant, COE without capture is about ~5 cents per kilowatt-hour.
  - Add capture and sequestration, and COE increases to about ~6 cents/kilowatt hour.

# New Business & Benefit to Utah!

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1. Global temperatures are increasing.  
Atmospheric CO<sub>2</sub> concentration is increasing.
2. Geologic CO<sub>2</sub> capture and storage (CCS) is one of many needed approaches to reducing emissions, but in the short term it will provide the greatest reduction.
3. CCS is an entirely new industry on the horizon!
4. What does CCS mean for Utah? Emissions reduction, new business, economic stimulation.
5. A new commercial-scale CCS demonstration in Utah is starting right now.

