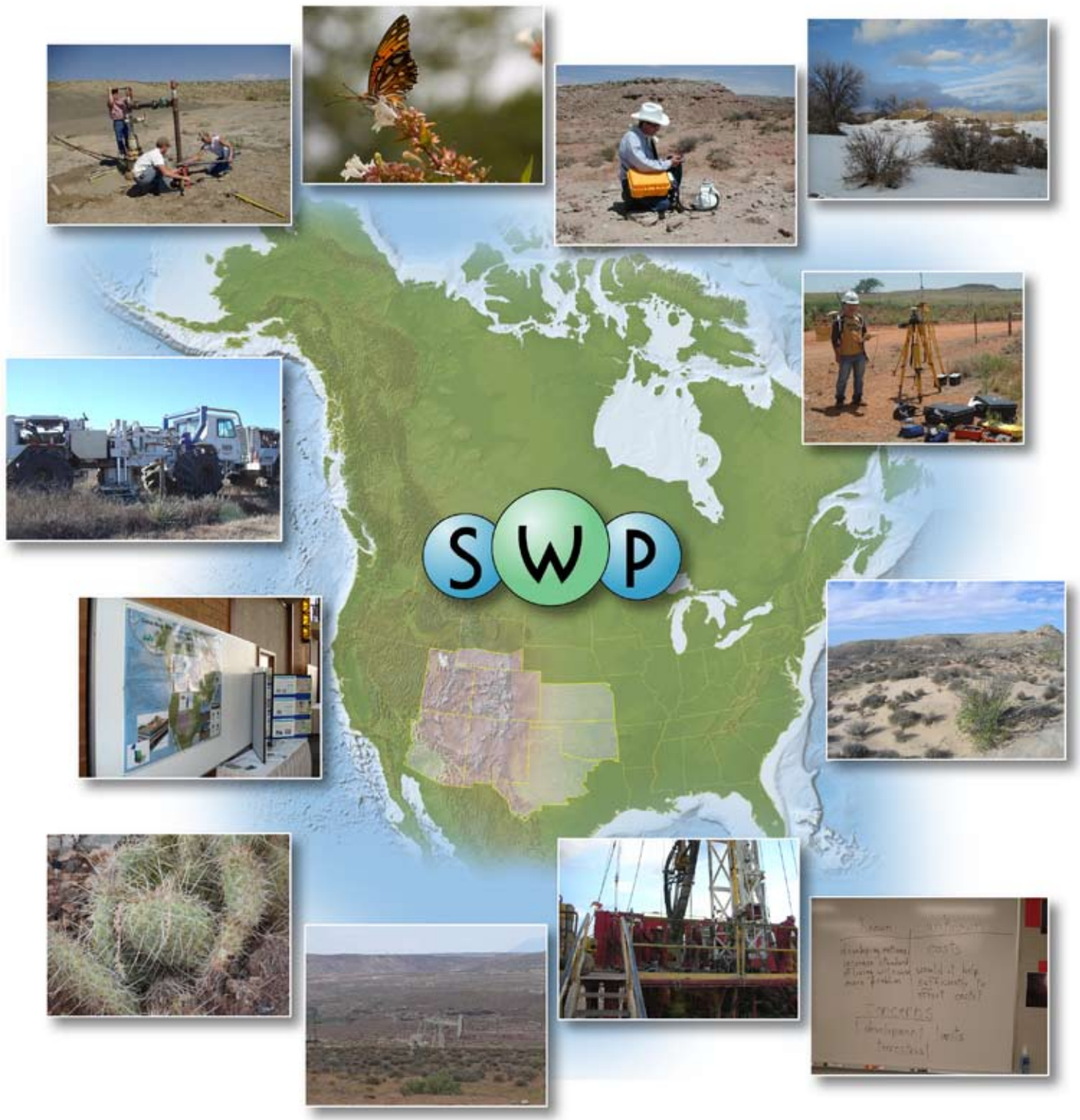


Southwest Regional Partnership on Carbon Sequestration

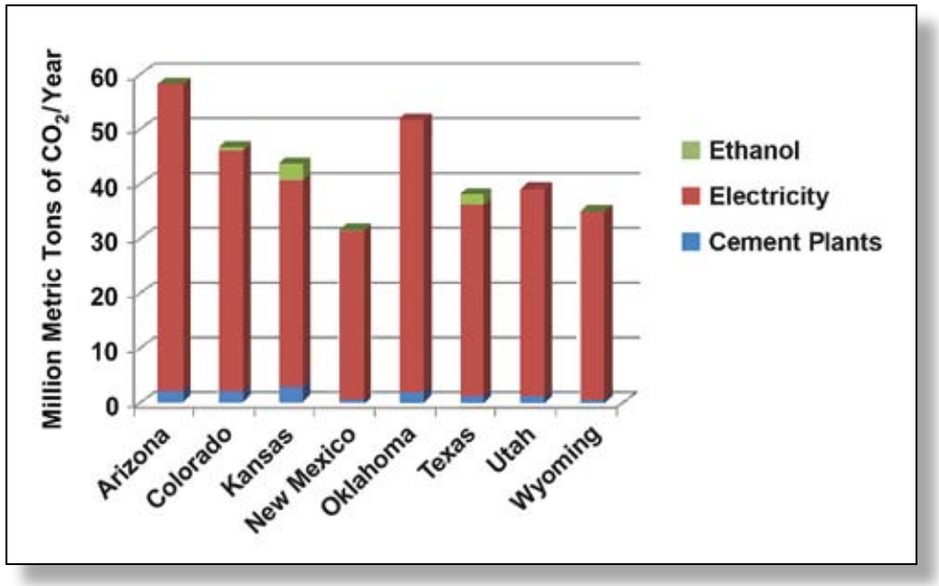
The Southwest Regional Partnership on Carbon Sequestration (SWP) was created to advance early commercial opportunities for the use of CCS systems, which are compatible with most existing energy infrastructures, and therefore have potential to be a least-cost option to mitigate CO_2 emissions contributing to global climate change. A growing body of governments, corporations, and public-private partnerships support CCS deployment, which has been endorsed by the international scientific community and a number of environmental non-governmental organizations (NGOs). Furthermore, an increasing number of companies recognize CCS as a potentially profitable line of business.

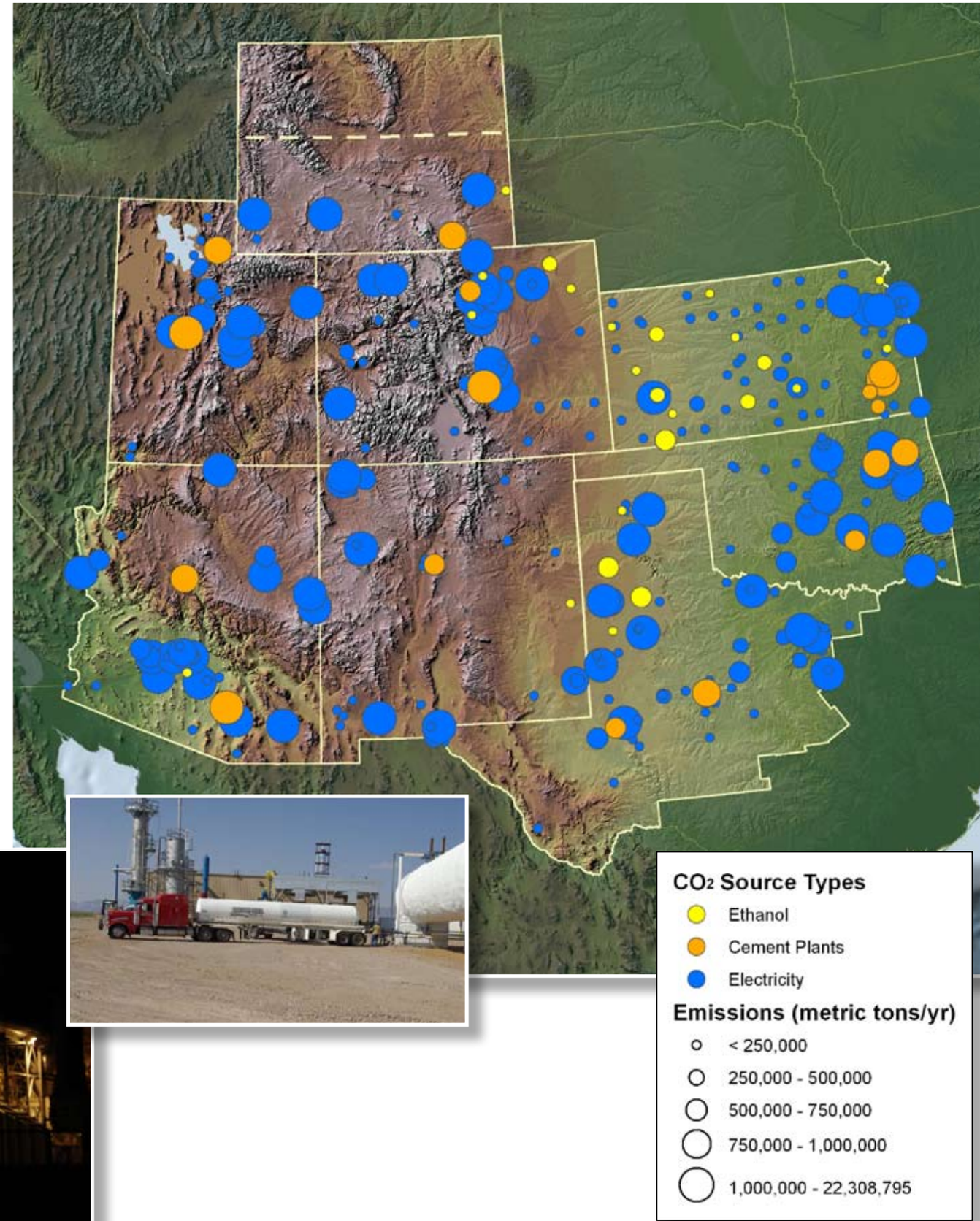
SWP is composed of a diverse group of experts in geology, engineering, economics, public policy, and outreach. These groups use their expertise to assess sequestration technologies to capture carbon emissions, identify and evaluate appropriate storage locations, and engage a variety of stakeholders in order to increase awareness of carbon sequestration. Stakeholders in this project are made up of private industry, NGOs, the general public, and government entities. There are a total of 44 current organizations represented in the Partnership including electric utilities, oil and gas companies, state governments, universities, NGOs, and tribal nations.

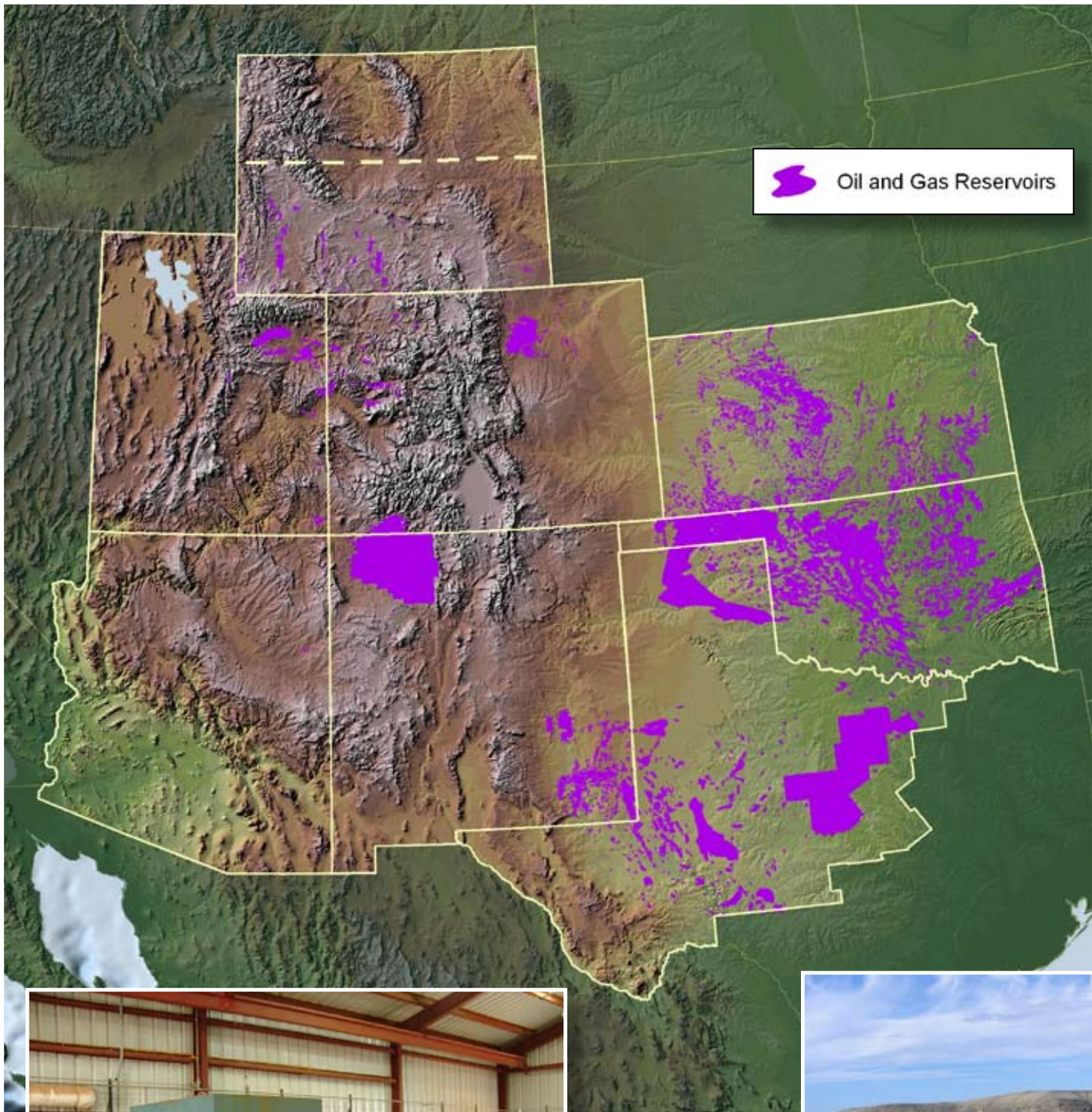
The SWP is coordinated by New Mexico Tech and encompasses New Mexico, Arizona, Colorado, Oklahoma, Utah, and portions of Kansas, Nevada, Texas, and Wyoming. Field test sites for the region are located in New Mexico (San Juan Basin), Utah (Paradox Basin and Farnham Dome), and Texas (Permian Basin).

SWP CO_2 Sources

The SWP Region is energy-rich and possesses one of the largest population and energy-production growth rates in the Nation. Two major CO_2 pipeline networks transport more than 27 million metric tons (30 million tons) per year of natural, subsurface CO_2 from southern Colorado and northern New Mexico to petroleum fields in the Permian Basin of Texas and New Mexico, where it is used for EOR. The 10 largest coal-fired power plants in the Region produce about 127 million metric tons (140 million tons) of CO_2/yr. Other stationary sources include natural gas processing plants, refineries, ammonia/fertilizer plants, ethylene and ethanol plants, and cement plants.







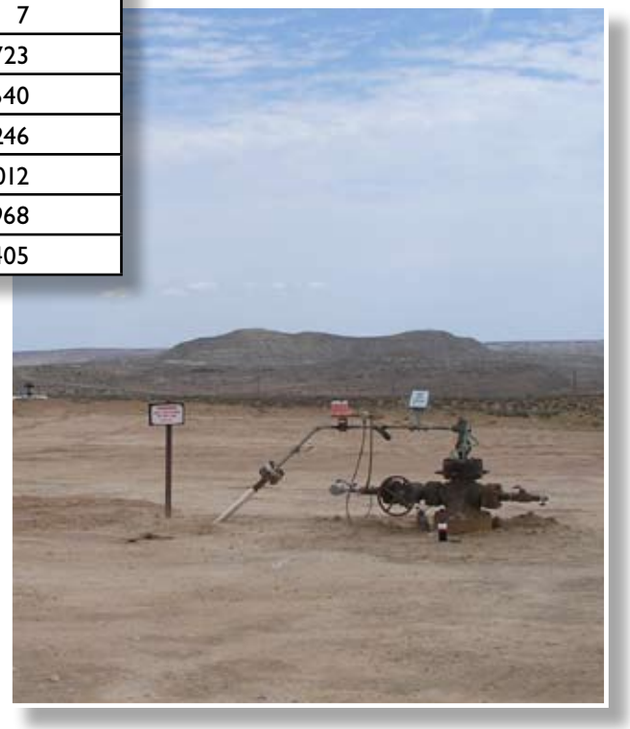
SWP Oil and Gas Reservoirs

The Aneth oil field, discovered in 1956, is among the largest in the nation. The Aneth field is located in the Paradox Basin of southeastern Utah. Aneth is a stratigraphic trap with fractures and minor faults, and covers approximately 16,800 acres. The field has produced about 149 million barrels of an estimated 421 million barrels of original oil in place. The pilot test site is located within the Aneth mound complex, which formed on a weak structural nose. The present day maximum structural relief of 150 feet is largely the result of differential compaction. The primary CO_2 sequestration test target is the Pennsylvanian Desert Creek and overlying Ismay members of the Paradox formation, the primary producers in the Greater Aneth Field.

In Texas, the SACROC oil field produces from Pennsylvanian-age strata. SACROC lies along a trend of fields described as the Horseshoe Atoll Play. Target sequestration reservoirs in SACROC include the producing Pennsylvanian carbonates.

Oil and Gas Reservoir CO_2 Storage Resources by State (million metric tons)

State	CO_2 Storage Resource
Arizona	7
Colorado	1,723
Kansas	1,640
New Mexico	8,246
Oklahoma	10,012
Texas	41,968
Utah	1,405

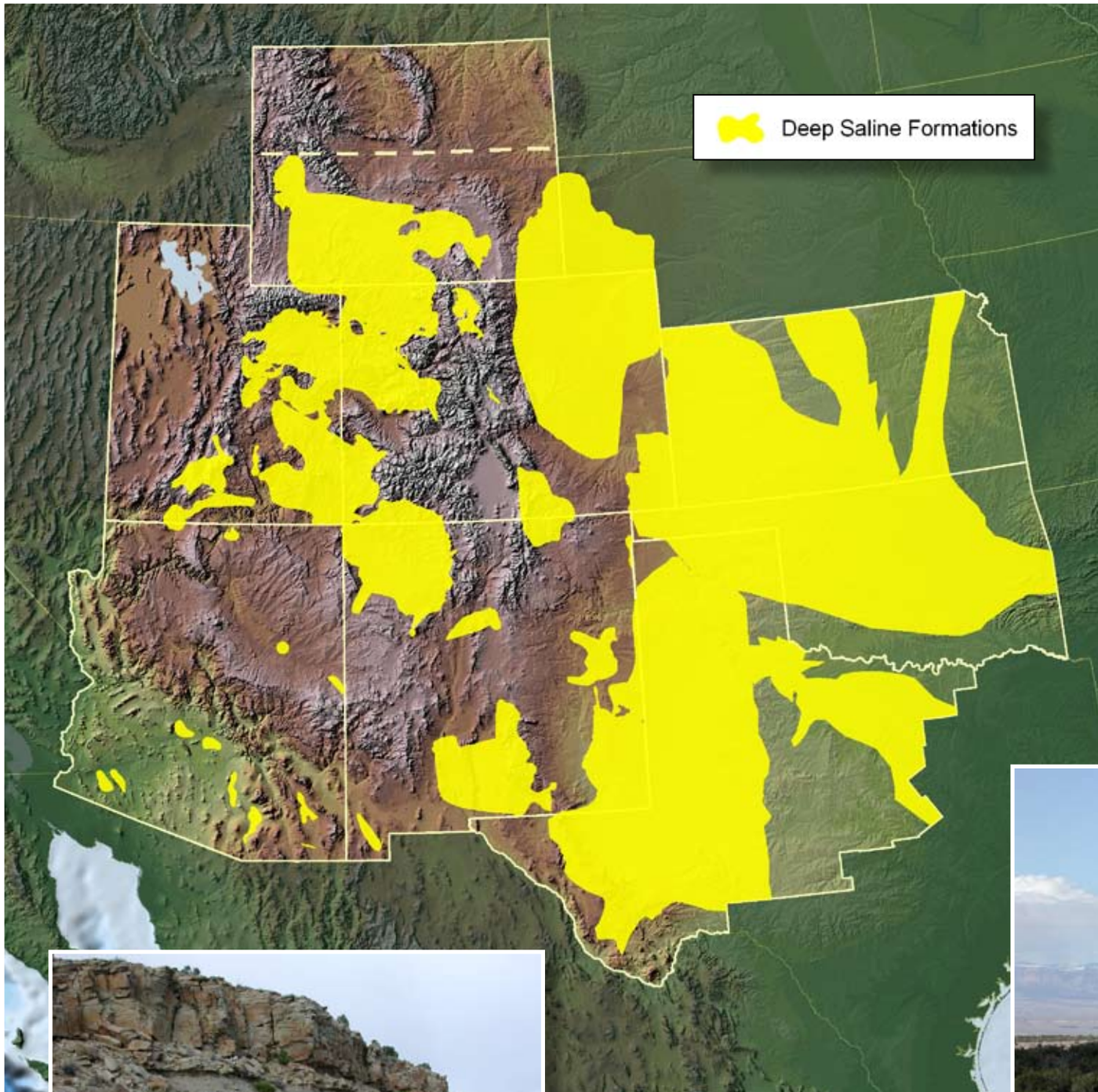


SWP Coal Seams

The San Juan Basin in New Mexico is one of the top ranked basins in the world for CO_2 coalbed sequestration due to (1) advantageous geology and high methane content; (2) abundant anthropogenic CO_2 from nearby power plants; (3) low capital and operating costs; (4) well developed natural gas and CO_2 pipeline systems; and (5) local companies with CBM and ECBM expertise. Because of its enormous coal storage resource, the San Juan Basin offers a tremendous sequestration opportunity with value-added natural gas production. An extensive CO_2 infrastructure is already in place, making the area ready for future operations.

The coals in the Basin fairway area are of exceptionally high permeability. Due to the tendency of coal to swell when in contact with CO_2, high initial coal permeability is required to maintain high CO_2 injection rates over time. Maintaining high injectivity is an important requirement for large-scale, low-cost CO_2 sequestration in coal.

Coal Seam CO_2 Storage Resources by State (million metric tons)		
State	Low CO_2 Storage Resource	High CO_2 Storage Resource
Arizona	0.1	0.1
Colorado	489.3	857.3
Kansas	2.1	8.4
New Mexico	75.4	301.8
Oklahoma	1.8	7.4
Utah	30.5	122.1
Wyoming	194.3	777.2

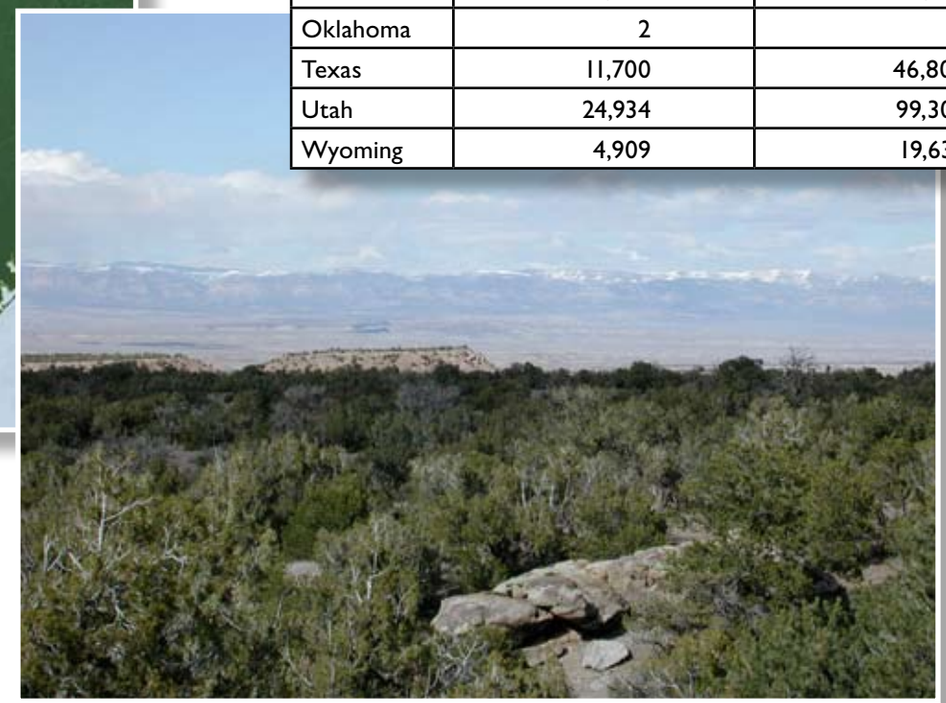


SWP Saline Formations

Farnham Dome, an elongated surface anticline located along the northern plunge of the San Rafael uplift and the southwestern edge of the Uinta Basin, contains numerous saline formations for large-scale CO_2 injection. Commercial-sequestration target formations for this site include many Jurassic and older formations. Specific targets for testing include the Permian White Rim sandstone and the Jurassic-Triassic Wingate sandstone. Saline formations make up a large portion of the United States CO_2 storage resource (estimated at 919 billion metric tons [1,013 billion tons]), with the added benefit of being in close proximity to CO_2 stationary sources.

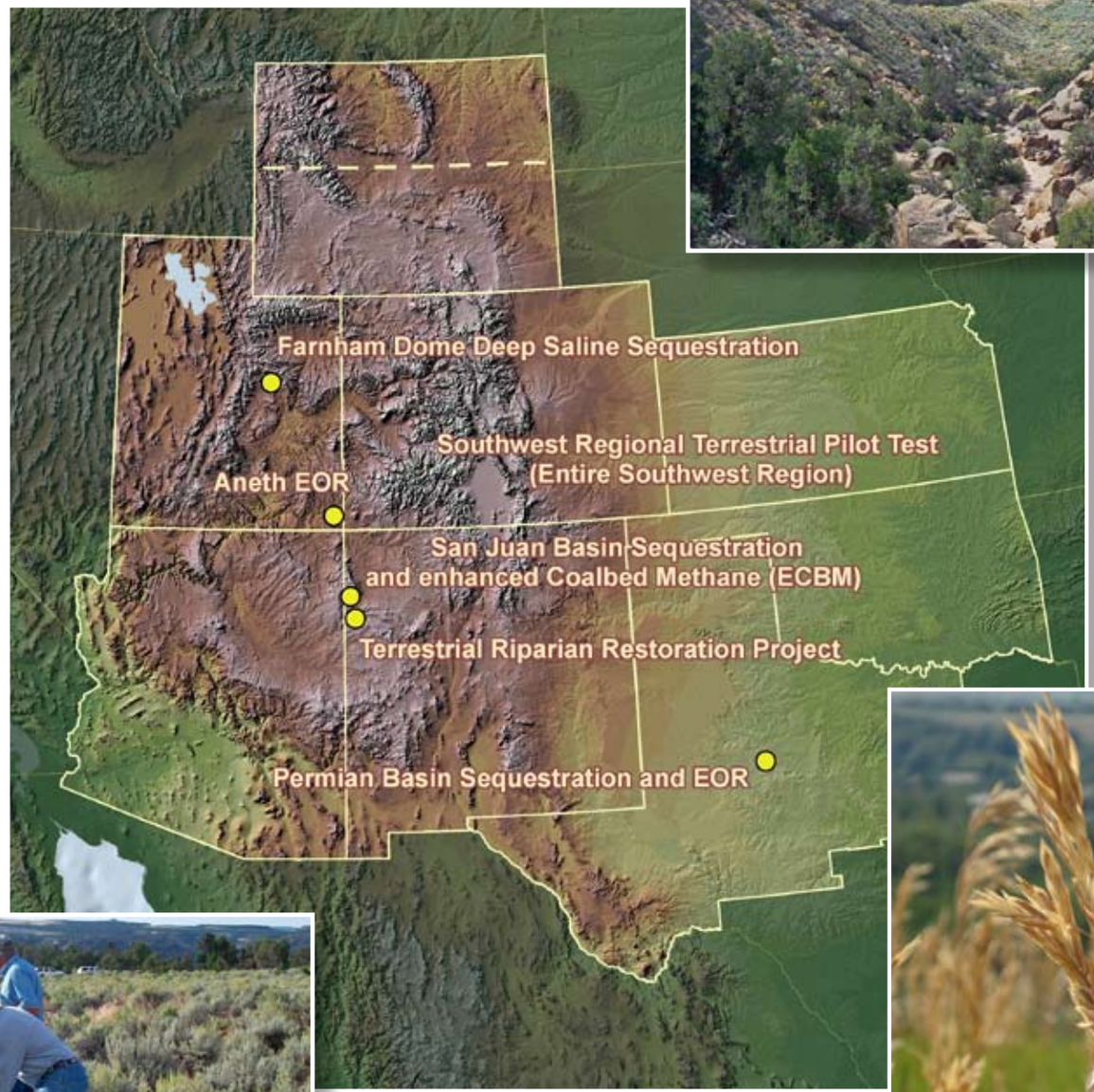
Saline Formation CO_2 Storage Resource by State (million metric tons)

State	Low CO_2 Storage Resource	High CO_2 Storage Resource
Arizona	199	752
Colorado	18,828	75,313
Kansas	8	9
Nebraska	87	348
New Mexico	33,054	132,215
Oklahoma	2	9
Texas	11,700	46,800
Utah	24,934	99,305
Wyoming	4,909	19,636



SWP Terrestrial Opportunities

In conjunction with the SWP's ECBM sequestration test, a terrestrial pilot test is being conducted in the San Juan Basin. ECBM operations are notorious for producing huge volumes of water. This water source could potentially be desalinated and used for irrigating a riparian restoration project, forming a combined ECBM – terrestrial sequestration project. Though the desalination process is an expensive one, the BLM and ConocoPhillips are both interested in making beneficial and environmentally-friendly use of the produced water. Rangelands in the San Juan Basin of New Mexico are a plausibly large reservoir for carbon, in addition to their value as recreational lands. The challenges to achieving the rangelands' potential lie primarily in the limited growing conditions and reduced capacity for recovery. Optimizing carbon storage in soils and vegetation while increasing the value of other ecosystem services requires a two-pronged strategy: enhancing existing and reintroducing woody plant species along riparian areas, and reestablishing native grasses and shrubs in upland areas. The limiting factor in both cases is water. A reliable source of water for agricultural irrigation, such as the water produced during ECBM production, could provide the necessary base for the reestablishment of native vegetation with a host of environmental benefits, as well as carbon sequestration. In addition to the terrestrial pilot test, the SWP is also conducting an extensive terrestrial analysis of the Region.



San Juan Basin, New Mexico—ECBM

San Juan Basin, New Mexico—Terrestrial

Paradox Basin, Utah—EOR

Permian Basin, Texas—EOR

SWP: Validation Phase Field Tests

San Juan Basin, New Mexico—Enhanced Coalbed Methane: The SWP is conducting the San Juan Basin ECBM field validation test in cooperation with ConocoPhillips. This test, begun in July 2008, will inject up to 35,000 tons of CO_2, to evaluate concomitant coalbed methane production and CO_2 storage optimization.

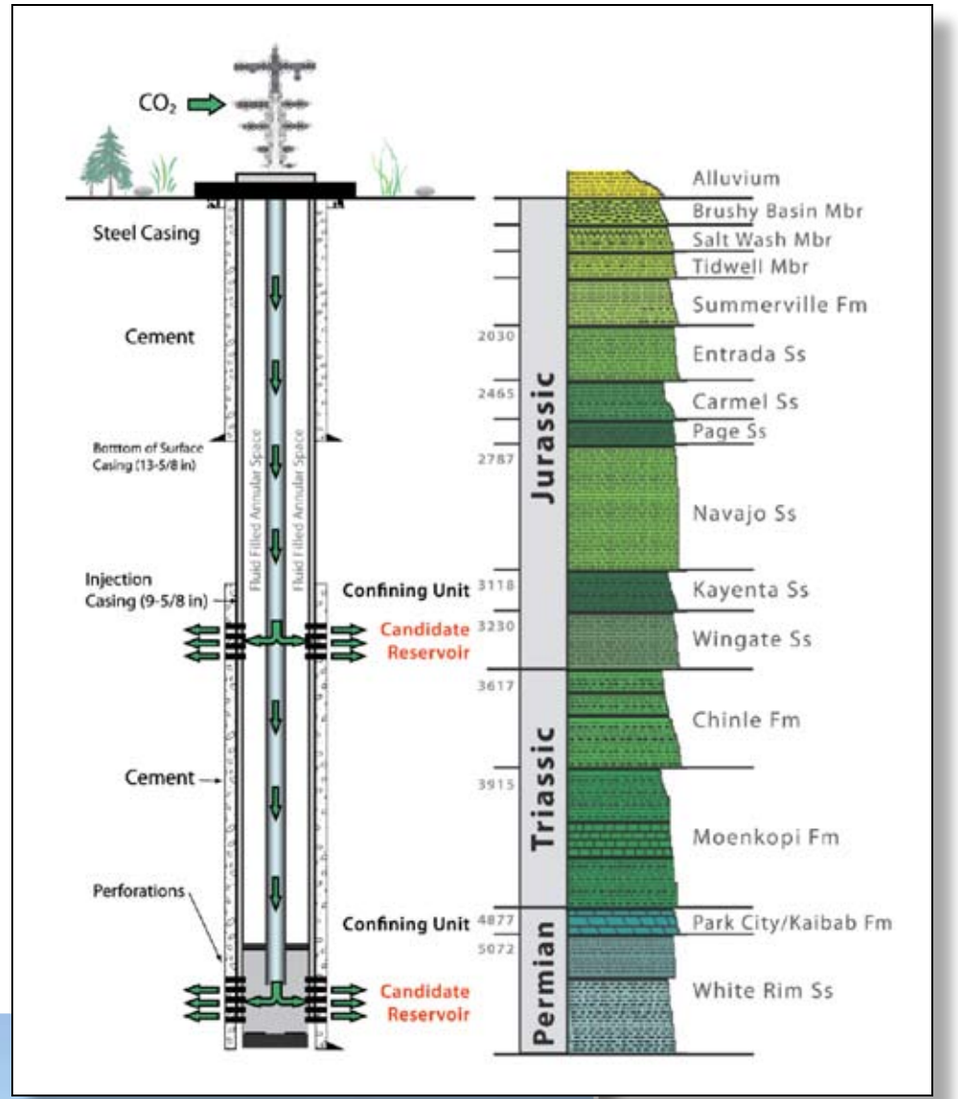
San Juan Basin ECBM Terrestrial Sequestration Pilot: The San Juan Basin ECBM project is also the location of one of the terrestrial sequestration pilot tests. Produced water from the ECBM project and other wells will be desalinated and applied to a drought-stressed riparian area—the interface between land and a flowing surface water body—where carbon storage will be monitored and evaluated.

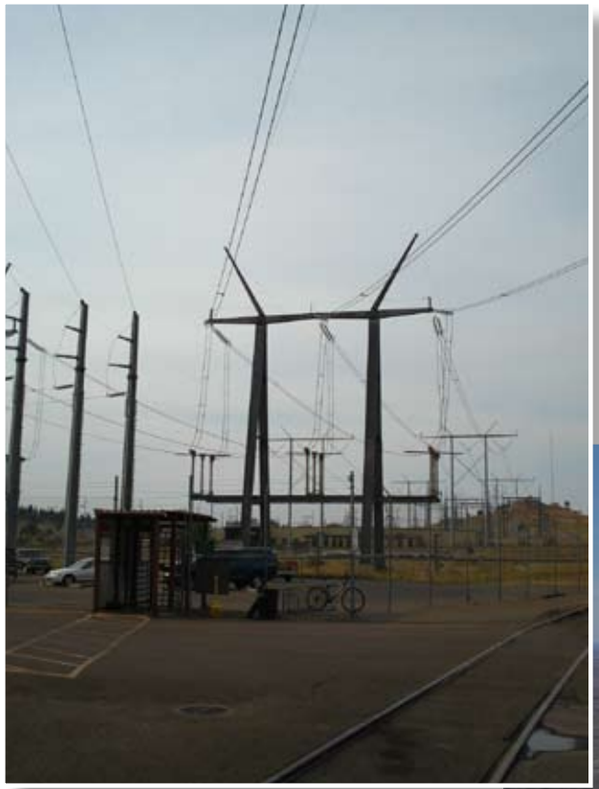
Paradox Basin, Utah—Enhanced Oil Recovery: At the Aneth oil field near Bluff, Utah, the SWP is conducting a CO_2 EOR storage test on an active CO_2 EOR site managed by Resolute Natural Resources Company and the Navajo Nation Oil and Gas Company. From August 2007 until September 2009, up to 136,000 metric tons (150,000 tons) of CO_2 will be injected per year over the 2-year period. Based on extensive geologic characterization and detailed reservoir models, SWP will design MVA protocols and conduct field studies.

Permian Basin, Texas—Enhanced Oil Recovery and Sequestration: The SWP is evaluating CO_2 EOR efficiency and CO_2 storage optimization at the SACROC field validation test site—a combined EOR/CO_2 storage operation—in cooperation with Kinder Morgan CO_2 Company, L.P. In late 2008, approximately 318,000 metric tons (350,000 tons) of CO_2 per year for 1 1/2 years will be injected. The geologies of Aneth and SACROC, both carbonate reservoirs, are similar, but their depth ranges vary, offering an opportunity to examine different hydrodynamic settings, which impact the flow and fate of CO_2 in the reservoir.

SWP: Development Phase Field Tests

Farnham Dome, Utah – Deep Saline Formation: In addition to the San Juan Basin, Paradox Basin, and Permian Basin projects, SWP has added a fourth test site for the Development Phase—Farnham Dome, located along the southwestern edge of the Uinta Basin in Central Utah. The SWP and its industrial partners, including Savoy Energy LLC, Rocky Mountain Power, Questar Gas, Southern California Edison, Pacificorp and others will test the effectiveness of deep saline formations for carbon sequestration capabilities. Mitigation planning and a rigorous risk assessment for the area are also important goals for the Farnham Dome site. Drilling of injection wells and monitoring wells will begin in mid-2009. Injection of CO_2 will continue into 2012 and will include injection of up to 1 million tons of CO_2 per year. Monitoring of the injection site will continue until at least 2017. The SWP is targeting saline formations, including deep Jurassic and older geologic strata. The SWP will test dual- injection intervals at the site, also called "stacked storage," to maximize capacity evaluation and optimize monitoring efficacy. Carbon dioxide from the Farnham Dome site will be transported to the Uinta Basin EOR market by pipeline. Potential future commercial opportunities associated with Farnham Dome CO_2 include enhanced oil recovery applications in the broader Uinta Basin.





SWP Opportunities for Commercialization

U.S. Energy and Economic Security

Fossil fuels are projected to remain a bastion of U.S. energy production for the rest of the 21st century. As the U.S. supply of oil decreases over time, the Nation will turn to other abundant domestic resources, such as coal and renewables, to minimize dependency on foreign oil and to ensure a reliable energy supply. Consistent, affordable energy supplies are linked to economic growth and prosperity. Energy is not a negotiable commodity—it is needed to run businesses, to power homes, and to transport goods. As new and enhanced domestic fossil fuel resources are developed, industry is challenged to mitigate on-site carbon emissions. CO_2, a by-product of fossil fuel combustion, is thought to contribute to global warming. As the threat of climate change becomes more apparent, the research community and governments are seeking ways to regulate CO_2 emissions at the source. The energy sector is a major contributor of greenhouse gases. In the Southwestern U.S., 95 percent of CO_2 emissions result from fossil fuel combustion and approximately one-half of those emissions are from power plants. Indeed, inexpensive and effective means to reduce CO_2 are necessary to ensure continued growth and development of new and enhanced fossil fuel-derived energy resources.

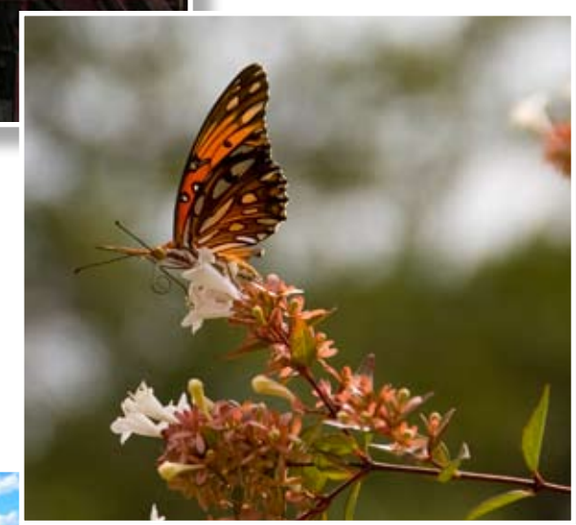
Market-based Opportunities

SWP is currently testing geologic and terrestrial CO_2 sequestration in the San Juan, Permian, and Paradox Basins as well as Farnham Dome, which reside in a major energy-producing region of the United States that includes abundant preexisting infrastructure suitable for sequestration activities. If the technology proves safe, reliable, and cost-effective, it will not only reduce the cost of regulatory-based CO_2 mitigation options, but substantial market penetration is anticipated within the next decade. This new technology offers the ability to develop an industry based on clean-burning oil, gas, and coal. With increasing support from industry and environmental constituents, CO_2 sequestration is now a catalyst for new, innovative ideas and investment capital. Funded in part by industry, state and federal governments, the advancement of this technology is expected to grow rapidly and eventually penetrate public and private energy sectors. Making way for new environmentally-friendly fuel resources, CO_2 sequestration technologies may provide a reliable, low-cost flow of energy for decades to come.

SWP Opportunities for Commercialization

Added Benefits to Industry

- Geologic carbon sequestration uses the same technologies that have been developed by the oil and gas industries. These technologies now provide an opportunity to offset carbon emissions through sequestration, allowing industry to prepare for or get ahead of anticipated state and federal regulations.
- Enhanced Oil and Gas Recovery: The injection of CO_2 into a geologic formation can enhance the recovery of hydrocarbons, providing value-added byproducts that can offset the cost of CO_2 capture and sequestration such as the recovery of oil or gas from a site that was not previously producing.
- Carbon sequestration in unmineable coal seams can enhance the recovery of methane gas because CO_2 promotes desorption which is needed for methane to separate from coal.
- Industry can accumulate carbon credits that can be traded on the global market.
- Close proximity to geologic repositories reduces transportation of CO_2 costs significantly.
- A market for sequestration is anticipated to develop when industries are mandated to offset their carbon emissions.
- Voluntary reduction of emissions and development of a market for sequestration provides industry in the Southwest an economically viable alternative to carbon emission mitigation as opposed to other propositions requiring extensive facility retrofit. Support of carbon sequestration technology also provides an alternative to policy makers who, in response to a growing demand for regulation, might support more stringent measures.



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