the ENERGY lab

PROGRAM FACTS

Strategic Center for Natural Gas & Oil

Enhanced Oil Recovery Program

The mission of the Enhanced Oil Recovery Program is to provide information and technologies that will assure sustainable, reliable, affordable, and environmentally sound supplies of domestic oil resources. The Strategic Center for Natural Gas and Oil (SCNGO) seeks to accomplish this critical mission by advancing environmentally responsible technological solutions that enhance recovery of oil from domestic reservoirs.

The Issues

Continued research is needed to find ways to improve recovery from mature fields with significant residual oil resources and from unconventional reservoirs where recovery is often low.

- Onshore domestic oil production is growing due to the development of tight oil and shale oil plays, but significant amounts of oil are being left behind in conventional reservoirs in mature oil fields, and enormous amounts of hydrocarbons remain locked in other unconventional reservoirs (oil shale, heavy oil, tar sands).
- Recovery of oil from tight reservoirs and shale formations, as a percentage of the original oil in place, remains low in most cases.
- Economic extraction of these resources will require research to provide a better understanding of the nature of these reservoirs, as well as new technologies for cost-effectively producing the oil. Yet the operators that are largely responsible for onshore domestic oil production are, for the most part, independent producers who do not invest in R&D.

In 2010, NETL demonstrated carbon dioxide flooding EOR in the Hall-Gurney field in Russell Kansas, using carbon dioxide recovered from a nearby ethanol plant.

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The need for scientific data collection and technology development is being driven by the following:

- Large volumes of residual oil remain in conventional oil reservoirs in mature fields. While enhanced oil recovery has been successfully applied in some areas where circumstances are favorable (e.g., CO_2 flooding in the Permian Basin), in many other areas, it remains just beyond reach. The development and demonstration of next-generation EOR technologies and new ways to apply existing EOR technologies can improve recovery efficiency and accelerate incremental production.

- Oil shale could be a game-changing resource in terms of U.S. energy security, but only if research can develop ways to generate oil from the shale's kerogen in ways that are energy-efficient and environmentally sustainable.

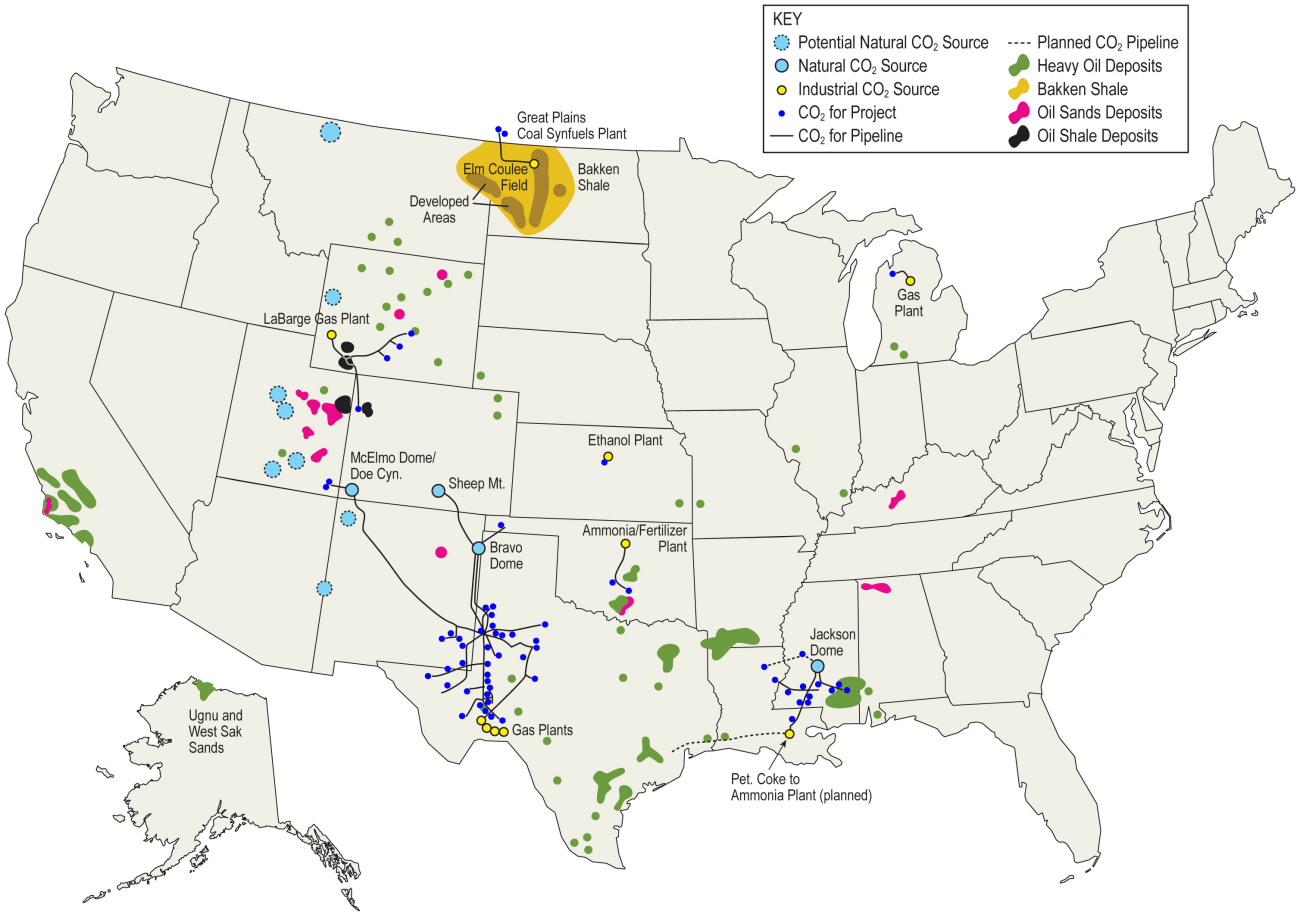
- Fractured shale reservoirs, such the Bakken shale in the Williston Basin of North Dakota, are currently being developed using a combination of horizontal drilling and hydraulic fracturing, but without the coordinated collection and evaluation of basic data, optimal development strategies may not be applied. Methods to increase recovery efficiency in oil reservoirs need to be developed and demonstrated.

- The unconventional resources located on Alaska's North Slope will require unique approaches to the problems posed by a combination of low temperatures, environmental sensitivity and unconventional oils (e.g., heavy or viscous crudes).

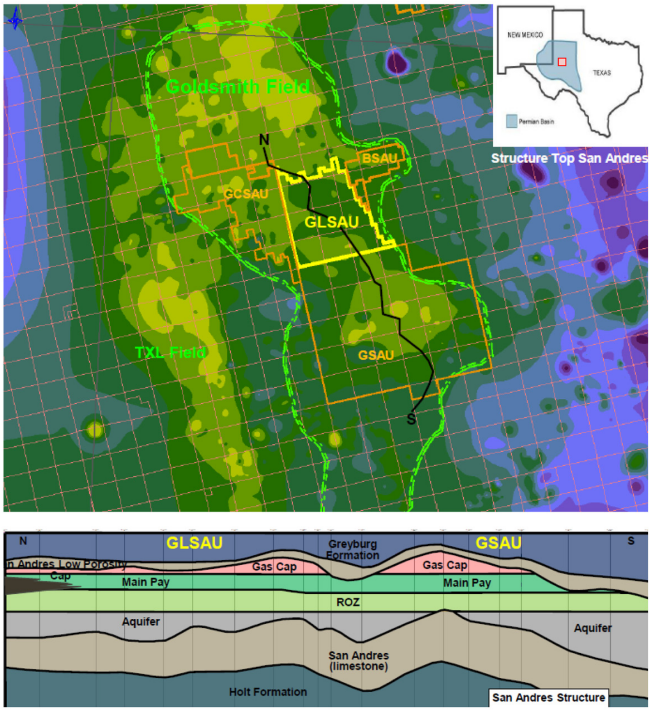
- In mature fields, small producers face challenges that are unique to scenarios of low productivity wells, high water cuts, aging infrastructure and tight regulatory constraints. These low margin operations are not targeted by large service company R&D efforts. However, relatively small investments in technology development and transfer could yield relatively large returns in terms of incremental production and delayed abandonments.

- Advanced computational tools, processes, and algorithms are needed to enhance production and minimize environmental impacts associated with development of the nation's unconventional fossil energy resources.

All of these challenges are the impetus behind the current portfolio of projects in the Enhanced Oil Recovery Program.



Location of current carbon dioxide EOR infrastructure and areas of development as well as domestic oil resources in unconventional reservoirs, including the fractured Bakken shale of the Williston Basin.



Structure map and cross-section of Goldsmith Field showing Goldsmith Landreth San Andreas Unit (GLSAU), the location of an ROZ CO_2 pilot project with a team led by U. of Texas – Permian Basin. The average ROZ thickness is 150 feet.

Project Portfolio Overview

There are 19 funded projects in the Enhanced Oil Recovery Program that are ongoing or were recently completed. These projects represent a total value of approximately $34 million. Fifteen of these projects are led by university researchers, one is led by industry specialists, two by scientists at national labs, and one by researchers at state government agencies.

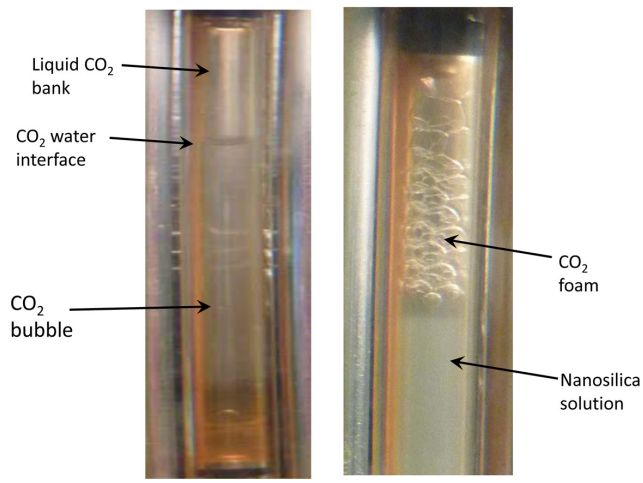
The Enhanced Oil Recovery Program projects can be categorized as being primarily focused on the following program elements: 1) carbon dioxide enhanced oil recovery (CO_2-EOR); 2) chemical EOR; 3) EOR imaging; 4) resource assessment; 5) waterflood efficiency improvement, and 6) other technology advancements focused primarily on mature fields.

The table on the following page provides a brief description of each project in the Enhanced Oil Recovery Program, the lead organization performing the project and the program element that the project addresses.

On-Site Unconventional Oil, Natural Gas, and other Fossil Energy Research

In addition to these extramural research projects managed by SCNGO at DOE's National Energy Technology Laboratory (NETL), scientists and engineers at NETL carry out independent research designed to complement these efforts. NETL currently has research underway in three key areas related to the production of oil from unconventional reservoirs: 1) prevention of fugitive methane emissions; 2) management of produced water; and 3) induced seismicity. On-site work under these areas includes Quantifying methane emissions from production operations, predicting the composition of produced water and its relation to water treatment and management alternatives, and understanding the nature and extent of induced seismicity related to hydraulic fracturing and fracturing wastewater disposal.

Together, these projects form a portfolio that is balanced and responsive to the issues facing stakeholders. The data, technologies, and tools developed through this portfolio will help industry and regulators make decisions and optimize operations in ways that will advance the goal of environmentally sustainable development of the nation's unconventional oil resources.



Pictures comparing (a) CO_2 mixed with water and (b) CO_2 foam generated in with a water/nanosilica solution, taken during experiments led by New Mexico Tech.

RELEVANT LINKS

NETL Brochure on Carbon Dioxide EOR
http://www.netl.doe.gov/file%20library/research/oil-gas/CO2_EOR_Primer.pdf

Stripper Well Consortium
http://www.energy.psu.edu/swc/

Tertiary Oil Recovery Project (TORP)
http://www.torp.ku.edu/

University of North Dakota Energy & Environmental Research Center
http://www.undeerc.org/

Petroleum Technology Transfer Council (PTTC)
http://www.pttc.org/

Category	R&D Objective
CO_2-EOR	Improve understanding of oil recovery from near-miscible CO_2 flooding in depleted Arbuckle Formation reservoirs (University of Kansas)
	Develop mobility control agents that utilize surfactants to reduce CO_2 mobility, improve distribution of injected fluids and achieve displacement efficiency below minimum miscibility pressure (University of Texas)
	Develop engineered nanoparticles with optimized surface coatings that can be used to create CO_2 foams that improve volumetric sweep efficiency (University of Texas)
	Develop and evaluate, through coreflood tests at reservoir conditions, a nanoparticle-stabilized CO_2 foam system that can improve sweep efficiency (New Mexico Tech)
	Delineate the presence and size of oil resource in ROZ "fairways" in the Permian Basin of Texas and New Mexico, and develop technology for identifying those portions of the ROZ resource recoverable with CO_2-EOR (University of Texas – Permian Basin)
	Optimize the performance of a ROZ CO_2 flood via pay zone characterization, laboratory analyses, and reservoir simulation in the Goldsmith Field (University of Texas – Permian Basin)
	Test the effectiveness of various CO_2 thickener compounds at typical injection pressures and reservoir conditions (University of Pittsburgh)
Chemical EOR	Evaluate surfactant polymer formulations that incorporate cosurfactants and co-solvents to create effective systems for chemical flooding reservoirs containing high total dissolved solids (University of Oklahoma)
	Design and implement a chemical flood for the Trembley field, located in Reno County, Kansas, and provide detailed results to the small-producer community (University of Kansas)
EOR imaging	Build and demonstrate an accelerometer suitable for microhole seismic imaging (Lumedyne Technologies Inc.)
	Develop a 3-D visualization and analysis software package that offers simultaneous viewing and analysis of multiple reservoir fluids and data mining of combined geologic models and reservoir simulation results (University of Illinois)
Resource Assessment	Provide reservoir-specific geological and engineering analyses of the Green River Formation tight oil plays in the Uinta Basin and understudied shales of the Paradox Formation in the Paradox Basin (Utah Geological Survey)
Waterflood Efficiency Improvement	Improve understanding of preformed particle gel systems used to reduce water production and improve oil recovery, through laboratory experiments and reservoir simulation (University of Texas)
	Evaluate whether a coupled particle gel/surfactant treatment can be used to control water production and improve oil recovery by improving both sweep efficiency and microscopic displacement efficiency (University of Missouri)
Other	Determine if seismic stimulation can increase oil production in mature oil fields via a controlled field test and modeling of the mechanisms involved (Lawrence Berkeley National Laboratory)
	Demonstrate radial jetting technology for stimulating production from low-permeability reservoirs with residual oil saturation (New Mexico Tech)
	Support the development of a variety of technologies that can help small producers lower the cost of recovering oil from mature fields via marginal wells (Penn State University)
	Demonstrate a novel ultrasonic technology for prevention of paraffin wax plugging in marginal oil wells that will enable their cost-effective performance (Battelle Memorial Institute/Pacific Northwest National Laboratory)
	Improve industry's ability to develop domestic oil shale and oil sands resources in a manner that will minimize environmental impact and effectively capture resulting CO_2 (University of Utah)