the ENERGY lab

PROGRAM FACTS

Strategic Center for Natural Gas & Oil

Unconventional Fossil Energy Resource Program

The mission of the Unconventional Fossil Energy Resource Program is to provide information and technologies that will assure sustainable, reliable, affordable, and environmentally sound supplies of domestic fossil energy resources. The Strategic Center for Natural Gas and Oil (SCNGO) seeks to accomplish this critical mission by advancing environmentally responsible technological solutions that bolster recovery of oil, gas, and other fossil energy resources from unconventional reservoirs.

The Issues

Continued research is needed to find ways to improve recovery from unconventional oil and gas reservoirs and to safely utilize coal that is currently deemed un-minable.

- Energy demand continues to grow, and the need to slow the growth in oil imports for economic and energy security reasons remains strong.
- Onshore domestic oil production is declining, but significant amounts of oil are left in conventional reservoirs in mature oil fields, and enormous amounts of hydrocarbons are locked in unconventional reservoirs (oil shale, heavy oil, tar sands).
- 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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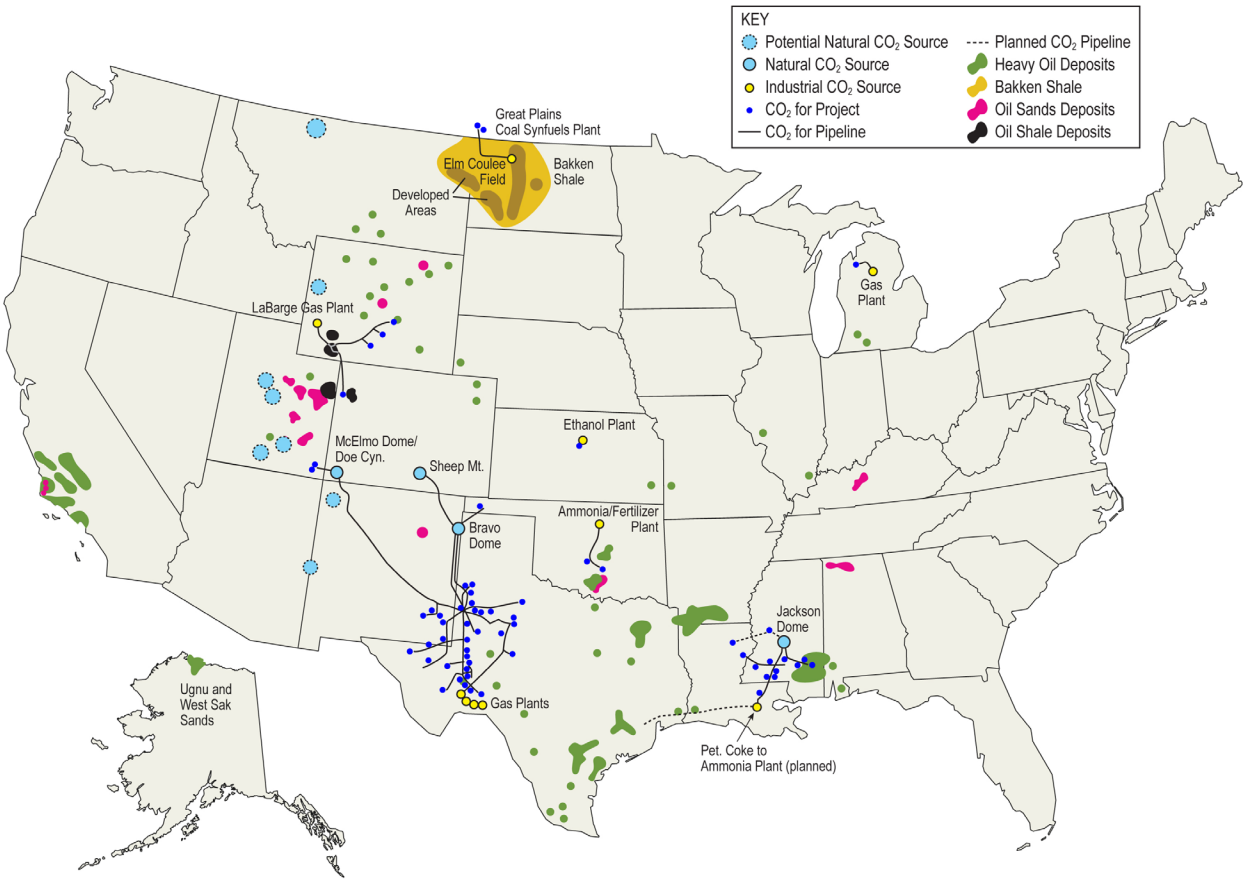
U.S. DEPARTMENT OF ENERGY

- New technologies are needed to increase production of gas from tight sands, gas shales, and coal seams. In addition, more accurate resource estimates and advanced drilling and production techniques are needed to produce the gas locked in methane hydrates. Finally, new strategies are needed to safely utilize coal resources that cannot be mined with conventional methods.

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 Unconventional Fossil Energy Resource 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.

NETL is actively involved in a number of research projects focused on the Bakken Shale of the Williston Basin, a fractured shale with potentially 100s of millions of barrels of recoverable oil. The research will help determine the most efficient ways to find and produce Bakken oil.

Project Portfolio Overview

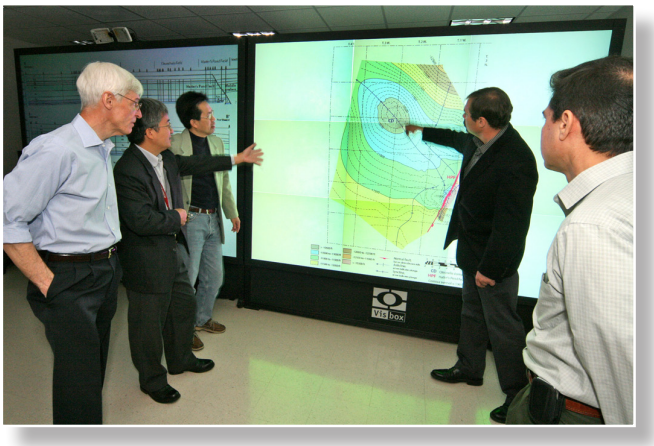
There are 32 funded projects in the Unconventional Fossil Energy Resource Program that are ongoing or were recently completed. These projects represent a total value of approximately $52 million. Twenty-one of these projects are led by university researchers, five are led by industry specialists, four by scientists at national labs, and two by researchers at federal and state government agencies.

The Unconventional Fossil Energy Resource Program projects can be categorized as being primarily focused on the following program elements: 1) enhanced oil recovery; 2) unconventional oil; 3) advanced seismic; 4) advanced simulation and visualization; and 5) mature fields and tech transfer.

The table on the following page provides a brief description of each project in the Unconventional Fossil Energy Resource 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: 1) unconventional fossil energy; 2) CO_2 enhanced oil recovery; and 3) high pressure/high-temperature equations of state for the CO_2-water-light hydrocarbon system. On-site work under these areas includes updating and prioritizing critical research needs for unconventional fossil energy resources; developing advanced CO_2 EOR technologies for increasing oil recovery from "unrecoverable" oil reserves; and developing improved equations of state for understanding pressure-volume-temperature-viscosity relationships in deep, offshore reservoirs. NETL scientists and University of Pittsburgh partners are working with Kinder-Morgan to implement a field demonstration of NETL-developed CO_2 thickeners to improve sweep efficiency in CO_2-EOR floods in the Permian Basin of West Texas.



NETL is investigating the potential for recovering incremental oil from the Citronelle Field in Alabama using carbon dioxide EOR. The first stage is developing an improved understanding of the geology using state-of-the-art interpretation techniques. Fields like Citronelle can demonstrate the potential for recovering domestic oil using carbon dioxide captured from industrial sources.

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, gas, and other fossil energy resources.

RELEVANT LINKS

NETL Brochure on Carbon Dioxide EOR
http://www.netl.doe.gov/technologies/oil-gas/publications/EP/small_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/

Program Element	R&D Objective
EOR	• Conduct CO_2 injection tests in the Citronelle oilfield in Mobile County, AL to improve the reliability of computer simulations of oil yield from CO_2-EOR and calculations of sequestration capacity. (U. Alabama at Birmingham) • Design efficient chemical formulations for chemical flooding processes so that oil producers can make informed assessments for implementation of pilot projects. (U. Kansas Center for Research) • Test the suitability of alkaline-surfactant-polymer (ASP) flood technology as an enhanced oil recovery technique for increasing oil production from the Lawrence Field in the Illinois Basin. (Illinois State Geological Survey) • Develop improved chemical oil recovery options for the Ugnu reservoir on Alaska's North Slope. (U. Texas) • Apply microbial permeability profile modification to CO_2 water-after-gas (WAG) flooding. (Mississippi State U.) • Develop methods using water-soluble polymers to recover viscous oil from unconventional reservoirs on Alaska's North Slope. (New Mexico Tech) • Develop a neural network model for CO_2 EOR and tools for rapid interpretation of marine-controlled source electromagnetic (CSEM) data. (University of Louisiana at Lafayette) • Characterize and test high-performance surfactants for improved chemical flooding technology as applied to EOR. (University of Oklahoma Enhanced Oil Recovery Design Center)
Next Generation EOR	• Improve mobility control in CO_2 Enhanced Recovery using SPI gels (Impact Technologies, LLC) • Improve sweep of CO_2 EOR processes using nanoparticle-stabilized CO_2 foams (UT Austin) • Optimize residual oil zone CO_2 flooding using next generation CO_2 EOR technologies (UT of the Permian Basin) • Develop real-time, semi-autonomous geophysical data acquisition and processing system to monitor CO_2 flood performance (Sky Research, Inc) • Improve CO_2 sweep efficiency using novel CO_2 foam concepts and injection schemes (UT Austin) • Develop nanoparticle-stabilized CO_2 foam for CO_2-EOR application (New Mexico Tech)
Unconventional Oil	• Develop a robust reservoir model to test possible production methods for Umiat and similar frozen Alaskan North Slope reservoirs that do not use steam or a liquid that will freeze. (U. Alaska – Fairbanks) • Improve recovery of Alaskan North Slope heavy oil resources in the Ugnu formation by improving understanding of the formation's vertical and lateral heterogeneities via core evaluation, evaluating possible recovery processes, and employing geophysical monitoring to assess production and modify production operations. (Colorado School of Mines) • Determine the in situ stress and geomechanical properties of the Bakken formation. (U. North Dakota) • Build a fully integrated, three-dimensional reservoir geo-model for the Middle Bakken reservoirs in the Elm Coulee area. (Colorado School of Mines and Idaho National Lab) • Quantitatively describe and understand the Bakken formation in the Williston Basin by collecting and analyzing a wide range of parameters that impact well productivity and oil recovery, including seismic and geochemical data. (U. North Dakota Energy and Environmental Research Center) • Evaluate methods to utilize the vast energy stored in domestic oil shale and oil sands, while minimizing environmental impacts and capturing combustion CO_2. (U. Utah) • Develop and test new technology for upgrading shale oil by removing nitrogen and sulfur after retorting and prior to refining. (Ceramatec)
Advanced Seismic	• Build and demonstrate new accelerometer technology for the purposes of microhole seismic imaging. (Lumedyne Technologies and Lawrence Berkeley National Lab)
Advanced Simulation and Visualization Tools	• Develop advanced numerical simulation capabilities to improve methane hydrate reservoir modeling and reservoir simulation codes. (Lawrence Berkeley National Lab) • Perform experimental testing on natural and synthetic hydrate samples to provide physical parameters for hydrate imaging and visualization tools. (Lawrence Berkeley National Lab) • Develop advanced capabilities for modeling of pore-scale fluid interactions in the hydrate stability zone. (UT Austin) • Perform advanced computational modeling to evaluate potential hazards associated with liquefied natural gas (LNG) carriers, with the goal of improving fidelity and safety of LNG carriers. (Sandia National Lab) • Develop advanced CO_2-EOR and sequestration planning software (NITEC) • Carry out simulations of clean and secure energy from stranded oil in residual oil zones (UT Austin) • Develop 3D analysis and visualization software to aid in management of unconventional oil and gas resources (U. Illinois and Illinois St. Geological Survey) • Quantify fracture density and orientation in unconventional reservoirs using simple-source vertical seismic profiles (UT Austin Bureau of Economic Geology)
Mature Fields and Tech Transfer	• Enhance the ability of the domestic production industry to keep stripper wells producing at economic production rates in an environmentally safe manner, maximizing the recovery of domestic hydrocarbon resources. (Stripper Well Consortium – Penn State U.) • Transfer new oil and natural gas-related technology and information to producers and other stakeholders in a concise, meaningful format. (Petroleum Technology Transfer Council)