the ENERGY lab

PROGRAM FACTS

Strategic Center for Natural Gas & Oil

Optimizing Recovery of Domestic Petroleum Resources

The mission of the Petroleum Technology Program is to provide the 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 bolster domestic petroleum recovery.

The Issues

Continued research into ways to improve recovery from domestic oil reservoirs is needed.

- 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 for a better understanding of the geologic 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.

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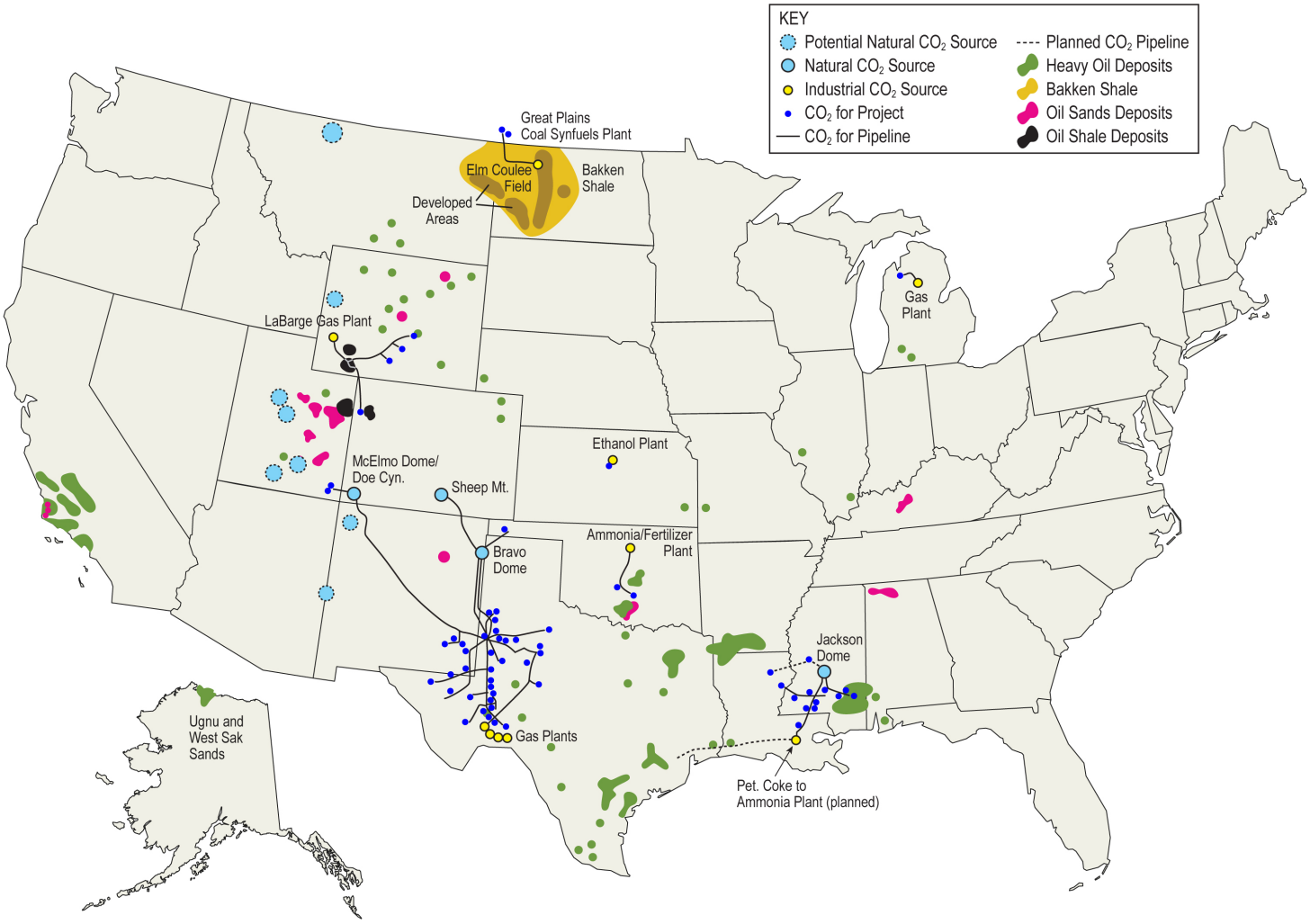
The need for scientific data collection and technology development is being driven by the following:

- 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 containing oil, 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 the low 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.



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.

All of these challenges are the impetus behind the current portfolio of projects in the Petroleum Program.

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.

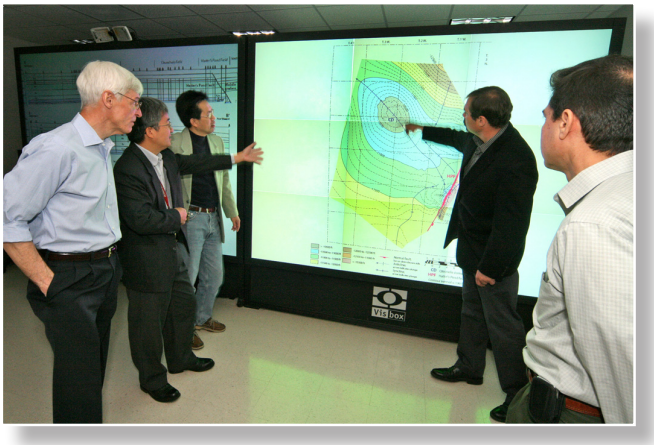
Project Portfolio Overview

Currently 26 funded projects in the Petroleum Program have either just been completed or are scheduled to continue through 2012. These projects represent a total value of roughly $50 million. Of this, the large majority (about $47 million) is directed towards projects with university researchers. Five projects are with industry partners. Two projects with national labs are directed towards supporting other projects. The Petroleum Program projects can be categorized as being primarily focused on enhanced oil recovery, unconventional oil, and advanced seismic. One additional category is mature fields research focused on improving production performance of stripper wells.

Both the number of projects and the total level of funding are relatively balanced between projects focused on technology development (13 projects and about $28 million) and projects focused on data gathering, analysis and decision tool development (13 projects and about $21 million). The R&D objectives of this portfolio are categorized in the associated table (see next page).

Onsite Petroleum Research

In addition to these extramural research projects managed by SCNGO at DOE's National Energy Technology Laboratory (NETL), scientists and engineers at NETL also carry out independent research designed to complement these efforts. For example, NETL currently has research underway in four key areas: designing CO_2-soluble surfactants that can increase CO_2 viscosity in EOR projects, assessing the potential of electromagnetic methods for producing oil from oil shale, characterizing multiphase flow in Bakken shale cores, and cataloging knowledge from historical oil-shale and tar-sand research and production activities in an easily accessible archive. http://www.netl.doe.gov/onsite_research/geological.html



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 domestic oil resources.

RELEVANT LINKS

Utah Heavy Oil Program
http://www.heavyoil.utah.edu/

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 (Extramural Performer)
EOR	• Develop improved chemical oil recovery options for the Ugnu reservoir on Alaska's North Slope (U. Texas). • 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. (U. Illinois). • Evaluate and enhance CO_2 flooding through sweep improvement (Louisiana State). • Design efficient chemical formulations for chemical flooding processes so that oil producers can make informed assessments for implementation of pilot projects (U. Kansas). • Improve CO_2 flooding sweep using CO_2 gels (SBIR-RTA Systems Inc.). • Apply microbial permeability profile modification to CO_2 water-after-gas (WAG) flooding (Mississippi State U.). • 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. Birmingham, AL). • Determine the economic and technical feasibility of using CO_2-miscible flooding to recover oil in a Lansing-Kansas City formation oilfield in central Kansas (U. Kansas). • Develop methods using water-soluble polymers to recover viscous oil from unconventional reservoirs on Alaska's North Slope (New Mexico Tech). • Employ molecular modeling and experiments to design inexpensive, environmentally benign, CO_2-soluble compounds that can decrease the mobility of CO_2 at reservoir conditions (U. Pittsburgh).
Unconventional Oil	• Accurately assess the hydrocarbon potential for the Bakken stratigraphic interval on a sub-regional basis, construct an integrated exploration model for the Bakken, and 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). • Determine the in situ stress and geomechanical properties of the Bakken formation (U. North Dakota). • 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). • 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). • 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). • Provide research support for addressing the wide-ranging issues surrounding the creation of an industry for unconventional oil production in the United States (U. Utah). • Demonstrate advanced technology for surface processing of oil shale (SBIR-Combustion Resources). • Develop high efficiency shale oil recovery technologies (SBIR-Energy Recovery Technology).
Advanced Seismic	• Develop innovative seismic-based methodologies and workflows for the incremental recovery of hydrocarbons from karst-modified carbonate reservoirs within the onshore continental United States (U. Kansas). • Build and demonstrate new accelerometer technology for the purposes of microhole seismic imaging. (Lumedyne and Lawrence Berkeley National Lab). • Develop a novel, low-cost method to install geophones for CO_2 monitoring (SBIR-Impact Technologies).
Mature Fields and Multiple Categories	• Develop a neural network model for CO_2 EOR and tools for rapid interpretation of marine-controlled source electromagnetic (CSEM) data. CSEM technology shows great promise as a method for directly indicating the presence of hydrocarbons in areas where seismic surveying is problematic (University of Louisiana at Lafayette). • 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.).