



the **ENERGY** lab

## PROGRAM FACTS

Strategic Center for  
Natural Gas & Oil

# Reducing the Environmental Impacts of Oil and Natural Gas Exploration and Production

The mission of the Environmental Program is to promote a reliable, affordable and secure supply of domestic oil and clean-burning natural gas, by providing cost-effective environmental regulatory compliance technologies, enhancing environmental protection during oil and gas E&P operations, and facilitating the development and use of scientific, risk-based environmental regulatory frameworks.

## The Issues

Several trends are currently converging, amplifying the need for continued research into ways to reduce the environmental impact of domestic oil and gas production.

- Energy demand continues to grow, and the need to slow the growth in oil imports for economic and energy security reasons remains strong.
- Conventional onshore domestic oil and gas production is declining, and all of the alternatives for replacing it (e.g., unconventional gas from coal and shale, enhanced oil recovery from mature fields, unconventional oil from heavy oil, tar sands or oil shale deposits) involve the potential for incremental increases in air emissions, water demand, waste disposal, and surface disturbances.
- Stakeholders at all levels and locations are increasingly interested in making holistic decisions regarding multiple land use options using scientifically sound data that reflect the costs and benefits of energy development decisions.

These trends have highlighted the need for scientific data and technology development to address issues facing both policymakers and energy producers. For example:

- Regulations have placed significant volumes of natural gas and oil resources off limits due to the perception that their development would involve a risk of environmental damage.
- Development of multiple gas shale plays has heightened concerns about hydraulic fracturing of these reservoirs using millions of gallons of water for each treatment, a large portion of which flows back and must be disposed of or reused.

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## NATIONAL ENERGY TECHNOLOGY LABORATORY

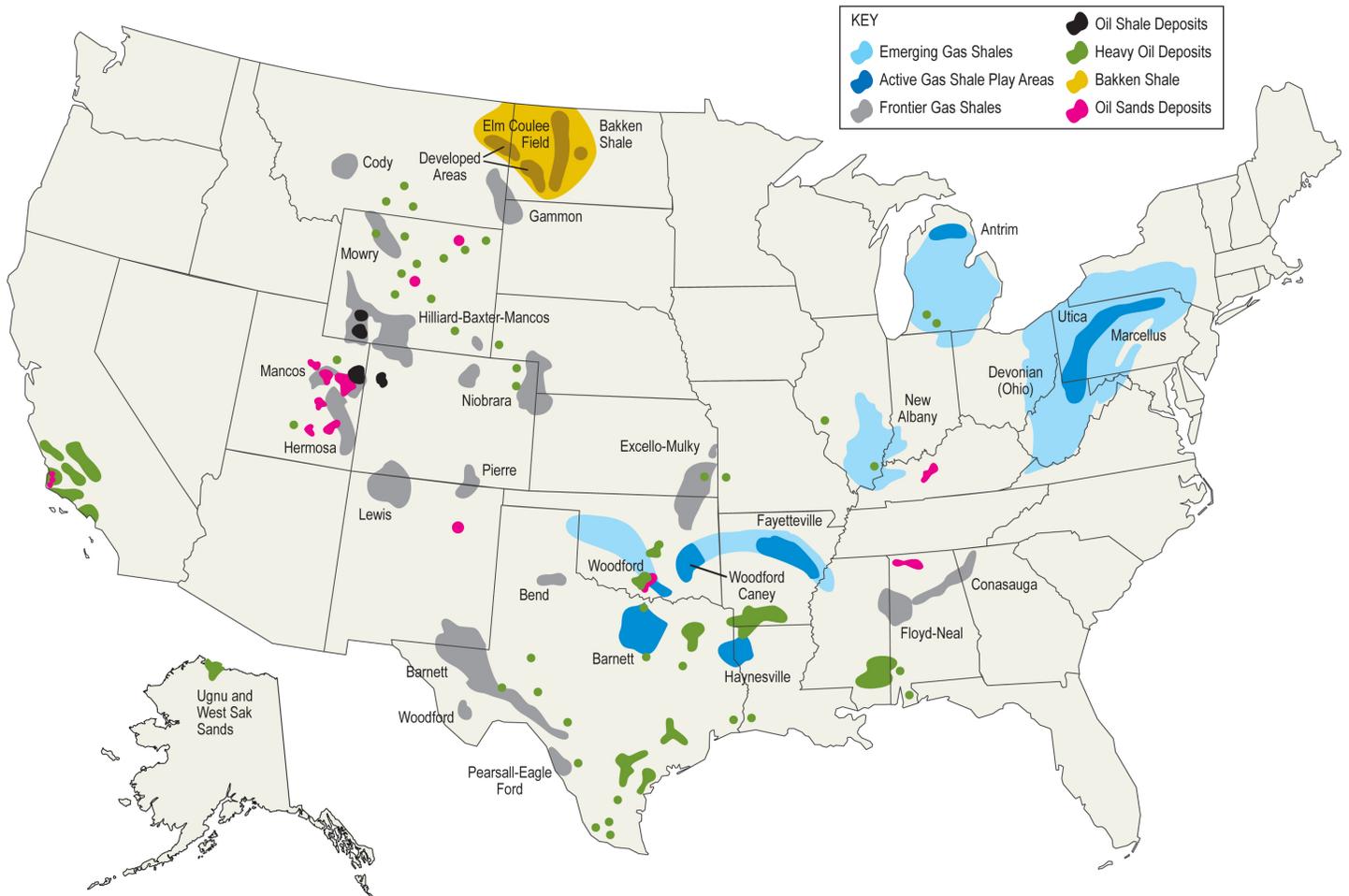
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*Location of major natural gas bearing shales and oil resources in unconventional reservoirs (including oil sands and heavy oil deposits), energy supplies that require innovative technologies and approaches for water management.*

- Produced water disposal constraints are limiting coalbed methane development in the Powder River Basin.
- The potential for future development of oil shale in Colorado, Wyoming, and Utah has raised concerns over the impact of such development on surface, water, and air resources in basins where other sectors of the economy are dependent on these same resources.
- Increased attention on future development of additional oil and gas resources in Alaska have elevated issues related to the unique challenges of operating in an arctic region, such as the environmentally acceptable use of fresh lake water for ice roads.

All of these challenges (see map above for location of unconventional resources), and more, are the targets of the current portfolio of projects in the Environmental Program.

## Project Portfolio Overview

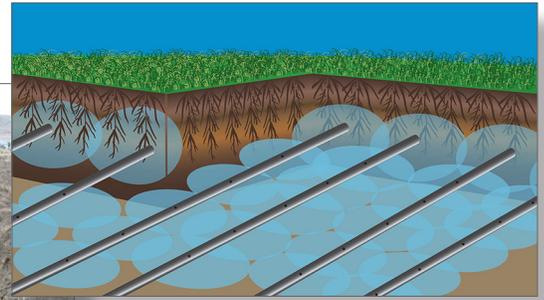
Eighteen funded projects in the Environmental Program have either just been completed or are scheduled to continue through 2013. Three of these projects include DOE-funded support from other national labs. The portfolio of projects represent a total value of roughly \$34 million. Of this, about \$12.1 million is directed towards projects with industry partners, \$10.4 million towards state agencies or national non-profit groups (e.g., state geological surveys or the Interstate Oil and Gas Compact Commission), \$9.5 million towards university researchers, and \$2.4 million towards national laboratories, that often provide specific technical support to the other project partners. These projects can be categorized as being primarily focused on arctic environmental issues, water impacts, air impacts, surface impacts, or the development of decision-making tools.

Both the number of projects and the total level of funding are relatively balanced between projects focused on technology development (8 projects and about \$18 million) and projects focused on data gathering, analysis, and decision tool development (13 projects and about \$16 million). The R&D objectives of this portfolio are listed in the associated table.

Program Element	R&D Objective (Extramural Performer)
<b>Arctic Resources</b>	<ul style="list-style-type: none"> <li>• Develop and test a snow control practice to enhance snow drift formation as a way to recharge depleted fresh water lakes for multiple uses, including oil and gas activity (<a href="#">U. Alaska-Fairbanks</a>).</li> <li>• Develop a scientific support system for water resources planning and management related to oil and gas development on the North Slope of Alaska (<a href="#">U. Alaska-Fairbanks</a>).</li> </ul>
<b>Water Related Issues</b>	<ul style="list-style-type: none"> <li>• Create an Internet-based Water Treatment Technology Catalog and Decision Tool that will pair an operator's water treatment cost and capacity needs to optimal water treatment technologies (<a href="#">ALL Consulting</a>).</li> <li>• Determine the optimal method for irrigating crops with treated produced water in order to maintain the long term physical integrity of soils in the Powder River Basin and achieve normal crop production (<a href="#">U. Wyoming</a>).</li> <li>• Develop constructed wetland systems for treatment and beneficial use of produced water (<a href="#">Clemson U.</a>).</li> <li>• Develop a new micro-filter technology based on forward osmosis/bio-desalination, to allow desalinated produced water to offset fresh water consumption (<a href="#">Lea Co. NM and NM Tech</a>).</li> <li>• Study ways to alleviate problems associated with produced water to facilitate increased conventional hydrocarbon production and resolve water-related environmental barriers to possible oil shale development (<a href="#">Utah Geological Survey</a>).</li> <li>• Develop a water resource geospatial infrastructure that will facilitate decision making for potential oil shale resource development, environmental impact studies, and scenario analyses (<a href="#">Colorado School of Mines and Idaho Nat'l. Lab</a>).</li> <li>• Develop a technically feasible, environmentally benign and cost-effective process for coalbed natural gas-produced water treatment at the wellhead based on gas hydrate technology (<a href="#">BC Technologies and Oak Ridge Nat'l. Lab</a>).</li> </ul>
<b>Air Related Issues</b>	<ul style="list-style-type: none"> <li>• Develop approaches to quantify air quality impacts of oil and gas exploration and production in the West (<a href="#">Lawrence Berkeley Nat'l. Lab and Colorado State U.</a>).</li> <li>• Create a database inventory of oil and natural gas industry compressor engines to evaluate emissions control technologies in lab and field tests (<a href="#">Kansas State U.</a>).</li> <li>• Conduct pilot scale field demonstration of process to capture and convert coal mine methane emissions into liquefied natural gas (<a href="#">A-P Coal Mine Methane Power Co.</a>).</li> </ul>
<b>Surface Impact Issues</b>	<ul style="list-style-type: none"> <li>• Identify critical enabling technologies for a prototype low-impact drilling system, test prototype systems in field laboratories, and demonstrate how these practices would benefit the environment (<a href="#">Texas A&amp;M U.</a>).</li> </ul>
<b>Decision Making Tools</b>	<ul style="list-style-type: none"> <li>• Develop a web-based decision support tool that will be used by mid- and small-sized oil and gas companies and regulators to proactively minimize adverse ecosystem impacts associated with the recovery of oil and gas reserves in sensitive areas in the Fayetteville Shale Play (<a href="#">U. Arkansas and Argonne Nat'l. Lab</a>).</li> <li>• Assist state governments in the effective, efficient, and environmentally sound regulation of the exploration and production of natural gas and crude oil through specific project efforts to address current issues (<a href="#">IOGCC</a>).</li> <li>• Develop a GIS-based decision support system for land use planning activities (<a href="#">Argonne Nat'l. Lab</a>).</li> <li>• Reduce the costs of information exchange between regulatory agencies and the petroleum and mining industries and provide baseline reference data for decisions about environmental protection and mineral resource development through the Risk-Based Data Management System (<a href="#">Ground Water Protection Research Foundation</a>).</li> <li>• Carry out regulatory analysis on water and waste issues relating to oil and gas exploration and production (<a href="#">Argonne Nat'l. Lab</a>).</li> </ul>

## Onsite Environmental Research

In addition to these extramural research projects managed by the Strategic Center for Natural Gas and Oil 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 two key areas: assessing the environmental impact of subsurface drip irrigation using produced water from coalbed methane operations in the Powder River Basin, and improving the reliability and accuracy of predictions of the impact of oil and gas activity on regional air quality through the use of new data acquisition tools and modeling techniques (see photos at right). [http://www.netl.doe.gov/onsite\\_research/geological.html](http://www.netl.doe.gov/onsite_research/geological.html)



*NETL is gathering scientific data to determine if subsurface drip irrigation is an environmentally acceptable way to manage produced water from coalbed methane wells while at the same time providing needed irrigation water to farmers in the Powder River Basin.*

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 help industry and regulators make decisions and optimize operations in ways that will advance the goals of environmentally sustainable development of domestic oil and natural gas resources.



*Helicopter drones are being used or employed by NETL to gather data for more accurately estimating the air quality impacts of oil and gas production.*



*Large scale hydraulic fracturing for gas shale wells in the Appalachian Basin (shown above) and other areas has highlighted the need for tools to help manage flowback water from fracturing operations as well as produced water post-completion. NETL is managing R&D focused on these problems.*

## WEBSITES RELATED TO PAST AND CURRENT RESEARCH

Produced Water Management Information System (PWMIS)  
<http://www.netl.doe.gov/technologies/pwmis/index.html>

Fayetteville Shale Infrastructure Placement Analysis System (IPAS)  
<http://lingo.cast.uark.edu/IPAS/>

Fayetteville Shale Information  
<http://lingo.cast.uark.edu/LINGOPUBLIC/>

Environmentally Friendly Drilling Systems  
<http://www.harc.edu/OurWork/Projects/DrillingSystems>

New Mexico Water and Infrastructure Data System  
<http://octane.nmt.edu/waterquality/>

Drilling Waste Management Information System (DWMIS)  
<http://web.ead.anl.gov/dwm/>