



the **ENERGY** lab

R&D FACTS

Geological & Environmental Systems

DOE Leads Collaborative Effort to Quantify Environmental Changes that Coincide with Shale Gas Development

Background

DOE's National Energy Technology Laboratory (NETL) is leading a joint industry/government research project to document environmental changes that occur during the lifecycle of shale gas development. The research plan calls for one year of environmental monitoring before development takes place to establish baseline conditions and account for seasonal variations. Monitoring then will continue through the different stages of unconventional shale gas development including: road and pad construction, drilling, and hydraulic fracturing, and for at least one year of subsequent production operations. The study will take place at a Range Resources-Appalachia well pad site in southwestern Pennsylvania where the drilling and completion of two horizontal Marcellus Shale gas wells will occur in 2013.

One unique aspect of this study is the rigorous attempt to establish baseline conditions at the well location, which is absolutely necessary for a study that intends to quantify environmental changes that may be linked to shale gas development. No prior study has acquired comprehensive, baseline environmental data from a well site prior to drilling and fracturing. Pre-operation data are essential for quantifying environmental impacts and for ascertaining what portion of the post-development environmental footprint is due to current natural gas development operations versus that which may be due to past energy development activity or concurrent industrial, agricultural, or recreational activities. Accordingly, this study will provide important reference points for discussions regarding the need for further research and the development of regulatory policy at both state and federal levels.

The NETL-led Marcellus research effort is part of the laboratory's unconventional fossil energy research program, a larger effort that is focused on developing technologies that enable environmentally sustainable development of oil and natural gas resources. NETL will monitor air quality and surface water quality at the Range Resources-Appalachia site pre- and post-drilling to quantify the extent that these vital resources are impacted by shale gas production. Further, NETL will conduct soil gas surveys, hydraulic fracturing tracer studies, and electromagnetic induction surveys to identify any possible migration of natural gas, completion fluids, or production fluids.

Goals and Objectives

Goal - To eliminate or minimize unwanted environmental changes resulting from shale gas development

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NON-INDUSTRY PARTNERS

Range Resources-Appalachia, Inc.

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Objective 1 - To identify environmental changes, both positive and negative, that coincide with the different stages of shale gas development,

Objective 2 - To perform more focused research that establishes linkage between observed environmental changes and shale gas development,

Objective 3 - To develop new technology or management practices that mitigate unwanted environmental changes.

Project Description

NETL will monitor air quality, soil water quality, and avian habitat prior to, and during the different stages of shale gas development. Because the area of well development is known to contain numerous old oil and gas wells (prior to laws requiring effective plugging) and improperly plugged wells provide a pathway for the vertical migration of natural gas and fluids, a helicopter magnetic survey was conducted to determine locations of existing wells.

Ambient air quality is monitored using NETL's mobile air monitoring laboratory, which comprises instruments to monitor 52 volatile organic compounds (VOC's), methane, carbon dioxide, ozone, sulfur dioxide, nitrous oxides, particulates, and radon. The laboratory also contains a cavity ring-down spectrometer that measures stable isotopes of carbon in methane and carbon dioxide. Carbon isotope measurements are important for distinguishing between methane migrating from deep underground formations (thermogenic methane), methane from near-surface sources (biogenic methane), and atmospheric methane. Similarly, carbon isotopes can help distinguish between carbon dioxide from fossil fuel combustion and atmospheric carbon dioxide.



Helicopter with two, boom-mounted magnetometers surveying for existing wells at Marcellus Shale gas well location in Washington County, PA.

NETL is using multi-frequency electromagnetic surveys to detect the unwanted migration of conductive drilling and completion fluids, and production water away from on-site containment. Fluids associated with shale gas production are highly conductive because of their high salinity. In contrast, the rain-leached soils of Pennsylvania are relatively non-conductive. This conductivity contrast allows plumes of conductive fluids from shale gas production to be mapped easily with electromagnetic surveys.

West Virginia University, a NETL-RUA partner, is quantitatively evaluating the effect of shale gas development on the avian community at various distances from the drill pad. The study focuses on avian community changes, such as changes in habitat, nesting behavior, and number and diversity of birds.

Benefits

This comprehensive, rigorously scientific collaborative effort between DOE-NETL and a natural gas producing company will provide valuable information that can be used to quantify the potential risks of environmental impacts from hydraulic fracturing during the development of shale gas resources. Quantifying potential risks and providing sound, unbiased and transparent scientific data is the first step towards building a rational, scientific approach to regulating sustainable resource development.

Accomplishments

In 2011-2012, NETL deployed its mobile air emissions monitoring laboratory at the location for a period of nine months to determine air quality prior to development.

In 2011-2012, NETL conducted three electromagnetic induction (EMI) surveys of the area where the drill pad will be constructed.

In 2012, NETL conducted a helicopter survey of a 2.5 square-mile area surrounding the well site to identify existing natural gas and oil wells based on the magnetic response of their buried well casing. The survey identified 123 magnetic anomalies that are suspected wells, both water supply wells and oil and gas wells. Airborne magnetic surveying is the only quick way to locate old, unrecorded wells that can be the source of communication between a shallow underground source of drinking water (USDW) and historical producing formations. Such unmarked wellbores should be located and properly plugged to address historical methane migration problems.

In 2012, West Virginia University conducted a census of the shrub land bird community at the well site prior to development. Based on census results, one species was selected and monitored for three months to determine nest success. Other areas in the region with similar avian habitat were identified to serve as controls when well development commences at the test site.