

## Marcellus Shale: Natural Gas Energy

The extraction of natural gas in Pennsylvania's Marcellus Shale formation is running at a fast pace. New data and the recent realization of this vast energy resource have escalated the gas drilling industry in Pennsylvania. In response, drilling techniques have caused much public concern.

The dark sedimentary rock, named after a visible dark shale outcrop in the town of Marcellus, New York, underlies much of the Appalachian Basin. It covers more than two-thirds of Pennsylvania and has a depth from surface level to more than a mile below ground. The location is close to metropolitan areas on the east coast, providing an ideal market. Marcellus Shale is an exceptional energy resource for natural gas because it is rich in organic content, signifying substantial gas production. An estimate for the amount of natural gas that can be captured from Marcellus Shale ranges from 50 to 500 trillion cubic feet. PA currently has an annual natural gas consumption rate of 750 million cubic feet (EIA: Official Statistics). This reservoir could supply Pennsylvania with gas energy for seemingly endless years and the U.S. for numerous years. A recent study states: "Fully developed, the Marcellus Shale has the potential to be the second largest natural gas field in the world..." (*The Economic Impacts of the Pennsylvania Marcellus Shale Natural Gas Play: An Update, Pennsylvania State University, 5/24/2010*).

New extraction technologies have also made the natural gas more accessible. The total permits issued for Marcellus Shale natural gas drilling in 2010 was approximately 3,300 (DEP). As a comparison, in 2005 only 4 drilling permits were issued. New data on the natural gas reserves and new technologies have made Marcellus Shale a prime energy resource. There has been substantial concern and opposition to drilling procedures with regard to environmental, health and safety issues, including water contamination. The industry's hydraulic fracturing technique and its effect on ground and surface water is a major contention. Tapping the rich natural gas reserves in Marcellus Shale poses a question and challenge: can this immense energy resource be extracted while protecting our water resources and natural environments?

### **Shale and Natural Gas Basics**

Shale, sometimes called mudstone, is a sedimentary rock. It forms in thick slab layers from accumulated deposits of sand, clay, shells and often organic matter in bodies of water. Shale is finely grained and can act as a barrier for trapping petroleum and natural gas reservoirs. In addition, the shale rock itself can contain natural gas, as in Marcellus Shale.

Natural gas forms over millions of years from the decomposition, deep burial, intense pressure and heat of organic (plant and animal) matter. Natural gas is a mixture of hydrocarbons, primarily methane. The fine grained Marcellus Shale is high in organic matter, making it high in hydrocarbons. Thus, this dark-colored rock harbors an abundant amount of natural gas in rock fractures and pore spaces. Marcellus is considered unique because in addition to trapping gases in sealed reservoirs, it contains natural gas within its own matrix.

Natural gas, a non-renewable fossil fuel, accounts for about 24% of the world's energy and slightly less for U.S. consumption. It is a clean, odorless substance that is extremely volatile. Natural gas is used as a fuel for heating, cooking, electricity generation, industry and in the production of synthetic materials. Although the burning of natural gas produces carbon dioxide, it is considered a much cleaner fossil fuel than coal or petroleum.

### **Well Drilling and Fracturing Techniques**

The extraction of natural gas in Marcellus Shale uses vertical and horizontal drilling. A vertical well is drilled to a specified depth; then a directional tool is used to gradually turn the drill horizontally. The horizontal well bore may be more than 5,000 ft. long. Steel casings and cement are inserted to support and protect well bores. Horizontal drilling allows for numerous attempts to tap natural gas reservoirs.

A technique called hydraulic fracturing is used to extract gas more efficiently. The well bore casings and cement are perforated to begin this process. Then water, sand and chemicals are forced into the shale at high pressures to break open fractures and tap natural gas. The gas flows into the well bore and up to the surface. A single hydro-fracturing job uses approximately 3-5 million gallons of water. The water used becomes waste and is reused in fracturing or sent to a treatment facility. Drilling wells can drain natural gas from acres around it. The construction of major pipelines is currently being debated.

Most well sites are set up in rural areas and leases are drawn with landowners for a five-year period. Initially, the standard lease rate was \$25 an acre with a royalty of 12.5%. As the drilling escalated, signing bonuses increased over \$5,000 an acre plus the established royalties. The natural gas industry is hoping to secure gas extraction rights from surrounding landowners who are not in a lease agreement.

## Environmental Impacts

The development of the Marcellus Shale well drilling industry has environmental groups and public citizens concerned. The impact on water resources, including private well waters, leads the list. Approximately 20,000 square miles of the Susquehanna River Basin underlies the Marcellus Shale formation. Millions of gallons of water used in hydraulic fracturing (3-5 million per well) are withdrawn from the basin and 60% or more may be reused in fracturing with the remainder being contaminated water. The extracted fluids and rock contains chemicals and may contain radioactive uranium. Waste fluids are stored in steel tanks and temporary waste pits and sent to authorized waste water treatment facilities. The risks of elevated uranium levels and chemicals reaching water supplies have caused substantial concern. The Pennsylvania Department of Protection, in cooperation with the Susquehanna River Basin and the Delaware River Basin, has created guidelines and rules for the withdrawal, usage, treatment and disposal of waste water.

Other concerns including the impact on land such as acres of clear cutting, road damage, erosion and habitat destruction. Land sites are to be restored within nine months of plugging a well. Some drilling (exploration/production) companies are more diligent than others and exceed requirements with regard to environmental mandates.

Environmental impact studies and the debate over Marcellus Shale natural gas development continues.

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The Energy & Environmental Committee of the Greater Lehigh Valley Chamber of Commerce thanks Eric Epstein of EFMR Monitoring Group, Inc. for this primer on Marcellus Shale.

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