



Balancing the opportunities
and risks of shale gas exploration



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The excitement surrounding the potential for shale gas development in the U.S. is so high that some have already likened it to the California Gold Rush of the mid-1800s. Others have called the U.S. the “Saudi Arabia of Natural Gas.” While there are rumors of 21st century “wildcatters” scooping up shale gas leases and making fortunes, the truth is the majority of the development and drilling is performed by experienced companies with the knowledge and capital to manage large-scale operations and the associated risks.

The Department of Energy notes that unconventional natural gas production (including shale gas) now accounts for 46 percent of total U.S. production, and could rise to more than 60 percent by 2020.¹ Shale gas opportunities are located throughout the West, the South and the Northeast’s Appalachian Basin. The Barnett field in Texas spans 5,000 square miles and provides six percent of the U.S. natural gas supply. The Marcellus area in the Northeast covers ten times the square miles of the Barnett, and some experts believe it has the potential to be the second largest gas field in the world. The economic potential of shale gas is equally vast offering long-term development and exploration projects for private industry, stable and well-paying jobs for U.S. workers, and increased tax revenues for federal, state and local governments. One estimate indicates that the Marcellus shale could generate nearly 300,000 new jobs, \$6 billion in tax revenue and \$25 billion to the economy overall by 2020.²

Beyond the economic benefits, shale gas offers an environmental advantage over other fossil fuel sources. In August of 2010, 17 countries sent representatives to the U.S.-sponsored Global Shale Gas Initiative (GSGI) to discuss the importance of shale gas as a lower-carbon fuel option that can help reduce CO₂ emissions while ensuring energy security and economic development in the 21st century. The World Resources Institute estimates that shale gas provides a 50 to 70 percent reduction in greenhouse gas emissions compared to coal. Together with wind and solar energy, natural gas from shale rock offers the U.S. a strong foundation for a low-carbon electricity system.

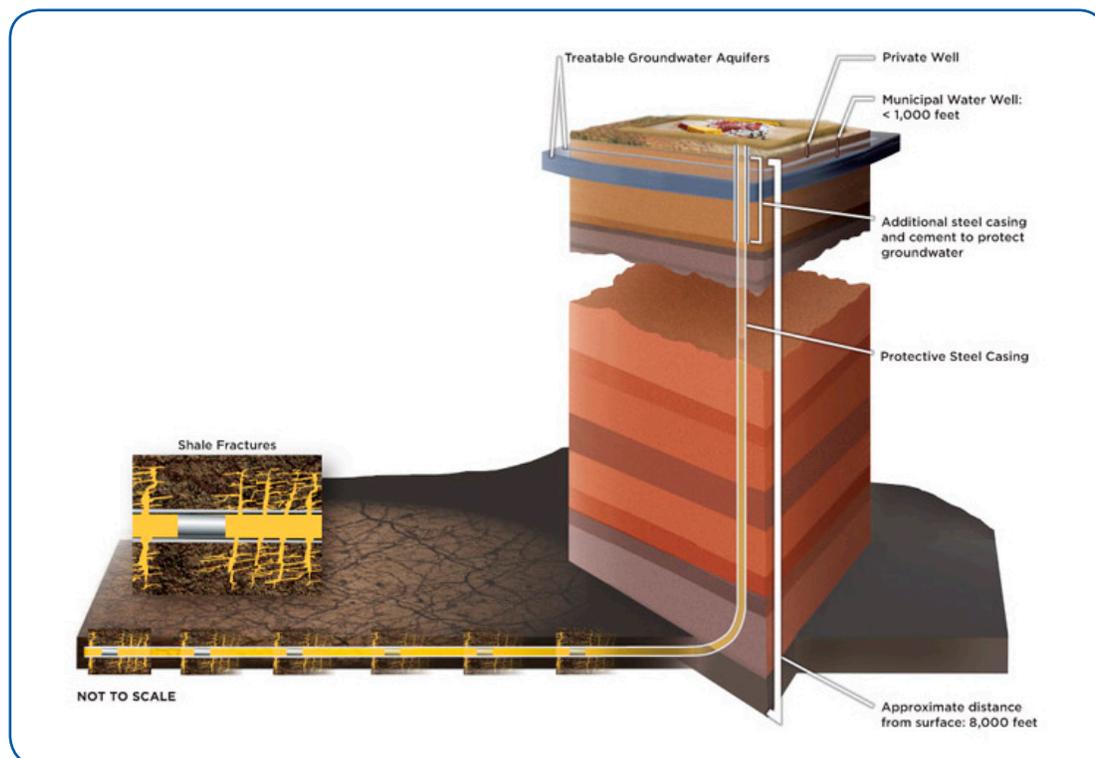
Advanced technologies enable today’s shale gas extraction

Shale gas is extracted from “unconventional” reservoirs, which are tight rock formations with low permeability. The primary difference between modern shale gas development and conventional natural gas development is the extensive use of horizontal drilling and multi-stage hydraulic fracturing instead of vertical wells. Shale gas production has become more economically viable in recent years because of the advances in horizontal drilling and hydraulic fracturing.

¹ Modern Shale Gas Development in the U.S.: A Primer, April 2009

² “The Economic Impacts of the Marcellus Shale: Implications for New York, Pennsylvania, and West Virginia,” by Timothy J. Considine, Ph.D. of Natural Resource Economics, July 2010

Exhibit 1: Horizontal drilling and hydraulic fracturing



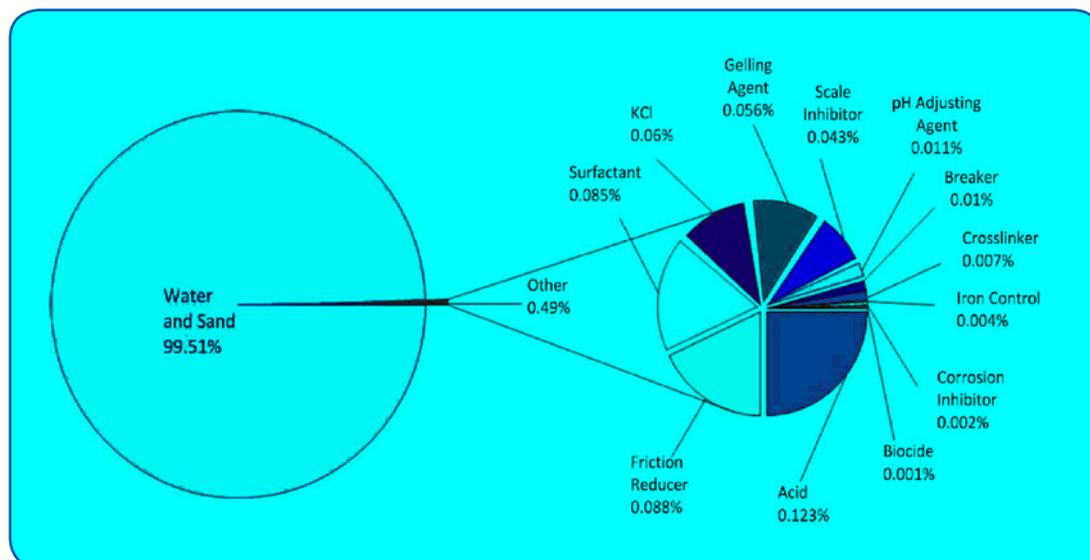
While horizontal wells typically cost up to three times as much as vertical wells, they can produce at up to five times the rate of verticals. Horizontal drilling requires fewer wells than is necessary when using vertical wells. Developing a one square mile section typically takes 16 vertical wells each with its own site pad, access roads, and pipeline installation. With horizontal welling, up to eight wells can be drilled from a single site pad. The use of this advanced horizontal welling significantly reduces the impact to the public, the natural habitat, and the overall environmental “footprint.”

Removing shale gas from the tight rock formations requires a stimulation of the reservoir to increase permeability. Hydraulic fracturing is the technology that does this by pumping a water-sand mixture into the underground rock. The pressure creates tiny fissures in the rock, and the sand opens up the fissures allowing the gas to escape into the well. Although hydraulic fracturing has been in use since the 1940s, recent advances in technology have made it more feasible to use at the depths required for shale gas extraction.

During hydraulic fracturing, ground water is protected through the combination of the casing and cement that is installed when the well is drilled. In addition, there are typically thousands of feet of rock between the fracture zone and any fresh or treatable aquifers. Fracture fluids are 98% water and sand, and the remaining 2% is additives that help improve the fracturing process.

Approximately 2 to 4 million gallons of water are needed for hydraulic fracturing in each well, which is less than used by agricultural operations, electronic power generation, and municipalities. Once used, fracturing fluids are typically recovered and recycled in a closed system or disposed of according to the Clean Water Act and other regulations.

Exhibit 2: Components of frac'ing fluids



Drilling for shale gas: Common operational risks

Much of the shale gas operations in the U.S. are performed by subcontractors that have years of experience and specialize in high-pressure, deep well drilling. Current demand for these types of services across the country is attracting less experienced contractors to this type of exploration work, while they may only have experience with low-pressure, low-volume type of drilling. From a risk management perspective, it's critical that companies use subcontractors that have certificates or insurance and have annual master contracts with hold harmless clauses.

Even for experienced subcontractors, potential risks that can emerge during shale gas operations include:

- **Bending of the steel pipe** – The pipe needs to fit into a small diameter hole and then curve into the horizontal leg. Although improvements have been introduced to the steering tools used in placing the pipe in horizontal wells, the bend is the one area that is susceptible to failure under high pressure if not installed to the highest standards.
- **Integrity of pipe and casings** – Shortages of U.S. milled pipe have led some contractors to buy foreign made supplies that may not be fabricated or rolled to American Petroleum Institute (API) specifications. In addition, if strings of casing are mixed between sources, this can cause breaches. It's important to review the casing program to determine what specific pressures can be applied, and limit the squeeze pressures to a level below what the pipe is designed for.
- **Perforation of steel casing** – The cyclical stress on the casing can cause perforations. Casing is manufactured to API standards, but repeated high pressure of 8 to 12 thousand pounds can build up stress on the casing. When casing is perforated, the inside of the pipe can be exposed to the outer rock formation.
- **Fracturing pressure intermediate casing** – Intermediate casing normally has a lesser internal yield or burst pressure, and once it is drilled through has even less. A good casing program should not allow for fracturing through intermediate casing.

- **Surface valve failure** – Having the ability to control frac'ing operations at the surface is important. Good risk management prefers to see redundancy in frac valves at the surface in order to have back-up if one becomes inoperable.

Beyond the risks posed by these underground drilling operations, other issues can arise at the surface:

- Employee injuries caused by blowout preventer malfunction, hose bursts, manual moving of fracturing fluid additives, fleet and transportation accidents to and from the job site, and environmental exposures (heat exhaustion, etc.)
- Public nuisance claims resulting from the damage to neighboring property caused by trucks
- Vehicle accidents caused by inexperienced drivers and rough terrain

Heightened environmental scrutiny for shale gas operations

If the operational risks mentioned above were the only issues facing developers, the subject of shale gas drilling in this country wouldn't be making as much national and local news as it has over the last few years.

Two of the largest shale gas formations—Barnett and Marcellus—are located close to major urban population centers. The Marcellus shale is also located next to abandoned coal mining operations where methane gas is present. In the Northeast, the legacy of environmental damage from coal mining operations still weighs heavy over public officials and residents.

Environmental concerns for shale gas drilling include:

- Potential chemical spills causing pollution of local pond and irrigation canals
- Natural gas or fracturing chemicals seeping into the water table due to an inadequate casing cementing
- Natural gas leaching into municipal drinking water
- Inappropriate disposal of fracturing mixture
- High water volume required for shale gas fracturing

Regulations governing hydraulic fracturing have been in existence for 50 years. Multiple federal, state and local government rules address environmental protection during shale gas operations, including the protection of water resources. These rules cover well permitting, well materials and construction, safe disposition of used hydraulic fracturing fluids, water testing, and chemical recordkeeping and reporting.

Although fracturing fluids are 98% water, concern has been raised about the nature of the additives in the remaining 2% of the fluids. Ten states already require some level of disclosure of substances used in shale gas drilling. On September 9, 2010, the Environmental Protection Agency issued voluntary information requests to nine leading national and regional hydraulic fracturing service providers. The EPA is seeking information on the chemical composition of fluids used in the hydraulic fracturing process, data on the impacts of the chemicals on human health and the environment, standard operating procedures at hydraulic fracturing sites and the locations of sites where fracturing has been conducted. The data will be incorporated into the Hydraulic Fracturing Study with initial study results available by late 2012.

In the Marcellus area, the Delaware River Basin Commission recently published new regulations that govern a range of drilling activities, including requiring drilling companies to post a bond of \$125,000 per well to cover the plugging and restoration of abandoned wells, and any remediation necessary.

Transferring environmental and other risks through appropriate coverages

A shale gas operator's general liability may not cover all the risks associated with shale gas exploration and production. That's because most casualty policies provide "sudden accidental coverage" and have a defined reporting and discovery period, sometimes as little as 72 hours for discovery and 30 days for reporting.

Pollution policies, on the other hand, provide for "gradual accidental coverage" and do not have defined reporting provisions. For example, in the case of a fracturing fluid leaking into a water supply, general liability would not cover this incident while a pollution policy would. An environmental pollution policy can bridge the coverage gap that exists if a shale gas operation is only covered by general liability.

Shale gas exploration represents a great opportunity for energy independence and economic growth in the U.S. For developers, balancing this opportunity with the appropriate risk management strategies and risk transfer products is critical in order to have the necessary protection if an operational or environmental event does occur.

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