



Fracking Under Pressure

The Environmental and Social Impacts
and Risks of Shale Gas Development

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This report is the first in Sustainalytics' series exploring unconventional fossil fuel development. Shale gas, deep water drilling and oil sands are examples of the unconventional oil and gas plays that producers are currently exploiting in response to growing global energy demands. Sustainalytics will examine these emerging trends in fossil fuel production and address the potential risks and opportunities faced by companies and their investors.



Fracking Under Pressure

Executive Summary

Despite mounting evidence of climate change and the resulting need to shift toward a lower-carbon economy, the demand for fossil fuel continues to rise. Natural gas production and consumption are projected to continue to increase in both absolute terms and as a proportion of the fossil fuel mix. Meanwhile, reserves of conventional sources of oil and gas are dwindling and producers are increasingly focusing on unconventional sources, the development of which usually generates higher environmental and social risks.

Shale gas is one such unconventional source. Shale gas reserves are vast, with especially large deposits in China, the U.S., and Russia. However, the environmental and social impacts of shale gas extraction have generated a significant amount of controversy. Impacts such as high levels of fugitive emissions are causing concerns about local air quality and contributions to climate change. Many communities are also concerned about industrial development in rural and remote regions; high levels of water consumption and the disposal of contaminated water; the increased risk of earthquakes in some areas; and surface water contamination. Many of these impacts are directly related to the process of hydraulic fracturing, which has generated the majority of the controversy surrounding the shale gas industry. It is important to note, however, that hydraulic fracturing is just one step in the shale gas extraction process.

Although some public concern may be based on exaggerated estimates of likely impacts, these impacts have nonetheless generated, and will continue to generate, significant reputational risks for individual companies, their investors, and the shale gas industry as a whole. The industry also faces regulatory risks, including regional moratoriums on the practice of hydraulic fracturing, and litigation risks related to alleged contamination and negative impacts on human health.

The basic methods employed in shale gas extraction are not new, and over the past 20 years energy service companies and producers have worked to advance the technology, making significant gains in efficiency and costs, in addition to environmental gains. However, there is still a long way to go to develop and improve best practices. To reduce their risks investors should encourage their holdings to improve transparency, use green products, implement process changes, manage contractors, and engage with communities. Specifically, risk mitigation can be accomplished by implementing best practices such as disclosing the composition of fracturing fluid, baseline water testing, using green fracturing fluids, recycling flowback water, and conducting well integrity testing. Ensuring that contractors adhere to company standards is also a major factor to both regulatory compliance and risk aversion. In this equation there is not only risk but also opportunity to develop lower-impact methods and technologies. Innovation will be the key to long-term success.

Responsible investors have an important role to play in decreasing impacts and mitigating risks associated with natural gas development. They should use their leverage, through engagement and other means, to encourage the adoption and ongoing development of best practices, and encourage innovation among their holdings.

At the same time responsible investors should view shale gas development in the context of the broader need to shift our economy away from its dependence on fossil fuels. Shale gas development, even with best practices in place, does nothing to contribute to this shift. Therefore, while pushing for best practices, responsible investors should push even harder for investment in renewable, sustainable forms of energy and for regulatory environments that incentivize such investment.

Introduction

In the winter of 2010, in a remote region of Canada, a gas company completed 274 fractures in 16 wells from a single well pad over a 111-day period. According to the company, 21.2 million litres of water and 50.3 million kilograms of sand were used in the project. Extrapolating those numbers, approximately 1.0 million litres of toxic chemicals were pumped into the ground. The goal of this massive input of energy and chemicals was to release natural gas that was trapped in the rocks below. At the time the project was cited as the “World’s Largest Frac Job,” a title that the project did not hold for long.

The shale gas boom in the United States has garnered significant media attention, especially related to one aspect of the extraction process: hydraulic fracturing, also known as fracking or hydrofracking. Water usage, water pollution and a host of other environmental and social impacts have resulted in regulatory fines and have caused some companies to lose their social license to operate. Such impacts have marred the reputation of the global unconventional gas industry, which is now struggling to address concerns among investors, politicians and the public about the scale and probability of negative impacts.

In this report Sustainalytics looks at the consequences and risks of shale gas development that are of primary interest to investors, profiles best practices, outlines an investor initiative, and provides a clear agenda for shareholder engagement with shale gas companies.

Global Energy Demand and the Shift Toward Unconventional Oil and Gas

Climate change pressures have resulted in a global call for a reduction in energy demand and a lower-carbon fuel supply; however, this transition will take decades. The current reality is that energy consumption, mainly in non-OECD countries, is on the rise. The International Energy Agency’s *World Energy Outlook 2010: New Policies Scenario* projects that by 2035 global energy consumption will increase by 36 per cent above 2008 levels.¹ In this scenario fossil fuels continue to supply the bulk of energy well past 2035. Natural gas consumption has the highest projected growth rate among fossil fuels.

As demand for fossil fuel continues to grow, many conventional sources are being depleted, and a large proportion of known available reserves on the planet today – an estimated 87 per cent – are under the control of national oil companies (NOCs).² NOCs do not completely impede the access of publicly traded companies to these resources; however foreign companies are subject to operating restrictions which often include partnerships with NOCs and technology transfer requirements.

Due to restricted access to known reserves, many public companies are shifting their operations into higher-risk areas and into unconventional oil and gas deposits. High-risk regions are generally characterized by social volatility or environmental sensitivity, while unconventional deposits are those that either contain heavier or more contaminated oil or gas, or that occur in less accessible reservoirs or rocks. Typically, unconventional reservoirs have low permeability, meaning that oil or gas is present but it cannot easily flow, and therefore conventional extraction methods do not generate profitable returns.

The scale of global unconventional fossil fuel resources is vast. In the case of natural gas, total recoverable resources could sustain today's production rates for 250 years.³ Unconventional gas is where much of the growth in production will be in the coming decades; 35 per cent of the global increase in gas production projected by the International Energy Agency (IEA) by 2035 is expected to come from unconventional sources such as shale gas, coalbed methane, tight gas and methane hydrates.⁴

It should be noted that major growth in natural gas production may result in lower natural gas prices, which are expected by some to weaken incentives to develop renewable energy. Fatih Birol, chief economist at the IEA, recently stated that "If gas prices come down, that would put a lot of pressure on governments to review their existing renewable energy support policies ... We may see many renewable energy projects put on the shelf."⁵ Also important is unconventional oil and gas extraction generally has a higher risk profile and is more resource intensive than conventional oil and gas extraction, meaning that, for investors, the environmental and social risks for the entire industry are increasing. This report explores this trend as it relates to shale gas development.



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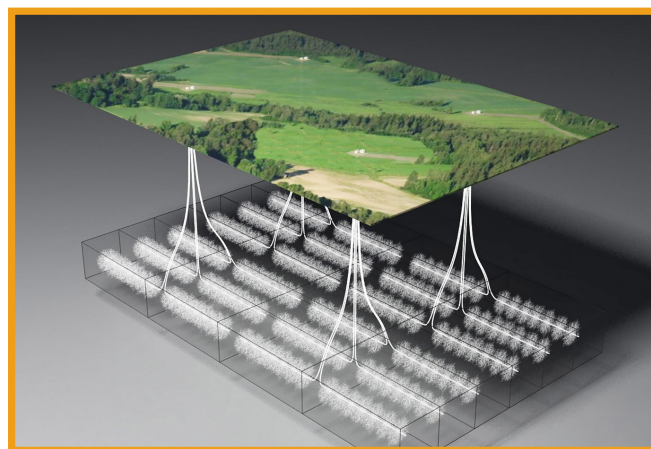


Shale Gas Explained

Shale gas is natural gas (also known as methane or CH₄) produced from organic-rich, fine-grained sedimentary rocks with low permeability. The shale rock can be both the storage material and creator of the gas through the decomposition of organic matter. Shale gas occurs in a wide variety of rock compositions, often requiring operational adaptations. Therefore, the technology and techniques used at one well may not translate into success at another shale gas location.

Unconventional extraction techniques, including horizontal drilling and hydraulic fracturing, are required to access shale gas. Typically, wells are drilled vertically from the surface down to the target formation. Horizontal drilling is then conducted through the target formation. Vertical well sections may be drilled to a depth of hundreds to thousands of feet, while horizontal sections may extend 1,000 to 6,000 feet away from the well.

Once the exploration well is drilled hydraulic fracturing is used to stimulate the well, causing natural gas to flow freely from the rock pores to production wells that bring the gas to the surface. During hydraulic fracturing sand, water and chemical additives are pumped down the well into the formation at high pressure. When the pressure exceeds the rock strength, the fluids open or enlarge fractures that can extend several hundred feet away from the well. The sand keeps the newly formed fractures from closing when the pumping pressure is released. These fractures allow the natural gas to flow.



This illustration shows an example of a shale gas development with several well pad sites. Each well pad has six producing wells. Multiple horizontal wells per pad limit footprint and impact on the surface (source: Statoil).

The Growth of Shale Gas Development

The U.S shale gas boom began in Texas' Barnett Shale in the 1980s and, around 2006, shifted to other U.S. shale formations such as the Fayetteville, Haynesville and Marcellus formations in the southern and north eastern U.S.⁶ Although hydraulic fracturing began in the 1950s and horizontal drilling began in the 1980s, the combination of the two techniques stimulated growth within the shale gas industry. Between 2000 and 2006, U.S. shale gas production grew at an average annual rate of 17 per cent, while the average annual rate between 2006 and 2010 grew to 48 per cent.⁷ U.S. shale gas production is projected to grow almost fourfold above 2009 levels by 2035, when it is expected to represent 47 per cent of total U.S. gas production, up from its 16 per cent share in 2009.⁸

Although much development has occurred in the U.S., shale gas deposits are found in many countries. Canada, Poland, France, South Africa, Argentina and China are all known to be developing shale gas.

Shale gas resources are vast. As of January 1, 2010, world technically recoverable shale gas resources were estimated at roughly 7,060 trillion cubic feet, or about 25 per cent of total technically recoverable global natural gas, as illustrated in Table 1.⁹ It should be noted that estimates are uncertain and will likely be higher when better information becomes available.

Region	Total Gas (TCF)*	% Shale Gas
Eastern Europe & Eurasia	8,119	0%
Middle East	4,907	10%
Asia Pacific	4,095	44%
OECD North America	4,836	40%
Latin America	2,577	48%
Africa	2,330	44%
OECD Europe	1,341	42%
World	28,205	25%

Table 1: Remaining Recoverable Natural Gas Resources by Region

*trillion cubic feet

Source: *World Energy Outlook 2011 Are we entering a golden age of gas? Special Report*. 2011. Paris: International Energy Agency.

Although shale gas is being developed globally, production is much more advanced in the U.S., which is at the forefront of the hydraulic fracturing debate in the both the political arena and investor circles.

Shale Gas Developments Around the World



1 Canada

The Horn River Basin has been called the most geographically remote, commercial-scale gas field producing in North America. Although pipeline infrastructure is a major limit to growth in the region, the South Peace Natural Gas Pipeline (Spectra Energy) and the Pacific Trail Pipeline (Apache, EnCana and EOG Resources) will alleviate bottlenecks in the region. Active companies include Apache, EnCana, ExxonMobil, Devon Energy, Talisman and PetroChina.

2 Argentina

Shale gas deposits are 2-3 times thicker than North American deposits. Development speed will depend on government policy which has historically kept gas prices artificially low and has recently created the Gas Plus Program to encourage unconventional development. The area is currently a gas importer via liquid natural gas. Active companies include Repsol YPF, ExxonMobil, Total and Apache.

3 South Africa

Water sourcing and infrastructure issues will be key to the development of the water-scarce Karoo Basin. However, potential shale gas resources may be very attractive as natural gas can be used as a feedstock to their gas-to-liquids and coal-to-liquids plants. Active companies in the region include Chesapeake Energy Corp., Statoil ASA, Sasol Ltd and Royal Dutch Shell.

4 Poland

Exploration is concentrated in a corridor running from Poland through Germany to the U.K. Demand is high due to the region's current reliance on Russian gas. Unconventional gas production is likely to experience delays due to logistics, as the majority of the equipment and expertise is already occupied in North America, and regulatory delays since European regulators are likely to approach hydraulic fracturing in a more cautious manner than their North American counterparts due to environmental concerns. Active companies include PGNiG, ExxonMobil, Chevron, Marathon, and ConocoPhillips.

5 China

Complicated geology and national policies result in technological and cost barriers. However in 2009, U.S. President Obama and Chinese President Hu signed a Shale Gas Initiative which would promote environmentally sustainable development of shale gas resources, and conduct joint technical studies to accelerate development of shale gas resources in China. Foreign companies looking to operate in the region must participate in production sharing contracts with an NOC. Active companies include PetroChina, Sinopec, CNOOC and Shell.

Potential Impacts of Shale Gas Extraction

The entire shale gas development process – from exploration to production to transportation – has significant impacts on air, land, water and people.

GHG and Other Air Emissions

With respect to greenhouse gas (GHG) emissions, the burning of natural gas creates fewer GHG per unit of energy than the burning of oil or coal; however, this may not hold when looking at the full life cycle of natural gas. In April 2011, scientists at New York's Cornell University found that current shale gas extraction techniques may result in a greater carbon footprint than oil, coal and conventional gas over at least a 20-year period.¹⁰ This higher footprint is caused by higher fugitive emissions generated during the fracturing and completing processes, and from emissions related to the transportation of materials. The average fractured well requires hundreds of truck loads of water and sand. Oil and natural gas production and processing accounts for nearly 40 per cent of all methane emissions in the U.S., making the industry the nation's single largest methane source.¹¹

With respect to other air emissions, shale gas production has negatively affected local air quality in some regions as a result of the release of volatile organic compounds (VOCs), which occurs during the completion or flowback phase of well development, and during the compression and transportation of the natural gas. These emissions contribute to the formation of ground-level ozone (smog) and have been linked to cancer and other health effects such as increased asthma attacks, hospital admissions and emergency room visits, and premature death.



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Land

Companies can drill tens of horizontal wells from a single vertical well, resulting in fewer well pads and associated infrastructure, such as roads and pipelines. However, in some shale gas rich regions, development is progressing at an alarming rate. As a consequence, the disturbed area can be large and the cumulative effects of the development can create fragmented habitats. For example, in north eastern British Columbia, Canada, mammals with large territories such as caribou and grizzly bears are likely to be impacted. The potential for spills is also of concern. In the U.S., incidents have included spillage of hydraulic fracturing chemicals en route to drill sites, spillage of produced water en route to wastewater disposal sites, and on-site spillages caused by improper hose connections or pits that were not lined adequately.

Water

From an environmental perspective, the most significant impact of shale gas development results from the use and disposal of the water needed to fracture wells. Fracturing requires tens of millions of litres of water, and local withdrawal sites must be able to support massive and often ongoing water removal. The impact of fracturing on water quality is also significant.

When water is injected into the well, about 0.5 per cent of it consists of chemicals that facilitate the fracturing process. Although this percentage is low, the total quantity of chemicals used is alarming. For example, a fracturing job that uses 15 million litres of water contains 75,000 litres of chemicals.¹² Moreover, the fracturing fluids are not all returned to the surface. An estimated 50-90 per cent of the fluids remain underground in the shale formation. Some fracturing water is returned to the surface, often with saline water that naturally existed in the shale formation. This produced water can be reused, disposed of via reinjection wells (in some regions) or shipped to an offsite wastewater disposal facility.

Worth noting is a 2011 New York Times investigation which revealed that fracturing wastewater containing worrying levels of naturally occurring radioactivity was being released into Pennsylvania rivers.¹³ Furthermore, there are many anecdotal reports linking reinjection sites to earthquakes.¹⁴ One study of seismic activity in Texas found reinjection wells to be a plausible cause for a series of earthquakes that occurred in the area.¹⁵

Natural gas is extracted through the well. However, incorrectly cemented wells or improperly installed casings can allow the natural gas or fracturing fluids to migrate to local receptors such as groundwater, surface water, neighbouring rock formations and even into homes. Natural gas can be fingerprinted to determine if it is of deep or shallow origin. However, it is difficult to connect the fracturing chemicals directly to groundwater contamination because the composition of the fracturing materials, including chemical formulas, is proprietary information. Thus groundwater monitoring programs cannot be designed to detect the fracturing substances.

Evidence of Groundwater Contamination

Cases of water contamination near gas drilling sites have been reported by residents in Colorado, Ohio, Pennsylvania, Louisiana and Texas; and the U.S Environmental Protection Agency (EPA) is gathering data at a site in Wyoming. In May 2011, a peer reviewed study was published in Proceedings of the National Academy of Sciences that tested methane concentrations in 60 drinking-water wells in north eastern Pennsylvania and nearby areas of New York State. The study found significantly elevated levels of methane in wells located within one kilometre of hydraulic fracturing operations. The study did not examine a mechanism for the methane migration; however, analyses indicated that the methane could be traced to the deposits the oil and gas companies were fracturing deep underground. * No evidence of fracturing chemicals was found. However, the report noted that in some cases a mile of rock separated the bottom of the shallow drinking water wells from the deep fractured zones. The report also cited several potential mechanisms for the gas migration including: displacement due to underground pressures; migration via new fractures or connections to faults created by the hydraulic fracturing process; or leaks from the well casing and/or cementing closer to the surface. **

*Dissolved methane concentrations in water from the 34 wells located more than 1 kilometre from fracturing operations averaged about 1.1 milligrams of dissolved methane per litre. Dissolved methane concentrations in water from the 26 wells located less than 1 kilometre from fracturing operations averaged about 19.2 mg/L. See S.G. Osborn, A. Vengosh, N. R. Warner, and R. B. Jackson, Proceedings of the National Academy of Sciences USA advance online publication (2011).

**See Abrahm Lustgarten, "Scientific Study Links Flammable Drinking Water to Fracking," *ProPublica*, May 9, 2011. See <http://www.propublica.org/article/scientific-study-links-flammable-drinking-water-to-fracking>.

Social Impacts

Shale gas development in the U.S. and Canada is occurring largely in rural and remote regions. In rural regions large increases in transport traffic and oil and gas workers can dramatically alter a community's way of life. Although local economies stand to benefit, local infrastructure can quickly become degraded, and inflationary pressures can make regions unaffordable to long-time residents. Drilling rigs, running twenty-four hours a day, can create disturbing light and noise pollution. Furthermore, various lawsuits have been launched by homeowners in the U.S. citing detrimental health effects related to contaminated air and water.

Investor Risks

Reputational Risk

Gasland, an Oscar-nominated documentary, displays images of homeowners lighting on fire the water that flows from their kitchen faucets. Videos showing simple garden hoses being used as flame throwers are easily accessible on the Internet. Such visuals have discredited company messaging that hydraulic fracturing is not linked to water contamination. The negative media attention has led to a general mistrust of the shale gas industry, which can make it more difficult for companies to obtain both the legal and social license to operate in some regions. It is also evident that controversy in the U.S. shale gas industry has negatively affected public acceptance of hydraulic fracturing in Europe and Africa.

Regulatory Risk

Negative attention has prompted regulators in certain jurisdictions to issue moratoriums while the practice of hydraulic fracturing is investigated further. Currently, moratoriums or de facto moratoriums exist in New York, Maryland, Quebec, France, and South Africa. In India, an auction for shale gas exploration blocks was delayed for a year. Related to the moratoriums, various government investigations are underway in search of scientific evidence to help inform regulators' decisions. A likely outcome of these investigations is more restrictive regulations, which typically translate into higher compliance costs for operators or even the loss of drilling rights if moratoriums are extended. Companies with assets concentrated in regulated regions will face higher costs than other operators. Incidents such as spills of hydraulic fracturing fluids have already led to some significant fines for both operators and drillers.



Screen shot of a homeowner lighting their tap water on fire, from the film Gasland. Source imdb.com.

Regulatory Initiatives to Watch in the U.S.

The EPA is currently undertaking a Hydraulic Fracturing Study to understand the relationship between hydraulic fracturing and drinking water resources. The report will include the full life cycle of water in hydraulic fracturing, from sourcing, through the mixing of chemicals, fracturing, post-fracturing, to the management of flowback and produced water, and its ultimate treatment and disposal. Initial research results are expected by the end of 2012 with a goal for a report in 2014.*

In May 2011, U.S. Energy Secretary Steven Chu set up an expert panel as a subcommittee of the Secretary of Energy's Advisory Board. Within 90 days the panel is to identify any immediate steps that can be taken to improve the safety and environmental performance of hydraulic fracturing. Within six months the group is to provide recommendations to U.S. agencies on practices for shale extraction that will ensure the protection of public health and the environment.**

In July 2011, the EPA proposed four new air regulations for the oil and natural gas industry: 1) a new source performance standard for VOCs; 2) a new source performance standard for sulfur dioxide; 3) an air toxics standard for oil and natural gas production; and 4) an air toxics standard for natural gas transmission and storage.***

*See "U.S. Environmental Protection Agency Oil and Natural Gas Air Pollution Standards," EPA.gov. See <http://www.epa.gov/airquality/oilandgas/>

**See <http://www.energy.gov/news/10309.htm> See <http://www.shalegas.energy.gov/> for updates.

***See "U.S. Environmental Protection Agency Oil and Natural Gas Air Pollution Standards," EPA.gov. See <http://www.epa.gov/airquality/oilandgas/>

Litigation Risk

The risk of litigation is generally related to health effects and pollution. Lawsuits have been filed in several U.S. states alleging health impacts. In the state of Arkansas, at least five different cases were filed in May 2011 against companies such as Southwestern Energy Company, XTO Energy, Chesapeake Energy Corporation, and BHP Billiton. The cases relate to the practice of hydraulic fracturing and are all seeking class action status.¹⁶ Even if the companies implicated in such lawsuits are not found to be at fault, the legal costs will mount.

In January 2009, the Pennsylvania Department of Environmental Protection (DEP) began investigating connections between Cabot Oil & Gas's hydraulic fracturing activities in Dimock, Susquehanna County and residential water contamination. In November 2009, residents filed a lawsuit against Cabot for contaminating their water, causing illness and other issues. In September 2010, the DEP announced its plan to create a USD 12 million water pipeline for the 19 affected homes, with the intention of recouping costs from Cabot at a later date. In December of that year, the residents' lawsuit against Cabot was settled with the assistance of the DEP. The resulting settlement requires Cabot pay a total compensation package of USD 4.1 million to Dimock residents, as well as a provision to install whole-house gas mitigation systems in the affected homes.

Best Practices in the Shale Gas Industry

The composition of shale formations is not consistent; therefore a prescriptive list of operational best practices is not feasible. Oil and gas companies, working with their energy service providers, should evaluate local conditions and regulatory frameworks to determine locally appropriate best practices to limit impacts to the environment, local populations and the bottom line. Although not an exhaustive list, below are some topics on which investors can engage with shale gas operators and examples of companies that are implementing programs to reduce their impacts.

Transparency

Companies should disclose the chemicals, and their quantities, used in hydraulic fracturing fluids. Some are doing so, to varying degrees, through Fracfocus.org, a U.S. hydraulic fracturing chemical registry website jointly operated by the Ground Water Protection Council and the Interstate Oil and Gas Compact Commission. This site allows the public to search, on a well-by-well basis, for information about the chemicals used in hydraulic fracturing. Disclosure levels vary, from relatively simple, such as the Material Safety Data Sheet (MSDS), to the more detailed chemical disclosure by 43 oil and gas companies, and may include the fracture date, location, operator, and well depth.¹⁷ Some companies have also included specific information about the ingredients injected into the well such as the purpose of the product, the Chemical Abstract Service Number (CAS#), the concentration in the additive and the concentration in the fracturing fluid (% by mass).

Best practice in this area should include disclosure of all chemicals, not just those that appear on MSDS, according to the Shale Gas Subcommittee of the Secretary of Energy Advisory Board. The Subcommittee has recommended that regulatory entities immediately develop rules requiring the disclosure of all chemicals used in hydraulic fracturing fluids on both public and private lands.¹⁸ Best disclosure practices should also include public reporting of both operational successes and failures in order to build trust with local communities and investors.

Disclosure on Fracturing Fluid and Regulatory Infractions: Talisman Energy

In May 2011, a group of 12 companies expressed support for a Texas bill that would require the public disclosure (beyond MSDS standards) of ingredients used in hydraulic fracturing fluids on wells drilled in the state. The supporting companies included, among others, Apache, Anadarko Petroleum, BG Group, Southwestern Energy, and Talisman Energy.^{*} Furthermore, Talisman Energy recognized the controversy associated with Marcellus Shale operations and the need to communicate with the public about its operations. The company has dedicated a section of its website to the disclosure of all Notice of Violations issued to Talisman Energy USA by the Pennsylvania Department of Environmental Protection.^{**} Not only does the site list 2010 and 2011 violations, it also outlines each incident and how the company is responding to correct the issue. The disclosure assists stakeholders in tracking the company's violation trends and determining whether or not it is successfully addressing its shale gas risks.

^{*}Other companies supporting the bill include, El Paso, EnCana Natural Gas, EXCO, Linn Energy, Petrohawk Energy, Pioneer Resources, and Range Petroleum.

^{**} See http://www.talismanusa.com/how_we_operate/notices-of-violation/how-were-doing.html.

Baseline Water Testing

Investors should look for assurances that, in areas with drinking water wells, companies are obtaining and disclosing baseline water data and testing residents' water supplies before, during and after fracturing activities to monitor for changes. In the U.S. lawsuits have been filed by residents claiming that shale gas extraction activities caused natural gas to migrate into their drinking water supplies. Companies often claim the drinking water had methane in it prior to the shale gas activities. However, without baseline testing there is no clear, scientific answer to the issue. Baseline water testing can help protect companies against litigation and, in the case of contamination, provide homeowners with the evidence they need for timely and fair compensation.

Baseline Water Testing: Royal Dutch Shell

As few jurisdictions currently require baseline water testing it is often not a company-wide practice. Several companies, such as Chesapeake Energy and EnCana, engage in baseline water sampling when operating in contentious areas. However, for its operations in the water-stressed Karoo Basin in South Africa, Royal Dutch Shell has committed "to establishing mutually acceptable protocols for the independent monitoring of the water quality in existing water wells and surface water surrounding our activities."* Furthermore, the company has issued *Onshore Tight/Shale Oil & Gas Operating Principles*, in which it publicly commits to best practices in several areas, notably: "For development projects in new areas, we test potable groundwater before and after we drill to help determine whether changes have occurred as a result of our activity."

*"Commitment to the Karoo Community," Shell.com, http://www.shell.com/home/content/zaf/aboutshell/shell_businesses/e_and_p/karoo/commitments.html

Use of Green Products

Removing the toxic components of products is an effective way to reduce risk. In the medium to long term, companies should strive to reduce the quantity and toxicity of the materials they use. Such reductions will decrease the risk profile of operations by reducing the likelihood of water contamination and chemical exposure of employees, and by increasing the level of acceptance by local communities.

It is important to note that less toxic drilling materials were developed for offshore drilling operations in order to allow operators to discharge wastes into the ocean. Such products are now the industry norm. To capture this emerging opportunity in onshore shale gas operations, various energy service companies now offer green or less toxic fracturing fluids.

Reducing Toxics in Fracturing Fluids: Halliburton

In May 2011, El Paso Corporation completed a well using Halliburton's proprietary CleanSuite™ production enhancement technologies for both hydraulic fracturing and water treatment. CleanSuite™ includes CleanStim™, a hydraulic fracturing fluid comprised of ingredients sourced from the food industry, CleanStream™, a process that uses UV light instead of additives to control bacteria in water, and CleanWave™, a water recycling system. Overall the well produced faster, biocides were not needed and freshwater use was reduced.*

*See http://www.halliburton.com/public/news/pubsdata/press_release/2011/corpnws_050211_1.html?SRC=ElPasoandHalliburton

Process Changes: Fluid Management and Minimization

Water efficiency and strong fluid management practices are important for decreasing costs and avoiding spills. As water recycling and water use efficiency increases operators can reduce water transportation, treatment and disposal costs. Where possible, closed loop systems should be used instead of open pit storage. When operating properly, closed loop systems eliminate impacts associated with leaking storage ponds, decrease the release of volatile air emissions, and prevent evaporation, reducing the amount of water needed for each fracture operation.

As shale gas extraction develops in water-stressed regions the importance of minimizing freshwater use will grow; for instance, some companies are exploring the use of saline water and sea water. Nonetheless, water availability will be a resource constraint in some areas. Companies operating in the Canadian province of Quebec will also need to consider the cost of water use.¹⁹ Given water availability and cost constraints, technology to minimize and/or eliminate the use of water in shale gas extraction is an area of opportunity for energy service companies. Service companies investing in the research and development of alternatives such as nitrogen-based or freeze-thaw-based fracturing may have significant advantages in regions in which the water supply is limited or if water costs are prohibitive.

Flowback Water Recycling: Range Resources

By October 2009, Range Resources was successfully recycling 100 per cent of its flowback water in its operating areas in the Marcellus Shale, Pennsylvania. The company reported that water recycling had resulted in savings of approximately USD 200,000 per well. Furthermore, a reduction in truck traffic can decrease costs associated with road repairs, and a reduction in local noise and dust levels can improve relationships with local communities.



Process Changes: GHG and Air Emission Reduction

Fugitive emissions are unintended emissions of gases or vapours from pressurized equipment. Businesses naturally look to increase sales and decrease the loss of product. In the natural gas business the product is volatile and can literally leak out of vessels designed to transport and store it. These fugitive emissions are, essentially, revenue that is disappearing into the air. GHG and other air emissions are also released during the completion or flowback phase of shale gas production. Investors should request that companies implement aggressive leak detection and repair programs as well as green completions in order to limit the release of methane and VOCs during storage and transportation, as well as to increase revenues.

Green Completions: Devon Energy

Green completions have been Devon's standard practice in the Barnett Shale since 2004. Green completions, or reduced-emissions completions, use specialized equipment to separate gas and hydrocarbons from the fluid that flows back to the surface from the well. The gas is separated from the water and placed in a pipeline instead of being released to the atmosphere. The gas and hydrocarbons can then be treated and sold. Some states, such as Wyoming and Colorado, require green completions, and a number of companies are voluntarily using this process through the EPA's Natural Gas STAR program. Devon has been a member of the STAR program since 2003. In July 2011, the EPA proposed four new air regulations for the oil and natural gas industry (see text box above). Companies that are already implementing green completion, leak detection and repair programs, like Devon, are likely to have lower compliance costs associated with the new regulations proposed by the EPA.

Process Changes: Well Integrity Testing

Proper well design, drilling, well cementing and casing are all critical elements of well integrity in the long term. Wells are generally designed to meet minimum regulatory requirements. Companies rely on drilling progress reports, drilling fluid reports and cement design reports to track the well construction process. However, assessing the quality of a cement job and overall well integrity requires other supporting data such as laboratory reports, open-hole log information, and mechanical integrity tests. For example, the effectiveness of the cement seal should be tested with various hydraulic pressure tests to ensure well integrity. Acquiring cement bond logs, which measure the presence of cement and the quality of the cement bond or seal between the casing and the formation, is considered a best practice. Although there is a cost associated with such testing, it does provide a clear indication of proper cementing.

Contractor Management

Investors also need assurances from companies about the reliability of contractors, particularly those contractors performing critical tasks such as drilling and casing. Sloppy drilling practices, inconsistent cementing and poor fluid management have caused the majority of the negative attention on the shale gas industry. In many cases wells have not been constructed properly, causing methane migration. In other cases hydraulic fracturing fluid has spilled during transport or from storage vessels. Generally, companies have an on-site representative at drilling operations who is responsible for ensuring that the drilling process is conducted in accordance with the operator's standards.

However, given the number of incidents in the U.S., it is clear that the presence of this representative may not always be sufficient. Clear contractual expectations as well as ongoing contractor auditing and training are essential.

Community Engagement

Although the prospect of jobs, tax revenue, and local procurement can be attractive for some communities, others will be opposed to extractive activities, especially those involving the large-scale industrialization of natural areas. Given this reality, engagement with local communities should begin early in the process and continue throughout the project. Resolving issues early can build positive local relationships which can be leveraged for future growth opportunities.

In this regard it is important to note the pace at which shale gas extraction and production took off in the U.S. The upswing in shale gas development has brought many smaller operators into communities very quickly. Generally, smaller operators do not have clear community engagement strategies or detailed written operating procedures. Everything from emergency response plans to drilling contracts and logistics coordination are often adopted boilerplate from other projects. As a result, the shale gas industry has been very controversial in states with weaker regulatory environments. In other jurisdictions, pre-emptive public policy and regulations should serve to smooth out concerns surrounding development by tailoring the regulatory system to the specific challenges associated with unconventional gas extraction.

Early Public Commitments and Engagement: Royal Dutch Shell

Royal Dutch Shell is in an early exploration phase for shale gas in South Africa. Although the company has not determined the extent of the resource in the area, it has engaged with the local community and has publicly committed to: setting up an independent advisory committee and a citizen advisory group; compensating landowners; utilizing best practices; and ensuring that it does not compete with the people of the Karoo for water resources. The company states: “Nobody will go short of fresh water because of our operations; either in the exploration phase, or if there is any further development.”* By clearly articulating how it plans to operate and demonstrating actions to meet those commitments, the company is more likely to gain community acceptance and local approvals.

*See “Commitment to the Karoo Community,” Shell.com, http://www.shell.com/home/content/zaf/aboutshell/shell_businesses/e_and_p/karoo/commitments.html

Investors Respond

In order to limit exposure to the potential shareholder impacts associated with shale gas extraction and maximize the opportunities, investors should engage with their holdings and ask for disclosure and the use of best practices.

In the U.S. the most active investor coalition is led by the Investor Environmental Health Network and Green Century Capital Management. In addition to dialoguing with companies and other stakeholders about the risks associated with hydraulic fracturing, the coalition has filed 21 shareholder resolutions with U.S.-based companies in the past two years, focusing largely on enhanced reporting of environmental impacts related to hydraulic fracturing and on options to mitigate such impacts. In 2010, six resolutions went to a shareholder vote and averaged 30 per cent support. In 2011, five resolutions averaged 40 per cent support, with a high of 49.5 per cent at Energen. If abstentions were included in the statistics, there were several cases in which the majority of shareholders did not support management.²⁰ To put these numbers into context, support in the range of 30-40 per cent for first- and second-year environmental resolutions is unprecedented in the U.S. Climate change resolutions have usually taken 6-10 years to gather this level of support. The coalition members continue to dialogue both publicly and privately with their holdings, and shareholder resolutions will continue to be filed with companies that are not adequately addressing the risks associated with hydraulic fracturing.

There is growing interest in shale gas issues among institutional shareholders outside the U.S. as well. In Canada, for example, Shareholder Association for Research & Education (SHARE) and NEI Investments are engaging with companies with respect to hydraulic fracturing chemical disclosure and water risks respectively.²¹



Conclusion

As global demand for natural gas increases, producers are increasingly looking to unconventional oil and gas sources such as shale gas. The shift is, however, raising the risk profile of the industry. Global reserves of shale gas are vast, but its development causes environmental and social impacts, the most significant of which are impacts on water, the release of greenhouse gas emissions and methane migration. Such impacts have created reputational, regulatory and litigation risks for companies and for their investors.

These impacts and their associated risks can, to a significant degree, be mitigated through the implementation and further development of best practices. In some areas, best practices can be implemented immediately. In others they will require time and innovation. Of primary importance are:

- **Transparency** – Increasing transparency, especially regarding fracturing fluid, is of immediate importance. Some U.S. investors and regulators have already raised the bar in this area.
- **Baseline water testing** – In order to monitor and better understand the impact of hydraulic fracturing on local water quality, baseline testing is essential. The results should be reported to local communities and to regulatory authorities.
- **Green Products** – Companies should strive to reduce the toxicity of the fracturing fluids that they use in order and lessen the risk of water contamination. This will require innovation.
- **Process Changes** – These should include green completions (to reduce fugitive emissions), the recycling of flowback water (to reduce pressure on water resources), and well integrity testing (to reduce contamination risks). Innovation is key to this area as well, and investors should be looking for opportunities associated with second- and third-generation fracturing techniques.
- **Operational Management** – Critical to this area is contractor supervision and auditing. Companies need assurances that their contractors are executing the agreed upon procedures in a responsible manner.
- **Community Engagement and Consultation** – This needs to begin at an early stage, to be continuous, and to include both households and local government.

While the practices above are important and should be encouraged, it should be noted that they do nothing to mitigate the contribution of the consumption of natural gas to climate change. Indeed, large supplies of cheap shale gas may detract from incentives to develop renewable energy and shift away from fossil fuels. Therefore, while pushing for impact mitigation in the shale gas industry, responsible investors should also push for investment in renewables and for regulatory environments that incentivize such investment.

Responsible investors therefore have an important role to play, both to encourage best practices and support innovation in the natural gas industry, and to support the much-needed shift toward a more sustainable energy economy.



Endnotes

¹ *World Energy Outlook 2010* [2010]. Paris: International Energy Agency.

² NOCs are companies that are fully or majority owned by a national government.

³ *World Energy Outlook 2011 Are we entering a golden age of gas? Special Report*. 2011, Paris: International Energy Agency.

⁴ *World Energy Outlook 2010* [2010]. Paris: International Energy Agency.

⁵ Fiona Harvey, "Natural gas is no climate change 'panacea', warns IEA," *The Guardian*, June 6, 2011. See <http://www.guardian.co.uk/environment/2011/jun/06/natural-gas-climate-change-no-panacea>.

⁶ *World Shale Gas Resources: An initial assessment of 14 regions outside of the United States*, April 2011, Washington: U.S. Energy Information Administration, U.S. Department of Energy. (<http://www.eia.gov/analysis/studies/worldshalegas/pdf/fullreport.pdf>).

⁷ *Annual Energy Outlook 2011 with Projections to 2035*, April 2011, Washington: U.S. Energy Information Administration, U.S. Department of Energy.

⁸ Ibid.

⁹ *World Energy Outlook 2011: Are we entering a golden age of gas? Special Report*, 2011, Paris: International Energy Agency.

¹⁰ Robert W. Howarth, Renee Santoro, and Anthony Ingraffea, "Methane and the greenhouse-gas footprint of natural gas from shale formations. A letter," *Climatic Change* 106 (2011):679–690 (<http://www.springerlink.com/content/e384226wr4160653/fulltext.pdf>). Global-warming potential (GWP) is a relative measure of how much heat a GHG traps in the atmosphere over a specific time interval, commonly 20, 100 or 500 years. The 20-year GWP of methane is 56, while that of carbon dioxide is 1, meaning that methane will trap 56 times more heat than the carbon dioxide over a 20-year period. The study concludes that the GHG footprint for shale gas is greater than that for conventional gas or oil when viewed on any time horizon, but particularly over a 20-year period. Compared to coal, the footprint of shale gas is at least 20 per cent greater and perhaps more than twice as great on the 20-year horizon, and is comparable when measured over 100 years.

¹¹ *Proposed Amendments to Air Regulations for the Oil and Natural Gas Industry Fact Sheet*, July 2011. Washington: U.S. Environmental Protection Agency. See <http://www.epa.gov/airquality/oilandgas/pdfs/20110728factsheet.pdf>.

¹² "Range Answers Questions on the Hydraulic Fracturing Process," RangeResources.com. See <http://www.rangeresources.com/Media-Center/Featured-Stories/Range-Answers-Questions-on-Hydraulic-Fracturing-Pr.aspx>. Typically, it takes 11-15 million gallons of water to stimulate a shale well, which is equivalent to the water usage at a typical golf course for nine days.

¹³ I. Urbina, "Regulation lax as gas wells' tainted water hits rivers," *The New York Times*, February 26, 2011.

¹⁴ Joyce Nelson, "Does Gas Fracking Cause Earthquakes?" *Water Sentinal*, March/April 2011 issue. See <http://www.watershedsentinel.ca/content/does-gas-fracking-cause-earthquakes>.

¹⁵ Cliff Frohlich, Eric Potter, Chris Hayward and Brian Stump, "Dallas-Fort Worth earthquakes coincident with activity associated with natural gas production," *The Leading Edge*, March 2010, 270. See <http://smu.edu/newsinfo/pdf-files/earthquake-study-10march2010.pdf>.

¹⁶ Gregg Rosen, "Hydraulic Fracturing Cases in Arkansas Seeking Class Action Status," *Mondaq Business Briefing*, August 3, 2011.

¹⁷ As of August 2011, see <http://fracfocus.org>.

¹⁸ "The SEAB Shale Gas Production Subcommittee Ninety-Day Report – August 11, 2011," Shalegas.energy.gov. See http://www.shalegas.energy.gov/resources/081111_90_day_report.pdf.

¹⁹ Gowlings, *Environmental Law for Business Seminar*, May 12, 2011 outlines that, as of January 2011, oil and gas operations must track their usage and pay CAD 0.07 per m3 of water used. Annually, companies must pay for the water whether it comes from a distribution system or is taken directly from the surface water or groundwater.

²⁰ See <http://iehn.org/resolutions.shareholder.php> for the text of the resolutions, the lead filers and the outcome of the resolutions.

²¹ See <http://www.share.ca/services/shareholder-engagement/current-engagement-topics/toxic-chemicals/> and <http://www.neiinvestments.com/NEIFiles/PDFs/5.2.1%20Focus%20List%202011/Corporate%20Engagement%20Focus%20List%202011%20EN.pdf>.



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As Sustainalytics' global energy sector lead, Dayna is responsible for overseeing research, ensuring quality assurance and conducting best-of-sector analysis for energy companies. Prior to joining the firm, she developed a combination of academic understanding and practical experience working within the agricultural, forestry, mining and oil industries. Her previous experience spans corporate policy writing, environmental auditing and hydrogeology-focused consulting. Dayna holds a Bachelor of Science in Earth Surface Science from the University of Guelph and a Master's degree in Environment and Sustainability from the University of Western Ontario. She has conducted field work in Ontario, Alberta, Nunavut, the U.S. mid-west, St. Kitts and Nevis and Iceland.

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