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Hydraulic fracturing and water pollution: Investor risks from North America's shale gas boom

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Abstract: North America's vast shale gas resources are projected to become a major resource for the coming decades, as the U.S. and other countries seek to move toward cleaner energy sources and to become less dependent on foreign oil and natural gas imports. Shale gas extraction presents significant risks, however, and concern is growing that the methods that make it viable are polluting drinking water sources with toxics. As companies prepare to intensify shale gas extraction in Canada and the U.S., investors need to look into the risks that the extraction process presents, and the steps they can take to mitigate those risks.

Introduction

The Wall Street Journal recently predicted that natural gas extracted from shale rock "will become the game-changing resource of the decade."[1] A wave of drilling has uncovered enormous supplies of natural gas embedded in shale rock deep below the Earth's surface, which thanks to new technologies can now be recovered in a cost-effective manner. According to some estimates, shale gas recoverable in North America alone would be enough to supply the United States' natural-gas needs for the next 45 years.[2]

North America's shale gas resources are extremely appealing for at least two reasons: first, natural gas produces considerably fewer greenhouse gases than both oil and coal, so it is expected to play a central role in the transition toward clean fuels in a low-carbon global economy. Second, the development of North America's shale gas resources will enable the U.S. and other Western countries to become less dependent on the Middle East for oil, and on natural gas imports from major producers such as Russia, Iran and Venezuela.

Shale gas extraction also presents risks, however, and there is growing concern over claims that the methods that make it viable are polluting underground sources of drinking water with toxic chemicals. As companies gear up to expand shale gas production in the U.S. and/or Canada (including Canadian companies EnCana Corporation, Talisman Energy Inc. and Nexen Inc.), investors need to look into the regulatory, litigation, reputational and social risks associated with shale gas extraction, and consider the steps they can take to mitigate those risks.

What is unconventional gas?

Unlike conventional gas, unconventional gas sources such as gas shales, tight gas sands and coalbed methane require special extraction methods to be economical. In order to develop shale gas in a cost-effective way, companies must use a combination of new, horizontal drilling techniques, and a technology called "hydraulic fracturing."

In plain terms, hydraulic fracturing involves pumping vast amounts of fluid into a gas well at extremely high pressure in order to produce mini-earthquakes in the rock that surrounds the well. The objective is to open fractures or cracks in the rock through which tightly stored gas can be released and find its way into the gas well. Thanks to recent advancements in drilling and fracturing techniques, companies can now drill up to 30 horizontal wells from a single location, and fracture each well up to 10 times.

Why is hydraulic fracturing a cause of concern?

In addition to surface disruption common to oil and gas development, hydraulic fracturing presents challenges due to the nature of the fluids used in the process. Hydraulic fracturing fluids (commonly known as 'frac fluids') are made up of millions of gallons of water, a mix of chemicals that fulfill various purposes (e.g., the prevention of micro-organism growth in fractures and of metal pipes corrosion), and sand or another agent to ensure that the cracks remain open and allow the gas to continue to flow through them.

Companies rarely disclose the chemical composition of their frac fluids, but information gathered by independent researchers and government agencies reveals that toxic chemicals that can have serious health effects in low doses are often part of the mix. Although frac fluids are injected thousands of feet below the water table, since shale gas is typically located several thousand feet below groundwater resources, wells pass through groundwater aquifers. To ensure that drinking water aquifers are protected from substances that could enter the water supply, steel casing and cement typically surround the wellbore at depths of 1,000 to 4,000 feet. Proper well casing and cementing seek to eliminate potential leak paths for hydrocarbons or frac fluids into sources of drinking water.

Although a significant portion of frac fluids is pumped back to the surface once the process is completed, studies have found that between 40 and 75 % of frac fluids remain underground, and company representatives have reportedly stated that as much as 50% of the fracturing compounds can remain trapped beneath the ground.[3] Recovered wastewater is usually stored in open pits, and then sent to treatment facilities for recycling and/or disposal. Because the fluids may evaporate, seep into the ground and contaminate groundwater or overflow if rain or snow overfills the pit, companies sometimes use best practice, closed loop systems that gather wastewater as it comes out of the gas well, separate some water for reuse, and confine the remaining waste in a steel tank.

In recent years, a series of water contamination cases documented near unconventional gas wells across the U.S. have raised concerns that the chemicals used in hydraulic fracturing fluids may be polluting the groundwater and threatening drinking water supplies. These incidents have drawn increased attention to the environmental risks of hydraulic fracturing by the media, government agencies and legislators, local communities near gas well operations, public interest organizations, researchers and, more recently, investors.

What are the risks for investors?

Regulatory and litigation risks

Energy companies claim that hydraulic fracturing is a safe, proven technology that has been used in North America for over 60 years, without a single confirmed case of water contamination associated with the practice. Hydraulic fracturing operations have become more complex since the 1990s, however, and shale gas production (rather than tight gas and coalbed methane production) did not really take off until 2005,[4] after the adoption of the U.S. 2005 Energy Policy Act. The Act exempted hydraulic fracturing from federal oversight, so the U.S. Environmental Protection Agency (EPA) currently has no jurisdiction over hydraulic fracturing under the federal Safe Drinking Water Act. New regulations proposed in the U.S.

Congress could change this, giving the EPA full authority to regulate the practice and requiring companies to disclose all frac fluid chemical ingredients to the EPA.

In most U.S. states, regulations do require companies to provide information to government personnel regarding the composition of frac fluids, primarily through Occupational Safety and Health Administration "material safety data sheets" (MSDS). However, MSDS rarely list all the chemical ingredients of frac fluids. Companies may list products but not their various chemical ingredients, provide only a general description of the content of listed products (such as "plasticizer" or "polymer"), or list some or all of the ingredients of a product as being proprietary information.

The lack of information on the exact composition of frac fluids could be one of the primary reasons why no cases of water pollution from fracturing have been confirmed. In 2009, the U.S. EPA hired a consultant to look into documented cases of water contamination allegedly linked to hydraulic fracturing. The firm concluded that twelve of the cases examined were possibly connected to hydraulic fracturing, but the EPA lacked sufficient information on which to make a definitive decision. EPA officials are also investigating drinking water contamination near the town of Pavillion, Wyoming, and have found that at least three water wells contain a chemical used in hydraulic fracturing. They have not yet confirmed whether frac fluids are responsible for groundwater contamination in those cases.

If the regulations being proposed in the U.S. Congress become law, companies will be required to disclose the chemical ingredients of the frac fluids used in their wells (typically, energy companies hire contractors to fracture their wells). This will increase litigation risks for companies if toxic chemicals used in frac fluids are found in water wells and a clear connection can be made between water pollution incidents and hydraulic fracturing operations.

Litigation risks could be significant, as suggested by a case involving one of North America's largest gas producers, EnCana Corporation, with which SHARE has been engaging since 2009 on behalf of investor clients. According to media reports, in 2001, wells owned by EnCana were fractured near a home in Colorado and caused a nearby-water well to explode, resulting in the water turning gray, smelly and bubbly. Two years later, Laura Amos, the resident whose water well had exploded, was diagnosed with a very rare type of tumour in her adrenal gland that has been associated with a solvent called 2-butoxyethanol (2-BE). EnCana initially told the press that it did not believe 2-BE had been used near Amos's home, but the Colorado Oil and Gas Conservation Commission later confirmed that 2-BE had been used in a frac. In 2006, Amos reached a settlement with EnCana, the terms of which she was barred from discussing.

EnCana was also fined $176,800 for "failure to protect water-bearing formations," although the State of Colorado concluded that hydraulic fracturing was not to blame. More recently, in May 2010, Pennsylvania's Department of Environmental Protection (DEP) issued a sweeping order requiring Texas-based Cabot Oil & Gas Corp. to take extensive actions and help the residents of Dimock Township who have been affected by the company's gas drilling activities. Cabot was ordered to pay $240,000 in fines, to plug three wells believed to be the source of migrating gas that contaminated groundwater and the drinking water supplies of fourteen homes in the region, and to install permanent water treatment systems in those homes. Cabot's pending permit applications for new drilling activities in Pennsylvania have been suspended until it fulfills its obligations under the order, and the company is barred from drilling any new wells for

at least one year in the Dimock Township area. In April 2010, Cabot was also ordered to close and remove an open pit holding drilling fluids while authorities determine whether the fluids are contaminating nearby water resources. In March 2010, another company based in Texas, Range Resources, was fined $141,175 for spilling frac fluids in a waterway in Hopewell Township, Washington County. These few examples emphasize the risks associated with frac fluids, well design and construction, and handling of the waste water that results from unconventional gas extraction.

Reputational and social (license to operate) risks

Most shale gas development has taken place in the U.S., where companies have faced a significant number of complaints from local residents that fracturing operations are negatively affecting nearby water wells. According to Earthworks, a U.S.-based non-profit organization, residents have reported changes in water quality and/or quantity following fracturing operations near their homes in Alabama, Colorado, New Mexico, Virginia, West Virginia and Wyoming. Reuters also reports that "neighbours of shale drilling operations in [several] U.S. states have complained their drinking water has become discolored or foul-smelling, their pets and farm animals have died from drinking it, and their children have suffered from diarrhea and vomiting."[5]

Although companies have not acknowledged any fault in causing water pollution incidents, they have reportedly compensated residents with the worst cases of contamination, and it is not uncommon for companies to provide potable water to communities near gas operations while they investigate complaints.

Companies thus far have been able to cope with complaints from local residents, but attention to local community concerns has led to growing opposition to hydraulic fracturing, putting corporate licenses to operate in certain areas at risk. For instance, the decision to start drilling the massive Marcellus shale, which extends across four states and covers major U.S. cities such as New York and Philadelphia, has drawn a wave of media coverage regarding the environmental risks associated with hydraulic fracturing. In March 2010, Philadelphia's City Council adopted a resolution calling on the Delaware River Basin Commission to reject all permits related to hydraulic fracturing until a full environmental impact assessment is completed. The New York City Council passed a similar resolution in November 2009, calling on the state to ban natural gas drilling within New York City's watershed, and asking the federal government to regulate hydraulic fracturing in order to give greater protection to water supplies.

Most shale gas development in Canada has been exploratory or experimental, but interest has dramatically increased since 2007, and many companies are exploring for potential shale gas deposits in British Columbia and Alberta, as well as Saskatchewan, Ontario, Quebec, New Brunswick and Nova Scotia. Local media articles are starting to emerge on the risks of hydraulic fracturing and the need for more stringent regulations to protect water resources. Jessica Ernst, an Albertan biologist who has opposed hydraulic fracturing since her water well was allegedly contaminated following the fracturing of wells owned by EnCana near her home, is being referred to as "Canada's Erin Brockovich." According to recent media reports, Ernst says that she has heard from at least 50 landowners since she decided to go public against hydraulic fracturing, and that groundwater contamination from the practice is "pretty widespread" in Alberta.[6]

As companies gear up to start large-scale, commercial shale gas production in Canada, in particular in British Columbia, Alberta and Quebec, they will likely face increased public scrutiny and regulatory risks associated with hydraulic fracturing and frac fluids, especially if new legislation is adopted in the U.S. which tightly regulates the practice at the federal level.

What can investors do to mitigate risks?

To mitigate risks from shale gas extraction, investors can take steps to ensure that energy companies are protecting sources of drinking water from hydraulic fracturing. Most energy companies hire contractors to drill and fracture their wells, so risk mitigation requires an examination of contractual agreements, as well as direct company operations.

Key issues to consider include:

Hydraulic fracturing fluids: Has the company developed clear specifications regarding chemical ingredients in frac fluids for contractors? Are chemicals of particular concern being used to fracture any of the company's wells?[7] Are non-toxic frac fluids being used in company wells? If so, what proportion of company wells are using non-toxic frac fluids?

Water testing and monitoring: Is the company testing and monitoring groundwater before *and* after hydraulic fracturing operations, or are contractors required to do so? Are water quality data publicly available?

Policies, standards and/or agreements: Has the company adopted policies, standards or agreements to ensure that all contractors take necessary steps to prevent water pollution every time they hydraulically fracture company wells? (Relevant standards include specifications on well design and construction to eliminate potential leak paths for hydrocarbons and frac fluids, such as full-length cementing of well casings; use of closed loop systems to contain recovered frac fluids; and environmentally sound disposal of wastewater).

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NOTES

[1] "Shale Gas Will Rock the World," by Amy Myers Jaffe, The Wall Street Journal (10 May 2010).

[2] See *ibid.*

[3] See Earthworks Oil and Gas Accountability Project, "Frac Fluids: Injected and Left Behind" (2009).

[4] See Don Warlick, "Unconventional gas development in North America facing major hurdles," Oil and Gas Financial Journal (August 2009).

[5] "Update 3: Chesapeake says NY could drive away gas drillers," by Edith Honan, Reuters (5 January 2010).

[6] In "Ugly Reality of Fracking," by Joyce Nelson, Watershed Sentinel, March/April 2010. See also "A Lucrative Dirty Secret," by Chris Wood, The Georgia Straight, Jan 28-Feb. 4, 2010.

[7] For a list of toxic chemicals that have been found in frac fluids and their impacts on human health and the environment, see Michael Berkowitz, "Toxic Chemicals on Tap: How Natural Gas Drilling Threatens Drinking Water," Environment America Research and Policy Center (November 2009).

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