Shale Gas and Hydraulic Fracturing in the US: Opportunity or Underestimated Risk?

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Summary

- Shale gas presents a huge new potential investment opportunity and could possibly transform the US energy market. However, financial returns from shale gas face pressure due to **emerging environmental liabilities**, **community opposition** that limits access to resources, **recoverable reserves uncertainties**, and **natural gas price volatility**.

- Significant ramp up in production will likely unveil two major drivers of increased operational cost and liabilities: **lack of water availability** and **contamination from high volume of waste water**. Different environmental and social profiles of the various basins means that drilling in some basins entails potentially higher operational costs and liabilities.

- Some of the largest shale gas producers, such as **Exxon** and **Anadarko,** do not face the highest valuation risk from their shale involvement due to diversification of oil and gas resources. The more pure play companies such as **Chesapeake Energy**, **Encana, Ultra Petroleum**, **Range Resources**, and **Cabot Oil and Gas** face higher risks.

- Based on MSCI ESG Research's assessment of companies' performance on environmental issues, we believe that companies with poor historical performance such as **Cabot Oil and Gas**, **BP**, and **Chesapeake Energy** are more likely to face community opposition and permitting issues, possibly hindering long term growth potentials.

Introduction

Shale gas, hailed by some as a game changer and even a 'silent revolution' in the US, is drastically altering the domestic energy landscape with international market implications. The substantial reserves base and steep domestic production increase are already changing the international natural gas market, freeing up liquefied natural gas (LNG) capacity and lowering contract prices in regions such as Europe and Russia. While natural gas is already the backbone of a wide range of industries, from petrochemicals and plastics to fertilizers, the prospects for greater use in power generation and transportation may ensure its long term expansion. The proliferation of activity into new shale plays has increased shale gas production in the US from 0.39 trillion cubic feet (tcf) in 2000 to 4.87 tcf in 2010, or 23% of US dry gas production. Estimates of proved US shale gas reserves by the US Energy Information Administration (EIA) have shot up from 34 tcf in 2008 to 84 tcf in 2011 with a total of 862 tcf proved and unproved resources. Production is forecast to reach 12.6 tcf by 2020[1].

For investors, however, the potential economic returns from shale gas production are still highly uncertain. In addition to competing claims about the actual size and value of the recoverable reserves, community resistance, negative media attention to potential environmental hazards, grassroots activist opposition, and increased regulatory scrutiny have called into question the companies' ability to operate in an environmentally safe manner and still meet high expectations of financial returns. Nevertheless, given continued high prices for oil, and the prospect of cheap natural gas in the short to medium term, ***we believe that the oil and gas sector will continue to pursue shale gas as a major part of their growth strategy in unconventional energy extraction. But we question the long-term valuation of companies that are unprepared to handle the complex interplay of environmental and social risks in this space.***

While most oil and gas players are present in multiple shale basins, the different environmental and social profiles of the various basins means that drilling in some basins entails potentially higher operational costs and future liabilities. (For a summary of the key processes in shale gas recovery, please see Appendix I: *What is Shale Gas and Hydraulic Fracturing?*). Specifically, where companies are drilling determines the exposure to some of the most high profile and controversial elements of hydraulic fracturing, including the issues of water stress, wastewater management, and community opposition to land use changes.

Reliance on Shale Gas Reserves

Among companies in the MSCI World Index, we estimate that 54 players are currently involved in shale gas exploration and production globally.

While major shale reserves are located in many countries as estimated by the US EIA (such as China, Argentina, Mexico, and Canada) we focus on the US, which accounts for 13% of resources (technically recoverable, unproven reserves) and where exploration and production is currently most aggressive. (For a breakdown of the countries with major shale gas reserves, please see Appendix II: *Global*

[1] According to SBI Energy estimates http://www.sbireports.com/about/release.asp?id=2354

Distribution of Unproven Shale Gas Reserves). We have analyzed the top 25 companies in the US, as this market is currently seeing the quickest investment growth. All of these companies face devaluation risks if environmental or safety failures cause additional operational costs, reputational damage, or limited access to resources. While the greater the production of shale gas the greater the risk exposure to the environmental and social risks, the companies with the largest shale gas production are not necessarily most exposed to valuation risk. The less diversified companies whose oil and gas resource base is highly dependent on hydraulic fracturing such as **Chesapeake Energy, Encana, Ultra Petroleum**, **Range Resources**, and **Southwestern Energy** (figure 2), face the highest risk exposure. Nonetheless, we note that multinational integrated oil companies **ExxonMobil**, **BP**, **ConocoPhillips**, **Chevron**, and **Shell,** with significant US natural gas reserves totaling about 57 tcf, largely made up of shale gas, are more diversified and thus less dependent on shale gas, but still face some valuation risks and potential losses on investments.

FIGURE 1 **Top 25 Shale Gas Players in US** – Estimates of Shale Gas Reserves and Production**

Quote Symbol	Company Name	Estimated US Natural Gas Reserves (Bcf)	Natural Gas Production (mmcf/d)*	Estimated Shale Gas Share in Overall O&G Production
XOM	Exxon (XTO)	26,100	3,873	0 to 20%
CHK-N	Chesapeake Energy Corporation	15,455	2,639	75 to 100%
APC-N	Anadarko Petroleum Corporation	8,100	2,369	0 to 20%
DVN-N	Devon Energy Corporation	9,000	1,997	50 to 75%
BP_GB	British Petroleum (BP)	13,700	1,869	0 to 20%
ECA-N	EnCana Corporation	7,500	1,833	75 to 100%
COP	ConocoPhillips	10,500	1,621	0 to 20%
SWN-N	Southwestern Energy Company	4,345	1,312	75 to 100%
CVX	Chevron (Atlas)	2,500	1,284	0 to 20%
EOG-N	EOG Resources, Inc.	6,861	1,124	50 to 75%
RDSA_GB	Royal Dutch Shell (East)	4,502	953	0 to 20%
APA-N	Apache Corporation	4,340	869	0 to 20%
HK-N	Petrohawk Energy (BHP Billiton)	3,392	792	75 to 100%
OXY	Occidental	Not Reported	748	0 to 20%
QEP-N	QEP Resources Inc.	2,612	641	50 to 75%
UPL-N	Ultra Petroleum Corp.	4,200	614	75 to 100%
NFX-N	Newfield Exploration Company	2,490	510	20 to 50%
EQT-N	EQT Corporation	5,200	464	50 to 75%
COG-N	Cabot Oil & Gas Corporation	2,644	439	75 to 100%
RRC-N	Range Resources Corporation	4,442	346	75 to 100%
PXD-N	Pioneer Natural Resources Company	2,594	331	75 to 100%
XEC-N	Cimarex Energy Company	1,254	326	20 to 50%
TLM-T	Talisman Energy Inc	5,240	315	20 to 50%
PXP-N	Plains Exploration & Production Company	1,157	285	20 to 50%
HES	Hess Corporation	568	103	0 to 20%

Bcf = billion cubic feet; mmcf/d = million cubic feet per day
*Daily Shale Gas Production values represent statistics in first half 2011, source: Natural Gas Supply Association (NGSA)
** Williams Energy, El Paso Energy, and Marathon are also major players in US shale gas but are excluded from this analysis

Major Environmental and Social Challenges

The most controversial aspects of hydraulic fracturing (fracking) revolve around the issue of water. Large quantities of water are needed for the fracking job, which can increase regional water stress and creates challenges with the management of post-fracking wastewater. The high risk of water contamination and regional water stress during fracking and production are prompting strong community opposition to shale gas developments. Methane, which makes up 70-90% of the natural gas, can leak and contaminate drinking water supplies. The release of the leaked natural gas in the atmosphere also has climate change implications since methane is a highly potent greenhouse gas.

FIGURE 2 **Major Risks Associated with Hydraulic Fracturing (fracking)**

Risk	Specific to Hydraulic Fracturing
Operational	●Wastewater or 'flowback' water presents significant operational challenges (wastewater consists of 'fracking fluids' + substances picked up underground such as hydrocarbons and heavy metals) ●More wells needed for production than equivalent oil production - more chances of mishaps and higher land disturbance ●Fracking occurs at about 9,000 pounds per square inch pressure or greater ●Poor casing provides a path for gas migration underground and then aquifer contamination ●Traces of radiation in shale rock and found in wastewater (low levels) ●Marcellus and likely Utica basins are not well equipped for reinjection of wastewater or water treatment (local water treatment plants not equipped to handle these volumes or substances)
Regulatory	●Increasing state and federal regulations are likely in the next two years due to pending study by US Environmental Protection Agency (EPA)
Reputational	●Public opposition to hydraulic fracturing (temporary moratorium in NY state) due to fears of water contamination
Environmental	●High levels of wastewater and chemicals raises risks of surface spills ●High levels of inefficiencies in production and transport (methane losses estimated to be as high as 8% of potential production, industry admits losses of 1 to 3%) leading to high emissions of powerful greenhouse gas ●35,000 gallons of fracking fluid additives (often toxic) injected underground per well
Land Use and Access to Resources	●Average of 7 million gallons of water needed per well per drilling job potentially stressing water supplies in a region (drilling job lasts about a week, additional fracking may be needed to re-stimulate a well) ●Large land disturbances from access roads, trucking, storage ponds, and other surface operations such as piping, storage and wellpad construction, resulting in losses of natural value (trees, vegetation, biodiversity) adversely affecting the ecosystem as well as allowing for higher migration of emissions, contaminants, and sediments

Water Needs and Water Stress

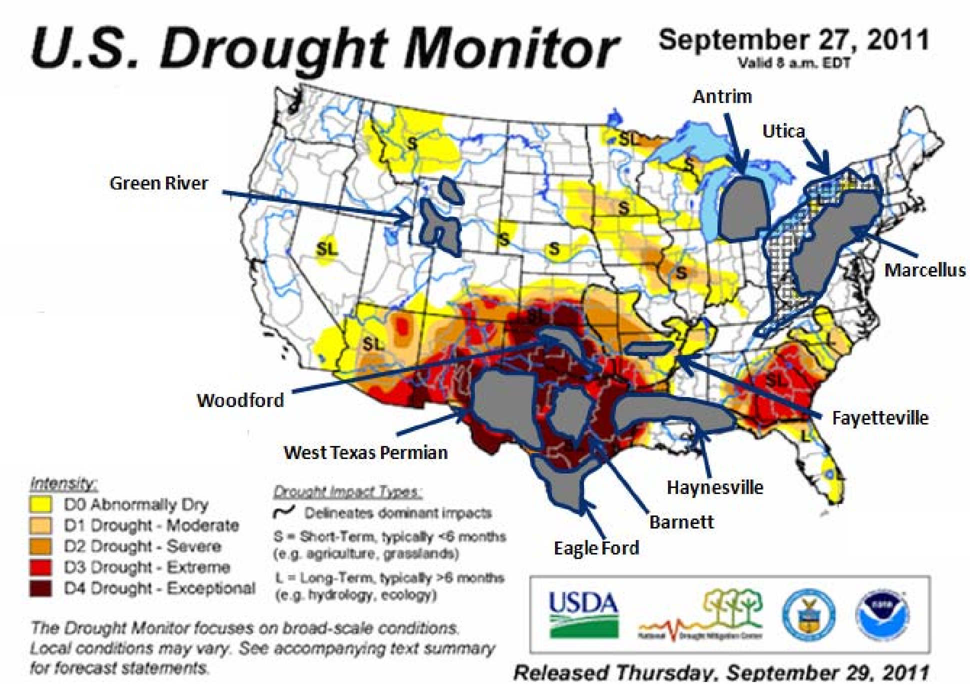
The 12 major shale basins in the US face different levels and types of water-related risks, with some facing acute problems of water availability and other basins facing concerns with the high volume flowback of highly toxic waste water. The hydraulic fracturing process requires an enormous amount of water use – estimated averages are between 3 to 9 million gallons per fracking operation of a well – both as a coolant for drilling and as fluid used for fracturing (fracking fluid). For example, we estimate that the 414 shale gas wells that ExxonMobil drilled in 2010 alone required between 1,242 and 3,726 million gallons, equivalent of the water supply for 22,000 to 67,000 persons for a year in the US[2].

Shale basins in the South and Southwest commonly face water shortages and drought conditions, with water stress expected to increase due to climate change. Hydraulic fracturing imposes significant demands on the water supply that compete with increasing demands from industry, agriculture, and growing populations. The severe drought in Texas this year has already called into question the oil and gas sector's ability to tap water supplies. The Texas state water board estimated that fracturing a single well in the Eagle Ford shale requires about 13 million gallons of water, which can supply water for 240 adults for a year; this is estimated to be three or four more times the amount of water used for fracturing at Barnett shale, due to geological differences. The state water board has indicated that it might be forced to ration water given significant water needs for agriculture, where crop losses in the state have topped USD 5 billion so far this year.

Based on metrics from the US Geological Survey, the gas basins projected to face the greatest water stress include Barnett, Fayetteville, Green River, Woodford (Anadarko), Eagle Ford, and the West Texas Permian basins. In our view, ***water availability will present material risks to operations for some companies***, as the cumulative demand from increased drilling will compete with local needs; the seasonal timing of the water withdrawal and the location of available water will constrain production in some areas; and the regulations governing water withdrawals could drive up operational costs.

[2] Assuming 575 liters/day/person. Source: UNDP, Human Development Report, 2006

FIGURE 3 **Major Shale Basins and Recent Drought Conditions**



Source: USDA Drought Monitor. Droughtmonitor.unl.edu/. Shale basin overlay from MSCI ESG Research.

FIGURE 4 **Major Shale Plays and Water Stress**

Shale plays	States	Water Stress	Major Players
Eagle Ford	TX	●●●●	Exxon, Petrohawk, Chesapeake, Aurora, Pioneer
West Texas Permian	TX	●●●●	Cabot, Chesapeake, Devon, EOG, Pioneer
Woodford	OK, TX	●●●●	Cabot, BP, Devon, EOG, Exxon
Barnett	TX	●●●	Range Resources, Exxon, Chesapeake, Devon, Encana, EOG, Pioneer
Haynesville/Bossier	LA,TX	●●	Petrohawk, Exxon, Cabot, Chesapeake, Plains, Encana, EOG
Fayetteville	AR	●●	Southwestern, Petrohawk, Chesapeake
Marcellus	PA, NY, OH, WV	●	Cabot, Chesapeake, Ultra, EQT, Talisman, Range, Anadarko, Shell, EOG, Exxon (XTO)

Water Stress	
●●●●	High
●	Low

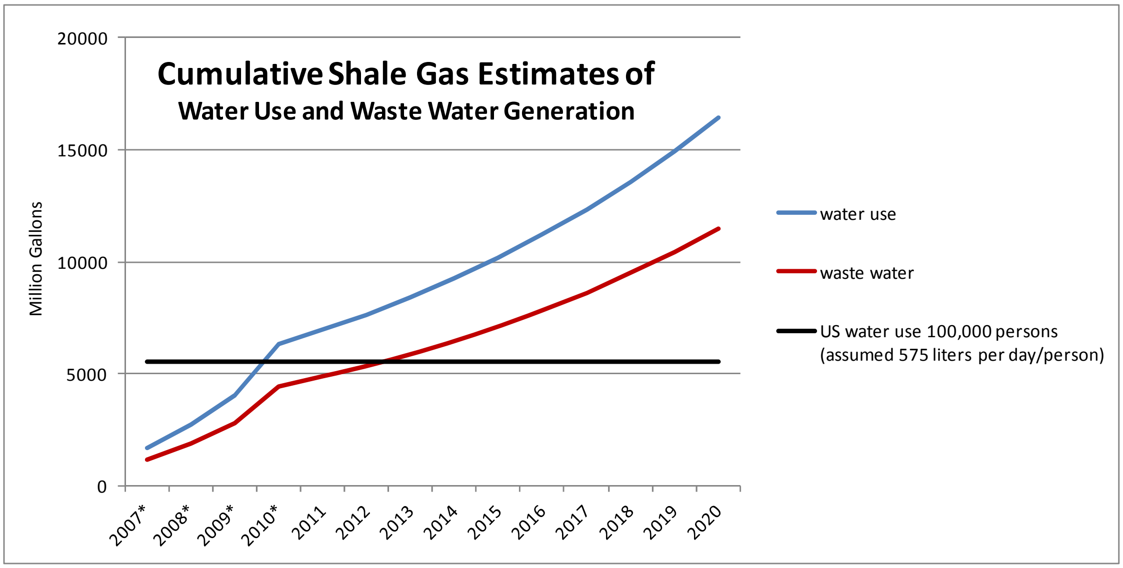
Water Contamination

In addition to demands on water availability, hydraulic fracturing also introduces a large amount of toxic chemicals into the environment that could pose environmental and health hazards, increasing the prospects of future liabilities. Although 95% of fracking fluid is water with only 0.5% of the contents consisting of toxic chemicals (such as hydrochloric acid, ethanol, diesel, ethylene glycol and sodium hydroxide), the total amount of toxic chemicals used during hydraulic fracturing can be as high as 110,000 gallons per well and is typically around 25,000 gallons per well. The injection of these toxic chemicals may create long-term liabilities for companies as large quantities of these contaminants remain underground even after production ceases. (See Appendix III: *Composition of Fracking Fluid*).

A more immediate problem - is that a large amount of the fracking fluid flows back to the surface. As much as 70% flowback is common at some basins, creating the challenge to manage a tremendous volume of wastewater that is laden with the original fracking chemicals as well as dissolved substances picked up from deep underground such as hydrocarbons and heavy metals. The intensive water use and extensive production of waste water presents an enormous challenge to companies operating in this space. As figure 5 shows, the sharp increase in production (2007-2010) and sustained increase up to 2020 will translate into almost a tripling of water need and waste water generation this decade.

One option many companies pursue to manage the waste water produced is through deep geological injection disposal. However, geological characteristics differ among the basins, presenting different flowback rates and the inability to do deep injection in some cases. For instance, deep injection of wastewater is not possible at Marcellus, where flowback rates of 10 to 40% are common and injection volumes of fracking fluid may be up to 50% more than other major basins such as Fayetteville and Barnett. This leaves companies operating in the region with few alternatives to manage the wastewater other than to build roads and truck away the waste to treatment plants, creating disturbances in local communities. Also, in the Marcellus basin the sheer volume of wastewater is overwhelming many wastewater treatment plants that are not equipped to effectively treat the levels and types of substances in the flowback wastewater. Companies have few options besides carrying the burden of treating huge volumes of waste water themselves. Failure to treat this wastewater properly could lead to far ranging water resource contamination and liability issues.

FIGURE 5 **Estimated yearly water use and waste water**



*2007-2010 represent estimates based on actual shale gas production levels. 2011-2020 are estimates based on a projected 12.6 tcf production by 2020 (source: SBI Energy). We assumed a 10% annual production increase over the period. Water use estimates are based on a 1.3 gallon/million British Thermal Units (MMBtu) water needs average[3]. Waste water generation estimates assume that 70% of water used returns as flowback and ignores any other additional produced water, which may drastically increase the estimated levels.

Methane Leaks

An additional concern about shale gas extraction is that it may release large amounts of methane, which could contaminate drinking water as well as contribute to climate change. Natural gas consists of 70-90% of methane, a non-toxic, highly flammable and asphyxiant gas with high climate change potency.

Academic studies from Duke University[4] have confirmed systematic evidence of methane contamination of drinking water associated with fracking in Pennsylvania and New York. The health impact of methane-contaminated water is unknown. The oil & gas industry argues that methane leaks are associated more generally with natural gas drilling, not with hydraulic fracturing per se.

[3] *Water Consumption of Energy resource Extraction, Processing, and Conversion*, Erik Mielke, Laura Diaz Anadon, and Venkatesh Narayanamurti, Harward Kenedy School, Belfer Centre for Science and Interantional Affairs, Energy Technology Innovation Policy Research Group, October 2010

[4] *Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing*, Stephen G. Osborn, Avner Vengosh, Nathaniel R. Warner, Robert B. Jackson, center on Global Change, Nicholas School of the Environment, and the Biology Department, Duke University, Durham, NC 27708, January 2011

Methane fugitive gases and leaks in the atmosphere, throughout the lifetime of a well, are also significantly increasing the shale gas overall carbon footprint. According to Cornell scientists[5], methane leakage from fracturing is worse than with conventional drilling; as much as 8% of methane in shale gas leaks into the air during the lifetime of shale gas production. The fact that unburned methane released in the atmosphere has 20 times the warming effect of carbon dioxide (pound for pound) calls into question whether any future constraints around greenhouse gas emissions could impact the long term growth of the shale gas industry. On average, natural gas emits 30% less carbon when burned compared to oil's energy content, which makes natural gas as a cleaner energy alternative. However, the relatively high rate of methane loss during fracking (through leakage) could dilute the benefit of natural gas in mitigating climate change compared to oil and coal.

Community Opposition – Marcellus in focus

Environmental and health concerns are the key reasons that environmentalists and local land-owners or community residents are opposed to hydraulic fracturing. These concerns include:

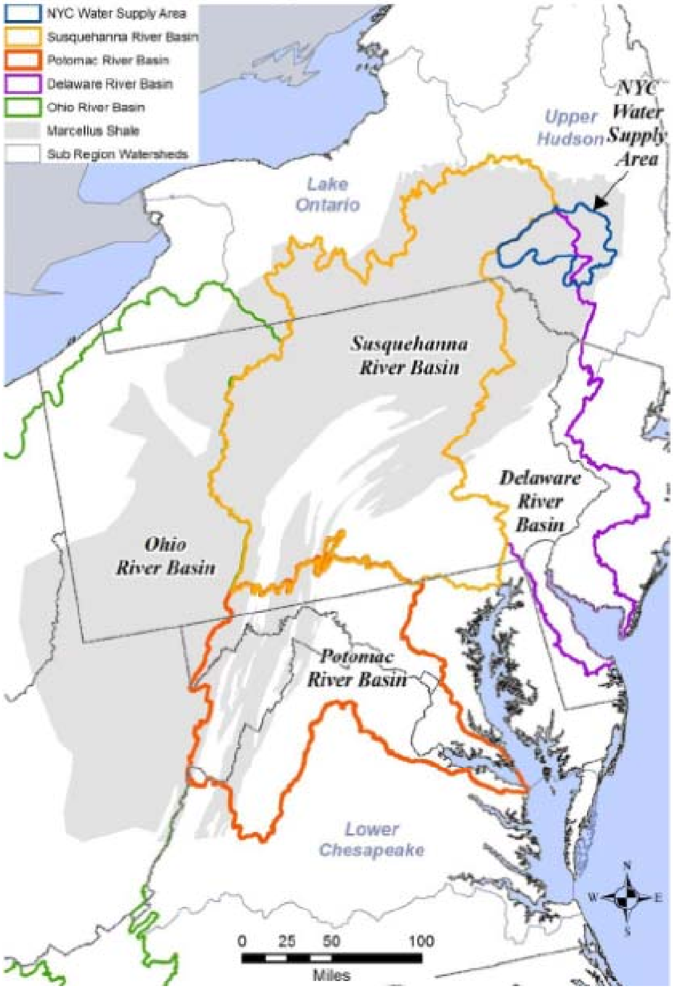
- potential ***underground water contamination*** from toxic chemicals in the fracking fluids and natural gas seeping from faulty wells
- increasing ***strain on water resources*** due to large water requirements for drilling
- potential soil, surface, and underground water contamination from inadequate management or ***accidental spills***
- increased ***land disturbance*** due to road construction, water storage (ponds and lagoons), and large numbers of wells drilled
- ***traffic and noise*** from increased activity: tracks, compressors and other engines used during drilling
- potential ***increased radioactivity*** from radioactive substances brought to the surface by the flowback and produced water

Land disturbance and the intensity of land use for shale production are also quite high. ***Fourteen shale gas wells are needed to produce the same amount of natural gas as produced in conventional oil fields*** on an equivalent energy basis. Each well requires roughly 4 to 5 acres per pad, including waste water storage, and other supporting equipment.

Compared to other basins, community opposition is significantly stronger in the Marcellus shale basin, which covers large areas of varying population densities. While public opinion in Pennsylvania is divided on shale gas drilling, intense community opposition in some townships has delayed production and could ultimately impose higher operational costs through more stringent regulations on fracking activities.

[5] *Methane and the greenhouse-gas footprint of natural gas from shale formations,* Robert W. Howarth, renee Santoro, Anthony Ingraffea, Department of Ecology and Evolutionary Biology, Cornell University, March 2011

FIGURE 6 **The Marcellus Shale and Major Water Basins Map**

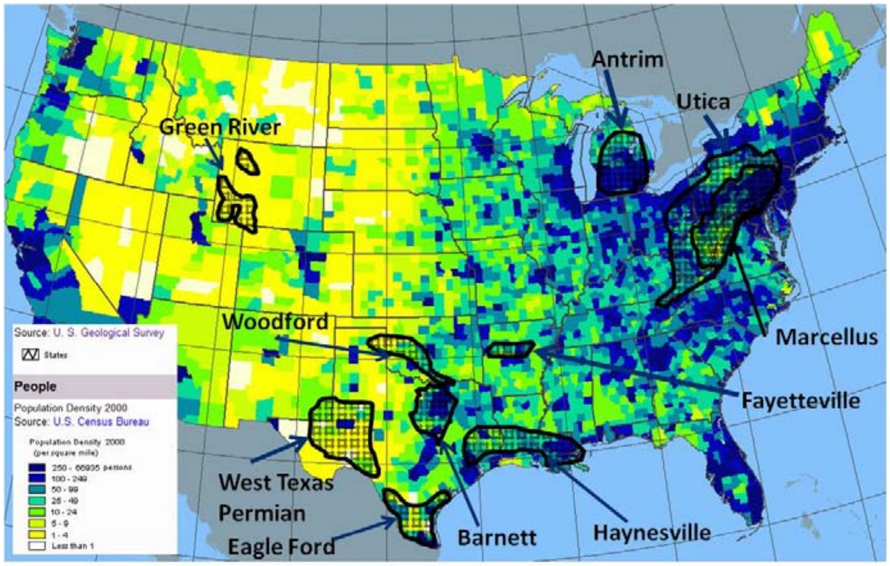


Source: Water Resources and Use for Hydraulic Fracturing in the Marcellus Shale Region. J. Daniel Arthur, P.E., SPEC; Mike Uretsky, PhD.; Preston Wilson – ALL Consulting, LLC

In the state of New York, which has jurisdiction over a small portion of the Marcellus Shale, the local government imposed a temporary moratorium on new drilling permits in December 2010. As of the end of June 2011, the state administration indicated that it has been contemplating policies that would only allow fracking on private lands, and exclude areas that contain aquifers used for city drinking water (the New York City and Syracuse watersheds) as well as parks and wildlife reserves; the issue has been undergoing a public comment period and new ruling is expected imminently.

The community opposition in parts of the Marcellus shale basin, while motivated by environmental and health concerns, is also largely a byproduct of prevailing social sentiment and political opinion in that region. Not unexpectedly, the expansion of oil & gas activities into areas previously untouched by the industry will continue to face fierce opposition from the community, unless companies adequately manage environmental impact and community health concerns through communication and adoption of best environmental practices. The population dependent on the water resources in the Northeast is quite high (see figure 7), which means that any potential issues with water contamination would arguably have a larger impact in parts of the Marcellus shale basin as contamination of drinking water there could ultimately impact more people.[6]

FIGURE 7 **Overlay of US Population and Shale Basins**



Source: US National Atlas. http://nationalatlas.gov/. Shale basin overlay from MSCI ESG Research.

Companies with significant interests in the Marcellus basin, as opposed to all other shale plays, face the highest community opposition and regulatory risks. Despite the heightened risks from wastewater management and intense community opposition, 15 out of the 25 major shale gas players are actively pursuing production opportunities in the Marcellus basin (see figure 8).

Companies' capabilities in stakeholder engagement can help reassure communities, facilitate the permitting process, and ultimately head off costly litigation. In evaluating companies' relative capabilities, MSCI ESG Research takes in account of companies' programs targeting relationship building with NGOs and particularly land owners; strategies to build local economies through support for local businesses and suppliers, employment, training and professional development; and support for local community services such as education and health. We note that **Ultra, Cabot Oil & Gas,** and **EOG** lack strong records or clear programs to manage community impact. Lack of community engagement strategy at EOG, for example, has exposed the company to ongoing community resistance, impeding its ability to carry out planned hydraulic fracturing jobs in new communities. The company name continues to appear in the news in negative association to hydraulic fracturing after a shale well blowout prompted regulators to issue a work-stop order in 2010.

[6] We note that the Barnett shale basin in the Dallas-Fort Worth area, where more than two million people reside, is also highly populated. Arguably, spills and water contamination in this basin would also affect a large number of people.

FIGURE 8 **Marcellus Operations and Community Programs**

Company Name	Shale Dependency on Marcellus	Active Wells in First Half 2011 in PA	MSCI Evaluation of Community Programs
Chesapeake Energy Corporation	●●	1326	◆◆◆
Talisman Energy Inc	●	673	◆◆◆
Range Resources Corporation	●●●●	609	◆◆◆
Anadarko Petroleum Corporation	●	421	◆◆
EQT Corporation	●●●●	367	◆◆◆
Cabot Oil & Gas Corporation	●●●●	254	◆
EOG Resources, Inc.	●●●	242	◆◆
Ultra Petroleum Corp.	●●●●	226	◆
Chevron (Atlas)	●	182	◆◆◆
Exxon (XTO)	●●●	106	◆◆
EnCana Corporation	●	14	◆◆◆
Hess	●	8	◆◆
Southwestern Energy Company	●		◆◆
Shell (East)	●		◆◆
Newfield Exploration Company	●		◆◆
Devon Energy Corporation	-		◆◆
BP	-		◆◆◆
ConocoPhillips	-		◆◆
Apache Corporation	-		◆◆◆
Petrohawk (BHP Billiton)	-		◆
Occidental	-		◆◆◆◆
QEP Resources Inc.	-		◆◆
Pioneer Natural Resources Company	-		◆◆◆
Cimarex Energy Company	-		◆
Plains Exploration & Production Compan	-		◆

Shale Operations in Marcellus	
●●●●	50% or more
●●●	10 to 50%
●●	Under 10%
●	Low or under development
-	No presence

Community Engagement Programs	
◆◆◆◆	Strong
◆	Weak

Proxies for Measuring Risk Management

In our 2011 Environmental, Social and Governance (ESG) ratings research, we found that the ***companies with the highest concentration of assets in shale gas plays are also the ones with the poorest disclosure*** of key metrics such as fresh water withdrawal, incidence of spills, waste generation and treatment. These companies include: **Ultra Petroleum**, **Chesapeake Energy**, **Range**, and **Cabot Oil and Gas**.

While companies' overall track records can be indicative of their ability to manage the social and environmental risks around shale gas drilling, we note that currently most players in the industry have not disclosed sufficient data to allow investors to make in-depth analysis on the specific risks involved or the companies' risk management capability. Given the different levels and types of exposure to environmental risks in the different shale basins, more detailed data on the location of companies' shale reserves is necessary to gain a fuller picture of the operational and reputational risks facing each company. Additionally, disclosure specifically around the use and treatment of water in shale gas operations is imperative for investors to understand the extent to which companies have built in the costs of maintaining operational integrity and potential exposure to future liability associated with accidents and contamination.

Investors are actively pursuing specific disclosure of fracking operations. For instance, the New York State Common Retirement Fund has successfully included fracking shareholder proposals at 16 companies. Furthermore, the U.S. Securities and Exchange Commission has asked oil and gas companies for detailed information on fracking, including fracking fluid chemicals composition and management initiatives for dealing with the environmental impact. Legislation at the state level – including Delaware, New York, Pennsylvania, and Wyoming – has been proposed or adopted regarding disclosure and standards of operations and environmental management practices.

2011 Proxy Voting

Oil and gas companies have come under pressure to provide more information regarding their exposure to risks associated with shale gas drilling. During the 2011 proxy season, Institutional Shareholder Services Inc. (a subsidiary of MSCI) reported that shareholder resolutions related to the environmental risks of shale gas drilling garnered an average of 40.7% support, a rise of 10 percentage points from 2010. The table below shows the resolutions filed in 2011 seeking greater transparency on the environmental impacts of hydraulic fracturing and the implementation of policies to reduce hazards from the process.

Companies with fracking related proposals filed in 2011	Voting percentage
Energen	49.5%
Carrizo Oil & Gas	43.7%
Ultra Petrleum	41.7%
Chevron (Atlas)	40.5%
Exxon (XTO)	28.2%
Cabot Oil & Gas Corporation	withdrawn*
El Paso	withdrawn*
Anadarko Petroleum Corporation	withdrawn*
Southwestern Energy Company	withdrawn*

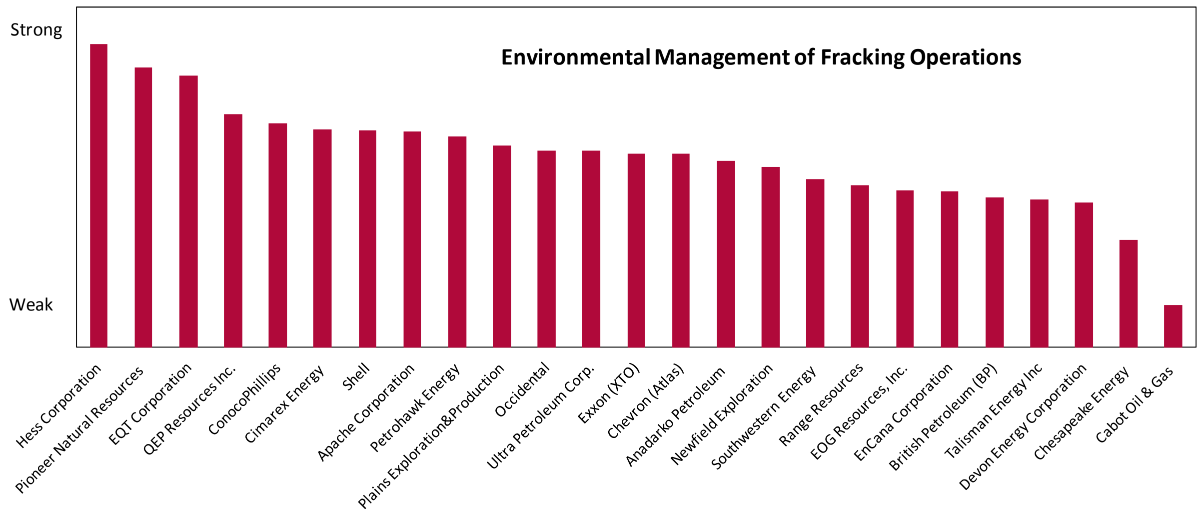
*The proposals were withdrawn after various agreements with the shareholders.

Our assessment of a company's ability to manage environmental impact to land resources is based on the following factors:

- Performance track record on fracking operations
- Performance on water use and spills (benchmarked against peers based on available data)
- Evidence of overall policy implementation: environmental and social impact assessment prior to operations, initiatives for minimizing environmental disturbance and impact, and community and stakeholder engagement
- Clear policies to protect biodiversity and respect traditional land use practices

We have identified **Cabot Oil & Gas** and **Chesapeake Energy** as having the poorest performance track record, due to significant fines and pending lawsuits stemming from contamination and community impact from fracking. Other companies with evidence of spills and blowups from fracking, or with pending or settled natural gas contamination lawsuits include **Devon**, **Talisman**, **EnCana**, **Southwestern**, **EOG**, and **Range Resources**. Super-major oil and gas companies, such as **Shell**, **Chevron**, **Exxon** and **BP,** while having comprehensive environmental and biodiversity management structures in place, have a history of controversies and poor performance including spills and contamination of sensitive environments. At the other end of the spectrum, smaller players, such as **Hess**, **Pioneer** or **EQT** do not seem to have the same level of involvement in poor performance while also having adequate biodiversity policies and practices in place.

FIGURE 9 **Proxy for Companies' Capacity to Mitigate Risks – Assessment of Environmental Management in Fracking Operations**



*Data analyzed is included in the assessment of companies' performance on **Biodiversity and Land Use**, one of the industry key issues on which we evaluate oil and gas companies in MSCI's annual ESG ratings research. On this key issue, we evaluate companies on both their exposure to and their ability to manage risks of losing access to resources and of incurring litigation and liability costs due to operations that damage fragile ecosystems. Other industry key issues that determine overall ESG ratings for companies in these industries include **Health & Safety**, **Corruption & Instability**, **Carbon Emissions**, and **Toxic Emissions.** Please refer to *IVA Industry Reports* on Integrated Oil & Gas and on Oil & Gas Exploration and Production, as well as company profiles for details.

We believe that in the medium term, companies with a poor track record of managing environmental impact – water use, waste, spills, as well as operational integrity and safety – or with poor practices of community engagement, will be less prepared to meet more stringent regulations around shale gas drilling. ***For companies unprepared to meet higher environmental and community standards, unanticipated future costs could include requirements to build waste treatment facilities, prolonged permitting processes, legal costs associated with lawsuits or other environmental liabilities, lost permits, and cleanup costs.***

More specifically, our recent analysis of **Cabot** shows that, unlike the majority of its peers in the oil & gas exploration and production industry, the company lacks a standard environmental policy, makes no commitments related to biodiversity or land use protection, and lacks key processes such as effective or adequate assessments of environmental impact before developing an area and programs to minimize environmental disturbances caused by its operations. Consequently, the company has faced fines, numerous lawsuits, and temporary bans from using hydraulic fracturing after repeated leaks and spills into local waterways. In one settlement in November 2009, the company was ordered to have all future casing and cementing plans approved by the Pennsylvania Department of Environmental Protection. (For comprehensive details on investigations and controversies implicating Cabot, please refer to MSCI's *ESG Impact Monitor* profile). These repeated offenses are indicative that the company is not well equipped from a management perspective to effectively mitigate its propensity for water contamination in its high risk operations.

Cabot is also on the Pennsylvania Land Trust's list of 25 drillers with the most violations, along with **EOG Resources**, **Southwestern Energy**, **Anadarko**, and **Talisman Energy**. The Land Trust issued a report in August 2010 that identified nearly 1,500 violations since January 2008 committed by 43 Marcellus Shale drilling companies. The Pennsylvania Department of Environmental Protection has also indicated large numbers of violations in connection with wastewater hauling. In one 3-day period, the DEP reported 669 traffic citations and 818 written warnings issued to trucks hauling waste water from drilling in the Marcellus.

The high profile nature of shale gas drilling in the US means that all top players are effectively being put on watch for how they manage the substantial environmental and social risks involved in these activities, which in turn may influence shale gas development globally, in regions such as Europe, South America, or Asia. For the super oil majors, any poor environmental performance that will generate health scares or impact local water resources will compromise the their ability to gain access to new markets in other regions.

CONCLUSIONS

- Companies in the shale gas market may face tremendous opportunities but a failure to properly address the challenges may put the company valuations at high risk
- Water availability may become a problem in specific basins
- Waste water generation will increase with growth in production, further raising operational costs and environmental liabilities from contamination
- Residential and environmental community opposition will likely remain high until adequate environmental management practices address water sourcing, waste contamination, and methane leaks at the operational level
- The most diversified companies face lower risk to their valuation and are in a better position to adopt best practices
- Smaller players that are highly reliant on shale interests face the highest risk of long-term company devaluation, especially for those with poor records of environmental and social issues and no clear plans to improve them

Appendix I: What is Shale Gas and Hydraulic Fracturing?

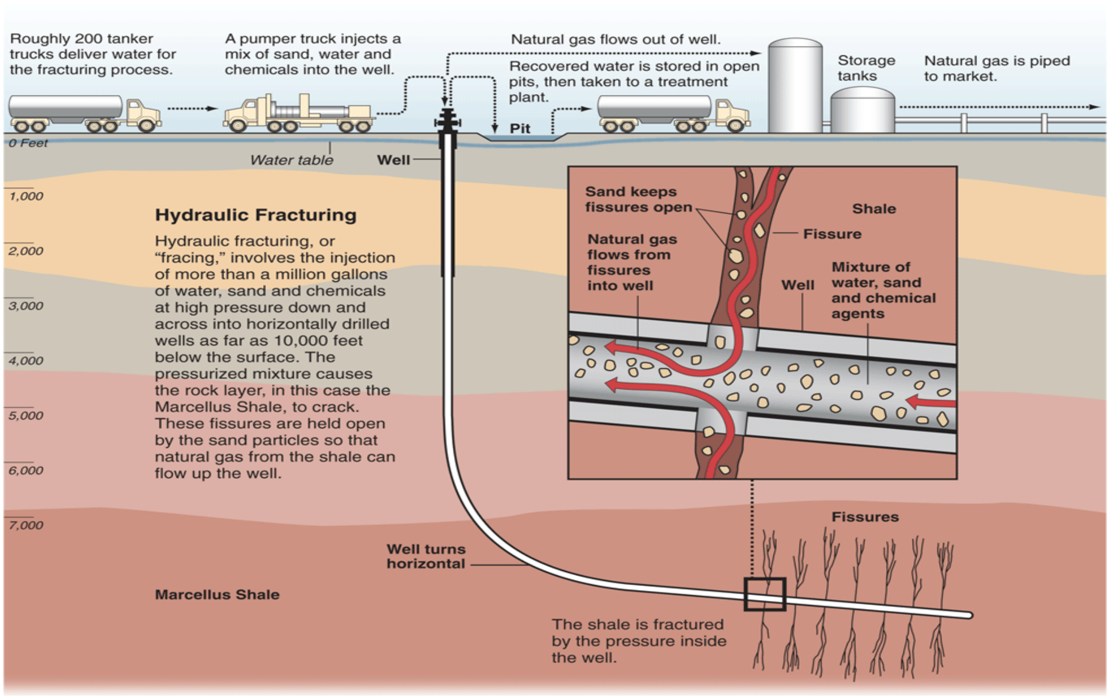
Shale is generally defined as fine compact grains of sedimentary rock that contain oil or natural gas (typically methane). While shale basins hold large amounts of fossil fuels that rival what is found in conventional fields, they have low permeability, making conventional extraction methods uneconomical. A process known as **Hydraulic Fracturing** (commonly referred to as *fracking*) is being employed increasingly by oil and gas companies to stimulate production of oil and natural gas from shale basins and other reservoirs such as coal beds. New drilling techniques that allow for horizontal and directional drilling at the depth of the targeted rock formation are opening up vast new quantities of oil and gas resources that previously were considered unrecoverable.

Key to the process is a fluid mix pumped at high pressure through steel and concrete wellbores into shale formations, creating fractures and freeing the fossil fuels to allow for desirable production flow rates.

The fracking fluid generally consists of about 95% water and sand, supplemented by chemical additives that typically are no more than 1 to 2% of the mix by weight. While the chemical additives are proprietary blends that vary by company, they commonly contain toxic substances such as benzene, toluene, hydrochloric acid and sodium hydroxide. These substances are linked with cancer, endocrine disruption and other major health hazards.

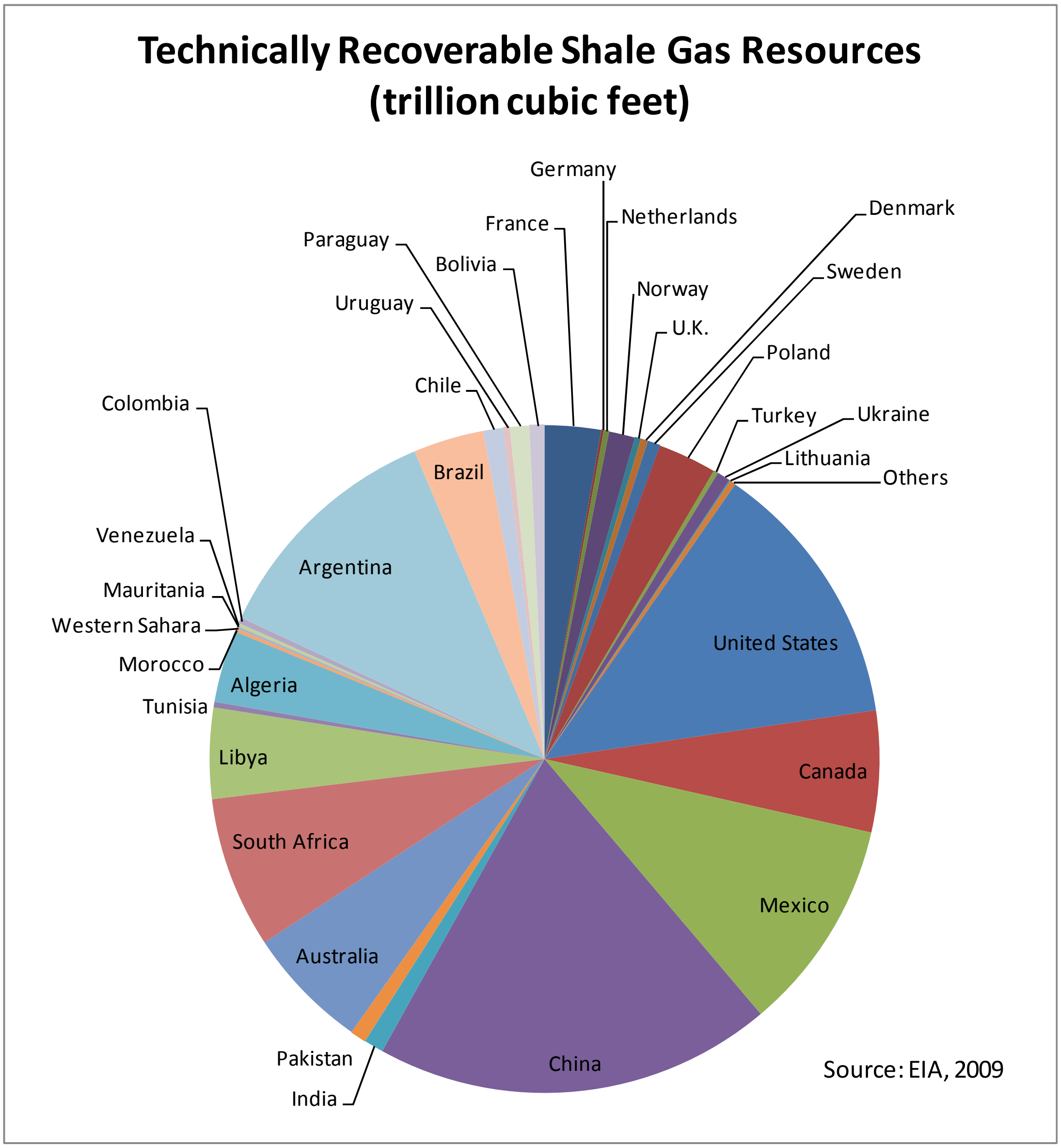
Hydrocarbon reserves in shale rock typically are deep underground at depths of 2,000 to 3,000 meters (~6,500 to 10,000 feet), though some reservoirs are much shallower or deeper. Most formations are well below drinking water resources and separated by impermeable layers of rock. However, production wells may go through drinking water resources to access these resources, and poor well casings can lead to water contamination. Reservoirs at shallow depths, which are common for other natural gas sources such as coal bed methane, present a much higher risk to shallow water resources.

Surface water contamination is another potential hazard. While a large amount of the fracking fluid remains underground (creating potential long-term liabilities), a large proportion also returns to the surface, depending on the well location and underlying geological characteristics. This high volume of fluid waste must be managed correctly to avoid contamination of surface water supplies. Because local wastewater treatment usually is not available, most fluid waste must be transported offsite. This creates a substantial land footprint consisting of wastewater pits, storage tanks, transportation lines, trucks and other equipment. Communities not accustomed to this level of industrial activity and exposure to toxic waste may seek to block development activity and increase regulatory controls.



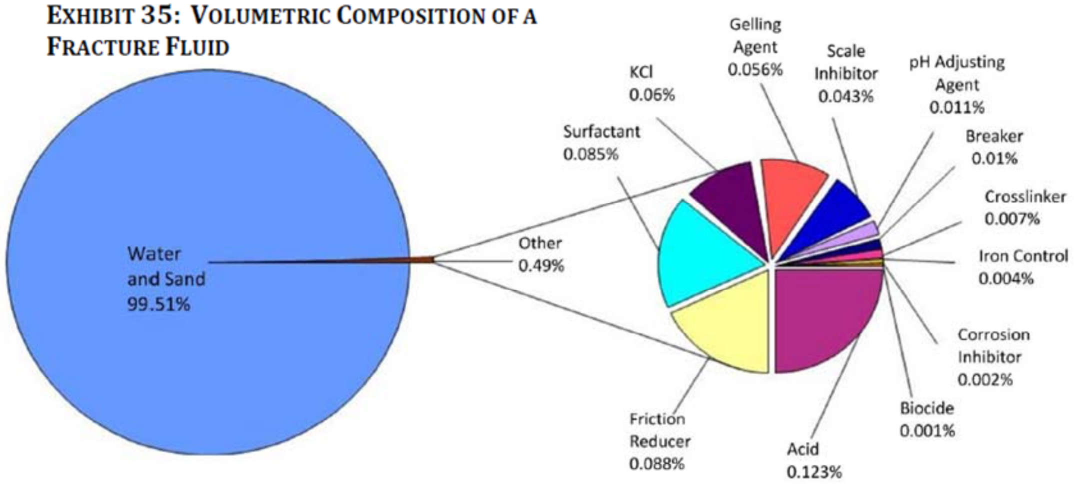
Source: ProPublica **http://www.propublica.org/special/hydraulic-fracturing-national**

Appendix II: Global Distribution of Unproven Shale Gas Reserves



Appendix III: Composition of Fracking Fluid

EXHIBIT 35: VOLUMETRIC COMPOSITION OF A FRACTURE FLUID



Source: Modern Shale Gas Development in the United States: A Primer, April 2009 Work Performed Under DE-FG26-04NT15455 Prepared for U.S. Department of Energy Office of Fossil Energy and National Energy Technology Laboratory Prepared by Ground Water Protection Council Oklahoma City, OK. ALL Consulting Tulsa, OK.

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