Hydrofracking in Europe:
Rights, Risks, and Challenges

Yavor Stoychev
Natural Resource Economics
Dr. James Myers
February 21, 2012

I. Introduction

Shale gas is an unconventional source of natural gas that can be extracted from shale – sedimentary rocks, that lie at depths of up to 20,000 feet beneath the surface. The procedure of extraction, known as hydraulic fracturing (or hydrofracking) involves drilling a large number of wells into the shale formation and inserting a pressurized substance into the ground. The induced pressure creates cracks in the rocks which enable the release of natural gas contained in the shale.

According to a study, conducted by the U.S. Department of Energy (2009), substances used for hydrofracking include mostly water (about 98%), mixed with resin-coated sand, silica, or man-made ceramics. Synthetic chemicals are often used to adapt the substance to the specifics of the well. In some cases, gas, such as nitrogen and carbon dioxide can also be used. In addition, a study conducted in 1976 (Reis) shows that radioactive "tracers" are often employed in order to determine the position and profile of shale fractures.

Shale gas is an economically viable source of natural gas, due to rising natural resource prices, and the development of techniques that enable drilling of horizontal wells, which provide better exposure to the resource (Seale, 2007). It is a widely discussed topic

in Europe. According to a study, conducted in Rice University, shale gas production can help Europe alleviate its energy dependence gas imports from Russia and oil imports from Persian Gulf countries (Brotzen, 2009).

Although shale gas can provide significant benefits to European economies as a source of cheaper natural gas, some studies have shown that hydrofracking involves risks to the environment. Hydraulic fracturing has the potential to cause ground water pollution, degradation of air quality, and introduction of chemicals, gas, and even radioactive elements in the natural environment (Committee on Energy and Commerce, 2011; Brown, 2007). In the United Kingdom, there have been reports of earthquakes allegedly caused by hydrofracking (BBC News, 2 November 2011). A study conducted in Columbia University also links several earthquakes that occurred in 2011 in the state of Ohio to a hydrofracking operation (Martineau 2012).

In this paper, I will examine the property rights that exist in two European countries where shale gas is currently being extracted – the United Kingdom and Poland. I will introduce the parties being directly or indirectly influenced by hydrofracking, and the legislation that is put in place to protect their respective rights. I will also introduce any institutions involved with enforcing these rights. I will provide a summary of economic research on the subject, and conclude the paper with my consulting opinion.

II. Historical Context

Although low-pressure shale gas was first extracted in the nineteenth century, it was

not immediately available as an alternative source of natural gas because of the low price of natural gas and the lack of cheap methods of extraction. It was only in the 1970s that the U.S. Government invested in the developments of more efficient extraction techniques such as horizontal drilling and massive hydraulic fracking (Shellenberger & Nordhaus, 2011).Economical hydrofracking became a reality in 1998 with the introduction of "slick-water fracturing" (The Breakthrough Institute, 2011).

Hydrofracking has since become a topic of much public debate. There has been strong opposition, and a number of European countries, including France and Bulgaria have banned any form of hydraulic fracturing due to environmental concerns. Other countries, such as Poland, have granted concessions for exploration and extraction of shale gas to foreign and domestic companies despite the lack of special environmental laws addressing shale gas (McGuire, 2012).

III. Users and Property Rights Issues

Shale is an object of interest for exporters and producers of natural gas. It is not always an object of interest to landowners, because in most European countries (Poland, for instance), landowners only have property rights to the surface of their land, while any natural resources below the surface are owned by the state. Thus, shale a resource of interest to the state – it is generally perceived as a means to lower energy dependence and higher energy supply. A recent study has estimated the existence of 5.3 million cubic meters of accessible shale gas reserves in Poland (U.S. Energy Information Administration, 2011), and polish officials see that as an opportunity to end Poland's dependence on Russian gas

(G. C., 15 January 2012, The Economist). If extracted, Poland's shale-derived gas could drive down domestic gas prices by as much as 50%, according to Polish Treasury Minister Mikolaj Budzanowski (Daly 2012). In the United Kingdom, Cuadrilla Resources – an energy firm involved in test drills for finding shale gas in Lancashire – reported that they have discovered 200 trillion cubic feet of gas. They have also estimated that an extraction operation "could provide 5,600 jobs in the UK, 1700 of those in Lancashire." (BBC News, 21 September 2011).

The good economic prospects of hydrofracking have made governments in Poland and the United Kingdom adopt a range of policies to create a good business environment and attract foreign investment. In Poland, where hydrofracking is a new industry, the government is has handed out 109 prospecting concessions at prices of around 100 euro per square kilometer – a price, considered low by certain members of the public. According to Polish officials, however, such prices are reasonable due to the speculative nature of the investment, and the lack of adequate service market for this sector (G. C., 15 January 2012, The Economist). In addition, the Geological and Mining Law in Poland states that if a company holding a concession is successful in finding hydrocarbons in a state-owned deposit, it may request the right to use the deposit for its own benefit (called a *mining usufruct*), while the state retains its ownership (Baginski, 2011) – in essence, creating a system of limited property rights. Requests for concession are reviewed on an individual basis by the Polish Ministry of Environment, and decisions are based on a number of factors, including environmental safety. Mining usufructs are also granted on an individual basis, in the form of a contract between the entrepreneur and the state treasury, and require

payments on the part of the entrepreneur. While the existing concession system is currently being applied in the context of shale gas, the procedure for obtaining mining usufructs for hydrofracking will likely be different from the one outlined in the current Geological and Mining Law (Baginski, 2011).

In England and Wales, there is no clear definition on how deep below the surface property rights of landowners go. Thus, there have been cases of landowners suing oil and gas companies for trespassing when companies drill horizontal or diagonal wells into a resource that might be considered private property. In the 2010 case of Star Energy v Bocardo, the Supreme Court ruled that Star Energy – an oil company – had trespassed Bocardo's property by drilling a downward diagonal well under the adjoining land (Hayes, 2010). The court also ruled that Bocardo was subjected to the damaged of a missed opportunity to negotiate a way-leave payment for the laying and use of pipelines under his land (Stacey, 2011). In an effort to clarify the situation, the government of the United Kingdom stated in a number of 2011 publications about shale gas, that landowners do not own the property rights to natural resources under their land – namely petroleum and natural gas. They also stated that companies interested in shale gas prospecting and extraction should acquire a license from the government. Companies should also follow proper procedures regarding landowner rights, otherwise they can be prosecuted for actionable trespass by landowners even if they hold a government license.

While oil and gas legislation in both Poland and UK was written without shale gas in mind, a recent study conducted by the European Commission in Poland, France, Germany,

and Sweden has concluded that existing EU and national legislation is applicable for the case of shale gas at this point. They also found out that EU legislation also covers issues of environmental impact – the Water Framework Directive, the Groundwater Directive and the Mining Waste Directive address water protection issues, while the REACH regulation addresses the use of chemicals in mining operations. The study also concludes that as shale gas exploration and extraction expands, more specific legislation might be needed (Tolbaru, 2012).

IV. Review of Economic Work Already Done on the Situation

There have been many studies on the economical viability of shale gas as a natural resource. Most of them, however, have been inconclusive. Profitability is very sensitive to fluctuations in gas price as well as geological factors such as depth and composition of the natural resource. It also depends on the availability of infrastructure (pipelines), support services, and favorable legislation. Thus, it is impossible to say whether shale gas extraction is profitable in general. Such conclusions can only be reached for specific cases after a detailed study.

To better understand the economics of shale gas, it is important that policy makers are aware of the peculiarities of shale gas production, as opposed to conventional natural gas production. The Research Triangle Energy Consortium – an organization dedicated to solving the world's economical and public policy problems – have written a short article that introduces the two main differences in the nature of the resource (Research Triangle Energy Consortium, 2011). According to this article, one important difference between

conventional natural gas and shale gas is that the output of shale gas wells declines rapidly – there is a drop of 60% to 80% in the first year alone (as opposed to 25% to 40% in conventional gas wells). This could be attributed to premature closure of the shale fractures, and might be offset by an improvement in technological knowledge – namely the introduction of better chemicals and more effective use of re-fracturing. Another major difference is that shale often contain the so-called "Wet Gas" – natural gas with a significant hydrocarbon content other than methane, which often add to the value of the resource. Wet gas often contains propane, butane, and ethane, all of which are more expensive than regular methane.

While countries such as Poland and the United Kingdom are looking at shale gas as a way of securing their energy independence and boosting their economies, based on their allegedly massive shale gas supplies, there are reports suggesting that shale gas might not be such a "blessing" after all. In an article published in June 2011, the New York times have reviewed a collection of leaked documents – "hundreds of industry e-mails and internal documents" – in which lawyers, geologists, and market analysts "voice skepticism about lofty forecasts and question whether companies are intentionally, and even illegally, overstating the productivity of their wells and the size of their reserves. Many of these e-mails also suggest a view what is in stark contrast to more bullish public comments made by the industry, in much the same way that insiders have raised doubts about previous financial bubbles" (Urbina, 2011).

In the case of Poland, a valuation study conducted in November 2011 by

Schlumberger Ltd – a leading oilfield services provider – indicates that shale gas drilling in Poland costs almost three times as much as in the United States. “The cost of drilling a 2,000-meter (6,562-foot) horizontal well in the U.S. averages $3.9 million, compared with $11 million in Poland, Peter Richter, global unconventional technology and marketing manager at Schlumberger, said [...] at the Shale Gas World Europe 2011 conference in Warsaw.” The higher cost is attributed to the lack of infrastructure and expertise, as well as public concerns (Strzelecki, 2011).

There have been a number of studies discussing the potential adverse environmental effects on hydrofracking. Most of them have come from the United States, where hydrofracking is widely commercialized. In the United States, hydrofracking for the purpose of oil and natural gas production was exempted from the Safe Drinking Water Act with the introduction of the Energy Policy Act in 2005, according to the U.S. Environmental Protection Agency. Furthermore, waste water from hydrofracking is exempt from federal hazardous waste regulations, although it contain many toxins (U.S. Environmental Protection Agency, 2002, 2011). A 2011 House of Representatives report concludes that 650 out of 750 additives used in hydraulic fracturing contain chemicals that are controlled under the Safe Drinking Water Act or listed as hazardous. In addition, more than 270 compounds used in hydrofracking include chemicals that are considered “trade secret” and have remained undisclosed (U.S. House of Representatives Committee on Energy and Commerce Minority Staff, 2011). The apparent lack of information about such undisclosed chemicals has made it difficult, and in some cases even impossible to assess how hydrofracking affects the surrounding environment (Kris, Fitz, Patrick, 2011).

In 2011 there were a number of reports suggesting that hydraulic fracturing was directly or indirectly causing damages to the environment. A New York Times article from February 2011 reported that 116 out of 179 gas wells ins Pennsylvania contained “high levels of radiation”. The article also stated that there was no information whether drinking water had been affected, because radiation tests were not conducted on a regular basis. (Urbina, 2011) Researchers at Duke University tested groundwater in territories lying above the Utica and the Marcellus shale, and found that groundwater near fracking wells contained a heightened concentration of methane. They isotopic signature of the methane suggested that it had originated from the shale (Osborn, Vengosh, Warner, Jackson, 2011). After a three-year investigation of poor water quality in Pavillion, Wyoming, the EPA released a draft report in December 2011 that concludes that “constituents associated with hydraulic fracturing have been released into the Wind River drinking water aquifer” (U.S. Environmental Protection Agency, 2011).

All of these studies show that the existing policies in the United States concerning environmental protection have been largely ineffective. A new set of policies are in the works as of February 2012. According to a Reuters article, the draft policies designed by the Interior Department will mandate disclosing the “complete chemical makeup “ of all chemicals used in hydrofracking. It will also set standards for ensuring stability of wells, and safe disposal of waste water. (Gardner & Rascoe, 2011)

In the United Kingdom, similar regulations have already been put in place.

According to a report on shale gas, conducted by the British Geological Survey for the Department of Energy and Climate Change in 2011, although there have been cases of environmental problems caused by hydrofracking in the United States, “evidence seems to show that where the problems are genuinely attributable to shale gas operations, the problem is with poor well design and construction, rather than anything distinctive to shale gas. In the UK, well design and construction is addressed by the Health and Safety Executive through specific regulatory controls, which among other things require verification of the well design by an independent third party.” The Health and Safety Executive is also directly involved in the shale gas production license application process as well as monitoring and inspections of well operators. (British Geological Survey, 2012)

In Poland, no specific legislation for shale gas exists yet. However, there is a draft law that proposes that shale gas prospecting and extraction be performed by “a special purpose vehicle” with the direct participation of the Polish Treasury as a minority shareholder.

V. Consulting Opinion

Shale gas provides many challenges to policy makers. As a natural resource, shale gas should not be considered independently of overlying natural resources, because unsafe fracturing procedures could lead to damages to other natural resources – namely groundwater and land – and incur costs that are hard to assess, monetize, and compensate

for. Policy makers need to design policies that not only guarantee the efficient use of shale gas, but also protect groundwater and farmland from possible pollution. Thus, in order to asses the social cost of extracting shale gas, policy makers need to consider the value of the resources that might be affected. They must also consider the risk of damage to these resources, and estimate the potential costs incurred by the damage. Policy makers should also account for the benefits of cheaper gas – namely the lower demand for oil (assuming that oil and gas are substitutes), and the resulting benefit to the environment due to the reduction of greenhouse gas emissions.

Shale gas is often viewed from the perspective of weak sustainability. Companies involved in shale gas extraction make huge investments and rely on the fact that fuel prices rise in the long run to make a profit. They also believe that future technological improvements can drastically reduce their operating costs. Often, they engage in operations that are arguably not profitable today, but as gas prices gradually increase, they might become profitable in the future.

Calculating an optimal extraction rate for a shale gas resource is a difficult task because data on the quantity of gas is often unreliable. Moreover, due to the uncertainties of the fracking process, it is often impossible to estimate what fraction of the known reserves can be extracted using existing technology at an economically viable cost. All of these factors make shale gas an even bigger challenge than other fuel resources.

My personal perspective on shale gas is one of caution. I believe that when shale gas

is provably worth extracting, it should be extracted provided that strict regulations are put in place to prevent damage to other resources and existing technologies and procedures are proven to be safe. However, in practice, existing legislation does not always provide adequate protection. In the case of the United States, the responsibility of disposing of waste water and the use of chemicals in hydrofracking has fallen almost entirely on the well operators, with little or no government regulation. In Poland, several government officials (including the head of the Geology Department of Poland's Ministry of Environment) have recently been charged with offering or receiving bribes connected to the allocation of shale gas concessions. (G. C., 15 January 2012, The Economist) Such allegations of corruption put in question the ability of government agencies to provide effective monitoring and control over fracking operations.

The European Commission has determined that European legislation provides adequate measures to prevent damage caused by hydrofracking at this stage. (Tolbaru, 2012) While these laws are expected to be observed in all member states of the European Union, I believe that they are often difficult to enforce by individual countries.

It is also a subject of debate whether existing hydrofracking technology is “safe”. Until there is well-grounded evidence that hydrofracking is safe, I would argue against hydrofracking in general, since I place a high value on the environment and I feel that the risk of environmental damage (contamination of air, water, land) outweighs the benefits of cheaper natural gas and reduced greenhouse emissions.

Reference List

1. U.S. Department of Energy. (2009). Modern Shale Gas Development in the United States: A Primer. Retrieved from http://www.rrc.state.tx.us/doeshale/Shale_Gas_Primer_2009.pdf

2. Reis, John C. (1976). Environmental Control in Petroleum Engineering. *Gulf Professional Publishers.*

3. Seale, R. (2007). Open Hole Completion Systems Enables Multi-stage Fracturing and Stimulation along Horizontal Wellbores. Retrieved from http://drillingcontractor.org/dcpi/dc-julyaug07/DC_July07_PackersPlus.pdf

4. Brotzen, F. (2009). US-Canadian Shale Could Neutralize Russian Energy Threat to Europeans. *Rice University, News and Media Relations.* Retrieved from http://www.media.rice.edu/media/NewsBot.asp?MODE=VIEW&ID=12557

5. Committee on Energy and Commerce, U.S. House of Representatives (2011). Chemicals Used in Hydraulic Fracturing. Retrieved from http://democrats.energycommerce.house.gov/sites/default/files/documents/Hydraulic%20Fracturing%20Report%204.18.11.pdf

6. Brown, Valerie J. (2007). Industry Issues: Putting the Heat on Gas. *Environmental Health Perspectives (US National Institute of Environmental Health Sciences).*

7. BBC News. (2 November 2011). Fracking Tests Near Blackpool "Likely Cause" of Tremors. Retrieved from http://www.bbc.co.uk/news/uk-england-lancashire-15550458

8. Martineau, Kim. (2012). Ohio Quakes Probably Triggered by Waste Disposal Well, Say Seismologists. *Columbia University Earth Institute.* Retrieved from http://www.ldeo.columbia.edu/news-events/seismologists-link-ohio-earthquakes-waste-disposal-wells

9. Shellenberger, M. Nordhaus, (December 16 2011). T. A boom in Shale Gas? Credit the Feds. *Washington Post*, Retrieved from http://www.washingtonpost.com/opinions/a-boom-in-shale-gas-credit-the-feds/2011/12/07/gIQAecFIzO_story.html

10. The Breakthrough Institute. (2011). Interview with Dan Steward, former Mitchell Energy Vice President. *The Breakthrough Institute.* Retrieved from http://thebreakthrough.org/blog/2011/12/interview_with_dan_steward_for.shtml

11. McGuire, D. (2012). Pro-fracking or pro-Russia? The Shale Gas Debate in Poland. Retrieved from http://www.rnw.nl/english/article/pro-fracking-or-pro-russia-shale-gas-debate-poland

12. U.S. Energy Information Administration. (2011). World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States. Retrieved from http://www.eia.gov/analysis/studies/worldshalegas/

13. G. C. (15 January 2012). Shale Gas in Poland: Down to Earth. *The Economist.* Retrieved from http://www.economist.com/node/21542918

14. Daly, J. (2012). Poland Green-lights Massive Fracking Efforts. Retrieved from http://worldpress.org/Europe/3878.cfm

15. BBC News. (21 September 2011). Shale gas Firm Finds "Vast" Gas Resources in Lancashire. Retrieved from http://www.bbc.co.uk/news/uk-england-lancashire-14990573

16. Baginski, W. (2011). Shale Gas in Poland – The Legal Framework for Granting Concessions for Prospecting and Exploration of Hydrocarbons. Retrieved from www.felj.org/docs/elj321/18_145_shale_gas_in_poland.pdf

17. Hayes, S. (2010). Tresspass by Well Drilling in the UK. Environmental Law ReSource. Retrieved from http://www.environmentallawresource.com/2011/10/articles/uk-shale-gas/trespass-by-well-drilling-in-the-uk/

18. Stacey, C. (2011). Case Comment: Bocardo SA v Star Energy UK Onshore Ltd and Another. Retrieved from http://www.lexology.com/library/detail.aspx?g=d26cfac9-22d4-471f-8a41-b2d6b7639362

19. Tolbaru, A. (2012). Fracking Does Not Need More Regulation, Report Says. *The Guardian.* Retrieved from http://www.guardian.co.uk/environment/2012/jan/30/fracking-regulation-ec-report

20. Research Triangle Energy Consortium. (2011). Is Shale Gas Production Profitable? *Research Triangle Energy Consortium.* Retrieved from http://rtec-rtp.org/2011/07/04/is-shale-gas-production-profitable/

21. Urbina, I. (2011). Drilling Down: Insiders Sound an Alarm Amid a Natural Gas Rush. *The New York Times.* Retrieved from http://www.nytimes.com/2011/06/26/us/26gas.html?pagewanted=1&_r=3&ref=drillingdown

22. Strzelecki, M. (2011). Shale-Gas Drilling Cost in Poland Triple U.S., Schlumberger Says. *Bloomberg.* Retrieved from http://www.bloomberg.com/news/2011-11-29/shale-gas-drilling-cost-in-poland-triple-u-s-schlumberger-says.html

23. U.S. Environmental Protection Agency. Regulation of Hydraulic Fracturing Under the Safe Drinking Water Act. Retrieved from http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_hydroreg.cfm

24. U.S. Environmental Protection Agency. Exemption of Oil and Gas Exploration and Production Wastes from Federal Hazardous Waste Regulations. Retrieved from http://www.epa.gov/osw/nonhaz/industrial/special/oil/oil-gas.pdf

25. U.S. Environmental Protection Agency. (2011). Natural Gas Drilling in the Marcellus Shale NPDES Program Frequently Asked Questions. Retrieved from http://www.epa.gov/npdes/pubs/hydrofracturing_faq.pdf

26. U.S. House of Representatives Committee on Energy and Commerce Minority Staff.

(April, 2011). Chemicals Used in Hydraulic Fracturing. Retrieved from http://democrats.energycommerce.house.gov/sites/default/files/documents/Hydraulic%20Fracturing%20Report%204.18.11.pdf

27. Kris; Fitz; Patrick. (November 17, 2011). Ensuring Safe Drinking Water in the Age of Hydraulic Fracturing. Retrieved from http://sites.duke.edu/sjpp/2011/ensuring-safe-drinking-water-in-the-age-of-hydraulic-fracturing/

28. Urbina, I. (26 February 2011). Regulation Lax as Gas Wells' Tainted Water Hits Rivers. *The New York Times*. Retrieved from http://www.nytimes.com/2011/02/27/us/27gas.html?pagewanted=all

29. Osborn, Stephen G.; Vengosh, Avner; Warner, Nathaniel R.; Jackson, Robert B. (2011). Methane Contamination of Drinking Water Accompanying Gas-well Drilling and Hydraulic Fracturing. *Proceedings of the National Academy of Sciences*. Retrieved from http://www.pnas.org/content/early/2011/05/02/1100682108

30. U.S. Environmental Protection Agency. (2011). Investigation of Ground Water Contamination Near Pavillion, Wyoming (Draft). Retrieved from http://www.epa.gov/region8/superfund/wy/pavillion/EPA_ReportOnPavillion_Dec-8-2011.pdf

31. Gardner, T; Rascoe, A. (2012). U.S. to Require Disclosure of Fracking Fluids on Public Land. *Reuters.* Retrieved from http://www.reuters.com/article/2012/02/03/us-usa-fracking-interior-idUSTRE8121ZT20120203

32. British Geological Survey. (2012). The Unconventional Hydrocarbon Resources of Britan's Onshore Basins – Shale Gas. Retrieved from https://www.og.decc.gov.uk/UKpromote/onshore_paper/UK_onshore_shalegas.pdf