Shale gas: energy security laced with possible environmental perils

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In the last few years, the world's gas markets have and are still experiencing a revolution. Thanks to the newly developed U.S. technology, that allows drilling into shale formations and breaking them apart for extraction of gas, knowledge on how to tap into such gas resources became available to any country in the world. -This process, allowed the United States today to supply more than 23% of its internal gas needs and increase it to 40% in approx. 5-6 years. U.S. success, led many other countries to start searching for and extracting gas in their own territories. The result is a substantial decline in gas prices. Increased supply of gas and its transportation in liquefied form have become so plentiful that the United States, which had previously imported it, now began its massive export. Gas reserves are expected to increase globally in the foreseeable future at least 4% per year.

Gas extraction from shale deposits

Geologists have known for a long time about shale rocks containing gas deposits. However, the technology to extract gases from the deposits was developed only a few years ago. In this process, rocks are drilled vertically to depths of several thousand meters. Once the desired layer of shale rock is reached, the drill head is oriented to continue drilling horizontally several kilometers away of the vertical (see illustration). After the necessary underground targets are prepared, pipes are inserted into the drilled out boreholes and reinforced on the outside by blown-in concrete. Subsequently, the pipes are pressure filled with a special liquid mixture. The shale rock is penetrated by pulsating thrusts of the pressurized liquid through special ports all along the pipe. As a result of the pulsating pressure, fissures in the shale rock develop and keep expanding until a desired penetration level is reached. During the expansion, sand is injected into the fissures to prevent their collapse. Upon relief of the water pressure, the compressed liquid mixture, now containing gas, shoots out like champagne from a suddenly uncorked bottle. Escaping gases are then directed by special devices to gas storage facilities.

A special liquid mixture is used in the drilling and gas extraction process. It involves millions of gallons of water, mixed with sand and special chemicals, which facilitate drilling, reduce pipe corrosion, etc. Although the chemicals are only ½ per cent of the injected liquid mixture, most of them are toxic and dangerous to human health. If an unexpected equipment breakage were to occur during the drilling process, underground spillage of the special mixture could contaminate the penetrated aquifers. Similarly, any spillage and leakage from holding ponds containing used drilling liquids could contaminate the entire region’s drinking waters. They are extremely difficult, if not impossible, to neutralize, because in many instances the content of the chemicals in the drilling mixture is proprietary, different with each driller, and not readily disclosed even to the regulating authorities. Shale gas drillers are now under extreme pressure by environmental and public health departments and community organizations to improve the gas extraction methods and to find safe for human health substitutes for toxic chemicals.

Resources in Lithuania

For a few weeks now, Lithuania's government has been making public announcements about shale gas deposits in Lithuania. While their existence has been known for a long time, only the development of horizontal drilling and fracture technologies of shale deposits has brought a glimmer of hope of extracting gas for the country's own use. The news of these gas resources has created considerable public interest and enthusiasm for attaining energy self sufficiency. It has become even more relevant, when Lithuania's energy minister A.Sekmokas, while visiting Washington, D.C. in May of 2011, was informed by the U.S. Energy Information Resources Agency director, Richard Newell, that the south-western region of Lithuania may indeed contain significant shale deposits. Minister Sekmokas, upon his return from Washington, announced that shale deposits in Lithuania might be sufficient to supply the country's energy needs for the next 30-50 years. If true, it would completely change the energy situation in Lithuania and help to attain energy security for a long time to come.

It seems that discussions about shale gas resources in Lithuania have a good foundation. Consultants on shale gas deposits note, that Poland has most likely the largest shale deposits in Europe. They extend from the entire north coast of Poland to its distant southeast border. They could contain over 5 trillion cubic meters of shale gas. Some of these deposits extend into the south-western and western regions of Lithuania. Preliminary data indicate that 1 square km of shale rock area will yield about 390 million cubic meters of deliverable gas. However, currently there is virtually no knowledge of how many square kilometers of shale rock are within Lithuania's territory. The energy ministry noted that further drilling and testing will be conducted to make appropriate assessments.

Promise of bountiful energy and potential environmental risks

Although the first indications of bountiful energy supplies are received by cheers from shale gas fans, the euphoria, however, is laced sometimes by subdued warnings that cheap and bountiful gas might be just an unjustifiable and unrealizable illusion. The murmurs are even uttered by some Western experts and analysts. There are several reasons for this:

1. Research of shale deposits by U.S. geologists cover in good depth primarily the territory of the United States. Their knowledge about shale gas formations in other parts of the world are more theoretical deductions based on a relatively limited number of explored wells. Although news about the potential shale deposits in Lithuania are much welcome, they will need to be supported by concrete evidence from probes extracted from drillings of hundreds of exploratory wells. Potential resource assessment may take two, three, even four years. Only then will it be possible to assert which of the areas have formations with sufficient amounts of gas, and if there are opportunities to extract it at a reasonable price. It should be noted that not all shale formations contain gas. Past experience has shown that dozens of exploratory wells yielded not even one cubic foot of gas. Drilling does not always hit the sweet spot of high gas concentration, or it might find low levels of concentration that would not justify commercial extraction. Inasmuch as initial exploratory wells cost between three and eight mln. USD, drillers have to be fairly certain that the intended exploration area is large enough and has sufficient gas yield potential to justify initial research expenditures.

2. The greatest risk of extracting gas from shale deposits is contamination or even poisoning of drinking water resources. Contamination of water resources can occur during the drilling process towards the shale formation, through the escape of gas and/or drilling liquids via alternative paths after fracturing the shale rock, by bursts of underground pipes, or by pipe connection defects. Theoretically, ground water contamination by diluted mixtures of chemicals can be avoided since most ground waters are considerably above the shale rock deposits. However, drilling and gas extraction processes are not hermetically sealed operations, rock formations having large voids could result in large amounts of drilling fluid leakage during boring operations, and mistakes and accidents do occur. In such cases leakage, and underground spills can have serious consequences. According to U.S. media, drinking water contamination problems have been encountered at a number of drilling sites in the Marcellus formation region, encompassing Pennsylvania, Ohio and West Virginia regions, an area of approximately 250 thousand square kilometers. The contaminations involved, in some instances, ground waters, and in others streams and rivers. The media also cited a growing number of complaints by area residents of unexpected and strange health problems, death of animals grazing in meadows in the vicinity of drilling sites, and even ignition of water flowing out of kitchen faucets. Environmental authorities observe that the current water treatment systems have great difficulty coping with the contaminants, since they are many in numbers and many times unknown. According to the Texas environmental agency, of 37 shale gas wells tested for contaminants, 13 were found containing toxins considerably higher than allowable tolerance limits for human health. As a result, a number of gas well operations were terminated by orders of Pennsylvania and New York state health authorities. The state of New Jersey adopted a law in July 2011, prohibiting shale gas extraction in the entire state, until the license applying operator provides evidence that any materials used in shale rock drilling and fracturing processes will be absent of ingredients posing risk to human health. Similar legislation was also adopted by France. The city of Pittsburgh, Pennsylvania, as a result of contamination of its aquifer, advised its inhabitants in spring of 2011 to avoid use of city supplied water for drinking and food preparation

3. Underground shale gas production consumes significant amounts of water that is lost forever. In areas where availability of water resources is critical or is not in abundance, water scarcity could develop for human needs, particularly if the water for the extraction of shale gas is drawn from underground aquifers. Each repeated fracturing operation consumes some 13 million gallons of water which can in some areas deplete local reservoirs. Accordingly, *Energy Business Insider* notes, the notion that shale-gas could become the next gold rush may be jeopardized, particularly because its production in some regions might conflict with human needs. In other instances shale gas extraction may be impossible due to unavailability of water in the region. As demand on water resources grows, it will become an important consideration in the shale gas energy agenda alongside cost, carbon and security considerations.

4. According to the U.S. Energy Department estimates, Poland's shale gas reserves could exceed 5 trillion cubic meters, sufficient to satisfy that country's energy needs for some 300 years. However,

Poland seems to be in no rush to exploit these resources. It appears that they are doing this for several good reasons:

First is the price. According to the Wall Street Journal, European shale gas formations are more than one and a half times deeper from the surface than those in U.S. This makes the search for and extraction of gas not only more complicated, but also considerably more expensive. Oxford Institute noted that the cost of extracting one thousand cubic feet of gas in the U.S. is about 3 USD, while the. cost of extraction from deeper formations in Europe will be more than 16 USD. As is, it would be impossible to compete with the current price of gas supplied by Gazprom, which at the delivering pipe is between 6 and 8 USD per thousand cubic feet. At this price level, it is far more economical for Poland to buy gas from Russia or to import it in liquid form from someplace else rather than to extract from own deposits. Once the imported gas prices rise to internally extractable levels, Poland then will initiate shale gas exploitation.

The second factor is technological advancement. Over time, shale gas extraction technology will become more efficient, cheaper, less damaging to the environment and without danger to human health. Drilling will also become less expensive, because in several years competition to conduct gas extraction will be far more intensive

The third factor is competition and time advantages. Poland, by using competitive leverages in purchasing gas from several suppliers will achieve total energy independence from Russia, and even dictate to Russia, within limits, gas prices it is willing to pay. At the same time, Poland, in a matter of several years, will have the benefits of advancements in shale gas extraction technologies and a much better understanding of gas extraction consequences not only for the environment, but also to the health of its people.

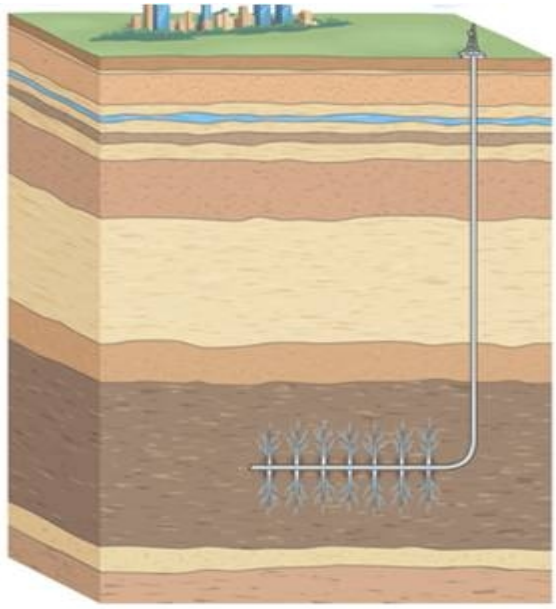
Moving towards energy security

Shale gas extraction and its world-wide availability in large amounts via liquefied transport is the twenty-first century's major revolution, and a salvation for many energy poor countries. Extraction of gas, at least in the U.S., outweighs the pollution and health risks, and it will improve in the future. Within a few short years, the emergence of shale gas has wiped out the fear of energy starvation for the rest of this century, if not longer. Use of gas to generate heat and electric power promises to reduce air pollution by more than 50% over energy produced by coal and oil. Due to very favorable gas prices in the foreseeable future, substantial changes are also expected in the transportation sector.

Shale gas promises to cause significant economic and political changes throughout the world. Russia has most recently invested billions of dollars in the construction of thousands of miles of pipelines to transport gas to Western Europe and China. Russia, assumed that gas prices will keep rising and so its economic well being. Russia was using in the late 1990s and early 2000 its gas producer Gazprom to intimidate energy deficient countries into attaining whatever political and economic goals it wanted to achieve. The arrival of shale gas began to reduce the importance of Gazprom as the primary supplier of

gas to Western Europe. Compared to 2008, Gazprom's revenues dropped in 2010 about 22 billion USD. Declining gas prices in world markets and the possibility of buying it from multiple sources will certainly create for Russia large financial problems in future years.

Shale gas revolution for Lithuania and the other Baltic countries is like a repetition of their political break away from Russia in 1990, except that this time it is in energy terms. The first and immediate stage will be by import of liquefied natural gas, and the second stage solution will be by extraction of shale gas from own shale deposits. Let us hope that the developing opportunity to attain nearly total energy sufficiency will be carefully and prudently realized.



Schematic of gas extraction from shale rock formation

Great Falls, Virginia, USA

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