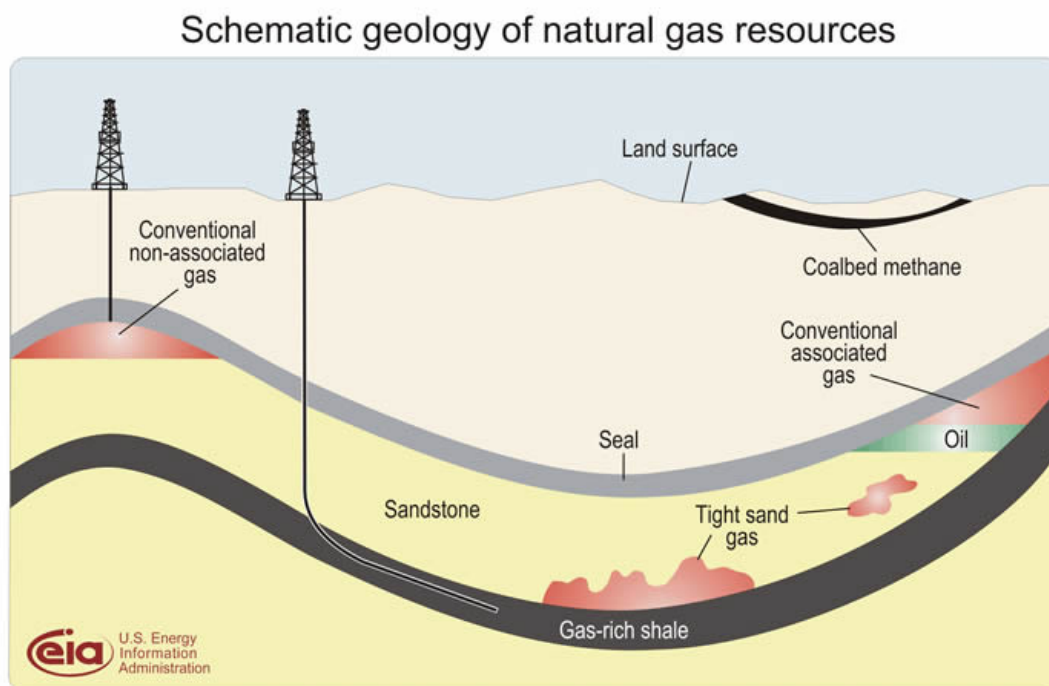


Shale gas in Poland.

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Based on various of articles and reports
of Polish Government and PKN Orlen



Characteristic of the shale gas

By the reason of type of rocks that contain hydrocarbons, we can differentiate conventional deposits and unconventional deposits. Gas from unconventional deposits is more difficult and more expensive to produce.

To the unconventional deposits of gas we can include:

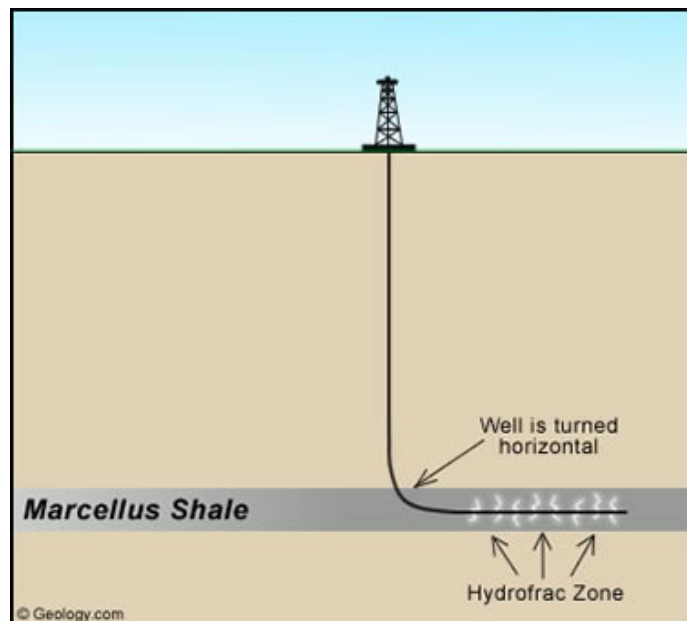
- shale gas
- tight gas,
- coalbed methane and
- gas hydrates.

Modern technology allows to produce gas from unconventional deposits on industrial scale.

Technology of production

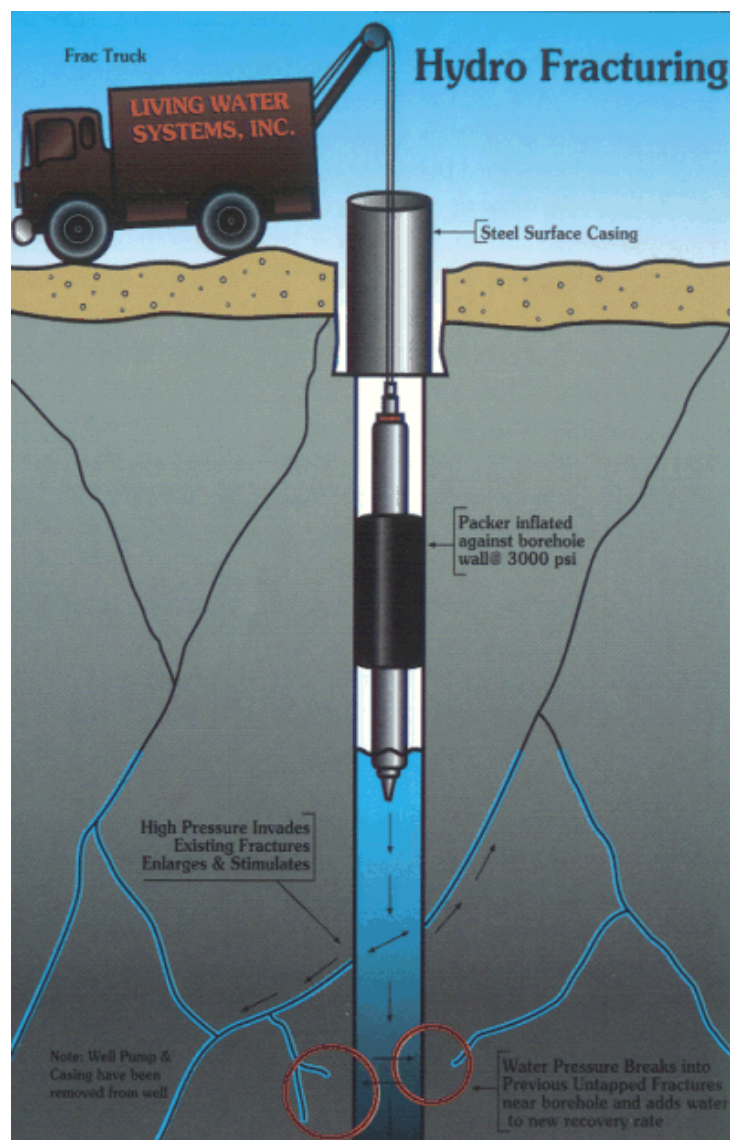
Production of shale gas is possible because of development of technology and lowering cost of horizontal drilling and hydraulic fracturing.

Horizontal drilling technique is based on the initial drilling of vertical section of the borehole, and then upon reaching the assumed depth, changing to the horizontal trajectory to drill in the selected rock layer.



Hydraulic fracturing involves pumping into a selected section of the drilling hole fluid under high pressure, consisting of a carrier (mainly water) with additional filler materials (mainly sand of selected grain and mechanical strength) and extra chemicals (mainly in order to enhance viscosity). The liquid under pressure creates a cracks in the rock structure, while sand fills and maintains the gap, creating a new way for gas migration in the hole.

During the one treatment of fracturing there is pumped fluid of average from 7.5 to 11.3 million liters and from 450 to 680 tons of sand.



Profitability

Profitability of production of shale gas depends on many factors:

- Mechanical properties and composition of the rock
- Ability to create a network of cracks on the basis of natural fracture system
- The cost of drilling
- The cost of hydraulic fracturing

In 2009, Credit Suisse has estimated that over the next few years the threshold of profitability of shale gas production will occur in the interval ratio of 0.12-0.37\$ per cubic meter of natural gas.

Due to the growing demand for drilling rigs and drills and popularization of technology could be expected to decrease the costs in the following years.

Impact on the geopolitics

The increase in shale gas production could significantly change the zone of influence and energy dependence of many countries in Europe and the USA.

U.S. thanks to its own shale gas extraction significantly reduced the import of LNG.

Production of natural gas from shale can decrease the EU's dependence on long-term contracts with Russia.

The increase in gas production due to the low emissivity of the CO₂ can decrease the investment in the energy sector based on coal and crude oil.

Market outlook for shale gas development in Poland

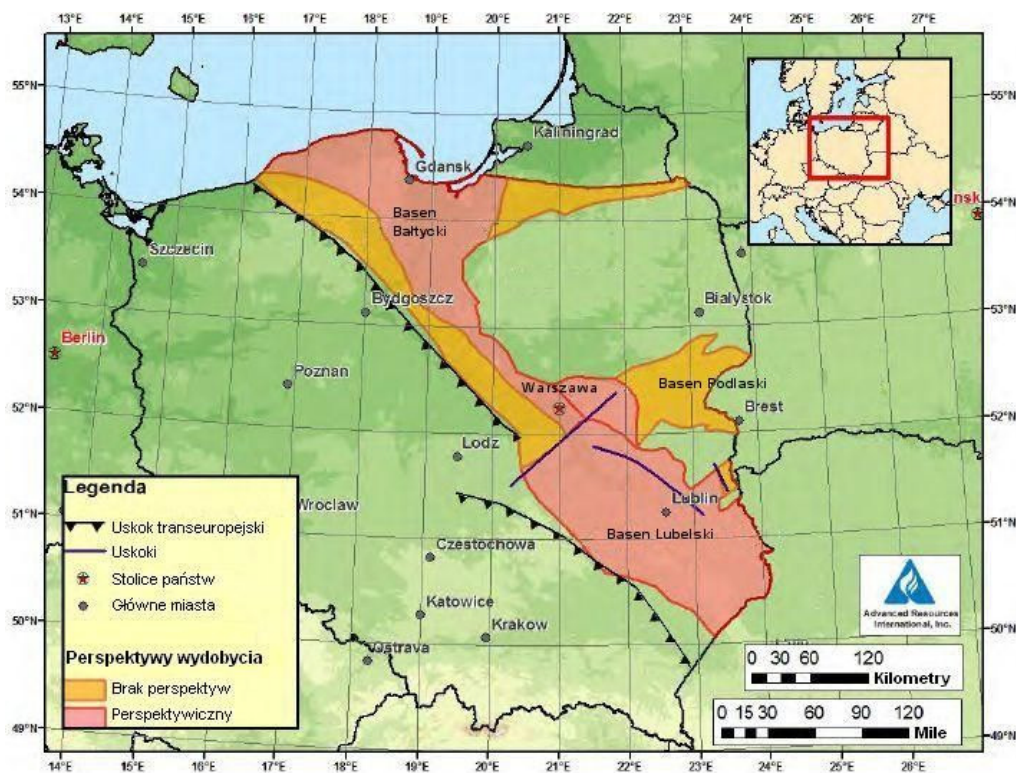
According to calculations made by the Energy Information Administration, production of shale gas by 2030 is expected to be 7% of the world production of natural gas. Wood Mackenzie estimates that, in Poland, there may be recoverable shale gas reaching 1.4 trillion m³. However, according to estimates of Advanced Resources International resources can be up to 3 trillion m³.

On March 21st 2012 National Geological Institute issued a report that estimated the size of the Polish deposits are most likely in the range 346 - 768 billion m³, but most reliable information about the real basis of the resource will be available probably in 2-3 years

when the exploration – finding work within the framework provided by the Ministry of Environment concessions will be over.

In Poland, until now has been issued 221 licenses for prospecting and exploration hydrocarbons, 111 to concessions aimed at extracting hydrocarbons from deposits such as shale gas. Exploration areas cover 12% of the Poland, equal the 37,000 km².

Polish "shale lane" is stretching from the coast, between Slupsk and Gdansk, to Warsaw, and further to the Lublin and Zamosc.



Forecasts indicate that the potential of shale gas deposits are located at depths from 1200-2500 m in the northern part of the lane to 2500-4500 m in the south part. There is estimated that the cost of a vertical drilling, depending on the depth, could range from 6 to 13 million dollars.

The first drilling in Poland, conducted by the PGNiG in Markowola (Masovia) did not give a positive result, while deposits in the area Lubocin (Pomerania) are considered promising. In September 2011, PGNiG announced that in 2014 that the gas from this drillings will go on the market. In June 2011, the company 3Legs Resources announced that has conducted drillings in search of shale gas and found the material.

Re-drilling in the Lublin region produced results. Shale gas was discovered in September 2011 by ExxonMobil.

By September 2012, have been able to accomplish fully about 25 boreholes, and another 12 are in progress. According to PMR, by the end of 2012, will begin later nearly 20 boreholes. Recent projects focus primarily on obtaining new data profiles that will develop further plans for development of the sector.

Legal Aspects in Poland

Polish Geological and Mining Law does not provide specific procedures for exploration, appraisal and production of natural gas from unconventional sources.

Everything takes place as in the case of conventional sources. Practice shows that the Treasury has a mining agreement and licenses issued in two stages, i.e. first for prospecting and exploration, followed by production.

Operator who recognized and documented unconventional gas field will be entitled for a period of two years priority to obtain concessions to produce shale gas.

Service charges in Poland, ranging from 1% to 2.5% of the revenue from gas production depending on the size of production. According to the government, this will attract the largest possible number of companies that are able to extract gas from shale. In a similar way, the U.S. government implemented the discounts and tax breaks for businesses exploiting unconventional gas reserves.

Potential problems in the way of extracting shale gas in Poland

- No definite government policies supported by the Council of Ministers, for activities designed to develop shale gas market in Poland.
- In Poland, it is not currently available technology necessary to extract gas from shale of the magnitude required to provide low cost, and the profitability of projects.
- In Europe, there is currently not enough drilling rigs for this type of production.
- Locally, there may be problems with water supply required for fracturing.
- It is possible that drilling will show a low cost-effectiveness.

Opportunities and benefits of the shale gas in Poland

- A chance for Polish gas self-sufficient for years, and potentially export of raw materials.
- A chance for Polish companies related to the oil sector for the development and expansion on the international market.
- The acquisition of cutting-edge exploration and production technology and development of managers and engineers.
- Development of transport and transmission infrastructure needed to manage raw material.
- National CO2 emission reduction due to increase of the share of natural gas in the national energy balance.

Market context

- World primary energy consumption increased in the years 1990 - 2010 by over 40% and by 2035 will increase by another 20%. The role of natural gas - in the years 1970 - 2011 world consumption increased from 1 to 3 trillion m³, and its share in the world's energy sources will reach 25% in 2025
- Conventional gas reserves estimated at 400 billion m³, but more than 50% of these resources are in non-democratic countries. Gas in shales is 200 billion m³ raw material, which is largely deployed in more politically stable areas.
- Natural gas is, in addition to oil, the main fuel of the EU - in 2010, 25% of the energy came from natural gas, and by 2035 the share of gas will increase to 29%. At the same time - by 2035 - the EU's gas production will fall by 45% (non-shale gas), which will increase our dependence on imports.
- Prospects for gas production in Europe is different than in the U.S., primarily due to geological conditions, infrastructure and law. That's why no one today promise that shale gas completely decoupling Europe from imports gas. But it will be enough to stabilize imports and will replace the decreasing supply of conventional gas from within the EU.
- Poland can be found in the group of 10 countries with the greatest potential of shale gas resources. However, the global capital has a great variety of countries for investments in unconventional hydrocarbons mining and does not have to decide on Poland.

- Today Poland is not yet ready for the additional supply of gas. Currently postponed demand is about 1.5-2.3 billion m³ per year. Without significant investments there is no way to locate the volumes of more than 5 billion m³ per year.
- The creation of the national gas demand requires liberalization of the gas market by providing access to infrastructure, trading, choice of supplier and commercial freedom, i.e. the free disposal of their own gas.

The results of the analysis at the request of of the Polish Government

The development of shale gas production may follow essentially three ways:

- (1) participation will be limited to only domestic companies without investment from abroad (moderate growth scenario)
- (2) in the extraction will participate domestic companies and to some point foreign companies (increased investment scenario)
- (3) will be created friendly conditions for investors (domestic and foreign) and, consequently, there will be a large inflow of foreign direct investment (accelerated growth scenario).

Polish company engaged in the exploration and production of shale gas in each scenario are at the winner position. Any increase in domestic production of gas improves their situation by reducing the need to purchase, and the lack of strong competition in scenarios (1) and (2) does not produce pressure for downward the prices for consumers. The strong increase in competition due to the foreign direct investment (scenario 3) poses a requirement and the chance for domestic firms to develop, which may result in the improvement of the competitive position of Polish companies in international markets.

Only the accelerated growth scenario can bring a qualitative change in the economy. The results show that the execution with a view to 2025, resulting in 305 of new drillings per year, gas production up to 12 billion m³, and the creation of 510 thousand new jobs and accelerate average GDP growth rate of 0.8% (years 2019-2025) . In this way the state

will receive an additional stream of tax revenues from economic activity, with a total value in the years 2012-2025 of 87 billion PLN.

Conclusion

For now market of the shale gas in Poland is at the beginning stage of development, but in the next 10 years it will be shown how much our resources are worth. However the effects of macroeconomic development of shale gas production will increased investment and employment in the sector and business partners and in the effect - revenue growth of companies and households.

