VIEW FROM RUSSIA

# "HEAVY" SHALE GAS

## Shale gas: history, problems, prospects

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THE LARGE-SCALE PRODUCTION OF SHALE GAS that has been launched in recent years in North America has had a serious impact on the global gas market. At the same time, the current optimistic assessment of shale gas resources for Europe and the countries of the Asian Pacific region were based on geological analogies with the North American basins, but have not yet been confirmed by results of actual geological surveying. Moreover, shale gas so far comes in behind traditional natural gas in all technical and economic respects. Finally, the serious impact on the subsoil caused by shale gas production creates greater environmental risks than traditional gas production does.

### AN ALTERNATIVE TO TRADITIONAL GAS?

Specialists are in many different minds when it comes to assessing resources and reserves of shale gas, since they are often using different concepts. The world's total possible resources are estimated at approximately 200 trillion $m^3$, including about 44 trillion $m^3$ in the USA. The gas in place figures obtained by geological surveying will most likely be only a third to two-thirds of this. Yet it is most difficult to determine which part of these may be classed as proved reserves suitable for commercial development. Shale gas is not underlain by water and is not restricted by a cap above, so traditional methods for calculating reserves are not applicable here. In order to obtain a reliable assessment, a dense grid of exploratory wells needs to be drilled over a huge area of a field, which is not economically realistic.

Outside the USA and Canada – in Europe, the Asia Pacific Region, and Australia – geological surveying for shale gas is in its infancy. So far, only very approximate estimates may be made by geological analogy with the North American basins. We predict that, after the geological surveying, the proved reserves of shale gas in the world, in consideration of the environmental, technological and economic restrictions, will not exceed 12 trillion $m^3$.

Production of shale gas was launched in the USA at the end of the 1970s but to no significant extent during the period of low gas prices. The rapid growth of the development of hard-to-recover gas reserves in the USA was initially connected with exhaustion of traditional fields. In the 1990s, the rise in proved reserves of natural gas leveled out at 4.5 trillion $m^3$, the growing demand being met by imports, which increased 2.5–fold from 1990 through 2000, from 40 to over 100 billion $m^3$ a year. It was at this time that the LNG projects were launched by the transnational and multinational companies (Shell, Exxon and others) throughout the world – in Algeria, Nigeria, Qatar, Mexico, and Russia.

In 2005, under the conditions of rapid rise in energy prices and reduction in production of traditional natural gas, the government of the USA took energetic steps to stimulate its domestic gas industry. Severance tax for gas was cut significantly and mandatory payments in favor of landowners increased, so the latter became more willing to conclude contracts with production companies. On the technological plane, mass development occurred of horizontal drilling and multistage hydraulic fracturing

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operations. As a result, over five years, production of shale gas increased more than 6.6–fold from 19 to 126 billion $m^3$ per year, thereby ensuring an overall increase in gas production in the country.

## DEPTH PROBLEMS

The Barnett Shale field in the northern part of Texas, in the USA, is the biggest and has a long history of shale gas production. The methane-containing structures here lie at a depth of from 450 to 2000 meters over an area of 13 thousand $km^2$. The seam is between 12 and 270 meters thick. In 2006, the 6.1 thousand wells produced 20 billion $m^3$ of gas; from 2007 to 2011, the number of wells has increased by about 2 thousand units a year to total 15 thousand units, but since 2008 the yield has ceased rising and has stabilized in 2009–2011 at a level of 50 billion $m^3$ a year.

The shale gas production technology consists in drilling of wells with a horizontal sidetrack of up to 1200 meters in length and multistage hydraulic fracturing. As the flow decreases, the hydraulic fracturing is repeated over and over. For the first hydraulic fracturing operations, in the order of 1000 tons of water and 100 tons of sand were required. Nowadays, in horizontal wells, at a cost of $2.6–3 million per hydraulic fracturing operation, in the order of 4000 tons water and 200 tons of sand are needed. On average, three hydraulic fracturing operations are carried out each year at each well.

**The growth of shale gas production in the USA and the press-created euphoria over the forecast reserves has aroused enormous interest in surveying for shale gas all over the world**

With shale gas production costs of $80–150 per 1,000 $m^3$ and depreciation of $100–200 per 1,000 $m^3$, full-scope imple-

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**SHALE GAS PRODUCTION PROGNOSIS UNTIL 2030,**
BILLION M³ (AVERAGE VALUE)

| Region, country | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| Northern America | 126 | 171 | 195 | 230 | 258 |
| USA | 126 | 168 | 183 | 210 | 230 |
| Canada | 0 | 3 | 12 | 20 | 28 |
| Europe | 0 | 0 | 9 | 15 | 18 |
| Poland | 0 | 0 | 3 | 6 | 6 |
| Ukraine | 0 | 0 | 2 | 4 | 4 |
| Germany | 0 | 0 | 1 | 1 | 2 |
| France | 0 | 0 | 1 | 1 | 1 |
| other | 0 | 0 | 2 | 3 | 5 |
| APR | 0 | 0,5 | 13 | 15 | 16 |
| China | 0 | 0,5 | 7 | 7 | 7 |
| Australia | 0 | 0 | 2 | 4 | 5 |
| India | 0 | 0 | 1 | 1 | 1 |
| other | 0 | 0 | 3 | 3 | 3 |
| World total | 126 | 171,5 | 217 | 260 | 292 |

**Source:** INSTITUTE FOR ECONOMICS AND ORGANIZATION OF INDUSTRIAL PRODUCTION, SIBERIAN DIVISION, RUSSIAN ACADEMY OF SCIENCES

mentation of projects to develop shale gas fields is possible only at a consumer sales price of at least $350–500 per 1,000 m³. Assessing full cycle implementation of projects for developing shale gas fields, the majority of them will run at a loss, since, as they are implemented, there is a galloping increase in the need for new investment. At the same time, since shale gas is, in the main, located close to the final consumer, its sales price is higher than the prices for large-scale wholesale purchases at regional hubs, so, at a certain stage, current full production and supply costs of such gas can provide an operating profit, but the projects are, overall, so far loss-making. Such projects by small operators are financed by borrowed funds and those by the oil and gas majors – ExxonMobil, ConocoPhillips, Marathon – at the expense of other business segments, mostly oil production.

Shale gas is behind traditional natural gas in all technical and economic respects apart from transport distance and, in certain cases, natural and climatic conditions. Production of shale gas thus makes it possible to resolve the problems of local gas supply for a limited time interval (a maximum of 15–17 years), after which connection to external supply sources is required in order to maintain the gas supply.

The advantage of shale gas is that it is located close to consumption centers but this same factor also imposes additional environmental restrictions. In the oil and gas industry, nothing else has such a powerful effect on the subsoil as shale gas production, which entails a substantial destruction of the integrity of the subsoil and involves a huge area, with dense drilling work.

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The main threats to implementation of shale gas projects in densely-populated areas (Europe, China, the USA) consist in removal of substantial areas from traditional use and disruption of the traditional lifestyle; pollution of water horizons and supply systems with chemical reagents and gas; direct or indirect damage to the surface and infrastructure facilities, both from surface denuding and man-made earthquakes and mud-slides.

## PROSPECTS IN QUESTION

The growth of shale gas production in the USA and the press-created euphoria over the forecast reserves has aroused enormous interest in surveying for shale gas all over the world. In Canada, the Horn River and Montney projects are being implemented and promising territories have been identified in British Columbia, Alberta, Saskatchewan, Ontario and Quebec. In China, the shale fields are spread over four major provinces. There are also prospects in the Baltic basin in Poland, the Paris basin in France, and the Cooper basin in Australia. Clay shale fields are known in North Africa (Algeria, Morocco), South America (Columbia, Venezuela), and Russia.

The main impediment to large-scale development of shale gas both in the USA and in other parts of the world is the short service-life of the wells. After 5–10 years, the shale gas flow dries up and, in order to maintain the gas supply level, more and more new wells have to be drilled and gas pipelines laid to them. Countries that are more interested in energy security than the profitability of the gas business will develop them. Development of shale projects in the USA will continue, with the companies playing on the rise in gas prices, since the need is arising to cover the huge costs, which they will transfer to the consumer. In Canada, where production of traditional gas is falling, it will be partially

replaced by shale gas fields but, in connection with their remoteness from the target American market, the possible production volumes are quite restricted. In Europe, shale gas may be extracted in limited quantities in Poland, Ukraine, Hungary, Turkey, France and Germany. The gas-producing companies in these countries may also be supported both by a rise in prices and by state subsidies.

The optimistic assessment of shale gas resources in Europe and the Asia Pacific Region were by analogy with the North American basins but they are as yet not confirmed by results of actual geological surveying. Moreover, the geophysical studies and drilling work carried out over the past 1–2 years in all these regions so far indicate that the real geological results are not as good as initially anticipated.

We estimate that by 2020, shale gas production might top 200 billion $m^3$ and, by 2030, reach 290–300 billion $m^3$, accounting for 5–5.5 % of total gas production. The biggest shale gas producers will be the USA, as well as Canada, and in Europe, production will be mostly concentrated in Poland, Ukraine and Germany and in the Asia Pacific Region – in China and Australia.

Production of shale gas has impacted on the American and international gas markets, causing a reorientation of some but no critical volumes of LNG from the Atlantic coast of the USA and resulting, in 2009–2010, a drop in prices in the physical sales segment. In the long-term, shale gas has not exerted any global or fundamental influence on the market. By virtue of its enormous capital intensity, the gas business reacts sensitively to sharp price fluctuations and needs them to be regulated. In many countries of the world, the regulation function is fulfilled by state-owned gas companies, whereas in the USA and, partly, in Europe, this role will most likely be assumed by big transnational corporations.


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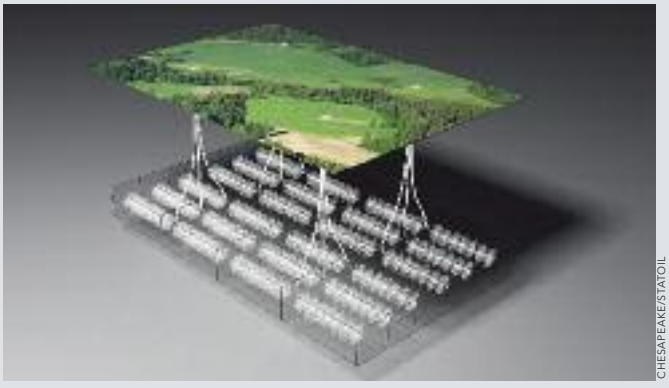
Having assets all over the world, the major corporations have a sufficient safety margin to maintain production of hard-to-recover reserves and increase the cost of gas within the relative price structure. We anticipate that this process will take 2–3 years; once the producers' prices have risen to $350–500 per 1,000 $m^3$, production of shale gas will gradually start increasing, but slowly rather than rapidly. Given rapid technological development and the energy unit prices of oil and gas drawing closer to each other, the given source has the right to exist. It will be less profitable than traditional ones but the countries lacking access to major fields will develop this source of energy supply. ■

BACKGROUND

## SHALE GAS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Shale gas is natural gas produced from shale formations that typically function as both the reservoir and source for the natural gas. In terms of its chemical makeup, shale gas is typically a dry gas primarily composed of methane (90% or more methane), but some formations do produce wet gas.

Shale is a sedimentary rock that was once deposited as mud (clay and silt) and is generally a combination of clay, silica (e.g. quartz), carbonate (calcite or dolomite), and organic material.

The existence of these structures has been known a long time but, in a period of low prices and excess reserves of traditional gas, production of shale gas involved far too great losses. Shale gas fields cover large areas but are widely dispersed and distinguished by a level of penetrability a thousand of times less than ordinary gas structures. For this reason, together with coalbed methane and tight gas fields, they are classed as non-traditional resources.

Directional drilling, hydraulic fracturing and advanced seismic modeling 3D GEO are used for shale gas production.

The first commercial gas well in shale formations was drilled in the U.S. in 1825 near the town of Fredonia, New York. Large-scale commercial production of shale gas was launched in the U.S. in the early 2000s on the Barnett Shale field, Texas.

World's possible shale gas resources are estimated at approximately 200 trillion $m^3$.

Shale gas has become an increasingly important source of natural gas in the United States over the past decade, and interest has spread to potential gas shales in Canada, Europe, Asia, and Australia.