

# Conclusions

Igor S. Zonn

**Abstract** This book highlights the problems of the shale gas production that influenced greatly the situation in the global gas market. It brings into focus such issues as production technologies, environment protection, and impact of the consequences of the shale gas production on a man. The book also investigates the role of shale gas in development and implementation of foreign policy of many world countries that welcomed the possibility to organize production of this hydrocarbon in their own countries. Taking into consideration the information published by world energy research centers, the prospects of the shale gas production in different regions of the world are studied. This book seeks to integrate such issues as shale gas production, politics, technological development, and ecology. It will be of use for the specialists in the area of hydrocarbon production, international relations and foreign policy, world economics and technologies, and ecology and environment protection.

**Keywords** Ecology, Hydrocarbons, Production, Reserves, Shale gas

## Content

References

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**Fig. 1** Diversification of the gas development ([http://www.mining.com/wp-content/uploads/2012/12/PetroChina\\_Alberta\\_shale\\_gas\\_Encana.jpg](http://www.mining.com/wp-content/uploads/2012/12/PetroChina_Alberta_shale_gas_Encana.jpg))



The beginning of the twenty-first century was marked by fundamental changes in the energy sphere. Production of the shale gas being a variety of the natural gas extracted from shales – the sedimentary rocks with high content of organic matter – produced most significant influence on development of the global gas market. Accomplishment of shale gas projects has become the goal for oil and gas companies as well as a part of the state policy of many world countries. Development of shale plays is targeted to attain energy independence (Fig. 1).

The first efforts on shale gas production were made in the nineteenth century in the USA. That time, the commercial shale gas extraction has not evolved due to inadequacy of technologies. But the efforts in this direction went on and the technologies of shale play development were constantly improving.

The cardinal changes in the shale gas production were witnessed after development and introduction of the revolutionary hydraulic fracturing technology which permitted to increase the shale gas production. By using chemicals and the new method of horizontal drilling when the bore gradually deflates from the vertical to 90° and continues moving parallel to the ground surface, the oil and gas companies managed to increase significantly the recovery of shale gas.

However, the breakthrough in shale gas production occurred in the mid of the first decade of the twenty-first century when the technologies were improved so as to ensure commercial scale production. That time, the term “shale revolution” appeared. The US success drew attention of many countries that started considering this factor in development of their own energy strategies. In 2009, the USA left behind Russia by the natural gas production: 624 bcm in the USA against 596 bcm in Russia. This became possible owing to the shale gas whose fraction had been gradually growing in the total gas production. At the end of the first decade of the twenty-first century, the information started appearing about the enormous shale gas reserves found in the Netherlands, Poland, France, Sweden, Austria, Britain, Hungary, Germany, and Ukraine.

Availability of the immense shale gas reserves permitted the USA to secure its leading positions and to have strong influence on formation of the global gas market. In 2013–2015, the USA demonstrated the high rates of shale gas production that exceeded 300 bcm. In the past years, the shale gas production in the USA had

risen more quickly than it was expected earlier and this led to the abrupt drop of the spot prices in the American continent and in Europe.

The commercial shale gas production in the USA forced Canada, China, and Argentine to launch shale play development. Despite considerable expenses and state support in these countries, the volume of the shale gas production was meager [1]. As a result, the USA remains the only country producing significant volumes of unconventional hydrocarbons. By 2030, it is expected that in the USA the shale and coal gas will account for 63% of the total gas output. According to projections of the International Energy Agency, by 2035 this figure will be as large as 71% [2].

Unlike the USA where the shale plays have been surveyed for several decades, other world countries have no accurate assessments of the reserves of this hydrocarbon as they have no reliable methods to determine the volume of gas-bearing shales; consequently, all data about shale gas reserves in different world regions are only rough specifying the potential resources of shale gas.

In the recent years, the situation has been changing. The investigations of shale gas reserves were initiated in many countries. As a result, the new, verified data about reserves of this hydrocarbon were published. This information is required, first of all, by oil and gas companies that are ready to take risks and invest money into development of shale plays.

The phenomenon of the “shale revolution” promoted by the US companies was not neglected in energy dependent Europe. The US experience and success in shale gas production stirred great interest in many European countries that initiated development of projects on recovery of their own reserves of shale gas and oil. These European countries were seeking to diversify the sources of hydrocarbons supply and to lower their price.

Many European countries have to acknowledge that they have no accurate data on the shale gas reserves, no adequately developed infrastructure, and they have no qualified personnel and technologies, too. At the same time, the movement of ecologists speaking against shale gas production due to its negative impact on the natural environment was expanding in Europe. The European countries believed that with the help of the shale gas they would attain energy independence.

The major oil and gas companies that in 2009 rallied their efforts promoted the projects on shale gas production and shale surveys in Europe. They are Statoil, ExxonMobil, Gas de France, Wintershall, Vermillion, Marathon Oil, Total, Repsol, Schlumberger, and Bayerngas.

The growth of the shale gas production in the USA drew more attention to the shale gas issue in Europe. In 2012, the European Parliament permitted the EU countries to extract shale gas and did not support the idea of moratorium on the fracking technology application. At the same time, the policy of European countries in respect of the shale gas prospecting and development was differing; they had no single position in this matter. The European countries proceeded from their own interests and assessments of opportunities for shale play development. Moreover, in united Europe there was no single strategy towards such technology of gas production [3].

The European countries like many other states that showed interest to the shale plays had to acknowledge that there were no accurate data about these hydrocarbon reserves. This encouraged many speculations concerning the shale gas reserves giving rise to fantastic projections about the future production volumes. Consequently, Europe has no accurate data about the shale gas reserves, but only rough assessments varying within a wide range.

Difficulties connected with the shale gas production in the absence of the verified information about its reserves and the associated environmental risks may also force to postpone the commencement of shale gas production in Europe to uncertain perspective. Consequently, it can be said that even in case of growth of the shale gas production the prices of this hydrocarbon in Europe will not drop so quickly as in the USA. Accordingly, the long waiting for development of the shale gas production will create prerequisites for maintaining high interest in Europe to further development of pipeline transport and to supply of liquefied natural gas.

The effect of the “shale revolution” in different European countries will vary widely and will be determined by such factors as the national energy strategy of a country, the degree of its dependence on energy import, forecasts of the gas demand growth, the cost of alternative competing energy deliveries, and the attitude of the population. However, this effect may be decisive for small and medium independent companies whose business is oriented to the emerging shale gas industry in Europe. Therefore, the pace and feasibility of shale play development in Europe will depend on numerous factors, including environmental and social, energy prices, demand for gas as well as the taxation and regulation regimes.

One of the first European countries that have shown interest to shale gas production is Poland. According to preliminary estimates, Poland possesses considerable reserves of this hydrocarbon. The stimulus to assess shale gas reserves here appeared after commencement of its commercial production in the USA. The interest of Poland to the shale play development was enhanced by the dependence on Russian gas. Poland was the first in Europe to initiate surveys of shale plays and launching projects on shale gas production. The Polish authorities were forced to take such steps in view of the gas production drop in the country and stopping of prospecting of new fields.

In 2008–2009, Poland initiated the program of investments into development of large gas fields in dense rocks. It was expected that the Polish “shale revolution” supported by the US corporations would permit to increase the gas production from 5 to 109 bcm and even more [4].

The shale gas production was named by the Polish authorities as the priority direction in the energy policy. Poland believed that the shale gas reserves in the country might be much greater than in the USA as the geological conditions in Poland were much better than in US plays. This fact allowed for an assumption that the shale gas would free Poland of its dependence on the Russian gas.

In 2013–2015, Poland failed to make a breakthrough in shale gas production. Although considering it the key issue for ensuring the energy security, Poland, like many other European countries, faced such problem as a high cost of shale gas production due to complex geographical conditions in its territory. This makes the

shale projects in Europe more costly than in the USA and does not permit to expect the obtaining of additional volumes of shale gas in the nearest decade.

The implementation of shale projects in Poland encountered numerous problems: high cost of geological prospecting and extraction works, inadequate knowledge of shale plays, and lack of technologies. Poland also had to create the pipeline infrastructure. To attain the target of the shale gas production around 6 bcm per year by 2025, it will be necessary to invest 11 billion USD and further on to spend up to 1.5 billion USD each year for production increase by 2035 [5].

Great interest to the shale gas was shown also by Hungary and Bulgaria considering it as an additional source to satisfy the needs of their economics in this hydrocarbon. However, the inadequate geological study of shale plays did not permit these countries to launch commercial production. Recently only plays containing potentially significant reserves of shale gas have been surveyed.

The European countries face high cost of shale hydrocarbon development due to complex geographical conditions in their territories; thus, the cost of shale projects in Europe is much higher than in the USA. There are several factors that obstruct successful implementation of shale projects: complicated geological conditions, high population density, tough environment protection regulations, insufficiency of financial stimuli, and tax privileges. As a result, the shale gas may play its role in Europe not earlier than in 5–10 years [6].

The development of shale gas production in Europe is hold back by some factors. The shale plays in Europe are only in the early stage of development and have not been studied adequately in terms of geology and cost of extraction. In addition, the development of shale plays leads to disturbance of the bowels of the earth and pollution of water aquifers with chemicals used for hydraulic fracturing. The cost of shale development in Europe may be 4 times as high compared to the USA [7]. And, at last, the activities of ecological organizations restrain the promotion of the shale gas development projects in European countries. Consequently, the shale gas may become attractive for European countries in the future provided that the production costs are reduced and the efficiency of shale play development is improved.

The shale gas production in the USA drew attention of China that, like many other world countries, possesses considerable shale gas reserves. However, China has no accurate data on shale gas reserves, there are only rough assessments that vary greatly. Nevertheless, many researchers agree that China has immense shale gas reserves, but their development involves many difficulties.

In 2011, China officially recognized the shale gas as the independent hydrocarbon. During 2011–2015, China made serious efforts to develop the commercial scale production of shale gas so as to reduce the dependence of the country on gas import from Central Asia and other world regions.

The efforts of China to develop shale plays were not missed in the USA. The American companies were endeavoring to circulate as wide as possible and to resale the technologies of shale gas production. These issues were discussed during the visit of US President B. Obama to Beijing in November 2009. As a result, the

USA and China concluded the framework agreement, the key issue of which is provision of the US technologies to China to develop its shale plays [8].

The issues of feasibility of the shale play development are being actively discussed in the countries exporting natural gas to foreign markets. One of these is Russia. After the USA has increased considerably the shale gas production, the interest to this problem in Russia has also grown, but it came to nothing more than discussions in the expert community as availability of immense natural gas reserves makes shale gas less attractive [9]. And the more so as the production cost of traditional gas is much lower than the expected cost of shale gas [10].

No endeavor to organize the commercial scale production of shale gas may be attributed to the absence of accurate data on the available shale gas reserves in the territory of Russia, high costs of production, and high environmental risks. Moreover, there are no appropriate technologies, which brings up the question of improving the efficiency of enterprises in the gas industry [11].

Regardless of the lack of interest in Russia to shale gas production, the Russian authorities have to take into consideration the effect of the “shale revolution.” The greatest risks are connected with shale gas development in Europe especially as the European countries view the shale gas development as one of the alternatives of the Russian gas. Moreover, Russian company Gazprom faces the growing supply of liquefied gas and drop of demand for gas. This forces Gazprom to adjust the prices of the gas exported to the European market. Taking into consideration the pace of progress in the shale gas production in Europe, the Russian gas will remain for long one of the main hydrocarbon source for the European countries. But the key issue will be the price by which Russia will supply its gas to the European market. In any case, the shale gas production in Europe and its deliveries from the USA will cut down the segment of Russia in the Europe market [12].

The quick rise of the shale gas production in the USA affected significantly the global energy markets. This is connected, primarily, with the sharp curtailment of the natural gas import to the USA. In addition, the scenario of the US shale gas import to the European market that was found under great pressure of the “shale revolution” has been actively discussed recently. Other countries possessing shale gas reserves are also developing plans to increase shale gas production. Although the first results of export of the “shale revolution” have shown that the US experience would be quite unlikely repeated in the next decade, but still influenced by the growth of the shale gas output the global energy market is already changing immensely. Moreover, the growth of the shale gas production has already its geopolitical consequences playing the key role in weakening the opportunities of Russia to use its “energy weapon” against its European users by increasing alternative deliveries to Europe in the form of LNG forced out from the US market [13].

Apart from this, the USA has not abandoned the plans to supply the shale gas to the European market. Still in 2014, the US gas was not the cost-effective commodity for the European Union, but as the prices of natural gas are tied to the dropping prices of oil the purchase of shale gas has become feasible regardless even of its transportation across the Atlantic. The first gas-loaded vessel from the USA was dispatched to Europe in March 2016.

The degree of influence of the shale gas in different regional markets will vary significantly in view of the unique features of each of them. This may lead to considerable geopolitical changes that will affect the world politics. At the same time, it is too early to speak about the decreased role of hydrocarbons supplied via pipelines. The availability of considerable oil and gas reserves, developed infrastructure, and availability of effective technologies are still important factors making the pipeline transport vital.

The shale resource development is closely connected with the issues of food security and water resources. These three issues are so closely intertwined that their solution requires an integrated approach and long-term planning by many states [13].

The shale gas production forces to make adjustments in the foreign policy of many countries provoking new lines for rivalry and cardinally changing the alignment of forces in the global and regional energy markets. The production technology of shale gas the reserves of which are found in many countries that have not earlier entered the gas producer pool may change cardinally the situation. And the more so as many world countries, primarily, main producers and users of hydrocarbons, are involved in the process of shale gas production.

Many countries view the shale gas production as the sole alternative to the Russian supplies. In particular, Moldavia is very vulnerable in terms of natural gas supply. Russia is the only source of natural gas for this country. Diversification of energy supply may form prerequisites for lowering the gas prices, thus, creating rivalry to the Russian gas. However, such scenario may be realized in the far perspective. At the same time, Moldavia takes into account the negative environmental consequences of the shale gas production and is not in a hurry to spur the extraction of this hydrocarbon.

Ukraine is facing similar problems and attempting to address them as the energy independence is the priority goal for this country. One of the directions of this policy is development of new fields of hydrocarbons, in particular, of unconventional gas (shale gas, coal methane, tight gas reservoirs, etc.). However, the first attempts of Ukraine to develop domestic shale plays, including with invitation of the leading oil and gas companies, have failed. High political risks, lack of accurate data on the shale gas reserves, and lack of infrastructure played their role here.

The issues of shale gas production are also acute in Kazakhstan. But the inadequate geological study of potential shale plays, lack of legislation that will control the development process, high environmental risks due to imperfection of production technologies, and also high investment risks of shale projects obstruct, to a great extent, the implementation of this strategy oriented to shale gas recovery in Kazakhstan. But this does not mean that the country will not take attempts to develop the shale gas production.

The shale gas production in the USA not only enhanced the interest to seeking the alternative to pipeline gas, but stirred greater concerns about the consequences that will arise in the course of shale play development (Fig. 2). Primarily, these are environmental concerns. A breakthrough in shale gas production led to the growing negative impact on the natural environment and human health. Here the key issue is application of the hydraulic fracturing technologies. Investigations have shown that





**Fig. 2** Shale gas development ([https://www.irgc.org/wp-content/uploads/2014/02/iStock\\_ShaleGasLarge1.jpg](https://www.irgc.org/wp-content/uploads/2014/02/iStock_ShaleGasLarge1.jpg))

fracking causes serious changes in the geological structures, ground and surface waters, atmospheric air, soil, and earth conditions. Moreover, the negative effect is produced during preparation for shale gas recovery which is connected with the need to create the required infrastructure. All these factors urged the public to organize movements against the shale gas production. The ecological organizations are most active in the European countries where the consequences of the commercial shale gas production will be more extensive. For this reason, the EU is seeking to develop recommendations for protection of the environment and climate for application of fracking technologies in order to minimize environmental risks [14].

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