China Stakes on Shale Gas

Igor S. Zonn and Sergey S. Zhiltsov

Abstract The shale gas production in the USA was not missed in China for which the issues of hydrocarbon export and development of own resources are always in the focus of attention of its leadership. Preliminary investigations conducted in China have revealed considerable reserves of shale gas. The great attention to this hydrocarbon resource was supported by the special decision of the Chinese authorities that in 2011 officially referred the shale gas to individual mineral resources. In 2011–2015, energetic efforts were made in China to organize the shale gas production in commercial scales, thus, to reduce its dependence on gas import from Central Asia and other world regions.

Keywords China, Ecology, Production, Reserves, Shale gas

I.S. Zonn (✉)
Engineering Research Production Center for Water Management, Land Reclamation and Ecology "Soyuzvodproject", 43/1, Baumanskaya Str., Moscow 105005, Russia

S.Yu. Witte Moscow University, 12, Build. 1, 2nd Kozhukhovsky Proezd, Moscow 115432, Russia
e-mail: igorzonn@yandex.ru

S.S. Zhiltsov
S.Yu. Witte Moscow University, 12, Build. 1, 2nd Kozhukhovsky Proezd, Moscow 115432, Russia

Peoples' Friendship University of Russia, 6, Miklukho-Maklaya Str., Moscow 117198, Russia

Diplomatic Academy of the Ministry of Foreign Affairs of the Russian Federation, 3/2, Build. 1, Ostozhenka Str., Moscow 119021, Russia
e-mail: sszhiltsov@mail.ru

S.S. Zhiltsov (ed.), *Shale Gas: Ecology, Politics, Economy*,
Hdb Env Chem, DOI 10.1007/698_2016_84,

Contents

1 Introduction

China takes a special place in discussions of shale gas. China is interested in extension of the shale gas production due to likely reduction of its dependence on hydrocarbon import and in the face of soaring demand for gas in the recent years. In 2009, this demand showed the 20% growth and in the next years it maintained quite sustainable growth rates.

China is seeking to offset the reduced share of coal in its energy balance with gas. For this purpose, Beijing has concluded contracts for delivery of liquefied gas from Australia, and cooperates actively with Turkmenistan in the implementation of gas pipeline projects that will bring Turkmen gas to China [1]. However, these efforts are not sufficient to cover the requirements of China in hydrocarbons. Consequently, China is still interested in development of its own shale gas plays. According to experts from the China National Petroleum Corporation (CNPC), by 2020 the demand in natural gas in China will be as high as 270 bcm.

The intention of China to develop its shale gas plays stirs great interest in the USA. The US companies were seeking to circulate and resale the shale gas production technologies as wide as possible. The technologies of the shale gas production were discussed during the visit of the US President B. Obama to Beijing in November 2009. As a result, the USA and China concluded the framework agreement, the key point of which was the technological support for China by the USA in development of the shale gas plays [1]. This political marketing of the US technologies was accompanied by the really global PR campaign involving the leading consulting companies, the major oil and gas corporations, and governmental agencies, both the US and international [2].

China as well as other world regions possessing considerable shale gas resources has no accurate data of their hydrocarbon reserves. Wide scattering of reserve assessments published in scientific researches and mass media may be connected with the too short period of geological surveys. Thus, the Chinese data and the assessments of international research centers and foreign oil and gas companies differ greatly. Nevertheless, all researchers agree that China possesses considerable shale gas reserves, but their development involves many difficulties.

Fig. 1 Major shale gas basins in China (http://www.cnpc.com.cn/en/UnlockingTightGasandShaleGasPotentia/UnlockingTightGasandShaleGasPotentia.shtml)

2 Shale Gas Reserves

The progress in the shale gas production attained in the USA enhanced the interest to this problem in China for which the energy security has become the key issue in the recent decade. In 2010, the State Research Center for Shale Gas [3] was established in China, which emphasized how important for China were the issues related to investigation of shale gas plays, development of new technologies, and studies of environmental consequences.

Significant shale gas reserves in China are found in two basins – Sichuan in the south of the country and in Tarim in the west (Fig. 1). These two basins have thick series of shales rich in organic substances spreading extensively and possessing good collecting properties for their development [4]. The data on the shale gas resources trapped in them are illustrated in Table 1 [5].

The Sichuan basin located near the water sources is surveyed most actively. China suffers from water shortage and the factor of water availability becomes the key one.

Rough data of the shale gas resources in China have shown that this country possesses considerable reserves of this hydrocarbon. By late 2011, some wells were drilled in the shale rocks in China, while in 2011–2013 several dozens of them were

Table 1 The shale gas resources in the Sichuan basin and Tarim basin

	Sichuan basin	Tarim basin	Total
Risky geological resources (tcm)	78.3	66	144.3
Risky recoverable resources (tcm)	19.6	16.5	36.1

drilled. For this reason, the assessments of the shale gas reserves cannot be considered proven. According to experts of the Chinese Ministry of Land and Resources, only dozens of wells were drilled in different regions of the country for assessment of the resource base. This is, obviously, quite insufficient to present the full picture of the available shale gas resources.

Regardless of the limited scale surveys that confirmed only the probable shale gas reserves, China still asserted that it had the largest shale gas reserves. Publication of such figures was taken into account in decisions of state authorities. In March 2012, China presented the Plan of the Shale Gas Development for 2011–2015 that envisaged extensive surveys of shale rocks and it was expected that around 200 bcm of technically recoverable shale gas resources would be investigated.

In 2012, China continued drilling of wells applying fracking technologies in each. The drilling was conducted by China Petroleum and Chemical Corporation (Sinopec), Yanchang Petroleum, PetroChina, and CNPC. And only 25% of the drilled wells provided good shale gas flow. The first success urged China to announce about availability of new, verified data obtained as a result of drilling in main shale plays. Accordingly, it became widespread that the shale gas reserves in this country reached 134.42 tcm, which moved Beijing to the circle of countries possessing the world's largest shale gas reserves [6].

In the same year, the Chinese Ministry of Land and Resources published the Report on the Oil Resources Development Abroad saying that the technically recoverable shale gas reserves in the world reached 187 tcm, out of which 36 tcm were found in China. Based on these data, China takes the first place by the shale gas reserves outrunning such countries as the USA, Argentine, Mexico, and SAR [7]. According to this document, by 2020 the shale gas production entered the period of quick development and the annual output should exceed 100 bcm.

The USA also published its data about the shale gas reserves in China. According to rough estimates of the US Department of Energy, the shale plays in China may trap 12 times more gas than traditional gas basins and their reserves are assessed at 26 tcm. The data of the US experts practically coincided with the data of Chinese researchers. Thus, the National Development and Reform Commission of China assessed the shale gas potential at 28 tcm.

In 2014, the verified data on the shale gas reserves in China were made public. According to the US DoE experts, China possesses the world's largest resources of shale gas – 31 tcm, or 15.3% of the total shale gas reserves [8].

In 2015, the reserves of 26 shale plays discovered in China were evaluated at 25.08 tcm. In November 2015, the new data about the proved geological resources of shale gas in China were published. According to the most recent data published

in China [9], they made already 106.8 tcm. And although the country has not yet triggered the "conveyor" of shale gas production and still faces many difficulties in the development of this business, it is believed that by 2030 the country will be one of the largest shale gas producers in the world [10]. China assumes that the efforts made in this area will permit to increase the shale gas production to 60–100 bcm.

3 Shale Gas Production

The shale gas production business in China is controlled by the state. The China's policy in this area is developed based on the data of experts asserting the availability of considerable shale gas reserves in the country.

The shale gas production in China was started in 2010 in the Sichuan basin. The China Petroleum and Chemical Corporation (Sinopec) got the commercial scale flow of shale gas in two parts of the Sichuan basin – in the northeast near Yuanba and in the southeast near Fulin.

The survey and prospecting works are underway in the Tarim basin located in the west of China possessing the largest shale gas reserves. The main obstacle here is the arid climate which is a serious constraint as the fracking technology requires much water.

In mid-2011, China conducted shale gas exploration competitive bidding and invited four state-owned major oil and gas companies to participate in bidding. As it was already mentioned, in the early 2012 China started drilling in shale plays. Half of the wells produced gas. However, the volumes of extracted gas were not large (Fig. 2).

China started inviting the world oil and gas giants having the required technologies to prospecting and development of shale plays, such as Chevron (USA), BP (Britain), Royal Dutch Shell (Britain–Netherlands), Total (France), and Statoil (Norway). The largest Chinese corporations such as CNPC, China Petroleum & Chemical Corporation (PCC), and China National Offshore Oil Corporation (CNOOC) actively cooperate with the Western companies. The trial drilling is conducted in the Sichuan province. In addition, China organized the tender for shale gas prospecting rights in the territory of 11,000 km^2 in the Guangzhou province and Chongqing municipality in the southwest of China.

In September 2012, China announced about the second public tender for the sale of shale gas prospecting rights. This time, state companies and private Chinese companies as well as joint ventures with foreign companies with the Chinese controlling share were admitted to participate in this tender. It is quite obvious that China will do everything possible to increase the production of unconventional gas disregarding the environmental detrimental consequences. The seriousness of the China's intentions was confirmed by setting up of the Chinese National Energy Administration (CNEA) for research of shale gas in Langfang, near Beijing, to be sponsored mostly by PetroChina Ltd., the subsidiary of CNPC. The studies of shale

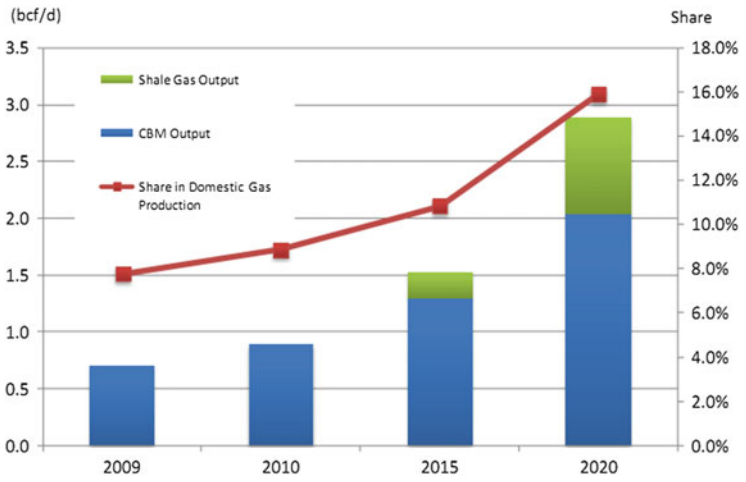

Fig. 2 Unconventional gas production in China (http://www.endofcrudeoil.com/2013/03/chinas-shale-gas-dream.html)

technologies are conducted by various institutions headed by the Guangzhou Institute of Geochemistry of the Chinese Academy of Sciences.

In the early 2013, China conducted the next auction for the right to develop 20 shale areas in which the successful bidders were 16 national companies that have never drilled wells. They intended to conduct drilling in cooperation with such foreign partners as Schlumberger and Halliburton. The Chinese government plans to promote this sector of the economy and by 2020 to increase by 10% the total shale gas production due to the development of shale areas. In the 2009–2014 timeframe, China had invested US$3.7 billion into shale gas prospecting and development.

4 Production Forecasts

Still prior to commercial extraction of shale gas, a great number of forecasts started appearing in China. As in many world countries, the projections of shale gas production in China differed greatly, too. Thus, first it was published that by 2015 China was going to increase production by 30–50 bcm, largely, due to shale gas extraction. In April 2011, the Chinese officials asserted that the first shale gas would be produced by 2015. Deputy Senior Economist of SNPC Planning Department Sun Syaodan detailed on the vision of the Chinese leadership having said that the plan of shale gas production till 2015 was approved. This plan envisages extraction of 6.5 bcm of shale gas and by 2020 it should reach 80–100 bcm [11]. By 2015, CNPC proper should produce 1.5 bcm of shale gas.

Based on such projections, the Chinese officials developed the policy on shale gas play development. In 2011–2015, the Chinese government set the goal to create the basis for large-scale development of this business in the next 5 years. In 2014, the special program of subsidizing the companies engaged in shale gas production was suggested. A producer should get 6 cents per each extracted cubic meter of shale gas which after recalculation per thousand cubic meters gives additional payment of 64 USD.

The assessments of the leading energy institutions and consulting agencies of the prospects of the shale gas production in China till 2030 differ even greater – the extraction of unconventional gas is expected to vary from 57 to 114 bcm. In 2020, the share of this hydrocarbon in the total gas production will reach 17% and by 2030 – 44%. In absolute figures, this makes 14 bcm and 57 bcm of gas, respectively [12].

China has no extensive pipeline network that could supply the extracted gas directly to users. In the early 2012, CNPC arranged with the Shell Concern about setting of a joint venture that would extract gas in the Sichuan province on the production sharing basis. The companies had equal shares in this venture and Shell should bring technologies of shale gas production tested in North America, in particular, of automatic directional drilling. As a result, this joint venture should have become a part of the world alliance of the major oil and gas companies of Europe and Asia. It was announced that time about construction in China of the first pipeline for shale gas transit with a capacity of 36 mcm per year.

So far, the leading company producing shale gas in China is Sinopec. It extracts small quantities of shale gas in the Fulin play in the Sichuan province in the southwest of China. In 2015, the company plans to complete the preparatory works and to start the production, increasing the output to 5 bcm.

5 Problems of the Shale Gas Production

The development of the shale gas production in China is held back by various problems. China faces serious difficulties in shale gas production connected with complicated geological conditions. The Chinese companies have to drill to a depth of 4–6 km (compare in the USA to 3 km). Due to specific geological conditions of shale plays, the fracking technology requires 30% more water than in the USA and here it should be remembered that many regions of China suffer from water shortage. In general, the problem of availability of water resources required for development of the shale gas plays is more acute in China, than in the USA. And water deficit is growing especially in the regions where the shale gas reserves are most abundant [13].

Unlike the USA where shale gas occurs not deep which makes it more accessible, in China the main shale gas reserves are found in the far away Sichuan province at great depths. Accordingly, the shale gas production in China is technologically more complex and requires great investments. As a result, this sector develops at a slower pace than it was expected earlier due to a number of factors beginning from

more complex geological structure of local shale plays to the shortage of water and energy required for their development [14], which increased sizably the cost of drilling of one well – in China it ranges from 5 to 12 million USD, while in the USA it is around 2.7–3.7 million USD. One more problem is the lack of experience. As a result, the forecasted volume of shale gas output (80 bcm) by 2020 is quite doubtful. China may achieve such production level only by investing heavily into this sector with simultaneously abolishing the state control of hydrocarbon prices.

6 Shale Expansion in China

Apart from developing its own shale plays, Beijing shows great interest to the shale gas extracted in other countries. The Chinese companies purchased the shares in the North American shale projects. China is trying to adopt their experience and technologies. In 2009, Chinese PetroChina invested US$1.8 billion into joint development of two shale plays in Canada with Canadian Athabasca Oil Sands.

In the early 2010, the Chinese companies spent around US$46 billion on the purchase of such assets. China actively purchased the shares in development of technologically complex oil and gas plays in North America not only for getting access to technologies. So, Chinese company China National Offshore Oil Corporation (CNOOC) extended its cooperation with the US Chesapeake Energy having purchased one-third of the Eagle Ford play for US$1.1 billion [15]. In this way, Beijing intended to ensure its future energy security.

In February 2011, the Chinese companies signed some more agreements on purchase of the shale gas production assets and among them is the agreement with the Canadian Encana, the largest shale gas producer in North America, on joint development of the shale gas play in Canada. Under this agreement, PetroChina and Encana would jointly develop the Cutbank Ridge play. The proven resources of this play make 28 bcm, and the output will be around 7 mcm per day. The project also includes 3,400 km of gas pipelines and the underground gas storage. The play covers a territory of 5,260 km^2 in the British Columbia and Alberta states. Moreover, CNOOC purchased one-third of the Niobrara play in the Colorado state for US$1.3 billion. Other Chinese company Sinopec purchased from Devon Energy the shares in the plays located in the Ohio, Louisiana, Oklahoma, and Michigan states.

Investing into the purchase of companies and some plays was considered in Beijing as its strategic goal. This was made with a view to get access to the shale gas extraction technologies lacked in China. In fact, the transnational companies engaged in the shale gas production act as technological donors [16].

The enhanced attention to wider cooperation with foreign countries and purchase of assets in other countries were connected with the difficulties faced in developing Chinese shale plays. Poor geological study of plays, environmental constraints, water shortage, and lack of own extraction technologies [2] are the factors that pushed Beijing to cooperate with foreign companies in shale play development and purchase of foreign assets. In March 2015, the Chinese CNPC

announced about its plans to join the US shale projects. Earlier China Petrochemical Corporation (CPC) invested over US$1 billion into oil fields in Oklahoma (USA). Besides, CNOOC made a major purchase – the Canadian Nexen Corporation for US$15.1 billion. In the second half of 2015, China pursued further its policy on acquisition of foreign assets connected with the shale gas production. The Chinese state-owned companies invested more than US$6 billion into purchase of shale gas assets in North America.

7 Conclusions

Regardless of the difficulties with exploitation of shale plays, China continues to keeping their development in the focus of attention. So far, the efforts in this direction go on at a slow pace as Beijing receives liquefied gas and pipeline gas. However, in the future the situation may change due to the appearance of new technologies of shale gas production and price factors [8].

Still prior to careful researches to verify the shale gas reserves in the Chinese territory and producing the first flow of this hydrocarbon, the long-term projections were formulated that predicted quick rise of the shale gas production. One of such projections said that by 2020 China would produce up to 100 bcm of shale gas. This permitted Chzhan Davey, Deputy Head of the Center for Strategic Research of Oil and Gas Resources of the Ministry of Land and Resources, to announce that this would help to change completely the energy structure in China [17]. The implementation of this objective determines the policy of the Chinese leadership. In the late 2015, the Chinese government planned to expand the shale gas production by establishing the wider cooperation with the British-Dutch Royal Dutch Shell and American Chevron.

In the next 1–2 decades, the role of unconventional gas in China may grow significantly and become one of the key factors for promotion of gas production. It was noted that by 2030 China could become one of the leaders in the production of not easily recoverable gas [18].

References

1. Zhiltsov SS, Zonn IS (2011) The Caspian Pipeline Geopolitics: the conditions and implementation. Vostok-Zapad, p 320
2. Tomberg IR (2012) Prospects of unconventional gas production in China. In: Simoniya NA (ed) Russia and ATR: perspectives of gas cooperation. MGIMO, Moscow
3. Melnikova S, Sorokin S, Goryacheva A, Galkina A (2012) The first five years of the "Shale Revolution": what we now know for certain? RAS Institute of Energy Research, Moscow, p 32–34
4. Chak B, Bill C, Rick L, Miller CC (2011) The shale gas – the global resource. Oil & Gas Review, Autumn 2011, p 36–48

5. Polyakova TV (2013) Peculiarities of shale gas play development in foreign countries. Center of Global Problems, 12 July 2013. http://prostov.viperson.ru/wind.php?ID=662543&soch=1 (date of application 16.12.2015)
6. Azarin AV (2012) Chinese shale revolution. NG-Energia, 9 Oct 2012
7. He C (2012) The world on the threshold of the shale revolution, No. 3. Moscow. Magazine Russia and China, p 38–39
8. Karpova NS, Lavrov SN, Simonov AG (2014) International gas projects of Russia: European alliance and strategic alternatives. TEIS, p 161
9. ChinaPro – business journal about China: news, economics, business with China, 2 Nov 2015
10. By 2015 China will produce shale gas. Information Agency Lenta.ru, 18 Nov 2015
11. Kulikov SA (2011) The Europeans puff up new bubbles. Nezavisimaya gazeta, 13 Oct 2011
12. Report "Prospects of the Natural Gas Market in China" (2010) IMEMO RAS, p 43–44
13. IMEMO Report "The Shale Revolution: Risks and Opportunities for Russia" (2010) IMEMO, 2 Dec 2010
14. Yu Y (2015) Vague future/oil and gas. Izvestia, Apr 2015, p 14
15. Zabolotsky SA (2013) Hydrocarbon revolution in production and processing: shale gas, gas chemist and petrochemistry. Eurasian Chemical Market 7:92–98
16. Mastepanov AM, Stepanov AD, Gorevalov SV, Belogoriev AM (2013) Unconventional gas as the factor of the regional gas markets. IC "Energia", Moscow, p 66–67
17. He C (2012) Whether gas from Russia will go to China along the "Western" route Euroasian review. Report (2016), No. 20. Moscow. Magazine Russia and China, p 32–33
18. Nazarov A (2013) Shale gas. Revolution in North America, Limited effect on other world. Industry overview Gazprombank, Moscow, pp 3–41