# The Evaluation of the World Potential of Shale Gas Reserves

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**Abstract** At present there are no accurate estimates of the shale gas reserves in the world as we have no so far reliable techniques to determine the size of shales entrapping shale gas. In the recent decades, some additional geological surveys were conducted which provided new data about shale gas reserves in different world regions. However, all available forecasts may be treated as tentative as they give only potential volumes of shale gas that could be extracted by applying available technologies.

**Keywords** Global gas market, Reserves, Shale gas

## Contents



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# 1 Introduction

There are no accurate data about the shale gas reserves in the world and we have so far only rough global estimates. One of the reasons for the absence of accurate data about shale gas reserves is that prior to 2011 the shale gas production was conducted only in North America [1] and nowhere else.

In the recent years, some changes are visible. Surveys of shale gas reserves were initiated in different countries. As a result, new verified data about reserves of this hydrocarbon resource worldwide and in different regions and countries started appearing. Such attention to the shale gas reserves in some countries may be connected with potential of its production which is considered a new path to attaining energy independence.

Such information is greatly needed by the oil and gas companies that are ready to risk and invest their money into development of shale gas plays. While in the USA the shale plays are developed both by large oil and gas companies and small companies ready any time to change their market strategy, then in Europe the world's leading oil and gas companies having experience in development of similar plays are attracted to survey and production of shale gas (Fig. 1).

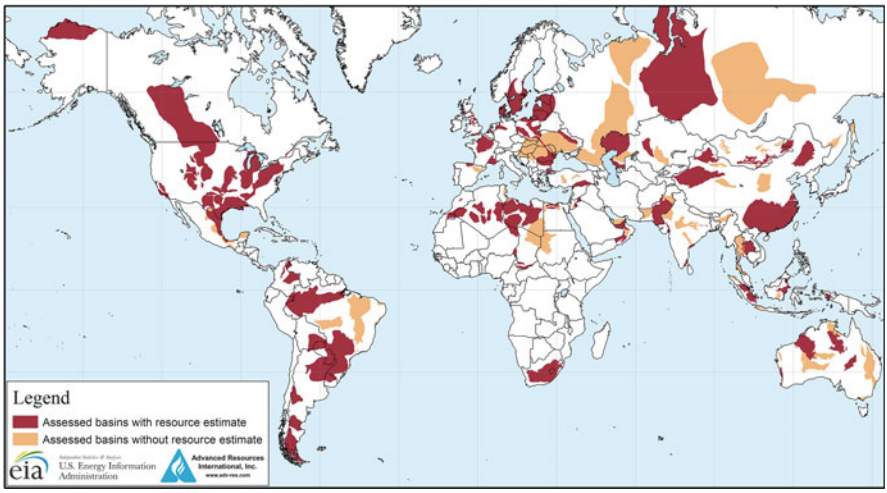


**Fig. 1** Shale gas assessed basins in the world (https://www.eia.gov/analysis/studies/worldshalegas/images/EIA_ARI_World_Shale_Gas_Oil_Basins_Logos_Map_092215_HighRes.jpg)

## 2 Preliminary Estimates

For over 15 years, all sources citing data about considerable shale gas resources were based on the publication of German specialist in energy economics Hans-Holger Rogner written still in 1997. The German expert estimated the global shale gas resources at 456 tcm referring at the same time to his figures as "speculative."

For many years the data published by Hans-Holger Rogner were not used. However, after sharp boost of the shale gas production in the USA, the interest to the German expert's data has grown. They are used by the International Energy Agency (IEA) as well as by sectoral experts and representatives of companies. As a result, the data on the shale gas resources are abundant, but their reliability is very low; accordingly, the data on the global reserves of shale gas may be considered only tentative. They depend greatly on the techniques applied for evaluation of shale plays.

There are also expert estimates made by representatives of various international organizations and research companies. Thus, IEA evaluates the global shale gas reserves at 200 tcm, while the International Atomic Energy Agency (IAEA) estimates the world gas reserves in shales at nearly 500 tcm. More than one decade will be required to survey these resources, and the final results will be, most likely, adjusted significantly.

In general, the data for the same shale plays in different reports vary greatly. The reason for this should be sought in preliminary, often tentative, evaluations of shale gas reserves that can be confirmed or disproved only by exploratory drilling.

Shale gas is found on all continents, and their considerable reserves are available in more than 40 countries (Fig. 2).

## 3 Geography of Shale Reserves

The shales from which gas can be extracted are great and may be found on all continents possessing considerable areas of sedimentary rocks. However, the shale gas reserves are distributed very unevenly and the data on them are rather contradictory. The shale gas reserves are estimated at 200–450 tcm, and these data are constantly changing due to the lack of scientifically reliable data about the nature of shale gas, regularities of shale play formation, the criteria of their forecast, survey, and prospecting [2].

The proven gas reserves in the world are 182 tcm, of which, according to IEA, the unconventional reserves account only for 4% or some 7 tcm of gas [3]. Nevertheless, the statistics agency at the US Department of Energy in March 2011 increased the reserve level having assessed the world recoverable gas reserves (conventional and unconventional) to 640 tcm, of which 40% or 256 tcm account for shale gas. Here only high-quality formations promising in terms of shale gas production were considered.

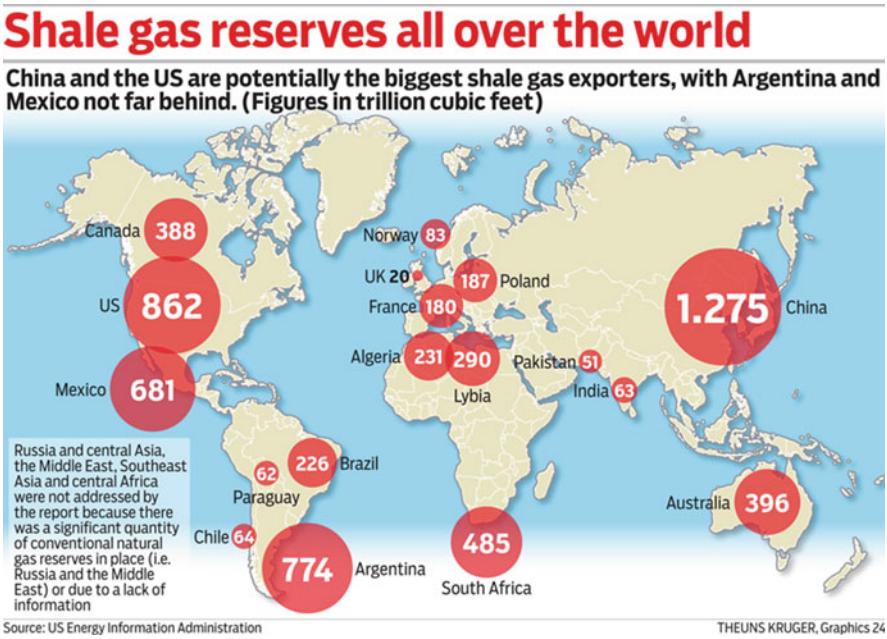


**Fig. 2** Shale gas reserves in the world (http://www.grafika24.com/wp-content/uploads/2012/09/Shale-gas-reserves-all-over-the-world-WP.jpg)

In 2011 the US Energy Information Department published its report "World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States" where it was stated that the technically recoverable shale gas resources in the world were estimated at 185 tcm. This report analyzed 48 shale gas plays in 32 world countries. According to the authors, the USA accounted for 13% of the world resources and China for 19%, while the shale gas resources of Europe were assessed at 10% of the world reserves.

The proven resources of shale gas in the USA are estimated at 24 tcm, of which the recoverable are only 3.6 tcm. However, in the recent years, the assessments of the shale gas resources were revised and the obtained figures were lower – 14 tcm.

Unlike the USA where the shale gas survey and prospecting have long history, in other world countries, the assessments are only rough. The greatest resources of shale gas are found in China, the USA, and Argentina with Mexico taking the fourth place.

In Asian countries the shale gas reserves amount to 57 tcm. Thus, in particular, China, according to rough estimates, has 45 tcm. But regardless of adoption of the state program that includes the conduct of geological surveys, the shale gas production goes on at a slower pace.

Significant shale gas resources are found in the countries of Latin America, Libya, Australia, Canada, Argentina, and Mexico [4]. The shale gas resources in

Argentina are assessed at 27 tcm. The first well was drilled in 2011, but for the lack of technologies and finance, the shale gas production has not attained wide development.

In the South African Republic (SAR), the shale gas resources are roughly estimated at 17 tcm. But the water deficit, the ban of application of hydraulic fracturing technology, and the lack of foreign investments make the perspectives of shale development rather vague.

Enormous shale gas resources are found in the European countries. The cumulative shale gas reserves here are evaluated at 18 tcm, of which France and Poland account for more than 10 tcm – 5.1 tcm and 5.6 tcm, respectively. Austria, Germany, Britain, Poland, and Sweden also possess perspective resources. The world resources of recoverable shale gas are presented in Table 1 below. The regions and individual countries possessing the largest shale gas reserves are presented in Fig. 3.

Currently the active shale play surveys are conducted in Canada, Europe (Poland, Denmark, Sweden, Ukraine, Great Britain), Australia, Israel, and other countries [5].

Considerable shale gas resources are also found in the post-Soviet countries and, first of all, in Russia, Ukraine, Kazakhstan, and Belarus. Ukraine was the first to start exploration of shale gas plays and verification of available resources (see chapter by Tsivatyi in this book).

In 2013–2015 the data about the shale gas resources in different world regions and in individual countries were updated. In general, many results of new researches coincide with the previously published figures as many data about shale gas resources are taken by researchers from the already published reports without making any adjustments there. As a result, estimates of many resources may be treated as only tentative, probabilistic. Similar situation is observed in many countries, except the USA, where the researches have been conducted for a long time, including by exploratory drilling.

So far the shale gas remains the strictly regional factor influencing significantly only the market of North America, primarily, the USA. In other world regions, there is no shale gas production on a commercial scale, although its resources are available in many countries.

The published data about the shale gas reserves and production has already changed the landscape of the global gas market. Although many of them have not been confirmed so far, but the shale gas factor has already affected significantly the energy policy of many world countries. In the final run, the progressing changes in the global energy market after the “shale revolution” may lead to new structural changes [6].

**Table 1** World resources of recoverable shale gas (by countries)

| Region/country | Proven natural gas resources, bcm | Recoverable shale gas resources, bcm |
|---|---|---|
| *Europe* | | |
| France | 5.6 | 3,056 |
| Germany | 175.5 | 226 |
| The Netherland | 1,386 | 481 |
| Norway | 2,037 | 2,348 |
| Great Britain | 254.7 | 566 |
| Denmark | 59.4 | 651 |
| Sweden | – | 1,160 |
| Poland | 164.1 | 5,292 |
| Turkey | 5.66 | 425 |
| Ukraine | 1103.7 | 1,188 |
| Lithuania | – | 113 |
| Others | 76.6 | 537 |
| *North America* | | |
| USA | 7,712 | 24,395 |
| Canada | 1,755 | 10,980 |
| Mexico | 339 | 19,272 |
| *Asia* | | |
| China | 3,028 | 36,082 |
| India | 1,072 | 1,782 |
| Pakistan | 840.5 | 1443 |
| Australia | 3,313 | 11,206 |
| *Africa* | | |
| SAR | – | 13,725 |
| Libya | 1,548 | 8,207 |
| Tunisia | 65 | 509 |
| Algeria | 4,500 | 6,537 |
| Morocco | 2.8 | 311 |
| Others | 2.8 | 198 |
| South America | | |
| Venezuela | 5,062 | 311 |
| Colombia | 56.6 | 537 |
| Argentina | 379.2 | 21,904 |
| Brazil | 365 | 6,395 |
| Chile | 2,801 | 1,811 |
| Uruguay | – | 595 |
| Paraguay | – | 1,754 |
| Bolivia | 750 | 1,358 |
| Total | 36,054 | 187,402 |

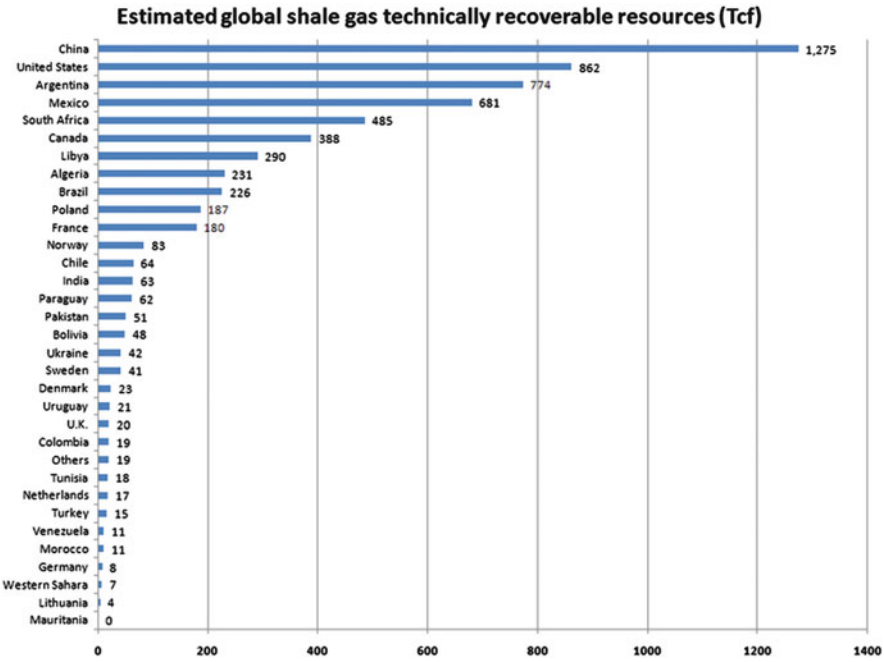


**Fig. 3** Estimated global shale gas recoverable resources (http://3.bp.blogspot.com/-vBaFLDhKINA/TZ0bdlzQZZI/AAAAAAAAHG4/JRTIpiIv5-Y/s1600/worldnatgas.png)

## 4 Conclusions

The soaring growth of the shale gas production in the USA became possible due to long-time investigation of this hydrocarbon resources and drilling in the plays having potential reserves. The attempts of other countries to repeat the US experience were not successful which may be attributed largely to the lack of accurate data about the shale gas resources.

The recently published data about shale gas resources in the world and by regions are only tentative and not confirmed by fundamental research. Accordingly, numerous publications describe only potential possibilities preventing individual countries and oil and gas companies to work up the long-term strategy of shale gas play development. Moreover, in addressing the issues related to the shale gas play development, the political factors often come to the fore, leaving the economic estimates in the background. Thus, using such unverified data, many countries, especially those that depend greatly on hydrocarbons import, are seeking to use the "shale revolution" factor in their foreign policy.

Regardless of only rough assessments of the shale gas resources, this factor has already influenced the formation of the regional gas markets and spurred the negotiations between producers and consumers of gas concerning the price of this

hydrocarbon resource. The attempts of some countries to organize the shale gas production draw more attention to further researches endeavoring to obtain more accurate data about this hydrocarbon reserves and also initiating forecasts concerning the future effect of shale gas on the world energy. According to forecasts of the International Energy Agency, by 2035 the shale gas fraction may account for 25–27% and after 2050 reach 40%. But, of course, this forecast will be adjusted by taking into consideration various factors. Shale gas is a local resource, while the reserves of natural gas are great and technologies of their production are developed much better [7].

The estimates of shale gas resources have been changing from time to time as in many world regions the geological surveys are either in their initial stage or they verify the previous estimates. For this reason all published data are mostly positive [8].

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