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The future of natural gas as the European Union's energy source – risks and possibilities

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CONTENTS

Executive summary

1) During the recent years, the EU's natural gas demand has been growing and a similar trend is expected to continue in the future. In 2030, natural gas is expected to account for 30% of the EU's primary energy consumption, reaching nearly 700 billion cubic meters. At the same time, the EU's domestic natural gas production, even if Norway is included, is expected to decrease steadily. As a consequence, there will emerge a substantial gap between European natural gas supplies and demand, and thus the EU will be forced to increasingly rely on imported natural gas. Russia is currently the EU's most important natural gas supplier but the country's capability to export natural gas in the future is in doubt due to several internal and external factors. Thus the EU may be forced to diversify its natural gas imports away from Russia in the future and find alternative natural gas sources, suppliers and routes.

2) The diversification of natural gas supply is not just compulsory for the EU but increasingly in the EU's interests. Diversifying natural gas suppliers and supply routes, increasing the use of LNG and if possible, exploiting the domestic unconventional gas resources in Europe can enhance the EU's energy security in the future. However, none of them can alone substitute for Russian natural gas as the EU's energy source. Instead, the EU's natural gas demand in the future could best be met by forming a new diversified European natural gas supply, in which all the above mentioned natural gas sources would be combined.

3) Currently the biggest wild card in the world natural gas market is unconventional gas, especially shale gas. The shale gas revolution has already been spreading in the United States and is soon expected to reach other parts of the world as well. If the shale gas revolution spreads throughout the world it can indeed have wide geopolitical implications. It can completely transform the strategic energy relations between countries. The new-found energy resources in different parts of the world can loosen the dependencies between the regions and countries that are currently producing energy and the ones purchasing it. The new indigenous gas resources would be especially beneficial for Europeans who simultaneously struggle with their shrinking domestic gas production and aim to decrease their dependence on imported energy. However, the unconventional gas exploration in Europe is in embryonic stage and both the size and the exploitability of the European unconventional gas resources remain highly uncertain

1 Introduction

Energy issues have emerged as one of the greatest challenges facing the European Union in the future. While the climate change is acknowledged as the main concern, more traditional problems such as dependence on energy imports, strain on energy resources and access to affordable, secure energy still remain high on the EU's agenda. Indeed, there is a constant search for solutions to the abovementioned problems, usually through the diversification of the EU's energy supply, whether by finding new energy sources, routes and suppliers or increasing the use of renewable energies. Furthermore, energy sector is one of the most important, as well as most complex, elements of the EU-Russia relations.

With regard to the EU's energy security, one of the most important factors affecting it is Russia's future ability to deliver natural gas to the EU. Despite its huge natural gas resources, Russia will not necessarily be able to meet the EU's natural gas demand in the future. Old giant gas fields brought into play during Soviet times are draining and the development of new major fields is delayed, mainly because of the lack of adequate investments. Furthermore, the current economic crisis is worsening the situation. Indeed, Russia may face a serious fall in its gas production in the future if the start-up of production in new regions will be further delayed. In such situation, there won't necessarily be enough of Russian gas for everyone – but who would be left without it?

In the EU the risks of over-dependency on Russian energy have been already recognised. During the Ukrainian gas crisis in the beginning of 2009 the EU caught a glimpse of the effects of disruptions in the Russian gas deliveries. To a certain degree, the events in Ukraine awakened the EU but in general the member states still remain inadequately prepared to sudden energy crises, such as supply disruptions. In the EU the conversation has been mostly dominated by gas pipes and political disputes related to them. However, to make it simple, there's no use of building pipelines if there's not enough gas available to fill them.

Indeed, there is a need for analysis that, instead of focusing on the EU-Russia pipeline competition, concentrates on the possibilities of satisfying the EU's natural gas demand in the future, either by Russian gas or other sources. The EU's domestic natural gas production is decreasing while simultaneously the demand for gas is expected to grow. Increasing the role of alternative natural gas suppliers and delivery routes would all

contribute to the diversifying of the EU's natural gas supply. Increasing use of liquefied natural gas (LNG) and the possibilities related to unconventional gas production can further enhance the EU's energy security. A glimpse of this unconventional future is already in view in the United States where the shale gas revolution has been spreading, profoundly transforming the North American gas market. The countdown has started in other world regions as well – Europe included.

In this research the focus is in specifying the focal questions, threats and possibilities related to the sufficiency and security of supply of natural gas as the EU's energy source in the future. The first part of the research concentrates on analysing Russia's ability to deliver natural gas to the EU in the future. The second part focuses on the EU's possibilities to diversify its natural gas supplies by finding alternative natural gas sources, constructing new delivery routes and increasing the use of LNG. In addition, the impact of shale gas on the global gas market and European energy security is analysed. All in all, this research wishes to shed light on the EU's realistic possibilities to satisfy its natural gas demand in the future.

The author is grateful for the financial support of the **Jenny and Antti Wihuri Foundation** and the **Vihanto Oy Foundation** who have made it possible to conduct this report.

Turku, 3.5.2010

Hanna Mäkinen

2 Energy situation and the role of natural gas in the European Union

2.1 Energy profile of the European Union

Energy consumption in the European Union has been growing during the 2000s. Between 2000 and 2007 there was an average annual growth of 0.7% in the gross inland energy consumption, compared to the growth rate of 0.4% in the previous decade. However, according to Eurostat, the growth in energy consumption has shown some signs of stabilising during the recent years.[2] On a global scale, the growth in energy demand has temporarily halted as a consequence of the current economic crisis. However, on current policies it is expected to soon resume its upward trend. The International Energy Agency (IEA) predicts the world's energy demand to increase by an average of 1.5% annually to 2030, which would indicate 53% more coal, 42% more gas and 22% more oil than today.[3]

While there has been a steady growth in the overall energy consumption, the energy structure of the European Union has seen some changes in recent years. The major trends have been the decrease in the consumption of coal and the increases in the consumption of renewable energy sources and natural gas (Table 1). The consumption of renewables saw the highest increase, 52% from 1997 to 2007, although their share of the EU's total gross inland consumption remained only at 8% in 2007 (Figure 1). Likewise, the consumption of natural gas increased 20% from 1997 to 2007 – both in electricity and other uses – and its share of the total amounted 24% in 2007. Oil retained its significance as an energy source, especially because of the lack of alternatives in the transport sector. Its contribution to the total gross inland consumption was the largest, a 36% share in 2007, and its consumption decreased only 1% between 1997 and 2007. All in all, the share of fossil fuels in the EU's total energy consumption in 2007 was 79%.

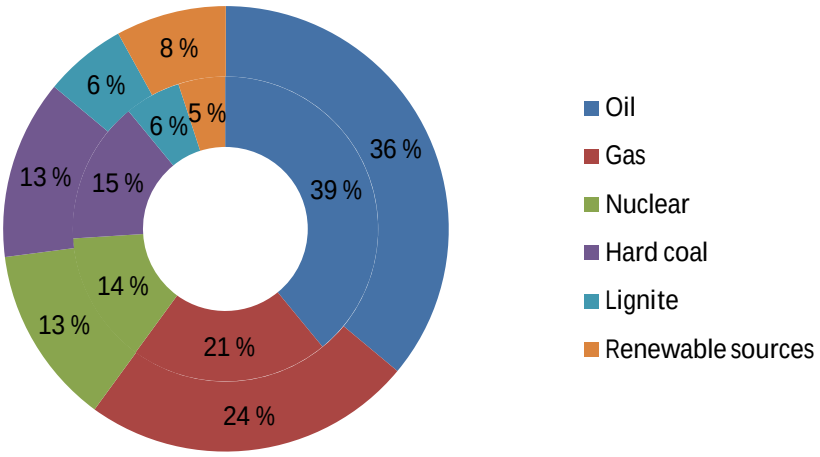
[2] European Commission 2009c, 84.
[3] Tanaka 2010.

Table 1 **EU-27 gross inland energy consumption of 1997 and 2007 (Mtoe), and change 1997–2007, by fuel**

EU-27	1997	2007	Change 1997–2007
Total	**1704**	**1806**	**6%**
Oil	663	657	-1%
Gas	359	432	20%
Nuclear	236	241	2%
Hard coal	248	232	-7%
Lignite	101	99	-1%
Renewables	93	141	52%

Source: European Commission 2009a.

Figure 1 **EU-27 gross inland energy consumption of 1997 and 2007, by fuel**



Source: European Commission 2009a.

The general shift away from solid fuels towards natural gas and to some extent renewable energy sources reflects the growing importance of the climate change policy in the EU. The burning of fossil fuels is the main source of carbon dioxide emissions and the extraction of them causes large methane emissions. Natural gas, however, is often promoted as the cleanest fossil fuel because it produces lower carbon emissions than other fossil fuels. In this respect it is regarded as a bridge between oil and coal, and renewable energy sources. Naturally, environmental concerns have been a major driving force in the increase of the use of renewable energy sources as well.

In December 2008 the EU adopted climate change targets for 2020, the so-called 20-20-20 plan, which aims at cutting greenhouse gas emissions by 20%, reducing energy consumption by 20% through increased energy efficiency, and increasing the share of

renewable sources to 20% in the EU's energy mix. Energy efficiency is the key component of the European Commission's energy and climate package because it contributes to all main goals of the 20-20-20 plan. It reduces greenhouse gas emissions, advances energy security, improves competitiveness and reduces energy costs for consumers.[4] However, considering the high share of fossil fuels in the EU's energy structure, it will be very difficult for the EU to meet the 20-20-20 targets. Indeed, it would require profound changes in the EU's overall energy mix.

2.2 Natural gas as the EU's energy source

In addition to environmental concerns, securing European energy supplies is very high on the EU's agenda. Energy demand and dependency on oil and gas imports are rising in the EU while supplies are becoming scarcer and the risk of supply failure is increasing.[5] With regard to the security of supply of energy in the EU, natural gas plays an important role. On one hand, the import dependency in natural gas is high. On the other hand, natural gas is a significant fuel for industrial and service sectors and households alike and thus a critical element in keeping the EU warm and in motion.

There are various elements which distinguish natural gas from other energy sources and which make security of supply concerns especially important in relation to natural gas. Contrary to for instance oil that can be shipped almost anywhere by sea, there are considerable limitations in both natural gas transportation and storage. First of all, the delivery system of natural gas is rather inflexible. Natural gas is mostly exported by pipelines, which determines the potential customers it can reach and strengthens the interdependence between a seller and a buyer. This relationship is further reinforced by the fact that currently natural gas is mostly, especially in Europe, traded under long-term bilateral contracts between a seller and a buyer. These agreements define delivery terms and the price, which is usually indexed to oil. A so-called take-or-pay principle is also commonly applied: it refers to a system in which customers are required to pay for a certain volume of gas even if they do not take delivery of all of it. On the other hand, continuing agreements are not applied when natural gas is traded on spot markets, where delivery will take place immediately or very soon.

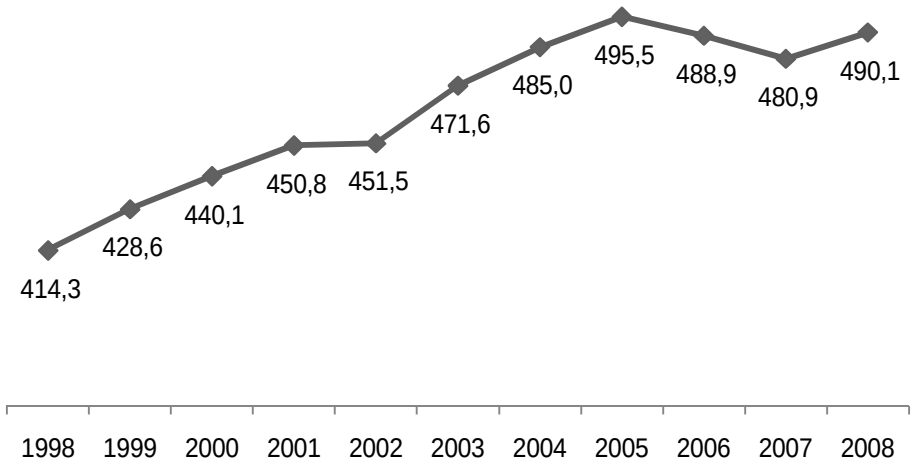
Currently there is no global gas market. Instead, in Europe there is a regional gas market dominated by a few non-European suppliers, mainly Russia and to a lesser

[4] European Commission 2009b, 5.
[5] European Commission 2009c, 83.

extent Algeria. Currently over 70% of the natural gas exports to Europe are by pipeline and the rest in the form of LNG.[6] In addition to the limitations in natural gas delivery and trade systems, one of the commonly acknowledged weaknesses related to natural gas as an energy source is *the lack of adequate "shock absorbers" that allow the supply system to respond to sudden unexpected increases in demand or loss of supply*.[7] Natural gas production usually goes side by side with gas demand, meaning that when there is a reduction in demand producers are forced to cut back production levels. On the other hand, production can only be increased in response to a heightened demand.[8] There is a practical reason for that: natural gas storage facilities are rare and rather expensive to construct, and because the bulk of deliveries are tied to pipelines, it is hard to find alternative markets for gas. The inadequacy of storage capacity is also a great problem for several EU member states and reduces their abilities to react in the event of an energy crisis.

In general, the EU's natural gas consumption has followed an upward trend during the last ten years (Figure 2). Recently the gas demand in the EU has weakened in consequence of the economic crisis but is expected to rise again along with the economic recovery, which means that short-term fluctuations are not likely to have a decisive impact on the long-term development of the EU's gas demand.

Figure 2 EU-27 natural gas consumption 1998–2008, billion cubic meters

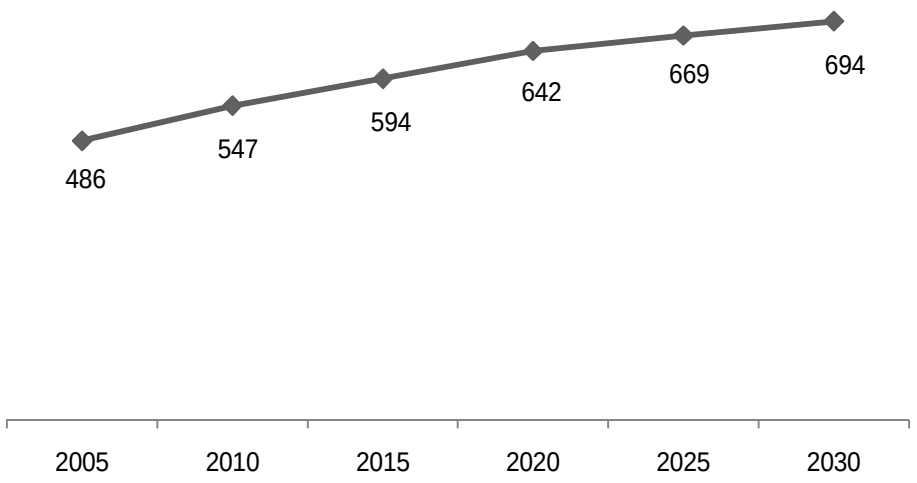


Source: BP 2009.

[6] EIU 2009; Götz 2007, 7.
[7] IHS CERA 2010, ES-6.
[8] Solanko & Sutela 2009, 60–61.

While the natural gas consumption in the EU is likely to grow in the future, it's more unclear how large the increase will be. Forecasts of the EU's future natural gas demand are characterised by a great degree of uncertainty. Factors influencing the future demand include the EU's climate policy and the development of the natural gas price. If the EU pursues an active energy-saving policy and facilitate transition to renewable energy sources, gas demand will grow more modestly.[9] However, Eurogas predicts a considerable growth of 43% in the EU-27 natural gas consumption between 2005 and 2030.[10] This would mean a consumption of almost 700 billion cubic meters of natural gas in 2030 (Figure 3).

Figure 3 EU-27 natural gas demand outlook, billion cubic meters

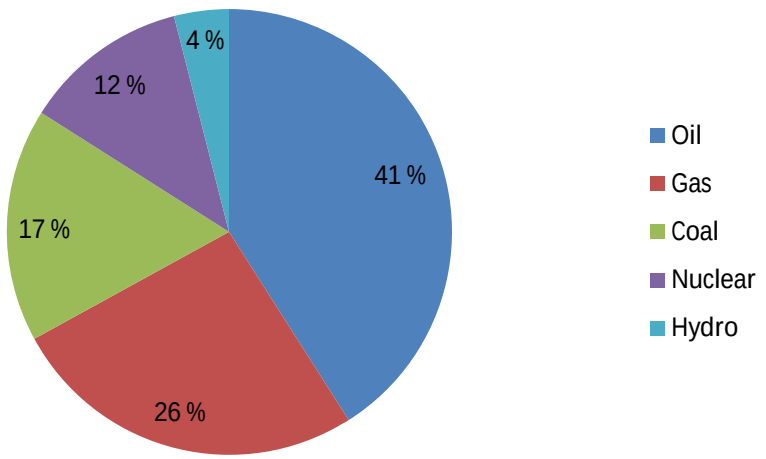


Source: Eurogas 2007.

At the same time natural gas will increase its share in the EU's primary energy consumption, which already is some 26%, although the growth is expected to moderate after 2010 (Figures 4 and 5). The share of natural gas in the EU's primary energy consumption is expected to reach 30% in 2030.

[9] Götz 2007, 9–10.
[10] Eurogas 2007.

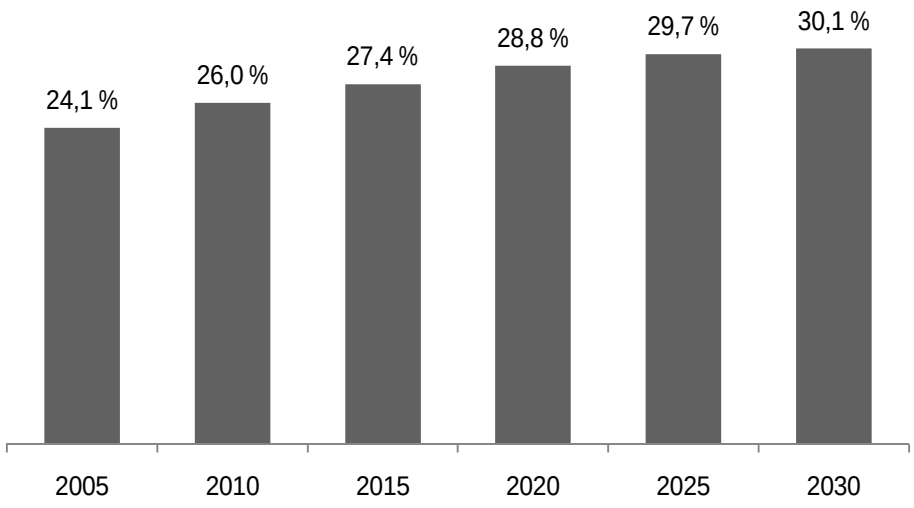
Figure 4 Primary energy consumption of the EU in 2008, by fuel*



*commercially traded fuels only

Source: BP 2009, author's calculations.

Figure 5 The share of natural gas in the EU-27 primary energy consumption



Source: Eurogas 2007.

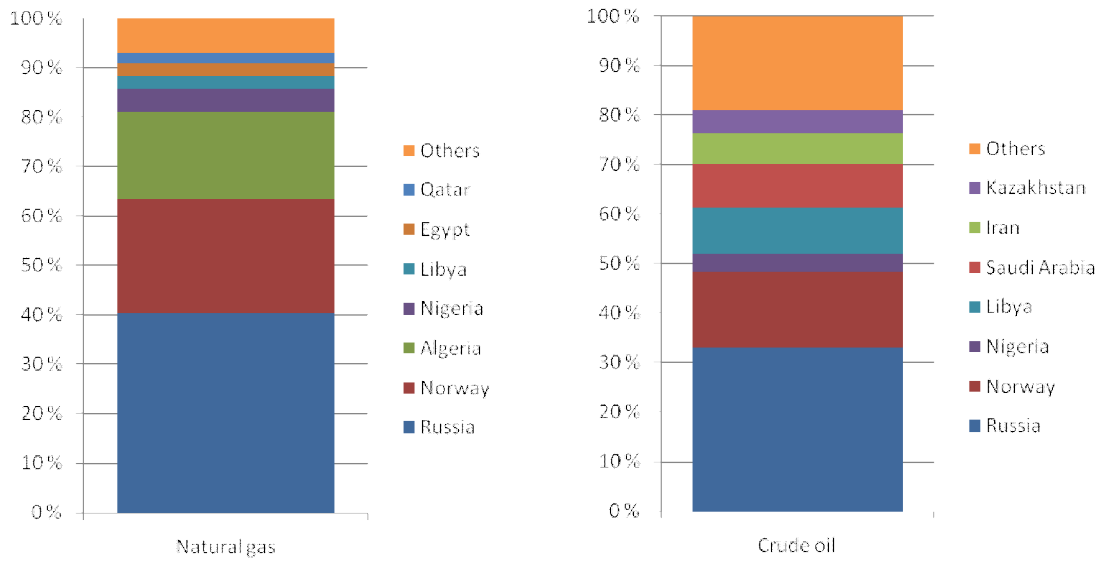
The increasing role of natural gas as the EU's energy source has, however, also increased the EU's dependency on energy imports.[11] All in all, the importance of fossil fuels in the EU's energy structure contributes to the EU's high import dependency.

[11] European Commission 2009c, 84.

Between 2000 and 2007, the EU's natural gas imports increased by 30%, hard coal imports by 20% and crude oil imports by 4%.[12] Oil and gas imports are mainly driven by demand whereas in coal the quality of imports is a determining factor.[13] In total, the EU's dependency on imported energy has been growing from around 45% in the 1990s to 55% in 2008.[14]

In both natural gas and crude oil imports, Russia is the main country of origin (Figure 6). In 2006, 40.4% of the total natural gas imports and 32.9% of the total crude oil imports to EU-27 originated from Russia. Norway was the second most important supplier, with 23.3% and 15.5% shares respectively. The third most important supplier of natural gas to the EU was Algeria, whose share of the total gas imports was 17.5%. However, European Commission's data shows that Algeria's role as the EU's natural gas supplier has been diminishing during the recent years.[15]

Figure 6 EU-27 natural gas and crude oil imports in 2006, by origin



Source: Eurostat 2009.

Although Russia is the main country of origin of natural gas imports to the EU, its share has declined sharply during the last two decades. In 1990 75% of the EU's total gas imports came from Russia, compared to some 40% of today. Russian gas imports' share of the EU's total natural gas consumption, on the other hand, has stabilised

[12] European Commission 2009a, 33.
[13] Coal available within the EU is mostly lignite, and hard coal, which is of higher quality, is increasingly being imported from outside the EU. European Commission 2009b, 5, 22.
[14] European Commission 2009c, 83.
[15] Eurostat 2009.

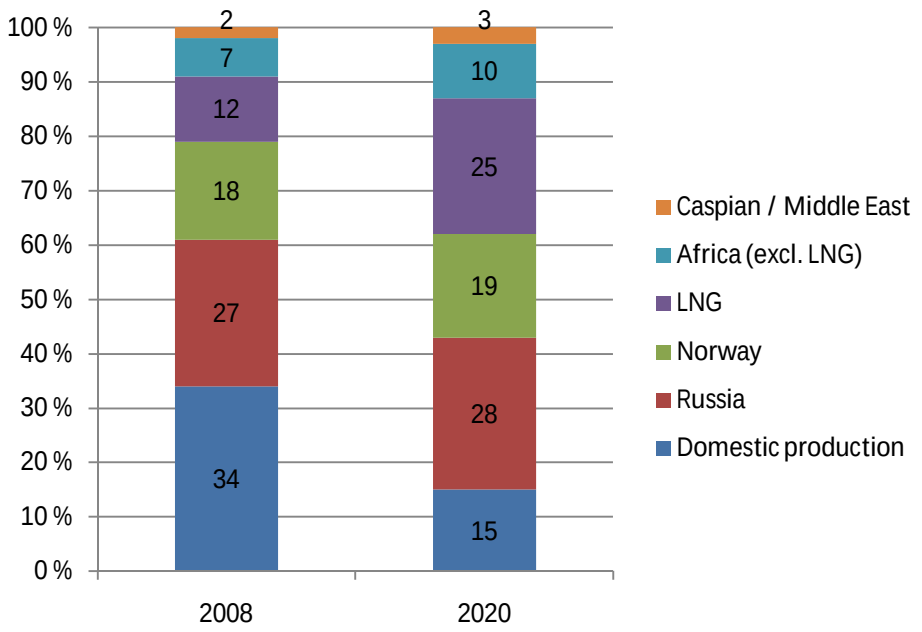
around 25%. The most significant indicator of the EU's energy dependency on Russia is, however, the share of Russian natural gas of the EU's primary energy consumption, which has stabilised around 6.5%.[16] In practise it indicates that 93.5% of the EU's energy consumption is covered by other energy sources than Russian natural gas.

However, if one looks at the EU member states separately, the importance of natural gas as an energy source and their dependency on Russian supplies varies greatly. In general, new member states are more dependent on Russian gas than the old ones. According to the data presented by Noël (2008), in Latvia, Lithuania, Slovakia and Hungary the share of Russian gas of the country's primary energy supply was more than 30% (in 2006). Russia's most important client in the EU, Germany, covers some 10% of its primary energy supply with Russian natural gas. Other EU-27 countries rank somewhere between 0 and 20%.[17] The Nord Stream pipeline, the building of which started in April 2010, will increase the significance of Russian natural gas as an energy source in Germany and therefore the share of Russian gas of Germany's primary energy consumption will grow after the completion of the pipeline.

While natural gas demand in the EU is increasing, domestic production is expected to decrease in the future. Figure 7 shows that domestic production currently accounts for 34%, and Norway included, 52% of European natural gas supplies. By 2020 the share of domestic and Norwegian production combined is expected to drop to 34% and LNG is forecasted to account for a relatively large share of 25% in the EU's natural gas supplies.[18] Eurogas predicts a quite similar share of domestic production in 2020. According to its forecast, the EU's domestic natural gas production, Norway included, will account for one third of the EU's natural gas supplies in 2020 and decrease further to a quarter by 2030.[19]

[16] Noël 2008, 5.
[17] Noël 2008, 14.
[18] Stoppard 2009.
[19] Eurogas 2007.

Figure 7 European natural gas supplies in 2008 and 2020, %

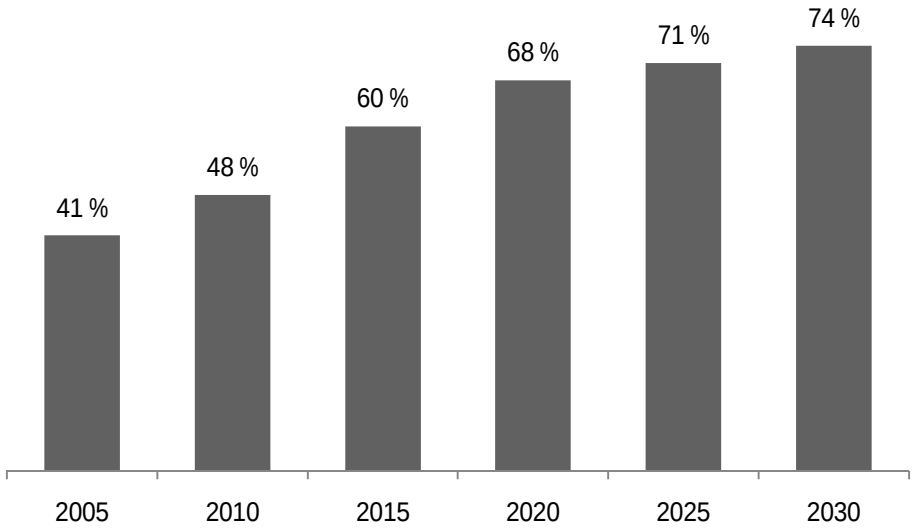


Source: Stoppard 2009.

The data from Eurogas suggests that after 2015 there will emerge a substantial gap between European natural gas demand and supplies.[20] Conventional natural gas resources in Europe are limited and the domestic production is expected to decline steadily after 2010.[21] The EU possesses only 1.6% of world's proved natural gas reserves, against for example Russia's 23.4%, and the share of the EU's natural gas production of the world total in 2008 was only 6.2%.[22] Therefore the EU is forced to increase its natural gas imports, either from Russia or from other countries. Eurogas predicts that the EU's dependency on natural gas supplies outside Europe will grow significantly during the coming two decades (Figure 8).

[20] Eurogas 2007.
[21] European Commission 2003.
[22] BP 2009.

Figure 8 EU-27 natural gas import dependency from outside Europe



Source: Eurogas 2007.

All in all, the EU will likely be faced with difficulties in meeting its growing natural gas demand in the future. It has to increasingly rely on gas imports, which can undermine the EU's energy security. The availability of sufficient natural gas imports to the EU from Russia won't be a certainty and therefore there is a constant search for new natural gas sources, suppliers and transportation routes. Indeed, there is a need for increasing natural gas deliveries, either in the form of liquefied natural gas (LNG) or more traditional pipeline deliveries. Moreover, the development of unconventional natural gas exploitation could contribute to the EU's domestic natural gas production in the future. These potential future scenarios will be analysed in the following chapters.

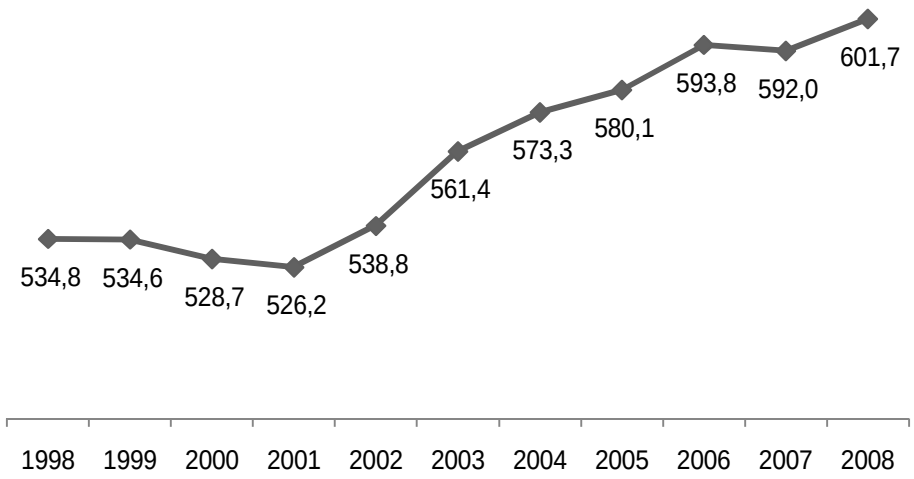
3 Russian natural gas as the EU's energy source

3.1 Current natural gas production and consumption in Russia

Russia possesses the largest proved natural gas reserves in the world. Until the last year it was also the world's largest natural gas producer – in 2008 Russia's share of the world total natural gas production was 19.6%.[23] However, according to recent estimates, in 2009 the United States took over the leading position in worldwide natural gas production, mainly as a result of the avalanche of unconventional gas production but also due to the fall in Russian gas production caused by the economic decline.[24]

In 2008 Russia produced 601.7 billion cubic meters of natural gas and the production has been growing during the most of the 21st century along with the economic growth that started after 1998 (Figure 9). Between 2002 and 2006 Russian natural gas production grew an average of 2.5% per year. In 2007 the production declined mainly because an especially mild winter reduced gas demand. From 2007 to 2008 the growth was again 1.4%.[25] However, due to the economic decline, the natural gas production turned down in 2009.[26]

Figure 9 Natural gas production in Russia 1998-2008, billion cubic meters

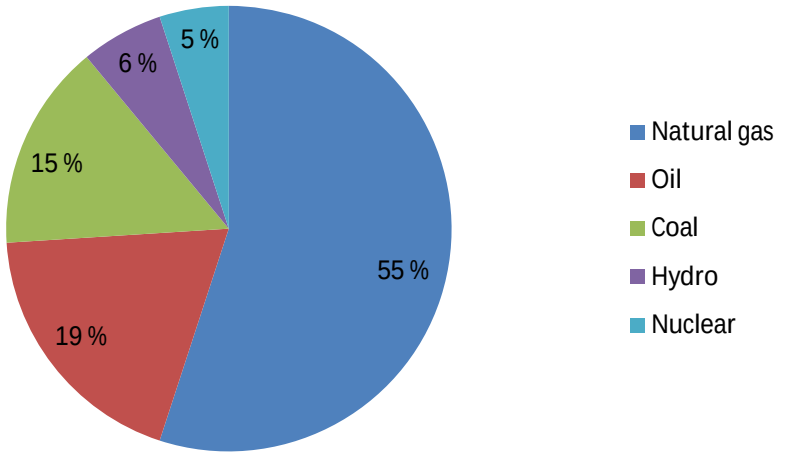


Source: BP 2009.

[23] BP 2009.
[24] US passes Russia as top gas producer. Upstream, 12 January 2010.
[25] BP 2009; Solanko & Ollus 2008, 6.
[26] Godzimirski 2009, 4.

Besides a large producer, Russia is also a significant consumer of natural gas. Natural gas is the most important energy source in Russia, the share of which in the country's overall energy consumption in 2008 was 55% (Figure 10). Other energy sources such as oil and coal come far behind, and the role of renewable energy sources is still insignificant in Russia's overall energy mix.

Figure 10 Primary energy consumption of Russia in 2008, by fuel*



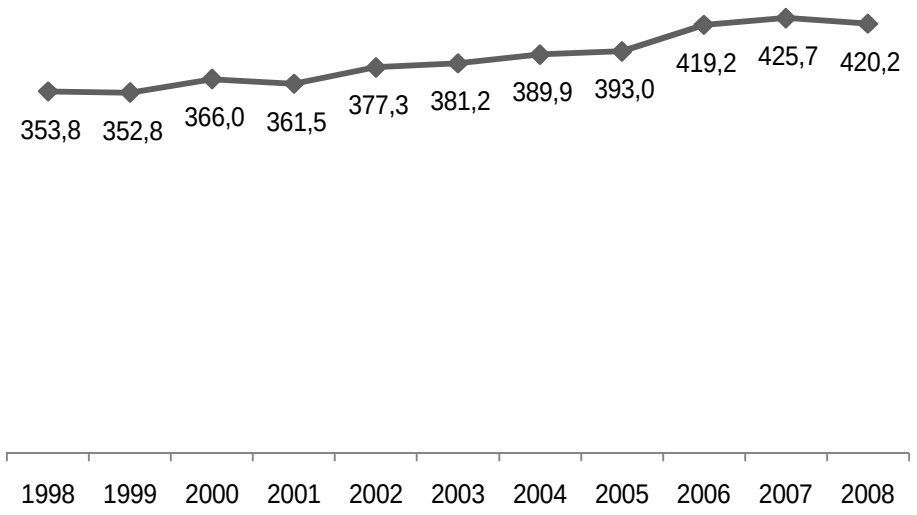
*commercially traded fuels only

Source: BP 2009, author's calculations.

One of the largest problems regarding energy consumption in Russia is the inefficiency of the use of energy. The country is among the world's most energy inefficient countries, when energy consumption is compared to the GDP.[27] In 2008 Russia consumed 420.2 billion cubic meters of natural gas (Figure 11). That makes it the second biggest consumer of natural gas in the world after the United States which in 2008 consumed 657.2 billion cubic meters of natural gas.[28] Moreover, the natural gas consumption of Russia is significantly larger than of the U.S. when compared to the size of the economy.

[27] Anker 2009.
[28] BP 2009.

Figure 11 Natural gas consumption in Russia 1998-2008, billion cubic meters



Source: BP 2009.

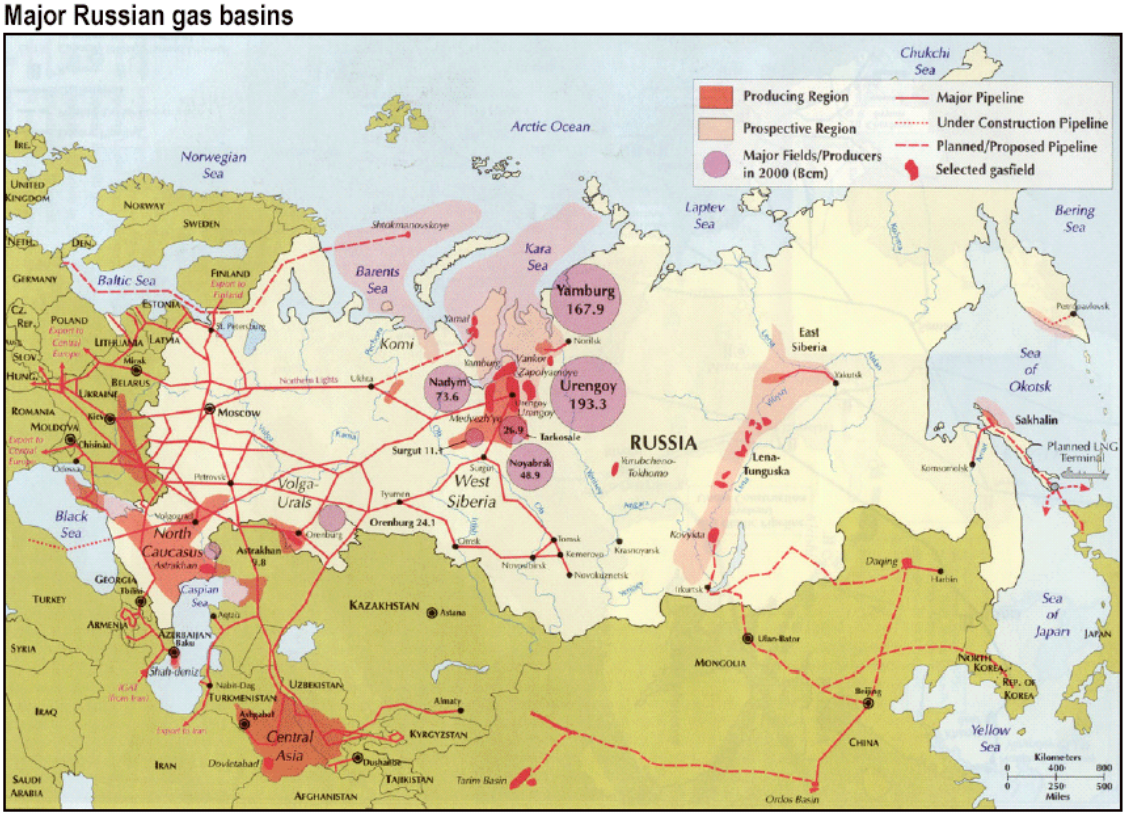
A significant reason for the high level of the natural gas consumption in Russia is the inefficiency of gas usage. Domestic natural gas prices in Russia are relatively low since providing people with inexpensive power and heat is, as a Soviet legacy, seen as a public service. During the recent years domestic gas prices have been raised gradually but they are still far behind European prices.[29] Only a few gas consumers, residential and industrial alike, have meters and therefore they can't receive any information on their gas usage and are unable to control it. In addition, the payment system is quite unreliable.[30] This has lead to wasteful natural gas consumption among both Russian industry and households and poses the lack of energy efficiency as one of the great energy challenges Russia is facing.

Currently the majority of natural gas produced in Russia comes from old Soviet fields, mainly the giant fields of West Siberia, such as Urengoy and Yamburg (Figure 12). However, the production of these major fields has already reached its peak and is now declining rapidly.[31] There have been attempts to compensate the depleting fields' declining production levels with smaller Siberian fields but this hasn't led to any significant outcomes. The only new large gas field, Zapolyarnoye, began production in 2001, and although it produces more gas than small fields, it can only partially

[29] Anker 2009.
[30] Makarova Victor 2008, 14.
[31] Solanko & Ollus 2008, 6.

compensate the decrease in the old giants' production.[32] Hence, in order to avoid a significant fall in its natural gas production, Russia would need to develop new gas producing regions as soon as possible.

Figure 12 Major Russian gas basins



Source: IEA

Source: IEA 2008; from EIA: Country Analysis Briefs – Russia. May 2008

However, the current economic crisis has had implications for both Russian natural gas consumption and production. The economic decline has weakened the gas demand both in Europe and in Russia, as a consequence of which the Russian natural gas production contracted sharply in 2009. Gazprom's gas production plunged by 16% in 2009 and Russian gas exports by 11% respectively.[33] The low oil and gas prices have further deteriorated the situation. If the lacking demand of natural gas continues, the fall in Gazprom's production can lead to a substantial drop in the company's incomes in the coming years. This could significantly hinder the realisation of the company's ambitious investment plans, including the development of highly complex next-

[32] Makarova Victor 2008, 12–13.
[33] Åslund 2010.

generation gas fields in Northern and Eastern Russia.[34] Although the economic slowdown has temporarily cut back the natural gas consumption in Russia and in the short term eased the shortfall of gas, in the long run the gas consumption is nonetheless expected to increase along with the economic recovery. This could lead to a significant supply gap in the future. Therefore the lack of investments, caused by the poor economic situation, can have long term deteriorating effects to the Russian gas production.[35]

3.2 Effects of the Russian energy policy and the role of Gazprom

One of the main goals of Russian foreign policy has been to reassert the country's role as a global superpower, in which the development of Russia's strategic resources has been seen as a key factor. Energy relations have opened up an important possibility for Russia to exert international influence.[36] Vladimir Putin's accession to the Russian presidency in 1999 significantly transformed Russian energy policy. Putin saw a strong, centrally governed state as a key to Russia's strength. Russian ownership of the state's strategic resources, including energy, was essential for the country's economic recovery and the re-establishment of it as a significant international actor.[37] Indeed, trade in raw materials has been the main driver of Russian economic growth.[38] In addition, the high world market prices for gas and oil during Putin's presidencies contributed to Russia's economic growth and helped the country to increase its importance on global energy markets.[39]

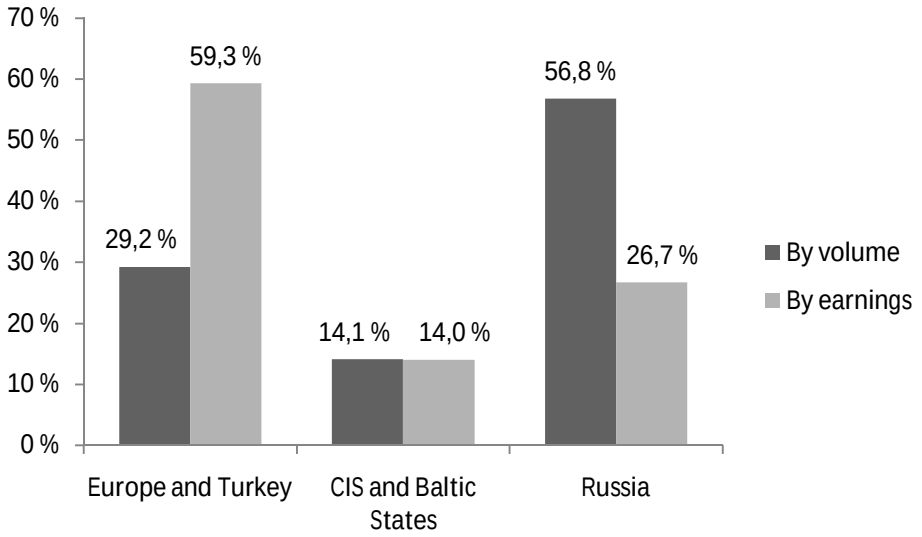
During the Putin era the Russian natural gas production and pipeline system were effectively brought under the control of the Kremlin.[40] Russian state acquired a controlling share in the gas giant Gazprom in 2005. Before that Gazprom was formally a private company but still controlled by management that was mainly appointed by the government.[41] Due to the Russian state's ownership of Gazprom the production of natural gas in Russia is currently strictly controlled by the government. Gazprom is the most significant gas producer both in Russia and on a global scale, controlling around 69% of Russian proved natural gas reserves and, according to the company's most

[34] Godzimirski 2009, 4–5.
[35] Kefferpütz 2009, 100.
[36] Jaffe 2009, 8.
[37] Olcott 2004, 9, 16.
[38] Ulkolinja: Kaasua, kaasua! YLE TV1 2010.
[39] YLE 2009.
[40] Kefferpütz 2009, 98.
[41] Solanko & Ollus 2008, 6.

recent figures, having an 83% share in Russian natural gas production.[42] However, according to Åslund (2010), Gazprom's share of Russian natural gas production has declined to 75% in 2010.[43] It also controls the Russian natural gas pipeline system and has an exclusive right to export Russian gas.[44] Moreover, in its strategy the company aims at establishing a leading position among global energy companies.[45]

Gazprom is of great significance to the Russian economy since it accounts for 10% of the Russian GDP.[46] The largest share of Gazprom's revenues comes from gas exports to Europe although the majority of the gas it produces is sold to Russian consumers (Figure 13). This disproportion, illustrated in Figure 13, is due to a significantly higher price Gazprom charges for the gas exported to Europe, compared to the domestic price within Russia. Domestic gas price in Russia is regulated by the state, whereas export prices are oil-linked and based on long-term contracts.[47]

Figure 13 Gazprom's earnings by region



Source: Russian Analytical Digest 2009; from Gazprom company data.

Gazprom's own natural gas production is already insufficient to meet all its commitments to its domestic markets, the CIS and European countries. Natural gas imports from Central Asia and output of independent (private) companies are crucial

[42] OAO Gazprom: Gazprom in Figures 2004–2008.
[43] Åslund 2010.
[44] Kefferpütz 2009, 98.
[45] Gazprom 2009: Strategy.
[46] OAO Gazprom: Gazprom in Figures 2004–2008.
[47] Makarova Victor 2008, 6.

elements in filling the company's needs.[48] It could even be said that during the recent years Gazprom has increased its gas imports instead of investing in new fields.[49] Gazprom's gas imports from Central Asia, especially Turkmenistan, have multiplied since 2005. In 2008 Gazprom purchased 66.1 billion cubic meters of Central Asian gas, of which 42.3 billion cubic meters from Turkmenistan, 14.2 billion cubic meters from Uzbekistan and 9.6 billion cubic meters from Kazakhstan.[50] This equates to approximately half of the amount of gas Russia exports to the EU.

The future of the Central Asian gas imports is, however, uncertain for both economic and political reasons. Russia has aimed at monopolising the transport of gas from the Caspian region. It has tried to bargain for the price and succeeded in gaining a discount price for many years. However, over the last couple of years, Russia has been faced with competition, especially from China's side, and therefore been forced to offer more competitive, market-based prices for Central Asian gas. The purchase-agreement of China for Turkmen gas has helped the Central Asian states to demand higher prices for their gas from Russia. Also the U.S.-supported Baku–Tbilisi–Ceyhan oil pipeline poses a challenge for Russia's central position in the Caspian energy sector. However, it hasn't yet significantly reduced the Central Asian states' dependency on Russia in their energy transport.[51] Still, there are clearly some changes on the way on the Central Asian gas market. For example, in 2009 the gas sales from Turkmenistan to Russia were halted for nine months because of the rupture of the main export pipeline and complicated negotiations following it. While Turkmen gas is now flowing to Russia again, it is also going to China through a newly-built pipeline opened in December 2009.[52]

In Russia, the so-called independent e.g. private producers have raised their natural gas production during the recent years. According to Soyuzgaz, the Union of Independent Gas Producers in Russia, the independent producers' share of Russia's total natural gas output has increased from 6.4% in 1999 to around 15% in 2009.[53] In 2010, their market share may have already increased to some 25%.[54] Around 80% of the output of the independent producers is in the hands of five companies: Novatek, Russia's second-largest gas producer, and the oil companies Rosneft, Lukoil, TNK-BP,

[48] Noël 2008, 5.
[49] Solanko & Sutela 2009, 62.
[50] Gazprom 2009: Gas purchases in Central Asian countries.
[51] Jaffe 2009, 27–28, 31.
[52] Åslund 2010.
[53] Blagov 2009a.
[54] Åslund 2010.

and Surgutneftegaz.[55] However, due to Gazprom's exclusive rights the independent producers don't necessarily have a strong incentive to increase their production.[56] Since Gazprom controls the Russian gas pipeline network and has an export monopoly of natural gas, independent producers are unable to reach consumers directly. Instead they have to sell their gas at domestic price to Gazprom, which sells it forward to international markets at higher export price.

The oil companies in Russia are also producing substantial amounts of natural gas as a by-product of oil production. Gazprom's monopolistic stand sets significant barriers for them as well. The limited access of oil companies to gas processing plants and pipeline network leads to their reluctance to even look for gas, not to mention to produce or deliver it. In consequence many companies are forced to flare their gas, and according to IEA some 60 billion cubic meters of gas is flared in Russia per year.[57] If the oil companies had the needed infrastructure, they could for their part help to fill the supply gap. With 60 billion cubic meters of natural gas Russia could cover almost half of the gas it exports to the EU in a year.

To make matters worse for Gazprom, the company has often been criticised as inefficient and poorly managed, and accused of wasting its resources outside its core business. The company is involved in a variety of activities, ranging from media to agriculture and banking. Thus, instead of investing in gas production, Gazprom has expanded its activities for example into media sector.[58] In addition, Gazprom's monopolistic position has raised critique among observers. In its 2009 economic survey on the Russian Federation the OECD highlighted the lack of competitiveness in the Russian gas sector. According to the OECD's report, *Gazprom has pursued an active acquisition policy, which extends well beyond its core activities, and increased its dominance in the domestic gas market.*[59] The OECD is concerned of the strict control the Russian state exerts on Gazprom and the monopoly Gazprom has over both Russian gas pipeline network and gas exports.[60] Indeed, also inside Russia the independent gas companies are demanding the loosening of Gazprom's monopoly and thus better access to pipelines the gas giant currently controls.[61]

[55] Blagov 2009a.
[56] Noël 2008, 5.
[57] Makarova Victor 2008, 15.
[58] Solanko & Sutela 2009, 62–63; Solanko & Ollus 2008, 9; Makarova Victor 2008, 35–35. Åslund 2010.
[59] OECD 2009, 146.
[60] OECD 2009, 146.
[61] Åslund 2010.

Whereas Gazprom remains optimistic about its capabilities to respond to the natural gas demand in the future, other experts are not as certain on the company's capacity to develop new gas fields. As Makarova Victor (2008) points out, the great paradox of Gazprom is that *on the one hand, it control's the world's largest gas resources and yet, on the other hand, it faces a looming gas crisis as production in its major fields continue to decline, while it fails to invest adequately in new fields*.[62] Indeed, as many experts[63] have emphasised, Russia has enough natural gas resources to produce significant levels of gas also in the future. The problem lies instead in the rapid decline in the production of the old giant gas fields and the lack of investments in the development of new fields. The situation has been only worsening as a consequence of the economic slowdown.

3.3 Russian natural gas production in the future

With regard to Russian energy policy, the energy strategy the Russian government adopted in 2009 sets the targets for the development of the country's energy sector until the year 2030. The energy strategy aims at modernising the country's energy sector and increasing energy efficiency. By 2030 the currently large role of energy in the Russian economy is expected to decrease significantly (Table 2).

Table 2 Forecasted change of the fuel and energy complex's role in the Russian economy between 2005 and 2030

	2005	2030
Energy sector in GDP	30%	18%
Energy sector's export in GDP	19%	5%
Energy resources in export	64%	34%
Investment in energy sector in total investment	27%	11%

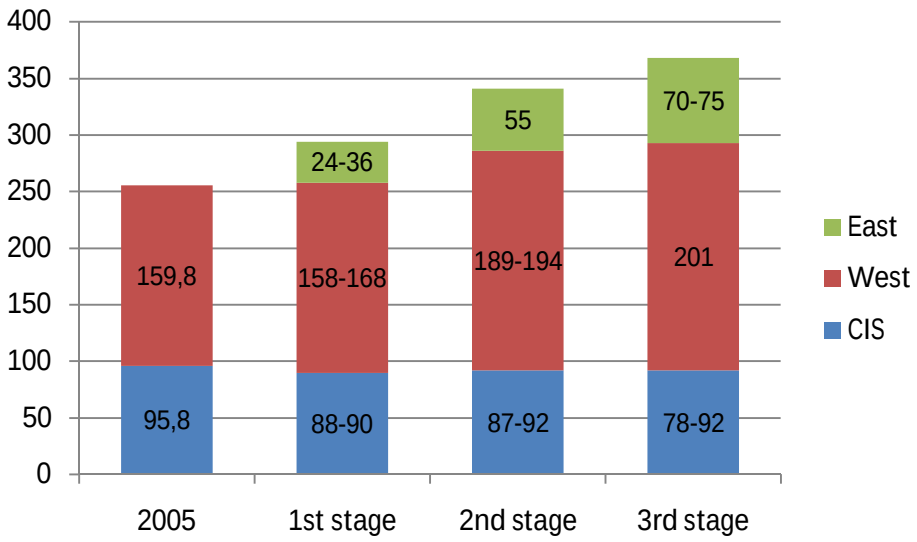
Source: Gromov 2009.

The development and diversification of energy infrastructure play an important role in the strategy. With regard to natural gas, this includes constructions of North Stream and South Stream. The development of gas (and oil) resources in Eastern and Northern regions of Russia, including Arctic offshore will contribute to satisfying domestic demand in Russia and diversifying export directions. Indeed, the strategy proposes a significant geographical reorientation of Russian oil and gas exports.[64] By

[62] Makarova Victor 2008, 6.
[63] In addition to Makarova Victor (2008), see e.g. Noël 2008; Solanko & Sutela 2009.
[64] Gromov 2009.

the year 2030 20% of Russian gas exports and 25% of oil exports are expected to go to the Eastern market.[65] It will leave 279 to 293 billion cubic meters to be exported to other markets, of which 201 billion cubic meters to Western markets (Figure 14).

Figure 14 Structure of Russian gas export according to the Russian Energy Strategy until 2030, billion cubic meters



Source: Gromov 2009.

The strategy aims to improve the ecological security and efficiency of the Russian energy sector. The potential for energy saving in Russia is huge – 45% of the current consumption of energy resources.[66] The energy consumption per capita in Russia is expected to increase at least 40% by the year 2030 but there will be a shift from natural gas to non-fuel energy – nuclear, hydro and renewables – especially in power generation. The share of natural gas in the overall energy consumption is estimated to decline to 47% whereas renewable energy is expected to account for 14% of Russia's total energy consumption by 2030.[67]

Despite of the predicted shift in Russian energy structure, the strategy expects the country's crude oil and natural gas production to increase significantly by 2030, annual oil production to 530–535 million tons (up by 8.6–9.7% from 2008), and annual natural gas production to 885–940 billion cubic meters (up by 33–42% from 2008). By the

[65] Energy strategy 2030. Russian-American Business magazine, 3 November 2009.
[66] Gromov 2009.
[67] Ibid.

same year, the crude oil exports are expected to reach 329 million tons and natural gas exports 349 to 368 billion cubic meters.[68] Indeed, although the current economic crisis has significantly decreased the demand for natural gas, Russian energy strategy suggests an optimistic scenario for its future development. Underlying assumptions in the strategy are that both the domestic consumption and foreign demand for energy will rise in the future.[69] Still, in the energy strategy the years 2013–2015 are reserved for recovering from the economic crisis and preparing for the future.[70]

Gazprom, as well, expects the natural gas demand to increase again in the next two or three years.[71] The company is also confident that it can respond to the heightening gas demand in the future. According to Gazprom's Chief Executive Alexei Miller's recent statement, the company is expected to produce 565.5 billion cubic metres of gas in 2013 compared to a projected 529 billion cubic meters in 2010 and 461 billion cubic meters in crisis-hit 2009.[72] Gazprom claims that the gas production levels will be maintained by intensifying production in existing fields and taking new fields and sites into production. After 2010 the company aims at developing new strategic gas production areas on the Yamal Peninsula, the Barents Sea offshore, the Ob and Taz Bays, Eastern Siberia and the Far East.[73] If several new regions will be brought into production, it will lead to a clear geographical shift in Russian natural gas production (Table 3). Currently most of the company's resources are concentrated on the development of the natural gas fields on the Yamal Peninsula.

Table 3 Shift in natural gas extraction in Russia, 2005 and 2030, billion cubic meters

	2005	2030
Nadyum-Pur-Taz Region	585	317-323
European part of Russia	46	131-137
New regions:		
Bolshekhetskaya Valley	3	30-32
Yamal		185-220
Ob-Taz Estuary		67-68
Eastern Siberia	4	45-65
Far East		85-87
Others	3	8-25
Total	641	885-940

Source: Gromov 2009.

[68] Blagov 2009b.
[69] Blagov 2009b.
[70] Energy strategy 2030. Russian-American Business magazine, 3 November 2009.
[71] Gazprom sees increase in gas demand. Upstream, 10 November 2009.
[72] Gazprom shrugs off shale gas "threat". Upstream, 14 April 2010.
[73] Gazprom 2009: Gas & Oil Production.

The Yamal Peninsula is a strategically important region for Russia with waste natural gas and oil reserves. The most significant gas reserves on Yamal are in the Bovanenkovskoye field, according to Gazprom 4.9 trillion cubic meters, and the company ranks the development of the field as a top-priority project on the peninsula. The natural gas production from the field is projected to reach 115–140 billion cubic meters annually. In addition, the initial natural gas reserves of the Kharasaveyskoye, Kruzenshternskoye and Yuzhno-Tambeyskoye fields reach to approximately 3.3 trillion cubic meters.[74] Gazprom is planning to start up the natural gas production on the Yamal Peninsula and adjacent offshore areas in 2011 (Table 4). In addition, the development of the promising areas offshore Yamal in the Kara Sea is scheduled to start after 2025.

Table 4 Gas production forecast for the Yamal Peninsula and adjacent offshore areas

Year	2011*	2015	2020	2025	2030
Gas production (bcm)	7,9	75–115	135–175	200–250	310–360

**Production start-up on Yamal*

Source: Gazprom 2009.

Like the Yamal region, also the Shtokman gas field development project is of strategic importance to Russia, holding a resource base for deliveries of Russian natural gas to the Atlantic Basin markets. Shtokman gas field is located on the arctic shelf of the Barents Sea, about 600 km from shore at a depth of 320–340 meters. It is estimated to contain natural gas reserves of 3.8 trillion cubic meters. Gazprom is cooperating with Norwegian StatoilHydro and French Total in developing the Shtokman gas field, and in 2008 the three companies signed an agreement establishing Shtokman Development AG company, of which Gazprom owns 51%, Total 25% and StatoilHydro 24%. The pipeline gas production in the Shtokman field is projected to start up in 2016 and the LNG production in 2017.[75]

However, the exploitation of the next-generation fields in Yamal and Shtokman is far more challenging than the old fields.[76] Both areas are located in harsh environment and offer very challenging conditions for natural gas production. Development of the fields

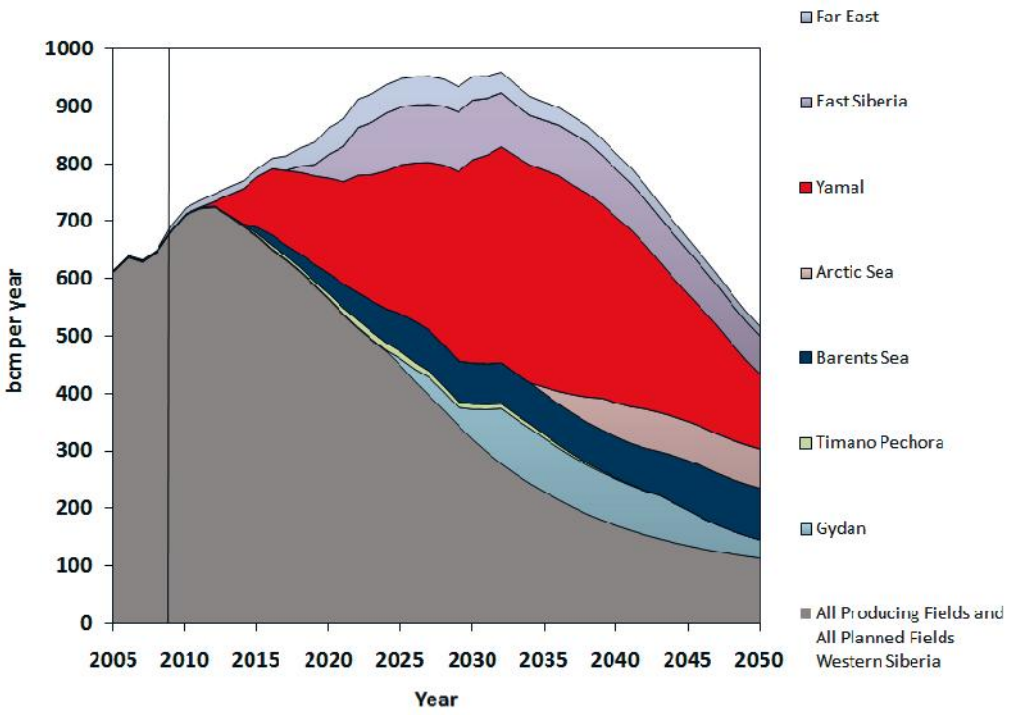
[74] Gazprom 2009: Yamal Megaproject.
[75] On meeting dedicated to Shtokman field development. Gazprom News, 28 January 2010; Shtokman Development AG Board of Birectors approve way forward on Shtokman. Gazprom News, 5 February 2010; Gazprom 2009: Shtokman.
[76] Solanko & Ollus 2008, 7.

is technologically and financially challenging, necessitating large investments and implementation of new technologies. New gas transportation systems need to be constructed and infrastructure improved. Indeed, several experts have doubted whether the production in either of the fields will start up according to schedule. With regard to Yamal, Gazprom's plans to begin the natural gas production in the Bovanenkovskoye field in 2011 may prove to be overly ambitious because of technical, logistical and project management -related problems. It will take years to construct a completely new production site and the required infrastructure. As a reference point Solanko & Sutela (2009) mention the bringing of the recent new large gas field, Zapolyarnoye, into production, which took more than 10 years since the project was launched.[77] Concerning Shtokman, there has been a lot of discussion about a delay in the project and some experts predict the start-up of the natural gas production in the field to postpone at least until 2020.[78] However, despite of all difficulties, in Russia the timetables of both Yamal and Shtokman are considered to be realistic.

In addition to the abovementioned technical challenges, the position of Yamal Peninsula and Shtokman fields is special because they are essential in order to avoid a decline in Russian natural gas production. Indeed, Russia's capability to supply natural gas to the EU in the future depends greatly on the pace of development of Yamal's production. If Yamal fields are not developed as planned, Russia's export volumes to the EU and CIS can fall significantly. Söderbergh (2010) further illustrates the significance of the development of new fields.[79] In his study he presents two scenarios, of which one with all planned production from giant fields and the other with a five-year delay in Yamal production (Figures 15 and 16). As illustrated in Figures 15 and 16, the difference is remarkable.

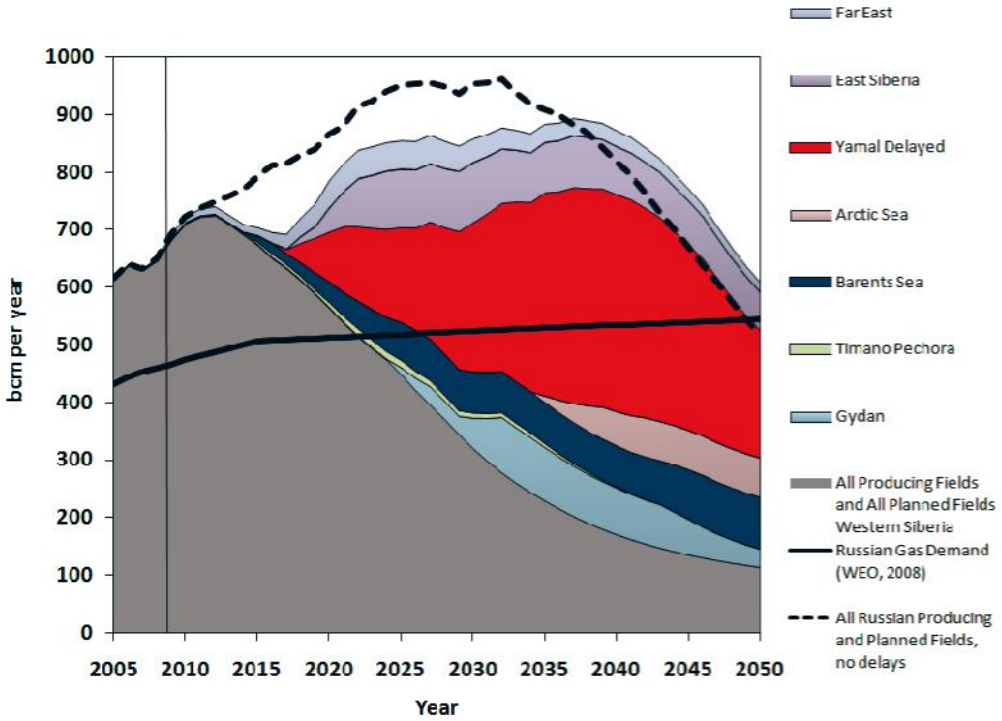
[77] Solanko & Sutela 2009, 63.
[78] See e.g. Solanko & Ollus 2008, 7.
[79] Söderbergh 2010.

Figure 15 Forecast for all producing giant fields in Russia and all planned production from giant fields



Source: Söderbergh 2010.

Figure 16 Forecast for all producing giant fields in Russia and all planned production from giant fields, Yamal production delayed by five years



Source: Söderbergh 2010.

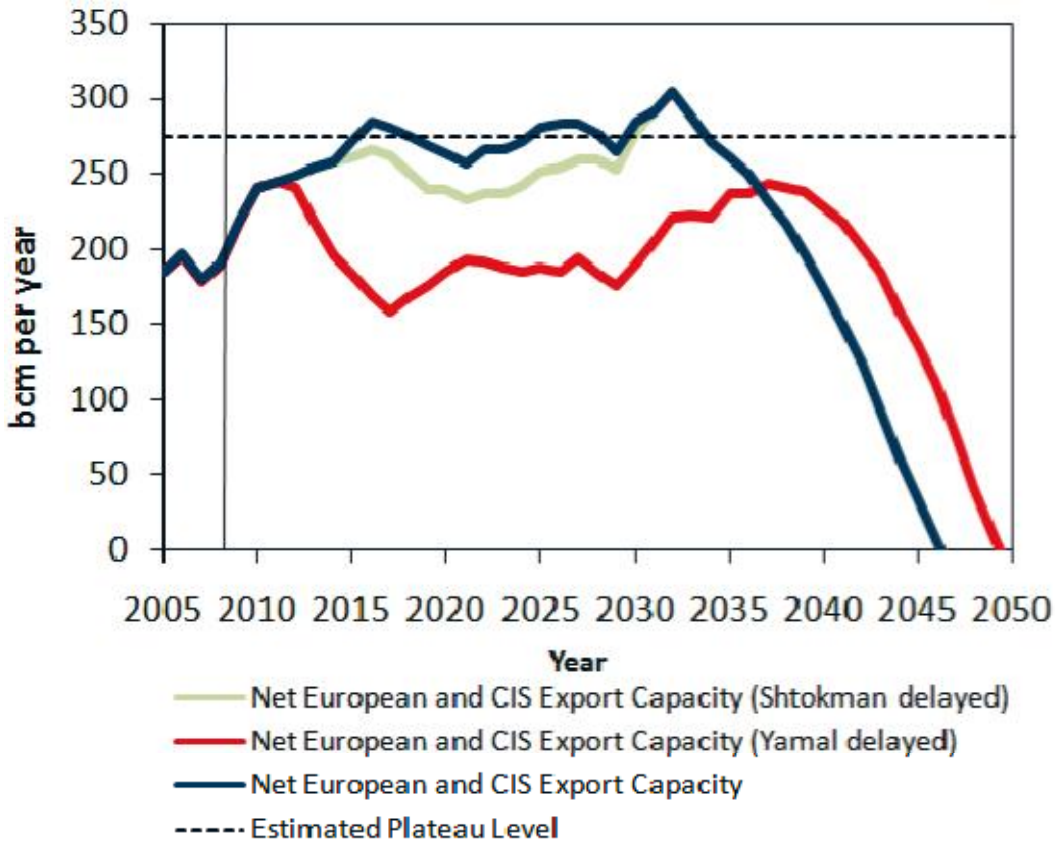
According to Söderbergh's study, the year 2013 represents a significant turning point in the Russian natural gas production. The production of the Western Siberian fields will turn into rapid decline in 2013 and large supplies from Yamal will be needed to keep the natural gas production from declining.[80] If all planned fields start up production without further delays, Russia's natural gas production will continue its growth and the country will produce around 860 billion cubic meters of natural gas in 2020 and some 950 billion cubic meters in 2030 (Figure 15). Figure 16 presents a scenario, in which production in Yamal is delayed by five years. In that case the natural gas production in Russia will turn into decline in 2013. It will start to grow again after 2018 following the start-up of the Yamal production.

As a comparison to Söderberghs calculations, the EIA in its International Energy Outlook 2009 forecasts Russian natural gas production to increase to 784 billion cubic meters by 2020 and 876 billion cubic meters by 2030. This forecast is calculated without any investment delays affecting the production growth, but the EIA also warns that the current economic crisis may lead to inadequate investments in the Russian energy sector.[81]

Regarding Russian gas export volumes in the future, according to Söderbergh Russia will be able to export around 275 billion cubic meters of natural gas to the European and CIS markets in 2030, if the Yamal fields will be developed as planned (Figure 17). On the other hand, if the start-up of the production in Yamal is delayed and Russian gas demand continues its steady growth, it will lead to lower export volumes to European and CIS markets, more or less 200 billion cubic meters, from 2013 until far to the 2030's. A delay in Shtokman, on the other hand, wouldn't have as decisive impact on exports due to its significantly lower production volumes.[82]

[80] Söderbergh 2010, 50–52.
[81] EIA 2009a, 39–40, 43.
[82] Söderbergh 2010, 50–52.

Figure 17 **Forecast for available net exports capacity for the European and CIS markets. Exports to CIS markets were 101 bcm in 2007 and Gazprom Central Asian imports were 60 bcm.**



Source: Söderbergh 2010.

According to the EIA, Russia's natural gas export capacity would reach some 220 billion cubic meters in 2020 and over 260 billion cubic meters in 2030. These numbers represent the total export volume, which would be divided between Western and Eastern markets.[83] Indeed, the EIA estimates it to be significantly less than suggested in the Russian energy strategy (349–368 billion cubic meters in 2030). If the EIA's estimates proved to be closer to truth, it would definitely complicate Europe's attempts to satisfy its gas demand in the future.

To sum up, there are several issues affecting Russia's capability to export gas in the future, many of which are also included in the country's energy strategy. First of all, by improving its energy efficiency, most importantly lowering gas consumption, Russia would be able to save large volumes of natural gas. This goal would be further reinforced by increasing the use of renewable energy sources and thus transmuting the

[83] EIA 2009a, 39–40, 43.

country's energy structure less natural gas -oriented. Second, guaranteeing the continuation of natural gas imports from Central Asia is essential for filling Russia's gas needs. However, there is a great geopolitical game going on in Central Asia and it is by no means self-evident that Russia will be able to maintain its leverage in the region. Third, the increase in the input of independent gas producers and oil companies in Russia could contribute to the country's natural gas production. However, this would require facilitating their position in Gazprom-dominated Russian natural gas markets. Most importantly, Russia's natural gas production faces a sharp decline if new major gas fields will not be brought into production as scheduled. Thus opening new major gas fields, such as in Yamal, will be fundamental in order to even meet Russia's domestic gas consumption in the future, not to mention to ensure its ability to export gas to Europe.

However, the future of Russian natural gas production doesn't rest only on the country's internal developments but various external factors can influence it as well. Both the current economic situation and the flow of gas from new sources into European energy market could place Gazprom and the entire Russian natural gas production into a difficult position. The demand for Russian gas in Europe has already plummeted because of the economic crisis and the increased use of Norwegian gas, LNG and alternative energy sources. Moreover, if the current oversupply of gas continues in the U.S., large volumes of LNG will flow into European markets, which can further reduce the demand for Russian gas in Europe, its most significant market. This could lead into a vicious cycle – Gazprom's readiness to invest in production will suffer both due to smaller revenues and pessimistic estimations of European future gas demand, which will cause a shortage of gas in the future when the demand, along with the economic recovery, rises again. Finally, if the unconventional gas production boom spreads from North America to other parts of the world and even gains ground in Europe, Russia may be challenged as the dominant natural gas supplier in Europe. It could even turn out that Russian gas will no longer be needed in Europe in a similar way and same volumes as before.

4 Future natural gas alternatives for the EU

4.1 Diversifying sources and routes

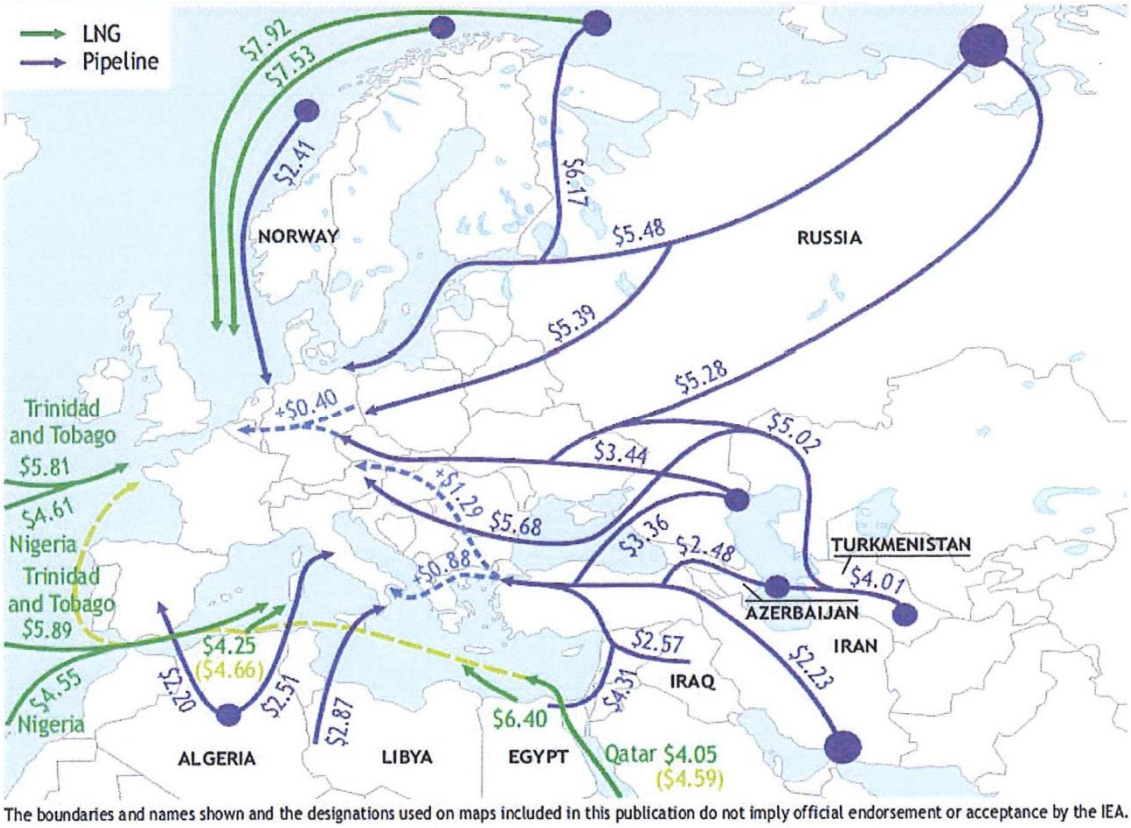
4.1.1 Bypassing Russian territory

Safeguarding the security of energy supply, especially natural gas supply, is one of the key elements of the EU's energy strategy. The constantly increasing external energy dependence is seen to involve several risks to the EU, of which the security of supply aims to reduce.[84] Diversification of energy sources, suppliers and transportation routes is mentioned as one of the key factors in improving the EU's energy security.[85] In this respect, promoting independence from Russian natural gas supplies remains the main goal. During the Russia-Ukraine gas dispute in January 2009 the EU caught a glimpse of the consequences of possible interruptions in Russian natural gas supplies. The crisis left Europe without Ukrainian gas for two weeks and in consequence people in several East European countries struggled without heating in midwinter.

This incidence challenged Russia's reliability as a supplier of natural gas as well as Ukraine's role as a transit state, and further encouraged the EU to look for alternative natural gas suppliers and routes that bypass Russian territory.[86] As an alternative for Russia, the potential new sources of gas in the future include Central Asian and Caspian countries, Middle East and North Africa (Figure 18). It is also worth of consideration that the indicative costs of gas deliveries from for example the Caspian region are much lower than from the new sources of the Russian north.

[84] See e.g. European Commission 2000.
[85] See e.g. Ferrero-Waldner 2009.
[86] Winrow 2009, 1.

Figure 18 Indicative costs for potential new sources of gas delivered to Europe in 2020, $/MBtu



Source: IEA 2009b.

In the aftermath of the gas crisis a number of actors in Europe have called for construction of new pipelines and LNG terminals in order to diversify Europe's gas imports. The European-supported southern gas transport corridor, with the Nabucco pipeline as its flagship, is designed to reduce Europe's reliance on Russian gas by opening up access to gas suppliers outside Russia and offering a route that bypasses Russian territory.[87] The aim of the Nabucco pipeline is to bring gas from the Caspian region, Middle East and Egypt to Austria and further on to the Central and Western European gas markets. The 3300 km long pipeline starts at the Georgian/Turkish border and Iranian/Turkish border, passes through Turkey, Bulgaria, Romania and Hungary, and leads to Baumgarten in Austria (Figure 19).

The maximum transport capacity of the Nabucco pipeline is designed to reach 31 billion cubic meters of natural gas per year and the estimated investment costs amount to approximately 7.9 billion Euros. The shareholders in the Nabucco project, each

[87] Götz 2009, 2–4.

holding an equal share of 16.67%, include Turkish BOTAS, Bulgarian Bulgargaz, Hungarian MOL, Austrian OMV, German RWE and Romanian Transgaz.[88] The possible natural gas suppliers of the pipeline include Azerbaijan, Turkmenistan, Iran and Iraq but the exact source of the gas is still unclear.[89]

Figure 19 The route of Nabucco

Source: Botas 2008.

The European Commission recently granted 200 million Euros to the Nabucco project, which is identified as a priority project by the EU.[90] However, the project hasn't been progressing smoothly due to both financial and political obstacles. Preparations for the project started already in 2002, and currently the pipeline is planned to start operation gradually in 2014 and reach its full capacity in 2015. Although the Nabucco pipeline would be an important step towards reducing Europe's dependence on Russian gas imports, its annual transport capacity of 31 billion cubic meters would be only a fraction of more than 500 billion cubic meters of gas imports required in the EU in 2030.

[88] Nabucco Gas Pipeline International GmbH 2009.
[89] Winrow 2009, 29.
[90] European Commission 2010; Winrow 2009, 29.

Furthermore, the disputes over the status and division of the Caspian Sea pose a problem for the construction of the Nabucco pipeline. The littoral states disagree on the maritime borders, which significantly hinders the development of the Caspian region. Without an international agreement on the division of the sea area the construction of the trans-Caspian pipeline seems very difficult.[91]

Another question mark related to Nabucco is the Russian-supported South Stream -project, which is designed to go under the Black Sea from southern Russia to Bulgaria and further on to Central and South European countries. The overall annual capacity of South Stream is planned to reach 63 billion cubic meters and its construction is scheduled to be completed in 2015.[92] There are striking similarities in the Nabucco and South Stream projects: both bypass Ukraine and are planned to use the same sources, Central Asian and Caspian natural gas.[93] However, South Stream would also bypass Turkey whereas Nabucco would go through Turkish territory.[94] Although it seems that there will be demand for both Nabucco's and South Stream's gas in Europe in the future, it is unclear if there will be enough gas available to fill both pipelines.

Whereas Europe is trying to find natural gas delivery routes that bypass Russian territory, Russia is also aiming at reducing its dependence on gas transit states, mainly Ukraine and Belarus. Nord Stream will soon allow Russia to transport gas in the Baltic Sea bed straight to Germany. The route of South Stream, on the other hand, would go through the Black Sea to the EU and deliver gas to Austria and Italy. There is indeed a risk that the building of the planned gas pipes will create dividing lines between the EU and its neighbouring areas, and even between member states inside the Union.

4.1.2 Central Asia and the Caspian region

Central Asian and Caspian countries are rich in energy reserves. In the Caspian region, Azerbaijan has both oil and gas reserves and is exporting them both to Georgia and Turkey, oil through the Baku–Tbilisi–Ceyhan pipeline and gas through its parallel South Caucasus pipeline, also known as the Baku–Tbilisi–Erzurum pipeline. The largest natural gas reserves in Azerbaijan are situated in the Shah Deniz offshore field in the Caspian Sea. The phase one of the Shah Deniz field is operated by BP and the company estimates its recoverable natural gas reserves at almost 190 billion cubic

[91] Winrow 2009, 6; YLE 2009.
[92] South Stream 2009.
[93] Putin and Berlusconi seal 'South Stream' pipeline deal. EurActive, 18 May 2009.
[94] Winrow 2009, 1.

meters.[95] Significant increase in gas production is expected after the launch of the second phase of Shah Deniz in few years, and in Europe Azerbaijan is seen as a potential gas supplier to Nabucco. However, Georgia, Iran and Russia are also showing their interest in Azeri gas, and Gazprom has already offered to buy all the gas Azerbaijan can export.[96] The Russian energy giant has recently declared that it will purchase 1 billion cubic meters of Azeri gas in 2010 and around 2 billion cubic meters in 2011.[97] This naturally hinders Europe's attempts to diversify its natural gas imports.

According to Götz (2009), Kazakhstan, Turkmenistan and Uzbekistan have a combined potential to export around 150–200 billion cubic meters of natural gas in the long run, from approximately 2020 onwards. However, currently the countries are very dependent on Russian pipeline system. Their gas will mostly be exported to Russia since there already is an existing Soviet-era pipeline system capable of delivering significant volumes of natural gas.[98] After the collapse of the Soviet Union, Russia has seen its sphere of influence to extend to Central Asia. As mentioned before, Central Asian gas supplies are also essential for Gazprom to fulfil its commitments as a gas exporter.

The EU would prefer Kazakhstan, Turkmenistan and Uzbekistan to diversify their gas deliveries. However, Since Gazprom has been offering market rates for Central Asian gas it is increasingly difficult for Europeans to compete for their gas with Russia. In addition, there might be fears among Central Asian governments that the EU could, as a concomitant of the energy trade relations, put pressure on them to improve poor human rights situation in the area and therefore the Russian option may sound more tempting to many of them.

Turkmenistan and Uzbekistan have recently signed contracts with Gazprom of significant natural gas deliveries in 2010. Gazprom has agreed to buy 30 billion cubic meters of gas from Turkmenistan and 15.5 billion cubic meters of gas from Uzbekistan.[99] However, during the recent years China has stood up to challenge Russia's influence in Central Asia. China has an immense need for energy to fuel its rapid economic growth and is extremely interested in the energy-rich Central Asian countries. It has been investing significantly in the countries and as a consequence for

[95] BP Caspian 2009.
[96] Newman 2010.
[97] Gazprom to increase gas purchases from Azerbaijan to 2 bcm in 2011. RIA Novosti, 21 January 2010.
[98] Götz 2009, 2–3.
[99] Gazprom signs deal to buy 15.5 bcm of gas from Uzbekistan in 2010. RIA Novosti, 28 December 2009.

example already controls one third of Kazakhstan's energy resources. The Russian gas transport monopoly in the area was already dismantled when Turkmenistan–China pipeline was opened in December 2009.[100] The opening of the new pipeline is very important for Turkmenistan with regard to diversifying its natural gas exports away from Russia since 70% of its gas exports used to go through Gazprom's network. Uzbekistan and Kazakhstan can also gain from the pipeline because they will be able to supply it with their gas. The pipeline can be of a significant advantage to the three countries since they are no longer dependent on the Russian natural gas transportation system and give them a trump card in bargaining with Russia.[101] It also has wider geopolitical implications. It can radically change Russia's position in the Central Asian energy markets and might undermine its capacity as a natural gas supplier in a global scale.[102]

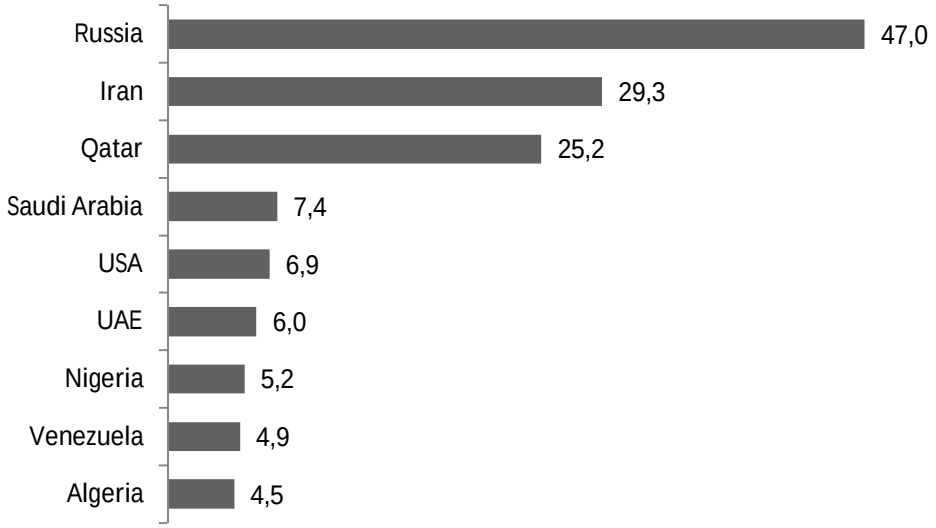
In Europe Turkmenistan has been considered to be a potential gas supplier to Nabucco. However, it's unclear if Turkmen gas resources are sufficient to supply both the Turkmenistan–China pipeline and Nabucco. Turkmen government has expressed its willingness to provide gas to Nabucco but various experts still disagree on the actual size of the country's natural gas reserves.[103] There have also been concerns about the security of the gas pipeline network in southern Caucasus, especially in consequence of the Russia–Georgia war in 2008 and the ongoing tension between the two countries.[104]

4.1.3 Middle East and North Africa

Several Middle Eastern countries hold significant natural gas reserves but the possibilities of them to export natural gas depend largely on the political developments in the area.[105] Iran has the world's second largest natural gas reserves after Russia. According to 2010 estimates of Oil & Gas Journal, it holds proven reserves of 29.3 trillion cubic meters (Figure 20).

[100] YLE 2009.
[101] de Leon 2009.
[102] YLE 2009.
[103] Ibid.
[104] Winrow 2009, 4.
[105] Götz 2009, 3.

Figure 20 World natural gas reserves by country in January 1, 2010, trillion cubic meters



Source: IEA 2010; from Oil & Gas Journal Jan. 1, 2010.

However, the majority of Iran's natural gas reserves haven't been developed yet. Both the natural gas production and consumption in Iran have grown rapidly during the last two decades. Iran consumes almost its entire production of natural gas domestically and according to EIA, even though Iran's gas production is still expected to increase in the future, its exports will stay minimal because of the constantly rising domestic demand. The most significant Iranian energy development project is underway in South Pars field in the Persian Gulf, the reserves of which reach 12.6 trillion cubic meters of natural gas, almost half of the total Iranian reserves.[106] However, the progress of the project is slow and bounded by American sanction policies. The overall situation in the Middle East, Iran's international position and its domestic developments all affect the possibilities and willingness of the country to export natural gas in the future. Due to the high level of uncertainty regarding the abovementioned issues, as well as economic factors, it is very unclear when Iranian gas exports could be of relevance to Europe. Currently there is a natural gas pipeline running from Iran to Turkey but it operates at very low capacity and cut-offs in supplies are regular.[107]

In the Middle East and North Africa, Iraq and Egypt have some potential to become natural gas providers to Europe.[108] In Egypt, the natural gas sector is expanding rapidly

[106] EIA: Country Analysis Briefs – Iran. January 2010.
[107] Götz 2009, 3.
[108] Ibid.

and Egypt has potential of becoming an important supplier of natural gas in the Mediterranean region. The Arab Gas Pipeline that currently connects Egypt, Jordan and Syria is planned to be expanded to Turkey in 2011, from where the gas could be exported to European markets.[109] Iraq's proven natural gas reserves reach 3.1 trillion cubic meters, of which two thirds are associated with oil fields. Probable reserves are estimated at 7.7–8.4 trillion cubic feet but an exploration to update these numbers is currently underway.[110] There have been discussions between Iraq and Turkey on a natural gas pipeline to transfer Iraqi gas to Turkey and further to Europe through Turkey.[111] However, in order for Iraq to become a realistic source for natural gas supplies to Europe, the situation there would have to stabilise first. Thus Iraq could be a potential supplier only in a longer term.

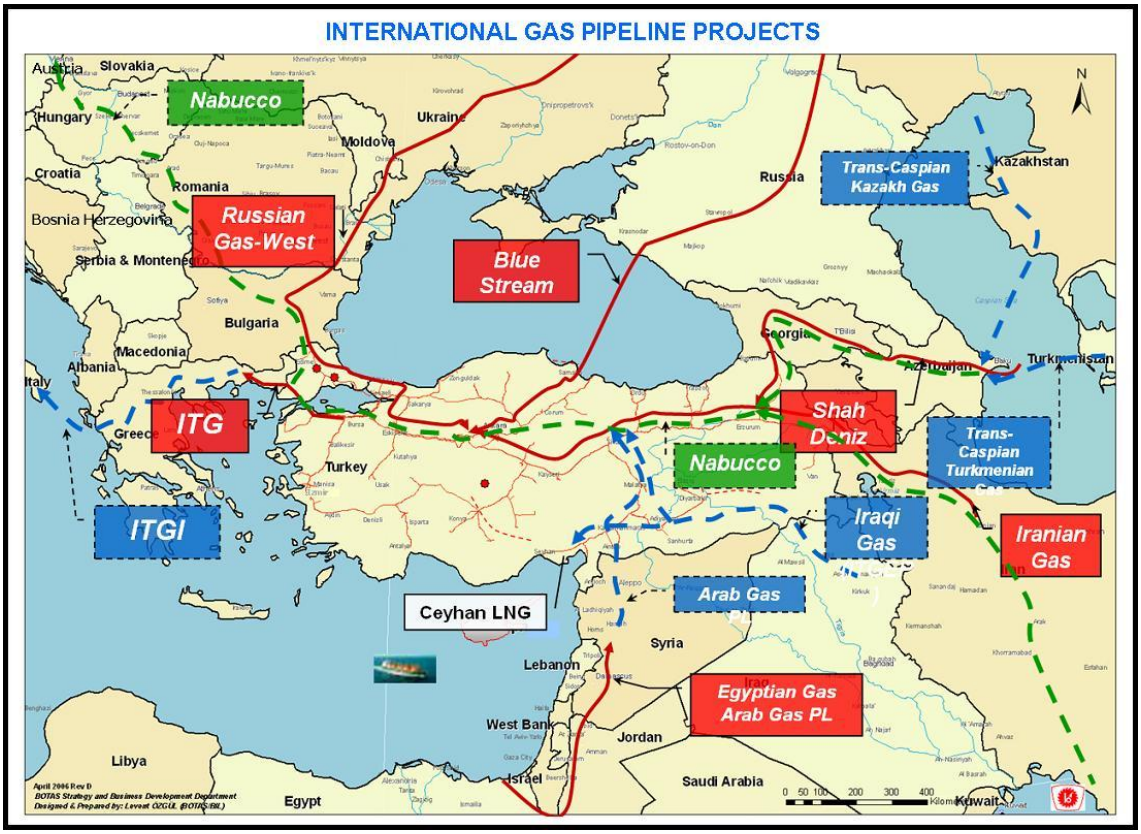
Moreover, CERA considers Algeria as a potential pipeline gas exporter to Europe, in addition to its LNG exports. Algerian gas production can provide around 60 billion cubic meters for exports annually, and a pipeline connection from Algeria to Spain allows North African gas to flow north and thus makes Algerian gas available for Europe.[112]

If the plans to build pipelines from Central Asia and Caspian region, Middle East and North Africa to Europe materialise, Turkey has a potential to become an energy transit state to Europe. Indeed, the location of Turkey is strategically important: between east and west, and neighbouring the energy-rich Caspian, Central Asian and Middle Eastern countries. Naturally the Turks have also recognised their country's potential as becoming an energy corridor to Europe and are more than willing to host both oil and gas transit pipelines. Many believe that this could also boost the country's admission to the EU. However, there are several other issues, such as the status of Cyprus, hindering Turkey's EU membership talks.

The Turkish state-owned petroleum pipeline corporation Botas is planning several gas pipeline projects that could make Turkey an important natural gas hub (Figure 21).

[109] EIA: Country Analysis Briefs – Egypt. August 2008.
[110] EIA: Country Analysis Briefs – Iraq. June 2009.
[111] Botas 2008.
[112] Stoppard 2009.

Figure 21 International gas pipeline projects of Turkish Botas



Source: Botas 2008.

Caspian and Central Asian countries and Iran presumably hold large enough gas reserves to supply gas to Europe through Turkey at reasonable costs. Thus, even though Russian natural gas deliveries can't be superseded by the Caspian and Central Asian, Middle Eastern and North African supplies, they would bring competition to the European gas market and restrain the prices Russia can charge for its gas.[113] Thereby, in addition to enhancing energy security, diversifying Europe's gas imports could bring economic benefits as well. All in all, although the EU's indigenous natural gas resources are relatively small and its domestic gas production is declining, it is geographically well situated in relation to current and potential gas suppliers. European gas market has a relatively easy access to gas-rich neighbouring regions, such as Russia and other CIS countries, North Africa and Middle East. Thus Europe could potentially diversify its natural gas supply in the future, and that way increase the security of supply. On the other hand, Europe is not alone in its interest in the energy resources of Central Asia, the Caucasus and Middle East but has many competitors, the largest and most influential being Russia and China. Moreover, the competition is

[113] Tekin & Williams 2009, 429.

as much affected by political factors than economic ones, in which Europe is not by definition the favourite. Therefore other options to diversify the European natural gas supply should be considered as well. In the future, one of the possible contributors to it is the increasing LNG deliveries.

4.2 Liquefied natural gas (LNG)

The shipment of liquefied natural gas (LNG) in a container by sea offers an alternative to pipeline deliveries of natural gas, which could relieve the EU's concerns about the security, diversity, reliability and affordability of natural gas supply. LNG could particularly contribute to the EU's efforts to secure and diversify its gas imports. LNG is more flexible than pipeline gas because it can be shipped almost anywhere by sea. Moreover, different countries dominate the LNG market than the pipeline gas market.[114]

Qatar bestrides the global LNG market with a 17% share in world LNG trade, followed by Malaysia, Indonesia and Algeria (Table 5). In contrast, the world's largest natural gas producer Russia is not yet present as a significant player in the LNG market.[115] However, the Russian Strategy until 2030 stipulates the start-up of the production and transportation of LNG and thereby to expand into the new markets of the Asia-Pacific and the US.[116] Russia's first LNG plant was opened in 2009 on Sakhalin Island. Gazprom aims to gain some ground in the global LNG market and plans to start up LNG production also in the Shtokman field.

LNG production has been growing rapidly during the past three decades and currently accounts for approximately 8% of world total natural gas production. Furthermore, the growth in LNG production is expected to continue in the future.[117] With regard to various countries capacities for LNG production, many LNG supply projects are still in the planning phase and may come into operation between 2010 and 2020 (Figure 22). However, it is also worth taking into account the varying probability of the proposed projects to materialise.[118]

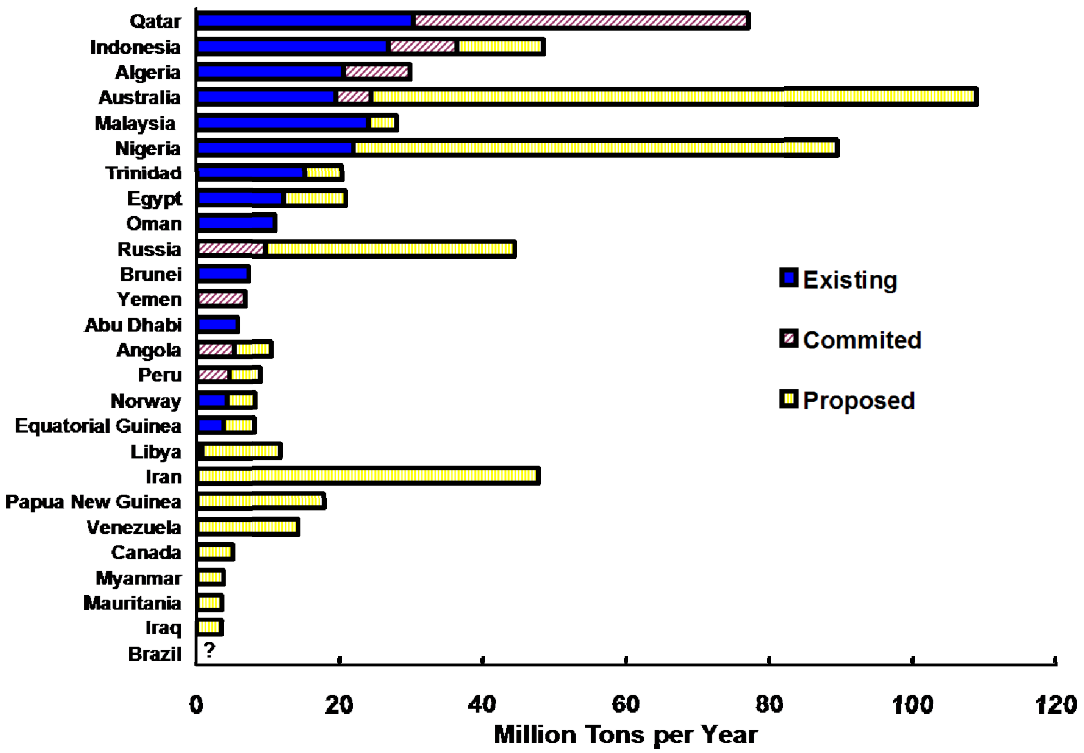
[114] Kavalov et al. 2009, 3–6; King & Spalding 2006, 3.
[115] Kavalov et al. 2009, 6.
[116] Gromov 2009.
[117] See e.g. IEA 2009a.
[118] Stoppard 2009.

Table 5 **LNG exporting countries, their shares in world LNG trade and share of export to the EU in their total export in 2007**

LNG exporters	World share, %	Share of export to the EU, %
Qatar	17.0	19.4
Malaysia	13.2	0.0
Indonesia	12.3	0.0
Algeria	10.9	65.2
Nigeria	9.3	68.1
Australia	8.9	0.0
Trinidad & Tobago	8.0	14.4
Egypt	6.0	42.0
Oman	5.4	1.0
Brunei	4.1	0.0
United Arab Emirates	3.3	0.0
Equatorial Guinea	0.6	0.0
United States	0.5	0.0
Libya	0.3	100.0
Norway	0.1	100.0

Source: Kavalov et al. 2009.

Figure 22 **LNG Capacity by Status and Country (March 2009)**



Source: Stoppard 2009.

According to Kavalov et al. (2009), global LNG exports will reach 393 billion cubic meters by 2015 and 758 billion cubic meters in 2030. Already in 2015 LNG is estimated to account for 14–16% of the worldwide gas demand. Expanding LNG trade will also

contribute to the trade of natural gas between world regions. The relative share of the interregional trade in total world natural gas trade is forecasted to grow from 13% in 2005 to 22% in 2030. LNG trade is the main driver of that growth, accounting for nearly 85% in it. However, currently only around 10% of LNG is traded in the more flexible spot market and the majority of the LNG trade is still under long-term contracts, although the share of the spot trade is forecasted to grow to 20–25% by 2020.[119] Thus, currently LNG trade is not quite as flexible as one would think.

The global LNG production and exports are concentrated within a few countries, of which the majority are members of the Gas Exporting Countries Forum (GECF). While the GECF's share in the global pipeline gas trade is only some 38% (in 2007), it controls an impressive position in the global LNG market with an 85% share in world LNG production and exports. Indeed, also most of the LNG exports to Europe come from GECF members. The GECF is a relatively young organisation, created in 2001, and is still searching its role in the global natural gas market. Considering its weight in the worldwide LNG trade, it could become an important player in the global LNG market. It is possible that GECF could develop into a cartel-like organisation. In such scenario the organisation could turn either to harder or softer measures in promoting its members interests.[120] However, GECF hasn't yet turned into a gas equivalent of OPEC although there have already been proposals in the forum of applying OPEC-style production cuts to ease off the current global oversupply of gas and stabilise weak spot prices.[121]

Along with the increasing gas demand, the LNG trade in Europe is expected to expand as well. The overall LNG trade volumes in Europe are predicted to reach 99 billion cubic meters by 2010, 220 billion cubic meters by 2020 and 254 billion cubic meters by 2030. Currently the European share in worldwide LNG trade is approximately 25–27% and in 2030 it is expected to account for about 35%.[122] The main consumers of LNG in the EU are Spain and France – the former's share in total LNG imports to the EU is more than half and the latter's share over a quarter.[123] So far, the ability to deliver LNG to European markets has been constrained by a lack of regasification terminals. Currently there are operational LNG import terminals in Belgium, France, Greece, Italy, Portugal, Spain, Turkey and the UK, and the construction of several others have been

[119] Kavalov et al. 2009, 6–7, 12.
[120] Kavalov et al 2009, 8–10.
[121] Gas cuts off GECF agenda. Upstream, 18 April 2010.
[122] Kavalov et al. 2009, 6–7.
[123] Kavalov at al. 2009, 6.

proposed in addition to aforementioned countries in e.g. Germany, the Netherlands and Poland.[124]

Growing global LNG production can affect natural gas markets and globalise them. However, the pipeline deliveries won't become insignificant overnight, if ever.[125] Indeed, the future of LNG will largely depend on the competition with pipeline gas. One of the important issues concerning LNG is its affordability. LNG projects are very expensive and thus affordable for only a few. According to Kavalov et al., the proven reserves of natural gas need to be sufficient for 30 years of production in order to justify an investment in a liquefaction plant. Few gas fields actually fulfil these criteria and thus additional pipelines to deliver gas to a liquefaction plant would often be needed. Naturally the construction of pipeline infrastructure would also add to the costs. On the other hand, the establishment of the regasification capacity is rather inexpensive and easy. Finally, the shipping costs appear to fluctuate the most in the overall cost structure of LNG chain. In general, LNG becomes economically feasible in contrast to 3000 to 4000 kilometres of land pipe or 2000 kilometres of offshore pipe. However, logistics and political factors can affect the distance as well.[126]

All in all, LNG is a relatively expensive energy option and as such can remain mainly as an energy choice for developed countries. Energy-hungry, rapidly developing economies like China and India that are in quest for cheap energy might not benefit from LNG that much.[127] Therefore pipelines are likely to retain their economic and geopolitical significance, at least partially.[128] With regard to the security and diversity of the EU's gas supply, LNG could perhaps best contribute to it if it is used modestly. When Russia is aiming to enter the LNG market and GECF could turn into a cartel, there is a risk that the EU could find itself again dependent on very few suppliers of gas, this time only LNG.[129] Furthermore, the increasing LNG trade would involve environmental risks as well. The construction of new LNG terminals would bring along heavier maritime traffic and thus increase the risk of collision between tankers, which would have serious environmental consequences. The threat of an oil accident is

[124] GIE 2009; King & Spalding 2006, 3, 32.
[125] Götz 2007, 7; EIU 2009.
[126] Kavalov et al. 2009, 10–11.
[127] Kavalov et al. 2009, 10–11.
[128] Pipeline politics? Russia and the EU's battle for energy. EurActiv, 20 August 2009.
[129] Kavalov et al. 2009, 10.

already evident for example in the Gulf of Finland and increasing LNG shipments would further amplify it.[130]

Naturally, a lot depends on how much natural gas there is available in the future. If unconventional gas exploitation becomes more common and spreads outside North America, the amount of natural gas in the global markets may well increase. The shale gas revolution spreading in North America has already cut down natural gas prices and a flood of gas into the global market could make LNG more affordable in the future.

4.3 Shale gas

4.3.1 The beginnings of a shale gas revolution in the United States

Shale gas – natural gas from rock formations in ancient sea bed – has become an important resource for energy industry. Earlier its extracting was considered too difficult and expensive but recent technological advances have made the exploitation of shale gas easier and more cost-effective. The shale gas revolution has already been spreading in the United States and Canada, and profoundly transforming the North American natural gas market. Now some are expecting shale gas boom to hit Europe as well.

The exploitation of the so called unconventional natural gas sources – gas shales, coal bed methane and tight gas sands – began in North America some decades ago but has only recently experienced a rapid growth as a result of shale gas production. Earlier tight gas sands were the main source of unconventional gas production but during the recent years there has been a bulge in shale gas production, from quite insignificant 1% in 2000 to approximately 20% of the total U.S. natural gas supply today.[131] The existence of natural gas trapped in shale formations was nothing new but until recently oil and gas companies considered gas production from shales as uneconomical. The break-through in technology – hydraulic fracturing and horizontal drilling[132] – opened up abundant resources of unconventional gas and made shale gas exploitation highly productive. Currently shale gas development in the U.S. is even

[130] Liuhto 2009, 115.
[131] Figures according to IHS CERA 2010.
[132] In hydraulic fracturing a mixture of water, sand and chemicals is injected underground at high pressure to open gas-bearing fissures in shale and release the gas trapped in them. Horizontal drilling, in which wells are drilled sideways, enables much wider coverage of shale formations with less surface disturbance.

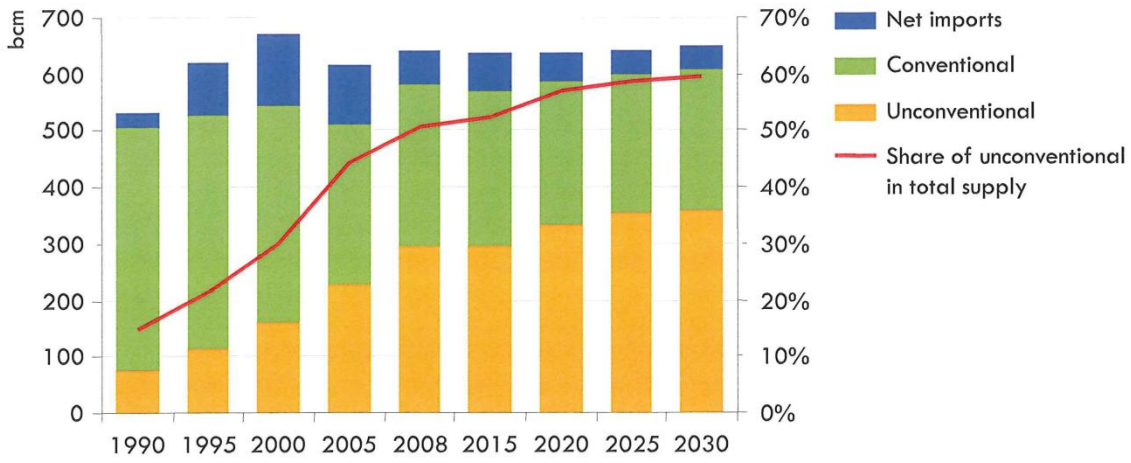
lower cost than most conventional natural gas sources.[133] In the U.S. the major oil companies didn't originally believe in the viability of the shale gas production. Instead, small drilling firms were the pioneers in exploiting natural gas trapped in shale formations. Now large oil companies, such as Exxon Mobil, BP, Statoil and Total are joining the battle for new gas resources by purchasing smaller firms and signing joint ventures.[134]

U.S. Energy Information Administration (EIA) projects the total U.S. natural gas production to grow by more than 0.14 trillion cubic meters per year from 2006 to 2030, unconventional gas production being the main contributor to that growth. Currently the share of natural gas in the United States' total primary energy demand is approximately 25%.[135] Its role in the U.S. overall energy mix can be even more important in the future because it can help in reducing greenhouse gas emission since it produces about half of the carbon dioxide emissions of coal. In addition, since shale gas development currently is often lower cost than conventional gas development, it may be able to meet substantially higher gas demand without significantly hiking up prices and thus prove to be especially beneficial for Americans.

According to the IEA, the share of unconventional gas in the total U.S. gas output jumped from 44% in 2005 to around 50% in 2008 and is projected to rise to almost 60% in 2030 (Figure 23). The IEA's estimate doesn't specify the share of shale gas in the total unconventional supply. However, the gas shale resources in North America are huge and the production from shale formations is expected to be the fastest-growing source of unconventional natural gas production. For example, Kuuskraa & Stevens (2009) project shale gas to account for one third of North American natural gas production by 2020.[136]

[133] IHS CERA 2010.
[134] An unconventional glut. The Economist, 11 March 2010.
[135] EIA 2009a.
[136] Kuuskraa & Stevens 2009, 2.

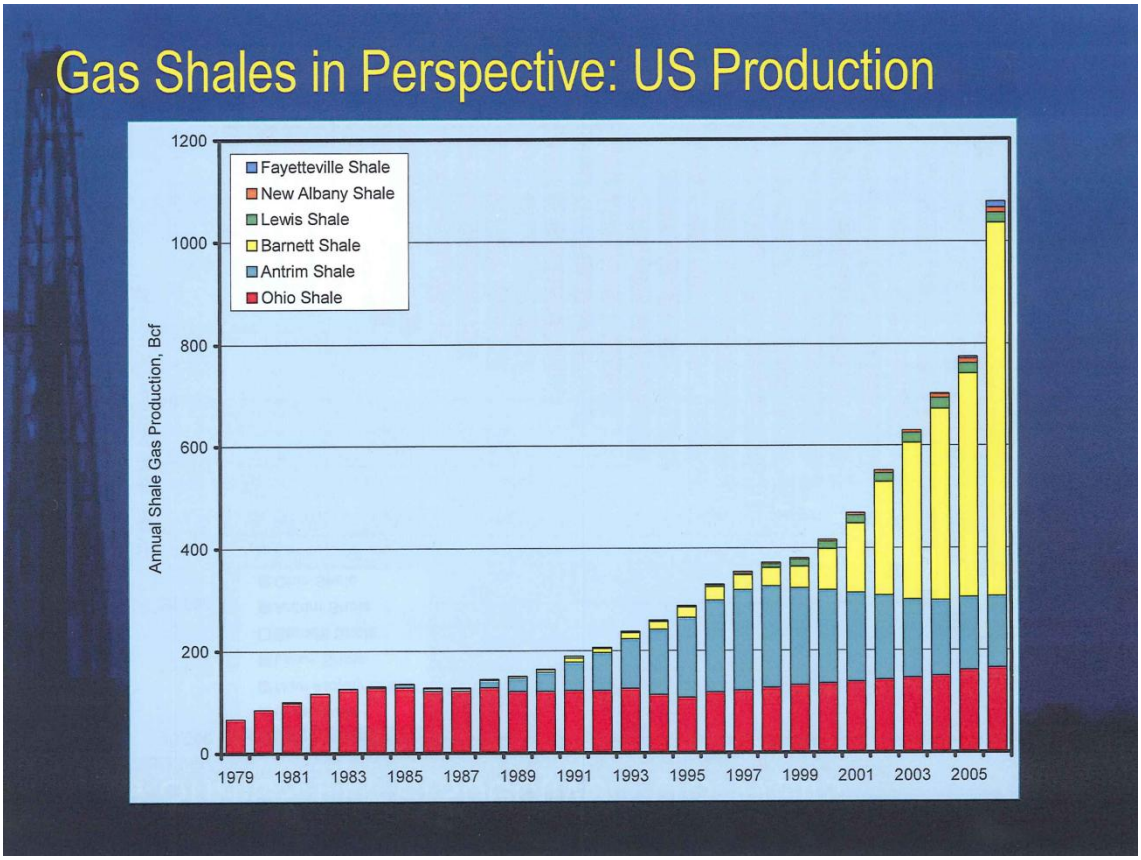
Figure 23 US natural gas supply



Source: IEA 2009b.

Indeed, shale gas production in the U.S. has been growing exponentially during the 21st century. Figure 24 illustrates the rapid development in the U.S. annual shale gas production, especially since the start up of production in Barnett shale, until 2006.

Figure 24 Shale gas production in the United States in 1979–2006, billion cubic feet



Source: Hopkins 2009.

According to the EIA's data, in 2007 the production reached 33.2 billion cubic meters and in 2008 56.6 billion cubic meters.[137] The official figures even have difficulties in keeping up with the rapidly expanding production.

The estimates of the U.S. shale gas reserves are surrounded by a high degree of uncertainty. Due to the rapid developments in knowledge and technology figures can become outdated quite fast and therefore require frequent updating. The Federal Energy Regulatory Commission (FERC) estimates the total recoverable U.S. shale gas reserves[138] to reach 20.8 trillion cubic meters.[139] On the other hand, Kuuskraa & Stevens assess the resources[140] of the five largest U.S. gas shale plays alone (Barnett, Fayetteville, Haynesville, Marcellus and Woodford) as 107 trillion cubic meters, of which 13 trillion cubic meters recoverable. All these five major shale gas plays are located in the Eastern U.S. and there are significant, yet mostly undeveloped, shale gas resources in the Western part of the country as well. In addition, Canada also holds important shale gas resources.[141]

According to a recent assessment of the Potential Gas Committee, the United States' total natural gas resource base reaches 51.4 trillion cubic meters, of which shale gas accounts for 33%, 17.1 trillion cubic meters. When these results are combined with the U.S. Department of Energy's figures of proved natural gas reserves, the United States' total available future supply would reach 58.1 trillion cubic meters, allowing the U.S. to continue its natural gas production at current production level for 90 years.[142] This reflects well the changes in the knowledge of the abundance of natural gas reserves during the recent years – not long ago the U.S. natural gas reserves were thought to suffice only for a decade.[143] Thus, regardless of the varying assessments, unconventional gas, especially shale gas, has significantly increased the natural gas resource potential of the U.S. and profoundly changed the North American natural gas market as well.

[137] EIA 2009b.
[138] Reserves are those estimated quantities of the endowment anticipated to be commercially recoverable from known accumulations from a given date forward. Reserves must satisfy four criteria: they must be *discovered*, *recoverable*, *commercial*, and *remaining* based on the development technologies currently applied. NPC 2007, 95.
[139] Federal Energy Regulatory Commission (FERC) 2008.
[140] Resources are those quantities of the endowment estimated, as of a given date, to be potentially recoverable from known or undiscovered accumulations. Resources are not considered commercial at the time of estimation. NPC 2007, 95.
[141] Kuuskraa & Stevens 2009.
[142] Colorado School of Mines 2009.; Cragg 2009.
[143] Cragg 2009.

4.3.2 Europe – in the United States' footsteps?

It's not a surprise that the idea of new-found indigenous natural gas reserves sound particularly appealing to Europeans who simultaneously struggle with their shrinking domestic gas production and aim to decrease their dependence on imported energy. However, the unconventional gas exploration in Europe is in embryonic stage and both the size and the exploitability of the European unconventional gas resources remain highly uncertain.

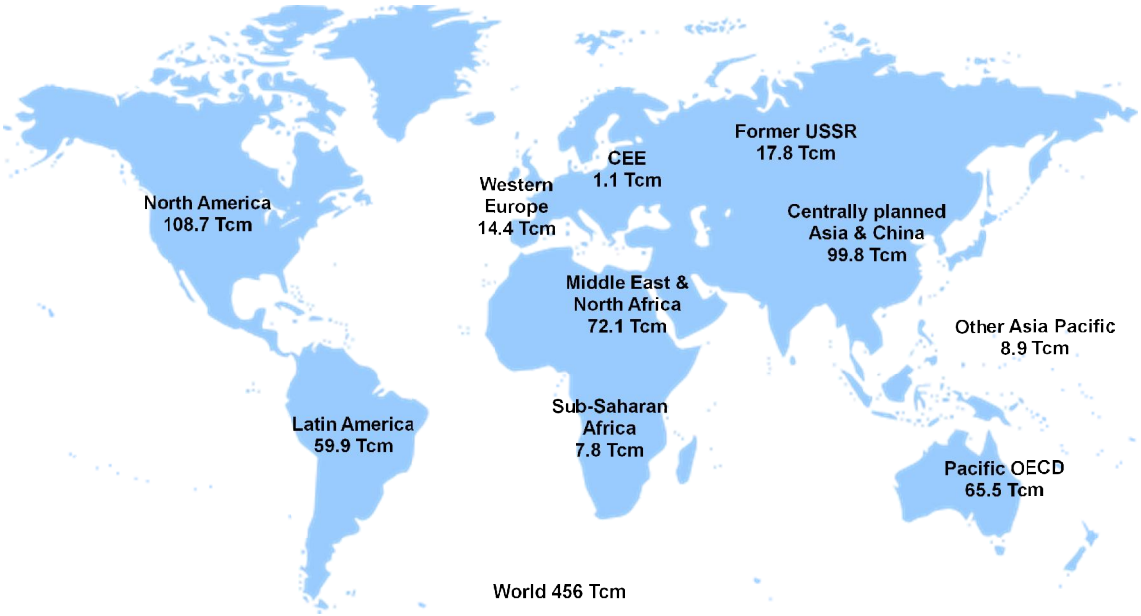
H.-H. Rogner's study in 1997 presented the first current estimates of the worldwide shale gas resources, which he assessed at 456 trillion cubic meters.[144] Figure 25 presents the regional division of world shale gas resources estimated by Rogner (1997) and Kawata & Fujita (2001)[145], who summarised Rogner's work. The IEA's World Energy outlook 2009, cited by Kuuskraa & Stevens, estimated that approximately 40% of Rogner's assessment of the worldwide shale gas resources could be recoverable.[146] On a global scale this would mean 182 trillion cubic meters of natural gas. However, their assessments precede the major advances in shale gas exploitation techniques made during the 21st century and may prove too conservative in the light of current developments.

In the early estimates presented in Figure 25 the European shale gas resources are assessed at 15.5 trillion cubic meters. With regard to more recent assessments, in 2007 National Petroleum Council (NPC) estimated unconventional gas to multiply European natural gas resources nearly by six, assessing the European (excluding Russia) unconventional gas resources at 34.7 trillion cubic meters.[147] The International Energy Agency's (IEA) recent estimate is more optimistic. According to IEA, Europe's unconventional gas reserves could reach 35 trillion cubic meters, of which almost half in shale. Although amounting far less than in North America, the IEA estimates that these reserves would be enough to substitute natural gas imports for 40 years at current levels.[148] On the other hand, CERA presents a slightly more moderate

[144] Rogner, H.-H. (1997): An assessment of world hydrocarbon resources.
[145] Kawata, Y. & Fujita, K. (2001): Some Predictions of Possible Unconventional Hydrocarbon Availability Until 2100.
[146] Kuuskraa & Stevens 2009.
[147] Cragg 2009.
[148] The hunt for shale gas in Europe: Bubbling under. The Economist, 3 December 2009.

assessment, estimating European shale gas recoverable resources to be between 3 and 12 trillion cubic meters.[149]

Figure 25 World shale gas resources by region, trillion cubic meters

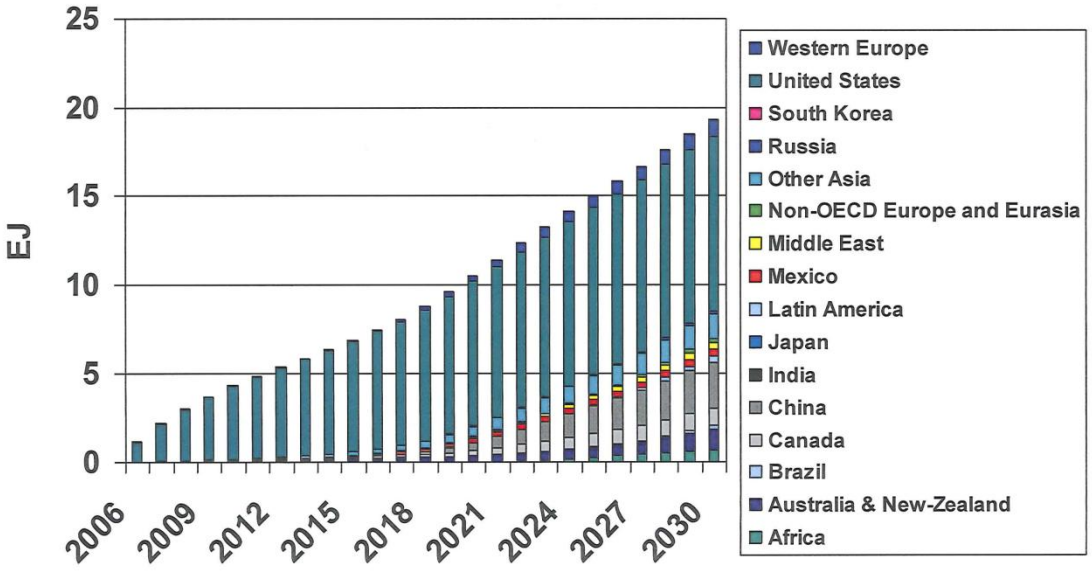


Source: Rogner 1997, Kawata & Fujita 2001 and author's calculations.

Shale gas could indeed multiply the European natural gas reserves, which according to BP reached 2.87 trillion cubic meters in the end of 2008 (the EU's proved natural gas reserves).[150] However, whatever the size and recoverability of European shale gas reserves, it will certainly take a long time before any significant shale gas production can take place in Europe. It is expected to take at least a decade before shale gas can have a significant effect on European natural gas supply (Figure 26). Before 2020 only minimal production volumes are predicted.[151]

[149] Stoppard 2009. Includes Ukraine.
[150] BP 2009, 22.
[151] Cala 2009.

Figure 26 Tight/shale gas production by region – reference scenario



Source: Pepper 2009

CERA predicts that the unconventional gas may decelerate the decrease in the EU's domestic natural gas production but cannot totally reverse it. It estimates that unconventional gas could potentially add 50 billion cubic meters to the EU's indigenous gas production by 2030.[152] According to the Eurogas's estimates presented earlier, the EU's natural gas demand in 2030 will reach 694 billion cubic meters of which imports outside Europe will account for 74%, in other words 514 billion cubic meters of natural gas. In this respect, an additional 50 billion cubic meters of indigenously produced natural gas sounds rather small and insignificant.

There are various views on the significance of shale gas for the European future energy production, mainly because of the high degree of uncertainty related to European shale gas resources. Some experts see great potential in them whereas others regard the early estimates as highly exaggerated.[153] For now it seems that shale gas can indeed diversify the European natural gas supply and thus increase energy security but it is not a panacea that would dispose all the problems related to the European energy demand.[154] Thorough and detailed, up-to-date assessments of gas

[152] Stoppard 2009. Includes Ukraine.
[153] See e.g. Cala 2009; Madslien 2009; Williams 2009.
[154] Shale gas "is no silver bullet". Upstream, 8 April 2010.

shales, and unconventional gas in general, would assist in building confidence in the existence of new-found natural gas supplies.[155]

There are also several factors that can slow down or complicate the shale gas production in Europe. To begin with, there are considerable geological differences with North America, and European shale formations aren't expected to have as much gas trapped in them.[156] In the U.S. it took several years and required a lot of resources to overcome technological problems related to gas production from shales. It might not be possible to transfer the technology developed in the U.S. to Europe as such but instead it needs to be adjusted to European environment.[157] Indeed, the exploration and development of European shales are estimated to be much more expensive than in the U.S.[158] The production of shale gas also requires large infrastructure and building it up takes time.[159]

Furthermore, it is possible that the production of unconventional gas becomes more expensive in the future.[160] The high decline rates of the shale gas wells currently in production have attracted attention, calling into question the economics of shale gas production. It would require continuous drilling and bringing new wells into production to prevent decline in output.[161] The long-term exploitation of unconventional gas resources requires constant scientific development and advances in knowledge and technology. Only a small part of the unconventional resource base fall into high quality/low cost -category. According to the Advanced Resources International, of the total undeveloped gas shales in the U.S. over a half are of lower quality. Therefore new inventions are required for converting the resources that are lower quality and higher cost into affordable natural gas supplies.[162] On the other hand, whereas just a few years ago the entire gas production from shales was considered uneconomical, currently shale gas production in the U.S. is very cost-effective, even cheaper than gas production from some conventional sources. Therefore the economics of shale gas production relies greatly on future technological advances.

In addition, drilling is a large operation which can cause problems in densely populated Europe where wide open space is hard to find. In this respect the situation is much

[155] Kuuskraa & Stevens 2009.
[156] Cala 2009.
[157] Fortson 2009.
[158] Williams 2009.
[159] Fortson 2009.
[160] Gronholt-Pedersen 2010.
[161] Berman 2009; Forbes 2009.
[162] Kuuskraa 2009, 25.

different than in the U.S. Conflicts with land owners are also likely to occur.[163] Finally, one of the biggest question marks is the environmental impact of shale gas drilling. In the U.S. some environmental groups and scientists claim that hydraulic fracturing can have a negative impact on environment, especially drinking water supplies and the Environmental Protection Agency has started researching the potential impact of hydraulic fracturing on human health and the environment.[164] Also the massive water consumption in the hydraulic fracturing may well become an issue.[165] The environmental impact of shale gas drilling will likely be brought on the agenda in Europe as well.

Despite all the uncertainties concerning the potential of Europe's shale gas reserves, several oil and gas companies are already exploring on European soil. Countries, where exploration projects are taking place, include at least Austria, France, Germany, Hungary, Poland, Sweden and the U.K., and the results are still pending.[166] Ukraine and Bulgaria can also host shale gas reserves.[167] However, for example the Alum Shale of Sweden, the Silurian Shales of Poland and the Mikulov Shale of Austria are already considered to have high shale gas potential – according to some estimates the recoverable shale gas resources of the three basins combined range up to 4 trillion cubic meters.[168] In Poland the exploration has perhaps proceeded furthest – the energy companies are not too keen on publishing information on the exploration – and Polish natural gas from shales is predicted to be on market already in 2011. Naturally, in Poland the enthusiasm for shale gas has risen remarkably.[169] On the research front, the 6-year Gas Shales in Europe (GASH) project was launched in 2009 by the German Research Centre for Geosciences. According to the project's web page[170], the aim of the oil industry-funded project is to predict shale gas formation and occurrence in time and space, focusing on the potential gas shales of Europe.

4.3.3 A global game-changer?

If the shale gas revolution spreads, it can significantly transform the global geopolitics of energy. New indigenous gas reserves around the globe can substantially reduce the

[163] Williams 2009.
[164] EPA Begins Study on Shale Gas Drilling. The New York Times, 18 March 2010.
[165] EPA to Study 'Fracking' Gas Drilling Method. The New York Times, 18 March 2010.
[166] Williams 2009.
[167] Shale gas "is no silver bullet". Upstream, 8 April 2010.
[168] Kuuskraa & Stevens 2009, 4.
[169] Ulkolinja: Kaasua, kaasua! YLE TV1 2010.
[170] Http://www.gas-shales.org.

dominance of traditional oil and conventional gas exporting countries.[171] If shale gas exploitation proves to be productive in Europe, it can potentially decrease Europe's dependence on Russian energy.

The surge in American natural gas production from the unconventional sources and the weakened demand of gas caused by the economic slowdown have already led to some oversupply of natural gas, especially in the U.S. The gas storage in the U.S. is near its peak, which has driven prices down and forced companies to temporarily cut back drilling. Before the new technological advances in the shale gas production, there was a common worry in the U.S. about a gas shortage in the future because indigenous natural gas reserves were thought to be draining and gas prices were rocketing. Therefore energy companies were investing billions of dollars in LNG facilities in the U.S. Now, after the shale gas boom hit the continent, LNG import terminals run at very low capacity and there has even been discussion about turning them into export terminals instead.[172]

The gas exporting countries were also preparing for the increasing LNG demand in the U.S., making huge investments in the LNG production and export capacity because the U.S. was believed to need substantial amount of LNG imports in the coming years.[173] However, the sudden boom in American shale gas production has nearly dashed their plans to supply LNG to the U.S., at least profitably. Even though there might be a buyer for LNG in the U.S., its price is certainly not what the exporters expected before, and they are certainly tempted to turn to other markets instead.[174]

In the future, the global market might indeed be glutted with natural gas, if the unconventional gas production continues to balloon. When the U.S. becomes increasingly self-sufficient with regard to natural gas, there will be more LNG available for the global markets. Thus the gas glut in the U.S. can potentially increase LNG affordability and availability by freeing LNG shipments to other destinations, possibly to Europe, and decreasing natural gas prices even on a global scale.

The increase in the available natural gas supply to the global market can reduce the risks of a major global disruption because it can compensate possible production

[171] An unconventional glut. The Economist, 11 March 2010.
[172] Brower 2009; Krauss 2009; Silha 2008.
[173] An unconventional glut. The Economist, 11 March 2010.
[174] Gazprom Finally Accepts that Shale Gas Has Changed the World. Oilprice.com, 3 March 2010; An unconventional glut. The Economist, 11 March 2010.

shortfalls in some countries.[175] The IEA predicts that the global unconventional gas output will rise 71% between 2007 and 2030 which could lead to an acute glut of gas in the world in next few years.[176] On the flipside the IEA warns that plummeting natural gas prices and weakening demand together with the current economic situation could jeopardise future investments. This could lead to the re-tightening of the natural gas market after a few years, when the demand for natural gas supplies recovers.[177] The oversupply of gas is likely to continue in 2010 and 2011 but may ease off in 2012 and after, when the demand is expected to return and prices to rise as a consequence of increasing use of natural gas in power generation.[178]

The increasing flow of natural gas into the spot market has increased competition.[179] It has already depressed spot gas prices globally, and currently natural gas is very cheap compared to crude oil.[180] This puts Russian gas trade in a difficult position since in this light it is increasingly difficult to explain to European buyers why they should enter into long-term contracts with Gazprom, where the gas price is indexed to currently pricier oil, when they can purchase cheap LNG on spot markets.[181] For example in January 2010 the spot market price for gas was 30% lower than the gas price under long-term contracts. This has forced Gazprom to rethink its gas pricing system to defend its market share in Europe. The company has already made some adaptations to its long-term contracts with European companies, agreeing to supply some of Europe's gas at spot market prices.[182] However, although Russian Natural Resources Minister Yuri Trutnev recently admitted that shale gas can cause changes in the gas market, Gazprom still remains optimistic about increasing its gas output in the coming years, despite the competition it faces from shale gas.[183] The company hasn't yet decided to invest in shale gas development although Russia is considered to host significant shale gas reserves. Instead, Gazprom is concentrating on the development of its LNG production and intents to gain market share there, remaining confident about the competitiveness of LNG.[184]

[175] Medlock 2009.
[176] Gazprom says LNG can compete with shale. Upstream, 3 March 2010.
[177] IEA 2009a.
[178] A gas future beyond US. Upstream, 11 March 2010.
[179] Gazprom sees increase in gas demand. Upstream, 10 November 2009.
[180] Gazprom Finally Accepts that Shale Gas Has Changed the World. Oilprice.com, 3 March 2010.
[181] Gazprom Finally Accepts that Shale Gas Has Changed the World. Oilprice.com, 3 March 2010.
[182] Dempsey 2010.
[183] Trutnev says shale is "a problem". Upstream, 19 April 2010; Gazprom shrugs off shale gas "threat". Upstream, 14 April 2010.
[184] Gazprom says LNG can compete with shale. Upstream, 3 March 2010.

Shale gas has already brought uncertainties to the previously quite safe gas market. Energy companies' prospects to sell LNG look unclear after the bulge in the U.S. shale gas production and it has already made them to consider the profitability of new investments in LNG production.[185] In Russia, all gas trade has been based on long-term contracts and oil-indexed pricing for 30 years. Long-term contracts with take-or-pay-principle used to guarantee a steady flow of revenue for Gazprom. However, the weakened gas demand has already reflected on Gazprom's readiness to invest in production. In February 2010 the company decided to postpone pipeline gas production from Shtokman field by three years to 2016. The delay in the Shtokman project might have implications also on Nord Stream, the building of which has just started in April 2010. The scheduled doubling of the pipeline's capacity is open to doubt because it was supposed to receive gas from Shtokman. However, Russian Prime Minister Putin assured in April 2010 that the development of the Shtokman field will nevertheless start in 2011.[186] Still, the Shtokman project is extremely difficult to execute due to its Arctic location and the complexity of the field – and thus also very expensive. Because of the high production costs the Shtokman gas will hardly be price competitive in comparison with many other sources.

If the shale gas revolution spreads throughout the world it can indeed have wide geopolitical implications. It can completely transform the strategic energy relations between countries. The new-found energy resources in different parts of the world can loosen the dependencies between the regions and countries that are currently producing energy and the ones purchasing it. The natural gas market has potential to become increasingly global, with gas flowing from various regions, and countries could become less dependent on traditional pipeline deliveries and one single supplier. It could significantly alter the position of Russia where the aim to re-establish country's role as a global superpower rests on its energy resources and the energy relations are seen as an important means to exert influence on other countries. So far it seems that in Europe shale gas is found especially in the East which is more dependent on Russia. Thus it could significantly diminish the Russian influence and transform the strategic relations in the area.

The future gas demand around the globe is hard to predict. However, the abundant new natural gas resources could create a change in countries energy structure by increasing the share of natural gas in their energy mix. To gasify power generation by

[185] Shale creates uncertainty. Upstream, 16 March 2010.
[186] Putin on Shtokman's Start. The Moscow Times, 19 April 2010.

replacing coal-fired power plants by gas-fired ones could be both economically and environmentally viable option. Gasification of transport may be more remote but still worthwhile considering.[187] The shale gas revolution could thus create favourable conditions for replacing other fossil fuels by natural gas which would contribute to the global aim of decreasing greenhouse gas emissions. This, if any, renders natural gas a viable option in the battle against global warming. However, there is also a risk that new-found abundant natural gas resources could slow down the transition to renewable energies. As an energy source gas is still more a means to an end, than an end itself.

Moreover, potential damages caused by shale gas drilling can call into question pro-environmental aspects of natural gas use. In the United States the contamination of drinking water has raised concerns. New York City has already banned gas drilling in its watershed because a city-commissioned study in 2009 revealed that drilling poses risks to the city's water supply. In several places in the U.S. methane and chemicals injurious to health have been found in drinking water wells near natural gas drilling operations and local residents blame gas companies for endangering their health.[188] Naturally, energy companies usually deny these allegations.[189] However, the fact that energy companies keep as a secret the actual content of the chemical mixture they inject into the ground in hydraulic fracturing looks suspicious to public eyes. In the U.S. energy companies are not required to disclose the chemicals they use in hydraulic fracturing because it is not regulated under the federal Safe Drinking Water Act. This exemption from law was granted to the oil and gas industry in 2005. Now some politicians are acting to close this so-called Halliburton Loophole in the Safe Drinking Water Act.[190] Gazprom's Deputy Chief Executive Alexander Medvedev has also addressed the problem of environmental risks caused by shale gas drilling.[191] However, the motives of the company in criticising its competitors' drilling methods can naturally be questioned.

Nonetheless, it is likely that the environmental impacts of hydraulic fracturing will raise concerns in Europe as well. It is hard to imagine that energy companies would be allowed to conceal the content of chemical mixture they inject underground. In densely populated Europe the impacts of drilling would also be more in view than in the wide

[187] An unconventional glut. The Economist, 11 March 2010.
[188] See e.g. Hurdle 2009; Lustgarten 2009.
[189] See e.g. Industrial Minerals Association North America 2009. Http://www.ima-na.org/Hydraulic-Fracturing-Exclusion-from-the-Safe-Drinking-Water-Act.
[190] See e.g. Earthworks 2009: Press releases: Senators, Representatives act to close Halliburton Loophole in the Safe Drinking Water Act. Http://www.earthworksaction.org/PR_2009HalliburtonLeg.cfm.
[191] Gazprom knocks US shales. Upstream, 9 February 2010.

emptiness of North America. It seems clear that shale gas drilling should be made increasingly transparent in order to dispel suspicions related to the process and the drilling to gain currency. In the end, a thorough examination on the environmental impacts of shale gas drilling will be needed.

5 Concluding remarks

During the recent years, there has been a general shift in the European Union's energy structure from solid fuels towards natural gas and renewable energy sources, which reflects the growing importance of the climate policy in the EU. Therefore, despite the overall global trend emphasising energy efficiency and saving, the EU's natural gas demand has been growing and a similar trend is expected to continue in the future. In 2030, natural gas is expected to account for 30% of the EU's primary energy consumption, reaching nearly 700 billion cubic meters. At the same time, the EU's domestic natural gas production, even if Norway is included, is expected to decrease steadily. As a consequence, there will emerge a substantial gap between European natural gas supplies and demand, and thus the EU will be forced to increasingly rely on imported natural gas.

Russia, the EU's most important natural gas supplier, possesses the largest natural gas reserves in the world. However, the country's capability to export natural gas in the future is in doubt due to several internal and external factors. The increasing domestic natural gas demand, a possible downturn in Russia's natural gas production as a consequence of the draining of old giant natural gas fields and the delay in developing new major fields, the continuing of the gas imports from Central Asia and the input of independent gas producers and oil companies in Russia will either increase or decrease the volume of gas available for exports. The economic crisis and the developments in the world gas market will also affect Russian natural gas production. Moreover, if there is less Russian gas available for exports, political factors may be one important motive determining the direction of Russian exports, which in the future may be increasingly directed to the East, as is stated in the Russian energy strategy as well.

Thus the EU may be forced to diversify its natural gas imports away from Russia in the future and find alternative natural gas sources, suppliers and routes. It is not just compulsory for the EU but preferable as well – in the light of some recent developments the diversification of natural gas supply is increasingly in the EU's interests. The potential risks of supply disruptions, of which the EU member states

already caught a glimpse during the 2009 Russian-Ukrainian gas crisis, can be diminished by diversifying natural gas suppliers and supply routes, increasing the use of LNG and if possible, exploiting the domestic unconventional gas resources in Europe. However, whereas all these factors can enhance the ever important EU's energy security, none of them can alone substitute for Russian natural gas as the EU's energy source. Instead, they could all together form a new diversified European natural gas supply in the future.

One vision of how the EU's natural gas demand in could be met 2030 is presented in table 6.

Table 6 EU natural gas supply in 2030, billion cubic meters

EU-27 natural gas demand 2030	**694 bcm**
Domestic conventional production (including Norway)	174 bcm
Russian exports	201 bcm
Nabucco	31 bcm
LNG	174 bcm
Shale gas	50 bcm
Gap to be covered	*64 bcm*

Sources: Eurogas 2007, Gromov 2008, Nabucco Gas Pipeline International GmbH 2009, Stoppard 2009, author's calculations.

This scenario is rather optimistic presuming that everything will go as planned and several factors can change the situation. For example, if the production in Russia will turn into decline as a consequence of a delay in the start-up of Yamal, if the Nabucco project will not proceed according to its schedule and if shale gas production in Europe will not be profitable, the EU may need to cover much wider gap in its natural gas supply than just some 60 billion cubic meters. On the other hand, if shale gas production proves to be even a bigger success in Europe, less additional supplies will be needed. This just illustrates the large amount of variables and *ifs* in the EU's future natural gas supply and in general, in the whole future of natural gas as the EU's energy source. The time will tell, of course, but it is still worth considering the alternatives and preparing for different scenarios.

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