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Some future scenarios of Russian natural gas in Europe

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ABSTRACT

This study contains a number of scenario studies to assess the share of Russian natural gas in the European natural gas mix going forward. Scenarios were calculated using the NEXANT world gas model (WGM) integrated in ERIRAS modeling information complex SCANER. The calculations in the WGM are based on demand and potential production forecast in each gas producing and/or gas consuming country of the world up to 2040. The paper continues with a discussion of the (limitations of the) most often debated alternatives to Russian gas. We conclude that remarkable little changes in the European natural gas mix in the scenarios under study, and that absent very drastic policy interventions Russian natural gas will continue to play a prominent role in the EU.

1. Introduction[1]

Ongoing turmoil in Ukraine has once again sparked a debate about European energy dependence on Russia. That debate is not new and has been revitalized repeatedly since the first major supply disruption in 2006, which took place after several decades of fairly stable supplies. That decade-long cooperation between the then Soviet Union and European Economic Community has resulted in a European gas market that has a vast network of pipeline infrastructure, connecting roughly 75% of European markets and facilitating the transportation of significant supplies of natural gas to come into the market (for a detailed account of the origins of Europe's dependence on Russian natural gas, see Ref. [9].

Since the 1990s, European institutions have been engaged both in liberalizing European gas markets, which had historically been developed at the member state level, and in further integrating them. This process is not complete, despite the explicit ambition of the European Commission (EC) to achieve an integrated internal market by 2014. These efforts are crucial for the European Union (EU) as a whole, as domestic production of natural gas continues to dwindle, and import dependence increases despite the fact that demand is predicted to be largely flat, and possibly even decreasing. Other studies provide detailed overviews of the progress that has been made over the last two decades in terms of European cooperation [1,3]. Their central argument is, that by integrating national gas markets, and investing in sufficient infrastructure, natural gas can flow freely through the EU, and give member states access to various sources of supply. This in turn increases competition, and decreases chances of market power abuse. For the vast majority of the EU, this approach has demonstrably worked. For this paper, suffice to say that completion of the internal market is not expected before the end of the decade, and several member states in the EU as a result will be single-source dependent for the nearby future.

Despite a new push for European market integration under the flag of the so-called Energy Union, absent drastic interventions in the institutionalized division of labor between public and private actors in European gas markets, on the European level we do not foresee a radical shift away from dependency on Russian natural gas supplies that has been plead for by so many politicians and commentators, on both sides of the Atlantic. Instead, absent such interventions, we assume that the fundamental incentive for private entities to act (i.e. price) has not changed, and that political preference will not enter the commercial lexicon. This, combined with the reality that most alternative supplies are only second best

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options (because their costs are higher and the quantities are not expected to be sufficient to replace 150 bcm of Russian gas, or because supplies will not reach the market in the foreseeable future) and a substantial amount of natural gas supplies is tied up in long-term contracts, leads us to believe that despite the often expressed political desire for change no significant change will in fact happen.

Based on these observations and premises, we have conducted a number of scenario studies to assess the share of Russian natural gas in the European natural gas mix going forward. Their method, data, and main conclusions are discussed subsequently. Then we discuss the limitations of the most often debated alternatives, e.g. importing more liquefied natural gas (LNG), or bringing in alternative supplies through the so-called Southern Corridor (we include reference to the Mediterranean in this context). We then discuss our main findings and highlight what they mean for the EU gas market development and energy security.

2. Method

Apparent and implicit changes in the European energy diversification policy are examined using analytical and statistical methods. For an assessment of the role of the different gas suppliers and their competitiveness, optimization modeling, which covers all the potential gas supply options and their costs, was necessary. As the European gas market is becoming more integrated in the global gas trade, gas is expected to come from different sources from all over the world, so the assessment of the supply options and their potential role in covering European gas demand requires the use of the global gas model. There are just few global gas models optimizing total gas supply costs: Global Gas Model (GGM) developed by Wood MacKenzie[2], WGM (World Gas Model) developed by the University of Maryland[3] and DIW[4], world gas model (WGM) developed by NEXANT[5] and World Gas Trade Model developed by Rice University[6].

In this study the NEXANT world gas model (WGM) integrated in ERIRAS modeling information complex SCANER [12] was used. The calculations in the WGM are based on demand and potential production forecast in each gas producing and/or gas consuming country of the world up to 2040. The model contains a few thousands of routes of LNG and pipeline gas supply connecting these countries (and corresponding transportation costs). The aim of the WGM is to deliver optimized volumes of gas supply by each route. The optimized solution is set to be the cheapest one. In other words, the WGM searches for the minimum cost of meeting world gas demand. Unlike many energy markets models, which use prices as assumptions, the WGM calculates gas prices as long-run marginal costs of supply in each country. To account for the features of gas markets pricing mechanisms the data on volumes, prices and take-or-pays of long-term contracts is also included in the model.[7]

One of the basic assumptions of the WGM – gas demand forecast by country – is obtained from SCANER and calculated based on countries' energy balances forecast, that involves projections for economic development, demography indicators, and energy policy analyses. The SCANER complex contains data on almost 200 nodes all over the world, including detailed data on Russian fuel and energy complex. Primary gas demand from SCANER can be adjusted by the WGM if resulting gas prices indicate low competitiveness of gas compared with coal, nuclear or renewable energy.

A set of scenarios were prepared, covering what we believe are the major potential developments regarding Russian gas supplies to European gas market. In these scenarios, the ways in which Russian gas could be replaced were regarded. This resulted in four scenarios: a baseline scenario (assuming no major changes in Russian gas supplies), a scenario without the Extension of the Russian Contracts (reflecting a political desire to stop purchasing Russian gas), a scenario without the construction of Turkish Stream (suggested by Gazprom as an alternative to the cancelled South Stream project), and finally a scenario without Ukrainian Transit (an ambition often voiced by Russian authorities, and often said to take effect in 2019, though comments vary).

2.1. General assumptions for all scenarios

In all scenarios we have made a number of general assumptions.

- In the period from 2015 to 2040, we assume that global gas consumption will increase by 48% to 5.3 trillion cubic meters (tcm). This corresponds to an average annual growth rate of 1.6%.
- We assume that demand for natural gas in Europe[8] will begin to recover as early as 2015 and will increase by 20% to 2040, which is an average annual growth rate of 0.6% in the forecast period, thus reaching the pre-crises level.
- Natural gas production in Europe (with account for a new production profile in the Netherlands) will drop to 212 billion cubic meters (bcm) as early as 2020. However, after 2020 we expect domestic production to continue to decline very modestly, to 199 bcm by 2040. This includes assuming a total of 20 bcm of shale gas production in 2040. In our calculations we assume that over 80% of the European shale gas production takes place in the UK and Poland.
- We assume an average CO_2 emission price of 40 euros per ton in the period from 2015 – 2040.[9]
- Due to the political instability in Iraq, high domestic gas demand in Iran, and limited resource availability in Azerbaijan, the

[2] http://www.woodmac.com/content/portal/energy/highlights/wk5_Nov_14/Global%20Gas%20Model%20Overview.pdf.

[3] Optimization Models in the Natural Gas Industry [текст]/Qipeng P. Zheng, Steffen Rebennack, Niko A. Iliadis, Panos M. Pardalos//Handbook of Power Systems I (Energy Systems)/ed. Panos M. Pardalos, Steffen Rebennack, Mario V. F. Pereira, Niko A. Iliadis. – Ganeswill, Florida, U.S.: University of Florida, 2010.

[4] The World Gas Model: a Multi-Period Mixed Complementarity Model for the Global Natural Gas Market/Ruud Egging, Franziska Holz, Steven A. Gabriel. – Berlin: DIW, 2009.

[5] http://thinking.nexant.com/program/world-gas-model.

[6] P. Hartley, K.B. Medlock. The Baker Institute World Gas Trade Model. The James A. Baker III Institute for Public Policy. March 2005. http://bakerinstitute.org/media/files/Research/81966512/the-baker-institute-world-gas-trade-model-biwgtm.pdf.

[7] Data on gas production capacities, long-term contracts and massive datasets on world gas transport infrastructure is provided by Nexant - http://www.nexant.com/solutions/oil-and-gas/natural-gas.

[8] Europe includes 34 countries: Albania, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Republic of Macedonia, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom.

[9] It is important to note that in light of the 2015 Paris agreement on climate change governments may proceed to implement more stringent carbon regulations. Writing in early 2016 though, carbon prices in the European Emissions Trading Scheme (ETS) hoover around 6 €/ton, and reforms to the ETS will not be implemented before 2018. The carbon price after 2018 is uncertain at this point. Even though this is beyond the scope of this study, we would speculate that a higher carbon price would actually have an upward effect on natural gas consumption, as it would make it a more competitive fuel source for electricity generation in comparison to more carbon intensive coal. In the United Kingdom, policy makers installed a price floor of £18.08 for every ton of carbon emitted, incentivizing fuel switching from coal to natural gas. We cannot rule out more ambitious carbon pricing policies in the EU, but appreciating the complicated politics around this topic believe we should not assume this at this point.

Southern Corridor will be significantly expanded only after 2030 (existing 10 bcm deliveries from Iran to Turkey and 3–4 bcm from Azerbaijan to Turkey will be expanded by 10 bcm from Azerbaijan by 2019 and another 10 bcm from Iran plus 10 bcm from Iraq after 2030).
- We assume that only planned LNG terminals are being built, including long-debated terminals such as the one in Croatia, not the proposed ones.

In the following sections we describe the different scenarios that we have studied, and their main outcomes. We start with our baseline scenario, and then with scenarios, in which we respectively assume that Russian long-term contracts are not renewed, the average Brent oil price is $120/bbl[10] (instead of $100/bbl in the baseline scenario), the controversial transit pipeline Turkish Stream is not constructed, and finally there is no transit of natural gas to the EU through Ukraine. After the analysis we discuss the most often debated alternatives to Russian gas, and then end this paper with our conclusions.

3. Results

3.1. Baseline scenario

In our baseline scenario, it is assumed that:

- The Brent oil price is $60/bbl in 2015, $70/bbl in 2016, $80/bbl in 2018 and reaching $100/bbl by 2035;
- All Russian contracts are extended by ten years after their expiration, with a share of spot-pricing of 35%;
- Ukrainian transit is accessible;
- Turkish Stream (instead of South Stream) is constructed.

Below, we discuss the main findings of our baseline scenario.

European LNG imports grow quite steadily until the end of forecast period, from an estimated 65 bcm in 2015 to 144 bcm in 2040, while natural gas imports by pipeline increase moderately only until 2025 and then level out (from 218 bcm in 2015 to 240 bcm in 2040). Hence, the utilization of LNG terminals, i.e. the share of existing capacity that is used, in the EU increases from 30% in 2015 to 48% in 2040, while the utilization of import gas pipelines decreases from 58% to 49% (Fig. 1).

In 2015, with anticipated (rather modest) natural gas demand of 500 bcm, hub prices throughout Europe attain 7–8 $/MBtu. If, for example, due to cold winter natural gas demand in Europe in 2015 would increase by 50 bcm up to 550 bcm, the hub prices would grow up to 10–15 $/MBtu. In other words, the current amount of excess supply in the market that Europe can attract at competitive prices (meaning prices below those that Asian buyers are willing to pay for LNG) is very limited.

The dramatic increase in LNG import by 2020, which is driven by huge liquefaction capacity additions expected globally (in Australia and North America), will lead to a marked decline in the spot price down to 6–8 $/MBtu (at British hub NBP and Baumgarten in Austria, CEGH, respectively). As early as 2025 however, the LNG glut will be absorbed by the Asian consumers and the European hub prices will rise up to 7–10 $/MBtu and continue to grow up to 9–11 $/MBtu by 2040 (Fig. 2).

The utilization rate of LNG terminals in Turkey, Greece, Croatia, the Netherlands, Poland and Sweden is close to maximum for almost the whole forecast period – their expansion could contribute to some reduction in import prices.

In fact, the structure of the European gas balance (Fig. 3) will not change dramatically during the forecasted period: pipeline supply share remains nearly flat (about 40% of the European gas consumption), while growing LNG imports to Europe will become the major source to compensate for the declining indigenous gas production and will increase their share in demand from 13% in 2015 up to one quarter in 2040, getting more diversified (Fig. 5) (see Fig. 4).

The share of African pipeline supplies in European gas imports will remain stable (7–8% of total European gas demand – Fig. 5), while the share of Caspian and Middle Eastern countries (Azerbaijan, Iran and Iraq) will triple (from 3% in 2015 to 10% by 2040) upon the corresponding decline in the share of pipeline gas supplies from Russia (from 31% in 2015 to 24% by 2040 with the major decline occurring in 2030–2035) (see Fig. 6). This decline in Russian pipeline exports will be partially compensated by the growing export of Russian LNG (up to 32 bcm by 2040). In absolute terms, optimization calculations based on cost minimization show that pipeline gas import from Russia will remain at the level of 150–160 bcm until 2030 (including re-export from Central Asia) and then, as the existing contracts expire, it drops down to 125–135 in 2035–2040.(see Fig. 7)

3.2. Scenario without the extension of the Russian Contracts

It is assumed that:

- The Brent oil price is $60/bbl in 2015, $70/bbl in 2016, $80/bbl in 2018 and reaching $100/bbl by 2035;
- Existing gas supply contracts with Russia are not extended;
- Ukrainian transit is accessible;
- The Turkish Stream pipeline is constructed.

Compared to the baseline scenario, LNG imports into the EU grow faster, with a factor of 2.8, to 178 bcm by 2040. Similar to our baseline scenario, pipeline gas imports increase until 2025, and then decrease, but the total volume of pipeline gas imports eventually becomes more modest, namely 203 bcm in 2040 (as compared to 240 bcm in the baseline scenario).(see Fig. 8)

The average utilization of LNG terminals in Europe is twice as high (60%) in 2040 than in 2015. In other words, European consumers compensate for the fall in pipeline imports by importing significantly more LNG. In addition to the countries specified in the baseline scenario, Belgium is added to the European countries, where LNG terminals work at maximum capacity.

No significant changes in spot prices are observed as compared to the baseline scenario. In 2015, 2017, 2020, 2028 and 2031 the spot prices are about 1% lower than in the baseline scenario, but the average spot prices for the entire forecast period at the major eight European hubs by 2040 are 3% higher than in the baseline scenario, which clearly demonstrates, that LNG options in fact are only slightly cheaper than Russian gas.

In this scenario pipeline gas exports from Russia to Europe fall from 159 bcm in 2015 to 103 bcm in 2040. The first sizeable fall of Russian pipeline exports happens in 2030, likewise in the Baseline scenario, and is mainly compensated by Iraq and Iran, since new pipeline capacities in these countries are coming into force. For the second time Russian exports drops in 2035 and it leads a small decline in the European gas demand, which means that for some part of the contracted Russian exports to Europe the optimal alternative is switching to coal. The dynamics of LNG exports from Russia is almost identical to the baseline scenario, in other words, a steady growth up to 32 bcm to 2040 is expected. Hence, the total Russian share in European natural gas consumption will fall from 31% in 2015 to 23% in 2040.

[10] All prices in constant 2012 dollars.

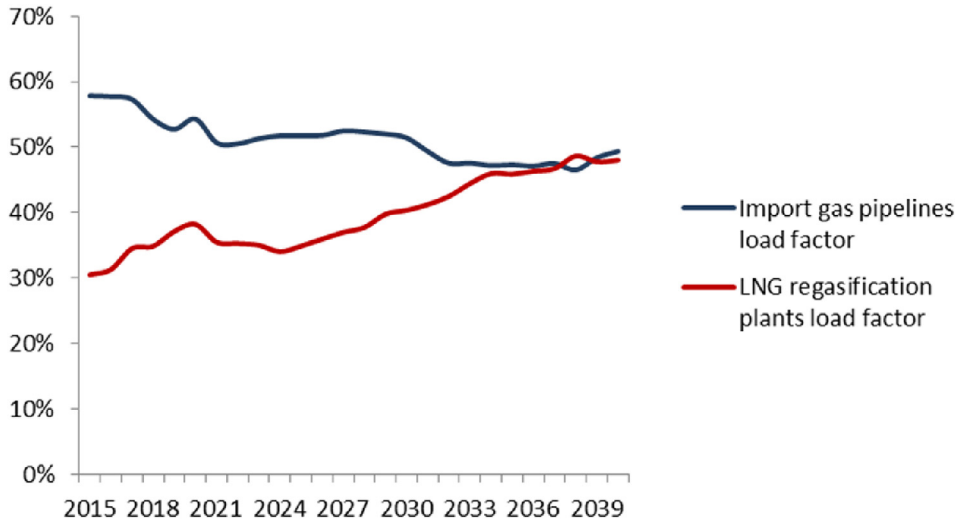

Fig. 1. European import gas pipelines and LNG terminals load factors forecast, Baseline scenario, percent.

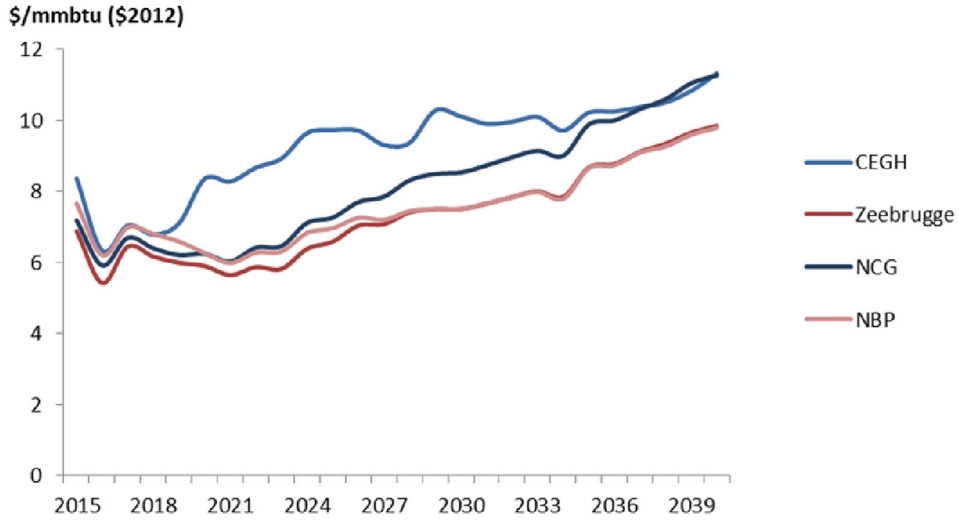

Fig. 2. European gas hub prices forecast, Baseline scenario, $/MBtu ($2012).

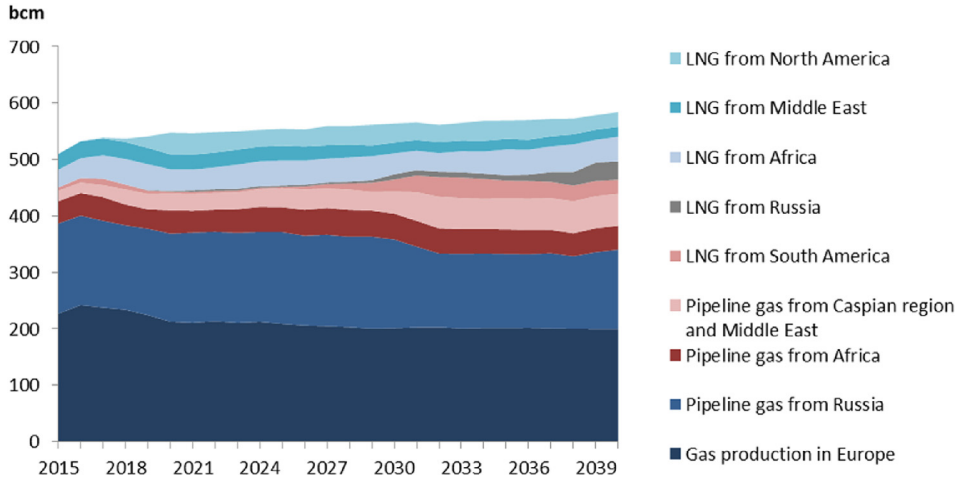

Fig. 3. European gas balance forecast, Baseline scenario, bcm.

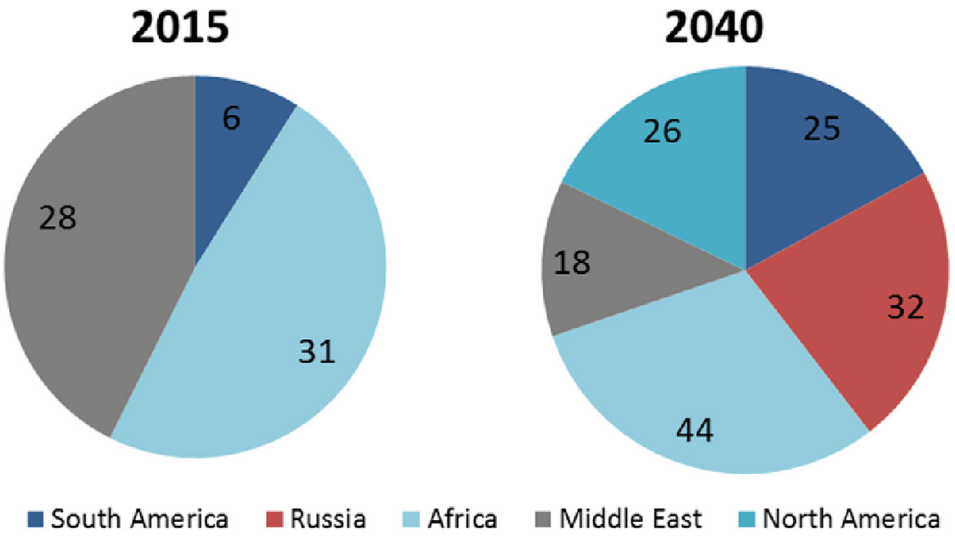

Fig. 4. LNG import structure by source in 2015 and 2040, bcm.

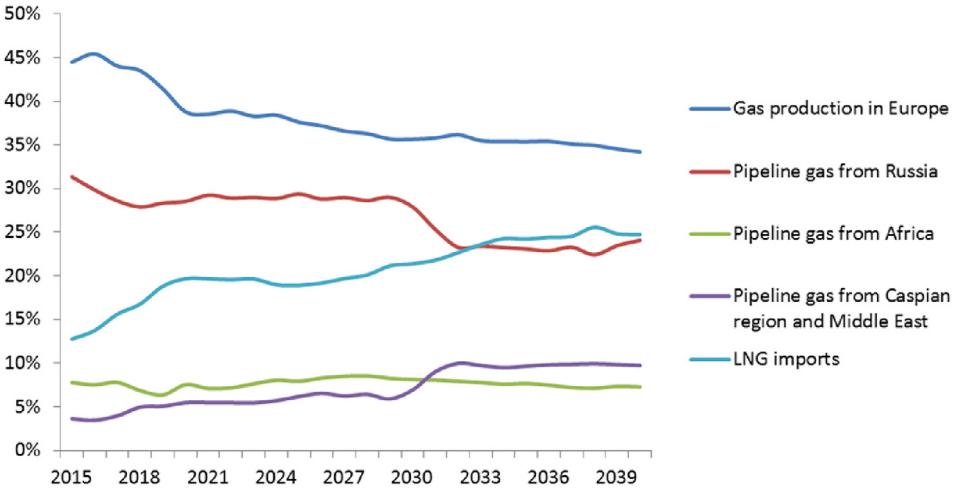

Fig. 5. European gas market shares by major supply sources, Baseline scenario, percent.

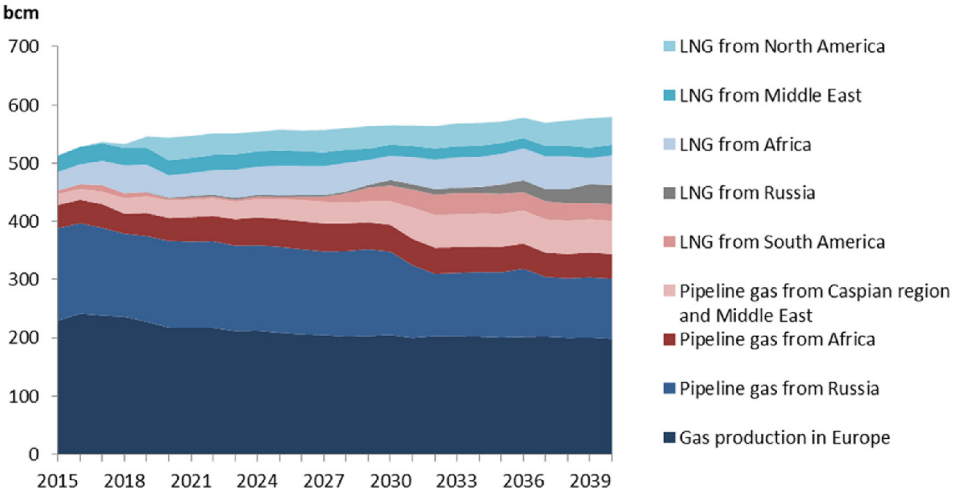

Fig. 6. European gas balance forecast, Scenario without the extension of Russian gas contracts, bcm.

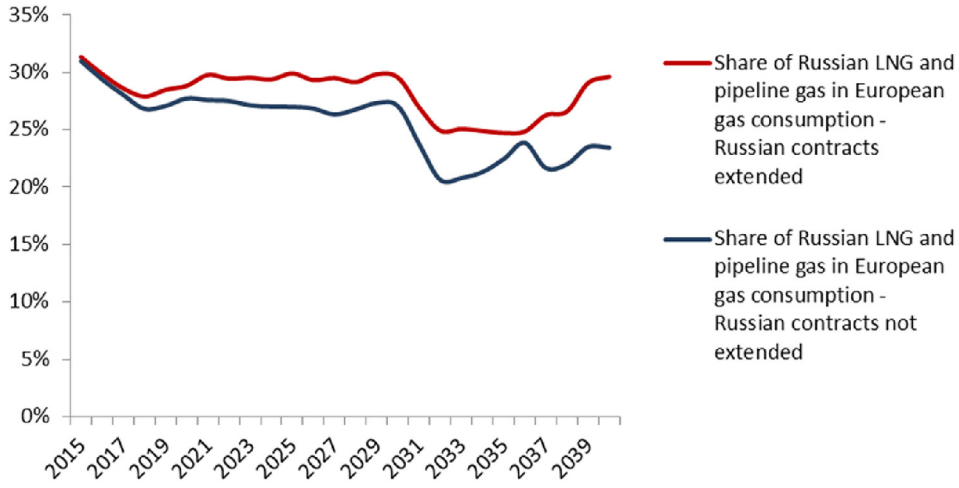

Fig. 7. Share of Russian gas in the European gas market by scenario, percent.

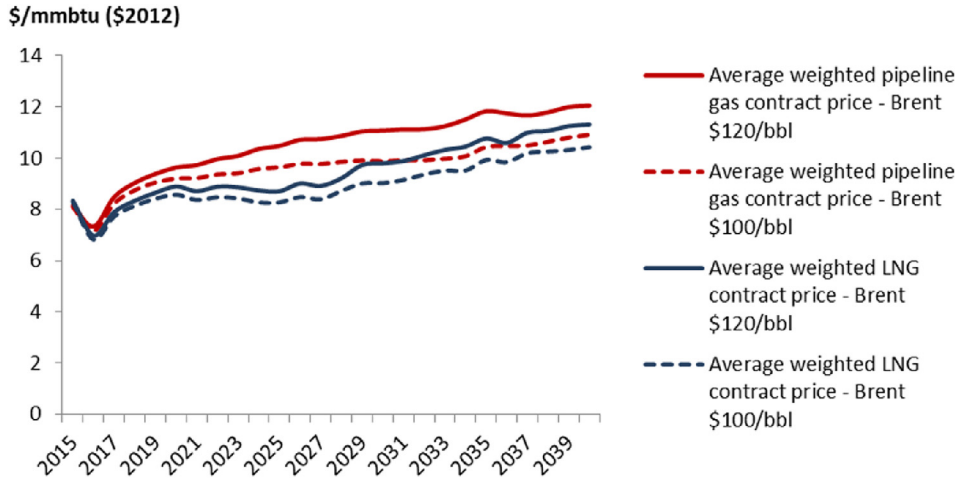

Fig. 8. Average weighted European gas contract prices forecast by scenario, $/Mbtu

3.3. Scenario with Brent oil price — 120 dollars

It is assumed that:

- The Brent oil price is growing and reaching 120 $/bbl by 2035;
- All Russian contracts are extended by ten years after their expiration, with a share of spot-pricing of 35%;
- Ukrainian transit is accessible;
- Turkish Stream is constructed.

Below we discuss our main findings, in comparison to our baseline scenario.

The imports volume and structure are virtually unchanged as compared to the baseline scenario. So far as oil price has only slight impact on LNG transportation cost, the only way it could affect gas balance is through contracted gas flows. In this scenario shipments under contracts also have not changed much since in the model the contracts are inevitably taken and are not revised, so changes in oil prices define only whether the contracts are taken at minimum take-or-pay level or at annual contracted level or somewhere in between. Taking into account that some European countries, especially North Western ones, are over contracted with gas, a lot of contracts are taken at minimum take-or-pay level already in the Baseline scenario. It means that there is almost no room to maneuver in the scenario with a high oil price.

Spot market prices at the major European hubs remain almost unchanged (3% higher on average for the period under study at eight European hubs). Prices of pipeline gas supply contracts in 2015–2040 are 9% higher than in the baseline scenario due to the higher oil prices, 10.5 $/MBtu on average. Prices of long-term LNG contracts in 2015–2040 are also 6% higher than in the baseline scenario, 9.5 $/MBtu on average. As a result, the weighted average gas price in Europe is higher by 3% in 2015–2040.

3.4. Scenario without the Turkish Stream

It is assumed that:

- The Brent oil price is $60/bbl in 2015, $70/bbl in 2016, $80/bbl in 2018 and reaching 100 $/bbl by 2035;
- All Russian contracts are extended by ten years after their expiration, with a share of spot-pricing of 35%;
- Ukrainian transit is accessible;
- Turkish Stream is not constructed.

Below we discuss our main findings, in comparison to our baseline scenario.

There are no significant differences from the baseline scenario in

terms of imports, including the imports from Russia (the difference in the volume of non-Russian gas imports to Europe from the baseline scenario does not exceed 3 bcm). There are also no significant differences from the baseline scenario in terms of spot prices at eight European hubs (difference is about 0.1%). In fact, in the baseline scenario the rate of Turkish Stream utilization is quite low, therefore the absence of the project has no significant consequences for the market. In the scenario without the Turkish Stream, these volumes are delivered to Europe via Ukraine (up to 6 bcm), through Moldova (up to 10 bcm), and through the Blue Stream (up to 10 bcm).

3.5. Scenario without the Ukrainian Transit

It is assumed that:

- The Brent oil price is $60/bbl in 2015, $70/bbl in 2016, $80/bbl in 2018 and reaching 100 $/bbl by 2035;
- All Russian contracts are extended by ten years after their expiration, with a share of spot-pricing of 35%;
- Ukrainian transit is not accessible;
- Turkish Stream is constructed.

Below we discuss our main findings, in comparison to our baseline scenario.

Shutting off the gas transit through Ukraine will reduce the gas consumption in Europe by 6% in 2015 and by 1% in 2040, if no compensatory measures are undertaken. The expansion of LNG terminals in Poland, Greece, and Turkey (or construction in Bulgaria) could normalize the prices and consumption volumes to the level specified in the baseline scenario.

Countries affected by the shutting off the gas transit through Ukraine are as follows: Austria, Bulgaria, Bosnia and Herzegovina, Hungary, Serbia, Slovakia (these countries see a consumption reduction in 2015–2020 of 50–100%), the Czech Republic, Romania, Slovenia (20–50%), Turkey, Croatia, and Poland (1–10%).

The LNG import volume also remains nearly unchanged relative to the baseline scenario, as “regas bottlenecks” (such as LNG terminals in Greece, Turkey, and Poland), which supply gas to the Balkans and Eastern Europe, are already fully loaded, while due to the lack of interconnectors and pipeline infrastructure gas from the unloaded LNG terminals in North-Western Europe cannot reach these countries. It is worth noting that in due time interconnection levels will improve, enabling more alternative supplies to flow to this part of the continent.

The import of non-Russian pipeline gas is almost similar to the baseline scenario (in some years it increases by max 4 bcm). Without Ukrainian transit in 2015 the import of Russian pipeline gas is less by 48 bcm (30%) than in the baseline scenario, and it does not recover to the level of the baseline scenario until the end of forecast period (in 2040 it is 5 bcm lower than in the baseline scenario). At the time of writing an alternative pipeline has been proposed, Nord Stream 2, and its impact, if it were constructed, should be part of future scenarios studies.

Spot prices at seven of eight European hubs remain unchanged compared to the baseline scenario (Belgium, France, Germany, Italy, Netherlands, Spain, and the United Kingdom). However, the prices at the Austrian hub CEGH more than double in 2015, but after 2020, as Austria will start receiving gas from the Turkish Stream, they will be only 10% higher on average compared to the baseline scenario. This demonstrates first remaining isolation of the Central European gas market and second – importance of the Turkish Stream if Ukrainian transit is abandoned.

Absence of gas transit through Ukraine is compensated by fully loaded two lines of the Nord Stream, Blue Stream, increasing transit through Belarus (9 bcm on average), and an increase in the Turkish Stream utilization rate.

4. Discussion of the most often debated alternatives to Russian gas

In light of the ongoing turmoil in Ukraine, policy makers' call for diversification away from Russian natural gas has increased significantly since February 2014. These calls have echoed across the Atlantic Ocean as well, giving Washington policy makers and interest groups a new argument to fuel the U.S. domestic debate about facilitating exports of liquefied natural gas (LNG) to countries without a free trade agreement (for one of the earlier contributions, see Ref. [4]. Earlier analyses of these efforts and debates have suggested that the rhetorical value of these debates has to be kept in mind since even if more U.S. LNG could come to the market, it could not do so quickly and would unlikely have any meaningful effects in still poorly developed and commercially unattractive Central and Eastern European gas markets [7]. In addition, as global LNG prices have collapsed over the last year, it is increasingly uncertain how much additional liquefaction capacity will be financed, and built. It is likely that in the current price environment LNG exports from North America too will not be as significant as many at some point believed [13]. This section briefly discusses the most often debated alternatives to Russian natural gas, and the limitations of each supply source. By no means is this section intended to downplay the value of alternative market outlets. To the contrary, we believe that in combination the efforts made by the EC and private sector entities are invaluable as a cornerstone of European energy security, and a means to safeguard competition. Rather, this section aims to put these alternatives in perspective.

4.1. Increasing LNG imports

Importing more LNG is an often noted supply alternative. What policy makers and commentators, however, frequently overlook is that Europe is in fact well equipped to start importing large amounts of LNG today. Currently, 22 LNG regasification terminals are in operation along European shores, clustered mostly in Spain, Italy, the UK, and France, but also in Belgium, the Netherlands, Portugal, Greece and Sweden. These terminals collectively have an import capacity of 197 bcm/year, which comprises around 35% of European annual gas consumption, an amount substantially in excess to total Russian imports, which in 2013, reached a record of 161 bcm.[11] However, the amount of existing LNG regasification capacity says little if anything about the amount of LNG that actually reaches European markets. One must keep in mind that contrary to pipeline natural gas, which serves regional markets, LNG is a global commodity. Though prices vary somewhat with the distance covered, in essence LNG can travel all over the world. Thus, as contracts have become more flexible in recent years and contracted volumes can be reshipped to other destinations, LNG is sold where the highest price for the cargo is paid (for a detailed analysis on LNG pricing, see Ref. [8]. In recent years, with Asian economies accounting for the vast majority of growth in natural gas demand, it should not be surprising to note that Europe's share in global LNG trade has continued to decline, with most of that demand shifting to Asia, where in 2013 over 75% of global LNG trade took place.[12] As a result of this market shift, utilization rates of existing LNG terminals in Europe have declined substantially with most terminals

[11] See GLE presentation on overview of LNG projects in Europe, April 2014 - http://www.gie.eu/index.php/publications/cat_view/3-gle-publications.

[12] http://www.giignl.org/news/75-global-lng-demand-asia-2013.

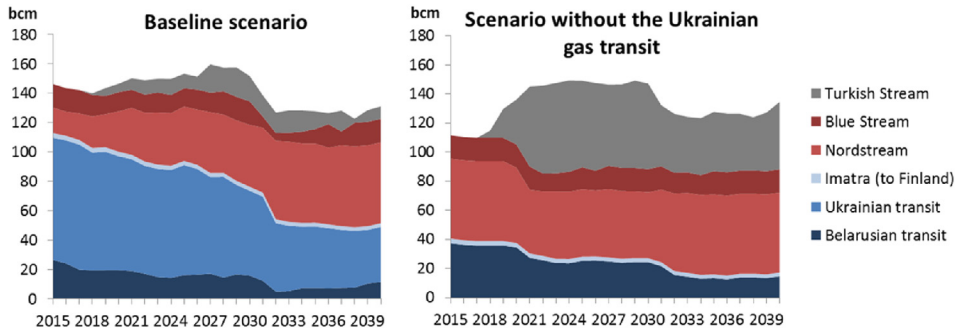

Fig. 9. Russian pipeline gas exports to Europe forecast by scenario, bcm.

running at only a fraction of their capacities. As an illustration, Europe in 2013 imported just over 40 bcm of LNG (including Turkey), and the average utilization rates of Europe's existing terminals was around 20% (based on net import volumes) [10]. The fact that LNG imports into Europe are not per definition attractive commercial proposition is further underlined by the fact that as of August 2014 six planned LNG regasification plants in Italy, Spain, Cyprus, the UK, France, and Germany have been suspended or cancelled.[13] On the other hand, we have witnessed some interest in smaller scale solutions like floating LNG regasification units, for instance in Lithuania (which in turn saw its gas tariffs substantially reduced, another confirmation that increased competition through access to diverse supplies is a solid recipe to enhance energy security). We would note that if European buyers were willing to pay a premium for LNG, then of course its share could be increased (Poland in essence made this decision by signing a long-term oil indexed contract with Qatargas to supply LNG through its newly built regasification terminal) (see Fig. 9).

In sum, Europe can import more LNG if it chooses, but it depends on the price it is willing to pay. Regarding costs of the current major gas suppliers to Europe, many of them are not able to substantially increase exports volumes (i.e. Algeria, Libya, Trinidad and Tobago, Qatar). In addition, to our knowledge we should not anticipate substantial changes to the LNG cost structure. Supplies from Iran and Iraq could affect Russian gas exports, but because of political risks it is doubtful that gas flows from these countries would exceed those volumes that are already assumed. So far Russian gas remains among the cheapest options (on the cost basis) for the European consumers (Fig. 10). If current price reviews will go on and if Russia will be ready to provide further price discounts to the oil-linked contracts, it has very strong position in a “price war” with new LNG.

It should come as no surprise that in the European liberalized market private actors generally opt for the most attractively priced natural gas available in the market. In the case of Europe, that effectively means that natural gas that is domestically produced, or imported by pipeline, albeit from Norway, Algeria, Libya or Russia, is more competitive and hence preferred over LNG. In addition, as we have seen happening in late 2015 and early 2016, in response to a glut of LNG targeting markets around the world, including Europe, traditional suppliers have dropped prices to prevent LNG from taking over significant market share. It is important to note that this mostly applies to the more liquid parts of European gas markets, and so in parts of Central and Eastern Europe the room for competition is still limited, though recent history has shown that in these situations too existing contracts are renegotiated if the difference between spot-prices and long-term contract prices grows substantially. On the other hand, it is likely that in the future the share of LNG in the European fuel mix will recover, as more supplies come on stream in the global market space, and we expect that LNG will claim a significant share of European gas demand that comes available as domestic production continues to dwindle. In this context, it is important to observe that the Dutch government, under pressure from Parliament and public following a series of earth tremors linked to conventional natural gas extraction, has decided to significantly lower its annual production ceiling for natural gas production (to 27 bcm in 2016). It is almost certain that this decision will prove to be a structural one, and if so this too will free up market share for external suppliers (as the Netherlands is the largest producers of natural gas in the EU). However, it is unlikely that LNG will be more competitive than natural gas that is produced domestically or supplied by pipeline from neighboring countries like Russia. This seems surely to be the case in the parts of the European gas market that are less integrated.

4.2. *Increasing imports through the Southern Corridor*

Importing more natural gas through the so-called Southern Corridor has been on European policy agendas for quite some time. For many years, the Nabucco pipeline, explicitly backed by the EC and the U.S. government, featured prominently in these debates, the idea being that 30 bcm of natural gas could be imported from countries like Azerbaijan, Turkmenistan, and at some point possibly Iran. The Nabucco pipeline was envisaged to transit countries like Romania, Bulgaria, with a final destination in Austria, allowing it to bring new supplies and additional liquidity to Central and Eastern European gas markets.

As it turned out, it made more sense to have the large Italian market as a final destination, and so in June 2013 the operators of the Shah Deniz gas field offshore Azerbaijan (e.g. BP and Statoil) decided to construct the Trans-Adriatic Pipeline to Italy after transiting Greece and Albania.[14] This pipeline will have an initial capacity of 10 bcm, and is expected to start delivering supplies to Europe by 2019 [5]; annex 2, p.23). As a consequence, it seems that the government backed Nabucco project has lost its viability. It is worth noting that even the significant Italian market requires less natural gas than was anticipated some years ago, particularly due to an increased share of renewable energy.

It is not inconceivable that in the long term additional natural gas supplies will come to Europe through the Southern Corridor, but we believe that given the modest size of expected volumes in the nearby future the importance of the Southern Corridor is

[13] http://www.globallnginfo.com/index.aspx.

[14] For more information, we refer to – http://blog.gmfus.org/2013/07/26/what-the-trans-adriatic-pipeline-means-for-europes-energy-diversity/.

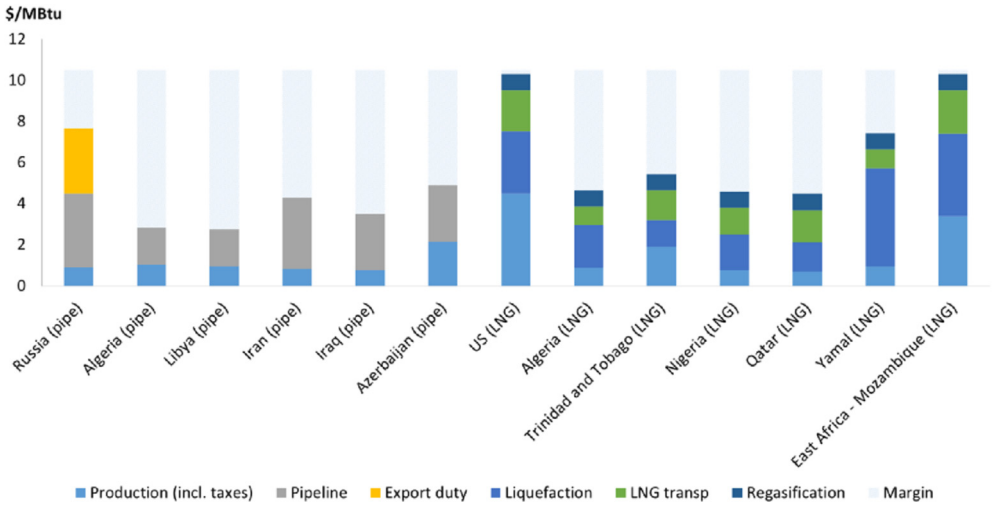

Fig. 10. Long-run marginal costs and margins of the major gas suppliers to Europe in 2025, $/MBtu.

overblown. Granted, there are potentially significant other resources in the area that may at some point come to fruition and turn into possible commercial alternatives, such as natural gas from Kurdistan, Azerbaijan, Israel, Iraq, Iran, and possibly Turkmenistan. Today, however, the reality is that none of these alternatives is likely to come to fruition in the near future because of significant security, political and/or commercial challenges, making us believe that we should not expect significant impacts on European gas markets before 2025. As an illustration, even though significant reserves have been discovered off the shores of Israel in recent years that does not mean these easily find a market. The development of the largest discovery, the Leviathan field, at this point remains uncertain due to significant regulatory uncertainty, and complex political relations between the government of Israel, and all its neighboring countries [15].[15]

4.3. *Ramping up domestic production of unconventional gas*

For a number of years, policy makers in several European member states, most notably Poland and the UK, have been eager to develop some of their alleged unconventional gas potential. Others, such as the Netherlands and Germany, have been more hesitant following environmental concerns that have been linked to hydraulic fracturing, while France and Bulgaria have banned fracking outright. These developments and the different motives behind them have been well documented (e.g. Refs. [2,11].

The reality is that to date all over the entire EU not even 100 unconventional exploration wells have been drilled. It is therefore difficult to say what amount of unconventional gas may eventually be recovered. Yet even in countries where the government has actively backed the industry in an effort to get production started, this has not generated any meaningful results. It may be argued that in Poland a number of infrastructural and regulatory hurdles have contributed to this situation [11]. Moreover, by now it appears that the geological conditions may not be as favorable as initially hoped. Nonetheless, the departure of Exxon Mobil, Talisman Energy, Marathon Oil, and ENI from the Polish market suggests that shale gas development will remain moribund for some time. In the UK too, to date the government's efforts to spur shale gas developments have not been successful. Even after announcing fees over £100 million per exploration well drilled for local communities, very few exploration activities have been reported and local opposition continues to be fierce.[16]

We believe that in several European member states shale gas extraction will take place eventually. However, in line with EC estimates, we also believe it is unlikely that unconventional gas is going to be transformative in Europe as it continues to be in North America. According to the Joint Research Center, even if shale gas extraction takes off in Europe, in the best case scenario it is expected to halt European import dependence at around 60% [14]. In sum, shale gas in Europe can play an important role and can become part of the natural gas market mix, but its potential should not be overstated.

5. Conclusions and policy implications

In this section we discuss the main findings of the different scenarios that we have studied. Our main conclusion is that remarkably little changes in the European natural gas mix in the coming decades in the different scenarios we have looked at. Even in fairly drastic contextual variations, such as the absence of gas transit through Ukraine, in the long term this would hardly have meaningful effect on the origins of natural gas in Europe. In our view, this puts all the noise and upheaval about diversification of Russian gas in perspective. By no means do we want to downplay or reject the political sentiment that we have observed since the skirmishes in Ukraine started in February 2014. However, our analysis does confirm that absent very drastic policy interventions or breach of existing contracts not much change should be expected in the European gas mix, which will include a significant share of natural gas from Russia in all scenarios under study.

Of course there a number of important observations that deserve extra attention by policy makers, in particular in Europe. First and foremost, in the short term the lack of market integration in Central and Eastern Europe continues to be a risk in terms of European energy security, as vividly demonstrated in our scenario where Ukraine no longer functions as a transit country for Russian natural gas. While at seven of the eight major European hubs in our

[15] See also http://www.brookings.edu/research/articles/2015/11/meddling-in-the-med-boersma.

[16] http://www.bloomberg.com/news/2014-01-13/u-k-to-give-millions-of-pounds-to-councils-allowing-shale-gas.html.

study this would have no meaningful impact, at the Austrian hub Baumgarten spot prices would spike and more than double in 2015. This provides us with two important lessons. First, market integration and European collaboration on energy security generates results and for the larger part of Europe a dramatic change in supply routes (almost 50% of Russian supplies are transited through Ukraine) therefore does not have a meaningful impact. Second, and unfortunately, the slow progress of market integration in Central and Eastern Europe is not new. The European Commission however has put the issue high on its agenda, and the responsible Commissioners have for instance thought of new ways to attract public and private capital for investments in energy infrastructure in this part of the continent, which is direly needed.[17] It is too early to assess whether these new initiatives will be successful, and speed up the process. We should hope that also in this part of the continent a more regional approach to energy security is embraced, and countries can harness themselves to market abuse by facilitating competition in their respective markets.

Second, our analysis confirms that Russian pipeline natural gas will be very competitive until 2030, and after that Russian companies lose a part of their market share, which then stabilizes at around 130 bcm (which is still a significant share of the expected 240 bcm of pipeline imports). Interestingly a part of the loss of market share in terms of pipeline gas is compensated by LNG that comes from the Russian Federation, which we expect to increase up to 32 bcm by 2040.

Third, in our analysis LNG utilization rates, which as described are currently dramatically low, recover from 2015 onwards, and the share of LNG increases significantly in the European natural gas mix. However, it is important to emphasize that LNG should not be seen as a substitute for Russian natural gas, as is regularly argued, but rather as a substitute for declining European domestic production. Our analysis suggests that fiercely debated LNG supplies from the United States will be competitive in the UK, Netherlands, and Belgium, but not in the larger part of Europe.

Finally, in our analysis we account for all major alternative natural gas supplies that feature in (mostly public) debates. We expect that commercial shale gas production will take place within the European Union, but based on experiences so far and most realistic forecasts we do not believe that unconventional gas will be transformative in Europe the way it has been in North America. We also account for alternative supply routes such as the Southern Corridor, but these too do not have a large impact on the overall supply picture in the period under study. Thus, we expect that from 2019 onward 10 bcm of natural gas from Azerbaijan will reach European markets with potential for further increase, and in the longer term an additional 20 bcm from Iraq and Iran will contribute to the establishment of the long-desired Southern Corridor.

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