

# The future of Russian gas exports

FINN ROAR AUNE,<sup>b</sup> ROLF GOLOMBEK,<sup>c</sup> ARILD MOE,<sup>d</sup> KNUT EINAR ROSENDAHL,<sup>a,b,e</sup>  
and HILDE HALLRE LE TISSIER<sup>c</sup>

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## ABSTRACT

*Disputes between Russia and Ukraine over the terms for gas transit and deliveries prompted Russia to accelerate development of new gas pipelines to Europe circumventing Ukraine, as well as exploring the potential for gas export to additional markets like Turkey and China. The current paper examines implications of Russia increasing its gas exports capacity by building Nord Stream 2 (to Germany), Turkish Stream (to Turkey and Greece) and Power of Siberia (to China). We find that these projects have moderate effect on Russian gas exports and also that the impact on the European natural gas market is minor. We have also examined the impact of new Russian export pipes if subsidies to large Russian natural gas consumers are halved, or there are no sales to, or transit via, Ukraine. We find that the effects of increased export capacity are much stronger in these cases. The main policy implication of our study is that the EU and Russia have common interest in supporting further integration of European markets, although for somewhat different reasons. Russia wants to sustain, or increase, its exports to Europe, whereas the EU wants to make sure that the market functions well and that no country becomes vulnerable to pressure from Russia.*

**Keywords:** Russian gas export; Russia-Ukraine natural gas disputes; Turkish Stream; Russia-China natural gas trade agreement

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## 1. INTRODUCTION

Disputes between Russia and Ukraine spurred the construction of the Nord Stream pipeline, whereby Russia could bypass Ukraine by transporting some of its natural gas *directly* to Europe (Germany). More pipelines bypassing Ukraine are under construction or planned; one—Turkish Stream—to Turkey and Greece, and another—Nord Stream 2—to Germany. While Russia repeatedly argued that its disputes with Ukraine should have no impact on its business reputation as a secure source of natural gas, the disagreements, which also affected EU member states, initiated political processes in the EU aiming at reducing the dependence on Russian natural gas. Therefore, Russia has a clear incentive to find additional markets for its natural gas, for example, piped gas to China and Turkey, or LNG.

This paper examines how the ongoing conflict between Russia and Ukraine may have powerful implications on the Russian and European natural gas markets. We discuss how new pipes for Russian gas to Europe, bypassing Ukraine, may affect the natural gas markets. We

<sup>a</sup> Corresponding author: Universitetstunet 3, N-1430 Ås, Norway. [knut.einar.rosendahl@nmbu.no](mailto:knut.einar.rosendahl@nmbu.no), +47 99522521.

<sup>b</sup> Statistics Norway.

<sup>c</sup> Frisch Centre.

<sup>d</sup> Fridtjof Nansen Institute.

<sup>e</sup> Norwegian University of Life Sciences.

also investigate to what extent gas exports from Russia to China will have an impact on the European gas market.

Russia is the biggest exporter of natural gas to Europe. In 2015, approximately one third of natural gas imported to the EU came from Russia (BP 2016). The dependence on Russian gas varies considerably between EU member states; Russian gas covers more than 40 percent of Italy's gas consumption and approximately one third of Germany's, but the share is significantly lower in other Western European countries. In Central Europe, Russia's share is much higher, but here the role of natural gas in primary energy consumption is smaller.

Although the EU is highly dependent on Russian gas imports, Russia's dependence on the EU export market is also very high. In 2015, more than 60 percent of total Russian gas exports were delivered to the EU market. The remaining gas was sent to a number of countries; the biggest were Turkey, Belarus, Ukraine and Japan (LNG).

A substantial portion of Russian gas exports to Europe is transported through Ukraine, a country that traditionally has been a big consumer of Russian gas. After the break-up of the Soviet Union, Ukraine enjoyed a low price for natural gas because of its historical ties to Russia. Later, the contractual price faced by Ukraine was raised, and in 2006 a dispute over the new commercial terms triggered a serious crisis where Russia turned off the gas supplies to Ukraine. Unexpectedly by Russia, also customers farther west were affected because some of the gas intended for transit through Ukraine was diverted to domestic use.

Although the conflict was resolved quickly, for Russia the lesson was to reduce transit through Ukraine. Russia had already developed plans for building a pipe—Nord Stream—that would make it possible to transport gas directly to Germany, thereby circumventing Ukraine. The conflict spurred Russia to follow up on these plans and materialize Nord Stream.

For the EU, the Ukraine-Russia conflict changed the general perception of Russia as a secure supplier; the new goal of the EU was to reduce the vulnerability of the member states to imported fossil fuels, in particular to reduce the dependence on Russian gas. Such a response prompted Russia to look for additional markets for its natural gas exports.

First, Russia launched South Stream—a giant project to transport gas to Southern Europe. Because of disagreements with the EU on third party access, the project was cancelled, but another giant pipe project—Turkish Stream—landing gas in Turkey and the Balkans, was announced. For Russia, Turkey and the Balkans may be seen as alternative markets to the EU natural gas market. Also, Russia may build Turkish Stream partly to fend off potential competitors in the Caspian region; these are also aiming at supplying natural gas to Turkey and Southeast Europe. Second, after years of negotiations, Russia and China signed an export agreement in 2014. The agreement involves a pipeline in Eastern Siberia—Power of Siberia—that is already under construction.

Russia's piped gas export is completely controlled by one company—Gazprom. Another key characteristic of the Russian natural gas market has been very low end-user prices. Whereas Gazprom has lobbied to bring domestic gas prices up to European net-back parity, a policy that was accepted and partly implemented by the Russian government in 2007–2013, the current policy is to increase end-user prices slowly. The aim is to establish a domestic industry gas price around 70 percent of the European net-back price. As part of this paper, we will therefore examine how Russian exports of natural gas may change if domestic end-user prices for industry (large) customers are increased.

The present paper uses a well-established, numerical energy market equilibrium model (LIBEMOD—see Aune et al. 2008) to analyze how new pipes—both to circumvent natural

gas transport via Ukraine as well as to reach new markets—may have an impact on the Russian and European natural gas markets in 2030. LIBEMOD is well suited to explore these types of effects as it covers all European countries, including EU member states, Russia and Ukraine. It provides a detailed description of all major energy goods, including natural gas, through the entire energy value chain—investment, extraction of fossil fuels, production of electricity and bio energy, trade and consumption of energy—thereby offering a simultaneous and consistent determination of all prices and quantities in the energy markets. LIBEMOD takes into account different uses of natural gas (by sector and country), as well as inter-fuel competition between natural gas and other energy goods. Also the long distance between gas extraction sites and gas consumption centers in Russia, as well as the low and regulated end-user prices of natural gas in Russia, are integral parts of the model.

Our simulations suggest that if Russia builds Nord Stream 2, which is planned to have a capacity of 49 Mtoe,<sup>1</sup> Russian net exports of natural gas increase by 11 Mtoe only, which corresponds to 8 percent of Russian exports. Also net Russian exports to Europe increase by 11 Mtoe. Building Turkish Stream has almost the same effect on net Russian gas exports as Nord Stream 2, whereas net exports to Europe in fact slightly decrease. The drop in net exports to Europe reflects redirection of Russian exports; some of the export to Europe is replaced by export to Turkey. Note that lower imports of Russian gas to Europe are partly compensated by higher imports from other sources, in particular LNG. If Russia builds “Power of Siberia”, which is planned to have a capacity of 34 Mtoe, net Russian exports increase by 26 Mtoe, whereas net exports of Russian gas to Europe drop by 8 Mtoe. Again, the drop in imports from Russia is partly neutralized by higher imports from other sources.

Our paper contributes to the literature on Russian gas exports, in particular exports to the EU. Paltsev (2014) studies scenarios for Russia’s natural gas exports to Europe and Asia until 2050, using a recursive-dynamic, multi-regional general equilibrium model of the world economy—the MIT Emissions Prediction and Policy Analysis (EPPA) model. LIBEMOD differs significantly from the EPPA model along several dimensions. For example, LIBEMOD offers a more detailed modeling of the energy markets in each European country, but does not capture the interactions between the energy sector and the rest of the economy. Still, both studies find that (i) additional Russian pipeline capacity to Europe is not needed unless Russia wants to avoid transit via Ukraine, and (ii) Europe’s reliance on LNG imports may increase. In contrast to Paltsev (2014), our study provides information also on how increased Russian export capacities have impact on the Russian natural gas market.

Richter and Holz (2015) use the Global Gas Model (GGM) to assess implications of Russian gas disruptions for the EU, finding that most of the EU member states are not severely affected even by a complete drop out of Russian exports. In our study, we do not examine implications of no Russian exports to Europe, but we investigate long-run effects of no sales of Russian gas to Ukraine. We find that Ukraine is only moderately affected as long as it can compensate by importing natural gas from European countries.

A different strand of the literature examines games between Russia and potentially gas transit countries. One example is Hirschhausen et al. (2005). They analyze a non-cooperative game between Russia and Ukraine where Russia decides gas volumes transported through Ukraine to Europe, and Ukraine decides the transit fee. The study highlights the importance of transit options through Belarus. Our study has similarities with this study, but considers a

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1. Since LIBEMOD is an energy market model (i.e., not only gas), we report all volumes in Mtoe rather than bcm. To convert from Mtoe to bcm, a common conversion factor is 1.11 (BP 2016).

broader range of scenarios and applies a more detailed model for the energy markets in Europe and Russia.

Hubert and Ikonnikova (2011) apply cooperative game theory, thereby assuming that players negotiate effectively. Their approach allows to derive the bargaining power of the players endogenously. In the Hubert and Ikonnikova study, a number of gas pipeline projects are compared, for example, upgrading and extension of the existing pipe through Ukraine, upgrading and extension of Yamal 1 (Russian natural gas transported through Belarus and Poland to Germany), and Nord Stream. Assuming that countries have the power of veto over new pipelines on their territory, they find that the possibility to increase capacities of existing pipes does not change the bargaining power significantly. In contrast, the option of Russia to deliver natural gas directly to Western European customers (Nord Stream) is of major importance.

A related study is Nagayama and Horita (2014), who, using a network game model, examine how the Nord Stream pipeline has changed the relative power of Russia, Ukraine, Belarus and Western Europe. They challenge the traditional view that Russia is the player with the highest relative power; they find that prior to Nord Stream, Ukraine's relative power was comparable to that of Russia. This may rationalize the development of Nord Stream by Russia.

Chyong and Hobbs (2014) examine the now cancelled South Stream project, which was not that different from the Turkish Stream project. Assuming non-competitive behavior among natural gas producers and transit countries (Ukraine), they find that neither expectations of high demand growth in Europe, nor risk of transporting Russian gas through Ukraine, can justify construction of South Stream; the project has a negative NPV. This is similar to our conclusion.

Also Cobanli (2014) uses cooperative game theory to study investment in gas pipes. Building on Hubert and Ikonnikova (2011), the Eurasian gas market is examined, including the role of China. One main finding is that there is little demand competition for Central Asian gas. Further, because of Turkey's transit position, a large share of the benefits of the East-West gas trade accrues to this country. Finally, Hubert and Cobanli (2015), using the cooperative solution concept the Shapley Value to measure bargaining power, rank three pipe projects. They find that the strategic value of Nord Stream is huge. In contrast, additional leverage, obtained by developing South Stream, is much smaller, whereas the Nabucco project is not viable. In the present paper, investment in pipes from/to Russia is not determined endogenously. Rather, we explore the equilibrium effects (endogenous quantities and prices) of imposing different (exogenous) gas pipe projects. Therefore, our paper is complementary to the strand of the literature applying cooperative game theory to study investment in gas pipes within a simple economic framework. To the best of our knowledge, the latter is a tradition going back to Hoel et al. (1990).

Another strand of literature has focused on regulatory changes in the Russian gas market and/or a shift towards competitive Russian gas exports, and how this may affect gas exports to Europe, see, for example, Sagen and Tsygankova (2008) and Tsygankova (2010, 2012). Another example is Aune et al. (2015), which, using the same numerical model (LIBEMOD) as we do in the current paper, studies different liberalizations of the Russian natural gas markets under the assumption that export capacities are not altered. In the present study, we examine the partial effect of higher end-user prices of natural gas for industrial consumers when Russian natural gas export capacity to Europe is increased. Also Orlov (2015) studies implications of increasing domestic end-user prices for natural gas in Russia. Whereas his aim is to identify

the optimal domestic price of natural gas, we explore how higher end-user prices work under alternative assumptions about the Russian natural gas export capacity.

Hartley and Medlock (2009) use the Rice World Gas Trade Model (RWGTM) to study how the development in the world natural gas market depends on which Russian fields are developed and the Russian export capacity to the Asian natural gas markets. They conclude that in the long run, Russia has limited ability to adversely affect the Western European natural gas market, which partly reflects the important role of LNG. This is in line with our findings. For geoeconomic studies on Russian natural gas, including how development of Russia's natural gas resources might be the key to Russia's revival as a global power and the potential of natural gas trade between Russia and China, see Baker Institute (2009), Jaffe and Medlock III (2013), Henderson and Pirani (2014), Vihma and Turksen (2015), Henderson and Mitrova (2016), and Pirani and Yafimava (2016). Finally, also Goldthau (2008), IEA (2011), and Grimsrud et al. (2016) study the role of Russia in the future natural gas markets.

The rest of the paper is structured as follows. In Section 2, we discuss the prospects for the Russian gas industry, and in particular new export pipelines from Russia. The numerical model LIBEMOD is presented non-technically in Section 3. In Section 4, first the 2030 scenarios are presented. Each scenario covers extension of Russian gas export capacity—Nord Stream 2, Turkish Stream, Power of Siberia, or all three pipelines—relative to our 2030 reference scenario. Next, we discuss how the outcome of each scenario differs from the reference scenario. The robustness of each scenario is also examined in Section 4, for example, with respect to the outcome of more Russian export capacity if Russia bypasses Ukraine, and how a moderate liberalization of the domestic Russian natural gas price policy may have impact on Russian natural gas exports. In Section 5, we summarize the main findings and discuss policy implications of our study.

## ✎ 2. PROSPECTS FOR THE RUSSIAN GAS INDUSTRY ✎

### 2.1 Background—organization and driving forces

The Russian gas sector is not fully market based. It is dominated by one company—Gazprom—which inherited the production and transportation infrastructure from the Soviet gas ministry, see Kryukov and Moe (2013) for an analysis of the evolution of Gazprom. Natural gas is distributed in a system more akin to the principles of a centrally planned economy than a free market. The organization of distribution fits well with the pipeline infrastructure, which again is closely integrated with production sites.

In the early 1970s, the Soviet Union started to export natural gas to Western Europe—Austria, West Germany and Italy—after the pipeline network supplying Eastern Europe had been extended. The big increase in exports came in the 1980s after deals had been signed to construct a pipeline between the Urengoy field in West Siberia and the Soviet border with Czechoslovakia, see Estrada et al. (1988). After the break-up of the Soviet Union, monopoly for Russian pipeline exports was by law granted to the operator of the trunk pipeline system—Gazprom.

#### *Domestic Russian gas prices*

A key feature of Russian gas policy has been to keep domestic gas prices low. Whereas the oil sector to a large extent has been de-monopolized, and thus petroleum product prices

are market based, gas prices have been set much lower than the prices of alternative fuels, measured in energy content. The rationale behind this policy was Russia's ample and cheap gas supplies, and perceived market limitations for gas exports. Encouraging gas consumption was therefore a state priority, which is reflected in the high share of gas in domestic primary energy consumption (53 percent in 2015). This strategy was intertwined with social concerns: distributing gas at a low price was also a social stabilizer. Furthermore, low gas prices tend to lower electricity and heat prices, which are also important for everyday life.

For Gazprom deliveries to domestic customers have been a secondary activity, an obligation to serve, even if they represent much larger volumes than exports. The other side of the 'contract' with the government has been that Gazprom retains a large share of its export revenues. The reasoning behind this 'contract' was that export revenues would compensate for losses in the domestic market, as well as provide funding for investments. Gazprom honored its obligation to serve domestic consumers even during difficult periods in the 1990s when non-payment of delivered gas was rampant.

The situation changed in the early 2000s. Until then Gazprom had enjoyed ample supplies from its own fields and low capital costs because huge investments in production and transportation infrastructure had been made by the Soviet state. Now Gazprom had to invest in new production capacity as well as upkeep of infrastructure. In addition, exports to the European market did not grow as before.

Gazprom started to lobby for a domestic price reform that would ultimately bring domestic prices up to European net-back parity. This was accepted by the Russian government in 2007,<sup>2</sup> and was followed up in 2010 when the government decided to increase gas prices by 15 percent annually until 2015. By 2013 the regulated gas price had reached USD 105 per 1000 m<sup>3</sup>, see IEA (2014, 107), but then the government froze gas prices until 2015. The current policy is to let real gas prices grow slowly over time, see Aune et al. (2015). The aim is to establish a domestic industry gas price around 70 percent of the European net-back price by 2030.

Although Russian natural gas prices have increased considerably after 2000, they are still significantly lower than the corresponding user prices in the European natural gas market (corrected for differences in cost of transport and taxes). Moreover, it seems that the current Russian policy is to increase the price to large customers—gas power plants and manufacturing firms—rather than the price to small customers—households and services. There is, however, much uncertainty about gas price development even though Gazprom argues that the present price is too low to cover long-term costs and investments.<sup>3</sup> Below, we therefore examine how higher natural gas prices to large Russian customers may have impact on the Russian and European natural gas markets.

### *Disputes between Russia and Ukraine*

When the Soviet Union was dissolved, Ukraine became a transit country as well as the biggest importer of Russian gas. Due to its historical ties to Russia, Ukraine paid a much lower price for Russian gas than customers in the West, see Estrada et al. (1995).

2. Government resolution No. 333, 28 May 2007, "On improving state regulation of gas prices" <http://www.rg.ru/2007/06/02/a159632.html>

3. Gazprom is challenged by other producers (especially Rosneft and Novatek) who can offer gas at a lower price than the regulated price. For this reason, Gazprom lobbies for the right to compete on price. If Gazprom gets this permission, prices may actually fall in the short term, but probably not in the longer term.

The price was increased gradually, and raised tensions in the gas relations between the two countries. In 2006, a serious crisis erupted as Ukraine did not accept the newest Russian terms. Russia accused Ukraine for stealing some of the gas meant for transit and turned off the gas supplies. The conflict also affected customers further west and was a watershed in the perception of Russia as a reliable gas supplier. Both Gazprom and Russian authorities maintained that the crisis was a purely commercial dispute between Russia and Ukraine, and had no connection to its western customers. The immediate crisis was resolved quite quickly with Ukraine accepting a new price formula, but political processes were instigated in the EU with the goal of reducing Europe's dependence on Russian gas.

Three years later (spring 2009), a similar situation occurred with Gazprom cutting off supplies to Ukraine. This also led to supply disruptions to western countries (Stern 2014: 91–2). The negative image of Russia as a gas supplier was reinforced.

The next phase came after Russia's annexation of Crimea in 2014 and the violent conflict in Eastern Ukraine. Negotiations about the conditions for gas deliveries were going on, but, supplied with credit provided by western countries, Ukraine was in a position to import gas from European countries—mainly Slovakia—via reversed flows. This supply option had emerged due to a more integrated European gas transport infrastructure, which was partly spurred by the earlier gas supply crises. Ukraine's dependence on Russian gas has been reduced radically—in 2015 Ukraine's import of Russian gas was almost fifty percent less than the year before (Gazprom 2015). However, Ukraine also benefits from transit fees on Russian gas to the EU. In 2015, income from transit of Russian gas was 1.7 bill. USD—when it transited 64 bcm of Russian natural gas. It has since argued for much higher tariffs, which, if implemented, would make transit through Ukraine economically unfavorable compared with Nord Stream 1 and 2 (see next subsection). Currently, however, Russia remains dependent on transit through Ukraine, as approximately 60 percent of the Russian gas to the EU is transported through that country. Below, we therefore explore how no exports of Russian gas to and via Ukraine impact on Ukraine and the European natural gas market.

## 2.2 Natural gas export projects

### *The Nord Stream pipelines*

The dispute with Ukraine spurred Russia to launch a pipeline under the Baltic Sea—Nord Stream—that would bring Russian gas directly to Germany (no transit via other countries). The last string of Nord Stream was completed in 2012, and the total capacity of the pipe is now 49 Mtoe. Nord Stream was financed as a joint venture between Gazprom and western companies, reflecting that also consuming countries had been upset by the risk of instability in natural gas deliveries via Ukraine.<sup>4</sup>

In September 2015, an extension of Nord Stream—Nord Stream 2—with a capacity of 49 Mtoe was launched. The plan is that the new pipeline will use the same corridor as Nord Stream. The project was supported with letters of intention by several western companies. While an important Russian aim clearly was to reduce, or even abolish, dependence on transit through Ukraine, the western commercial participants see the project as a contribution to

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4. The business partners in the Nord Stream project were: Gazprom (51 percent), Wintershall Holding and E. ON Ruhrgas (15.5 percent each), and Gasunie and GDF Suez (9 percent each), see: <http://www.gazprom.com/about/production/projects/pipelines/active/nord-stream/>.

increased diversification and security of supply. The project is controversial, however, precisely because of the repercussions it may have for Ukraine (Riley 2015). After a conflict with Polish authorities about the legalities of a joint venture, the project company Nord Stream 2 AG was reorganized with Gazprom as the only shareholder and the western companies as ‘sponsors,’ committed to finance 50 percent of the total cost of 9.5 billion Euro.<sup>5</sup>

It is conceivable that Russian gas transported via Nord Stream to Germany could be pumped eastwards to e.g. Poland, that is, replacing Russian gas pumped via Belarus, especially in the event of disruption of supplies. Gazprom would probably express misgivings in the same fashion they have done over reverse flows to Ukraine in recent years. It is, however, hard to imagine that Gazprom would be able to block such flows because of the overarching principle in the development of the inner energy market that energy flows should be as unrestrained as possible.

### *South Stream—Turkish Stream*

After the first dispute with Ukraine, Gazprom also launched plans for a new pipeline under the Black Sea to Bulgaria—South Stream. The purpose of South Stream was also to fend off competition from gas producers in the Caspian region; these had worked out plans for competing projects, for example, the Nabucco pipeline.

Although there was considerable interest in the project in Southern Europe and the Balkans, the European Commission feared the project could establish a monopoly position for Gazprom in parts of Europe; it was deemed unrealistic that competing pipelines would be constructed once South Stream was operational. The European Commission therefore insisted that third party access had to be guaranteed. Preparations for the start-up of the construction work continued as the wrangling over principles went on. The general atmosphere between the EU and Russia deteriorated after the crisis in Ukraine, but it was still a surprise when President Putin in December 2014 declared that the project was cancelled, blaming the EU and Bulgaria.<sup>6</sup>

At the same time, Putin declared that an alternative pipeline—Turkish Stream—would be constructed, transporting gas to Turkey and Southeast Europe (via Greece). Development of the plan was frozen after political relations between Russia and Turkey soured in the autumn of 2015. By October 2016, relations were reestablished, however, and the project reinvigorated. The revised project includes two strings with an annual capacity of 15.75 bcm each (about 14 Mtoe), one destined for the Turkish market and the other for Greece and Southeast Europe.<sup>7</sup>

EU regulations, notably third party access, were an important factor in the discussions about South Stream since the pipeline would pass through EU countries (entering Bulgaria from the Black Sea). In the case of Turkish Stream, EU regulations do not apply since Turkey is neither a member of EU nor the Energy Community Treaty (Pirani and Yafimava 2016). But EU regulations are undoubtedly relevant for the extension of Turkish Stream into Greece and Bulgaria. Concrete plans have not been disclosed, but would probably have to include spare capacity to allow third parties the possibility to ship gas, in addition to the volumes from

5. The Western companies consist of ENGIE, OMV, Shell, Uniper and Wintershall. Nord Stream 2 AG and European energy companies have signed financing agreements, see: <https://www.nord-stream2.com/media-info/news-events/nord-stream-2-ag-and-european-energy-companies-sign-financing-agreements-47/>.

6. See Financial Times (2014). Anger and dismay as Russia scraps \$50bn gas plan. 2 December.

7. <http://www.gazprom.com/press/news/2017/may/article329932/>.

Gazprom. The EU has possibilities to exempt projects from the regulations of the Third Energy Package, but such exemptions are to a large extent dependent on political goodwill (Pirani and Yafimava 2016).

### *Power of Siberia*

China has seen soaring energy demand over several years. The country became the world's largest energy consumer in 2011. Coal accounts for a very high share of its energy consumption, representing about half of global coal consumption (BP 2016). China's energy policy aims to secure energy supplies, but also change the mix in favor of renewables and gas, which is important for the mitigation of the health and environmental problems associated with coal. Gas from Russia is one component in this policy.

Negotiations over pipeline gas sales from Russia to China had been going on for many years, but stalled several times because of disagreement over the price formula, with Russia demanding a price similar to the European market, which was unacceptable to the Chinese. There were also disputes over the location of pipelines and the sourcing of gas. As the talks dragged out, China negotiated comprehensive supply contracts with other producers, notably in Central Asia, and a common impression was that the Chinese were becoming less interested in Russian gas. However, in May 2014, shortly after the annexation of Crimea and the ensuing tensions with the West, Russia signed a gas export deal with China at terms acceptable to the Chinese. The agreement involves construction of a pipeline in Eastern Siberia—Power of Siberia—which will ultimately bring about 34 Mtoe from two fields, Chayanda and Kovykta, to China.<sup>8</sup> The China deal has been presented as a political victory, showing that Russia is not totally dependent on western markets for gas exports. Construction of Power of Siberia has started, but has slowed down, apparently because Chinese forecasts for gas demand have been lowered.

In 2014, at the time when the contract with Russia was negotiated, the Chinese National Development and Reform Commission estimated total gas demand by 2020 to reach 400–420 bcm, up from about 150 bcm in 2013. However, by the end of 2015 China's national petroleum company (Gazprom's contract partner) had adjusted its estimate for 2020 down to 300 bcm. Later, also this lower estimate has been questioned. At the same time, China's supply situation has improved (Rogers 2016); domestic production is growing, new sources of LNG have emerged, and piped supplies from Central Asia and Myanmar are increasing. Thus, there is less urgency in starting deliveries via Power of Siberia, but it is still reasonable to expect that the Russian gas will be needed by 2030.

The Chayanda and Kovykta gas fields are located far from the pipeline network that brings gas to the west. In fact, Russia would have preferred another gas corridor; the one via the Altai Mountains to western China. Such a project would be based on gas from West Siberia, which is the source for exports to Europe. Thus, such a line could involve arbitrage between deliveries to Europe and China. So far, China has not been much interested in this project because it would require costly transport of gas from the western part of China, where demand for gas is low, to the booming eastern part of China. Still, there is a possibility that this pipeline is also built before 2030, in which case a capacity of 27 Mtoe has been discussed.

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8. <http://www.gazprom.com/press/news/2014/may/article191451/>.

### *The future of Russian gas exports*

The discussion above suggests that it is pertinent to explore how the upcoming increases in pipeline capacity from Russia will affect its gas export, as well as prices and consumption of gas in Russia and in Europe. In Section 4, we investigate the effects of respectively Nord Stream 2, Turkish Stream, and Power of Siberia, comparing with a scenario for 2030 where none of these are built. We will also examine how these results are affected by potential changes in gas prices in Russia, and restrictions on gas sales to, and transit via, Ukraine. Finally, we assess the potential implications if a second gas pipeline is built between Russia (Western Siberia) and China.

### ✎ 3. THE NUMERICAL MODEL LIBEMOD ✎

We use the numerical model LIBEMOD, which provides a detailed description of the energy markets in 31 European countries, including Russia, to examine different scenarios for Russian gas exports. LIBEMOD is a deterministic, multi-good, multi-market, numerical, energy market model that covers EU-28 (except Croatia) along with Iceland, Norway, Switzerland and Russia. Because of long distances in Russia, and the fact that extraction of natural gas is located far from the main domestic consumption areas, Russia has been divided into three (LIBEMOD) regions; West, Middle and East Russia. Each Russian region is modelled as a separate country. Henceforth, the set of 31 countries, including the three Russian regions, is referred to as EUROPE-31, whereas we refer to EU-30 as the group covering EU-28 (except Croatia) along with Iceland, Norway, and Switzerland.

LIBEMOD determines *simultaneously* investment, extraction, production, trade, transport and consumption of all energy goods (prices and quantities) in EUROPE-31. In addition, LIBEMOD determines prices and quantities of the globally traded energy goods biofuel, coking coal, steam coal and oil. These equilibria are determined by global demand and supply, and hence all countries in the world (also EUROPE-31) are covered in this part of the model.

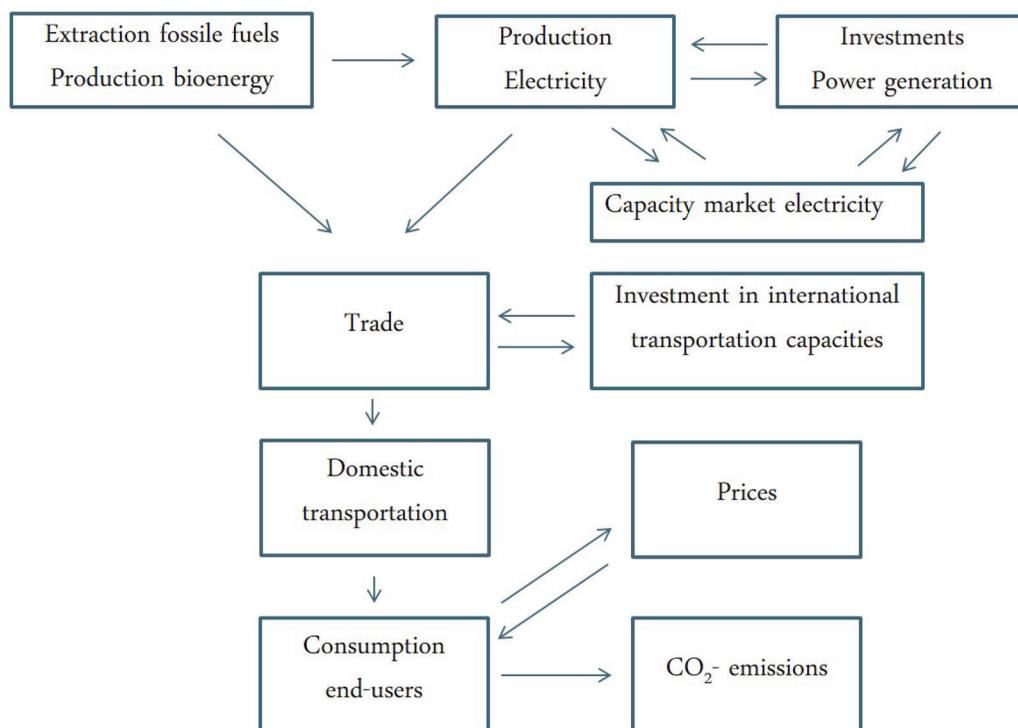
Figure 1 provides an overview of LIBEMOD.<sup>9</sup> There are five types of fossil fuels—coking coal, steam coal, lignite, natural gas and oil—and these are extracted in most of EUROPE-31, as well as in other countries. In addition, there is production of two types of bioenergy—biomass and biofuels. Bio energy is produced in EUROPE-31 as well as outside EUROPE-31.

In LIBEMOD, there are five big natural gas suppliers to the European market—Algeria, the Netherlands, Norway, Russia and the UK. For these countries, we distinguish between extraction from existing (“old”) fields in the data year of the model (2009), and (“new”) fields that may come on stream after 2009 if they are profitable. We use data from Rystad Energy to calibrate marginal costs of extraction from old and new fields in these five countries. There is also extraction of natural gas in (most of) the other EUROPE-31 countries, but the modeling is less detailed than for the five big natural gas extractors. Finally, there is price-sensitive export of natural gas to the European market from non-European countries, both piped gas and LNG.

Fossil fuels (except coking coal) and biomass are used as inputs to produce electricity in EUROPE-31. In LIBEMOD, electricity can also be produced based on nuclear, hydro (reservoir hydro, run-of-river hydro and pumped storage hydro), wind and solar energy. Each

9. Some arrows have deliberately not been included in order not to overload the figure. In particular, the figure does not incorporate the fact that prices affect all quantity decisions in the model, and that CO<sub>2</sub>-emissions also depend on fossil fuel extraction and notably electricity production.

## LIBEMOD



**FIGURE 1**  
Overview of the LIBEMOD model.

electricity producer solves a complex optimization problem that determines investment in new capacity, the share of total installed capacity that is maintained for economic activity, and what share of maintained capacity that is used to produce electricity—the remainder capacity is sold to a (domestic) system operator who is to ensure that the electricity system does not collapse.

Energy goods can be traded between countries. For piped natural gas, as well as electricity, trade requires infrastructure, that is, gas pipes or electricity transmission lines, running between two EUROPE-31 countries.<sup>10</sup> In the data year of the model, there is a set of pre-determined capacities. These can be expanded through profitable investments where costs of investment are compared to the corresponding benefits—the arbitrage possibilities of international natural gas (or electricity) trade. However, investments in pipelines between West Russia and European countries are handled according to the scenarios specified in Section 4.1.

In order to transport piped natural gas (and electricity) between countries, a transport fee (per unit of energy) has to be paid to the owners of the transport facilities. All fees are determined by LIBEMOD in a competitive manner. Hence, if there is excess demand for transport services, the fee will increase until demand for services exactly equals the capacity of the pipe.

10. In LIBEMOD, imports of LNG require infrastructure as well.

Within each EUROPE-31 country, natural gas (as well as all other types of energy) is transported to the customers at an exogenous cost, which differs between countries, energy goods and user groups. In LIBEMOD, there are five types of energy users. First, there is demand for energy from electricity generating plants using fossil fuels or biomass as an input. Second, there are four groups of end users; households, services (including the public sector), transport and industry. For each of these groups (in each EUROPE-31 country), there is a (CES) system of demand relations that ensures that demand for all types of energy is handled in a theory-consistent way. Calibration of the associated (CES) parameters reflects national and sectoral differences in energy structure and preferences.

In LIBEMOD, prices and quantities of *all* energy goods are determined simultaneously in a competitive manner. The model determines both producer prices and consumer prices. The latter reflect energy taxes and subsidies, environmental taxes, as well as VAT (many of these are de facto zero).

There is, however, one exception from the assumption of competitive markets, namely natural gas in Russia. As explained in Section 1, domestic Russian gas prices are regulated and are far below hypothetical competitive prices. In LIBEMOD, this is handled by calibrating subsidies that reflect the difference (in the data year 2009) between (i) the real cost of supplying natural gas to a user, for example, gas power stations or households, and (ii) the price this user actually paid for the natural gas. The calibrated subsidies are in the range of 120 to 166 €/toe in 2009, see Aune et al. (2015) for more details. Below, we use these subsidies for the 2030 scenarios. For given subsidies, the model determines producer and consumer prices of natural gas in Russia, and hence also natural gas prices in Russia are endogenous in LIBEMOD.<sup>11</sup>

We refer to Aune et al. (2008) for a more detailed and technical documentation of an earlier version of the model, and to Aune et al. (2015) and LIBEMOD (2015) for information about the latest version of the model, as well as data and calibration strategy.

## ✎ 4. RESULTS ✎

### 4.1 Alternative scenarios for 2030

We simulate LIBEMOD for the year 2030, with different assumptions about new pipelines from Russia. Table 1 shows the main scenarios. In addition, we have run some robustness scenarios, to which we return to at the end of this section.

The reference scenario for 2030 differs from the observed 2009 outcome along several dimensions.<sup>12</sup> First, while the 2030 demand system has the same parameters as the calibrated 2009 demand system, demand levels differ because the income levels differ. For each model country and end-user sector, demand for energy in 2030 reflects (exogenous) growth in GDP between 2009 and 2030 and the assumed income elasticity. The latter differs between energy

11. Because Russia is a large exporter of natural gas to the European market, it may have market power. In earlier work, see Aune et al. (2015), we have calibrated the market power of Russian gas, expressed as a mark-up over marginal cost. We found this mark-up to be relatively small (18 €/toe in 2009). In the present study, we assume there is no mark-up of Russian gas. First, the calibrated mark-up for 2009 is relatively small and will therefore have little effect on the European market. Second, the mark-up may change over time due to a number of factors. Whereas we found sign of market power in the 2009 European natural gas market, we assume that by 2030 the European natural gas market can be characterized as being competitive—this is line with the ambition of the EU.

12. Note that the reference scenario is not the scenario that seems most realistic, but simply a scenario where no new gas pipelines are built between Russia and Europe/China.

good and end-user group, and is calibrated to make the demand system consistent with IEA prediction for demand for energy in 2030, see IEA (2015).

Second, the 2030 predetermined capacities for electricity plants and international electricity transmission lines and gas pipes (that is, facilities that were established before 2010) are lower than in 2009 because of depreciation. On the other hand, there is expansion of a capacity if the corresponding investment project is profitable (except for transmission investments from Russia to other countries; these are assumed to be zero in the reference scenario).

Finally, we assume that the EU is successful in reaching its main 2030 climate and energy policy targets, that is, a 40 percent reduction in greenhouse gas emissions relative to 1990 (cf. the Paris agreement), and a renewable share in energy consumption of 27 percent. The EU imposes efficient EU-wide instruments to reach these targets in our scenarios, that is, a tradable quota system for the ETS sector, a uniform CO<sub>2</sub>-price for the non-ETS sectors, and a uniform renewable subsidy. We also impose CO<sub>2</sub>-prices to make emissions in non-EU member states in line with their Paris commitments.

In the three alternative scenarios, “Nord Stream 2,” “Turkish Stream,” and “Power of Siberia,” we assume that the respective gas pipeline is built and in operation in 2030. This is the only difference between this scenario and the reference scenario. In the scenario “All three pipes,” we consider the effects of building all three pipelines by 2030.

#### 4.2 Reference scenario

We start by comparing the reference scenario for 2030 with the historical base year 2009. Figure 2 shows the average user prices of natural gas in EU-30 and Russia, weighted over sectors and European countries/Russian regions. It is evident from the figure that the EU-30 user price was far above the Russian price in 2009—around ten times higher on average. One important reason is that gas users in Russia are de facto subsidized, whereas gas users in the EU are taxed, see Table 2, which shows the cost elements of the end-user price of gas in the EU-30 and Russia. As seen from the table, Russian consumers also enjoy the fact that they are located closer to major gas fields, and hence the marginal cost of supply (sum of extraction and international transportation cost) is much lower in Russia than in the EU.

Figure 2 shows that the average user price of gas in Russia is higher in the 2030 reference scenario than in 2009, which is due to a combination of several factors. First, we see from Fig-

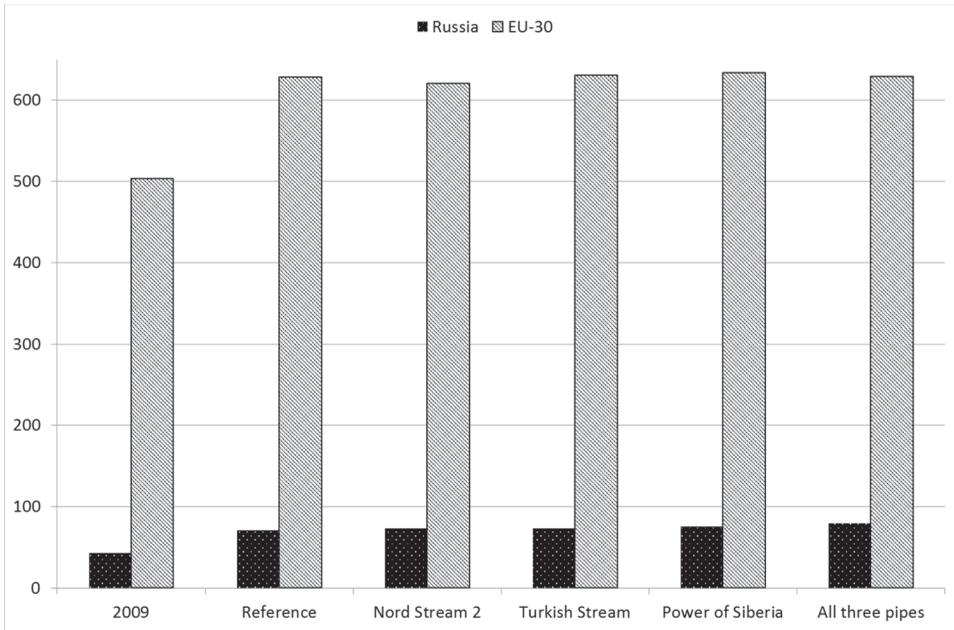
**TABLE 1**  
Alternative scenarios for 2030

Reference	See description in the text
Nord Stream 2	Same as reference, but Nord Stream 2 is built
Turkish Stream	Same as reference, but Turkish Stream is built
Power of Siberia	Same as reference, but Power of Siberia is built
All three pipes	Same as reference, but Nord Stream 2, Turkish Stream and Power of Siberia are all built

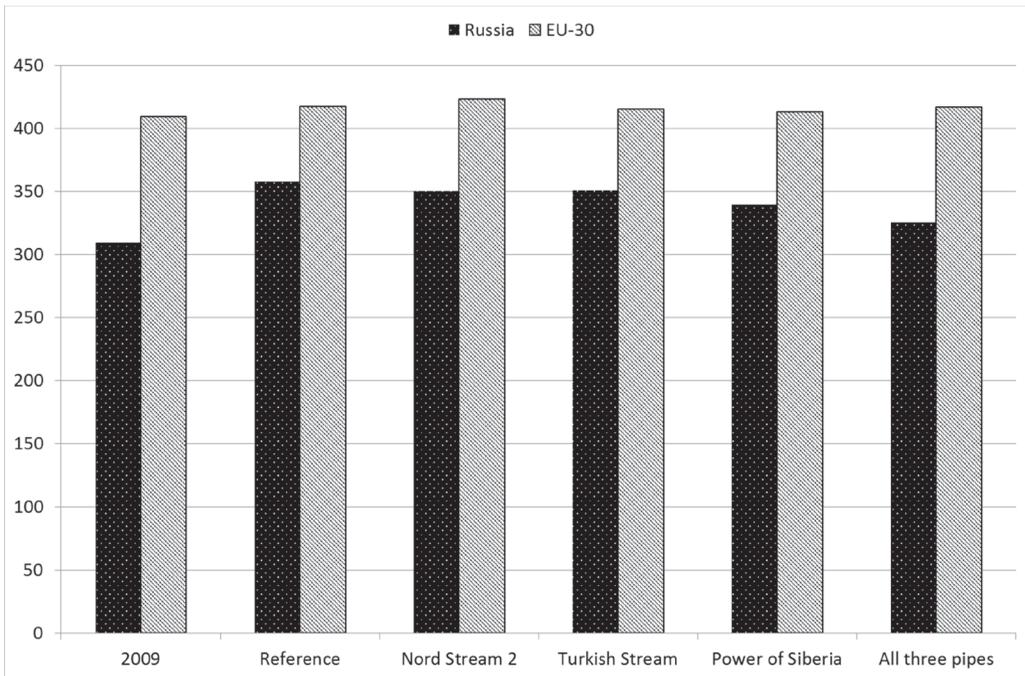
**TABLE 2**  
End-user prices for gas in Russia and EU-30 in the reference scenario. Euro<sub>2009</sub>/toe\*

	EU-30	Russia
Marginal cost of supply	196.3	120.4
Domestic energy losses	2.5	1.7
Domestic distribution costs	87.6	78.1
Energy taxes	26.5	0.0
Energy subsidies	0.0	-130.9
CO <sub>2</sub> -taxes	258.5	0.0
Value added tax (VAT)	57.3	1.7
End-user price (sum)	628.7	71.1

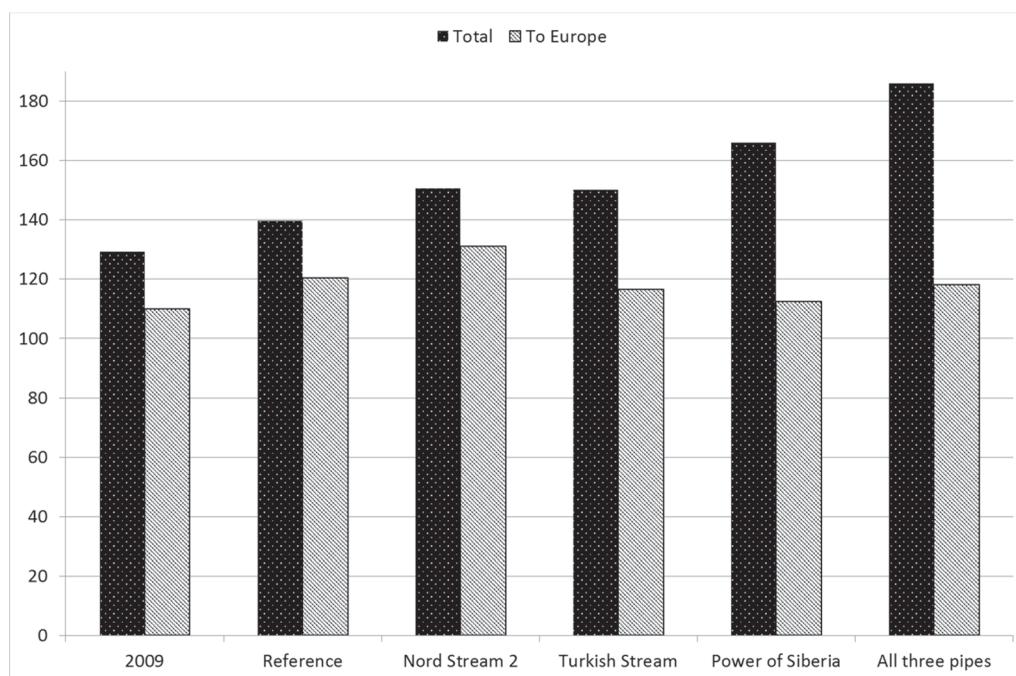
\*To convert from Euro per toe to Euro per million Btu, one has to divide by 39.7 (BP, 2016).



**FIGURE 2**  
Gas consumer prices in Russia and EU-30, Euro/toe.



**FIGURE 3**  
Gas consumption in Russia and EU-30, Mtoe per year.



**FIGURE 4**

Net export of gas from Russia, Mtoe per year.

Note: Europe includes here EU-30 (cf. model description in Section 3), Ukraine and Belarus.

ure 3 that Russian gas consumption increases towards 2030, despite higher prices, and are on average 16 percent higher in the reference scenario than in 2009. This is caused by economic growth, which stimulates energy demand in Russia, putting upwards pressure on gas prices. Second, gas extraction costs in Russia increase as production expands and more expensive fields are extracted. Third, Russian gas export increases somewhat (see Figure 4), which is related to higher gas prices in Europe. The average user price of gas in EU-30 has increased by 25 percent in 2030 vis-à-vis 2009, cf. Figure 2. Economic growth towards 2030, although somewhat sluggish in Europe, stimulates energy demand. On the other hand, EU's climate and energy policy has significant impacts on the European energy market, and the combined effect of CO<sub>2</sub>-prices and renewable support is to reduce demand for gas. Higher user prices of gas pull in the same direction. Higher gas prices in Europe are partly due to a significant reduction in own gas production towards 2030, which on the other hand is partly compensated by increased imports of LNG. The joint effect of all these factors is a minor increase in gas consumption in EU-30 compared to 2009, see Figure 3.<sup>13</sup> In the Appendix we display gas consumption levels at the country level in the different scenarios (Tables A.1 and A.2).

Figure 5 shows the transport volumes of gas from Russia in the reference scenario for 2030, and the corresponding pipeline capacities in the base year 2009. We see that Russia exports 35 Mtoe directly to EU countries (Germany (31 Mtoe), Finland (2 Mtoe), Lithuania (1 Mtoe) and Estonia (1 Mtoe)). In addition, 63 Mtoe is exported to Ukraine and 20 Mtoe to

13. Gas consumption in the EU has in fact decreased by 20 percent from 2010 to 2015 (BP 2016). Böhringer and Rosendahl (2010) shows that supporting renewables has particularly negative effects on gas consumption if an emission trading system like the EU ETS is already in place.

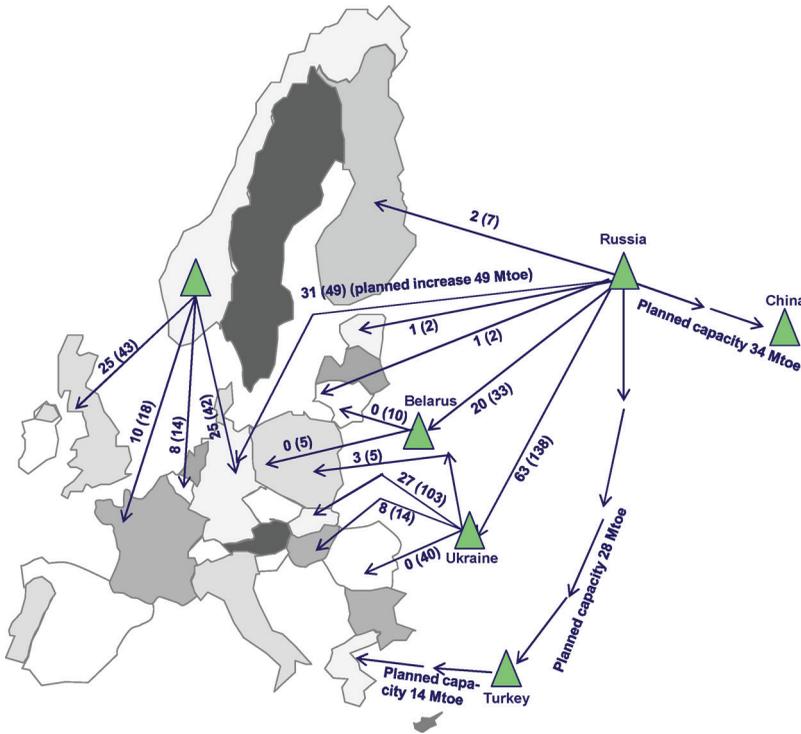


FIGURE 5

Transport of natural gas in the reference scenario (Transport capacities in 2009), Mtoe.

Belarus.<sup>14</sup> 60 percent of the export to Ukraine (38 Mtoe) is sent on to EU-30. Thus, Ukraine is an important transit country for Russian gas export to the EU.

In the following subsections, we will discuss the alternative scenarios shown in Table 1, and mainly compare them with the reference scenario.

### 4.3 New gas pipeline through the Baltic Sea

Our first alternative scenario considers the effects of building an additional gas pipeline directly from Russia to Germany, i.e., the Nord Stream 2 pipeline. The capacity of the new pipeline is planned to have the same capacity as the first Nord Stream pipeline, i.e., 49 Mtoe per year. This is a significant increase in Russia’s gas pipeline capacity—in the reference scenario Russian net gas export is 140 Mtoe.

The effect of the “Nord Stream 2” scenario is to increase Russia’s (net) gas exports by 11 Mtoe per year. Given the substantial increase in capacity (49 Mtoe), the increase in export level is rather modest. Export directly from Russia to Germany increases much more, however, by almost 40 Mtoe, whereas exports via Ukraine to central Europe drop by around 25 Mtoe. Thus, the Nord Stream 2 pipeline will make Russia less dependent on gas transit via Ukraine. Gas consumption in Ukraine is not much affected though—it declines by merely 0.5%.

The Nord Stream 2 pipeline has little influence on total gas consumption and average gas prices in EU-30—prices fall by 1–2 percent while consumption grows by 1–2 percent. Gas

14. Russia also exported 19 Mtoe to other non-EU countries (but this is not included in Figure 5).

prices and consumption in Germany do not react much more than in the rest of the EU. This is due to available pipeline capacity between Germany and neighboring countries. Hence, Germany imports less from other sources when Nord Stream 2 is built, and also sends some of the imported gas to other countries. The effects on Russian gas consumption and prices are more or less the mirror image of the effects in EU-30, see Figures 1–2.

Note that the Nord Stream 2 project does not obtain a positive present value in this scenario, and thus it is not profitable. This finding reflects partly that it is costly to build pipelines, and partly that the existing capacity to the European market is high from a pure profitability point of view.

#### 4.4 Gas pipeline through Turkey

Our second alternative scenario examines the consequences of the Turkish Stream pipeline, i.e., building a pipeline from Russia to Turkey, and another pipeline via Turkey to Greece. Based on the announced plans for the project, we implement into our model a pipeline capacity from Russia to Turkey of 28 Mtoe per year, and a capacity from Turkey to Greece of 14 Mtoe per year, see Figure 5. The difference (14 Mtoe) is assumed exported from Russia to gas users in Turkey (Turkey is not a separate region in the model, but part of the region Rest of World).

The “Turkish Stream” scenario has almost the same effect on total Russian gas exports as the “Nord Stream 2” scenario, that is, an increase of 10 Mtoe compared to the reference scenario. That includes the assumed 14 Mtoe exported to Turkey, which means that exports to EU-30 actually drop by 4 Mtoe (see Figure 4). In fact, none of the new capacity to Greece is being utilized. Hence, gas prices in the EU increase, gas consumption falls, and supply from other gas producers increases, but all these effects are only marginal.

Our conclusion is therefore that the Turkish Stream project, at least the second string into Greece, makes little sense when considering Russian exports to the EU, unless long-term strategic issues are taken into account. One such issue could be to prevent other proposed projects, such as the now abandoned Nabucco project. Ironically, realization of the Trans Adriatic Pipeline (TAP)—intended for bringing Azeri gas, pumped via Turkey, to Italy—could also become a channel for Russian gas via Turkish Stream.<sup>15</sup> Another issue could be to gradually become independent of transit through Ukraine. In a situation where the pipelines through Ukraine are not used, the effects of the Turkish Stream projects are bigger (see robustness analysis in subsection 4.7).

#### 4.5 Gas exports to China

In 2014, Russia and China signed an agreement on exports of gas from Russia to China, called “Power of Siberia”. According to the agreement, Russia will deliver around 34 Mtoe by 2030, transported via Eastern Siberia into the northeastern part of China. In our “Power of Siberia” scenario, we assume that 34 Mtoe is exported from East Russia to China in 2030 (China is not a separate region in the model, but part of the region Rest of World).

We find that total exports of gas from Russia increase by 26 Mtoe compared to the reference scenario, i.e., somewhat less than the new export volume to China. This means that net exports to Europe decline by 8 Mtoe, as gas transit via Ukraine to central Europe decreases (see Figure 4). Gas consumption in EU-30 decreases by 4.5 Mtoe, in Ukraine/Belarus by 0.5

15. TAP’s initial capacity will be 10 bcm, see <http://www.euractiv.com/section/energy/news/russia-can-use-trans-adriatic-pipeline-commission-confirms/>, and thus may have modest impact until its capacity eventually is increased radically.

Mtoe, which means that supply from other sources increases by 3.5 Mtoe (of which only 1 Mtoe comes from extraction in Europe).

The increased gas export from Russia comes partly from increased Russian gas production (8 Mtoe), but mostly from reduced Russian gas consumption, which drops by 18 Mtoe or 5 percent (see Figure 3). Average user prices in Russia increase by 6 percent in this scenario, as higher extraction implies somewhat higher marginal costs of extraction. This is especially the case in East Russia, where user prices increase by 25 percent.

#### **4.6 All three pipelines**

As explained before, all three pipelines considered in the preceding subsections are expected to be in operation by 2030. Hence, it is natural to also model the effects of having all three pipelines available. This is done in the scenario “All three pipes.” In this case, net exports from Russia increases to 186 Mtoe in 2030, that is, 46 Mtoe higher than in the reference scenario (see Figure 4). However, as 34 Mtoe is exported to China, and 14 Mtoe to Turkey, net exports to EU-30 actually slightly declines. The new Nord Stream 2 pipeline is extensively used in this scenario, whereas the second part of the Turkish Stream pipeline (going into Greece) is still not used. Gas transit via Ukraine is substantially reduced due to the Nord Stream 2 pipeline, similarly as in the “Nord Stream 2” scenario.

As net Russian gas exports to EU-30 are almost unchanged vis-à-vis the reference scenario, gas prices and consumption in EU-30 are also quite unaltered in the “All three pipes” scenario compared to the reference scenario. The effects in Russia are more pronounced. Average user price of gas increases by 12 percent, while total gas consumption drops by 9 percent. Again, the impacts are biggest in East Russia.

#### **4.7 Robustness analysis**

There are a number of uncertainties about the future gas markets in Europe and Russia, both with regard to policies and market development. Hence, it is useful to do some robustness analysis with regard to some of the most important assumptions. In this subsection, we will consider three important policy assumptions, and assess the impacts of the new pipelines given such alternative assumptions. As our main focus in this paper is on Russian gas exports to Europe, we will mostly focus on that in our robustness analysis.

First, as mentioned in Section 2, gas prices in Russia are highly regulated, with significant (implicit) subsidies to both small and large gas users. Previously, the Russian government intended to increase the regulated prices, but the process has been rather slow. It seems that the current Russian policy is to increase the price to large customers—gas power plants and manufacturing firms—rather than the price to small customers—households and services. Hence, we consider an alternative set of scenarios (“Reduced subsidies”) where the implicit subsidies to large customers are halved in 2030, while subsidies to small customers are unchanged.

Second, as also mentioned in Section 2, there is a conflict between Russia and Ukraine, which periodically has affected gas exports from Russia via Ukraine to Europe. If the conflict escalates further, the export route via Ukraine could potentially be blocked. Although a full blockade of the gas pipelines via Ukraine may seem unrealistic today, it is of interest to consider the consequences. Thus, we investigate an alternative set of scenarios (“No transit via Ukraine”) where Russia does not export any gas to or via Ukraine. Hence, Ukraine has to buy natural gas from other countries in order to supplement its domestic extraction of natural gas, and Russia has to use other routes than through Ukraine for its gas export to the EU.

TABLE 3

Net exports of gas from Russia in 2030 (Net exports to Europe in parenthesis), Mtoe per year

	Benchmark assumptions	Reduced subsidies	No transit via Ukraine	More gas to China
Reference	140 (120)	160 (141)	78 (59)	NA
Nord Stream 2	151 (131)	197 (178)	117 (98)	NA
Turkish Stream	150 (116)	190 (156)	107 (73)	NA
Power of Siberia	166 (112)	195 (141)	112 (58)	189 (108)
All three pipes	186 (118)	230 (162)	164 (96)	200 (105)

Note: Europe includes here EU-30 (cf. model description in Section 3), Ukraine and Belarus.

Third, in Section 2 we briefly discussed the possibility of an additional pipeline from Russia (West Siberia) to China. Although China has not been particularly interested in such a pipeline so far, this could possibly change if Chinese gas demand grows strongly and other gas supply options seem less favorable. Hence, we investigate a scenario (“More gas to China”) where Russia and China comes to an agreement about this additional pipeline, so that Russian exports to China become 61 Mtoe in 2030, rather than 34 Mtoe as in the “Power of Siberia” scenario.

We start with the effects of reducing subsidies to large gas customers. This has significant impacts on Russian gas exports. In all scenarios discussed above (cf. Table 1), net exports from Russia increase substantially if subsidies to large gas customers in Russia are halved, see Table 3. The reason is that the use of gas in Russia decreases significantly, both in the manufacturing industries and especially in electricity generation. Hence, more gas is available for export.

From Table 3 we also see that the impacts of the new pipelines for Russian gas export are more pronounced when subsidies to large gas customers in Russia are halved. For instance, whereas the Nord Stream 2 pipeline increases Russian exports by modestly 11 Mtoe per year with the benchmark assumptions, with lower subsidies Russian exports increase by 37 Mtoe. Thus, gas transport via the Nord Stream 2 pipeline to a much lesser degree replaces gas transit via Ukraine. Further, whereas the Turkish Stream pipeline does not bring any gas to Greece with the benchmark assumptions, the capacity is fully utilized if subsidies to large Russian customers are reduced. Finally, Power of Siberia no longer leads to reduced gas exports to Europe.

Next, we consider the impacts of blocking gas transit via Ukraine. This implies that the pipeline capacity to Europe is substantially reduced, and hence Russian gas exports drastically decline in the new reference scenario (see Table 3). This stimulates gas supply from other countries—gas production in Norway, the Netherlands, the UK, and Algeria increases by respectively 4 percent, 1 percent, 4 percent, and 2 percent (compared with the original reference scenario). Still, gas consumption in EU-30 declines by 9 percent, and the average user price of gas is now 7 percent higher in EU-30 than in the original reference scenario. Gas consumption in Ukraine is also reduced, but not more than in EU-30.

The effects of the new pipelines on Russian gas exports are much bigger than with the benchmark assumptions, and quite similar to the corresponding effects in the case with reduced subsidies. Thus, both the Nord Stream 2 pipeline and the Turkish Stream project seem more rational in a situation where Russia wants to be less reliant on gas transit via Ukraine, and might therefore be seen as strategic projects. However, we note that exports to Europe are lower with all three pipelines built but no transit via Ukraine (96 Mtoe) than with transit via Ukraine but no new pipelines (120 Mtoe), and hence gas prices in EU-30 are slightly higher in the former case.

If gas exports from Russia to China are increased to 61 Mtoe per year, exports to Europe are reduced by 4 Mtoe compared to the “Power of Siberia” scenario, and by 12 Mtoe compared to the reference scenario. Hence, increased Russian gas sales to China shift more of its exports away from Europe, but the impacts are far from dramatic.

## 5. POLICY IMPLICATIONS AND CONCLUDING REMARKS

Russia is the biggest gas exporter in the world, and most of its exports go to EU member states. As all other natural gas suppliers, Russia puts great emphasis on security of demand, which reflects the huge costs of extracting and transporting natural gas. At the same time, Russia is the biggest supplier of gas to the EU, and the EU puts great emphasis on security of supply.

Traditionally, this mutual interest for security—security of demand for the supplier vs. security of supply for the purchaser—has been handled by long-term contracts. The development towards a more competitive European gas market has increased the share of spot trade in the European gas market, and thus affected both security of demand and supply. Also the disputes and conflicts between Russia and Ukraine have had impact on security of demand and supply.

In this paper we have used the numerical energy market model LIBEMOD to investigate long-run effects of increased export capacity of piped Russian gas. We find that each of the three projects Nord Stream 2, Turkish Stream and Power of China leads to a moderate increase in net total Russian export, but the increases are lower than the capacities of the new pipes. The impact of consumption of natural gas in EU-30 is minor. If all three pipes are constructed, net total Russian export of natural gas increases by one third, whereas net Russian export to EU-30 is almost unchanged. We have also examined the impact of new export pipes for Russian gas if subsidies to large Russian natural gas consumers are reduced by 50 percent, or there are no sales to, or transit via, Ukraine. We find that the effects of increased export capacity are much stronger if natural gas subsidies to large consumers are halved.

We now turn to policy implications of our model runs. We believe the EU is facing a dilemma in balancing economic and political concerns related to gas supplies. According to conventional economic reasoning, the more pipelines actors are willing to build, the better for gas suppliers, provided the pipelines are built according to EU regulations and offer third party access. At the same time, developments in Ukraine are clearly a challenge for the EU, including shoring up the country’s economy. A situation where transit through Ukraine comes to a halt would imply that the country loses important income.

Another argument against pipelines circumventing Central Europe has been that transit countries would be more vulnerable to pressure from Russia if they did not control transit of Russian gas to the major buyers in Western Europe. These concerns have been particularly strong in Poland, which has feared that projects like the Nord Stream pipeline may allow Russia to cut off natural gas deliveries to Poland without affecting important EU customers located farther west. This reasoning has lost much of its strength, however, because of construction of interconnectors, and generally a more flexible gas market induced by EU’s policy. One example is Ukraine, which is now much less dependent on Russian gas than a decade ago. Thus, a further development of this policy seems like an obvious implication for the EU.

When it comes to Russia, our analysis shows that the various pipeline scenarios have little effect on the total volume of Russian gas exports to Europe. The existing transport overcapacity increases, and thus a pipeline like Nord Stream 2 is not profitable according to standard business calculations. Still, it is the expressed aim of Russia to build pipelines that will reduce, or eliminate, its transit risk.

As shown in our model simulations, more gas will be exported if Russian subsidies to domestic consumers are reduced. Even if such a policy may have negative domestic implications, it is still clear that there is scope for substantial gas conservation in Russia. But also the production potential in Russia is big (see Aune et al. 2015), indicating that there is not much of a supply constraint. Rather, the problem is demand in the export markets, which is determined by economic and political factors.

Russia has criticized and been uncomfortable with European policies aimed at reducing the dependence on Russian gas. Russia can mitigate some of this problem by not repeating the mistakes it made during the gas conflicts with Ukraine. It may even be argued that it would be in Russia's interest to keep some transit via Ukraine, to show good will. Also, keeping a transit corridor through Ukraine gives Russia some commercial flexibility. However, the terms for transit will of course be affected by the alternative routes for gas transport, like Nord Stream 2.

An important upshot of our analysis is that it is in Russia's interest to see a continued development of an open, flexible inner energy market with many interconnectors. As shown in the simulations, central European countries are not drastically affected in the long run if supplies via the traditional transit routes through Ukraine are phased out; this indicates that the leverage Russia has on this country is already reduced. Paradoxically, this means that Ukraine could be less concerned by contracting substantial volumes of Russian gas in the future.

Russia's challenge in the European market is also caused by sluggish demand. Some of the stagnation is connected to a development where gas, in many circles, is regarded as a less reliable energy source than earlier; some of the resentment has been caused by Russian behavior. A development where the market becomes more open and flexible will be beneficial for all suppliers. Therefore, the policy implications for the EU and Russia are similar—to support further integration of European markets—but for somewhat different reasons. Russia wants to sustain, or increase, its exports to Europe, whereas the EU wants to make sure that the market functions well and that no country becomes vulnerable to pressure from Russia.

We close by stressing that we have examined *long-run* effects of capacity expansions and policy shifts, that is, we have assumed that actors have rational expectations and therefore know several years in advance what will actually happen in the future. Thus, they can plan accordingly. Needless to say, short-run effects may differ radically from long-run effects. This might be the case, for example, if Russia stops transporting natural gas through Ukraine; in the short run, disruptions might not be counteracted by increased imports from other sources, and also demand responses might be stronger as substitution between energy carriers and adjustment of capital equipment take time. Yet, Bouwmeester and Oosterhaven (2017) find that short-run effects of disruptions between Russia and EU are negligible for the EU economy.

Finally, in this study Russia is the only large exporter of piped natural gas outside Europe. In the very long run, say, 30 years or more, other suppliers might deliver piped gas to Europe, like Turkmenistan, and even Iran; these are countries with vast natural gas reserves. Hence, security of supply might not be a major concern for Europe in the very long run—to the extent natural gas will be used in a Europe with strict climate targets.

✦ APPENDIX: DETAILED INFORMATION ON NATURAL GAS CONSUMPTION ✦

**TABLE A.1**  
Total use of natural gas (Mtoe)

	2009	Reference	Nord Stream 2	Turkish Stream	Power of Siberia	All Pipes
Austria	7	11	10	10	9	10
Belgium	15	16	16	15	15	16
Bulgaria	2	1	1	1	1	1
Cyprus	0	0	0	0	0	0
Czech Republic	6	10	10	10	10	10
Denmark	3	2	2	2	2	2
Estonia	1	0	0	0	0	0
Finland	3	1	1	1	1	1
France	38	31	31	31	31	31
Germany	76	96	97	96	95	96
Greece	3	1	1	1	1	1
Hungary	9	8	8	8	8	8
Iceland	0	0	0	0	0	0
Ireland	4	1	1	1	1	1
Italy	63	56	56	56	56	56
Latvia	1	1	1	1	1	1
Lithuania	2	2	2	2	2	2
Luxembourg	1	3	4	3	3	3
Malta	0	0	0	0	0	0
Netherlands	34	39	40	39	38	39
Norway	2	1	1	1	1	1
Poland	11	27	28	27	27	28
Portugal	4	2	2	2	2	2
Romania	10	6	6	6	6	6
Russia	309	358	350	351	340	326
Slovakia	4	5	5	5	5	5
Slovenia	1	1	1	1	1	1
Spain	31	18	19	18	18	18
Sweden	1	1	1	1	1	1
Switzerland	3	4	4	4	4	4
United Kingdom	72	71	71	70	70	71
<b>EU-30</b>	<b>409</b>	<b>418</b>	<b>424</b>	<b>415</b>	<b>413</b>	<b>417</b>
<b>Europe-31</b>	<b>719</b>	<b>776</b>	<b>774</b>	<b>766</b>	<b>753</b>	<b>742</b>

**TABLE A.2**  
End use of natural gas as a share of total use of natural gas (percent)

	2009	Reference	Nord Stream 2	Turkish Stream	Power of Siberia	All Pipes
Austria	63	45	47	49	51	48
Belgium	67	68	66	69	70	68
Bulgaria	54	99	98	99	99	99
Cyprus	no use	0	0	0	0	0
Czech Republic	85	100	100	100	100	100
Denmark	47	83	82	83	84	83
Estonia	39	100	100	100	100	100
Finland	36	100	100	100	100	100
France	83	100	100	100	100	100
Germany	77	76	76	77	77	76
Greece	37	90	90	91	91	90
Hungary	70	100	100	100	100	100
Iceland	no use	no use	no use	no use	no use	no use
Ireland	37	100	100	100	100	100
Italy	58	63	63	63	63	63
Latvia	37	100	100	100	100	100
Lithuania	50	100	100	100	100	100
Luxembourg	57	22	17	24	26	23
Malta	no use	0	0	0	0	0
Netherlands	63	70	69	71	71	70
Norway	51	100	100	100	100	100
Poland	89	61	60	60	61	60
Portugal	37	100	100	100	100	100
Romania	71	97	98	97	96	98
Russia	34	38	39	39	39	39
Slovakia	78	100	100	100	100	100
Slovenia	80	100	100	100	100	100
Spain	47	89	87	89	90	89
Sweden	51	100	100	100	100	100
Switzerland	92	100	100	100	100	100
United Kingdom	59	61	61	61	61	61
<b>EU-30</b>	<b>65</b>	<b>74</b>	<b>73</b>	<b>74</b>	<b>74</b>	<b>74</b>
<b>Europe-31</b>	<b>52</b>	<b>57</b>	<b>57</b>	<b>58</b>	<b>58</b>	<b>59</b>

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