EFFECTS OF INFRASTRUCTURE INVESTMENTS SUCH AS THE NORD STREAM 2 PIPELINE ON THE EUROPEAN GAS MARKET

Report on behalf of Nord Stream 2 AG

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EXECUTIVE SUMMARY

Infrastructure investments in the energy sector generally have a positive effect on security of supply and competition in the energy industry. Nevertheless, in the public debate arguments are sometimes put forward which claim the opposite.

Against this background, Frontier Economics has been commissioned by Nord Stream 2 AG to examine this debate and provide an assessment of the benefits of infrastructure investments for security of supply and competition in general and for the Nord Stream 2 project in particular. To support Frontier’s analysis, the Energy Economics Institute at the University of Cologne ("EWI") simulated the effects of Nord Stream 2 on gas prices in Europe using the TIGER European gas infrastructure model.\(^1\)

Infrastructure investments have a fundamentally positive effect on security of supply

Infrastructure investments in the energy sector make a positive contribution to security of supply:

- **Infrastructure investments increase the capacity of infrastructure and thus improve the resilience of the supply system** – New infrastructure creates additional capacity (on existing or new routes) and sometimes even additional transport options (e.g. in the form of new routes or new technologies). This makes the energy system less vulnerable to failure of individual infrastructure components. Infrastructure which is used to develop a new transport route also makes the system less prone to supply disruptions on individual routes.

- **Infrastructure investments create the possibility of transporting additional energy volumes** - Infrastructure investments not only increase the security of supply for energy volumes already delivered; they also create the possibility of transporting additional energy volumes. For example, this helps in case of an increase in demand for an energy carrier such as an increased need for gas for use in power plants in a scenario with phase-out of coal plants. It also helps to make the transport of energy more flexible. For example, in winter months with high heating demand, additional quantities can be transported during the winter peak.

Infrastructure investments also have a positive effect on competition

Infrastructure investments also have a positive effect on competition:

- **Infrastructure investments increases the excess of supply capacity over demand.** This intensifies competition even if the infrastructure investments do not bring new competitors into the market.

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\(^1\) The public short report presented here is based on an expert report prepared by Frontier Economics and the Energy Economics Institute at the University of Cologne ("EWI") in the context of Nord Stream 2 AG's application to the German Federal Network Agency (BNetzA) for a derogation from energy regulation under EU Directive 2019/692.
Competition is further intensified when an infrastructure investment creates or enhances the possibility for new players to enter the market.

Negative effects of infrastructure investments on security of supply or competition are only expected in exceptional cases

How can it then be argued that certain infrastructure investments may harm security of supply and competition? Such arguments refer to hypothetical scenarios. It is important to critically examine to what extent such specific situations actually occur in practice.

These special arguments are based on an alleged "deterrent effect" of the infrastructure investment in question ("predatory behaviour"). A new infrastructure could weaken the security of supply or competition in individual regions if the new infrastructure makes the use of another existing or prospective alternative infrastructure less attractive and this infrastructure is subsequently prematurely closed down, or not even built in the first place.

While such predatory may occur in hypothetical scenarios, in a practical energy sector setting it is extremely unlikely that new gas infrastructure will negatively affect security of supply or competition in the gas market (as for the case of the Nord Stream 2 pipeline, see below).

The Nord Stream 2 pipeline has a positive effect on security of supply and competition

The above-mentioned benefits of infrastructure investments on security of supply and competition can also be expected from the commissioning of the Nord Stream 2 pipeline. Our analyses show that Nord Stream 2

- increases the resilience of the European gas system and provides a considerable additional capacity buffer to meet European gas demand at peak times; and
- enables the import of additional Russian gas quantities that are needed to meet the future increasing import demand in Europe at low cost.

Some concerns have been expressed in public debate. For example it is sometimes argued that, as a result of the commissioning of Nord Stream 2, Russian gas will be transported to Europe via different routes, which will make gas supply in individual EU countries more difficult or more expensive.

These arguments do not stand up to detailed and critical examination:

- Russian gas from current and future gas fields to Western Europe is transported by the shortest route via the Nord Stream and Nord Stream 2 pipelines, which offer the most cost-effective and environmentally friendly transport of Russian natural gas to Europe.
- Market and price simulations show that the use of the Nord Stream routes reduces the costs and thus also the prices of gas supply in Europe. This applies not only to the European average, but also to each EU member state individually due to the significant increase in market integration within Europe in recent years. The underlying effect for the reduction in price is that, without
the Nord Stream 2 pipeline being available, a larger share of European gas demand will have to be covered by the comparatively longer and more expensive Ukrainian transit route and by more expensive LNG. In particular, this analysis shows that in the long term not only Nord Stream 2, but also the Ukrainian transit route will be needed to supply Europe with gas in the most cost-effective way. There will therefore be no crowding out of alternative transit pipelines which could affect the EU's security of supply.

Potential arguments against Nord Stream 2 therefore appear to be unfounded: it could be argued that Nord Stream 2 will displace some liquefied natural gas (LNG) from the European market. However, this would not be detrimental to security of supply or competition. LNG is a very flexible import option. The possible short-term replacement of LNG by gas via the Nord Stream route does not prevent LNG from remaining a competitor and a supply option. As soon as supply gaps occur or gas prices are threatened to rise, further LNG could be imported flexibly into Europe.

Against this background, Nord Stream 2 will make a positive contribution to the security of energy supply in Europe. Nord Stream 2 will not harm competition, but will benefit the European economy and society by reducing supply costs.
1 INTRODUCTION

Infrastructure investments in the energy sector generally have a positive effect on security of supply and competition. Nevertheless, in the public debate arguments are sometimes put forward which claim the opposite.

Against this background, Frontier Economics has been commissioned by Nord Stream 2 AG to examine this debate and provide an assessment of the benefits of infrastructure investments for security of supply and competition in general and for the Nord Stream 2 project in particular.\(^2\)

This report is structured as follows:

- In Chapters 2 and 3 we explain the positive effects of infrastructure investments in general terms with the help of simple examples and indicators. In doing so, we look at the (specific) cases in which infrastructure investments could have negative effects on security of supply and competition.

- In Chapter 4 we discuss these effects specifically for the case of the Nord Stream 2 pipeline. The Nord Stream 2 pipeline is a 1,230-kilometre-long transport link from Russia through the Baltic Sea to Germany, most of which has already been laid and is scheduled to be commissioned in the near future.

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2 POSITIVE IMPACT OF INFRASTRUCTURE INVESTMENTS ON SECURITY OF SUPPLY IN THE EUROPEAN GAS MARKET

Both Germany and the EU as a whole are dependent on the import of energy sources to cover their energy consumption. In total, more than half of Europe’s energy needs in the EU today are met by imports. While import dependency (measured as the share of net imports in gross domestic consumption and bunker stocks) on crude oil has remained stable between 80%-90%, and on hard coal between 40%-50% over the past 10 years, import dependency on natural gas has risen significantly over the same period (from 60% in 2007 to 75% in 2017 and 83% in 2019). This is due to the increasing exploitation and higher production costs of domestic reserves, and will continue to rise in the future.\(^3\)

A sufficient, technically reliable and diversified natural gas infrastructure therefore plays a decisive role in meeting European demand for natural gas now and in the future.

2.1 Security of gas supply has a large economic and social value for Germany and the EU

Natural gas covers around 25% of the primary energy needs of Germany\(^4\) and the EU\(^5\). A secure energy supply is therefore not conceivable without a secure supply of gas. At the same time, gas cannot easily be substituted by other energy sources and therefore has an important role in key sectors:

- **Heat market** - Gas is the most important primary energy source for heating in buildings. Around half of all homes in Germany are heated directly with gas. Gas can also be used indirectly as the primary energy source in district heating systems (approx. 14% of all heating systems).\(^6\)

- **Industry** - Around 35% of final energy consumption in German industry is fuelled by gas.\(^7\) Accordingly, gas is a key input for German (and by extension EU) industry.

- **Power generation** - Gas is an important fuel for power generation. Power generation from gas offers a flexible form of power supply, which is particularly capable of reacting at short notice to supplement the availability of intermittent renewable power generation from wind and solar. It thus ensures a reliable supply of electricity. Numerous power plants, which are classified as systemically relevant by the German Federal Network Agency (BNetzA) due to their important role in the power grid, are gas-fired. Such power plants are

\(^{3-7}\) Euromonitor International (2020).
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considered to be systemically relevant “insofar as a restriction of the gas supply to these power plants would with sufficient probability lead to a not inconsiderable endangerment or disturbance of the safety or reliability of the power supply system.” (Article 13f EnWG).

The importance of gas is also reflected in legal requirements which serve to maintain security of gas supply:

- At EU level – Regulation (EU) 2017/1938 concerning measures to safeguard security of natural gas supply obliges EU member states to carry out a risk analysis and, based on this, to draw up and publish national prevention and emergency plans. The German Federal Government, for example, is obliged to report regularly on the status of security of supply.

- At Member State level, e.g. in Germany - Various provisions of the German Energy Industry Act (EnWG) deal with gas security of supply. § 53a EnWG highlights household customers and district heating plants directly supplied by gas supply companies - insofar as they supply heat to household customers - as being particularly worthy of protection. Special supply standards apply to these customers.

2.2 Security of supply depends crucially and increasingly on imports

Germany is particularly dependent on gas imports

Germany is clearly dependent on imports: over 95% of the gas consumed in Germany is imported (compared to about 83% of the gas consumed in the EU in 2019).\(^8\),\(^10\),\(^11\)

It should be borne in mind that Germany uses the same countries of origin of the gas as other - in particular neighbouring - EU Member States. Ensuring gas supply security at the import level is therefore not only a national, but also a European challenge, as Germany’s Ministry of Economics and Energy (BMWi) emphasises in its Security of Supply Report:

“Security of gas supply in Germany cannot be considered in isolation on a national level as the markets are strongly interlinked. In particular, the answer to the question of whether gas supply companies have taken sufficient precautionary measures to avoid supply disruptions requires consideration of national and international contexts. The consideration must include not only the availability of sufficient quantities of natural gas necessary to meet demand, but also the development of the technical transport infrastructure.” (BMWi (2019): Security of

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\(^8\) Own translation from the German original: “…soweit eine Einschränkung der Gasversorgung dieser Kraftwerke mit hinreichender Wahrscheinlichkeit zu einer nicht unerheblichen Gefährdung oder Störung der Sicherheit oder Zuverlässigkeit des Elektrizitätsversorgungssystems führte würde.” (§ 13f EnWG)


There is also a Europe-wide dependence on gas imports

From a European perspective, it can be assumed that the demand for gas imports will increase in the future:

- **Stable gas demand in the medium term**: After a period of decline, gas demand in Europe has increased significantly in recent years (Figure 1). This was mainly driven by the increased use of gas-fired power plants in electricity production due to improved price competitiveness and political decisions to reduce coal-fired power generation in many EU member states. The majority of forecasts shown in Figure 1 indicate that this trend will likely continue and that gas demand will remain constant or increase moderately until 2030. Between 2030 and 2050 most forecasts imply that demand will fall, driven by efficiency improvements among consumers and efforts to decarbonize the energy system.

- **Domestic natural gas production declines**: The EU's domestic production has been declining sharply since 2004. Whereas in 2010 just under 50% of European gas consumption could still be covered by domestic production, it was only 25% by 2018 and 23% by 2019. The production of natural gas in the EU will continue to decline in the coming decades (Figure 2). This will be driven mainly by the short-term phase-out of production in the EU's largest gas field in Groningen in the Netherlands, and by the continued decline in production in Germany and the UK which is not offset by increases in production in other countries such as Romania or Cyprus.

- **Production or import of decarbonised gases**: In future, low-carbon gases such as biomethane, synthetic methane and hydrogen will play a growing role in the energy system in order to achieve the climate policy objectives by 2050. Domestic production of low-carbon gases may replace a part of declining domestic natural gas production. However, Europe is likely to continue to be dependent on gas imports in the long-term. Natural gas can be used as the feedstock for hydrogen production as a means of decarbonising the economy, using either methane reforming with Carbon Capture and Storage (CCS) or methane pyrolysis, which produces hydrogen and solid carbon. Existing plants such as power stations can also be fitted with post combustion CCS enabling continued use of natural gas as a fuel.

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12 Own translation from the original German text: „Die Gasversorgungssicherheit in Deutschland kann nicht isoliert national betrachtet werden, da die Märkte stark miteinander verknüpft sind. Insbesondere die Beantwortung der Frage, ob von den Gasversorgungsunternehmen hinreichend Vorsorgemaßnahmen zur Vermeidung von Versorgungsstörungen getroffen wurden, erfordert eine Betrachtung nationaler und internationaler Zusammenhänge. In die Betrachtung ist dabei nicht nur die zur Deckung der Nachfrage notwendige Verfügbarkeit ausreichender Erdgasmengen einzubeziehen, sondern auch die Entwicklung der technischen Transportinfrastruktur.” (BMWi (2019), S.5) BMWi (2019): Versorgungssicherheit bei Erdgas, Monitoring-Bericht nach § 51 EnWG, Februar 2019
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Figure 1  Scenarios for the development of demand for natural gas in the EU

Source: Frontier Economics based on the studies mentioned in the legend.

Note: We have interpolated the annual values between the first forecast year published in the respective studies and the last available historical date from Eurostat on a linear basis. In addition, we have interpolated the annual values between the data published by ENTSOG for 2025, 2030 and 2040 on a linear basis. The ENTSOG demand figures also take into account domestic demand in Switzerland and Western imports into Ukraine as these volumes can only be supplied from the European natural gas market.

Figure 2  Expected development of domestic gas production in the EU

Source: Frontier Economics based on TYNDP 2018 with own adjustments.

On the basis of the trends described it can be concluded that gas import demand will continue to rise well into the 2030s.

2.3 A reliable import infrastructure is therefore an essential requirement for a high degree of security of supply

The German Federal Government has defined a number of security measures to support German gas supply companies: 13

- Diversification of sources of supply;
- Diversification of transport routes/import infrastructure;

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- Domestic production;
- Stable relationships with suppliers and long-term gas supply contracts; and
- High reliability of the supply infrastructure including underground storage.

Two aspects therefore play a central role for security of supply in the gas market:
1. The gas networks must be able to fulfil their transport tasks.
2. Sufficient production or import capacities (as well as storage facilities) must be available to cover the forecast gas consumption.

Accordingly, a country or region has a high degree of security of supply if it has a diversified and reliable supply portfolio, liquid traded gas markets and a robust infrastructure with spare capacity. If these conditions are fulfilled the risk of gas supply bottlenecks is considered low.

New infrastructure providing additional capacity for gas imports therefore makes a positive contribution to security of supply.

### 2.4 Additional infrastructure investments increase security of supply

#### Increasing the resilience of the gas system

Infrastructure investments are helpful for security of supply in a number of ways, in particular via:

- **Additional capacities on existing transport routes** - For example, the laying of a second pipeline (pipeline B in Figure 3) parallel to an existing transport route (pipeline A in Figure 3) would be beneficial to security of supply. Pipeline (B) increases the capacity of the infrastructure and thus improves the resilience of the system. The increased redundancy makes the energy system less vulnerable to the failure of individual infrastructure components (e.g. pipeline B is available if pipeline A fails); and/or

- **Additional transport options, e.g. in the form of new routes or new technologies** (pipeline C in Figure 3). In addition, the infrastructure used to develop a new transport route makes the system less susceptible to supply bottlenecks due to disruptions on individual routes (for example in country B).
Security of supply will be enhanced if the new infrastructure allows the provision of additional gas

The extra capacity of Pipeline B in addition to Pipeline A enhances security of supply in two ways (Figure 4):

- Even if the total annual quantities transported are the same as those transported by Pipeline A alone – (left diagram in the figure), these quantities can now be transported more flexibly during the year (top right diagram), for example to meet peak demand in winter; or
- By transporting quantities in addition to those transported by Pipeline A (bottom right diagram).
Therefore infrastructure investments not only increase the security of supply for gas volumes already contracted, but also create the possibility of transporting additional gas volumes. As a result, new infrastructure also contributes to security of supply if it creates a possibility to meet the growing demand for gas imports in the coming years. This is a valuable aspect in light of the declining European natural gas production or in a scenario with a coal-fired power generation phase-out. New infrastructure can also help to make the transport of energy more flexible. For example, in winter months with high heat demand, additional quantities can be transported during the winter peak.

In the long term, CO₂ emissions from the combustion of fossil fuels will have to be largely reduced in order to achieve the climate targets in the EU and in Germany. The use of hydrogen based on natural gas can make a contribution to this:

- the production of so-called "blue hydrogen" e.g. by steam reforming and subsequent use and/or storage of the excess CO₂; or
- the production of so-called "turquoise hydrogen" using processes such as pyrolysis which produces hydrogen and solid carbon. There would basically be two options:
  - On the one hand conversion, including any CO₂ capture storage or use (CCSU) for blue hydrogen, could take place in Europe so that natural gas would still have to be imported.
Alternatively natural gas could be converted in the country of origin (for example by pyrolysis) so that Europe would import hydrogen directly, which would require hydrogen-compatible import pipelines.

In any case, it can be said that gas infrastructure will play an important role in a future decarbonized energy system, and that additional import capacity helps securing the gas supply.

2.5 The contribution of new infrastructure to security of supply can be measured objectively by means of politically accepted indicators

Various indicators measure the ability of the energy system to meet demand for gas

The resilience of the energy system to failures, e.g. of the largest gas infrastructure or the largest gas supplier, can be measured by various indicators. These indicators relate existing gas infrastructure capacities – for instance the sum of capacities from domestic production, storage facilities, pipeline imports and LNG regasification facilities - to gas demand on days of exceptionally high demand. To quantify the impact of new infrastructure on security of supply, the indicator is compared once with the new infrastructure and once without the new infrastructure. This is illustrated by a simple example:

If we assume that the demand for gas in a geographically defined area is 100 and the sum of all existing gas infrastructure capacities supplying this area is 150, then the existing capacities could cover 1.5 times the demand. In other words, the system has a capacity buffer of 50%. Now, if new infrastructure with a capacity of 20 is added the capacity buffer to meet demand increases by 20%. This equals a total capacity buffer increase from 50% to 70%.

A central indicator of security of supply is the robustness of the energy system against failures of large infrastructure

In a further development of this simple criterion the resilience of the system can be measured in case of failures of individual pieces of infrastructure or sources of supply. For example the legally mandated N-1 criterion examines the effect that the failure of the largest single piece of infrastructure (for example a pipeline or LNG terminal) feeding gas into the system has on the system’s ability to meet peak demand (see text box). The improvement of the N-1 measure by adding additional new infrastructure can be calculated, as shown above, by the difference in the measure with or without the new infrastructure.

We expand our initial example above and make the following assumptions: the demand for gas is 100, the existing infrastructure capacity is 150, the new infrastructure has a capacity of 20 and the largest single piece of infrastructure has a capacity of 30. In the initial state (without new infrastructure), if the largest

infrastructure fails, 1.2 times the demand can still be met. The new infrastructure then improves this figure to 1.4 times the demand.

In practice, the N-1 values of the individual European countries vary considerably. In a publication by the British Department for Business, Energy and Industrial Strategy (BEIS), based on supply and demand data from 2016, a relatively high resilience of the gas system was found for Germany, Belgium, Austria, the Czech Republic, Slovakia and Spain among others. These countries have very high import capacities via pipelines or LNG and/or gas storage capacities compared to their domestic demand and infrastructure was able to cover at least double peak demand in 2016. In contrast, gas infrastructure in countries such as Finland, Sweden, Greece, Ireland and Bulgaria is less developed and diversified and therefore more vulnerable to failures. These countries would not have been able to meet their peak demand in 2016 in the event of a failure of the largest single piece of infrastructure. In Section 4 of this report we also look at current and future data showing that, given Germany's increasing dependence on imports, further infrastructure is needed to ensure a high degree of resilience.

When using these indicators it is important to note that they are based on theoretical capacities and not on actual gas flows. This difference is particularly important with regard to LNG: the significant capacities at regasification terminals can have low utilisation rates, driven by factors in the global LNG market, even at times of high demand in Europe such as during the winter of 2017/18. Flows from gas storage facilities can also be low, for example towards the end of the winter when storage levels are low.

The capacity buffers resulting from the comparison of technical capacity and actual demand are therefore hypothetical. They show which buffers would exist if the available capacities could be fully utilized. In contrast, the buffer of realistically available gas quantities compared to the demand to be covered is significantly tighter. This aspect is discussed in Section 4 in the context of real data.

**N-1 CRITERION**

The N-1 criterion developed by the ENTSOs is a key indicator to measure the resilience of the system in terms of its ‘resistance’ to failures and its ability to handle peak loads.\(^\text{16}\) The indicator highlights whether the gas network can continue to cover the expected daily peak load if the largest single piece of gas infrastructure feeding gas into the system fails. EU regulation requires Member States to ensure an infrastructure standard which is determined by means of the N-1 criterion.\(^\text{17}\) The higher the indicator the higher the security of supply. If it is exactly 100, the gas without the largest gas infrastructure is just sufficient to cover (daily) peak demand. The following (simplified) formula describes this:

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N - 1 = \frac{EK - I_m}{D_{\text{max}}} \times 100
\]

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>EK</td>
<td>Sum of all technical capacities from all import pipelines, production facilities, storage facilities and LNG facilities in GWh/d</td>
</tr>
<tr>
<td>I_m</td>
<td>Technical capacity of the largest single piece of gas infrastructure (GWh/d)</td>
</tr>
<tr>
<td>D_{\text{max}}</td>
<td>Daily peak load, i.e. total demand on a day with exceptionally high gas demand (GWh/d)</td>
</tr>
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The capacities of import pipelines, national production, LNG terminals and storage facilities are taken into account. As the N-1 indicator divides the sum of all capacities after deduction of the capacity of the largest single piece of gas infrastructure by the daily peak load it measures how much of the peak load could still be covered after the largest single piece of infrastructure has been removed (multiplied by a factor of 100). A value of 200 therefore means that the system could cover the peak load twice even without the largest import infrastructure.

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\(^{16}\) ENTSOG TYNDP 2017, Annex F: Methodology.

3 POSITIVE EFFECTS OF INFRASTRUCTURE INVESTMENTS ON COMPETITION AND COST-EFFECTIVE SUPPLY TO THE EUROPEAN GAS MARKET

In this Section we discuss the role of competition (Section 3.1) and regulation (Section 3.2) in achieving energy policy objectives. We then discuss the positive competitive effects of new infrastructure given it increases capacity in the energy system (Section 3.3) and, where appropriate, also provides market access for new suppliers (Section 3.4). Finally, we examine the theoretical argument of predatory competition through new infrastructure (Section 3.5).

3.1 Competition has an important economic and energy policy function

Competition is the central organisational principle for the European economy as a whole and for the energy and gas industry in particular.\(^{18}\) Competition promotes innovation, growth and employment. In the energy industry the function of competition is to ensure the most cost-effective supply of energy and to give appropriate price signals, e.g. to steer investment to the right applications and technologies. In this way, competition also contributes to fulfilling the energy industry’s triangle of objectives for energy supply to be

- cost-effective,
- secure\(^{19}\), and
- sustainable/most environmentally friendly.\(^{20}\)

Ultimately competition benefits consumers who are at the heart of European competition and energy policy.

3.2 The extent to which competition is served by regulating import infrastructure to the EU is questionable

However, not all technical functions in the energy and gas industry can be organised competitively. Competition is possible and real in the production, trading and sale of energy. However, networks and pipelines often have the characteristics

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\(^{18}\) The European Commission has made this clear not least with the publication of the so-called Lisbon Agenda (European Commission (2005)).

\(^{19}\) For example, the EU Commission’s final declaration on the sector inquiry in 2007 states: “Competitive markets give the necessary investment signals so that security of supply is achieved in the most cost-effective way.” (European Commission (2007), p. 4).

\(^{20}\) As the EU Commission’s final declaration on the sector inquiry in 2007 states: “At the same time, market forces are forcing European companies to use the most cost-effective production methods, which can benefit sustainability under an appropriate regulatory framework.” (European Commission (2007) p. 4).
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of natural monopolies: it would often not be cost-effective to build parallel competing transport pipelines. Transport pipelines within the common market of the EU are therefore subject to official regulation in terms of tariff conditions and other access rules. This is to prevent dominant transport companies within the EU common market from

- levying excessive charges for the use of infrastructure, or
- treating potential users of the infrastructure unequally.

With regard to import pipelines a discussion has developed as to the extent to which they are pro-competitive, or at least not harmful to competition, even if they are not subject to explicit regulation. Regulation of such pipelines was only introduced recently (with Directive (EU) 2019/692 of 17 April 2019) although under certain conditions there is the possibility of a derogation from regulation (under Section 28b EnWG or Art. 49a of Directive 2009/73/EC).

However, the economic sense of such a regulation is questionable because:

- Each additional import pipeline increases the potential supply in the EU and thus the potential competition, even without regulation of this import pipeline (see also chapter 3.3).
- Without regulation the price and cost risks are borne only by the investors in, and users, of the infrastructure. If the import infrastructure is regulated, there is a risk that infrastructure costs will be passed on to all users of the whole regulated network of which the infrastructure becomes a part, not just the users or investors of the infrastructure. This can occur if the infrastructure is not used to the extent originally expected for example if EU customers choose to buy gas from other sources instead.

In this respect, the possibility of derogation from regulation offers a useful corrective to the regulatory risks for consumers cited above.

21 As stated in the EU’s 3rd Gas Directive: ‘In carrying out those tasks, national regulatory authorities should ensure that transmission and distribution tariffs are non-discriminatory and cost-reflective’ (Directive 2009/73/EC, recital 32).
23 These conditions include that the amortisation of the investments made or the security of supply would be jeopardised in the event of regulation and that neither competition nor security of supply would be affected by the regulatory exemption.
25 See e.g. ‘However, it is not clear from an economic point of view why these internal gas market requirements also apply to gas pipelines importing gas from third countries (“Lex Nord Stream 2”). This is because they differ from interconnectors within the EU in one very important respect: import pipelines are not used to transport gas within the internal market, but to import gas into it in the first place. However, the way in which gas from third countries enters the internal market is basically irrelevant for its functionality and security of supply in the EU. Rather, a sufficiently comprehensive gas transmission network within the EU and the strict application of the internal gas market requirements are prerequisites for gas to flow freely within the EU and be traded at uniform prices.’ Bonn and Voßwinkel (2019).
26 Similarly, Auer (2019): ‘Nord Stream II does not endanger the affordability of energy in Germany and Europe. It is an additional technical supply alternative, so it will improve supply. However, this project also carries risks: The market risks are initially borne by the investors, who should therefore have an interest in ample exploitation. The customers/consumers bear a smaller risk than the investors thanks to available gas alternative.’ Translated from the German original: ‘Nord Stream II gefährdet mitnichten die Bezahlbarkeit von Energie in Deutschland und Europa. Es handelt sich um eine zusätzliche technische Lieferalternative, sorgt also für eine Angebotsverbesserung. Allerdings birgt auch dieses Projekt Risiken: Die Markträtsel tragen zunächst die Investoren, die deshalb ein Interesse an einer reichlichen Nutzung haben sollten. Die Kunden/Verbraucher tragen dank verfügbarer Gasalternativen ein kleineres Risiko als die Investoren.’
In the following section, we discuss the extent to which a positive competitive effect can be expected from an additional import infrastructure (in any case, i.e. even without regulation).

3.3 New infrastructure increases supply capacity and intensifies competition

In Chapter 2.4 we explained that new infrastructure increases the excess of supply capacity over demand. As long as an investment in physical infrastructure allows access to additional sources or quantities, it is per se pro-competitive, because additional quantities always increase (at constant demand) the competition for existing demand. Even if no additional quantities are imported via new transport capacity, competition is increased by the potential for additional imports. Existing suppliers are further restricted in their ability to price independently by the possibility that additional quantities could be imported. This also applies if no new competitors enter the market at all with the new infrastructure.

3.4 New infrastructure enhances competition even more when it allows new entrants to enter the market

The stimulation of competition is particularly relevant if the new infrastructure enables new players to enter the relevant market. In this case, the number of supply sources for natural gas in a region increases. Additional suppliers in an existing market in turn increase competition in the market. The extent of the competitive effect of an additional supply source on a market also depends on the quantities that the new supplier can supply to that market.

Indicators that measure the intensity of competition in the gas market include the "Supply Source Access" (SSA), which measures the number of supply sources to which a particular region has access. In addition, the "Supply Source Diversification" indicator (SSDi) measures how strongly the costs of gas supply in a particular region react to a price reduction by a particular supply source. The higher the indicator the better the access to this supply source from a price perspective.

3.5 Negative impacts of infrastructure investments on security of supply or competition in the EU are only hypothetical

In the previous two sections we have explained that new infrastructure increases security of supply and is pro-competitive because it allows access to additional sources or volumes. How can it then be argued that certain infrastructure investments are allegedly detrimental to security of supply and competition?

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Such arguments refer to very specific individual case constellations and are based on an alleged "deterrent effect" of the infrastructure investment under discussion ("predatory behaviour"). According to this argumentation a new infrastructure could weaken the security of supply or competition in individual regions if the new infrastructure makes the use of another already existing, or possibly yet to be built, alternative infrastructure less attractive and this infrastructure is subsequently prematurely closed down or not built at all.

In principle, such impairments only occur in hypothetical scenarios:

- Security of supply could only be expected to be compromised if alternative infrastructure was actually displaced and the new infrastructure was less reliable than the alternative infrastructure that was displaced.

- A lasting impairment of competition and end-consumer prices would only exist in the hypothetical scenario in which, as a result of a new infrastructure, an initial phase of low prices would lead to the squeezing out of alternative infrastructure or suppliers, and prices could subsequently be increased sustainably without there being a market (re-)entry by alternative suppliers or infrastructure which would bring prices back to or below the previous price level.

Such displacement strategies through temporary price dumping are generally considered exotic and unlikely in the economic literature. In the case of new gas infrastructure in Europe such undesirable effects are particularly unlikely since even in the event of temporary displacement, a market re-entry can occur at any time, for example using the substantial existing LNG import capacities.

Overall, it can therefore be concluded that new infrastructure generally stimulates competition in the gas market and enhances security of supply, thus contributing to two key energy policy objectives: a cost-effective and secure energy supply.

In the next chapter we show that this applies analogously to the Nord Stream 2 pipeline and that the above-mentioned potential negative effects on security of supply and competition are not to be expected either in Europe as a whole or in individual European countries (see in particular Chapter 4.4).

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28 Siehe z.B. DiLorenzo (1992), The myth of predatory pricing, Cato Institute Policy Analysis No. 169: "The theory of predatory pricing has always seemed to have a grain of truth to it – at least to non-economists – but research over the past 35 years has shown that predatory pricing as a strategy for monopolizing an industry is irrational, that there has never been a single clear-cut example of a monopoly created by so-called predatory pricing, and that claims of predatory pricing are typically made by competitors who are either unwilling or unable to cut their own prices". See Motta (2004), p. 26 and Tirole (1988), p. 372 for economic assessments of predatory pricing.
4 ANALYSIS OF THE EFFECTS ON THE EUROPEAN GAS MARKET WITH NORD STREAM 2 AS EXAMPLE

In this section, we analyse to what extent the general arguments regarding positive effects from large gas infrastructure projects on security of supply and competition also apply to the specific case of the Nord Stream 2 pipeline.

For this purpose, we briefly describe the investment project (Section 4.1) and then discuss the resulting effects on security of supply (Section 4.2) as well as competition and prices in the gas market (Section 4.3). Finally, we explain why Nord Stream 2 does not threaten security of supply and competition in Central and Eastern Europe (Section 4.4).

4.1 Description of the Nord Stream 2 Pipeline

Nord Stream 2 pipeline connects Russia and Germany through the Baltic Sea

Nord Stream 2 AG, headquartered in Zug, Switzerland, is an international consortium founded in 2015 to design, build and subsequently operate two 1,230-kilometer-long natural gas pipelines from Ust-Luga, Russia, through the Baltic Sea to Lubmin near Greifswald, Germany. In Lubmin the natural gas is fed into the European gas network. Figure 5 shows the course of the Nord Stream 2 pipeline. The Nord Stream 2 pipeline route runs parallel to the existing Nord Stream pipeline.

Figure 5 Route of the Nord Stream 2 pipeline

Source: Nord Stream 2 AG
In Lubmin natural gas from Nord Stream 2 enters the German market area and the European gas market

The two Nord Stream 2 pipeline strings will have the capacity to transport a total of around 55 billion cubic meters (bcm) of natural gas per year (27.5 bcm per pipeline string). In Lubmin the natural gas transported via Nord Stream 2 enters the German market area and thus the European internal gas market. The North European Gas Pipeline (NEL) is available for physical transmission on the German mainland and additionally the European Gas Link Pipeline (EUGAL) is currently being built. EUGAL runs parallel to the existing OPAL pipeline (in North-South direction) and consists of two strings with a total capacity of 55 bcm per year. The first strand of EUGAL has been ready for transport since the beginning of January 2020, and the pipeline is scheduled to be fully operational over the course of 2020.

4.2 Nord Stream 2 contributes to security of supply in the European gas market

Nord Stream 2 will provide an additional transport infrastructure element, which will increase the resilience of the energy system

Nord Stream 2 contributes to diversification of transport routes to the EU

Nord Stream 2 will contribute to gas supply security in Germany and the EU already by providing an additional transport infrastructure element of about 55 bcm/a gas. This will increase the diversification of transport routes and the reliability of the European natural gas system in the event of e.g. technical failures of individual infrastructures.

The EU Commission has already made clear in earlier decisions on granting exemptions from regulation that an additional source or an additional transport route or additional import capacities increase the security of supply.²⁹

The positive contribution of the Nord Stream 2 pipeline to the resilience of the European gas system can be illustrated by analysing existing pipeline capacities in relation to gas demand on days with high demand. This shows that Nord Stream 2 provides a relevant additional capacity buffer on peak demand days.

This is particularly true if typical storage levels in the gas system are taken into account: On days with very high gas demand, EU imports and own production cannot cover supply even at maximum capacity utilisation. Gas withdrawn from storage facilities provides a buffer on such days, but storage withdrawal capability is reduced³⁰ when storage levels are low.

²⁹ Cf. EU Commission Statement on the application for exemption for the Austrian part of the Nabucco pipeline, 8 February 2008, paragraph 42, EU Commission Statement on the application for exemption for the Poseidon pipeline, 22 May 2007, p. 4, and EU Commission Statement on the application for exemption for the LNG Terminal Grain (Phase 4), 4 June 2013, paragraphs 28 et seq.

³⁰ When the storage tank filling level drops, pressure inside the gas storage tank tends to drop and only a smaller gas volume per hour or day can be discharged at the storage tank for a given maximum compressor capacity.
Nord Stream 2 pipeline increases the EU gas capacity buffer by almost 25% on peak days

This analysis is illustrated in Figure 6:

- The figure shows the existing entry capacities from production, pipeline and LNG imports and gas storage (shown as stacked bars) to meet peak demand (shown as the red line) for the years 2021, 2030 and 2040, both with and without the Nord Stream 2 pipeline:
  - Assuming full technical availability of all withdrawal capacities, without Nord Stream 2 the EU would have an additional capacity buffer of about 55% of demand (right bar). With Nord Stream 2, this available capacity buffer will increase by approximately 5-10% (left bar).
  - However, the withdrawal capability of the gas storage facilities decreases in the course of the winter as storage levels are reduced. At the same time gas demand is usually highest towards the end of the winter when the full withdrawal capability (see striped bars in the figure) is no longer available due to the lower storage levels. This makes the Nord Stream 2 pipeline even more important: With a typical withdrawal capability at the moment of peak demand, the Nord Stream 2 pipeline increases the capacity buffer on peak days by almost 25%. The pipeline thus makes a key contribution to the resilience of the European gas system.

Figure 6  
Increase in capacity buffer in the EU 28 through Nord Stream 2 Pipeline

Source: Frontier calculations based on ENTSOs TYNDP 2018 and the NEP gas database (Cycle 2018 - NEP Confirmed).
EFFECTS OF INFRASTRUCTURE INVESTMENTS SUCH AS THE NORD STREAM 2 PIPELINE ON THE EUROPEAN GAS MARKET

Nord Stream 2 creates a direct route to Germany and the EU without transit through third countries

Nord Stream 2 contributes to security of gas supply as it is an offshore pipeline without compressor stations. It connects Russia directly with Germany and thus the EU, and therefore does not rely on transits through third countries.

Nord Stream 2 reduces technical risks associated with transit via third countries

Transit via third countries inevitably creates uncertainties for gas customers in the end market as well as for the producers supplying them. These are automatically reduced in the case of a direct connection such as Nord Stream 2. In the case of a transit connection the supplier in the country of origin and the consumers in the EU are dependent on the operators of the transit pipelines to maintain these pipelines appropriately, and to make the necessary investments that ensure the desired reliability of gas supply to the EU is achieved.

For example, in the case of the transit route through Ukraine the pipeline system is old, in poor condition and urgently needs modernisation:

- Almost two thirds of all Ukrainian pipelines are over 32 years old, and the average age of the central transit pipelines is over 35 years.\(^{31}\)
- Indeed a large part of the gas network failures detected in Ukraine since 2013 can be attributed primarily to technical failures such as pressure drops, gas leaks and damages to pipelines (status 2017).\(^{32}\)
- As long as important transit routes are not modernised the transit through Ukraine is therefore associated with a technical risk for Europe’s security of supply.\(^{33}\)

Nord Stream 2 eliminates political risks of transit via third countries

In the case of a transit via third countries there is also the risk of political conflicts between the transit country and the supplier’s country of origin or between the transit country and the destination country. This can have a negative impact on the supply of gas to EU consumers. For example, in the past the difficult relationship between Russia and Ukraine on gas transit issues has repeatedly posed a risk to the gas supply of some European countries that depend on gas supplies from Russia through Ukraine.\(^{34}\)

Without attributing blame for these disputes, it can be objectively stated that transit via third countries increases the political risk associated with gas imports.

The BNetzA decision chamber also acknowledged this risk in its 2009 decision to exempt the OPAL pipeline from regulation.\(^{35}\) In its opinion on the BNetzA decision,

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\(^{31}\) See KPMG (2017), p. 28.
\(^{32}\) See KPMG (2017), p. 38.
\(^{34}\) See OIES (2009), pp. 19-25.
\(^{35}\) See BNetzA (2009), p. 54.
the EU Commission also agreed that the direct transport of gas without transit through third countries increases security of supply.\textsuperscript{36}

**Russian gas exports already contribute to security of supply in Germany and the EU today**

Gas exports from Russia have contributed to secure gas supplies in Germany and the EU for decades. This is particularly evident in the winter months when gas demand is high; Russian gas exports have made a consistently large contribution to security of supply in recent years. Higher deliveries of Russian gas exports have also compensated for the steady decline in domestic gas production. (Figure 7).

**Figure 7** Development of EU gas supply in the winter months since 2014

![Graph showing development of EU gas supply in the winter months since 2014](image)

Source: Frontier Economics based on Eurostat  
Note: The values for the respective years cover the months October to March

The flexibility of Russian gas exports was demonstrated during the cold spell lasting for several weeks in February and March 2018, referred to in the media as the "Beast from the East".\textsuperscript{37} During this period, Russian gas exports to the EU reached record levels of up to 713.4 mmcm/d for 10 consecutive days.\textsuperscript{38} In contrast, gas storage withdrawals and LNG imports did not increase enough to meet the additional demand during this period.\textsuperscript{39}

**Nord Stream 2 will provide the shortest route to the Russian gas sources of the future**

In addition, Nord Stream 2 will **connect Germany and the EU to the Russian gas production fields of the future** which are increasingly located in the north of Russia and whose production capacity far exceeds the current transport capacity to the EU (Figure 8). It is already foreseeable today that the existing transport capacities are less than the expected production in the new production areas on the Yamal peninsula and in the Barents Sea.

The existing Nord Stream pipeline has already reached the **limit of its transport capacity** by absorbing the production in the Yuzhno-Russkoye field and the first

\textsuperscript{37} See EU Commission (2018b).  
\textsuperscript{38} See OIES (2018a).  
\textsuperscript{39} See EU Commission (2018b).
EFFECTS OF INFRASTRUCTURE INVESTMENTS SUCH AS THE NORD STREAM 2 PIPELINE ON THE EUROPEAN GAS MARKET

expansion stage of the Bovanenkovo field. All further expansion stages in Yamal and later in the Barents Sea will require new transport capacities. These will be provided by Nord Stream 2 and the upstream pipeline extensions in Russia (e.g. Bovanenkovo-Uhkta 2).

In addition, both Nord Stream and Nord Stream 2 enable the transport of production volumes from the northern Russian production fields to the EU via a much shorter route. The routes via the Yamal pipeline (via Belarus) or the traditional southern route (via Ukraine) are up to 2,000 km longer. In the case of planned gas production from Shtokman, the distance via the more southern routes would be even longer; this is not rational given the location of the field and the shorter route via Nord Stream 1 or Nord Stream 2.

Nord Stream 2’s contribution to security of supply through the development of new supply sources has already been acknowledged in the planning approval decision for Nord Stream 2 by Bergamt Stralsund:

“The Nord Stream 2 project will further diversify both the transport routes to the EU and the natural gas fields available to supply the EU.”

Figure 8 Location and production potential of Russian gas fields

Source: Frontier Economics based on Gazprom and Nord Stream 2 AG. In the case of the Nord Stream route, the mileage refers to the pipeline length from the production fields on Yamal Island to the entry point to Germany in Greifswald (~3,100 km). In the case of the Brotherhood, it refers to the pipeline length from the Nadym-Pur-Taz fields to the entry point to Germany in Waidhaus (~6,400 km). The

Nord Stream 2 will enable the import of additional gas volumes and increases security of gas supply to the EU

Nord Stream 2 will also contribute to the security of gas supply in Germany and the EU by creating the possibility for additional gas import volumes to compensate for declining domestic gas production in the EU.

Overall, the EU has well diversified gas supply sources: it has access to pipeline imports from Norway, Russia, Algeria, Libya, and Azerbaijan and to the global LNG market. However, an analysis of the country-specific production and export potentials to Europe shows that the additional supply potential from Norway, North Africa and the Caspian region are limited. Gas imports from Norway will decline in future due to falling Norwegian production volumes. Future pipeline imports from North Africa and the Caspian region are subject to significant political and economic uncertainties. Even under optimistic scenarios, these regions can only partially compensate for the declining production trends observed in the EU and Norway.

The EU has significant potential to import LNG due to the extensive regasification capacities in the EU, and increasing global liquefaction capacity. However, the future development of LNG imports into the EU is subject to significant uncertainties as the majority of global production volumes are not contractually guaranteed for delivery to the EU; they can be flexibly delivered to the market with the highest selling price or netback value for the LNG supplier.41

As explained above, Russia will be able to increase its gas production and exports in the future, and will also have additional transport capacities to deliver gas to Europe, for example Nord Stream 2. As Section 4.3 sets out in more detail, Russian pipeline gas is also more competitive than LNG. In addition, Europe has to compete with other major LNG importers, such as China. LNG imports to Europe therefore cannot be considered as guaranteed. Therefore, from a cost and reliable gas supply perspective, Russia should and will provide a considerable portion of the EU’s additional gas import requirements in future.

Figure 9 illustrates the volume potential of the different available gas sources (including domestic production and imports) compared to gas demand today and in the future, with and without Nord Stream 2:

- The Nord Stream 2 pipeline increases the secure gas supply available to the EU (monochrome bars in the figure) and thus makes an important contribution to meeting the future gas import needs in the EU – even in a scenario of declining overall EU gas demand.
- In addition to the secure gas supply, additional gas volumes will be needed to satisfy future gas demand and various import options are available (striped bars

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41 The netback value for LNG is the market price achievable in the respective target market less the transport costs (pipeline and ship) and the costs for liquefaction and regasification.

42 Secure gas supply comprises the lowest estimates of gas supply available to the EU, based on the minimum scenario of TYNDP 2018. For more details see Annex A.
in the figure). As the additional supply potentials from Norway, North Africa and the Caspian region are limited, additional Russian pipeline supplies and/or additional LNG supplies will be necessary to cover the remaining import demand.

Figure 9 Nord Stream 2 makes an important contribution to the secure supply of future gas demand in the EU

This analysis shows that a share of the future required gas supply for the EU, which is not yet secured today, can be delivered reliably through Nord Stream 2. In addition, imports from other sources and other routes will be necessary.

Nord Stream 2 leads to a positive outcome for climate protection

The use of the Nord Stream 2 Pipeline will also result in a positive effect for climate protection for several reasons (for more details see ANNEX B):

- It will enable an increased **switch from CO₂-intensive fuels such as oil and coal**, which still account for around 50% of primary energy consumption in the EU, to the less CO₂-intensive natural gas (**fuel switch**).
- Gas transport via Nord Stream 2 will generate **lower greenhouse gas emissions** compared to transport via alternative pipeline routes. This climate advantage is based, among other things, on the comparatively **shorter transport distance** from the gas fields in Russia via Nord Stream 2 to Europe.

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43 The potential additional supply comprises the maximum amount of gas available for export to the EU under optimistic assumptions based on the Maximum Scenario of TYNDP 2018.
Imports via Nord Stream 2 will lead to lower greenhouse gas emissions than alternative imports by LNG. This is because the transport and liquefaction of LNG requires a comparably higher energy input than pipeline transport of gas from Russia (in particular via Nord Stream 2).
4.3 Nord Stream 2 reduces costs and prices in the European gas market

Nord Stream 2 enables a cost-effective gas supply in the EU

The Nord Stream 2 pipeline will contribute to the cost-effective supply of gas to EU consumers by enhancing competition between alternative sources of gas supply. An analysis by the Energy Economics Institute (EWI) at the University of Cologne, which is presented below, shows that the Nord Stream 2 pipeline has a cost and price-reducing effect on the European gas market. This result is mainly driven by the pipeline’s cost advantage compared to gas imports via LNG as well as compared to other Russian import routes.

First, importing Russian gas via pipelines has a cost advantage compared to LNG imports:

- The production and transport costs of Russian pipeline gas are significantly lower than the costs associated with importing LNG. Even when considering the Russian export duty of about 30% of the sales price, the total cost of Russian pipeline imports is lower than that of many LNG exporting countries. Excluding export duty, the total cost of Russian pipeline gas is lower than the comparatively low costs of LNG imports from Qatar and Nigeria.
- In addition, LNG suppliers compete in a global market. Therefore, not only the direct costs of LNG are relevant for pricing, but also the supply-demand balance in other countries outside Europe. When demand and prices in markets outside the EU (especially in Asia) are high, exporting LNG to the EU may involve high opportunity costs.

An increase in transport capacity from Russia to the EU through the Nord Stream 2 pipeline will therefore help to increase the supply of low-cost gas to the EU. As a result, fewer LNG imports will be needed. Higher LNG supply implies higher LNG prices based on the LNG supply curve. A requirement for lower LNG supply (enabled by more pipeline supply from Russia through Nord Stream 2) implies that the market price will be set by an LNG supplier with lower costs than in the scenario without Nord Stream 2, i.e. with lower pipeline imports from Russia. The extent of the market price effect also depends on global LNG demand and the corresponding opportunity costs of LNG marketing in other regions. This relationship is shown in Figure 10 both with low global demand for LNG (blue curve) and with high demand (yellow curve). Nord Stream 2 leads to a particularly large reduction in gas prices in Europe in case of high global LNG demand.

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44 For example, the Nord Stream 2 Planning Approval Decision states: “The Nord Stream 2 project also serves the objective of low-cost energy supply in accordance with Section 1 (1) Alt. 2 EnWG. […] The additional import capacity created by Nord Stream 2 competes with all offers from other natural gas suppliers in the German and European gas market, increases competition among them and, in the opinion of the planning approval authority, is likely to result in a lower price level on the EU gas market.” (See Bergamt Stralsund (2018), p. 99.)

45 Although the export duty is a cost element of Russian pipeline imports, unlike production, transportation, liquefaction and regasification costs, it is conceivable that it will be adjusted if Russian natural gas would otherwise not be marketable.
compared to the scenario without Nord Stream 2. But even in case of low global LNG demand, Nord Stream 2 will help to lower the gas price level in the EU.

Figure 10 Market price effect of increasing the supply of Russian pipeline gas

European gas transport model confirms price-reducing effect of Nord Stream 2 pipeline

An analysis by EWI, based on the TIGER European gas transport model, confirms this price-reducing effect of the Nord Stream 2 pipeline.46

The impact of the Nord Stream 2 pipeline on the European gas market was investigated by using the TIGER model to calculate several scenarios and comparing the results. In each scenario gas flows and prices in Europe were modelled with and without the Nord Stream 2 pipeline. The most important scenarios and results are briefly described below.

In the reference scenario with Nord Stream 2, the full capacity of the Nord Stream 2 pipeline is used to supply Europe with gas cost-effectively.

The reference scenarios represent the main comparison and analyse the effect of Nord Stream 2 on the EU gas market. In the reference case, European gas supply is first optimised for the case that the Nord Stream 2 pipeline is available and then for the counterfactual case that the Nord Stream 2 pipeline is not available. The comparison of the two reference scenarios shows the effect of Nord Stream 2 on the EU gas market in terms of gas flows, pipeline and LNG imports as well as prices in the Member States.

In both reference scenarios (with and without Nord Stream 2), it is assumed that transit capacities through Ukraine of up to 120 bcm/a are fully available. However, judging by the current state of the Ukrainian transit system, in reality it cannot be taken for granted that the entire capacity is actually available. For this reason, in another sensitivity the Ukrainian capacity is varied to examine both the impact of

46 Details of the methodology and assumptions are explained in ANNEX C.
the Nord Stream 2 pipeline on transit volumes and the effects of transit volume restrictions through Ukraine (see later).

The results for the reference case show that in the future almost all of the capacity of Nord Stream 2 (and Nord Stream) will be used to supply gas to Europe in a cost-effective manner (Figure 11).

**Figure 11  Gas flows 2030 with Nord Stream 2 pipeline (reference case)**

Source: EWI

Note: The yellow arrows represent pipeline transport, the blue arrows LNG imports. All figures in bcm/a.

In the reference scenario without Nord Stream 2, alternative import routes and LNG must be used leading to an increased cost of European gas supply

In the counterfactual case, in which the Nord Stream 2 pipeline is not available, the overall volume of Russian pipeline imports decreases only slightly (by 10 bcm) compared to the factual case with Nord Stream 2. This decrease of Russian volumes is compensated by an increase in LNG imports. However, overall it is more cost-effective to use alternative pipeline routes from Russia to Europe, for example via Ukraine, than to significantly increase LNG imports.

Although the lack of Nord Stream 2 imports can largely be compensated by Russian imports via alternative routes, the moderate increase in LNG volumes and the changed transport routes of the Russian gas still results in a price increase for gas supply in all the countries modelled. The average volume-weighted price in the EU in the case of Nord Stream 2 is 0.77 EUR/MWh lower than in the case without
Nord Stream 2. The percentage price reductions in each EU country are shown in Figure 12.

Similar volume and price effects can be observed if the calculations assume a lower European gas demand. Thus, the positive effect of Nord Stream 2 on the European gas market remain even if EU gas demand is lower in future.

**Figure 12** Price differences in the reference case in 2030 (scenario without Nord Stream 2 compared to scenario with Nord Stream 2)

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Long-term analysis indicates use of both Nord Stream 2 pipeline and the Ukrainian transit route

A further comparison illustrates the volume and price effects of limiting Ukrainian transit capacity both with the Nord Stream 2 pipeline in place and without it. For this purpose, a sensitivity with regard to the Ukrainian transit capacity is calculated where up to 120 bcm/a capacity is available in the unlimited case compared to 30 bcm/a in the limited case. Both cases are calculated with and without the Nord Stream 2 pipeline.

First of all, the results show that if the Ukraine transit is limited to 30 bcm/a, the Nord Stream 2 pipeline will continue to have a price-reducing effect on natural gas prices in Europe (compared to the unlimited case) which is even stronger than in the reference scenarios. Where Ukrainian transit is limited, and without Nord Stream 2, the lack of import volumes via Nord Stream 2 cannot be compensated by alternative transit routes (such as Ukraine) for Russian gas. Therefore even

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47 The average volume-weighted price reduction in the EU due to the availability of Nord Stream 2 is 0.96 EUR/MWh in 2021 and 0.58 EUR/MWh in 2040.
more expensive LNG needs to be imported which in turn increases gas prices in Europe.

A comparison of the sensitivity of limited versus unlimited Ukrainian transit capacity (where Nord Stream 2 is available in both cases) shows that both the import route via Nord Stream 2 and the import route via Ukraine are important for supplying the EU with gas at low cost in the long term.

If the full Ukrainian transit capacity is available in addition to the Nord Stream 2 pipeline, more gas can be imported from Russia than if Ukrainian transit capacity is limited. This becomes even more important in the long term, where declining domestic EU production and falling import volumes from Norway would otherwise have to be compensated by significantly higher and more expensive LNG imports. Even if Nord Stream 2 is available, a restriction of the Ukrainian route to 30 bcm/year in the long term would lead to significantly lower import opportunities for Russian gas and thus higher prices in the EU. The agreements concluded between Russia and Ukraine at the end of 2019 on future gas transit through Ukraine indicate that the Ukrainian transit route will continue to play an important role for Russian gas exports in the future.48

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48 The minimum quantity will be 65 billion cubic metres of natural gas in 2020. In the years 2021 to 2024 the minimum quantity will decrease to 40 bcm per year. Higher supply quantities are possible upon agreement. (Cf. https://www.energate-messenger.de/news/199248/russland-und-die-ukraine-einigen-sich-auf-details, accessed on 01.04.2020).
4.4 Nord Stream 2 will not damage security of supply and competition in European countries

In the previous sections we have explained that the Nord Stream 2 pipeline will lead to more secure, environmentally friendly and cost-effective gas supplies in Germany and the EU. Nevertheless, it is occasionally argued that the Nord Stream 2 pipeline may affect the security of supply in individual countries, and that the pipeline is in conflict with the concept of “energy solidarity.”

For the EU member states in Northern, Western and Southern Europe a positive or at least neutral effect of the Nord Stream 2 pipeline is obvious since the pipeline provides additional transport capacity as well as the possibility of additional import volumes as explained above.

For the EU countries in Central and Eastern Europe (CEE), the effect must be examined separately. This is due to the fact that Nord Stream 2 could have an indirect impact on the traditional transit countries between Russia and North-West Europe – especially Poland, the Czech Republic, Slovakia and Hungary – in two ways:

- On the one hand, gas imported into Germany via Nord Stream 2 will continue to flow into the CEE region – not least via the EUGAL pipeline, which can transport large quantities of gas directly from Nord Stream to the Czech Republic.

- On the other hand, concerns have been expressed in the past that an increasing transport of Russian gas through the Baltic Sea could have a negative impact on energy supplies in the traditional transit countries of Russian gas to the EU.

For example, concerns have been expressed that Nord Stream 2 could lead to a situation where direct supply of the Western European markets could cause "congestion" of intra-European West-East capacities, which could in turn reduce the integration of the Eastern and Western European markets.

However, these concerns are unfounded. For several reasons, Nord Stream 2 cannot be expected to damage competition and security of supply in Central and Eastern European countries:

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49 The concept of solidarity in the energy sector is laid down in Article 194(1) of the Treaty on the Functioning of the European Union (TFEU). In a decision of 10 September 2019, the Court of First Instance of the European Union annulled a decision of the European Commission from 2016 on the modified conditions of use of the OPAL gas pipeline, with reference to a lack of consideration of the impact on other affected countries in Eastern Europe under the heading “energy solidarity.” (See Court of First Instance of the European Union (2019)). In the judgment, the Court emphasised that the application of the principle of solidarity in the energy sector does not mean that the Union’s energy policy must never have a negative impact on the particular energy interests of a Member State. However, the Court considers that the Union institutions and the Member States are required, in the context of implementing that policy, to take account of the interests of both the Union and the various Member States and to weigh them against each other in the event of conflict. As we understand it, the judgment of the Court of First Instance of the European Union will be challenged in the courts.

50 See Bruegel (2017).

51 See REKK (2017).

52 This conclusion is also supported by various previous analyses conducted by EWI, which have examined the assumptions and results of Bruegel (2017) and REKK (2017), inter alia, using the TIGER gas transport model. Cf. EWI (2017b) and EWI (2018).
No harm to competition and prices:

- The increasing market integration both within the CEE markets and between the CEE markets and Northwest Europe is leading to increasingly diversified import options for the CEE countries, independent of gas transport via Nord Stream 2 (see also ANNEX D).

- Even if this potential competition were not to add a sufficient competitive constraint, the obligations of the DG Comp-Gazprom Antitrust decision also link the CEE markets more closely to North West Europe.\(^\text{53}\)

- The gas transport simulation by EWI in Chapter 4.3 reveals that the commissioning of the Nord Stream 2 pipeline will lead to lower gas prices also in CEE countries.

No harm to the security of supply:

- The gas transport simulation by EWI in Chapter 4.3 also shows that even after the Nord Stream 2 pipeline will be commissioned, the Russian transit routes through Belarus and Ukraine can still be expected to be used. Accordingly, it can be assumed that these transit routes will continue to be available to supply CEE countries.\(^\text{54}\)

- Even in the hypothetical case of “crowding-out” of the existing Russian transit pipelines, the individual potentially affected countries in CEE have diversified import options from pipelines and LNG. In addition, new infrastructure projects in all countries will significantly reduce the share of pipelines from Russia in total capacity in the coming years.

The import situation of the main transit countries of Russian gas will be examined in more detail below.

**Poland has sufficient import capacity to meet gas demand without Russian imports already today, and plans to further expand its infrastructure**

Poland currently has a gas demand of less than 20 bcm/a, with a slight upward trend. In 2018 Poland domestically produced 5.6 bcm/a of natural gas and the Polish government intends to keep production at about the same level until 2030.\(^\text{55}\)

The difference between demand and domestic production leads to an import demand of currently about 14 bcm/a.

On the other hand, Poland has extensive import options today and in the future (Figure 13):

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\(^{53}\) See EU Commission (2018a).

\(^{54}\) Transit via Ukraine is contractually guaranteed by the agreements between Russia and Ukraine concluded at the end of 2019, see footnote 48.

\(^{55}\) See comments in the National Energy and Climate Plan, Ministertwo Energii (2019), p. 30f., where the intention there refers to the production level of the years 2016 and 2017 of about 4 bcm/a.
Already today, Poland can import 9 bcm/a from Germany and 5 bcm/a via LNG. The capacities of the existing LNG terminal in Swinoujscie are currently being expanded. From 2022 the terminal will be able to import 7.5 bcm/a. In addition, the commissioning of a new LNG terminal in the Bay of Gdansk is planned for 2023 increasing LNG capacities by 8 bcm/a to up to 15.5 bcm/a. (This is not included in Figure 13 due to the less advanced project status).

The Baltic Pipe, which allows imports of up to 10 bcm/a from Denmark (or, indirectly, Norway), is expected to be commissioned at the end of 2022.

In addition, a bi-directional pipeline in the south with the Czech Republic with a capacity of 1 bcm/a has been in place since 2011.

However, these infrastructure are only the first part of a possible Eastern European North-South corridor which is intended to connect Poland with its southern neighbours, the Czech Republic, Slovakia and Ukraine (and these in turn with their southern neighbours). Since most of these pipelines are still in early planning stages they are not included in the conservative summary view presented in Figure 13.

Figure 13  Demand and import capacities in Poland (bcm/a)

Source: Frontier Economics based on Entsog TYNDP 2018 and own infrastructure assumptions. Gas demand is based on the ENTSOG Best Estimate (Gas-before-Coal) and Sustainable Transition scenarios.

56 Only physically available capacities at the Mallnow and Lasow border points are included here based on the compressors installed in Mallnow in 2014. These allow physical gas flow from Germany to Poland ("physical reverse flow") in addition to the normal direction of flow from Poland to Germany. These capacities make it possible to supply Poland from Germany even if Russian deliveries to Germany via the Yamal pipeline are temporarily or completely absent. When gas is flowing from Poland to Germany via Yamal, supply to Poland from Germany can be made using "virtual reverse flow." Nominations for gas flow from Germany to Poland are used to offset in part the nominated flows from Poland to Germany, without the need for physical gas flow from Germany to Poland. Cf. https://www.gascade.de/nc/en/press/press-releases/press-release/news/reverse-flow-towards-poland-starts-in-april/ and especially on the functioning of physical and virtual reverse flow in Mallnow, Peters (2018), p. 16ff.

57 Moreover, at the Mallnow interconnection point there are signs of a further expansion of cross-border transmission capacity from Germany to Poland so that a transmission capacity of just under 13 bcm/a can be assumed from 2021, see https://www.nep-gas-datenbank.de:8080/app/#!/capacities (NEP cycle: 2020 - SR consultation). Since, to the best of our knowledge, there are no final decisions on this yet, this additional capacity is not taken into account in Figure 13.

58 See Polskie LNG (2019).
59 See LNG World News (2019).
60 See https://www.baltic-pipe.eu/de/.
61 There is potential to expand this to 2.5 bcm/a, but this additional capacity has not been included in Figure 13.
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Note: Based on an assumed energy content of 10.6917 TWh/BCM (Eurostat).

A purely mathematical comparison of demand and transport capacities shows that Poland is already independent of physical gas imports from Russia (here specifically the Yamal-Europe pipeline) if domestic production is taken into account. Its entire import demand could be supplied by alternative sources.

Poland’s alternative import capacity will also increase significantly by 2030 due to further infrastructure expansion.

It is therefore not obvious why the commissioning of Nord Stream 2 should have a negative impact on security of supply in Poland:

- A look at recent years’ data shows that the transit route through Poland was fully utilised despite the commissioning and full utilisation of the original Nord Stream pipeline. A substitution of the transit of Russian gas through Poland has not taken place and is not expected in the future (see results of the gas transport simulation in Chapter 4.3).

- The analysis of Poland’s existing and expected production and import capacities reveals that, even in the event of a reduction in transit volumes, Poland still has sufficient possibilities to procure gas from non-Russian sources.

Other traditional transit countries for Russian gas have (growing) alternative import options to cover their gas demand independently of direct Russian imports

A similar picture emerges for the other traditional Russian gas transit countries such as the Czech Republic, Slovakia and Hungary. In all three countries import capacities systematically exceed domestic demand.

Historically imports in the Czech Republic were delivered via Slovakia. Today, by contrast, most of the Czech gas is supplied from Germany, not least through the OPAL pipeline which connects with Nord Stream. In addition, the aforementioned connection to Poland (0.5 bcm/a) has been in place since 2011. The commissioning of the EUGAL pipeline - connecting the Czech Republic to Nord Stream 2 - will increase the transport capacity from Germany. In addition, a planned interconnector to the Austrian gas grid at the border crossing point Postorna / Reintal is scheduled to become operational in 2022.
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Figure 14  Demand and import capacities in the Czech Republic (bcm/a)

Source: Frontier Economics based on Entsoy TYNDP 2018 and own infrastructure assumptions. Gas demand is based on the ENTSOG Best Estimate (Gas-before-Coal) and Sustainable Transition scenarios.

Note: Based on an assumed energy content of 10.6917 TWh/BCM (Eurostat).

Overall, the comparison between demand and import capacities shows that the Czech Republic's already strong connection to the German market will be even stronger in the future. In addition, the Czech wholesale market is integrated into the NWE market and final consumers enjoy an almost Western European standard of competition. **Unlike Poland, the share of Russian imports in the Czech Republic is almost 100% without this resulting in a negative impact on the gas market.**

Slovakia is physically strongly integrated with the Czech Republic (and has access to the market area of North-Western Europe via the Czech Republic). By 2022, import capacity from the Czech Republic will increase by 13 bcm/a due to the expansion of capacity at the Lanzhot border crossing point. In addition, Slovakia is physically connected to the Austrian gas market.

Figure 15  Demand and import capacity in Slovakia (bcm/a)

Source: Frontier Economics based on Entsoy TYNDP 2018 and own infrastructure assumptions. Gas demand is based on the ENTSOG Best Estimate (Gas-before-Coal) and Sustainable Transition scenarios.

Note: Based on an assumed energy content of 10.6917 TWh/BCM (Eurostat).

Overall, the comparatively low demand in Slovakia (approx. 5.4 bcm/a) could be met completely by imports from the Czech Republic (cross border capacity of 34 bcm/a in 2020 and 47 bcm/a in 2030) and/or Austria (9 bcm/a). As already

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explained above, there are existing plans to connect the Eastern European countries with a new North-South route. This could allow Slovakia to become part of a bidirectional corridor that could extend from Poland to the Western Balkans. In the future this EU-funded project would have the LNG terminals in Poland (Swinoujście) and Croatia (Krk) as start and end points respectively.\(^{64}\)

In addition, Slovakia is involved in the planned Eastring pipeline (which is not included in the conservative view presented in the Figure 15). This pipeline is planned to connect Slovakia with the gas markets of Hungary, Romania and Bulgaria, enabling Slovakia to import gas from the Balkan region and Turkey. The Eastring pipeline is expected to be commissioned by 2025, with a capacity of 20 bcm/a, increasing to 40 bcm/a by 2030.\(^{65}\)

**Hungary**’s status as a traditional transit country is also reflected in the comparison of demand (approx. 10 bcm/a) and import capacities (37 bcm/a in 2020, see Figure 16). Hungary’s import capacities amount to 29 bcm/a from the east (23 bcm/a from Ukraine, 2 bcm/a from Romania and 5 bcm/a from Slovakia). Hungary can also import gas from Croatia and Austria.

Furthermore, a connection between Hungary and Serbia is at an advanced planning stage. This is expected to provide a capacity of 15 bcm/a from Serbia from October 2021, and thus connect Hungary with the infrastructure that transports Russian gas to Turkey using the Turkstream pipeline and then on to Bulgaria and Serbia.\(^{66}\)

**Figure 16**  Demand and import capacities in Hungary (bcm/a)

![Figure 16](image)

*Source:* Frontier Economics based on EntsoG TYNDP 2018 and own infrastructure assumptions. Gas demand is based on the ENTSOg Best Estimate (Gas-before-Coal) and Sustainable Transition scenarios. 

*Note:* Based on an assumed energy content of 10.6917 TWh/BCM (Eurostat).

In addition to these infrastructure developments which have a high degree of certainty, further infrastructure projects exist. These have not been included in

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\(^{64}\) See Gaz System (2019b).

\(^{65}\) See Eastring (2018).

\(^{66}\) The final investment decision (FID) on the final Section of the onshore continuation of the TurkStream Pipeline from Serbia to Hungary has not yet been made. However, the project is in an advanced planning stage: the Hungarian regulatory authority has already approved the project, and the responsible FNBs opened an open season procedure in October 2019, see FGSZ (2019). Moreover, all upstream Sections of this TurkStream interconnector (i.e. from Turkey to Bulgaria and to Serbia) already have FID status, which is why we assume the future availability of the pipeline from Serbia to Hungary here.
Figure 16 as they are less certain. They do show, however, that there is significant potential for further West-East or North-South capacities:

- A connection between the Hungarian and Slovenian gas networks (with an import capacity of 2 bcm/a) is planned for 2024. As Slovenia is in turn connected to the Italian market, Hungary would thus also indirectly gain access to the Italian market and its large LNG import capacity (22 bcm/a in 2020).
- In addition, Hungary is part of the planned Eastring pipeline, the connection between the gas markets of Bulgaria, Romania, Hungary and Slovakia. Specifically, the Eastring pipeline would increase Hungary's import capacity from Romania to 47 bcm/a and that from Slovakia to 48 bcm/a in 2030.

In order to cover its gas requirements, Hungary can therefore rely not only on imports of Russian gas using the transit route via Ukraine but also on imports from Austria and Croatia and, from 2025, via Serbia and Turkey. The commissioning of the Eastring pipeline would further increase Hungary's connection to the gas sources of the Black Sea region and Turkey.

### 4.5 Conclusion: Nord Stream 2 leads to positive effects for security of supply and competition across Europe

Irrespective of the existing political discussions around the Nord Stream 2 pipeline, we can use established economic and energy policy criteria to measure the effects of the Nord Stream 2 pipeline on security of supply and competition in the European gas market as a whole and on individual markets.

Our analysis shows that the positive effects of the Nord Stream 2 pipeline on security of supply (e.g. strengthening the resilience of the gas system, diversifying transport routes, avoiding transit risks, connecting new gas fields, creating new import supply potential) and on competition (e.g. by increasing the supply of low-cost gas) apply throughout the EU. This is in particular due to the high level of gas market integration in Europe.

Therefore, concerns about the potential detrimental effect of Nord Stream 2 on security of gas supply and gas market prices in the traditional transit countries for Russian gas in Central and Eastern Europe are unfounded.

Market integration has increased considerably in Eastern European countries in recent years, both within Central and Eastern Europe and between Central/Eastern Europe and Western Europe. In addition, physical import capacities in Central and Eastern Europe have already been and continue to be considerably expanded, thereby providing the traditional transit countries for Russian gas (Poland, Slovakia, Czech Republic and Hungary) with diversified import options, regardless of how much gas flows through the traditional transit routes. As a result, there is no reason to fear that the Nord Stream 2 pipeline will endanger "energy solidarity".
EFFECTS OF INFRASTRUCTURE INVESTMENTS SUCH AS THE NORD STREAM 2 PIPELINE ON THE EUROPEAN GAS MARKET

LITERATURE


EFFECTS OF INFRASTRUCTURE INVESTMENTS SUCH AS THE NORD STREAM 2 PIPELINE ON THE EUROPEAN GAS MARKET


EFFECTS OF INFRASTRUCTURE INVESTMENTS SUCH AS THE NORD STREAM 2 PIPELINE ON THE EUROPEAN GAS MARKET


European Environment Agency (2020), Primary energy consumption by fuel in Europe.


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Taglia & Rossi (2009), European Gas Imports: GHG Emissions from the Supply Chain,


UBA – Umweltbundesamt (2016), CO2-Emissionsfaktoren für fossile Brennstoffe, September 2016,


UBA – Umweltbundesamt (2018), Entwicklung des durchschnittlichen Brutto-Wirkungsgrades¹ fossiler Kraftwerke, Dezember 2018,
ANNEX A METHODOLOGY AND CENTRAL ASSUMPTIONS FOR THE SECURITY OF SUPPLY ANALYSIS

Below we explain the methodology and key assumptions for the results presented in Figure 9. For this analysis we compare expected gas demand with expected available gas supply in the EU:

- We base our calculations on annual gas volumes (in bcm/a) and the gas demand in a normal year to analyse the need for an additional pipeline in typical situations (and not just in exceptionally cold winters).

- **EU gas demand:** We assume a relatively constant level for EU gas demand in the medium term and a slight decline in the long term (red line in Figure 9), based on the ENTSOG Gas-before-Coal and Sustainable Transition scenarios. We also consider a scenario with lower gas demand (dotted red line in Figure 9), based on the ENTSOG Distributed Generation scenario.

- **EU own production:** In line with numerous third-party studies we are assuming a sharp decline in European own production which cannot realistically be compensated by the production of renewable gases in the future. This trend is reinforced by the recent decision of the Dutch government to further restrict production capacity in the Groningen field.

- **Differentiation regarding gas imports into the EU:** We consider secure supply volumes and potential additional volumes for all potential gas import sources:
  - **Secure supply** comprises all volumes that can be considered to be available in any scenario from today’s point of view. These are based on country-specific analyses taking into account
    - Minimum production expectations;
    - minimum export volumes in the recent past; and
    - existing and realistically expected long-term supply contracts.
  - **Potential additional supply** comprises the maximum amount of gas available for export to the EU under the most optimistic assumptions, based on country-specific analyses taking into account

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67 Our assumptions are based on an extensive analysis of third-party studies, including EU and national institutions. A key source is the 2018 Ten-Year Network Development Plan (TYNDP) of the European Transmission System Operators for Gas (ENTSOG) and the scenario framework underlying TYNDP 2018 which was jointly developed for the first time in 2018 by ENTSOG and the European Transmission System Operators for Electricity (ENTSO-E) and contains, among other things, forecasts for demand, production and supply scenarios in the EU, ENTSOE and ENTSOG (2018). The TYNDP or its scenario framework has - in addition to its public availability (including all data used) - the great advantage that it is coordinated with key decision-makers in the EU, including the transmission system operators responsible for gas infrastructure planning. Accordingly it is a robust study of future developments in the European gas market.

68 This is done, for example, in the context of the Security of Supply Report of the European Transmission System Operators’ Association (ENTSOG).
EFFECTS OF INFRASTRUCTURE INVESTMENTS SUCH AS THE NORD STREAM 2 PIPELINE ON THE EUROPEAN GAS MARKET

- maximum future production expectations based on existing, new and yet to find sources, and
- maximum utilisation of available and planned transport capacities.\(^69\)

It is already clear from the description that the potential additional supply is subject to a high degree of uncertainty. Generally, the secure supply and potential additional supply represent the full range of possible future gas imports. They do not imply any statement on the probability of realising certain volumes.\(^70\)

### Country-specific gas import potentials

- **Non-Russian pipeline imports**: Gas imports from Norway will decline in the future due to declining production volumes. The Norwegian government also expects gas production in Norwegian fields to decline by 2030.\(^71\) Future pipeline imports from North Africa (Algeria, Libya) and the Caspian region (Azerbaijan, potentially Turkmenistan) are subject to a high degree of political and economic uncertainty. Even under optimistic scenarios, these regions combined cannot compensate for the declining production trends in the EU and Norway.

- **Russian pipeline imports**: Future pipeline imports from Russia will run through the four main transit routes: Yamal-Europe, Ukraine ("central corridor"), Nord Stream (1 and 2) and TurkStream. For our analysis we include the use of the existing routes Yamal-Europe, Nord Stream (1) and parts of the Ukrainian route as secure supply. Volumes that can be imported via pipelines that are currently under construction (e.g. TurkStream) as well as additional volumes via the Ukraine route are counted as potential additional supply. Moreover, we look at each situation with and without Nord Stream 2 to analyse the effect of the pipeline.

- **LNG imports**: The future development of LNG imports into the EU is the main factor of uncertainty for the analysis. On the one hand, LNG has great potential in terms of volume, as the EU has extensive regasification capacities for imports and global liquefaction capacities are also increasing. On the other hand, most of the global LNG production volumes are not contractually guaranteed for delivery to the EU and can therefore be delivered flexibly to the market with the highest sales price. Therefore, we assume (in line with ENTSOG in the context of the TYNDP) that only a small part of the LNG import potential into the EU can be considered as secure.

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\(^69\) The TYNDP takes into account, among other things, import pipeline projects that do not yet have a final investment decision (FID), which would allow, for example, the import of Turkmen gas into the EU. However, we currently consider the feasibility of these projects to be speculative and therefore do not include these potential volumes in our analysis.

\(^70\) See ENTSOG (2017c).

\(^71\) See Norsk Petroleum (2019).
Reduction of greenhouse gas emissions by switching to less CO₂-intensive fuel natural gas (*fuel switch*)

A key advantage of using natural gas compared to other fossil fuels is its comparatively low CO₂ intensity. For example, 1 kWh of natural gas contains only about 200 g CO₂, which is significantly lower than the values for hard coal (340 g CO₂/KWh) and lignite (400 g CO₂/KWh).\(^\text{72}\)

So far, primary energy consumption in the EU has been dominated by CO₂-intensive fuels such as oil and coal. Consequently, a switch from oil or coal to natural gas can in many cases be an effective and relatively quick measure to reduce emissions. This so-called *fuel switch* can thus represent a cost-effective start on the long-term path to a CO₂-free energy supply. This is not only theoretically possible, as shown by the sharp decline in CO₂ emissions in the US power plant sector in the course of the so-called "shale gas revolution". Between 2007 and 2018, emissions in the electricity sector were reduced by almost 30% through a far-reaching fuel switch from coal-fired to natural gas-fired power plants.\(^\text{73}\)

In addition to the lower emissions caused by the energy source, gas-fired power plants also generally reach a significantly higher efficiency level, so that fewer kWh of primary energy sources are used per kWh of electricity generated.\(^\text{74}\) Figure 17 illustrates the specific emissions from electricity generation depending on energy source and efficiency. Figure 18 shows a similar comparison for heat generation.

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\(^{72}\) See UBA (2018). The values given refer to the CO₂ intensity of the respective primary energy source.

\(^{73}\) See EIA (2019), p. 201.

\(^{74}\) According to UBA (2018) the average efficiency of gas-fired power plants is about 10 percentage points higher than that of lignite-fired power plants. When comparing a newly built gas-fired power plant with an existing lignite-fired power plant the difference is even 24 percentage points.
Figure 17: Emission factors [g CO₂ / kWh(el)] in electricity generation

Source: Frontier Economics after UBA (2018). The interval (min v max) reflects typical degrees of efficiency in the power generating technologies that are used.

Figure 18: Emission factors [g CO₂ / kWh(th)] in heat generation

Source: Frontier Economics after UBA (2016). The interval reflects typical degrees of efficiency in the heat generation technologies that are used.
Greenhouse gas emissions of Nord Stream 2 pipeline are lower than those of alternative pipeline routes

Greenhouse gas emissions from the transport of natural gas via pipelines are essentially dependent on three parameters, namely\(^{75}\):

- the length of the pipeline transport route;
- the number and energy consumption of compressor stations; and
- the structural condition of the transport infrastructure (pipelines and compressors)

The individual parameters also influence each other to some extent. For example, a longer route requires the installation of more compressors while the technical condition of the pipelines and compressors determines the level of methane leakage (methane slip). The latter is of particular importance due to the higher greenhouse effect of methane compared to CO\(_2\) (factor 34).\(^{76}\)

When comparing the Nord Stream route with the traditional export routes of Russian gas it is clear that the specific emissions are significantly lower when transported via Nord Stream or Nord Stream 2, because the transport distances of the Nord Stream route are shorter than the traditional export routes.

In addition to the shorter route, two other features of the Nord Stream route have a reducing effect on greenhouse gas emissions:

- As is typically the case with offshore pipelines, no compressors are required along this route (due to the generally higher ambient pressure offshore). This means that both the consumption of drive gas and methane slip are eliminated over long distances as these are largely generated at the compressor stations.\(^{77}\)

- In addition to the already more favourable technical and geographical conditions, a comparison between the Nord Stream corridor and the central corridor through Ukraine must also take into account the structural condition of the facilities. While Nord Stream and Nord Stream 2 are new state-of-the-art pipelines, some of the pipelines on the central corridor are more than 50 years old.\(^{78}\) In addition to an increased risk of failure and outages, this also leads to significantly increased methane slip and inefficiently high energy consumption by the outdated compressors. According to model calculations, the specific greenhouse gas emissions ("carbon footprint", expressed in g CO\(_2\) equivalent per unit of energy transported) of gas transported on the central corridor are over 60% higher than on the Nord Stream route.\(^{79}\)


\(^{76}\) See IPCC (2014), p. 714.


\(^{78}\) See in detail KPMG (2017), Chapter 3.

\(^{79}\) See DBI GUT (2016b), p. 18.
Greenhouse gas emissions from Nord Stream 2 pipeline are lower than compared to LNG imports

The Nord Stream route also has significantly lower greenhouse gas emissions than LNG imports.

In the case of LNG, the gas is transported from the production field by pipeline to a liquefaction terminal on the coast. These distances in the LNG producing countries are generally shorter than the transport distance from Russia to Europe. Greenhouse gas emissions from the pure pipeline transport to the LNG terminal are thus lower than those from Russian natural gas volumes.

However, this advantage is more than offset by the relatively high energy consumption for treatment and liquefaction of natural gas, and the unavoidable methane slip in such plants. A further source of greenhouse gas emissions are the LNG tankers, the emissions from which depend on the shipping distance. The final regasification, on the other hand, produces only a few emissions.

Figure 19 illustrates this with the results of model calculations for various LNG routes and for deliveries via the Nord Stream corridor.

**Figure 19** Comparison of specific greenhouse gas emissions from different transport routes

Source: Frontier Economics after Thinkstep (2017), p. 77

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80 Deliveries from Algeria to Europe therefore have comparatively low emissions, while those from more distant countries of origin such as Australia are associated with correspondingly higher environmental pollution.

81 See in detail Thinkstep (2017), Chapter 5, where a discussion and classification of other literature sources is also provided. The model calculations shown here as examples are usually in the middle range of the values discussed in the literature.
ANNEX C METHODOLOGY OF EWI’S GAS TRANSPORT MODELLING

The gas transport modelling was performed with the model "Transport Infrastructure for Gas with Enhanced Resolution" (TIGER). TIGER is a European infrastructure and dispatch model that optimises European gas supply under given infrastructure and demand assumptions (i.e. minimises the total cost of gas supply).

The infrastructure is represented in TIGER with a high level of detail (over 200 storage (projects), over 1200 pipelines, all LNG import terminals). Infrastructure extensions are also mapped in the model and are included in the model as exogenous inputs. Market areas are taken into account and tariffs for entry and exit in a specific market area are model inputs. Gas demand in 58 European regions, differentiated according to the needs of households, industry and the electricity sector is stored in the model.

Important natural gas producers are included in the model. Exporters assigned to the producers Russia, Norway, Libya, Algeria and Azerbaijan supply the entry points of countries/market areas either through long-term contracts (LTC) or spot trading. LTCs are characterised by minimum purchase quantities ("take-or-pay", TOP), annual contracted quantities ("ACQ") and a daily flexibility factor.

Figure 20 gives an overview of the TIGER gas transport model. The left column shows the "inputs" in terms of gas supply, gas demand and gas infrastructure, which are used to map the European gas system in a high level of detail. The right column lists the "outputs" of the model, i.e. the key results of the modelling.

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82 The model covers all EU countries with the exception of Malta and Cyprus, and simplifies Ukraine. The demand also takes into account the demand of Switzerland and the western imports of Ukraine, which must also be covered by the gas supplies available to the EU.
Mapping the European gas system in the TIGER model (main inputs)

In order to map the European gas system in the TIGER model, the following data were used:

- **Time horizon** - The calculations were done for the following three years:
  - 2021
  - 2030
  - 2040

- **Gas demand** - The gas demand shown in the model corresponds to the natural gas demand (i.e. gas demand minus biomethane injection). The data for 2021 is based on Eurostat's historical values (2019) for 2017, which have been interpolated to the forecast of TYNDP 2025 (Gas-before-Coal scenario). The assumptions for 2030 and 2040 correspond to the Sustainable Transition Scenario of TYNDP 2018.\(^3\)

In addition, a demand sensitivity is calculated, in which the Distributed Generation scenario is used instead of the Gas-before-Coal or Sustainable Transition scenarios of the TYNDP. This scenario is characterised by lower overall demand in the EU.

The two demand scenarios thus correspond to those underlying our analysis in Section 4.2 (see also ANNEX A).

- **Gas production (within the EU)** - The assumptions on gas production for 2021 (excluding biomethane) are based on Eurostat's historical values (2019) for

\(^3\) The value 11 kWh/m\(^3\) was used as the conversion factor from energy units to volume units.
2017, which have been interpolated to the forecast of TYNDP 2025 (Gas-before-Coal scenario). The assumptions for 2030 and 2040 correspond to the Sustainable Transition Scenario of TYNDP 2018.84

- **Gas infrastructure** - The existing gas infrastructure is mapped in high detail and is continuously updated in a Europe-wide geocoded database of the EWI. Future infrastructure developments (pipelines and LNG) are mainly based on the ENTSOG TYNDP 2018.85

- **Tariffs** - Entry/exit tariffs are based on data from the ACER Market Monitoring Report 201886 and were assumed to be constant for 2021, 2030 and 2040. Own calculations by EWI or other sources were required for the pipelines TurkStream, Ukraine Transit, TAP and Baltic Pipe.

**Mapping of LNG supply for the EU market in the TIGER model**

LNG supply for the EU market is represented in the TIGER model by means of year-specific LNG supply functions. An LNG supply function indicates which LNG quantity is available at what price. Importing LNG into the EU involves different costs depending on the LNG exporting country. In order to meet the demand for LNG in the EU, the first step is therefore to use exports from countries with comparatively low costs. If European demand for LNG is higher, additional LNG is sourced from countries with higher costs. This results in an increase in the LNG supply function.

Moreover, LNG supply for the European market is dependent on the global supply and demand situation for LNG. The year-specific LNG supply curves reflect the (expected) development on the global LNG market for the respective year.

The LNG supply curves used in the TIGER model were determined by coupling the TIGER model with the global gas market model COLUMBUS of EWI. The coupling of COLUMBUS and TIGER models allows the investigation of the influence of the global gas market on the intra-European market without having to impose restrictions on the calculations for the European market. LNG supply functions for the years 2021, 2030 and 2040 resulting from the model coupling are shown in Figure 21. Take-or-pay volumes in LTCs are treated as must-run flows, i.e. the flows occur independently of the price. Re-exports of LNG are not considered.

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84 The value 11 kWh/m³ was used as the conversion factor from energy units to volume units.
85 With regard to the OPAL, it is assumed that it can be used at full capacity from 2021.
86 See ACER (2019b).
EFFECTS OF INFRASTRUCTURE INVESTMENTS SUCH AS THE NORD STREAM 2 PIPELINE ON THE EUROPEAN GAS MARKET

Figure 21  LNG supply functions for the European market in the years under review

It is assumed that LNG imports have a price-setting effect as marginal supplier in all European countries. The costs of marginal gas supplies from Russia are assumed to be lower than the costs of marginal LNG imports. Therefore, the price of Russian gas at any point is determined by the price of LNG plus the cost of transport from the nearest LNG import terminal to that point. This approach implies that Russian gas is priced on the basis of alternative supply sources.

Source: EWI.

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87 See OIES (2015).
In recent years or even decades, Europe's gas markets have become increasingly integrated, triggered by the intensive efforts of the EU, other European institutions and national regulatory authorities such as the German Federal Network Agency BNetzA. This is reflected in the extensive alignment of wholesale price levels in the individual European states. According to ACER, the Agency for the Cooperation of Energy Regulators in the EU, most import and hub prices in Europe deviate only slightly from those of the most liquid trading market in Europe, the Dutch TTF. As can be seen in Figure 22, the deviations in almost all Western European and many Central and Eastern European countries amounted to less than €1/MWh on an annual average for 2018. For example, the hub prices in Poland, Czech Republic or Slovakia were almost identical to those in The Netherlands, Belgium or Germany. Larger price differences to the TTF could only be observed in rather isolated and peripheral markets with poor infrastructure connections such as Finland, Croatia or Ireland as well as countries outside the EU (such as Ukraine or Northern Macedonia).
EFFECTS OF INFRASTRUCTURE INVESTMENTS SUCH AS THE NORD STREAM 2 PIPELINE ON THE EUROPEAN GAS MARKET

Figure 22  Average wholesale prices in Europe and deviations from the hub price on the Dutch TTF (2018)

Source: ACER (2019a), p. 19

The high degree of convergence of the Western and Eastern European trading centres is illustrated in Figure 23. Both the correlations between the Eastern European trading centres among themselves and with those of Western Europe are consistently high and only slightly below the peak values of the continent. For example, the highly liquid trading centres in north-western Europe (especially TTF, NBP, GPL, NCG and ZEE) are almost 100% correlated. But also the correlations of the Polish (PL-VTP), Czech (CZ-VOB) and Slovakian (SK-VTP) prices among each other and with the Western European prices are in similarly high correlation levels (mostly in the range of 95 to 97.5%). This means that they achieve similar or even higher values than ‘classic’ comparative correlations such as NBP/TTF or ZEE/NCG.

The integration of the Hungarian hub is noticeably below these values. However, at 79 to 85% correlation with other Eastern and Western European hubs, the level is still sufficiently high to speak of far-reaching price integration. This applies to the Latvian hub only to a very limited extent. Even though the average price level is only about 1 to 1.5 €/MWh above the comparable markets the correlation coefficients are rather low at only about 50%.
The high correlations imply that the fluctuations in absolute price spreads over the course of a trading year are kept within narrow limits. For the Czech Republic, Poland, Hungary and Slovakia outliers of more than €3/MWh premiums compared to the TTF could only be observed on a few occasions in 2018. The share of trading days with such high deviations amounted to less than 5% of trading days in all four countries. This means that the Eastern European hubs performed significantly better than hubs in Spain, France and Italy where price premiums of more than €3/MWh occurred on up to almost 20% of trading days. Deviations were similarly high compared to the TTF in Lithuania (around 15%) although this was a significant improvement compared to 2017 (almost 40%).

Even when comparing Poland, Czech Republic, Slovakia and Hungary with each other, high price deviations are rarely observed.

Figure 23 Correlations between European hub prices (2018)

Source: ACER (2019a), p. 41 (own emphasis)

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89 See ACER (2019b), p. 43.
EFFECTS OF INFRASTRUCTURE INVESTMENTS SUCH AS THE NORD STREAM 2 PIPELINE ON THE EUROPEAN GAS MARKET