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Energy supply security in Germany can be guaranteed even without natural gas from Russia

By Franziska Holz, Robin Sogalla, Christian von Hirschhausen, and Claudia Kemfert

DIW focus

Special issue on the war in Ukraine

The Russian war on Ukraine and Germany's dependence on Russian gas require a rethink of German energy supplies. While there is a heated debate about an immediate energy embargo, Russia could also stop its supplies at any time. To date, Germany has purchased around 55 percent of its natural gas from Russia. DIW Berlin has developed scenarios for how the German energy system could become independent of these imports as quickly as possible in the European context: On the supply side, deliveries from other natural gas exporting countries could compensate for some of the Russian exports. Security of supply would be significantly strengthened if the pipeline and storage infrastructure were used more efficiently. On the demand side, there is a short-term savings potential of 19 to 26 percent of current natural gas demand. In the medium term, a push towards renewable heat supply and higher energy efficiency is particularly necessary. If the energy-saving potential is exploited to the maximum and supplies from other natural gas supplier countries are expanded as far as technically possible at the same time, Germany's supply of natural gas will be secure in 2022 and in the coming winter 2022/2023, even without Russian imports.

Following the announcement of the early warning stage of the gas emergency plan on March 30, 2022, by the German Minister for Economic Affairs and Climate Action, Robert Habeck, the energy crisis due to the war in Ukraine has progressed to the next stage.[1] The German government is stepping up precautionary measures to be prepared in the event of a Russian gas supply freeze. In this context, the German energy industry is now benefiting from the fact that the natural gas infrastructure has been expanded in the rest of Europe following the recurring natural gas crises since 2006.[2]

The expansion of renewable energies and the move away from fossil natural gas supplies will also make Germany and other European countries less dependent on fossil energy imports in the medium term. When considering the entire production chain, natural gas is a fossil energy source that damages the

[1] Bundesministerium für Wirtschaft und Klimaschutz, *Notfall Plan Gas für die Bundesrepublik Deutschland* (2019) (in German; available online).

[2] Russia had already closed transit through Ukraine to Europe for several days and weeks in 2006 and 2009, respectively, for obvious geopolitical reasons. Moreover, Russia's strategy in renegotiating Ukraine transit shortly after the 2014 annexation of Crimea and the Donbas was shaped by geopolitical considerations. The EU Commission and European Council have responded to each of these crises with renewed and clarified security of supply rule books. The most recent revision proposal for these regulations is only from December 2021 (available online). Currently, the 2017 regulation is still in force (available online).

climate similarly as coal due to methane emitted during extraction and transport. For years, DIW Berlin publications have suggested that Germany's medium- and long-term security of supply can be guaranteed even without natural gas supplies from Russia: On the one hand, it is possible to fall back on a diversified supply via pipeline and liquefied natural gas (LNG) terminals in neighboring countries; on the other hand, energy savings potentials of up to 26 percent of the current natural gas consumption can contribute to supply security. Now, measures that enable the efficient use of the existing infrastructure and simultaneously set the course for the medium-term end of the use of fossil natural gas, especially in the heating sector, are time critical.

Natural gas in the German energy supply

According to Eurostat figures, Germany consumed around 868 terawatt hours (TWh) of natural gas in 2020, which is around 86.8 billion cubic meters (bcm) of natural gas. The main consumers are industry (255 TWh, or 29 percent of total natural gas consumption), households (252 TWh, or 29 percent, excluding district heating), commercial/small consumers (116 TWh, or 13 percent), and the energy sector with electricity generation, heat generation, and natural gas use in refineries (a total of 243 TWh, or 28 percent). Around 95 percent of natural gas consumption was imported recently. As of 2020, more than 50 billion cubic meters of natural gas, i.e., more than half of imports, have come from Russia.

Russian natural gas comes to Germany through the Central Corridor through Ukraine, Slovakia, and the Czech Republic (Bratsvo ("Brotherhood") pipeline); through the Yamal-Europe pipeline through Belarus and Poland, which was opened in the late 1990s; and through the Nord Stream (1) pipeline from the St. Petersburg area through the Baltic Sea to Lubmin (Mecklenburg-Western Pomerania), which was opened in 2011. For a few years now, Russia has also been exporting LNG from Siberia to Europe, although this accounts for only a small part of Russia's exports and plays a subordinate role for Germany.

DIW Berlin has long drawn attention to the vulnerability of the German and European energy systems to Russian exports, especially natural gas exports and infrastructure. As early as 2014, Russia's Gazprom had strategic infrastructure under control in Germany and Eastern Europe, a trend that has continued since then.[3] The construction of pipelines through the Baltic Sea to bypass Ukraine as a transit country was also geopolitically motivated. In particular, the construction of Nord Stream 2 followed geostrategic rather than business considerations.[4] More recent publications show that even before the war in Ukraine, the potential existed to shift energy supply to a greater variety of energy sources.[5] In the following sections, the short-term adjustment options on the supply and demand side for the possible replacement of Russian natural gas supplies are considered and then reconciled.

To reduce purchases from Russia, more natural gas must be imported from other suppliers

Natural gas is imported from European suppliers as well as from global markets. This is predominantly done under long-term supply contracts, but since the liberalization of energy markets in Europe over the past ten to 15 years, these have been supplemented by short-term trading on spot and other markets. [6]

Alongside Russia, Norway has been the second major natural gas exporter to Germany since the late 1970s. Norway supplies natural gas via an offshore pipeline through the North Sea (approx. 37 percent of German imports in 2020). Since the 1960s, the Netherlands has been the third major supplier of natural gas to Germany. In addition to smaller fields in the North Sea, it has primarily exploited the

[3] Franziska Holz et al., "European Natural Gas Infrastructure: The Role of Gazprom in European Natural Gas Supplies." *DIW Politikberatung kompakt* 81 (2014) (available online).
[4] Anne Neumann et al., "Natural Gas Supply: No Need for Another Baltic Sea Pipeline," *DIW Weekly Report* 27 (2018): 241-248 (available online).
[5] Franziska Holz and Claudia Kemfert, "No Need for New Natural Gas Pipelines and LNG Terminals in Europe," *DIW focusl* 5 (2020) (available online).
[6] Christian von Hirschhausen and Anne Neumann, "Long-term contracts and asset specificity revisited: An empirical analysis of producer-importer relations in the natural gas industry," *Review of Industrial Organization* 32, no. 2 (2008): 131-143 (available online).

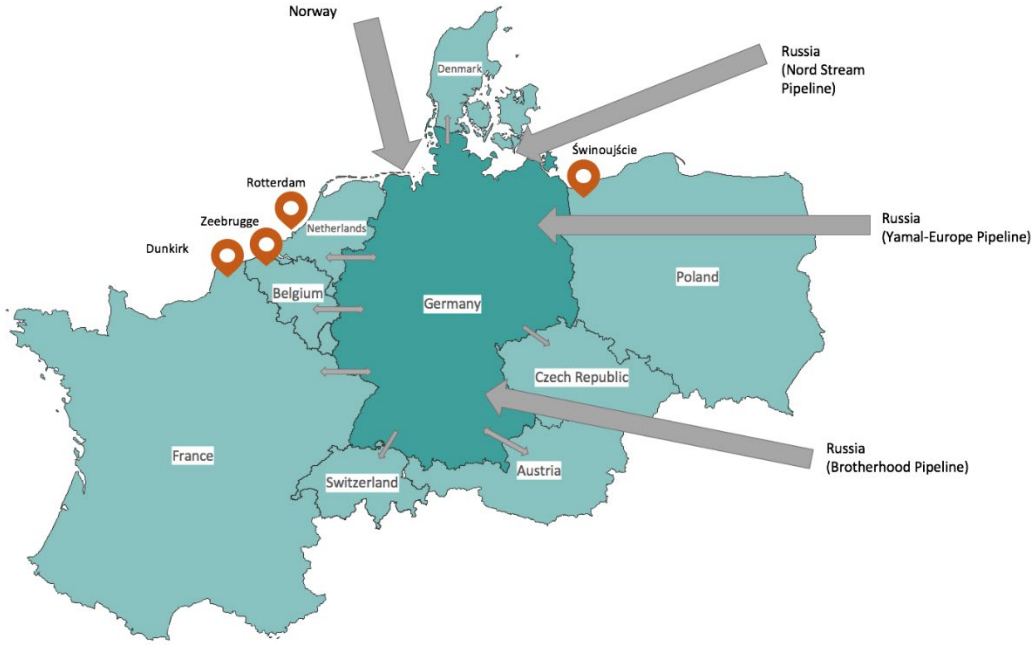
large Groningen natural gas field. However, there have been problems with earthquakes in the Groningen region for about ten years and production has thus been scaled back.[7]

In addition, German energy suppliers have the option of importing LNG via import terminals in neighboring countries. This is particularly suitable for terminals on the North Sea coast, for example in the Netherlands (Rotterdam), Belgium (Zeebrugge), and France (Dunkirk).[8]

Figure 1

Natural gas import connections to Germany

Simplified presentation of the main natural gas inflows and outflows



Notes: Blank map from GeoNames, Microsoft, TomTom (supported by Bing).

Source: DIW Berlin.

In view of the dependence on supplies from Russia to date, the question arises as to whether, or to what extent, Russian exports to Germany could be replaced. Due to the dependence on pipelines and/or LNG terminals, it is only possible to increase deliveries in the short term via existing infrastructure capacities. However, there is significant growth potential in relation to deliveries in recent years, as the deliveries in recent weeks, which have already increased, also show.[9] These potential increases total up to 37 billion cubic meters for 2022 as a whole and 28 billion cubic meters for the months of April to December 2022 (Figure 2). They will be briefly outlined here.

We distinguish between a baseline supply, a maximum supply potential, and a realistic supply. The baseline supply corresponds to the supply expected under normal circumstances for 2022 based on past years and current supply contracts.[10] Generally speaking, the maximum supply potential assumes the highest possible increase in deliveries to Germany, while the realistic supply also takes into account

[7] Franziska Holz et al., "Shaking Dutch Grounds Won't Shatter the European Gas Market," *Energy Economics* 64 (2017): 520-529 (available online). Franziska Holz, Hanna Brauers, and Thorsten Roobeek, " Earthquakes in the Netherlands Cannot Shake the European Natural Gas Market," *DIW Weekly Report* 48 (2015): 629-635 (available online).

[8] For example, Uniper has been booking import capacity at the gate terminal in Rotterdam for years and has recently increased these bookings (available online).

[9] Thanks to EU transparency requirements, gas flows can be viewed at the Association of European Transmission System Operators for Gas, among others (available online).

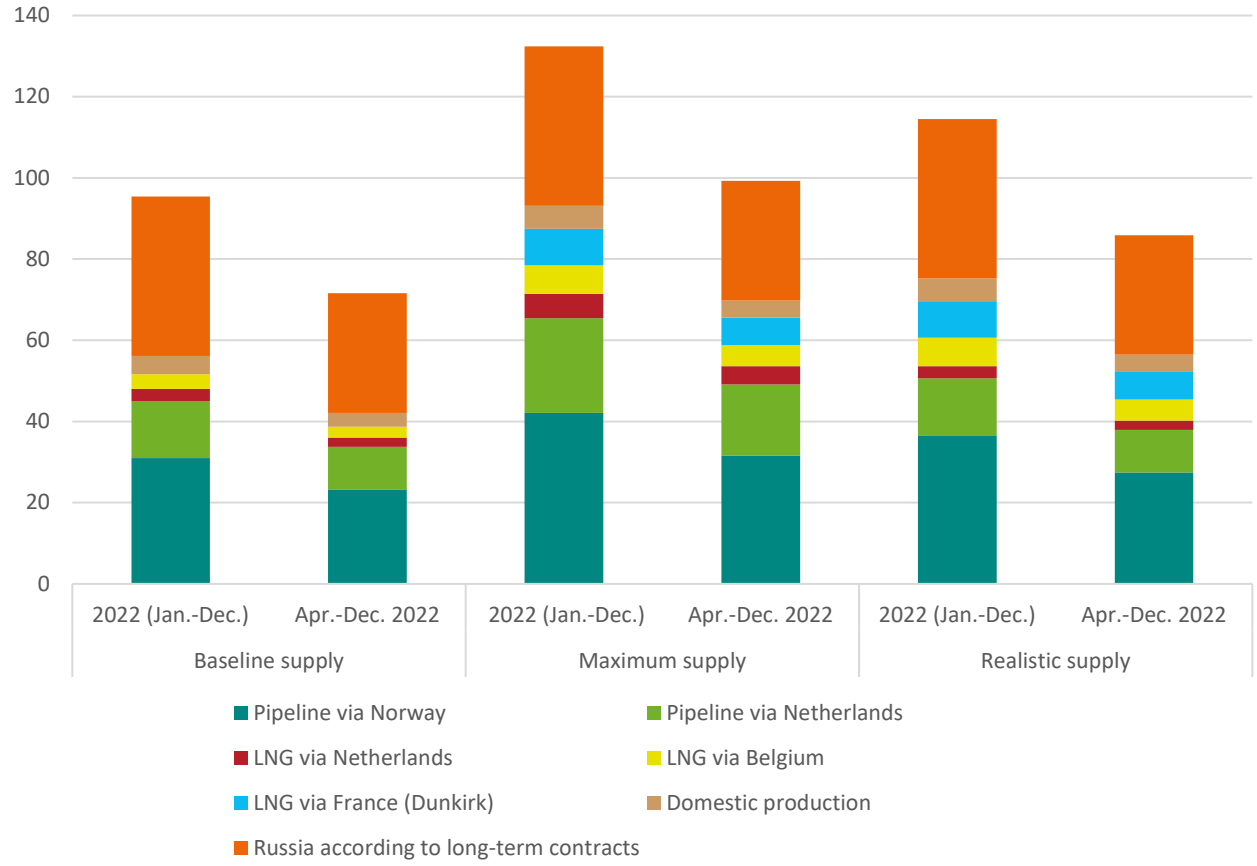
[10] Supply contracts according to Anne Neumann, Sophia Rüster, and Christian von Hirschhausen, "Long-Term Contracts in the Natural Gas Industry: Literature Survey and Data on 426 Contracts (1965-2014)," *DIW Data Documentation* 77 (2015) (available online).

the needs of Germany's neighboring countries and planned maintenance. The realistic supply is also higher than the baseline non-Russian supply by 19 billion cubic meters for the whole of 2022 and by 14 billion cubic meters for the months April to December 2022.

Figure 2

Possible supply increases of natural gas exports to Germany

In billion cubic meters



Note: In addition, minimum supply volumes of Russian natural gas are entered based on existing long-term supply contracts, as far as they are known (data from Anne Neumann et al., available online).

Source: DIW Berlin.

For the maximum supply, it was assumed that Norway would be able to supply Germany without interruption at the level of the pipelines' daily maximum capacity (i.e. 3.51 billion cubic meters per month) in 2022. Realistically, however, it must be assumed that, for safety reasons, annual maintenance will have to be carried out in the fields and pipelines, which will take approximately one month overall. In addition, beginning in the fall of 2022, Norway will send some of the gas previously supplied to Germany to Poland instead via the Baltic Pipe (ten billion cubic meters of annual capacity; here, two billion cubic meters are expected for 2022).

For the maximum supply from the Netherlands, it is assumed that the Netherlands will be able to supply at the highest monthly level in 2021 throughout 2022 (1.946 billion cubic meters per month). This implies that the reduction of production from the Groningen field will be temporarily suspended and production in the Small Fields will be maintained at a high level. However, this has not been achieved in recent months despite high prices. Realistic supply is therefore assumed to be 40 percent lower. This roughly corresponds to deliveries in 2021 and would therefore still be higher than previously planned.

The LNG terminals in northwestern Europe are connected to the German market via the European pipeline network. For the maximum supply scenario, it is assumed that at least half of the terminals'

capacities can be used for imports to Germany (Rotterdam). Respectively, the unused capacities from 2021 could be available for Germany (Dunkirk and Zeebrugge, minus the replacement of possible shortfalls of Russian exports to Belgium). In the realistic scenario, LNG import opportunities via the Netherlands (Rotterdam) must be set lower, as the Netherlands will likely need to compensate for both its own production difficulties and recent fairly high imports from Russia with LNG imports. In the global market, LNG supply and vessels are available, as LNG supplies are directed to Europe instead of Asia when prices in Europe are high. This has already been seen in the first months of 2022.[11]

Other possibilities for increasing supply in Germany through more efficient EU-wide network management have not yet been taken into account. For example, with appropriate network management, it would also be possible to trade LNG coming to Europe via LNG terminals on the Mediterranean and Adriatic coasts. This could be made possible, for example, by netting (virtual reverse flows) in the pipelines within Europe. By netting the flows in both directions in this way, sales can be made in the opposite direction in addition to physical capacity in one direction. The direction of flow in pipelines in the Eastern and Central European region is generally still from the east (Russia) to the west and south (Italy, for example). Netting or virtual reverse flows can be implemented immediately and would offer the possibility to bring gas from LNG terminals in Southern Europe (Italy, Croatia, Turkey, and so on) to Eastern and Central European countries previously dependent on Russia, even before the establishment of physical reverse flow capacity. Natural gas from North African suppliers delivering by pipeline to Italy (Algeria, Libya) could also be sold to Germany in this way.

In addition, the German government is currently supporting the use of floating LNG terminals on the German coast, which could provide relief for the coming winters. However, new capacities for the fossil fuel natural gas should include a phase-out date so as not to come into conflict with the goal of climate neutrality by 2045. Floating storage and regasification units (FSRUs) are often chartered under leasing agreements and are thus suitable for temporary use. Building fixed LNG terminals in Germany, on the other hand, does not make sense because of the long construction times and the sharp decline in natural gas demand in the medium term.

Short-term energy saving opportunities to reduce natural gas consumption

If current natural gas imports from Russia are discontinued, it will be necessary to reduce natural gas consumption. Given the current serious situation, a higher decline in demand can be expected than is implied by the long-term equilibrium models usually used for analysis. For example, in an equilibrium model of the international natural gas market, demand declined by only four percent annually following a price increase due to supply disruption.[12] In contrast, current energy industry studies show short-term savings potential of around 18 percent of gas demand in Germany.[13] In addition, the high price of natural gas on wholesale markets since summer 2021 provides incentives to reduce natural gas consumption.

Different scenarios are also distinguished for natural gas demand: a baseline scenario, a medium savings scenario, and an optimistic savings scenario (Figure 3). The baseline scenario contains the assumption of moderate savings (minus nine percent compared to 2020), which means that natural gas demand is roughly equivalent to the 2014/2015 level, when high prices also prevailed on the natural gas market. Natural gas consumption can be reduced, especially in the power sector (excluding heat generation), where replacing natural gas is more feasible from a technical perspective. However, this would require the use of more coal in the short term. The demand scenarios assume that at least 30

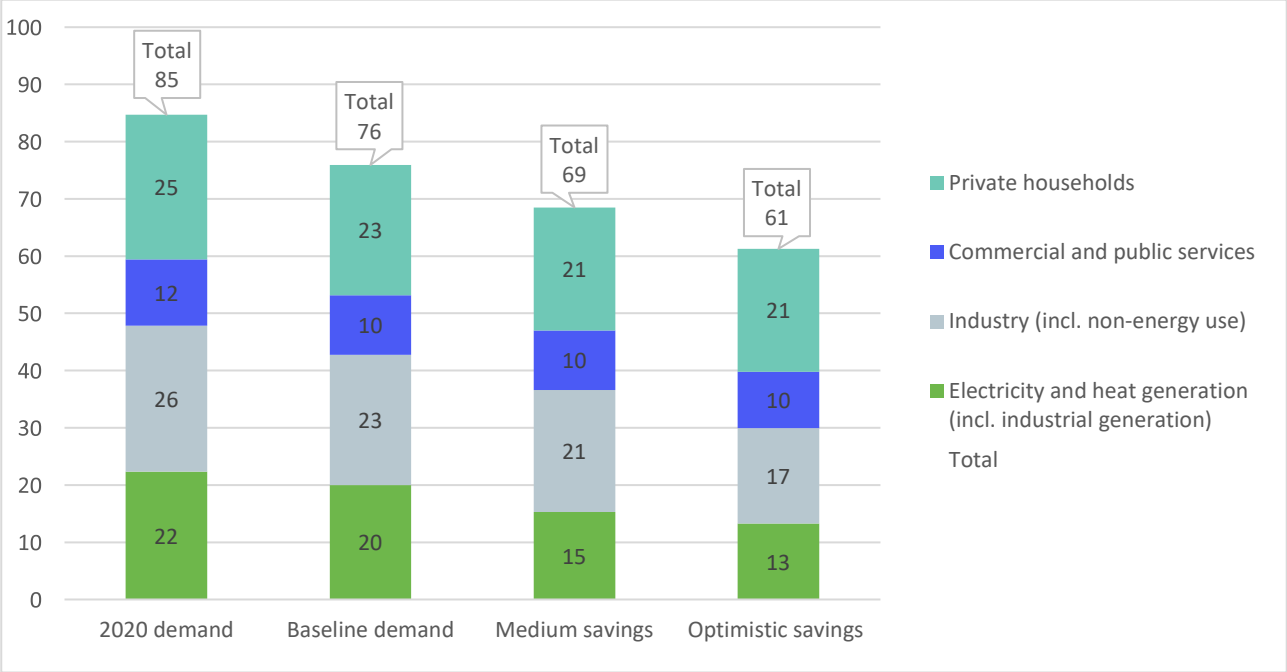
[11] Mike Fulwood et al., "The EU plan to reduce Russian gas imports by two-thirds by the end of 2022: Practical realities and implications," *Oxford Institute for Energy Studies Energy Insight* 110 (2022) (available online).
[12] Ruud Egging, Franziska Holz, and Victoria Czempinski, "Freedom Gas to Europe? Scenario Analyses with the Global Gas Model," *Research in International Business and Finance* 58 (2021): 101460 (available online).
[13] Cf. BDEW, *Kurzfristige Substitutions- und Einsparpotenziale Erdgas in Deutschland* (Berlin: German Association of Energy and Water Industries, 2022) (in German; available online); Forschungszentrum Jülich, *Wie sicher ist die Energieversorgung ohne russisches Erdgas?* (FZ Jülich IEK-3: 2022) (in German; available online); and Helen Burmeister et al., *Energiesicherheit und Klimaschutz vereinen* (Agora Energiewende: 2022) (in German; available online).

percent and up to 100 percent (relative to 2020) of natural gas consumption in the power sector could be shifted.

Figure 3

Natural gas demand in 2022 in possible short-term scenarios

In billion cubic meters



Source: DIW Berlin.

The scenario with medium savings (minus 18 percent compared to 2020) is similar to the demand estimates of other institutes, although the assumptions also differ in detail slightly.[14] The scenario is based on a complete substitution of natural gas in power generation (excluding heat generation). In addition, natural gas consumption in industry and in private households declines more sharply (minus 15 percent). In the case of households, this can be achieved by lowering the room temperature, reducing the use of hot water, and by increasing the use of heat pumps in the short term.[15] Low-income households need financial relief for high natural gas prices.[16] In industry, the greatest savings potential lies in switching to alternative energy sources in heat generation such as electricity, coal, or biomass. However, this switch is difficult for processes that require a high level of heat, which is why savings for industry are assumed to be rather moderate at 15 percent overall.

The scenario with optimistic savings is based on Agora Energiewende's Phase 2 scenario.[17] Compared to the "medium savings" scenario, a significantly greater reduction in demand is assumed in the industrial sector (minus 33 percent), which affects all sectors, although not equally. The greatest savings potential is assumed for the food and chemical industries, where it seems easier to switch to other energy sources. An above-average savings potential is also assumed for the chemical industry, since intermediate and end products that have been produced in Germany from natural gas up to now can also be imported to some extent.[18] Nevertheless, the reduction in natural gas consumption

[14] For example, BDEW (2022) assumes 19 percent savings potential and Burmeister et al. (2022) and FZ Jülich (2022) also assume 18 percent.
[15] Burmeister et al. (2022), op. cit.
[16] Karsten Neuhoff et al., "Gaspreisschock macht kurzfristige Unterstützung und langfristige Effizienzverbesserung erforderlich," *DIW aktuell* 78 (2022) (in German; available online).
[17] See Burmeister et al. (2022), op. cit.
[18] See BDEW (2022), op. cit. (S. 18)

assumed in this scenario will probably be accompanied by a temporarily significant decline in industrial production in Germany.

Scenarios for supply-demand ratios ("supply gap")

The scenarios outlined above for the possible natural gas supply and the possible (reduced) demand in 2022 are combined in the following analysis. The focus is on supply from April up to and including December 2022. This also includes the filling of natural gas storage facilities, which are used to stock up for the remaining winter months of the 2022/2023 heating season (usually until the end of March).

Compared with other European countries, Germany has generous natural gas storage capacities of 24.5 billion cubic meters, i.e., more than a quarter of annual demand to date or more than two thirds of demand in the winter months of January to March. The German government plans to require 80 percent of the storage facilities to be filled on October 1 and 90 percent on November 1.[19] The volumes to be stored must be procured during the summer months in addition to current consumption. If the storage facilities were to be filled completely, this would still amount to 17.85 billion cubic meters from April 1 and 16 billion cubic meters if they were filled 90 percent of the time.[20] Thus, the planned strict requirements potentially limit the availability of natural gas to consumers during the summer. At the same time, our supply analysis shows that non-Russian supply significantly exceeds one-third of demand even in the baseline scenario, so two-thirds of demand would not need to be held in storage. Therefore, the optimistic demand scenario assumes 80 percent filling, which will be achieved by the end of 2022.

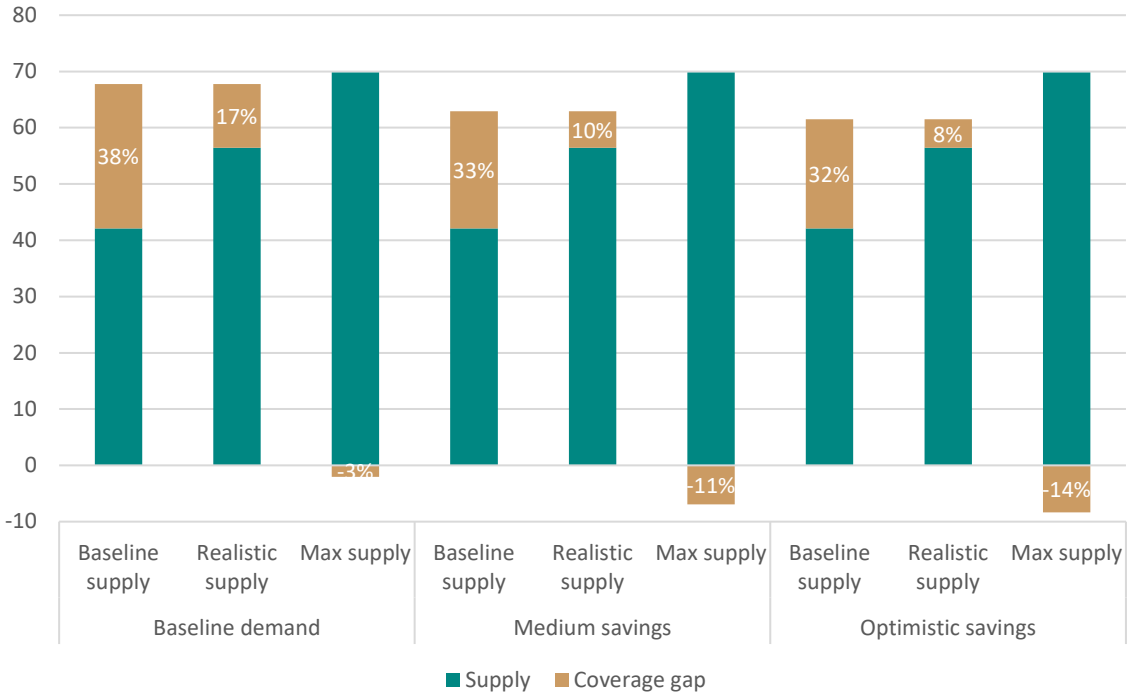
A maximum supply in combination with all demand scenarios results in a balanced picture for the year 2022 as well as winter 2022/2023 (Figure 4). A supply gap results with a lower supply. However, with a realistic supply and medium savings, the supply gap is only 10 percent. This could be achieved through additional savings.

[19] Proposed legislation "Introduction of fill level requirements for gas storage facilities" (available online). In addition, the proposed legislation provides for a minimum filling level of 40 percent on February 1. The European Commission plans a similar target of 90 percent filling on October 1 for the entire EU (see European Commission, "RePowerEU: Joint European Action for More Affordable, Secure and Sustainable Energy," press release, March 8, 2022, (available online).
[20] Storage level on 4/1/2022 was 6.4 billion cubic meters according to AGSI (available online).

Figure 4

Combined scenarios for supply and demand in the event of an interruption of natural gas supplies from Russia

In billion cubic meters



Notes: Demand (Fig. 3) and natural gas requirements for storage filling are subtracted from supply (Fig. 2). In the baseline demand and medium savings scenarios, storage is assumed to be 90 percent full by October 1 and 100 percent full by December 31; in the optimistic savings scenario, storage is assumed to be 80 percent full by December 31.

Source: DIW Berlin.

Conclusion: Security of supply possible without new LNG terminals even if Russian supplies cease

If the German energy system is adapted quickly, the loss of Russian natural gas exports could be compensated for in the course of 2022 and energy supplies could be secured in the coming winter. The condition for this is that Germany's natural gas imports from traditional supplier countries are significantly expanded. Furthermore, it is necessary to fill up existing storage facilities 80 to 90 percent before the start of the heating period in the winter of 2022/2023. More efficient use of the German and European natural gas pipeline system, and using it to link Germany to Southern Europe, could further ease the situation. While the additional supply is not enough to replace all of Russia's natural gas imports to date, in combination with declining natural gas consumption, Germany's energy supply can be secured. The construction of LNG import terminals on the coast does not make sense due to the long construction times and the sharp decline in natural gas demand in the medium term, and there are considerable risks of losses (known as stranded investments).

Under optimistic assumptions, natural gas savings of 18 to 26 percent of demand are possible. While natural gas in the electricity sector can be replaced by alternative energy sources in the short term, the savings in industry are accompanied by a drop in production. The industries that are particularly affected should therefore be compensated. These programs should aim to reduce natural gas consumption structurally and promote the switch to low-GHG production technologies. In the case of

private households, natural gas can largely only be saved by reducing energy demand, so energy-saving campaigns are needed as quickly as possible. In addition, measures to increase energy efficiency and facilitate the switch to renewable heat (in conjunction with heat pumps) must be implemented immediately.

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