LNG Import Capacity Expansion in Germany – Short-term Relief Likely to Turn into Medium-term Stranded Assets

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Abstract

This contribution critically assesses German LNG terminal plans. FSRUs may provide temporary relief in 2023 and 2024, but we see a risk of asset stranding for onshore import terminals.

1. Introduction

After the Russian invasion of Ukraine, security of natural gas supplies has proven to be a controversially debated topic in European and especially in German politics. Part of the debate has been on the necessity of siting new fossil LNG import terminals in Germany. Following February 24th, 2022, supply disruptions by the Russian side and interruption of demand via economic sanctions from the European side appeared equally plausible. Unexpected for decades, this "black swan" event is now reality, and since early September 2022, there have been no more pipeline imports from Russia to Europe via Germany or Poland.[1] The mysterious explosions of the Nord Stream pipelines on September 26th, 2022 have further cemented this state of a "new normal" in European gas markets without imports from Russia.

In this unique situation, the German industry and government has sought to diversify natural gas supplies, including with a large number of new LNG import terminals. These include five floating storage and regasification units (FSRU, total of 40 billion cubic meters per year, bcm/a) that have been or will be installed in 2023, and three fixed LNG terminals (total of 41 bcm) that are still under discussion. All this comes at a time when German energy and climate legislation focusses on the phase-out of fossil fuels, including fossil natural gas consumption, in the run-up of climate and plutonium neutrality by 2045, while the European Union also works towards climate neutrality by 2050.

While being unprecedented in German political debates, interruptions of Russian supplies to Europe have been subject to academic discourse for some time following the repeated conflicts between Ukraine and Russia over the gas transit (Egging et al. 2008; Egging, Holz, and Czempinski 2021). These analyses have shown the importance of access to the global LNG markets to provide an "insurance" option for Europe. Yet, Germany never had a terminal on its own coasts but German importers have booked capacity in terminals in Belgium and the Netherlands, benefitting from the dense European pipeline network to bring their LNG imports to Germany.

This article summarizes recent developments on LNG in Germany and asseses the rationale of the recent boom. We posit that while the short-term construction of a few floating terminals was a reasonable short-term reaction, the construction of fixed onshore terminals will produce stranded assets, given the legally binding objectives of the German energy transformation. The next section summarizes developments prior to 2022, including an overview of the *status quo*. We then discuss the current supply situation without Russian imports which has led to the realization of various LNG import projects in Germany. We then provide some details of the current LNG capacity expansion plans, before critically assessing them in light of the future German and European energy system developments. We conclude that floating terminals (FSRUs) provide flexible short term diversification of supplies while onshore regasification infrastructure is likely to strand in the long term while not being available in the short term.

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2. Fossil natural gas supplies to Germany

2.1 Status quo *prior to 2022*

Traditionally, Germany was fully supplied with fossil natural gas by pipelines, the most important source of which was the Soviet Union after the pipeline deal of the 1970s. Supplies from Norway, North Africa, and other European transit countries have also existed. Plans to develop an LNG import terminal in Wilhelmshaven had existed for several decades, but had not materialized due to the unfavorable economics: ample supply capacity in neighboring countries and competition from lower-priced pipeline gas.

In the context of the current crisis, it is important to note that dependence on imports from Russia have been developed to an extent to become politically dependent after 1990. This dependency has been maintained, and even expanded, through the Nord Steam 2 project, even after the 2014 occupation by Russia of the Ukrainian Crimea and East Ukrainian territories (Holz et al. 2014). Many countries in Eastern, Central and Western Europe were supplied from Russia via onshore high-pressure pipelines through Ukraine, mainly via the so-called Brotherhood pipeline system. Already the construction of the connection via Belarus (Yamal-Eu-

rope) in the 1990s testified to Russia's will to reduce the importance of the Ukraine transit after independence of the former Soviet republic (von Hirschhausen, Meinhart, and Pavel 2005).

In earlier years, Ukraine transit had a capacity of 140 bcm per year, while the Belarussian route had about 40 bcm/year (ENTSO-G 2021). The two Nord Stream projects directly connecting Germany and Russia with a capacity of 55 bcm/year each can be seen as the logical extension of Russian supply route diversification. Clearly, these projects did not following from techno-economic necessities and rather should serve as expensive double-infrastructure to by-pass Ukraine and (Neumann et al. 2018; Holz and Kemfert 2020).

Germany is well inter-connected in the European gas pipeline system. In addition to connections with Poland (30 bcm/year), Austria (15 bcm/year), and the Czech Republic (40 bcm/year), which were mostly used for the transit of Russian gas via Ukraine and Belarus, Germany has significant pipeline import capacities from Norway and the Netherlands at about 60 bcm/year each, in addition to smaller connections to France (20 bcm/year), to Belgium (10 bcm/year), to Switzerland (10 bcm/year) and to Denmark at about 3 bcm/year (ENTSO-G 2016). The real natural gas flows could be even higher, if an efficient use of the capacities, i.e. bi-directional use, was achieved, instead of the current negotiated bilateral contract volumes.

Figure 1 gives an overview of German natural gas trade flows by country in the recent past. In fact, Russian gas arrived via the Czech Republic (Central corridor) and Poland (Yamal-Europe pipeline). Following the start of direct imports from Russia via Nord Stream 1 in 2011, about one third of total imports had been re-exported, mostly to the Czech Republic.

2.2 The end of Russian natural gas exports in 2022

In June 2022, Russian imports via Nord Stream started to drastically decline, coming to a standstill by September 2022. The same happened with imports via Poland and the Czech Republic, coming from Yamal-Europe and the Ukrainian transit pipeline. Russia stopping deliveries to Germany was a breach of long-term contracts by the Russian side. There have not been any European sanctions on natural gas exports by Russia. Despite worries about supply security, the Russian supply disruptions to Germany could be compensated by increased imports from Belgium, the Netherlands and Norway, as well as cutting back on re-exports to the Czech Republic.

3. Demand and supply of future natural gas in Germany: Short-term and long-term conditions

3.1 Short-term worries about supply security

Supply security in Germany depends on the diversification of supply sources, away from Russian imports, and reduction of demand. In a scenario analysis shortly after the Russian invasion of Ukraine, we have weighted different options and have concluded that no shortage was to be expected for the winter of 2022/23, as long as non–Russian supplies were increased and demand decreased (Holz et al. 2022, Figure 4). As of January 2023, both trends have materialized, such that no shortage has occurred; in fact, prices have come down to a pre-war level.

Pre-war German supply and demand equilibrated between 80 and 100 bcm (2019: 88 bcm, 2021: 100 bcm). Since February 2022, in the wake of the decrease of Russian exports to Europe, consumers have reduced their natural gas use by about 20% compared to the average 2018-2021 under the influence of high prices and public media campaigns that warned about a potential supply shortage in the cold winter months. Demand reduction has been obtained from a mix of measures such as fuel switch, improved energy efficiency, energy savings, and milder weather. Savings in the residential

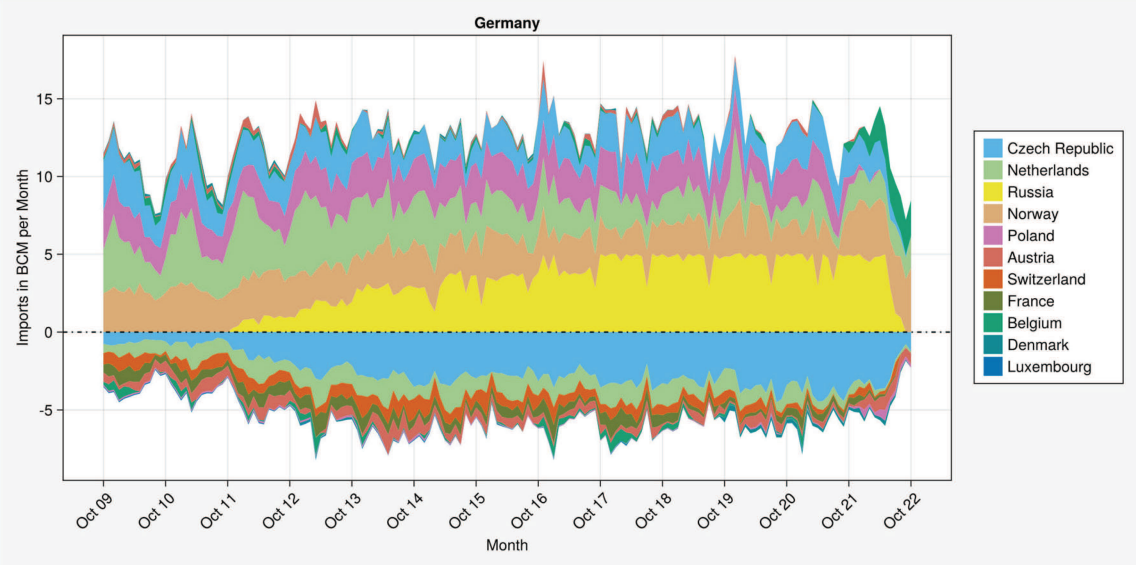

Figure 1: Natural gas trade flows into and out of Germany (2009-2022)

Source: Own calculations based on IEA (2022b).

and commercial sector in Germany – i.e. modified consumption behavior by small consumers independently of weather – were the equivalent of 23 LNG tankers in 2022 (Guéret et al., 2023).

Other suppliers have immediately increased their supplies when tensions with Russia started. In particular Norway has supplied Germany at its maximum capacity of pipelines and production capacity (47.5 bcm net imports in 2022, of which up to a third was re-exported to Austria, Switzerland, Poland, etc.). In parallel, German importers have increased their capacity utilization in LNG regasification terminals in Northwestern neighboring countries, i.e. Belgium and the Netherlands (about ~ 30 bcm of LNG imports in 2022). The capacities in these LNG terminals have been booked for several years. While Russian gas was still imported in Germany until September 2022, it now has to be replaced entirely. Despite the increase from Norway and LNG imports via Belgium and the Netherlands, this leaves a short term supply gap of about 25 bcm per year to be filled from other sources, or compensated by additional demand reductions.

3.2 The long-term role of natural gas in Germany

Overall, European demand for natural gas has been stable or slightly declining since 2000. The declining trend of fossil natural gas will continue in the next decades, even though forecasts vary on the speed of the decline. This is because the long-term use of fossil natural gas is not compatible with the climate targets adopted by Germany and the European Union, namely climate neutrality by 2045 and 2050, respectively. These targets imply a phase out of fossil fuels. In this context, the narrative of natural gas as a bridge technology has lost some of its relevance in recent years (Kemfert et al. 2022; von Hirschhausen, Kemfert, and Praeger 2022). Fossil natural gas faces the same fate as coal, i.e. an exit from the scene, within the next decades.

Therefore, Germany, too, is preparing for a natural gas exit in the next two decades or so, as foreseen by the Federal Government's strategy of decarbonization and de-plutoniazation until 2045. In addition to ending the commercial use of nuclear energy, Germany is targeting the phase out of coal by 2030 while strongly increasing the share of renewables. Overall, a massive expansion of renewables and energy efficiency is required as part of the energy transformation. If energy system developments in the EU respect the political target of 1.5°C global warming, the German energy sector will see a strong decline of primary energy consumption from natural gas, especially after 2030, up to a phase-out in the early 2040s (Figure 2). Between 2018 and 2050, renewables must multiply by three, while primary energy demand decreases due to better conversion efficiency of electric end-uses. In other words, the political targets of Germany and the EU leave no long-term role for natural gas.

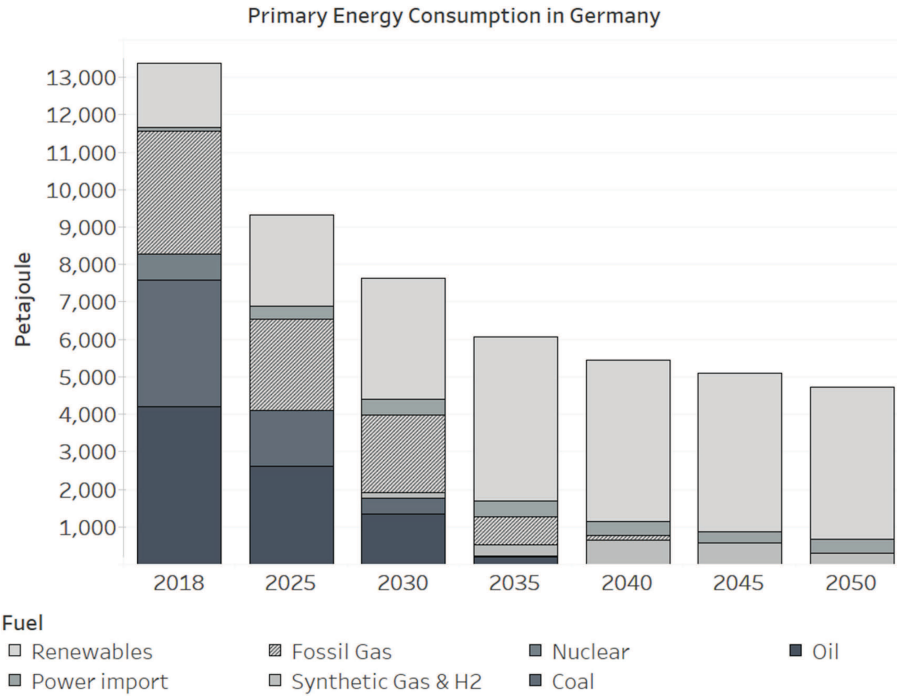

Figure 2: Primary energy consumption in Germany 2018-2050 in a 1.5°C scenario

Source: Updated GENeSYS-MOD results for mid-2022 in the openENTRANCE Societal Commitment Scenario; based on (Auer et al. 2020).

4. Implications for LNG in Germany

Prior to the Russian invasion of Ukraine, Germany did not have any domestic LNG import capacities. Some projects were discussed during the 2010s, but plans were surrounded by high uncertainty and failed to secure investment decisions (GIIGNL 2022). Modelling exercises did not show an economic rationale for new LNG terminals in Europe except in cases of strong subsidization or disruption of Russian supplies (Egging, Holz, and Czempinski 2021).

However, this changed in the aftermath of February 24th, 2022 when Russia invaded Ukraine. As a U-turn to the import policies of the previous decades, the German government and the gas importers quickly decided to start up LNG imports directly into Germany. The focus has been on floating terminals, so-called FSRUs (Floating Storage and Regasification Units) that can be installed rather quickly. The German "LNG acceleration law" (Beschleunigungsgesetz – LNGG") from May 24th, 2022 listed six locations, with a total of 8 FSRUs and 4 onshore regasification sites. However, not all of these projects appear likely, and Table 1 and Figure 3 show an updated overview of recent efforts at four locations for 6 FSRUs and 3 onshore terminals.

4.1 Floating terminals (FSRUs) for the short-term as backup

The German government decided to charter four FSRUs in spring 2022[2] and a fifth one in October 2022. The government-chartered terminals are in Wilhelmshaven, Stade, Brunsbuettel and Lubmin. In addition, one private FSRU terminal has been developed, also located in Lubmin. Lubmin was the landing point of the Nord Stream pipelines where large ongoing pipelines are connected. One of the two FSRUs planned in Wilhelmshaven was inaugurated in December 2022, with operations starting in January 2023. The FSRU in Brunsbuettel as well as the private FSRU in Lubmin are also scheduled to start operations in early 2023 and the remaining three FSRUs later in 2023. This adds up to almost 30 bcm per year of FSRU capacity by winter of 2023/24, of which 23.5 bcm annual capacity are state-chartered. With further planned expansions, more than 40 bcm of yearly floating regasification capacity will be in place in Germany by 2024.

4.2 Fixed onshore terminals potential stranded assets

In addition to flexible floating capacities, three onshore regasification terminals are currently discussed, totalling over 40 bcm per year of onshore regasification capacity. Some are located in the same ports as the floating installations. It is unclear whether the floating terminals will cease operations when the onshore terminals become operational. Given the charter contract durations, this seems unlikely, however, and there will potentially be parallel operations for some years of a total of 81.5 bcm yearly LNG import capacity.[3]

While FSRUs are relatively flexible by nature and can, hence, have a limited lifespan in Europe, the opposite holds for investments into fixed onshore import infrastructure. Considering an average lifetime of onshore LNG terminals of several decades, we see two problematic consequences. First, investments are likely to turn stranded even in scenarios not compatible with achieving the climate targets by 2045. In case of pure private-sector investments, it would in principle be pos-

Table 1: Current LNG plans in Germany

Location	Type of terminal	Operational when	Capacity (bcm/year)	Public / private	Contract Duration	Operator
Wilhelmshaven I	FSRU	January 2023	5	State-chartered	10 years	Uniper
Lubmin I	FSRU	Early 2023	Starting capacity: 5.2, Final capacity: 13.2	Private	5 - 10 years	Deutsche ReGas GmbH
Brunsbuettel	FSRU	Early 2023	Starting capacity: 3.5, Final capacity: 7.5	State-chartered	Until 2026	RWE
Wilhelmshaven II	FSRU	2023	5	State-chartered	5 years, or until the H_2 onshore terminal planned by TES is in operation	E.ON, Tree Energy Solutions (TES), Engie
Stade	FSRU	2023	5	State-chartered	Until 2026	Hanseatic Energy Hub
Lubmin II	FSRU	2023	5	State-chartered	15 years	RWE, Stena-Power
Total	**FSRU**		**40.2**			
Wilhelmshaven	Onshore	Late 2025	20		Following the LNGG, until end 2043	Tree Energy Solutions (TES)
Brunsbuettel	Onshore	2026	8	50% funding via government investment bank KfW	Following the LNGG, until end 2043	KfW, Gasunie, RWE
Stade	Onshore	2026	13.3		Following the LNGG, until end 2043	Hanseatic Energy Hub
Total	**Onshore**		**41.3**			
Total	**All**		**81.5**			

Source: Own compilation based on various public sources (available upon request).

sible to argue that asset stranding is part of the entrepreneurial risk. However, sunk costs appear particularly problematic due to the involvement of public money in some proposed terminals. Second, in addition to traditional carbon lock-in effects, stranding public investments into long-lived fossil natural gas infrastructure induces a conflict of interest on the regulatory side, creating further barriers to the phase-out of fossil fuels and, hence, hindering the energy transformation in a potentially drastic manner (Kemfert et al. 2022).

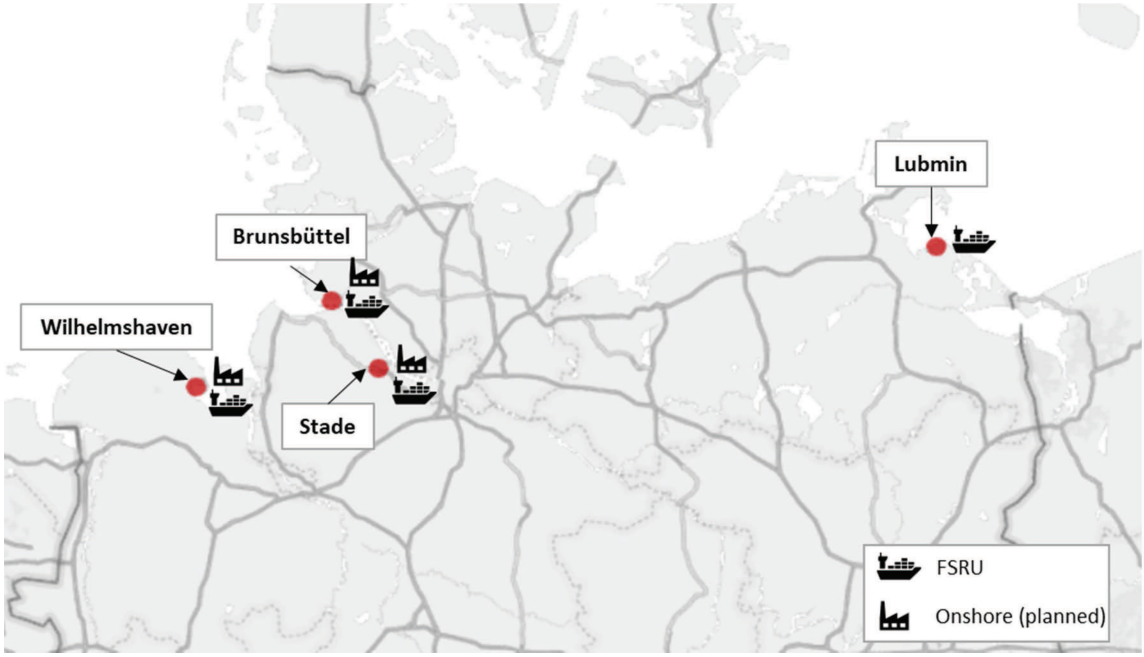

Figure 3: LNG terminal projects in Germany (floating and fixed), as of January 2023
Source: Own depiction based on (Table 1) and geographical data from TomTom

While not being compatible with long term demand projections, onshore regasification terminals also fail to address import needs in the short term. Due to long construction time, terminals are scheduled to come online in 2026 at the earliest. Given experience from other capital-intensive infrastructure investments in Germany, considerable delays are likely.

Even though onshore terminals are planned in an "H_2-ready" format, and operations of fossil LNG are only permitted until end of 2043 under the German LNG acceleration law, the actual degree of "H_2-readiness" remains highly questionable (Riemer, Schreiner, and Wachsmuth 2022). With the current state of technology, it is still unclear which part of the LNG equipment can be used for the imports of hydrogen or its derivates, so that "re-conversion" is likely to turn out a very expensive strategy with large sunk costs.

Conclusions

Following the invasion of Ukraine, Russian supply interruptions of natural gas have put considerable, but manageable stress on the German market. Supplies were never interrupted and ample storage capacities could be filled during the summer 2022, albeit at very high spot prices. The access to diversified imports from other sources than Russia ensured continued gas supplies, in particular from Norway and as LNG via terminals in neighboring countries.

Facing the end of imports from Russia, the federal German government has decided to charter five floating regasification terminals, with one additional private project underway. Total floating regasification capacities under development are over 40 bcm per year with an additional 40 bcm per year of onshore terminals scheduled to come online by 2026. These terminals are to fill a supply gap left by disrupted imports from Russia that we estimate at about 25 bcm per year. In other words, there would be an excess capacity of about 15 bcm per year of the floating terminals and up to 55 bcm per year of total planned regasification terminals.

FSRUs are relatively flexible by nature and can be chartered by other importers around the world. The opposite holds for investments in onshore infrastructure. While not being compatible with long term demand projections, the onshore regasification projects also fail to contribute to the import needs in the short term. We see a considerable risk of asset stranding. In the unlikely case of a natural gas shortage in the late 2020s, prolonging the use of FSRUs has a much lower risk of stranding investments and creates less barriers for the energy transformation.

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Footnotes

[1] See also https://www.bruegel.org/publications/datasets/european-natural-gas-imports/ .

[2] Detailed references on the terminal plans are available on request.

[3] All onshore terminals and some of the FSRU terminals have plans for a later conversion to other gases, be it hydrogen (H_2) or its derivatives such as ammonia (NH_3). In other words, "H_2 readiness" is part of the terminals' applications, but the plans are not concrete. We argue that a conceptual design to import 100% renewable energy carriers from the start of operations should be considered for onshore energy import infrastructures instead of an "H_2-ready" design.