GOSPODARKA SUROWCAMI MINERALNYMI – MINERAL RESOURCES MANAGEMENT

2025 Volume 41 Issue 2 Pages 31–54

DOI: 10.24425/gsm.2025.154549

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Analysis of the importance of LNG supply for balancing the demand for natural gas: the case of Poland

Introduction

The distribution of natural gas resources worldwide is highly uneven, with only the threecountries with the largest reserves, Russia, Iran, and Qatar; half of the known gas reserves are located, while the combined reserves of six countries account for 75% of global natural gas reserves. Also, a high degree of unevenness is observed when analyzing global natural gas production. In 2023, the combined gas production of the US, Russia, Iran, and China was 2,108 bcm, representing nearly 52% of global gas production (BP 2024). When analyzing the historical determinants of natural gas demand variability, it should be noted that demand was highly dependent on the geographical factor of gas production,

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as it was mainly transported via pipelines, limiting the transport distance to a few thousand kilometers (Zwickl-Bernhard and Neumann 2024). In fact, before 1980, the vast majority of internationally traded natural gas was transported via pipelines. The first transport of LNG did not take place until after the Second World War; in January 1959, the ship "Methane Pioneer" sailed from Lake Charles in Louisiana (USA) with cargo, including LNG, to arrive at Canvey Island in the UK. The first commercial delivery of LNG from Algeria to the UK market took place in 1964. The development of the importance of LNG technology should be traced back to countries such as Japan and South Korea and their investments in the expansion of the natural gas-fired power generation sector. Japan has, therefore, been the world's largest LNG consumer for decades, with annual imports exceeding 100 bcm between 2011 and 2021, peaking in 2014 at 121.8 bcm. Over the past decade, LNG supplies have, on average, covered around 98% of Japan's natural gas requirements. It is only in recent years that China has become the leader in LNG imports, recording an increase in imports from 52.9 to 110.1 bcm between 2017 and 2021 (US EIA 2022). The process of transforming international natural gas supply between 2000 and 2023 has been dynamic (Figure 1). While at the beginning of the 21st century, pipeline supply was by far the dominant form of supply, with LNG accounting for a small share, for example, in 2005, LNG supply held a 29% share,

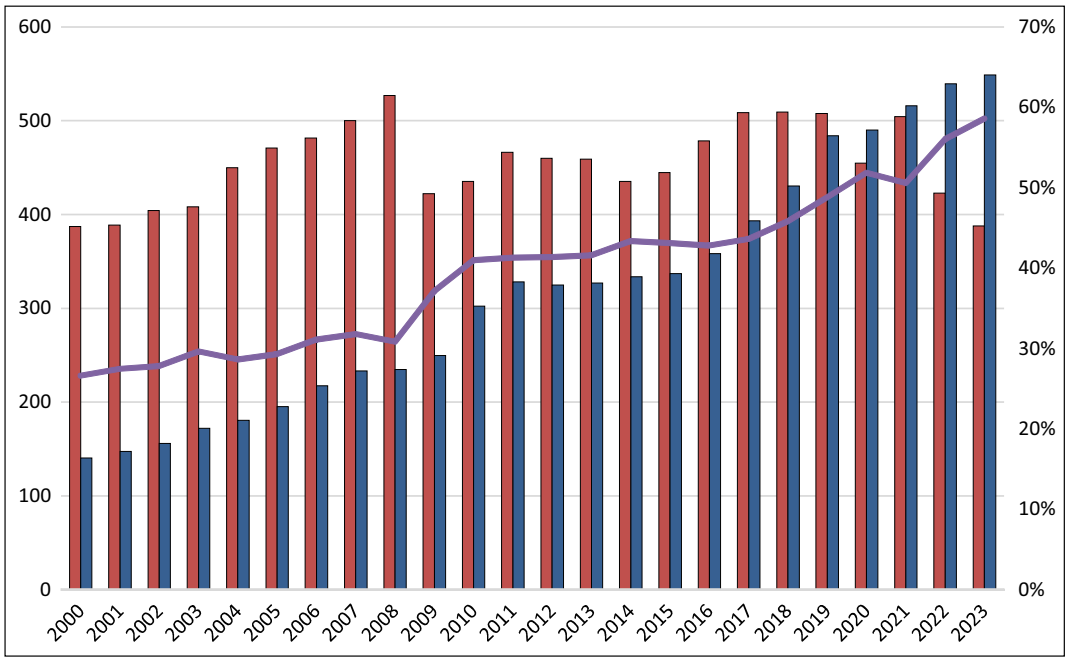

Fig. 1. Share of LNG in global natural gas trade in 2000–2023 (bcm – left axis; % – right axis)
Source: BP 2024

Rys. 1. Udział LNG w międzynarodowym obrocie gazem ziemnym w latach 2000–2023
(oś lewa – mld m^3; oś prawa – %)

there has been an increase in the importance of LNG technology in international natural gas trade since 2008. In 2020, for the first time ever, the share attributable to LNG exceeded half of the global natural gas trade at 52%, and in 2023, it continued to grow and reached 59%, corresponding to a volume of 549 bcm. The following comparison can attest to the growing importance of LNG technology: between 2014 and 2023, there was a 13% increase in global demand for natural gas. During the same period, the volume of LNG imports increased by 39% (Szurlej and Janusz 2013; BP 2024). It is worth noting that at the end of February 2024, global gas liquefaction terminal capacity was 483.1 MTPA, with a weighted average capacity utilization rate of 88.7%, similar to the rate for 2022 – 89% (IGU 2024). Selected technical aspects related to LNG technology are given in the articles (Łaciak and Włodek 2017; Łaciak et al. 2018; Włodek and Łaciak 2023), among others. The current geopolitical situation, including Russian aggression leading to the war in Ukraine, also has a significant impact on the growing importance of LNG (Ruszel and Turowski 2024).

For many countries today, LNG is not only a source of gas supply but also a fuel supply option to reduce CO_2 emissions. These countries include China, India, Nigeria, and Ghana. In developing countries, on the other hand, LNG supply makes it possible to meet growing energy demand and replace coal and oil (Kaygusuz 2012; Atul and Prakash 2021; Zhen et al. 2022).

In this article, an analysis of the importance of LNG supply for balancing natural gas demand is one of the fundamental aspects of energy security. In definitional terms, it is emphasized that the key to energy security is having access to affordable energy resources (Yergin 2006). An important role is played by energy infrastructure, the development of which influences the dynamics of the natural gas market (Dieckhöner et al. 2013). Referring to the energy security paradigm, the necessity of strategic planning, allowing for flexible management of energy security with guarantees of continuity of supply of energy raw materials and energy, is nowadays increasingly indicated (Ruszel 2016; Ruszel and Turowski 2024). The research analysis presented in the article refers to the state in objective terms, while in the subjective perspective, it refers to natural gas and LNG in particular. Factor analysis and comparative analysis were used. The synthesis of the statistical evidence made it possible to identify the key aspects highlighted in the conclusions, which relate to the goals of the paper and the research questions. The paper aims to answer the following research questions. What role will LNG occupy in the structure of the energy balance in the coming years? Has the Russian aggression in Ukraine influenced the global configuration of LNG exporters? Will the role of LNG in the diversification of natural gas supply sources to Poland change in the coming years?

1. The place of natural gas in the structure of Poland's energy balance in comparison with the EU

Comparing the structure of Poland's energy balance to that of the European Union, the following aspects can be observed (see Figure 2). The largest share in the EU is accounted

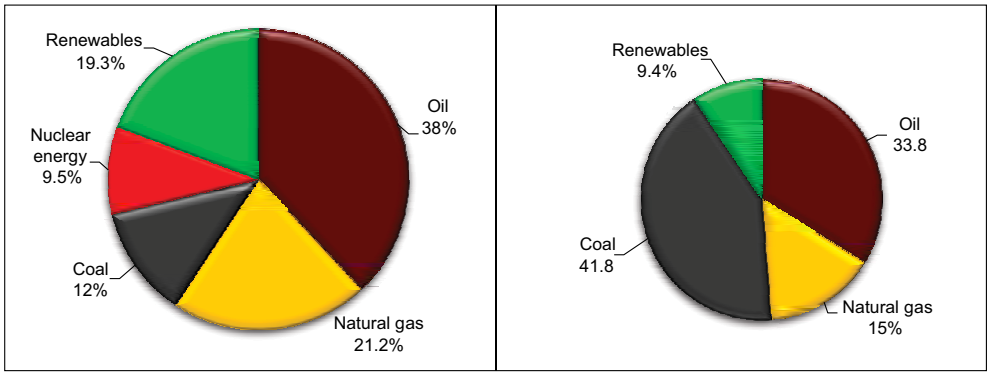

Fig. 2. Primary Energy: Consumption by fuel in Poland (right) and EU (left) – 2022 (%)
Source: BP 2024

Rys. 2. Struktura zużycia energii pierwotnej w Polsce (po prawej) i UE (po lewej) w 2022 r. (%)

for by oil, while in Poland by far, the most important energy source remains coal, which is a consequence of both the facts of having significant – in European terms – coal resources and the historical development of the energy sector in Poland; in this context, it is worth mentioning that in the 1980s, annual coal extraction exceeded 200 million tonnes (Mills 2007; Gawlik et al. 2016; Grudziński and Stala-Szlugaj 2024; Pepłowska et al. 2024). In the case of the EU, gas ranks second in terms of share, while in Poland, it ranks third. It is worth noting, however, that while in the EU the share attributable to natural gas is decreasing, in the case of Poland an upward trend can be observed. However, as a result of Russia's military aggression against Ukraine in 2022 and the measures taken at the EU level, gas consumption in European countries has declined significantly: compared to 2021, the decline was as much as 53 bcm. In Poland, too, the effects of the COVID pandemic and the Russian-Ukrainian armed conflict had an impact on the development of the gas market (Cieślik et al. 2021).

Looking at the changes in terms of LNG demand between 2015 and 2023, the EU member state market showed the highest growth with 103 bcm, while the Chinese market recorded a growth of 73 bcm. In the case of the European market, the increase in LNG demand is mainly the result of the impact of the full-scale armed aggression of the Russian Federation against Ukraine in February 2022 rather than an increase in total natural gas demand. This is confirmed by the following data: on the one hand, compared to 2021, LNG imports to European countries significantly increased by nearly 63 bcm in 2022 (58.4 per cent), while at the same time there was a significant decrease in gas supply via pipelines from Russia by more than 81 bcm. In addition, when analyzing the natural gas demand of EU countries, or more broadly, European countries since the beginning of the 21st century, it should be noted that the maximum gas demand in EU countries was recorded in 2008 – 419.2 cm, while for European countries it was in 2005 – 627.6 cm. Between 2020 and 2023, both the EU and European countries show a significant decrease in natural gas demand of 19% and 17%,

respectively (BP 2024). This decline in natural gas demand is linked to the achievement of the EU's primary energy policy objectives – the development of renewable energy use and the reduction of greenhouse gas emissions. In recent years, there has been a dynamic increase in the importance of RES in electricity generation in the EU; for example, between 2020 and 2023, the volume of electricity generation from RES increased from 1,057 to 1,212 TWh (BP 2024). In 2023, 44% of EU electricity came from renewable sources, of which 17.6% was from wind power. In 2023, wind power generation in the EU surpassed gas power generation for the first time. While as recently as 2020, gas still accounted for 20.3% of total EU electricity generation, by 2023, it had fallen to 16.8% (Figure 3) (EMBER 2024). In the case of Poland, as mentioned earlier, due to its significant coal reserves, solid fuels still play an important role in the electricity generation structure, as best evidenced by their 68% share in 2023. It is worth mentioning, however, that this share has been declining rapidly over recent years: in 2022 – 77%. In Poland, the importance of renewable energy sources in the electricity generation balance is growing dynamically, but natural gas is also gaining in importance: 2022 – 5.7%, 2023 – 8.3%, and in 2024 this share rises to 10% due to the commissioning of further natural gas-fuelled units (Wyrwa et al. 2015; Piech and Szurlej 2023; Pluta et al. 2023; URE 2024; PSE 2025). Looking at the significance of natural gas in the power generation sector over a broader time horizon, it can be seen that in most EU countries, the share of gas is decreasing, while in Poland, it is increasing (Kaliski et al. 2009).

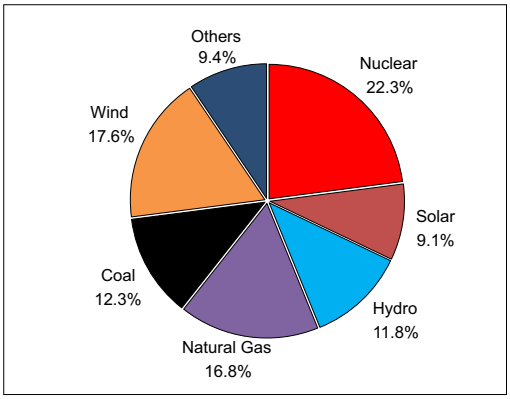

Fig. 3. Structure of electricity generation in the EU in 2023 (%)
Source: EMBER 2024

Rys. 3. Wytwarzanie energii elektrycznej w UE w 2023 r. w podziale na nośniki energii (%)

The increase in natural gas's importance in Poland is mainly due to two factors: the needs of the National Power System in view of the dynamically increasing share of RES in the electricity generation structure and the transformation in district heating.

Units using natural gas for electricity generation are characterized by high flexibility, which allows balancing the National Power System under conditions of continuous variability of energy generation and consumption. According to the Electricity System Operator, Poland needs 18 GW of additional available capacity by 2040 (PSE 2024). Additional dispatchable capacity is needed as early as 2025–2028. During legislative work on the reform of the EU electricity market (EMD – Electricity Market Design), the importance of capacity mechanisms, including capacity markets in the process of integrating electricity systems with increasing RES participation, has been recognized. One element of the reform was the possibility to extend emission derogations for coal-fired units. EU legislation introduced the principle that units not meeting the emission standard of 550 gCO_2/kWh could not participate in the capacity market from 1 July 2025. The EMD proposed the possibility of extending the derogation until 31 December 2028 (Leśniak et al. 2024). Supplementary auctions in the capacity market will be carried out between 2025 and 2027 and will allow the provision of additional available capacity in the system until the end of 2028. As the legislative work on the amendment to the Power Market Act progressed, another problem arose – the outcome of the main power market auction held in December 2024 for the delivery year 2029. This auction did not contract sufficient capacity for new generating units, especially for the gas projects desired by the electricity system operator. At the beginning of January 2025, the legislative work register announced another law amending the Power Market Act, enabling the organization of catch-up auctions that would still allow additional dispatchable capacity from 2029 to be contracted in 2025.

The use of natural gas is equally important in district heating. The Polish district heating sector makes significant use of cogeneration, especially in large district heating systems that supply energy to around 16 million consumers. New connections of consumers to district heating networks in large cities with more than 500,000 inhabitants amount to approximately 20–40 MW/year, the exception being the Warsaw district heating system, where in recent years, more than 100 MW of new consumers per year have been connected (data for 2022). The development of district heating brings with it the need to modernize, rebuild, and build new high-efficiency cogeneration units (Leśniak et al. 2023a).

The share of CHP in heat production (calculated by volume) in 2023 was 64%. The primary fuel used for heat production in cogeneration is anthracite, accounting for almost 56% of the fuel consumed, followed by biomass at 14.3% and, finally, natural gas at 13.8%, the share of which is increasing year on year – Figure 4 (URE 2023).

EU regulations require that high-efficiency cogeneration does not emit more than 270 gCO_2/kWh of electricity and heat generated. High-efficiency cogeneration is one of the technologies contributing to achieving or maintaining the status of an efficient district heating system. District heating systems in Poland will strive to achieve or maintain the status of an efficient district heating system – if this does not happen, they will have poorer access to investment financing, new buildings will not be connected, and customers will gradually decide to disconnect from the system – especially industrial customers. The emission threshold introduced means that new high-efficiency CHP units will have to use

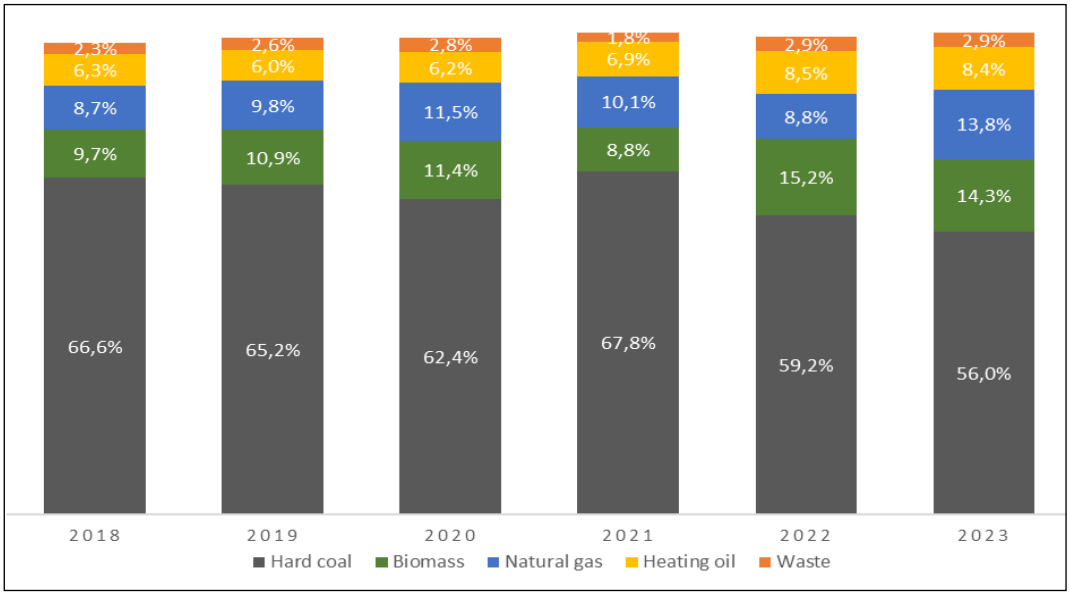

Fig. 4. Consumption of selected fuels for heat generation in cogeneration years 2018–2023 based on data published annually by the ERO

Fig. 4. Zużycie wybranych paliw do wytwarzania ciepła w kogeneracji w latach 2018–2023 na podstawie danych publikowanych rocznie przez URE

natural gas or renewable fuels, and over time, natural gas should be replaced by decarbonized gases. High-efficiency gas-fired CHP will acquire and maintain the status of an efficient district heating system at least until the end of 2034 and then until 2045 with a significant increase in renewables and waste heat (Leśniak et al. 2023b).

2. LNG exporters globally – a comparative analysis

Between 2015 and 2023, there were clear changes in the structure of LNG exports worldwide (Ruszel 2022). Until 2022, Qatar was invariably holding first place in terms of LNG exports. Qatar's natural gas story began in 1971 with Shell's discovery of the North Dome field. Persistent unfavorable trading and transportation conditions when natural gas was not a very attractive commodity meant that production only started in 1991, and the execution of the first LNG delivery to Japan was in December 1996. Since the 1990s, Qatar has steadily developed its natural gas export capacity through LNG mega-projects known as QatarGas and RasGas. Initially, Qatar's LNG supply was destined for the Japanese and Korean markets. However, it later diversified to a broader range of customers – in 2023, the main LNG customers were the following countries (bcm): China – 22.9, India – 15, South Korea – 11.8, and Taiwan – 7.6 (BP 2024). Following the finalisation of investments

in LNG liquefaction terminals in 2011, Qatar became the largest exporter of LNG and we now know that it has maintained this position for more than a decade. It is worth mentioning that investment in Qatar's gas sector has not been focused solely on expanding LNG liquefaction terminal capacity.

An example is the Dolphin project, a pipeline that allows natural gas exports to the United Arab Emirates and Oman. Qatar also has facilities to separate ethane from natural gas, natural gas liquids (NGLs), condensates, and gas to liquids (GTLs) (Meza et al. 2022). Qatar's maintenance of its leading position among LNG exporters for many years has been made possible by the low unit cost of LNG production and shipping (Ibrahim and Harrigan, 2012; Corbeau and Ledesma, 2016). Faced with competition from the United States, a long-time LNG export leader, Qatar has announced the expansion of its liquefaction facilities and the replacement and significant expansion of its fleet of LNG carriers as part of its plan to expand further in the LNG market. It is worth noting that Qatar is a significant supplier of LNG to Poland, with imports from Qatar in 2023 reaching 28.3 TWh (16.4% of total imports) and a 12.5% increase compared to 2022 (Minister of Industry 2024).

As can be seen from Table 1, the US is the country with the highest growth rate in LNG exports. These exports have been driven by the 'shale revolution'; the increase in the amount of natural gas exploited in the US has entailed a sharp increase in the amount of LNG exported by this country. We can speak of this gas revolution since 2005 and the shale oil revolution about three years later. The increase in US natural gas supply from unconventional reservoirs has ensured first place for the US in the global ranking of natural

Table 1. Top list of major LNG exporting countries (bcm)

Tabela 1. Lista największych eksporterów LNG (mld m^3)

Country	2015	2016	2017	2018	2019	2020	2021	2022	2023
Qatar	105.6	107.3	103.6	104.9	105.8	106.5	106.9	114.1	108.4
Australia	39.9	60.4	76.6	91.8	104.7	106.0	108.5	107.4	107.4
USA	0.7	4.0	17.1	28.6	47.4	61.3	94.7	104.3	114.4
Russia	14.6	14.6	15.4	24.9	39.1	41.8	39.5	40.2	42.7
Malaysia	34.3	33.6	36.1	33.0	35.2	32.5	33.5	37.4	36.3
Nigeria	26.9	24.6	28.3	27.8	28.8	28.4	23.4	19.6	17.5
Indonesia	21.6	22.4	21.7	20.8	16.5	16.8	14.6	15.5	16.1
Oman	10.2	11.0	11.4	13.6	14.1	13.2	14.1	15.0	15.3
Algeria	16.6	15.5	16.4	13.1	16.8	14.6	15.6	14.4	19.0
Papua New Guinea	10.1	10.9	11.1	9.5	11.6	11.5	11.5	11.4	11.5

Source: BP 2024.

gas producers since 2009 and has also changed the status of the US from a gas-importing country to a gas-exporting country (Janusz et al. 2015).

In the US, the growth in LNG exports has been impressive since 2015, with the US already ranking as the third largest LNG exporter in 2019 and the country being the world's leading LNG exporter in 2023. Compared to 2022, US LNG exports increased by as much as 12% (EIA 2024). The main LNG export terminals in the US are Sabine Pass (Louisiana), Cove Point (Maryland), Corpus Christi (Texas), Cameron (Louisiana), and Freeport (Texas). The incremental increase in global natural gas liquefaction capacity in 2023 compared to 2022 was mainly achieved by the development of projects in the US, most notably Calcasieu Pass (up 3 million tonnes) and Freeport LNG (up 6 million tonnes). For the US, it is worth adding that a helpful factor in the development of LNG export expansion is the access to the Atlantic and Pacific Oceans; in addition, it shows high potential and flexibility in exporting to different markets. In 2023, European countries received the most LNG from the US (bcm): France – 13.2, United Kingdom – 11.6, and Spain – 7.4 (BP 2024). In Europe, US LNG went to the following terminals: in Belgium (Zeebrugge), France (Dunkirk, Montoir-de-Bretagne), Spain (Barcelona, Bilbao), the Netherlands (Rotterdam), and Poland (Świnoujście).

It is important to emphasize that the available capacity and the planned expansion of LNG export terminal capacity in the coming years in the United States will consolidate its position as the world's leading LNG exporter.

Australia has maintained top spot among the largest exporters of LNG over the years. Australia's gas resources are conventional onshore and offshore gas reservoirs and unconventional coal bed methane (CBM). Australia is an important net exporter of natural gas, exporting about 70% of volumes produced as LNG in 2022. Over the past decade, LNG exports from Australia have increased by an average of 14% a year, with several new facilities commencing production during this period (DISR 2024).

According to IEA estimates, an incremental new LNG production capacity of 270 cm/year should be expected in the not-too-distant future until 2030. This is significant, bearing in mind that in 2023, the total installed capacity of natural gas liquefaction terminals was 578 bcm/year. Seventeen liquefaction projects were reported in different stages of construction worldwide (by March 2024). Global LNG production capacity is estimated to have increased by 20 million tonnes in 2024, located mainly in the US and Russia. Also, in 2025, the US is expected to account for the most significant increase in production capacity (19 million tonnes) (ACER 2024; IEA 2024).

3. Developments in global LNG imports – a comparative analysis

In 2023, the global regasification terminal utilization rate decreased from 43% on average in 2022 to 41%. This was influenced by weaker demand in the main markets, i.e., Asia and Europe, as well as the significant number of new regasification terminals commissioned in 2023. After a surge in 2022 to balance gas supply, the average utilization rate in Europe

in 2023 decreased to 54% from 62% in 2022, mainly due to the fact that European LNG demand was lower and underground gas storage facilities had built up a correspondingly high level of stocks (IGU 2024).

For the major importers of LNG, the most significant changes came in 2022 in Europe. Faced with a cut-off of natural gas supplies from Russia, there was a clear shift towards LNG in European Union countries. This is best seen in France, where, after a pandemic reduction in LNG imports, there was a more than 100 percent increase in LNG imports (bcm) in 2022: 2021 – 17.6; 2022 – 35.5 (Table 2). The increase in LNG imports occurred in almost all European customers – for example, in the case of Belgium, imports increased from 5.4 (2021) to 12.5 (2022). The LNG market situation was favorable for the diversion of more LNG supplies from the Asian direction to the European direction. As can be seen from Table 3, LNG supply for many EU countries is crucial for balancing gas demand; for some countries, it even exceeds this demand. This is the case for Lithuania, where the surplus LNG is re-exported to neighboring countries, including Poland.

Asian countries were clearly facing a post-pandemic economic downturn in 2022, but the situation changed again in 2024 in favor of the Asian direction. Undoubtedly, India should be counted among the Asian countries that will significantly increase their demand for natural gas in the near term. The share of natural gas in India's energy mix was 6.2% in 2019, and this is planned to increase to 15% by 2030. India is the third largest emitter of CO_2, and increasing the importance of gas in the energy mix will reduce carbon emissions by 33–35% below 2005 GDP emissions by 2030 (Tracker 2018). On the other hand, it is

Table 2 . Top list of major LNG importing countries (bcm)

Tabela 2. Lista największych importerów LNG (mld m^3)

Country	2015	2016	2017	2018	2019	2020	2021	2022	2023
Japan	115.9	113.6	113.9	113.0	105.5	101.7	101.3	98.3	90.3
China	27.0	36.8	52.9	73.5	84.7	94.0	109.9	93.2	97.8
South Korea	45.8	46.3	51.4	60.2	55.6	55.4	64.1	63.9	60.6
France	6.4	9.1	10.9	12.7	23.2	19.1	17.6	35.1	30.7
Spain	13.7	13.8	16.6	15.0	22.0	20.9	20.4	28.8	24.9
India	20.0	24.3	26.0	30.5	32.4	36.6	33.5	28.4	31.0
Taiwan	19.6	20.4	22.7	22.9	22.8	24.3	26.7	27.4	27.4
United Kingdom	13.7	10.7	6.6	7.2	17.1	18.6	14.9	25.3	19.4
Turkey	7.5	7.6	10.9	11.4	12.9	14.8	13.9	15.1	14.8
Italy	5.9	5.9	8.3	8.2	13.5	12.5	9.5	14.3	16.3

Source: BP 2024.

Table 3. EU LNG imports by country in 2023 (bcm)

Tabela 3. Znaczenie importu LNG do krajów UE w 2023 (mld m^3)

Country	LNG imports (Bcm)	The share of LNG in gas consumption
France	30.0	88.6%
Spain	25.4	86.7%
Netherlands	22.6	87.7%
Italy	16.2	27.6%
Belgium	11.1	81.0%
Germany	6.8	9.0%
Poland	6.6	33.7%
Portugal	5.1	113.8%
Lithuania	3.1	198.0%
Croatia	2.7	108.0%
Greece	2.6	48.3%
Finland	1.7	142.3%

Source: BP 2024.

worth mentioning that India's per capita emissions (2.7 tonnes of CO_2) are less than half the global average of 7 tonnes of CO_2 (Timperley 2019). Due to the insufficient supply of natural gas from domestic fields, India will increase the supply of LNG to balance its growing gas demand. Thus, persistently high crude oil prices over the past few years are having an impact on LNG price increases. High LNG import prices are the primary barrier to increasing LNG imports. Currently, the country mainly imports LNG under long-term contracts from Qatar, Australia, and Russia. However, with increasing dependence on LNG imports, the country needs to diversify its LNG supply portfolio to mitigate potential supply risk (Rawat and Garg 2021). LNG prices in Asia are indexed to oil prices and, as can be seen in Figure 5, outperform European markets. Given that the importance of LNG in balancing EU gas demand has increased significantly since 2022, and LNG has been important to Asian markets for years, the expected oversupply of LNG could stabilize European market gas prices, which increased significantly in the second half of 2024. Looking ahead to 2035, LNG demand will grow fastest in Southeast Asian countries, with growth estimated at 104 bcm. For the European market, demand is assumed to decline by 17 bcm (BP 2024; IEA 2024).

As can be seen from Figure 6, despite the expansion of LNG regasification terminals in European countries in recent years, more installations will be built in the coming years,

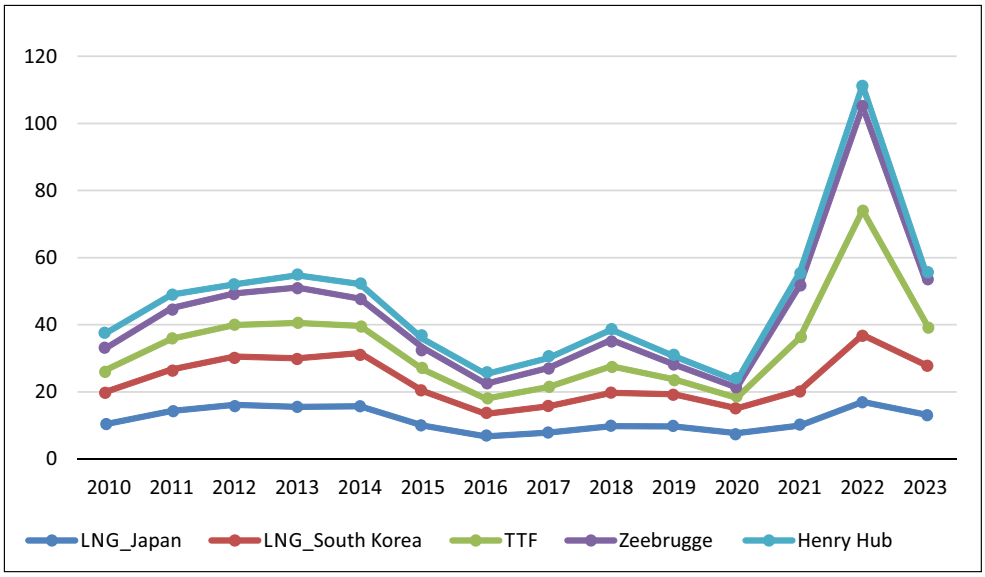

Fig. 5. Natural gas prices in 2010–2023 (US dollars per million BTU)
Source: BP 2024

Rys. 5. Notowania cen gazu ziemnego w latach 2010–2023 (USD/mln BTU)

including a second terminal in Poland at Gdańsk. It is worth mentioning that the outbreak of the Russian-Ukrainian war in 2022 has influenced the acceleration of investments in LNG infrastructure expansion in European countries. In 2023, 7 LNG terminals in Europe were commissioned, including two in Germany and a further five in Finland, Turkey, Italy, Spain, and France (IGU 2024).

4. Results and discussions: the importance of LNG supplies in the process of diversifying sources of natural gas supply to Poland

An analysis of strategic documents on Poland's energy policy since the 1990s shows that the main objective of ensuring energy security has been to diversify natural gas supplies. The development of gas infrastructure and the provision of infrastructural security has given Poland the security to use natural gas as an energy resource that enables the energy transition towards a low-carbon economy, enabling greater integration of volatile sources (Pikus et al. 2015; Szurlej 2015). In 2016, the LNG Terminal in Świnoujście, which was launched at the beginning of the year, appeared in the structure of natural gas supplies to Poland; at that time, gas supplies from the eastern direction dominated, accounting for nearly 90%. Initially, LNG supplies to Poland consisted mainly of a long-term contract with

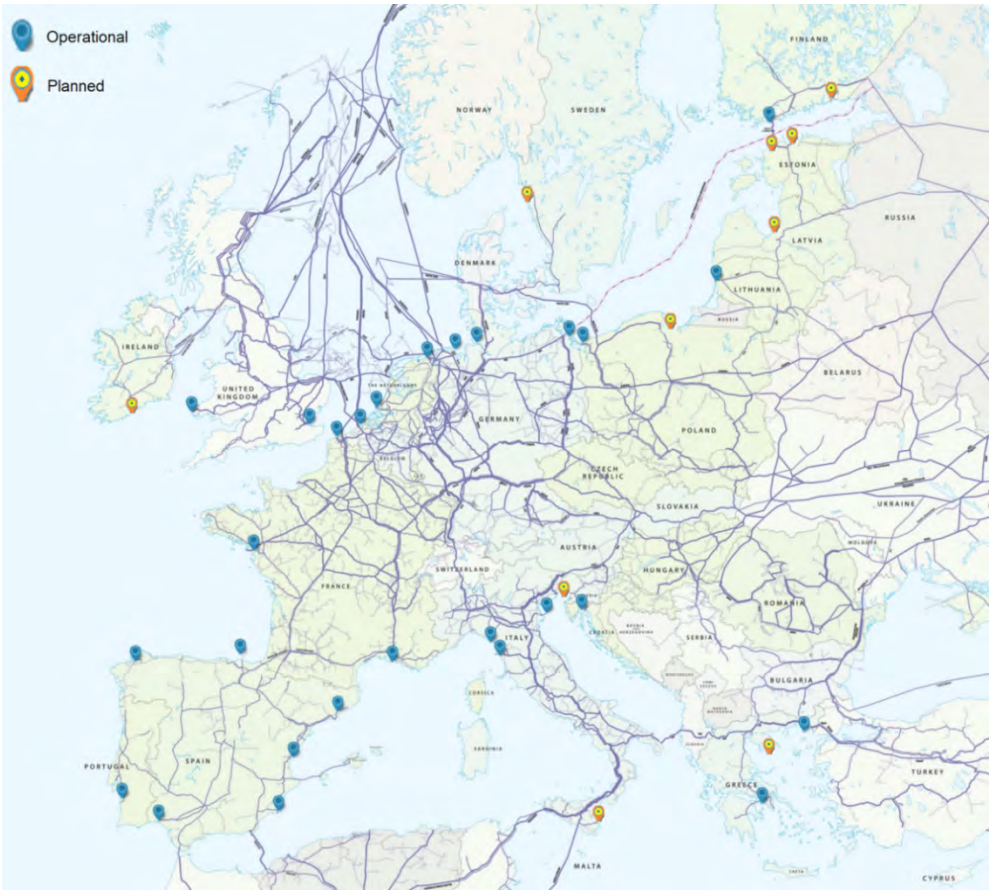

Fig. 6. Operational and planned LNG Terminals in Europe
Source: own study based on ENTSOG map

Rys. 6. Eksploatowane i planowane terminalne LNG w Europie

Qatar and single spot LNG supplies from various directions – initially mainly from the US and Norway (Ruszel 2020). With the increase in natural gas consumption in Poland, which in 2021 exceeded 20 bcm of natural gas per year, the share of gas supplies via the Swinoujscie LNG Terminal increased, and in 2020, it was already 24%. The Russian invasion of Ukraine and the consequent abandonment of natural gas supplies from Russia significantly increased the role of LNG in the structure of natural gas supplies to Poland, and the share of gas supplies via the LNG Terminal increased to 40% in 2022 (Figure 7). Since October 2022, the Baltic Pipe pipeline, through which gas is supplied to Poland from Norway, has been in operation. Currently, gas supplies via the Baltic Pipe pipeline have the largest share in the structure of natural gas imports to Poland, and the share of supplies via the LNG Terminal remains at around 40% (Figures 8 and 9).

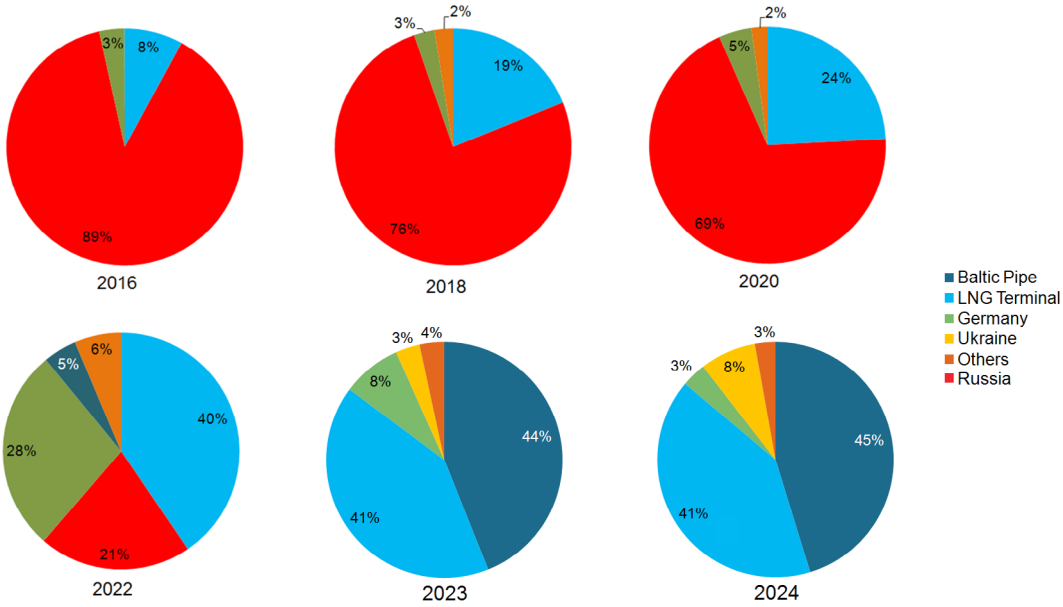

Fig. 7. Percentage share of directions of natural gas imports to Poland
Source: ENTSOG 2025

Rys. 7. Import gazu ziemnego do Polski w podziale na kierunki

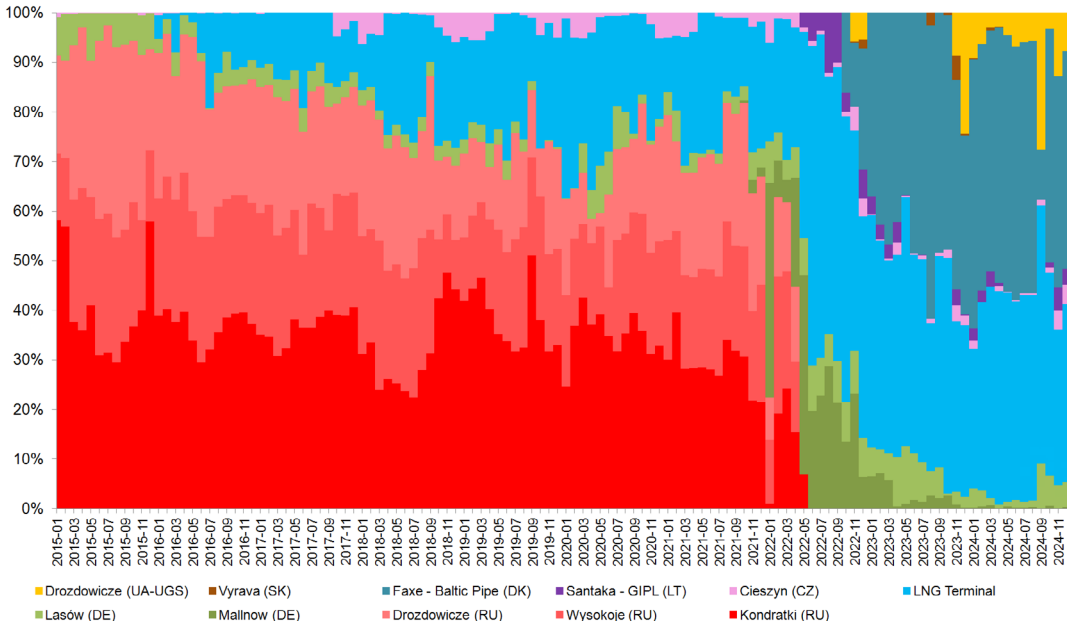

Fig. 8. Percentage share of supply directions in natural gas imports to Poland in 2015–2024 (%)
Source: ENTSOG 2025 (* – marginal entry points have been omitted)

Rys. 8. Procentowy udział kierunków dostaw w imporcie gazu ziemnego do Polski w latach 2015–2024

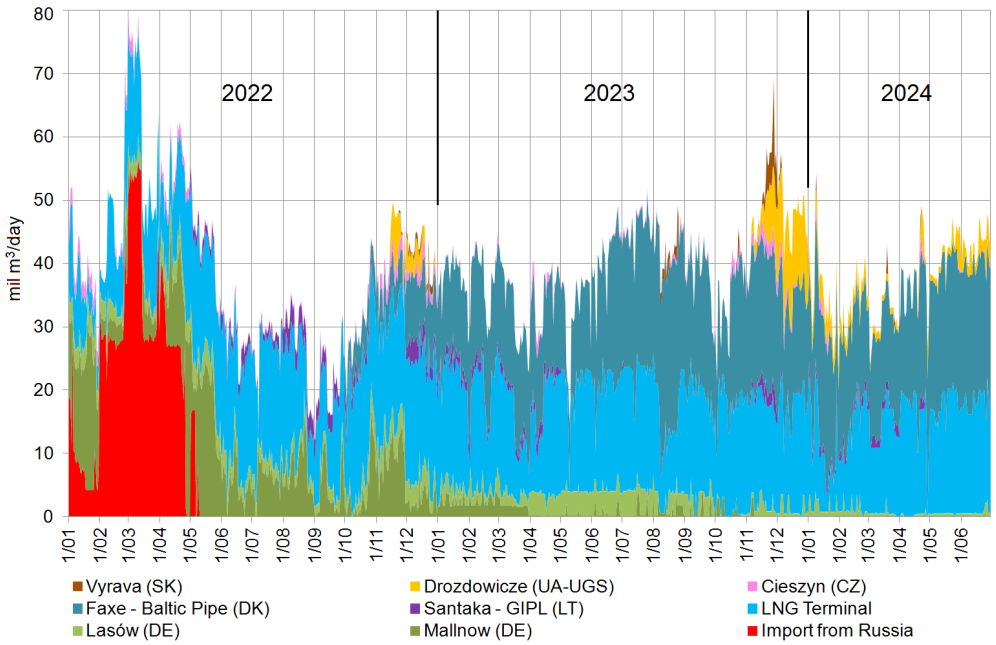

Fig. 9. Natural gas imports to Poland in 2022–2023 and in H1 2024 per day by entry points, million m^3/day
Source: ENTSOG 2025 (* – marginal entry points have been omitted)

Rys. 9. Import gazu ziemnego do Polski (dzienny) w latach 2022–2023 i w pierwszej połowie 2024 r. w podziale na punkty wejścia (mln m^3/dzień)

The year 2023 was a record year in terms of the amount of LNG imported into the European Union, with a total of approximately 1,350 TWh of natural gas imported, slightly exceeding the level of imports in 2022. In the first half of 2024, a marked slowdown (by approximately 15%) in the amount of gas supplied by LNG Terminals in the European Union is apparent. Despite this, it should be emphasized that, compared to 2018, the volume of natural gas supplied through LNG Terminals in the EU more than doubled in 2023 (Figures 10–12).

In 2023, approximately 5.9 bcm of natural gas was supplied to the Polish gas system via the LNG Terminal in Świnoujście (and approximately 0.2 bcm transshipped to tankers), corresponding to 62 LNG deliveries, a year earlier, approximately 5.6 bcm were supplied, corresponding to 58 deliveries, while in 2021, 3.9 bcm of natural gas was supplied (35 deliveries). In the first half of 2024, 2.66 bcm of natural gas was delivered to Poland via the LNG Terminal, approximately 7% less than in the corresponding period of 2023. In 2024, the Świnoujście LNG Terminal received 61 deliveries, marginally less than in 2023. As can be seen from Figure 13, the Swinoujscie LNG Terminal and Baltic Pipe are key infrastructures for ensuring natural gas supply to Poland. Figure 14 confirms that

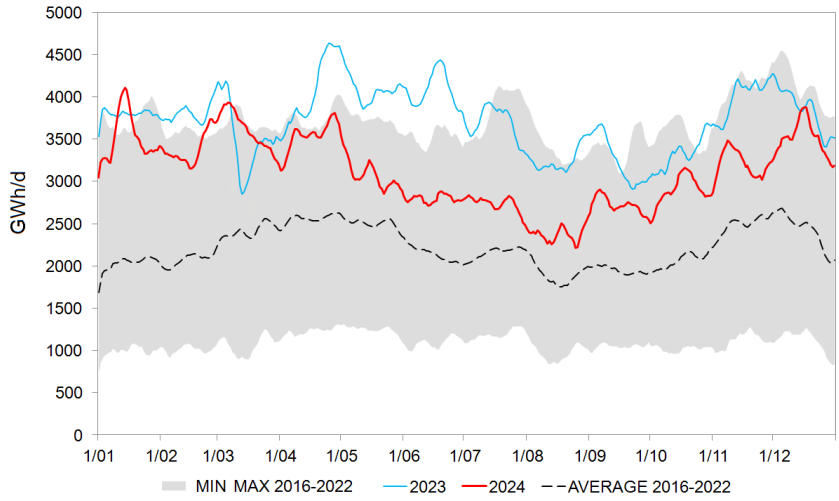

Fig. 10. Amount of gas regasified at LNG Terminals in the European Union in 2024 (compared to 2023 and to the range from 2016–2022), GWh/day Moving 7-day average. Source: GIE ALSI 2025

Rys. 10. Ilość gazu regazyfikowanego w terminalach LNG w Unii Europejskiej w 2024 r. (w porównaniu z 2023 r. i zakresem z lat 2016–2022), GWh/dzień

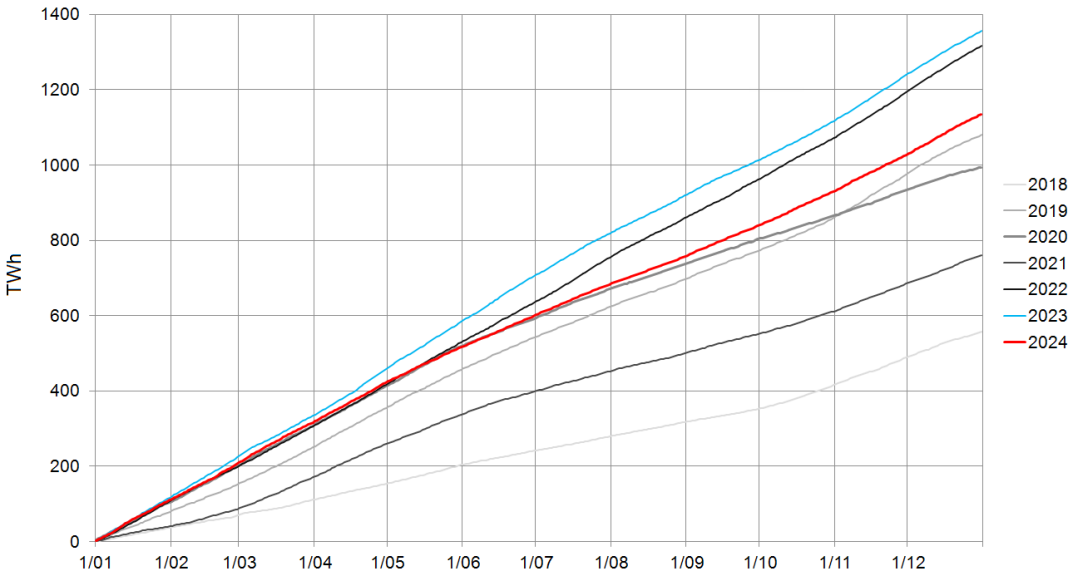

Fig. 11. Amount of natural gas regasified at LNG terminals in the EU in 2018–2024 cumulatively, TWh (without Great Britain before Brexit) Source: GIE ALSI 2025

Rys. 11. Ilość gazu ziemnego regazyfikowanego w terminalach LNG w UE w latach 2018–2024 łącznie, TWh

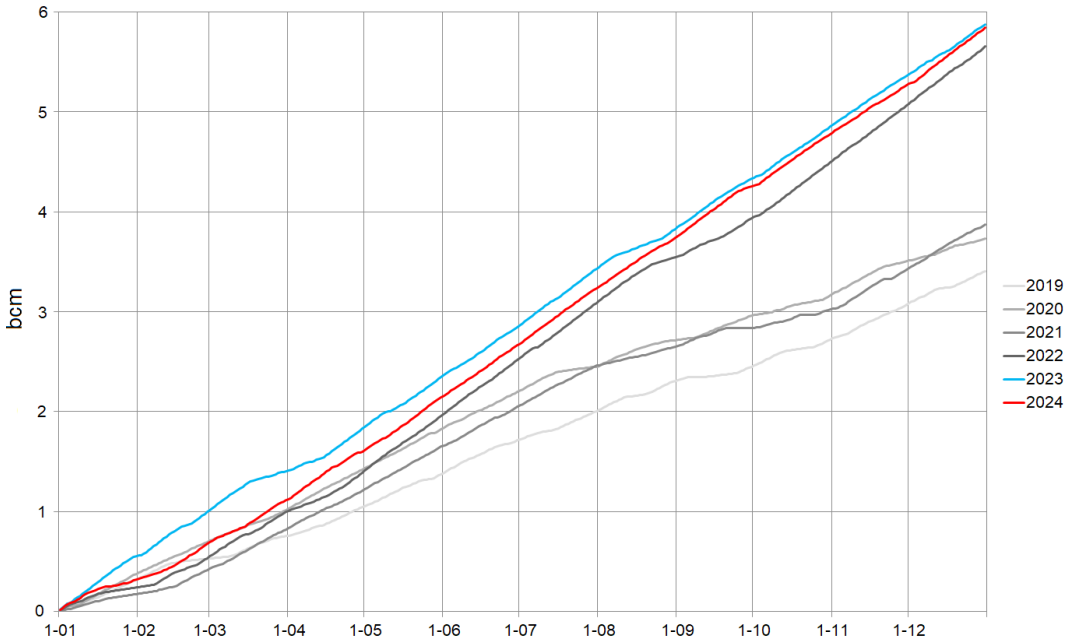

Fig. 12. Amount of natural gas regasified in Polish LNG Terminal in Świnoujście in 2019–2024 (cumulatively), bcm
Source: ENTSOG 2025

Rys. 12. Ilość gazu ziemnego regazyfikowanego w terminalu LNG w Świnoujściu w latach 2019–2024 (narastająco), mld m^3

the Świnoujście terminal is among the top European terminals due to its high utilization of available regasification capacity.

Since 2022, there has been a marked increase in the role of LNG supplies to Poland, which has translated into an increase in the use of the available regasification capacity of the LNG terminal. As recently as 2024, the maximum regasification capacity of the terminal was 220 GWh/d, i.e., approximately 19.5 million m^3 of natural gas supplied to the transmission system per day. From 1 January 2025, the annual regasification capacity is 8.3 bcm. After Russia's aggression against Ukraine, the LNG Terminal became one of the two key entry points (in addition to the Baltic Pipe gas pipeline launched on 2022.10.01) to the Polish gas system, especially in 2023, a high average annual utilization of the LNG Terminal's regasification capacity of almost 84% was visible (Figure 15). The change in the directions of gas supply to Europe was also evident in the load on the other terminals in the European Union. In most countries with LNG receiving terminals, the highest utilisation occurred in 2022 in order to ensure an adequate level of supply to fill European gas storage facilities. In the first half of 2024, the utilization of LNG terminals in the European Union decreased significantly (by up to 25%) due to two factors: the high level of filling of gas

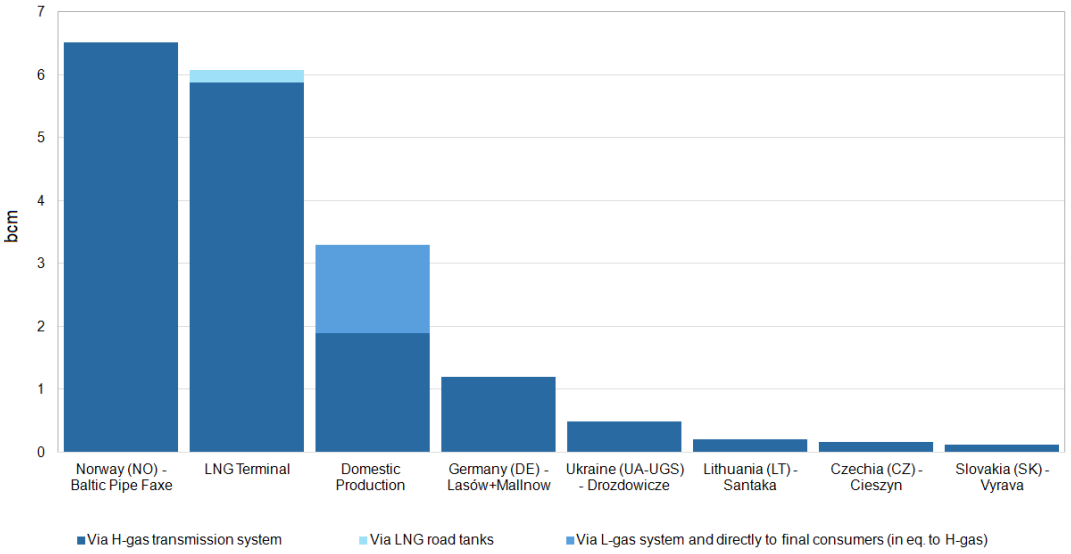

Fig. 13. Volumes of natural gas supplies to Poland in 2023 (bcm)
Source: ENTSOG 2025; GAZ-SYSTEM 2025; ORLEN

Rys. 13. Wolumen dostaw gazu ziemnego do Polski w 2023 r. (mld m^3)

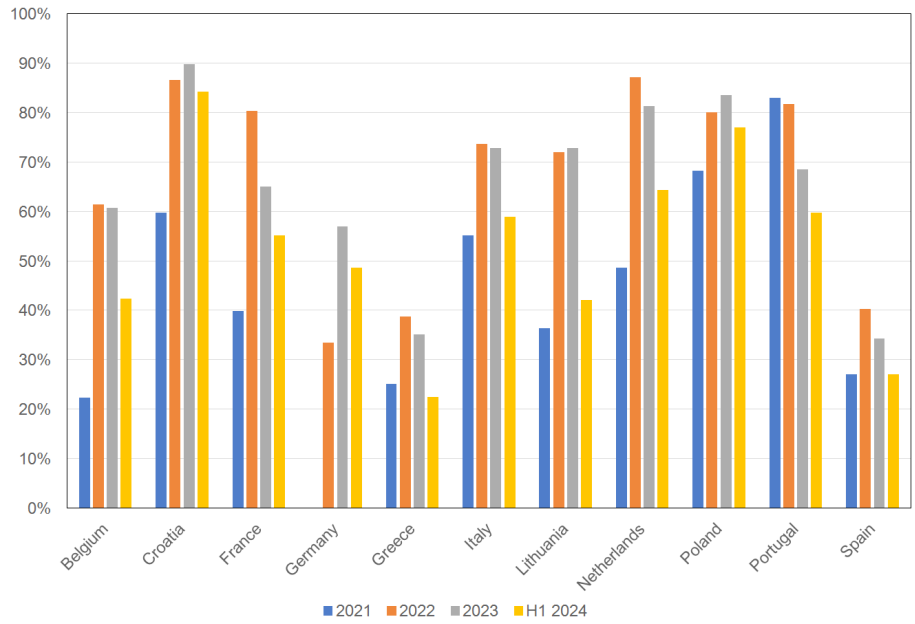

Fig. 14. Utilization of the available regasification capacity of LNG terminals in individual EU countries in 2021–2024. Source: GIE ALSI 2025

Rys. 14. Wykorzystanie dostępnej mocy regazyfikacyjnej terminali LNG w poszczególnych krajach UE w latach 2021–2024

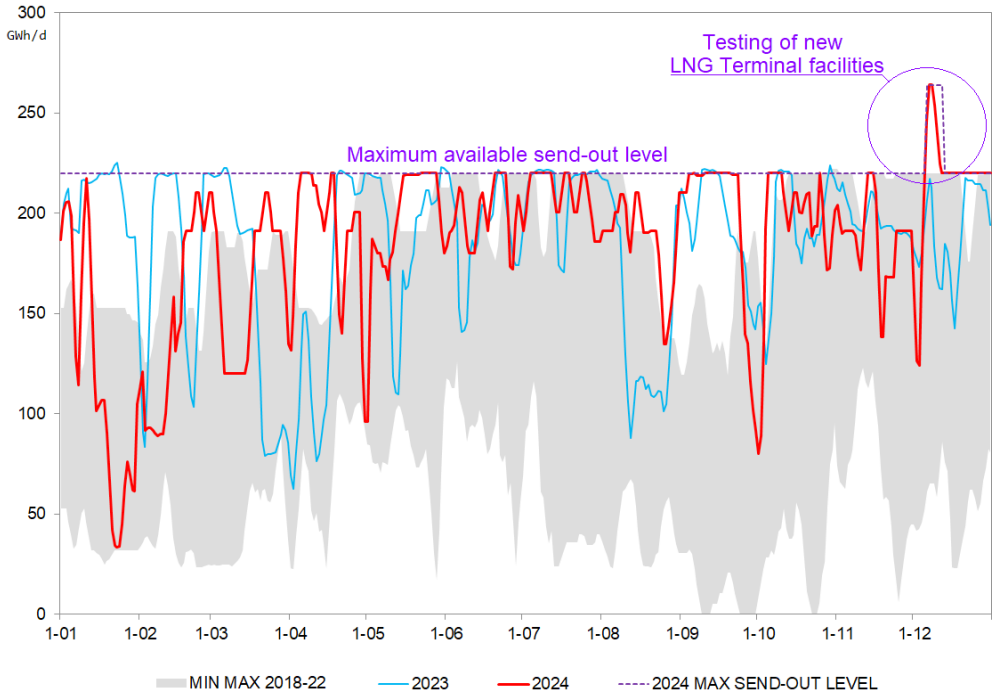

Fig. 15. Utilization of the regasification capacity of the LNG Terminal in Świnoujście in 2023 and 2024 compared to range from 2018–2022
Source: ENTSOG 2025

Rys. 15. Wykorzystanie mocy regazyfikacji terminalu LNG w Świnoujściu w 2023 r. i 2024 r. w porównaniu do zakresu z lat 2018–2022

storage facilities (resulting from the policy of refocusing supply directions and ensuring high levels of LNG supply in earlier years and the policy of reducing gas demand) and the volatility of LNG prices – in 2024 LNG prices are higher on the Asian market, which caused some LNG supplies to be redirected to that area of the world.

Conclusions

The current geopolitical situation has accelerated the shift of onshore natural gas supply via pipelines to offshore supply via LNG terminals. As of 2023, the share of LNG in global natural gas supply has a dominant position exceeding 52%. This momentum will continue in the coming years, which will translate into greater flexibility in LNG supply. The ongoing war in Ukraine has become a significant factor influencing the increase in demand for LNG and has changed the architecture of gas contracts. Based on the research analysis,

the questions formulated were answered. Firstly, the share of solid fuels in electricity production in Poland is higher than in the EU, but this difference will close in the coming years. Natural gas is important in the context of stabilizing the Polish electricity system, in which the volume of renewable energy sources is also being developed. At the same time, this raw material will be crucial for the efficiency of the district heating system, as high-efficiency gas-fired cogeneration will ultimately allow the share of renewables and waste heat to increase by 2045. Secondly, the dynamically changing situation in global energy markets has led to a change in the position of the global LNG export leader, which has become the USA. This has been significantly influenced by investments in the expansion of export infrastructure combined with the increasing production of shale rock gas. The competitive price of exported LNG and an appropriate LNG contracting policy also plays a key role in maintaining this position. Taking into account the geopolitical situation, international competition in the global LNG market will likely intensify in the coming years. Thirdly, the process of diversification of natural gas supplies to Poland is possible thanks to the developed energy infrastructure. Most natural gas is supplied through the Baltic Pipe pipeline and the LNG terminal, through which Poland receives nearly 40% of its annual demand for this resource. It is observed that since 2022, the importance of the LNG terminal in Świnoujście has increased and today it is one of the most strategic energy infrastructure facilities in the country. The dynamically changing geopolitical situation, influenced by Russia's aggressive policy, is leading to a change in the approach to energy security.

The Authors have no conflict of interest to declare.

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ANALYSIS OF THE IMPORTANCE OF LNG SUPPLY FOR BALANCING THE DEMAND FOR NATURAL GAS: THE CASE OF POLAND

Keywords

natural gas, LNG, energy security, energy policy

Abstract

In the past two decades, the significance of LNG trade within the framework of international natural gas exchange has grown dynamically. In 2020, for the first time in history, the share of LNG exceeded 50% of global natural gas trade. The issue addressed in this article-namely, the role of liquefied natural gas (LNG) in balancing natural gas demand-holds critical importance for energy security, particularly in the current context of the war in Ukraine. The research analysis presented in the article, from a subjective (actor-oriented) perspective, pertains to the state, while the objective (issue-oriented) dimension concerns natural gas, with particular emphasis on LNG. The study employs factor analysis as well as comparative analysis. The following conclusions have been formulated. First, the ongoing war in Ukraine has emerged as a principal driver of increased global LNG demand and has significantly reshaped the architecture of gas supply contracts. Natural gas is gaining importance in Poland. Second, the rapidly evolving conditions in global energy markets have resulted in a shift in global LNG export leadership, with the United States now assuming the dominant position. Third, the diversification of natural gas supplies to Poland has been made possible by the development of a robust energy infrastructure. Notably, since 2022, the importance of the LNG terminal in Świnoujście has increased markedly, and it is now regarded as one of the most strategically significant components of the country's energy infrastructure.

ANALIZA ZNACZENIA DOSTAW LNG DLA ZBILANSOWANIA POPYTU NA GAZ ZIEMNY W POLSCE

Słowa kluczowe

gaz ziemny, gaz skroplony (LNG), bezpieczeństwo energetyczne, polityka energetyczna

Streszczenie

W ostatnich dwudziestu latach obserwuje się dynamiczny wzrost znaczenia handlu LNG w ramach międzynarodowego obrotu gazem ziemnym. W 2020 r. po raz pierwszy w historii udział przypadający na LNG przekroczył ponad 50% globalnego handlu gazem. Podjęta w artykule problematyka analizy znaczenia dostaw gazu skroplonego do bilansowania zapotrzebowania na gaz ziemny ma istotne znaczenie dla bezpieczeństwa energetycznego, szczególnie obecnie w kontekście wojny w Ukrainie. Analiza badawcza przedstawiona w artykule w ujęciu podmiotowym odnosi się do państwa, zaś w kategorii przedmiotowej do gazu ziemnego, a w szczególności LNG. Wykorzystana została metoda analizy czynnikowej, a także analiza porównawcza. Sformułowane zostały następujące wnioski. Po pierwsze, trwająca wojna w Ukrainie stała się głównym czynnikiem wpływającym na wzrost zapotrzebowania gazu skroplonego oraz wpłynęła na zmianę architektury kontraktów gazowych. Gaz ziemny zyskuje na znaczeniu w Polsce. Po drugie, dynamicznie zmieniająca się sytuacja na światowych rynkach energetycznych doprowadziła do zmiany na pozycji lidera eksportu LNG w skali globalnej, którym stały się USA. Po trzecie, proces dywersyfikacji dostaw gazu ziemnego do Polski jest możliwy dzięki rozbudowanej infrastrukturze energetycznej. Obserwuje się, że po 2022 roku znaczenie terminala LNG w Świnoujściu wzrosło i stanowi on dzisiaj jeden z najbardziej strategicznych obiektów infrastruktury energetycznej w państwie.