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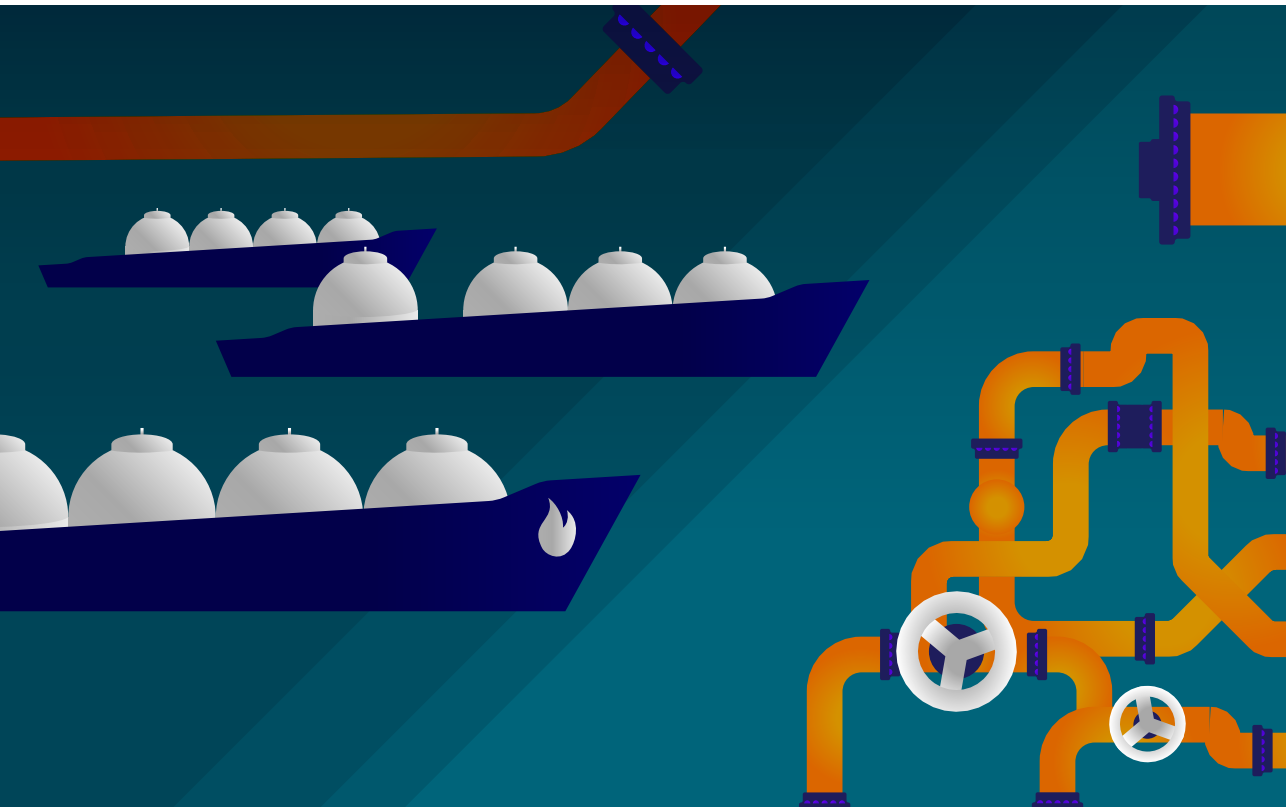

Secure gas supplies for the winters to come

European path from crisis to independence

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Key numbers

37%

increase in EU imports of Russian gas in 2014-2021 (including LNG)

sixfold

decrease in EU daily imports of Russian gas via pipelines in 2022

by 13%

EU countries reduced the gas consumption in 2022

double

expected increase in regasification capacity of LNG terminals in the EU by 2028

30%

minimum gas storage filling rate at the end of the winter, enabling achieving the 90% filling rate in November amid a 10% reduction in consumption, despite witholding of the Russian supplies

by 23% and 24%

Germany and Italy will have to decrease gas consumption in the absence of supplies from Russian in harsh competition scenario (compared to 2021)

by 9%

countries in the "gas seven" will have to reduce gas consumption in the full cooperation scenario during the 2023/2024 winter period (compared to 2021)

over 4%

of the potential consumption during the winter period will be lost by recipients in the «gas seven» countries due to infrastructural bottlenecks in the European gas transmission system

Key findings

- **Seven countries dominate the gas sector in the European Union: Germany, Italy, France, the Netherlands, Spain, Poland and Belgium. Together, they account for 80% of gas consumption, 88% of LNG import capacity, 70% of gas storage capacity,** and most of the pipelines bringing non-Russian gas to Europe. Their decisions influence the direction in which the EU gas market develops to the largest extent. Their position entails joint responsibility for the current gas crisis and ensuring that Europe emerges from it as quickly as possible.

- **Many of the "gas seven" countries' actions in 2014-2021 can be described as insufficient compared to the increase in gas consumption, which enabled Russia to trigger the energy crisis of 2021-2022 and may have made it easier for it to decide to invade Ukraine.** During this period, gas consumption rose rapidly (+19%), especially in the power sector (+39%) and among households (+30%), while domestic production of gas in the EU fell (-50%).

- **Despite the expansion of storage (+20%) and LNG terminals (+23%), the EU's dependence on gas supplies and imports from Russia (+37%) has increased and the security of supplies has fallen.** Russian companies have also managed to maintain their control over European gas storage facilities; **before the invasion, Gazprom was involved in around 15% of European gas storage capacity.**

- **Of all the "gas seven" countries, Poland has done the most to reduce its dependence on Russian gas.** Though it imported most of the gas it consumed from Russia in the past, it spent years consistently developing the infrastructure needed to diversify supplies. **In 2014-2021, Poland reduced gas imports from Russia by 14%, and in Q1 2023 it ended them completely.** The Baltic Pipe pipeline, the Poland-Lithuanian pipeline, the LNG terminal in Świnoujście and the interconnectors with Germany and Slovakia mean that Poland's energy security when it comes to natural gas has increased significantly and the new infrastructure can be used to reduce Russian supplies, which are currently financing the war against Ukraine. **Poland is the only "gas seven" country with LNG terminals that did not use them to import Russian LNG in 2022.**

- **In strategic terms, EU countries were better prepared for Algeria, Libya or Norway to terminate gas supplies than for Russia to do so completely.** This approach was inconsistent, failing to take into account both the history of EU-Russia relations and Gazprom's position on the European gas market. Though solidarity in the energy sector is one of the fundamental principles of EU law, Member States have approached it like a broad, blurred and irrelevant concept — as shown by the construction of the Nord Stream 2 pipeline or the attempt to bar third parties from access to the OPAL pipeline.

- **The gas market in Europe experienced a revolution in 2022: sources of supply, flow directions, relations between market areas, prices and consumption volumes have changed.** The average daily flow of Russian gas reaching the EU via pipelines fell sixfold, from over 5100 GWh/d in January 2022 to around 860 GWh/d in December 2022. **The diversification of supplies has played the largest role in replacing gas from Russia (46%). If LNG imports had not increased in 2022, the reduction in gas consumption in the EU would have had to be 88% higher and amount to over 24% y/y, rather than 13% y/y.** The main supplies of LNG was the US (42% of total LNG imports). **Despite the invasion, EU LNG imports from Russia grew by 29% in 2022.** The reduction in consumption played an important role (34%). Above all, industry connected to the transmission network reduced consumption (65% of the total reduction). The mild winter of 2022/2023 helped Europe, too; in Germany, it was responsible for a 11% y/y reduction in the use of gas in January 2023.

- Despite the challenges, the year 2022 was a success in terms of European solidarity and coordination, but the winter of 2023/2024 could be a challenge when it comes to the security of supplies. **To safely fill storage facilities in 2023-2024, Member States should reduce gas consumption by 10% m/m compared to 2021.** Every winter, gas storage facilities should be at least 30% full at the end of March.

- **Amid harsh competition for resources among Member States and the halting of Russian supplies during the winter, Germany, Italy and Poland will be forced to limit consumption during the 2023/2024 heating season by 23, 24 and 11% compared to 2021. Cooperation between Member States and the coordinated sharing of reserves at storage facilities will make it possible to spread out the costs of shortages, resulting in a reduction in consumption of just 9%.** It will be important to develop adequate and proportional mechanisms encouraging countries to cooperate fully, not only during the toughest crisis situations.

- **Bottlenecks in European gas infrastructure, which limit the possibility of cooperation, will remain a challenge: the insufficient capacity of Spanish-French connections, the lack of a France-Italy interconnector and, to a lesser extent, the low capacity of the French-Swiss, French-German, French-Belgian and Polish-German interconnectors.** They limit the potability of the Spanish and French LNG terminals being used to a full extent in crisis situations. In our report, we also consider the risk of coordinated sabotage, identifying which infrastructure in the "gas seven" countries is essential to ensure that the needs of solidarity protected customers and critical gas-fired power plants are met. **The time horizon for fully emerging from the crisis will be increasing the possibility of impairing LNG on a massive scale through the construction and expansion of terminals in Central Europe, foreseen for 2023-2027.** The effective completion of these projects will have a significant impact on the European energy sector's security and independence.

Introduction

The Russian invasion of Ukraine and the restriction of supplies to the European Union in 2022 destabilised the European gas sector. Through European countries' and EU institutions' joint actions, gas prices on EU markets returned to their pre-war level at the start of 2023 (still significantly higher than the average price in previous years) and the supply of gas from alternative sources was able to cover the reduced demand.

Despite this success, many questions remain, above all: are the European gas supplies already safe and secure? Will Europe run out of gas without Russian supplies? (MAE, 2022a). What role should the market, Member States, and EU-level regulations play? Who should cover the costs of security? What actually reduced demand for gas in 2022 — the price, the weather or regulations? (MAE, 2022b) Is it worth building and developing gas infrastructure, such as interconnectors and LNG terminals, or would it be more sensible to move away from this fuel, which made EU countries dependent on Russia for years, as rapidly as possible? Should all the countries limit consumption together and, if so, when? (www1)

This report answers to these questions by examining the sources of the crisis, its development, and various scenarios relating to the security of gas supply in Europe during the 2023/2024 winter and in subsequent years.

In 2022, Europe and the gas market were forced to undergo a revolution changing the sources of imports, gas flow directions, consumption volume, prices and even legal conditions in the gas sector. The roots of the crisis are much deeper. The chapter "Diagnosis..." describes Europe's "long march" towards the gas crisis — the rapid increase in consumption in sectors with the lowest elasticity of demand, coupled with the insufficient diversification of supplies and the increase in gas imports from Russia after its annexation of Crimea in 2014. In the chapter "Reaction...", we analyse the effectiveness of the response to the crisis: diversifying supplies, replacing gas with other sources of energy, limiting consumption, and changes in legislation. The chapter "Simulation..." presents the results of the modelling of the security of gas supply to Europe for winter 2023/2024 and subsequent years. Five scenarios were analysed, taking into account Member States' attitudes to the crisis, extreme weather conditions, and potential acts of sabotage targeting key gas infrastructure. The report closes with recommendations based on the conclusions of this analysis.

The "gas seven". The countries responsible for the EU's gas security

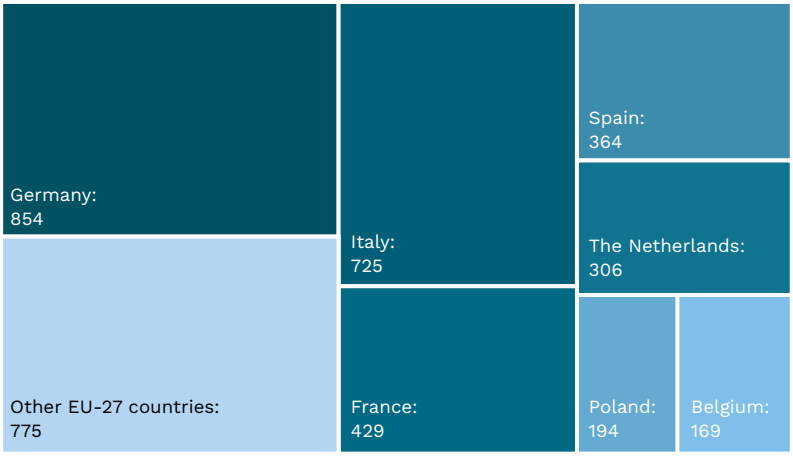
This report contains numerous references to the "gas seven" countries. For at least 15 years, the EU gas sector has been dominated by eight countries that account for over 80% of consumption. Now that Britain, the third-largest consumer of gas in the EU, has left, this leaves seven countries: Germany, Italy, France, the Netherlands, Spain, Poland and Belgium, which have the greatest

influence on the gas sector in Europe. By singling out these countries, we can analyse diverse strategies when it comes to the security of gas supply, and understand the synergies and tensions between EU and national policies.

The "gas seven" countries not only consume the most gas, but also control and develop related infrastructure to the greatest degree. They currently possess LNG terminals responsible for 88% of Europe's regasification capacity. Most EU gas storage facilities and 70% of their active capacity are located on their territory. Most Norwegian, Algerian and Libyan gas is imported to Europe via pipelines that run through their territory. The crisis of 2021-2022 did not weaken the position of the "gas seven" — it actually strengthened it, increasing the role of LNG and involving these countries in the public debate on EU gas policy.

Cooperation between the "gas seven" countries forms the "backbone" of the EU's energy security. With their significant position, their responsibility for the EU's incomplete preparation and the joint recovery from the crisis caused by Russia's invasion of Ukraine and the subsequent reduction of Russian gas supplies is growing proportionally. The "gas seven" countries' best and worst practices when it comes to gas security could be a starting point for the further stabilisation of this sector in Europe.

Chart 1. Gas consumption in the "gas seven" countries in 2022 (TWh)



Source: prepared by PEI based on Eurostat data.

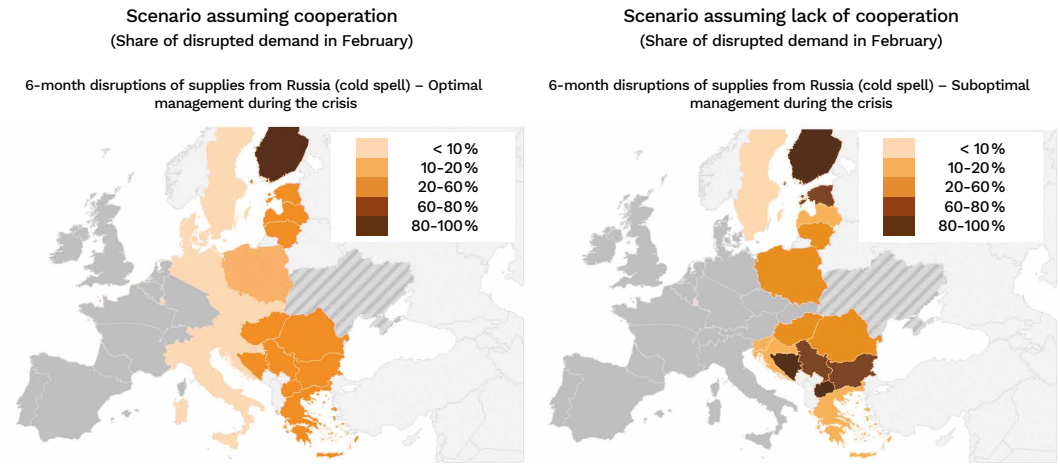
Diagnosis. The long march towards the crisis. The EU gas sector in 2014-2021

Russia's illegal annexation of Crimea and the part of the Donetsk and Luhansk regions in 2014 led to considerable unease in Member States and was firmly condemned (European Council, 2014). In response, EU countries imposed sanctions on Russians with links to the Kremlin political and business elite, as well as on institutions with links to Russia (Foreign Affairs Council, 2022). Certain restrictions also affected the oil and gas sector indirectly — exports of the technologies used to find and produce these commodities were supposed to require special permission (EC, 2014a). Despite Rosneft's legal efforts to undermine these very mild sanctions, the Court of Justice of the European Union (CJEU) deemed the sanctions compatible with EU law and defined Ukraine's sovereignty and independence as higher aims in the broader context of maintaining international peace and security (CJEU, 2015).

Since the start of the 1990s, Russia has actively used oil and gas supplies to exert political pressure. In 1992-2014, it repeatedly halted gas supplies to countries including Ukraine, Georgia, Estonia, Moldova, Slovakia and Poland. Experts at the Baker Institute identified 17 actions of this kind in 1990-2014 (Baker Institute, 2017). Aware of the risk of Russian gas supplies being limited in response to EU sanctions, the European Commission commissioned the European Network of Transmission System Operators for Gas (ENTSOG) analysis concerning the impact of the halting of gas supplies by Russia on the security of gas supply in the EU (2014b). The results were alarming: in 2014, even with solidarity and cooperation between Member States, the halting of supplies by Russia would affect 17 of the EU-27 countries.[1] It would force seven of them to limit gas consumption by over 20% — over 80% in the case of Finland — and another eight, including Poland, by 10-20%.

[1] Austria, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, Greece, Lithuania, Luxembourg, Latvia, Poland, Romania, Slovakia, Slovenia, Hungary, Italy.

Map 1. Gas security. Scenario: complete suspension of gas supplies to EU by Russia, prepared by EC in 2014



Source: ENTSOG, used by EC in COM(2014) 654 final.

In retrospect, actions after 2014 to reduce the EU's dependence on Russia can be deemed insufficient. **In 2014-2021, EU gas imports from Russia rose by 37%.** During this period, Russian exports to so-called "far abroad" states increased by 34%, too.[2] Although Russia was occupying Crimea and the Donetsk and Luhansk regions during this period, EU imports of Russian gas rose by 496 TWh per year and were similar to the combined increase in Norwegian gas imports and LNG imports from other countries (514 TWh per year in total). **In 2018-2021, Russia's budgetary revenue from exporting gas to the EU may have exceeded 30% of its total military expenditure.[3]** The profits from exporting gas to the EU enabled Russia to build the financial and political foundations of its invasion of Ukraine in 2022.

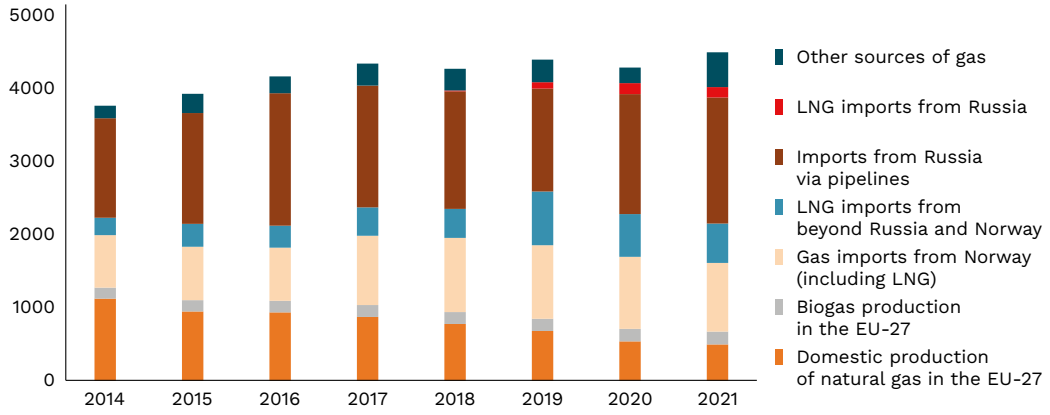
The increase in dependence on gas from Russia

Four general factors that increased the EU's dependence on Russia in 2014-2021 can be identified:

- **The increase in gas consumption in the EU: +19%,**
- **The fall in domestic gas production in the EU: - 50%,**
- **The overly slow development of alternative sources of gas: +13%,**
- **Limited solidarity between Member States when it comes to gas security: 2 out of the 34 required agreements concerning solidarity-based support.**

[2] Calculated by PEI based on Rosstat and Eurostat data. In the terminology used by institutions in the Russian Federation, "far abroad" states are those whose territories were not part of the USSR.
[3] Calculated by PEI based on Russian Ministry of Finance data for 2018-2021 on budgetary revenue from natural gas and on military expenditures.

Chart 2. Consumption, extraction and imports of natural gas in EU-27 countries in 2014-2021 (TWh/year)



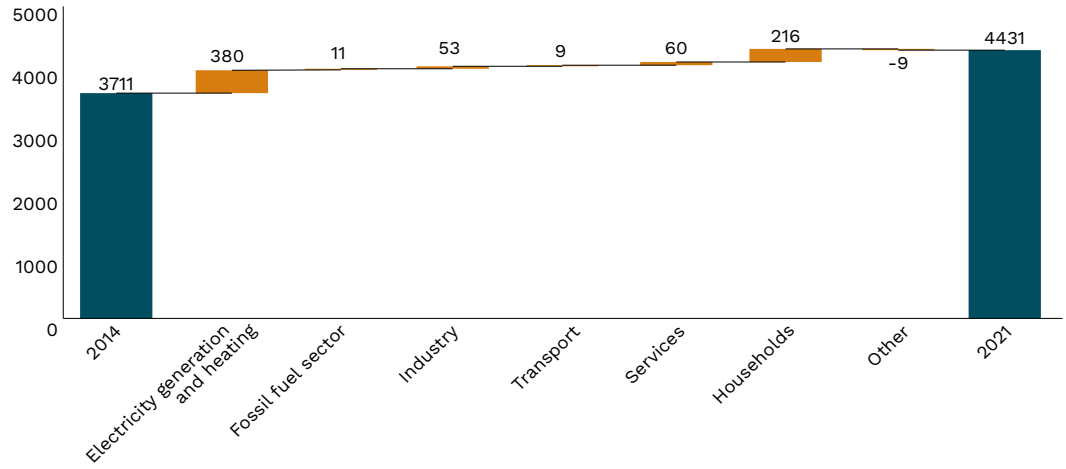
Source: prepared by PEI based on ACER, Eurostat and ALSI GIE data.

In 2014-2021, gas consumption in the EU increased and domestic production fell. Gazprom took advantage of the situation using its advantage when it comes to infrastructure, low costs, political lobbying (www2; Douo, Kieninger, 2020; MacLachlan, 2019) and consistent abuse of its dominant position on the European market (EC, 2018; EC, 2005). Russian gas filled the gap created by the irresponsible policy of European countries, which did not counterbalance the increase in consumption by diversifying supplies, and Gazprom and Novatek became the beneficiaries of the EU countries irresponsible energy policy.

Above all, the increase in gas consumption in the EU in 2014-2021 resulted from the replacement of coal in the power and heating sector with gas (52% of the total increase in EU consumption), connecting households to the gas network (30% of the increase of household consumption), and the increase in gas consumption in the energy sector and industry. In the energy sector, gas replaced coal and nuclear energy, and supplemented renewables. **Natural gas emits less than half the CO_2 emitted by hard and brown coal — replacing coal-fired blocks with gas ones made it possible to reduce emissions by over 0.5 million tonnes per TWh of electricity generated, which encouraged investors fleeing high emission costs.**[4] The rapid development of renewables, primarily wind and solar power plants, also fostered the development of flexible gas power plants that were meant to ensure the stability of supplies. Despite their advantages, gas power plants increased the exposure of the power sector, characterised by rigid demand and the lack of substitute goods for electricity, to potential crises on the gas market. Slight disruptions of the equilibrium between supply and demand on the gas market could destabilise prices on both the gas and electricity market.

[4] Calculated by PEI based on KOBIZE (2021) data.

Chart 3. Factors behind the increase in gas consumption in the EU in 2014-2021 (TWh/year)



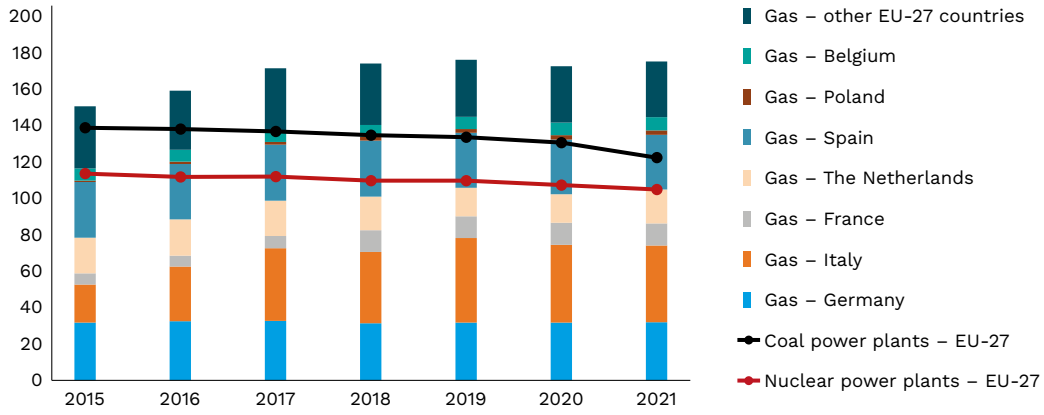
Source: prepared by PEI based on Eurostat data.

As a result, **gas power plants with a capacity of at least 24 GW were connected to the grid in EU countries in 2014-2021, and gas consumption in the power and heating sector rose by TWh per year (39%).**[5] In housing, gas replaced coal and fuel oil as a source of heat, which increased consumption by 216 TWh per year (24%). Although they were partially right, the assumptions behind these actions pushed up gas consumption in the EU significantly, increasing its dependence on Russia.

In retrospect, after the catastrophe in Fukushima in 2011, many EU countries made the mistake of closing down or legally restricting the development of nuclear power plants (*Code de l'énergie*, 2015), which were partly replaced by gas ones. **If EU countries had not hastily decided to close down nuclear power plants in 2014-2021, the increase in gas consumption in the energy sector would have been four times lower** (83 TWh per year instead of 380 TWh per year, a difference similar to Poland's annual gas needs).[6] It was not until the crisis caused by Russia's invasion of Ukraine in 2022 that nuclear energy was deemed a clean form of energy in the EU — one which supports the green energy transition (www4) — and many Member States began to postpone the phasing out of nuclear power plants or announced the construction of new blocks.

[5] Calculated by PEI based on transparency.entsoe.eu and Eurostat data.
[6] Calculated by PEI based on Eurostat data.

Chart 4. Production capacity using gas, coal and nuclear energy in the EU-27 in 2014-2021 (GW)



Source: prepared by PEI based on ENTSOE data.

Increasing the security of supply of gas in the EU and Russia's counteractions

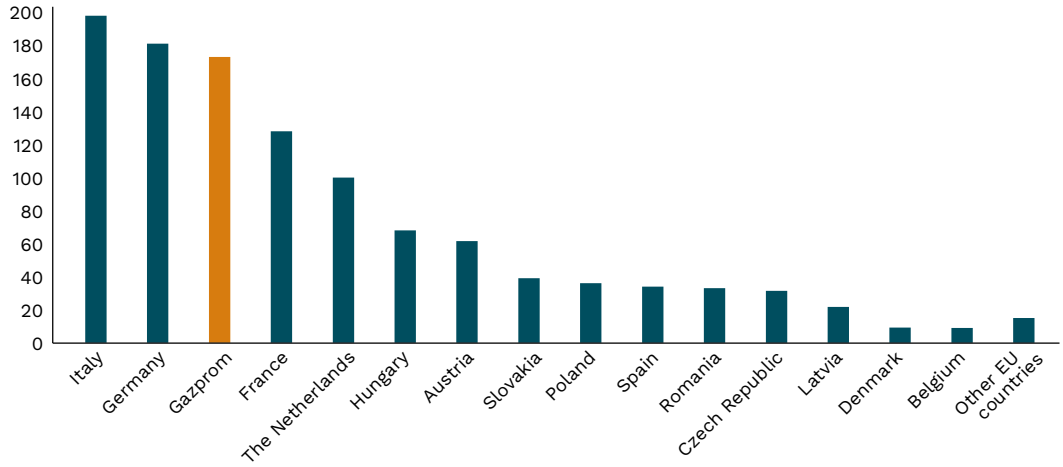
However, when it comes to security of supply, not all the actions taken in 2014-2021 were negative. Member States increased gas consumption and imports, but they also took steps to increase the security of supplies, such as:

- **Increasing the capacity of the EU's infrastructure for importing LNG: +23% in 2014-2021,**
- **Increasing the EU's gas storage facilities' capacity: +20% in 2014-2021,**
- **Incorporating solidarity in the gas sector into EU legal practice and increasing the technical capacity of the interconnectors between Member States.**

Aware of the significance of LNG, gas storage facilities and European solidarity for the security of gas supply to Europe, Russia took steps to increase its own influence over these elements. Russian LNG exports were developed (to around 150 TWh/y). **In 2021, Russia was the third-largest supplier of LNG to Europe (after the US and Canada) and Russian LNG accounted for 18% of supplies to the EU.**[7] Russian enterprises also managed to maintain control over some of Europe's gas storage facilities. In 2014-2021, Gazprom was a shareholder in facilities capable of storing 173 TWh of gas. **Gazprom was involved in around 15% of Europe's gas storage capacity. The fact that Gazprom did not fill storage facilities during the 2021/2022 winter season in Germany, Austria, the Netherlands and the Czech Republic (25% full; the EU average was 54%) was one of the significant factors influencing the sharp increase in gas prices in the EU.**

[7] Calculated by PEI based on Bloomberg Terminal data.

Chart 5. Gas storage facilities used in the EU in late 2021 (TWh)



Note: storage facilities that Gazprom was involved in were not included in Member States' resources.
Source: prepared by PEI based on agsi.gie.eu and OOO Gazprom Export data.

Two factors had the greatest impact on making the EU dependent on Russian gas: the increase in the use of natural gas (not just from Russia) in the main countries that consume it, the countries in the «gas seven», above all Germany (+19%), Italy (+23%), Spain (+24%) and Poland (+35%), and the increase in Russian gas imported by Germany (+35%). A comparison of the «gas seven» countries shows a variety of approaches to the security of supplies. Germany and the Netherlands banked on the development of gas storage facilities (+20% and +39%), France and Belgium expanded infrastructure for importing LNG (+68% and +22%), and Italy and Spain increased the total capacity of pipelines transmitting Algerian and Libyan gas.

In 2014-2021, Poland was the "gas seven" country the most dependent on Russian gas, but it drew conclusions from the very tough gas negotiations with Russia in 2009-2010 (NIK, 2011). While it increased natural gas consumption — above all in the energy sector — it systematically reduced its imports and dependence on Russian gas. In 2014-2021, Gas-System S.A. continued to expand LNG infrastructure (the first LNG terminal, +59 TWh/y; the construction process began in 2006). It also increased storage facilities' capacity (+28%) and diversified supplies (LNG, the Poland-Lithuania pipeline making it possible to use the LNG terminal in Klaipeda, the construction of Baltic Pipe). After the construction of this infrastructure was completed in 2022, Poland was capable of becoming independent from Russian supplies.

Table 1. Individual "gas seven" countries' impact on security of gas supply in the EU in 2014-2021 (%)

Country	Increase in gas consumption	Change in gas consumption for electricity and heating	Change in amount of gas produced, including biogas	Change in gas imports from Russia	Increase in LNG terminals' capacity	Change in storage facilities' capacity	New infrastructure to diversify supplies from outside EU
Germany	+19	+41	-32	+35	Lack of LNG terminals	+28	No change
Italy	+23	+45	-53	Increase of at least +7 (over 40 of consumption)	No change	+14	+6 Transmed (DZ), +23 Green Stream
France	+13	+104	Less than 1 of consumption	Fall to around 15-20 of consumption	+68	-5	Dunkerque LNG
The Netherlands	+4	-3	-70	Increase (to around 17 of consumption)	No change	+39	No change
Spain	+24	+57	Less than 1 of consumption	Increase (to around 20 of consumption)	No change	+18	Medgas +27 MEG +25
Poland	+35	+99	-10	-14	New TLNG (59 TWh)	+28	Baltic Pipe, TLNG, Świnoujście, PL-LT interconnector
Belgium	+21	6	Less than 1 of consumption	Increase (to around 30-60 of consumption)	+22	+2	Dunkerque LNG
EU	**19**	**+39**	**-50**	**c. +37**	**+23**	**+20**	

Note: orange denotes changes that have reduced the security of supplies in the EU significantly; blue denotes changed that have increased it.

Source: prepared by PEI based on Eurostat, ENTSOG and GIE data.

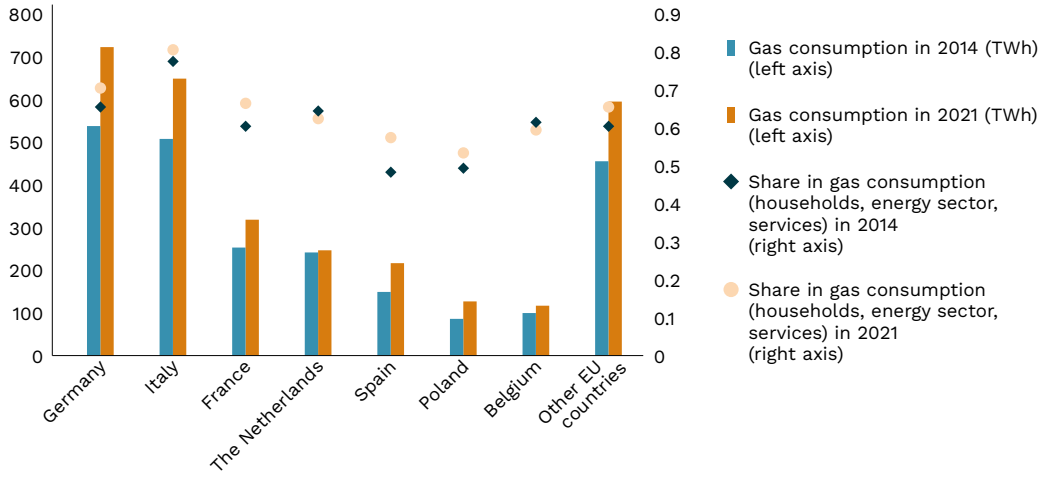
EU solidarity in the gas sector. The SoS Regulation and the OPAL case

The assessment of the EU's legislative activity in the field of security of gas supply in 2014-2021 remains inconclusive. One of the EU's essential objectives is to ensure the functioning of the internal market. Any intervention in market mechanisms in the EU should therefore always take into account and balance both the adverse social effects of it and those of the lack of it, which is the basis of the EU principle of proportionality (CJEU, 1963). At the same time, the goal of EU energy policy is not only to develop the internal market, but also to preserve and improve the environment and climate, and ensure the security of energy supplies (TFEU, Art. 194). As a result, EU institutions and Member States are stuck with an energy trilemma (World Energy Council, 2021), balancing security of supply, the efficient functioning of the energy

market, and sustainable development. In practice, the hierarchy of these values and the related role of security of supply in the EU are highly contextual (CJEU, 1983; 1998; 2017b). In the gas sector, Gas Directive 2009/73/EC gently encouraged Member States to cooperate in times of crisis, but this area was the responsibility of Member States, whose actions were meant to interfere with market mechanisms as little as possible (EC, 2009). Also, Gas Regulation 715/2009 primarily sought to create a competitive market (Kopp, 2015) whose technical coordination was to be facilitated by network codes (Mete, 2020), rather than to increase the security of gas supply. The trans-European energy infrastructure implemented based on Regulation 347/2013 (EC, 2013) was meant to complement the need to ensure strategic supplies.

When Gazprom cut off gas supplies to Ukraine in 2014, it made the EU aware of the threat of gas being used as a weapon for political purposes (Graaf, Colgan, 2017). Regulation 2017/1938 (the so-called SoS Regulation) was Europe's second approach to solve the problem; the first was Regulation 994/2010, after Russia cut off supplies in 2009 (EC, 2010). It was meant to establish transparent and predictable action mechanisms and coordination platforms in the event of a crisis, which would interfere with the market as little as possible (EC, 2017). The regulation systematised the division of competences between the EC, Member States, transmission system operators and gas undertakings. SoS Regulation established a set of infrastructure standards and gas supply standards, It also introduced the solidarity mechanism, as part of which a Member State could ask for help in protecting its solidarity protected customers. Solidarity protected customers were a new category of protected customers, common to all EU countries, covering households, essential social services, district heating installations and critical gas-fired power plants. While the protected customer category had existed before, it was up to Member States to define the protection criteria, which resulted in a variety of definitions; the common category of solidarity protected customers was an opportunity to standardise the security of supply system in the EU. **Unfortunately, in 2014-2021, gas consumption in the sectors protected by the solidarity mechanism— especially in the energy sector and households — increased by over 28%, more than the capacity of LNG terminals, storage capacity and the capacity toimpor gas from countries other than Russia. This significantly reduced the EU gas system's security.**

Chart 6. Increase in gas consumption by in households, the energy sector and the service sector in 2014-2021 (TWh)



Source: prepared by PEI based on Eurostat data.

Although Regulation 2017/1938 was a significant step forward in terms of security of supply, implementing its mechanisms turned out to be a much greater challenge. For example, in the "gas seven", only Belgium, Spain and Germany identified the category of solidarity protected customers in their preventive action plans and emergency plans (Federal Ministry of Economic Affairs and Energy of Germany, 2019; Ministry of Economic Development of Italy, 2019; of Ecological and Just Transition of France, 2020; Ministry of Economic Affairs and Climate Policy of Netherlands, 2019; Ministry of Ecological Transition of Spain, 2018; Ministry of Energy of Poland, 2019; FPS Economy, S.M.E.s, Self-Employed and Energy, 2019). **Despite the formal commitment to sign mutual agreements with their neighbours regulating the method of providing solidarity measures by 1 December 2018** (EC, 2017), **none of the countries signed these kinds of agreements on time.** The only countries that signed them between themselves in 2019-2021 were Germany and Denmark and Germany and Austria (www5).

In the form in force until 2021, the SoS Regulation did not require Member States to fill gas storage facilities or plan ways to diversify gas supplies above the (N-1 formula) infrastructure standard (EC, 2017). Although Russia had cut off gas supplies to EU countries in the past, none of the scenarios prepared covered the risk of all Russian supplies being cut off (ENTSOG, 2017; 2021a). This resulted indirectly from the provisions of the SoS Regulation, which did not identify this risk group (EC, 2017). **In strategic terms, EU countries were better prepared for gas cut-offs by Algeria, Libya or Norway than Russia.** It was an inconsistent approach that failed to take into account both the history of EU-Russia relations and Gazprom's position on the European gas market.

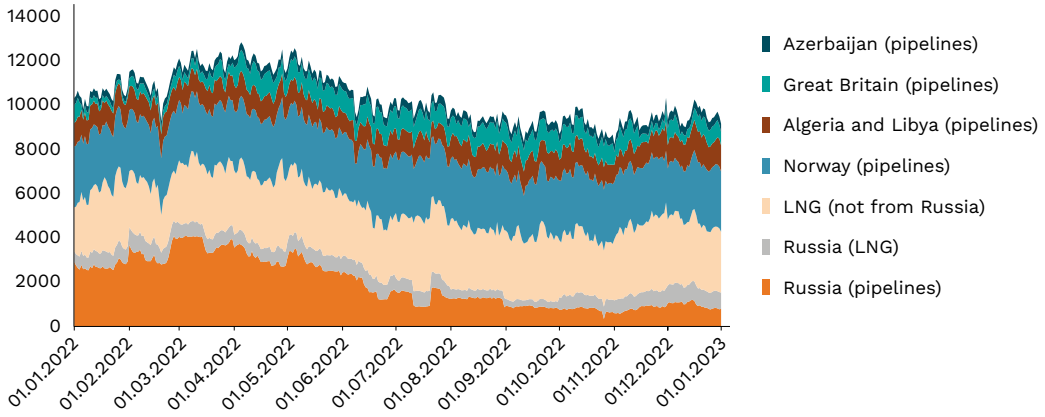
An example of Member States' inconsistency in the development of security of supply in Europe is the case of OPAL. Earlier, many Member States had approached solidarity in the energy sector as a general, broad and irrelevant concept with no practical application, that did not require them to take quantifiable actions. A glaring example was the implementation and attempt to exclude the OPAL gas pipeline from the third-party access obligation (CJEU, 2016a; 2019b). At the same time, Swiss company Nord Stream 2 AG, controlled by Gazprom, sought in vain to invalidate the changes to the gas directive to obtain additional benefits for itself in connection with the Nord Stream 2 gas pipeline's exemption from the obligation to split off an independent operator and provide third-party access (CJEU, 2019b; 2020). In the OPAL case, the concept of energy solidarity as a fundamental principle of EU law was defined and specified for the first time, an important step in developing community thinking about the security of gas supply (CJEU, 2019a).

Member States' actions in 2014-2021 can be described as disproportionate to the increase in gas consumption, which directly brought the energy crisis of 2021-2022 closer and made it easier for Russia to decide to invade Ukraine. Diversification, substitution and storage were not adequate to the increase in gas consumption, especially in the power sector. Despite the expansion of storage facilities and LNG terminals, the EU's dependence on supplies from Russia increased, while the security of supply decreased. **In 2014, assuming maximum use of LNG terminals and gas pipelines, the EU could satisfy around 110% of its consumption by importing gas from countries other than Russia. In 2021, just 94% of consumption could be covered in this way;** even with unlimited capacity of interconnectors between Member States, the full cut-off of Russian gas would therefore force the EU to reduce consumption by 6%.

Reaction. Europe in the face of the gas crisis of 2021–2022

The EU condemned Russia's invasion of Ukraine on 24 February 2022, which violates international law and threatens global security and stability (www6). In response, the EU, in consultation with the US and the UK, adopted subsequent packages of sanctions (EC, 2022a; Foreign Affairs Council, 2022). The EU-US joint response weakened the Russian economy significantly, resulting in the weakening rouble exchange rate. Russia's response to the sanctions in the energy sector was the so-called 'rouble decree' (President of the Russian Federation, 2022) obliging countries on the list of unfriendly countries (including the EU, US, UK and Switzerland) to pay for gas supplies by making payments in roubles to dedicated accounts opened with Gazprombank. Russia gradually reduced supplies, citing EU countries' unwillingness to implement its provisions (www8) and technical reasons (www9). Europe was forced to move away from Russian gas more rapidly due to the unsealing of two lines of the Nord Stream gas pipeline and one of the two lines of the Nord Stream 2 gas pipeline that was not approved for use (www10).

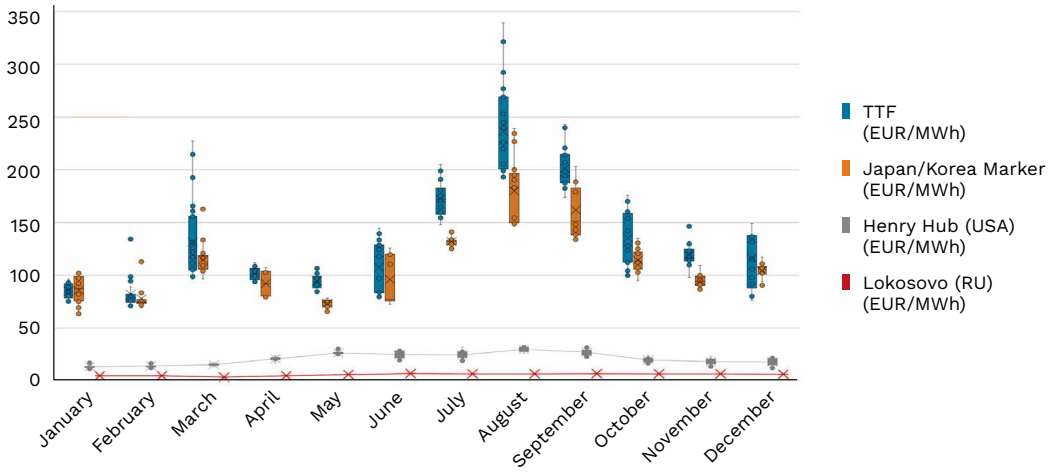
Chart 7. EU daily gas imports between 01.01.2022 and 31.12.2022 (GWh/d)



Source: prepared by PEI based on ENTSOG and Bloomberg Terminal data.

As a result, **in 2022 there was an unprecedented drop in Russian gas supplies to Europe: average flows of Russian gas to the EU via pipelines fell sixfold, from over 5,100 GWh/d in January 2022 to around 860 GWh/d in December 2022.** In the first half of 2023, the only entry points for gas from Russia to the EU were the Ukrainian-Russian Sudzha point (the Russian Urengoy-Pomary-Uzhhorod gas pipeline) and the Bulgarian-Turkish Strandzha 2-Malkoclar point (the Russian Turk Stream gas pipeline).

Chart 8. Gas futures prices at the European TTF hub in 2022, compared to the Asian, US and Russian markets (EUR/MWh)



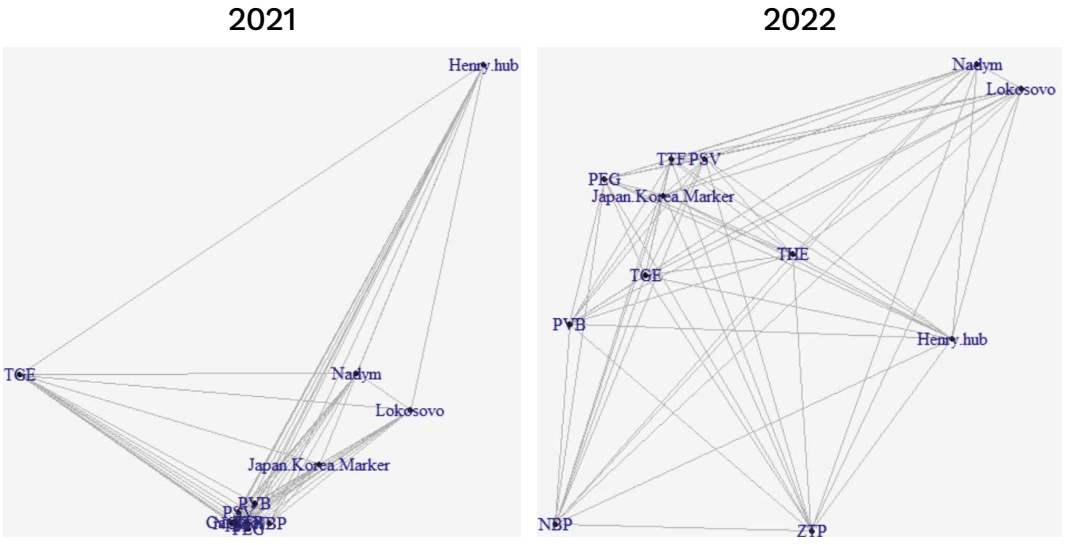
Note: for each year, the lowest price (lower whisker edge), the first quartile (lower border of the box), the mean price (the line inside the box), the median price (marked with an x), the third quartile (the upper border of the box) and the highest price (upper whisker edge) are presented. Outliers (more than 1.5 interquartile ranges above the third/ below the first quartile) are marked with points.

Source: prepared by PEI based on US EIA, СПБМТСБ (spimex.com) and investing.com data.

The reduction of Russian supplies increased and destabilised gas prices on European markets. **The first signs of the coming crisis could be seen as early as 2021, when Gazprom did not fill its European gas storages before the heating season; as a result, gas reserves during the winter were too low** (www12). In 2022, this volatility peaked at two key moments. **In March, the sharp increase in gas prices (60% m/m) resulted from the Russian invasion of Ukraine at the end of February and entrepreneurs' fears. In August, the rapid fluctuations in gas prices (a price increase of 37% m/m and a sixfold increase in the variance m/m) were the result of successive interruptions and restrictions in supplies via the Nord Stream pipeline, supposedly for technical reasons** (www13). The increase in gas prices had a domino effect and affected other areas, such as electricity and fertiliser prices. The war's economic impact was not limited to Europe; significantly higher prices were also recorded on Asian markets (prices increased by 47% in March

and by 36% in August) due to competition for LNG supplies. **The sharp increase in European demand for gas from other places also affected prices at the Henry Hub in the US, albeit to a much lesser extent (an increase of 8% in March and 22% in August).**

Diagram 1. The gas market. Change in the structure of connections between global market areas in 2021-2022



Note: graphs generated based on the Pearson correlation between gas prices in price areas in subsequent months (EUR/MWh). Two-dimensional representation of the graph using the Kamady-Kawai method in the R programme (igraph).

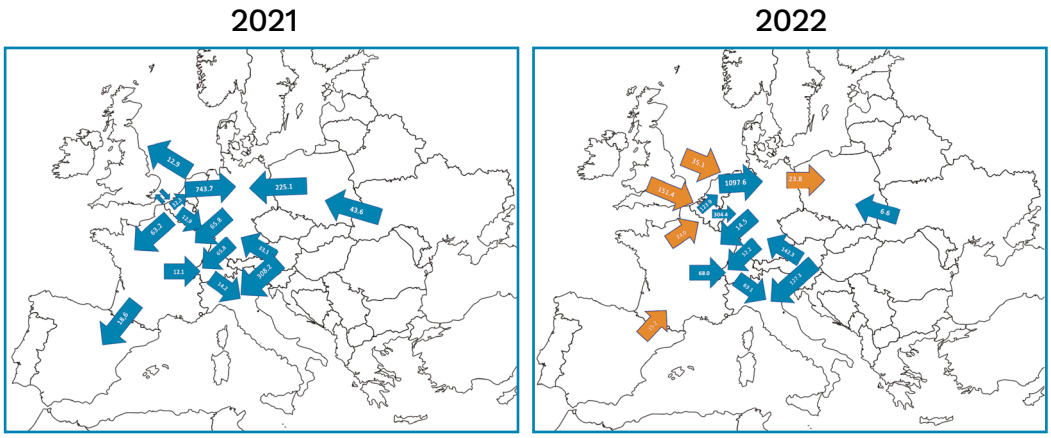
Source: PEI analysis based on US EIA, BnetzA, СПБМТСБ (spimex.com) and investing.com data.

The invasion and the resulting crisis transformed the structure of relations between individual market areas on the global gas market. In the past, European markets quoted in euros were very closely interconnected. Correlations between prices at the Dutch TTF hub, German NCG and Gaspool, French PGE, Italian PSV, Spanish PVB and Belgian ZTP exceeded 0.99. The supplier market with the strongest links to these areas was the Russian International Commodity and Commodity Exchange in St. Petersburg (СПБМТСБ, Lomosovo and Nadym price areas), with a correlation of 0.95, which was much more closely linked to the European market than the Henry Hub (correlation: 0.55). **The gas crisis in 2022 and the resulting diversity in Member States' strategies and infrastructure reduced the strength of links between individual price areas** (the average correlation between areas with gas quoted in euros was 0.71). **With the limitation of Russian supplies, the importance of the US increased; in 2022, the Henry Hub was twice as strongly correlated with prices on European markets.** It should be expected that,

with the reduction of Russian supplies to Europe, this trend will continue. Changes at the Henry Hub in the US and on Asian markets (the benchmark LNG Japan/Korean Marker) will have the greatest impact on the price of gas on European market in the future.

The decrease of Russian supplies has reversed the directions of gas flows in Europe. Before the invasion, gas entered Europe from the east and was sent westwards. In 2022, the dominant direction of gas flow was northwest-southeast due to greater imports from LNG terminals and Norway. Thanks to its LNG terminals and its own extraction, Britain went from importing EU gas to exporting gas to the EU. In 2022, thanks to their LNG terminals — which were unfortunately used to import Russian gas *en masse*, too — Spain, France and Belgium went from countries that use gas obtained from EU partners to countries capable of re-exporting gas to the EU market, which increased their neighbours' energy security.

Map 2. Gas flows in Europe before and after the crisis. Flow balances between the "gas seven" countries in 2021-2022 (TWh/year)



Source: calculated by PIE based on ENTSOG data.

The European response to challenges on the gas market in 2022

Actions taken by the European Commission and Member States sought to ensure the availability of gas, keep affordable, protect the vulnerable customers' standard of living, and limiting the impact of the crisis on other sectors (energy, industry). The International Energy Agency (IEA, 2022b), the European Commission (EC 2022f; 2022g) and Member States' institutions, including the PEI (Lipiński, Maj, Miniszewski, 2022), analysed how Russian gas could be moved away from and replaced, including by:

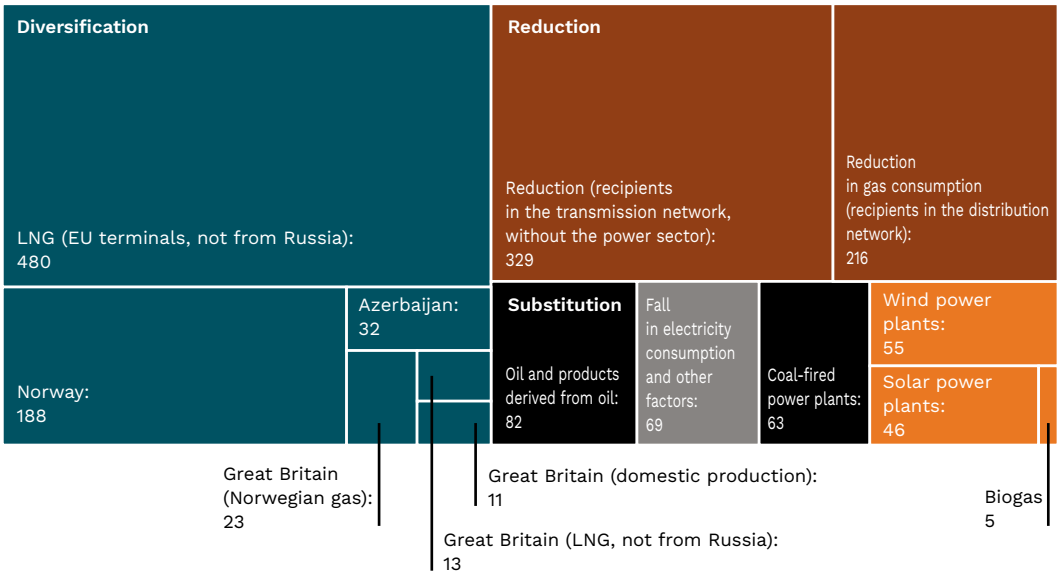
- **diversifying gas supplies:** providing supplies from elsewhere,
- **substituting gas:** replacing gas with energy from other sources (RES, fossil fuels),
- **reducing gas consumption:** a fall in gas consumption among specific groups of recipients,
- **legislative action:** obligatory gas reserves, coordination of solidarity mechanisms, a common purchasing platform, a reduction commitment, and a new benchmark for European LNG.

Imports of Russian gas to Europe (including LNG) fell by 955 TWh in 2022 (52%). Member States also increased their reserves by 336 TWh (by 56% compared to early 2021) over the course of the year to ensure security of supply during the 2022/2023 winter season and to make up for negligence when it came to filling storage facilities in 2021. Gas exports from the EU remained at a similar level (a decrease of 2 TWh). The data above shows that, in 2022, **EU countries had to increase the amount of gas obtained from countries other than Russia (or reduce their consumption) by as much as 1291 TWh (29% of EU consumption in 2021).**

The diversification of supplies played the biggest role in replacing gas from Russia (46%). Without the increase in LNG imports in 2022, the reduction in gas consumption in the EU would have had to be 88% higher and amount to over 24%. The increase in gas imports from Norway, Britain and Azerbaijan (268 TWh in total) also played a significant role. **Despite the high prices, Algeria and Libya reduced exports to the EU (41 TWh in total), which resulted from a decrease in gas production in these countries of at least 3%.**

The efficient reduction of gas consumption by as much as 540 TWh (a 34% reduction) was essential for security. Reducing the consumption of the largest consumers in industry and the energy sector connected to the gas transmission network was of the greatest importance, making it possible to reduce consumption by 329 TWh. In the case of SMEs and households connected to the distribution network, this was 216 TWh.

Chart 9. Ways in which Russian gas was replaced in the EU in 2022 (TWh)



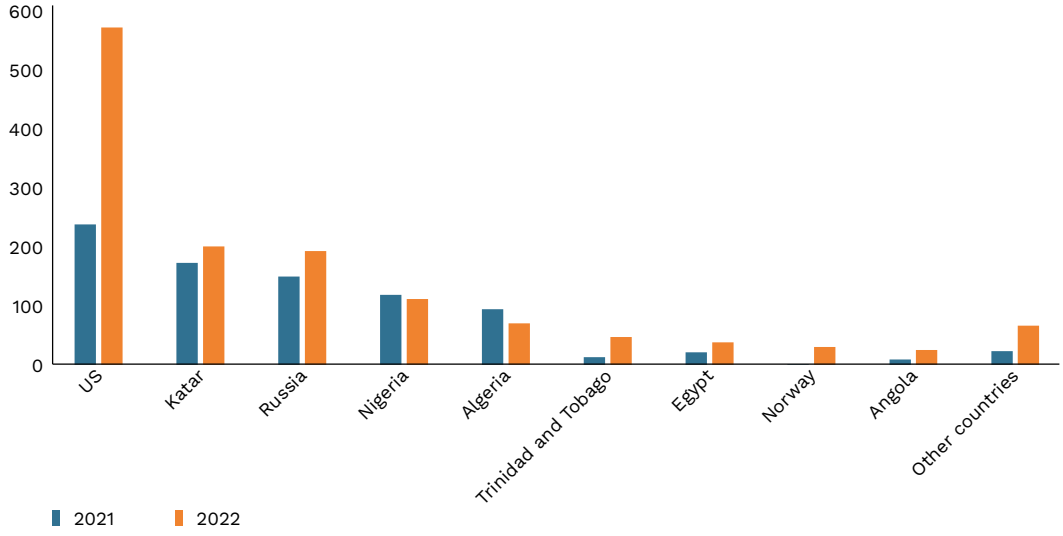
Note: blue indicates an increase in gas imports from elsewhere, red a reduction in gas consumption, black the substitution of gas with other fossil fuels, green the substitution of gas with RES, and grey factors reducing gas consumption or imports.

Source: prepared by PEI based on GIE (ALSI, AGSI), Bloomberg terminal, ENTSOG, ENTSOE, Eurostat, and JODI World Oil Database data.

Replacing gas with other energy sources turned out to be a major challenge for EU countries in 2022. In theory, the rapid **development of electricity generation from RES (wind and solar energy) and the increase in biogas production made it possible to replace approximately 106 TWh of gas in 2022.** Moreover, the **increase in the generation of electricity from coal in the EU and the replacement of gas with petroleum products made it possible to save about 145 TWh of gas during this period.** The fall in electricity consumption in the EU (around 69 TWh of gas) also had a positive impact on the security of gas supply. Unfortunately, the potentially beneficial effect of these actions was largely neutralised by the decline in electricity production at nuclear and hydro power plants (the equivalent of 282 TWh of gas). The unavailability of some units, resulting from abandoned modernisation plans and poor hydrological conditions, made it necessary to balance the system using gas power plants (Lipiński, Miniszewski, Pilszyk, 2022). **Despite the development of RES and the increase in the use of coal in the power industry, gas consumption in the power sector increased by around 48 TWh in 2022.**

In 2022, the US became the main supplier of LNG in the EU, more than doubling gas exports to Europe (42% of total LNG imports). This was made possible by increased gas production in the US (by 3%), which led to an increase in LNG exports (by 8%).[8]

Chart 10. LNG imports in Europe in 2021-2022 (TWh)

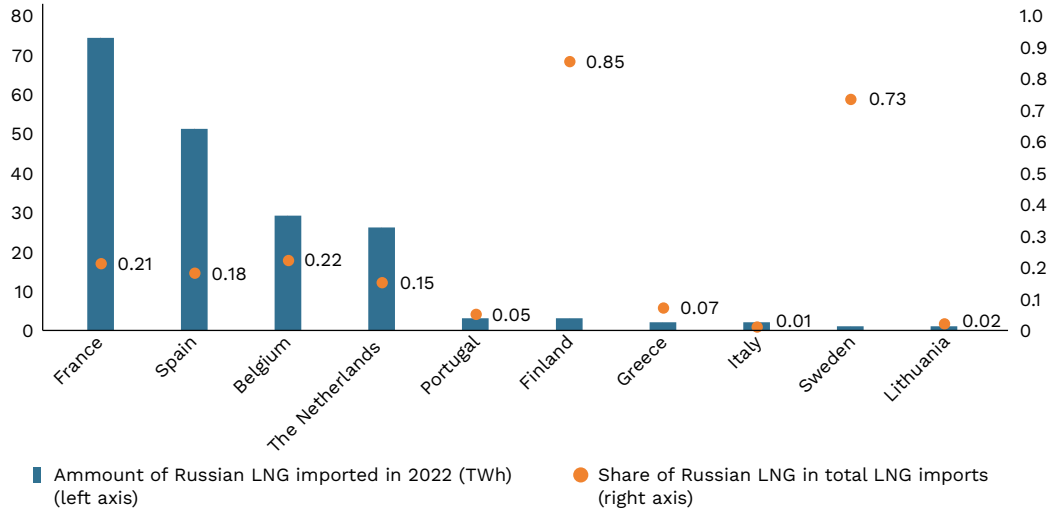


Source: prepared by PEI based on Bloomberg Terminal data.

Despite the invasion, LNG imports from Russia increased by 29% in 2022. LNG exports have enjoyed special privileges for years — also for social and political reasons — including exclusion from Gazprom's export monopoly. In 2022, LNG exports were not covered by the provisions of the Russian rouble decree (President of the Russian Federation, 2022), which made it easier for EU countries and companies to take advantage of what seemed like a way of diversifying supplies. **The largest importers of Russian LNG in the EU were France, Spain and Belgium, which in 2022 imported and reloaded 155 TWh of gas from Russia at their LNG terminals.** In these countries, the share of supplies from Russia was around 20%. **In 2022, Russian LNG dominated the market in Finland and Sweden, accounting for 85% and 73% of supplies, respectively.**

[8] Calculated by PIE based on Joint Organisations Data Initiative – Gas and Bloomberg Terminal data.

Chart 11. EU imports of Russian LNG in 2022 (TWh)



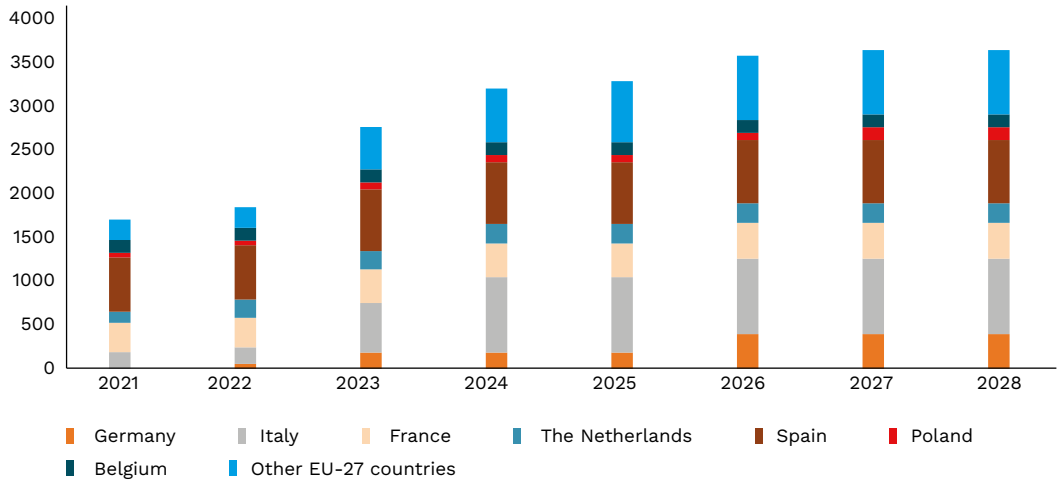
Source: prepared by PEI based on Bloomberg Terminal data.

The need to replace Russian supplies sparked an "LNG rush" (www15), accelerating the construction and expansion of LNG import infrastructure on an unprecedented scale. There are now 32 LNG terminals operating in the EU, four of which are being expanded. According to the Member States' and investors' declarations, 23 new LNG terminals will be built in the EU by the end of 2028 (eight onshore terminals and 15 FSRU). We must assume that some of the planned projects and proposals will be delayed. **If at least half the LNG terminals currently being built and planned in the EU are completed by 2028, this will increase regasification capacity by over 870 TWh/y, more than twice as much as in 2014-2021 (380 TWh).**[9]

The projects are currently at varying stages: six are being built, 17 are in the process of obtaining permits, and five have been approved. **Most of the new terminals' capacity (56%) will be built in the countries that neglected the diversification of supplies the most in 2014-2021; that is, Italy and Germany.** These countries will implement as many as 13 LNG terminal construction projects with a total regasification capacity of 973 TWh/y in 2023-2028. These projects' efficient completion will be of key importance for the security of gas supply in Central Europe. France will increase its potential with the construction of the Le Havre LNG floating terminal (around 46.4 TWh/y) and the expansion of the Montoir de Bretagne terminal, and Poland will expand the LNG terminal in Świnoujście and build a new FSRU terminal in Gdańsk.

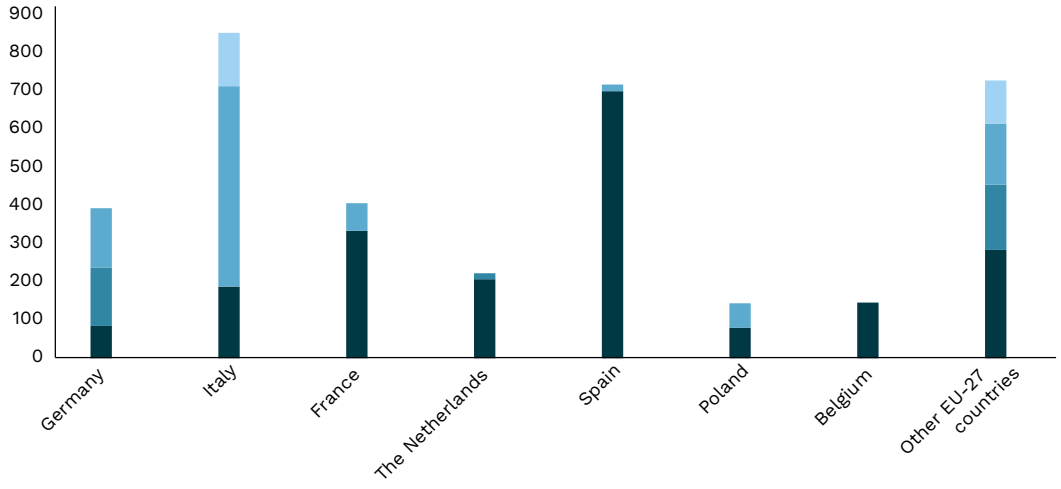
[9] Calculated by PEI based on ExxonMobil LNG data.

Chart 12. Regasification capacity of LNG terminals in the EU at the end of the year in 2021-2028



Source: prepared by PEI based on ExxonMobil LNG data.

Chart 13. Regasification capacities at LNG terminals in the EU (set to be completed by 2028)



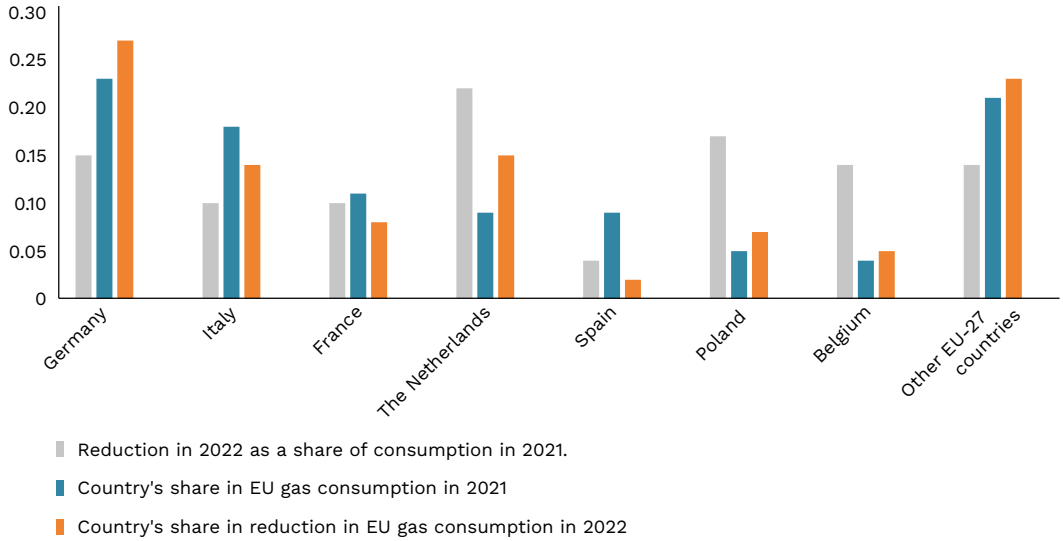
Source: prepared by PEI based on ExxonMobil LNG data.

European companies, public institutions and households reduced gas consumption by 13% in 2022. Countries that use gas as one of the main sources of electricity — Italy and Spain — were forced to use gas despite the high prices and limited availability. France also struggled to limit gas consumption; for example, due to the need to replace underfunded nuclear power

plants and the relatively low gas price in the summer season, related to access to LNG. The decrease in gas consumption in these countries was not proportional to their share in European gas consumption in 2021. **The Netherlands (22%), Poland (17%) and Germany (15%) reduced their gas consumption to the greatest extent.**[10]

The largest reduction in gas consumption took place at large industrial plants in Poland (28% of gas obtained from the network in 2021), Germany (17%) and Italy (15%). In the "gas seven" countries, approximately 65% of the total reduction was the result of consumers connected to the transmission network reducing consumption. Distribution network customers — mostly protected customers, including households — benefited from support mechanisms such as the top-down regulation of tariffs or tax cuts, which helped the weakest, but weakened the incentive to reduce consumption due to the high price gas. Large enterprises are characterised by greater price elasticity of demand and could more easily replace gas with other energy sources or survive a temporary reduction in production (CJEU, 2016b). **During the crisis, large enterprises reduced consumption twice as much as households and SMEs.**

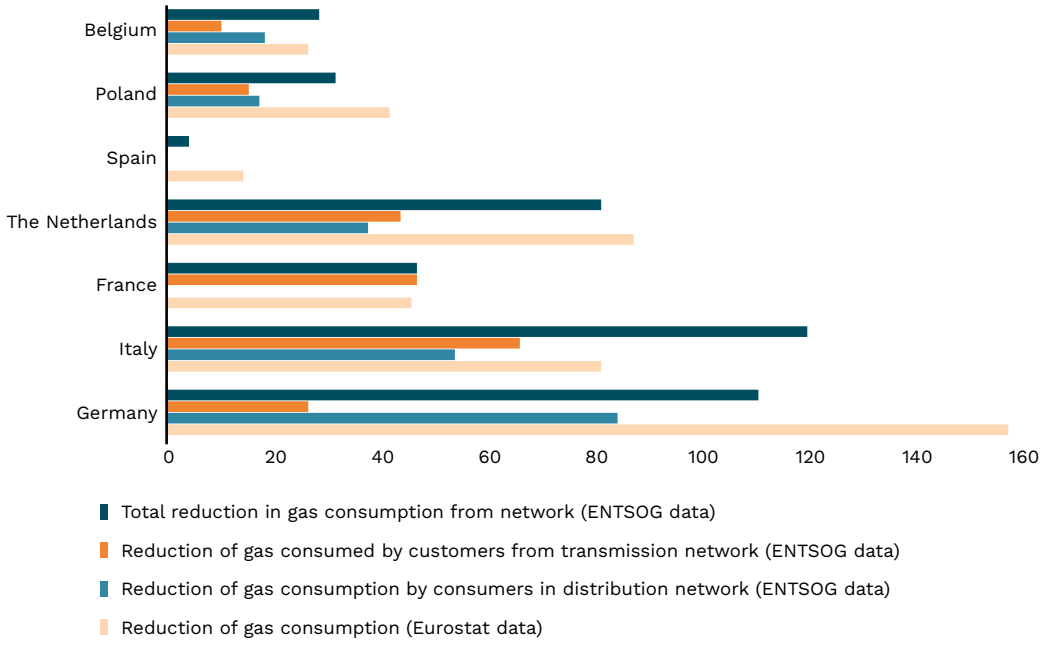
Chart 14. Reduction in gas consumption in 2022 as a share of consumption in 2021. Countries' share in the reduction in gas consumption in the EU



Source: prepared by PEI based on Eurostat data.

[10] Calculated by PEI based on Eurostat data.

Chart 15. stimated reduction in consumption in the "gas seven" countries in 2022 (TWh/y)



Note: due to missing data for Spain, only aggregated data is presented.
Source: prepared by PEI based on ENTSOG and Eurostat data

Many factors contributed to the reduction in gas consumption; not all of them resulted from the substitution of Russian gas. In the Central European countries, the temperature during the heating season was around 0.5°C above the 2018-2021 average, which meant that less gas was used for heating (weather reduction). **According to data from the German Federal Network Agency, the high temperatures in January 2023 made it possible to reduce German gas consumption that month by around 11%.** An important factor that encouraged lower consumption was the high gas price (price reduction), which mainly affected customers in industry. Many enterprises and public institutions decided to make strategic reductions; the long-term, gradual reduction of gas consumption. Separating the factors related to price reduction and strategic reduction would require further analysis. **The warmer heating season reduced gas consumption, which increased Europe's security not only during the winter of 2022/2023, but also during the next two winters, as it will make it easier to achieve storage targets.**

Chart 16. Impact of the weather on gas consumption in Germany (TWh)

Source: prepared by PEI based on German Federal Network Agency data.

The EU's regulatory response when it comes to the security of gas supply was to present first a general (March 2022) (EC, 2022f) and then a more detailed (May 2022) plan to overcome the crisis resulting from the lower supplies and high gas prices (EC, 2022g). A comparison of these documents shows that the Commission's became noticeably more realistic and multidimensional along the 27chem27. In the first main document, apart from LNG, Russian gas was meant to be replaced by rapidly increasing electricity generation from RES and developing biomethane. In the second document, the Commission expanded the scope of the measures, including substitution using fossil fuels and developing gas reduction measures. Similar solutions were proposed by the International Energy Agency (2022b) and the Polish Economic Institute (Lipiński, Maj, Miniszewski, 2022).

A surprising solution was the omission of gas transmission infrastructure and LNG terminals in the regulation on priority corridors and areas of trans-European energy infrastructure published in June 2022. While it noted the need to build new LNG terminals and the problem of bottlenecks in the European gas system in the REPowerEU plan and the ongoing crisis, one of the main elements of which was neglecting gas infrastructure and the diversification of supplies in 2014-2021, electricity and hydrogen transmission were deemed priority topics for Europe (EC, 2022h).

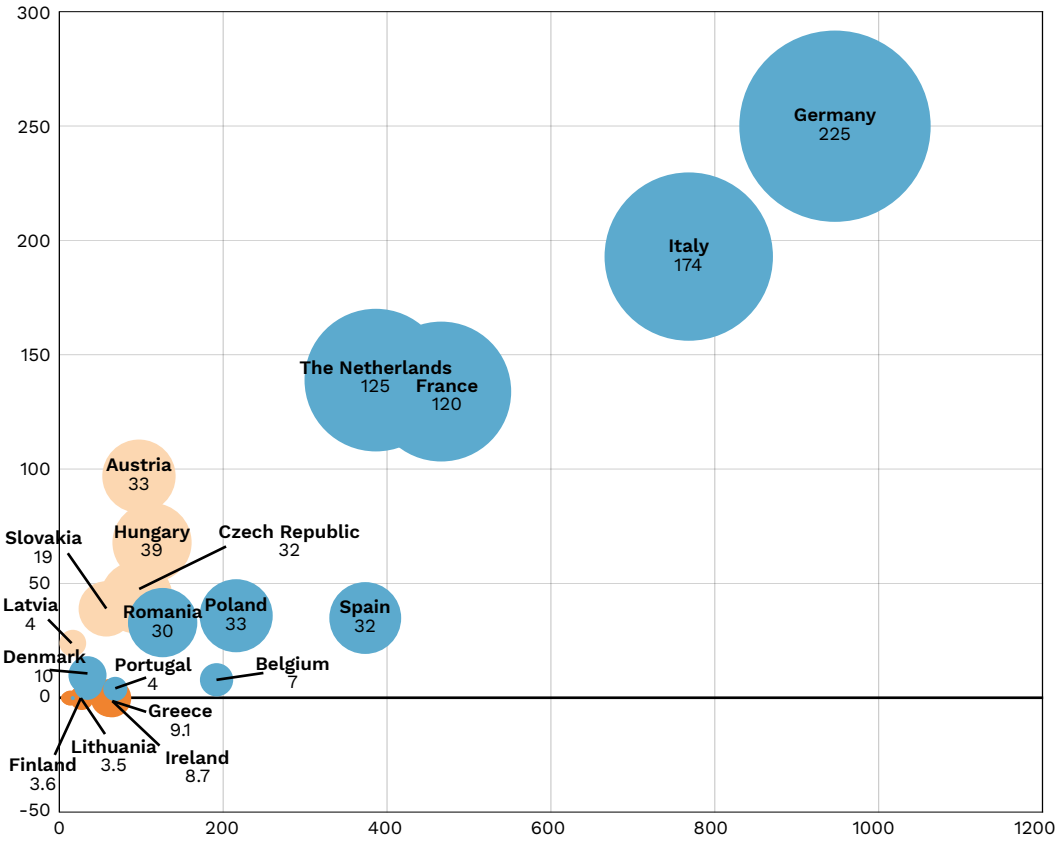
Adopted in June 2022, Regulation 2022/1032 was of key importance for the security of gas supply in Europe. It introduced the following targets: **gas storage facilities should be 80% full on 1 November 2022, and 90% full on every 1 November from 2023 onwards**, and provided filling trajectories.

The low level of gas at storage facilities (77% of capacity on 1 November 2021, including 72% in Germany and 62% in the Netherlands) was one of the factors that pushed up gas prices and limiting its availability in 2022. According to Regulation 2022/1032, countries with large storage facilities are obliged to fill 27chem to 35% of their average annual consumption during the reference period, and countries without storage should sign agreements with countries with storage, ensuring that they have reserves in the EU amounting to 15% of annual consumption. In practice, this means dividing the EU countries into four categories: EU-27 countries outside the EU gas system (Ireland, Cyprus, Malta), countries that lack their own storage facilities and must reserve capacity amounting to 15% of their annual consumption (Estonia, Finland, Greece, Lithuania, Luxembourg and Slovenia), countries with large storage facilities that fill 28chem with enough gas to cover 35% of their annual consumption (Austria, the Czech Republic, Denmark, The Netherlands and Latvia), and the remaining countries, where storage facilities must be 90% full. **This means that, in 2023, storage facilities must be roughly 82% full (approximately 922 TWh), corresponding to around 21% of annual gas consumption in the EU in 2021.**

The efficient filling of storage facilities in 2022, accelerated by Regulation 2022/1032, in the conditions of limited supplies from Russia, was one of the greatest achievements of the EU and its member sates. **European gas storage facilities went from 26% full on average in mid-March 2022 to 95% in early November 2022.** This level could not have been achieved without the Russian gas imported in 2022. It can be estimated that on 1 November 2022 around 33% of the gas in storage was Russian gas stored in 2022 and in previous years.[11] **Without imports of Russian gas in 2022, storage facilities would only have been around 64% full in November 2022, and 23% in March 2023, despite a mild winter.** Europe's success in 2022 should therefore not be interpreted as a guarantee of security in the event of the complete suspension of Russian supplies.

[11] Calculated by PEI based on AGSI GIE, Bloomberg Terminal and ENTSOG data.

Chart 17. Mandatory gas storage obligations in the EU in 2023 (TWh)



Note: blue denotes countries obliged to fill their gas storage facilities to a level of 90%, orange denotes countries that must have enough gas stored to cover 35% of their consumption, and red denotes countries without gas storage facilities. The circle's diameter represents the size of the mandatory gas reserves.

Source: prepared by PEI based on AGSI GIE and Eurostat data and the provisions of Regulation 2022/1032.

Regulation 2022/1032 contains an important attempt to define the "exceptionally low filling level" of gas storage facilities, which — observed in a country in March — may signal a potential threat to security of supply. **An alarming, extremely low level of 30% was suggested, but is not binding (2022e).** In addition to the filling trajectory, this minimum could be a starting point for creating cooperation mechanisms that would enable storage facilities to be filled more efficiently in crisis situations.

Given the difficult situation on the gas market, the EU obliged Member States to "make every effort" to reduce their consumption by 15% compared to the five-year reference period in August-March in the event of adopting an EU state of emergency (EC, 2022i). **Although, ultimately, an EU state of emergency was not announced in 2022, it should be noted that, between August and January, the reduction in the EU significantly exceeded the 15%**

threshold and amounted to about 19% compared to the reference period.[12] The only country in the "gas seven" that only just failed to meet this non-binding target during the period above was Spain (it reduced consumption by 14%). **The gas market brought about a much greater reduction in demand than EU states and institutions were ready to undertake, which indicates the high effectiveness of price as a factor regulating gas consumption in Europe.**

The experience of 2017-2021 prompted the EU institutions to adopt default solidarity rules (EC, 2022b), which apply when countries fail to reach an agreement. From an analytical perspective, requiring ACER to publish price estimates and LNG price benchmarks (EC, 2022b) is a valuable solution, increasing transparency of the EU LNG market. The benchmarks developed in this way, published by ACER from mid-January 2023, have become an additional, free source of information on the state of the gas market in Europe for anyone interested and will help raise the level of the public debate (www16).

To avoid competition between countries, a platform for joint gas purchases was created. **Although Member States must ensure that gas companies' share in the platform is at least 15% of the gas needed to fill storage facilities (EC, 2022b), at the beginning of March 2023, interest in purchasing via the platform in 2023-2025 amounted to just 187 TWh (www17). In annual terms, this is less than 5% of the EU's annual LNG imports and around 6% of the EU storage facilities' capacity.** This is definitely not enough to conclude that there is no competition for gas in the EU and that there will be none in the future.

The other solutions were complementary. To deal with price fluctuations on the TTF, a market adjustment mechanism was adopted by introducing a dynamic price cap for gas (EC, 2022d). The stabilisation of high prices limited the application of this provision; the gas price has not reached the level that would trigger the correction mechanism (EUR 180/MWh) since October 2022. Insufficient level of gas substitution using RES prompted actions that sought to accelerate the construction and connection of RES and heat pumps by streamlining the process for obtaining construction and environmental permits (EC, 2022c).

Despite the challenges, 2022 was a success when it comes to European solidarity and coordination in the gas industry. European countries — often under pressure from Russia, which uses gas to achieve its aggressive political goals — began seeking alternative supply routes. **The gas market underwent a revolution in 2022: sources of supply, flow directions, relations between market areas, prices and consumption volumes changed.** Previously declarative, real diversification has become a necessity. Unfortunately, the neglecting of the development of EU LNG infrastructure in 2014-2021, infrastructural bottlenecks in the gas system, the decrease in production in Algeria and Libya, and the overly slow development of renewable and nuclear energy mean that not all Russian gas has been replaced.

[12] Calculated by PEI based on Eurostat data.

Some of these arrears will be made up in 2023-2028, with the rapid development of RES and the increase in the regasification capacity of LNG terminals in the EU, which is set to double, but this was not possible in 2022. **The reduction in gas consumption in the EU in 2022 amounted to 13% and was, alongside LNG and Norwegian gas, the most important pillar of European security of supply.** However, the construction of a gas supply security system is far from complete. Many solutions are makeshift and temporary, and storage facilities were filled with the help of supplies from Russia, which could be suspended in the future for political reasons, and will make it more difficult to prepare for the next winter. Ensuring sustainable security of supply will be a gradual process, requiring analysis and risk-aware, solidarity-based cooperation between EU countries.

Simulation. Gas security during the winter of 2023/2024 and in coming years

We present the results of a model that seeks to estimate the security of gas supply in Europe during the winter of 2023/2024 and in coming years. It takes into account the various attitudes that countries in the "gas seven" may adopt during the winter season if Russian gas supplies are completely cut off in the long term. The simulations carried out after 2014 by ENTSOG did not provide for the complete cut-off of gas supplies from Russia (ENTSOG, 2017). In the scenarios analysed during this period in line with Regulation 2017/1938, it removed only the single most important element in infrastructure from a given direction of supply. In the case of gas from Russia, this meant that the risks of Russia cutting off supplies via Belarus, Ukraine and Turkey, supplies to the Baltic States, and supplies via the Nord Stream pipeline were analysed separately. Following Russia's invasion of Ukraine and its confrontational actions towards Europe, the risk of supplies to Europe from this direction being halted completely during the heating season has increased significantly. Moreover, the main recipients of supplies from the two gas pipelines from Russia operating in March 2023, via Turkey and Ukraine, were countries in Southeastern Europe, not the countries in the "gas seven". Remaining transmission of Russian gas to Europe can be halted by a political decision of Russian political leadership. It has been assumed that a fall in the supply of Russian LNG will not affect the supply of LNG in the EU significantly. In the current situation, the transmission of gas via pipelines from Russia during subsequent winter periods could be an additional factor increasing security, but for the purposes of this analysis, it should not be treated as a reliable source of supply.

The scenarios were prepared for the period from the start of November to the end of March, with the following assumptions:

Scenario 1. Isolation. No gas transmission between the "gas seven" countries. Countries compete for resources and focus solely on meeting demand among their customers. If possible, surpluses from imports and domestic production are stored at gas storage facilities.

Scenario 2. Competition. Countries send gas between themselves. After meeting local demand, surpluses are sent to countries that cannot meet demand. Surpluses from imports and extraction are divided in proportion to the country's

market power (volume of consumption in a given month). Gas that cannot be shipped is, if possible, stored at gas storage facilities.

Scenario 3. Cooperation. Countries fully coordinate their actions by working together during the winter. Countries with the surplus send it to countries unable to meet demand. Surpluses from imports and extraction are divided in proportion to needs. Countries that expect to have storage facilities over 30% full at the end of March withdraw gas from storage facilities to prevent a forced demand curtailment in other countries.

Scenario 4. Solidarity. In this scenario, the possibility of using solidarity mechanism to protect solidarity protected consumers was tested in two hypothetical, extreme situations: two weeks of extremely low temperatures (cold spell) and the day of peak gas consumption (peak day), proposed by ENTSOG (ENTSOG, 2021). Countries reduce their consumption to support those unable to meet the demand of solidarity protected customers and critical gas-fired power plants.

Scenario 5. Crisis. In this scenario, planned and coordinated sabotage activities were simulated to damage transmission infrastructure and gas storage facilities in the "gas seven" countries. As a result most crucial elements of the system were gradually excluded,during two weeks with extremely low temperatures (cold spell). In the model, infrastructure elements are removed gradually, starting with the most important in terms of balancing consumption during the winter period (N-1, N-2, N-3, ...), until a situation in which a country is unable to meet the demand of solidarity protected customers and critical gas-fired power plants is reached.

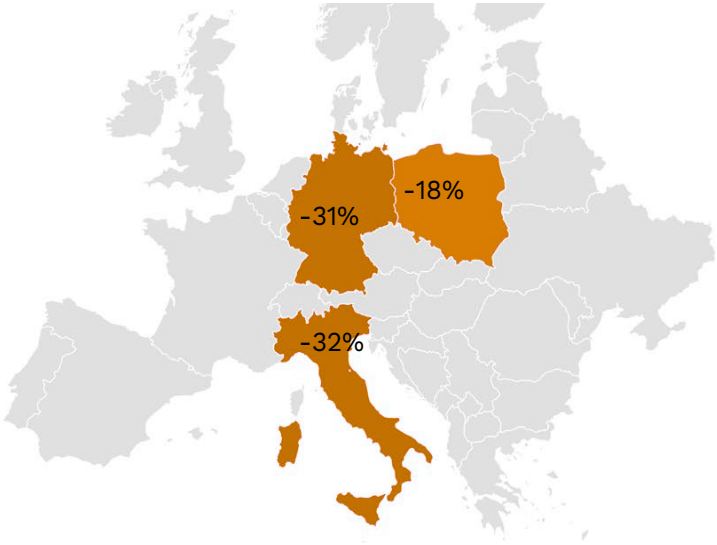
For scenarios 1, 2, 3, the average gas consumption during the 2021/2022 heating season (November-March) was assumed. For scenarios 4 and 5, demand in extreme conditions (two weeks of frost, the day of peak demand) were taken from the ENTSOG supply security simulation in 2021 (ENTSOG, 2021a). "Reduction in demand" means reduction compared to these values. The volume of gas supplies from specific directions and interconnectors' capacity were estimated based on ENTSOG's assumptions (ENTSOG, 2021b), data from the ENTSOG platform (www18) on maximum technical transmission capacity, average physical flows reported on the platform during the 2022/2023 heating season, GIE data on LNG terminals (www19) and Eurostat data. Gas storage facilities' active capacity, the maximum level to which they can be filled, and withdrawal capacity are based on GIE data (www20).

It was assumed that gas storage facilities were 90% full at the beginning of November. The purpose of subsequent calculations was for storage facilities in each country to be filled to the minimum level (30%) at the end of March, enabling them to prepare safely for the next winter, with a relatively small reduction during the summer season (10%). For the calculations related to determining the minimum level of reserves at the end of the heating season, see the Appendix.

Scenario 1. Isolation

In the absence of gas flows between the "gas seven" countries, three (Germany, Italy, Poland) are forced to reduce consumption significantly in the winter. The other countries are able to meet domestic demand and ensure that storage facilities remain more than 30% full at the end of March. In this scenario, Germany is forced to reduce demand for gas by 31% throughout the heating season, Italy by 32%, and Poland by 18%. The significant reduction in Germany and Italy — twice that in 2022 — would be a significant burden on the economy. For Poland, an alternative to reducing consumption would be a hypothetical increase in the use of Baltic Pipe to 100%, or increasing its use to 90% and additional gas imports via the Poland-Lithuania (GIPL) gas pipeline and the Klaipeda terminal, amounting to 30 GWh/d throughout the heating season.

Map 3. Scenario 1. Isolation. Required reduction in gas consumption during the 2023/2024 heating season (November-March) compared to 2021.

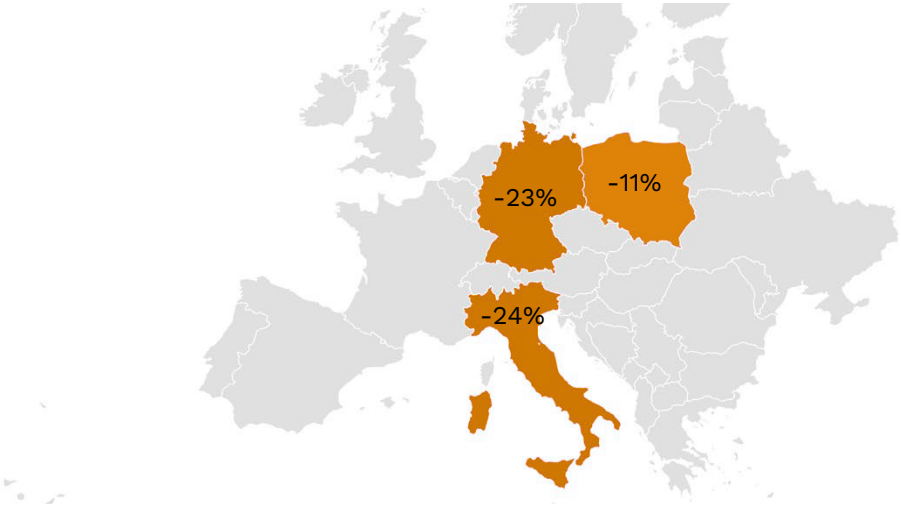


Source: prepared by PEI.

Scenario 2. Competition

The possibility of business transfers of gas enables countries in the "gas seven" to use the surplus imports of Spain, the Netherlands and Belgium, increasing other countries' security. The gas transfer significantly reduces the need to reduce consumption in Germany, Italy and Poland. Not all of Spain's surpluses are imported due to the Spanish-French interconnectors' limited capacity. Transfers are further limited by the lack of a French-Italian gas interconnector, which forces gas to be sent through Switzerland, where the French-Swiss interconnectors capacity is a significant limitation. Significant shortages start to occur when German, Italian and Polish storage facilities are filled below the required 30% level. The response, allowing to avoid the full depletion of stocks is for Germany (23%), Italy (24%) and Poland (11%) to reduce consumption throughout the winter. Like in Scenario 1, Poland can avoid the reduction by increasing the use of the Baltic Pipe to 84% or by increasing it to 75% and gas imports via the Lithuanian terminal in Klaipeda and the Poland-Lithuania gas pipeline (GIPL) of 30 GWh/d.

Map 4. Scenario 2. Competition. Required relative decrease in gas consumption during the heating season compared to consumption during the 2021/2022 heating season



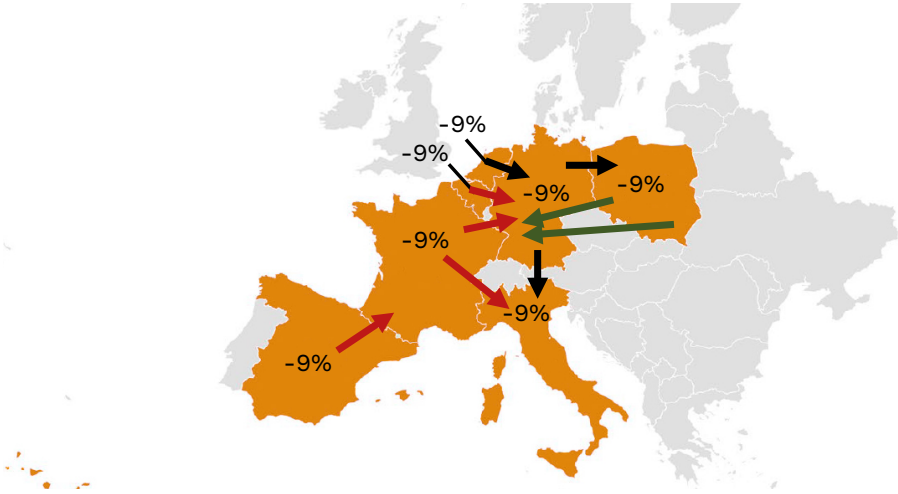
Note: the arrows show the directions of gas flows between "gas seven" countries. The red arrows show where interconnectors have been used to their full extent.

Source: prepared by PEI.

Scenario 3. Cooperation

Coordinated cooperation between the countries in the "gas seven" means adopting a common reduction target for the entire winter. The collective reduction of gas consumption throughout the heating season increases surpluses, which enables more gas to be sent to the countries most in need. Surpluses are divided in proportion to the size of the gas shortages. The next step in the analysis is to redistribute not only import-consumption surpluses, but also transferable stocks above the required minimum in March (30%). This enables greater support for the countries experiencing gas shortages, but also increases the use of interconnectors.

Map 5. Scenario 3. Cooperation. Relative decrease in gas consumption during the heating season compared to consumption during the 2021/2022 heating season



Note: reducing gas consumption in Spain does not affect other countries' ability to cover consumption. The arrows indicate the directions of gas flow between the countries in the "gas seven": red — maximum use of interconnectors, green — gas flow with Poland's increased use of Baltic Pipe and gas imports via the LNG terminal in Klaipeda (this lowers the EU reduction to 8%).

Source: prepared by PEI.

Cooperation between the "gas seven" countries means a reduction of just 9% during the heating season, less than the average gas reduction in the EU in 2022 (13%). **The collective reduction in the "gas seven" countries could be over 30% lower, and amount to just 5% compared to consumption in 2021, if not for infrastructural limitations.** The limited capacity of the interconnectors on the Spanish-French, French-Swiss, French-Belgian, French-German, Belgian-German border and the lack of a French-Italian interconnector significantly reduce how much gas can be sent to Germany and Italy. For this reason, the reduction of gas consumption in Spain does not affect the security of the "gas seven", because — even in the absence of reduction — Spanish

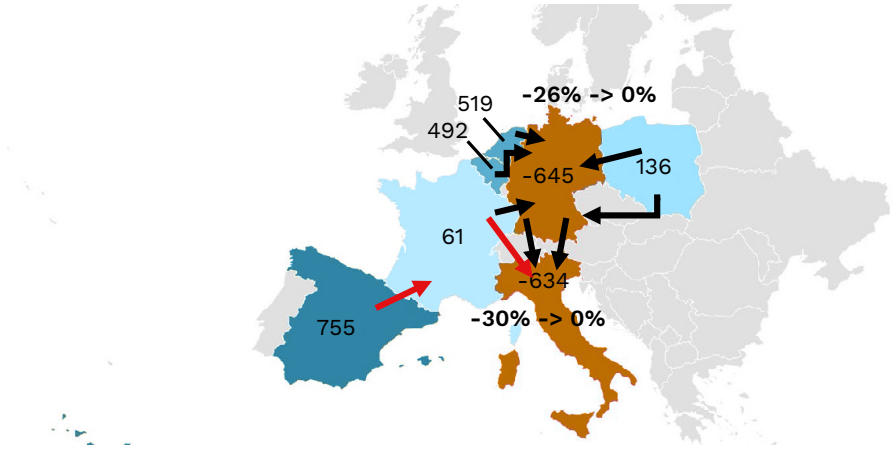
LNG terminals' significant potential surplus regasification capacity cannot be sent to France and on to Germany and Italy.

An additional solution, supplementing the EU reduction, is to increase the use of some of the infrastructure for gas imports. **Poland could slightly lower the EU reduction to 8% by increasing the use of Baltic Pipe's capacity to above 98% and importing 30 GWh/d of gas through the Lithuanian terminal in Klaipeda throughout the winter.** This would make it possible to transfer the storage surpluses obtained (around 100 GWh/d) to Germany via the Czech Republic and Slovakia during the November-February or December-March period

Scenario 4. Solidarity

In both extreme situations — two weeks of extremely low temperatures and a day of maximum gas consumption — Member States are able to meet the needs of solidarity protected customers; this requires reserves at storage facilities. Thanks to their storage facilities' high reception power, the "gas seven" countries are able to independently satisfy not only the needs of their own protected customers, but all customers in general. The exceptions are Italy (a hypothetical reduction of 10%) and Poland (a reduction of 1%); these relatively small shortages can be met by transferring surpluses from other "gas seven" countries without them having to reduce demand.

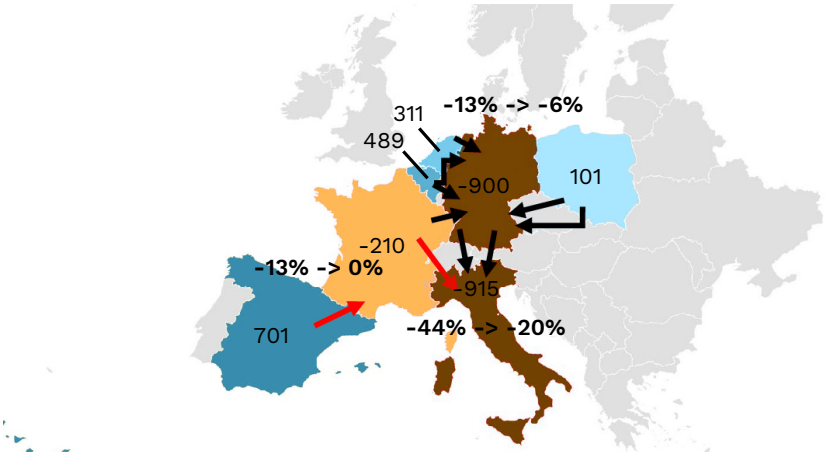
Map 6. Scenario 4. Solidarity. Two weeks of extremely low temperatures. Directions of solidarity-based support if there is a lack of gas at storage facilities (GWh/d)



Note: the arrows show gas flows between "gas seven" countries, red — maximum use of interconnectors.
Source: prepared by PEI.

The situation of the "gas seven" countries is more difficult if the Member States — in particular, the largest consumers, Germany and Italy — do not have any reserves at storage facilities during the extreme situations analysed. **Even with empty storages and two weeks of frost, solidarity-based support from the other countries in the "gas seven" would prevent Germany and Italy from having to reduce the consumption of protected customers and critical gas-fired power plants, reducing Germany's reduction from 26 to 0%, and Italy's from 30% to almost 0%.** Even this rather negligible reduction could be avoided if the Spanish-French, French-German and French-Swiss inter-connectors had a higher capacity or a France-Italy interconnector existed.

Map 7. Scenario 4. Solidarity. Day with maximum use of gas. Directions of solidarity-based support if there is no gas at storage facilities (GWh/d)



Note: the arrows show gas flows between "gas seven" countries, red — maximum use of interconnectors.
Source: prepared by PEI.

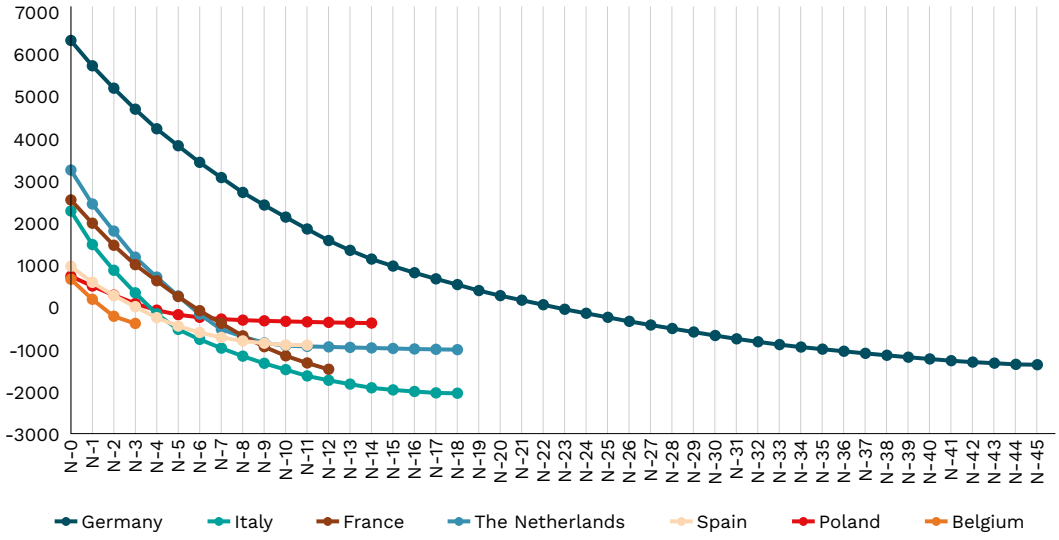
On the day with peak gas demand, Germany, Italy and France cannot meet demand if they do not have gas reserves at storage facilities. It is more difficult to meet the needs of protected customers with empty storage facilities due to higher consumption and smaller surpluses that can be sent to the countries struggling the most. **Despite these challenges, solidarity measures make it possible to significantly reduce the necessary reductions on the day of peak demand, even with empty storage facilities: from 13 to 0% in France, from 44% to 20% in Italy, and from 13% to 6% in Germany.**

However, the lack of reserves at storage facilities in the situations analysed is extremely unlikely, because the winter of 2021/2022 showed that low reserves result in a sharp increase in market gas prices, which limits consumption. Moreover, it is likely that, seeing rapidly shrinking reserves, the "gas seven" countries would have reacted earlier by preemptively reducing consumption. The results of Scenario 4 – full resilience in the presence of reserves and no reduction in most countries, even with empty storage facilities — show that the "gas seven" countries are much better prepared for short-term and intense spikes in demand than long-term supply constraints. Once again, stock management at gas storage facilities is crucial for the security of gas supply in Europe.

Scenario 5. Crisis

According to the data from the Dutch Main Intelligence and Security Service and Dutch Military Intelligence and Security Service, Russia has been mapping EU countries' energy infrastructure, including gas infrastructure, since at least its invasion of Ukraine and is taking preparatory steps to disrupt and sabotage this infrastructure. In this context, a proper analysis of the security of gas supply should take into account not only the damage to one element of infrastructure, but — in the event of escalation — the risk of sabotage conducted *en masse* to fully destabilise the European energy sector. To identify the elements most vulnerable to acts of sabotage, the effects of the disruption of individual elements in the "gas seven" countries' gas infrastructure were analysed.

Chart 18. Scenario 5. Crisis. "Gas seven" countries' ability to meet demand among their own solidarity protected customers and critical gas-fired power plants during two weeks of extremely low temperatures cold spell — despite gas reserves, in situations of the effective sabotage/ failure of key gas infrastructure (GWh/d)



Note: a positive result means a surplus of gas, while a negative result means the need to reduce consumption.
Source: prepared by PEI.

None of the "gas seven" countries base their security on just one element of their infrastructure. A threat to their security of supply would require a coordinated attack on at least several facilities. The results of our model show that **the country with gas system most resistant to sabotage is Germany (N-22). A threat to fulfill supply obligations to solidarity protected customers and critical gas-fired power plants would require the sabotage of as many as 23 facilities.** The other "gas seven" countries are less resistant, with a level of resistance ranging from (N-3) to (N-5). **The country most vulnerable to sabotage is Belgium (N-2).**

Table 2. Scenario 5. Crisis. Infrastructure without which the"gas seven" countries cannot meet the needs of solidarity protected customers and critical gas-fired power plants during two weeks of extremely low temperatures, despite gas reserves at storage facilities

Degree*	Germany	Italy	France	The Netherlands	Spain	Poland	Belgium
N-1	Europipe 2	Transmed	Hauterives	UGS Norg (Langelo)	Barcelona LNG Terminal	Baltic Pipe	Zeepipe I
N-2	UGS Rehden	Fiume Treste	Franpipe	Norpipe (Emden EPT 1)	Medgaz	TLNG Świnoujście	Zeebrugge LNG
N-3	UGS Storage Hub (Bernburg, Bad Lauchstädt)	Minerbio	Chémery	UGS Grijpskerk	Cartagena LNG Terminal	KPMG Mogilno	UGS Loenhout
N-4	UGS Epe Uniper H-Gas	Sergnano	Étrez	Rotterdam Gate Terminal	Huelva LNG Terminal	PMG Wierzchowice	
N-5	Europipe 1	Settala	Dunkerque LNG	UGS Bergermeer	Sagunto LNG Terminal	KPMG Kossakowo	
N-6	UGS Etzel ESE (Uniper Energy Storage)	Rovigo LNG	Montoir de Bretagne LNG	UGS EnergyStock	Bilbao LNG Terminal	PMG Husów	
N-7	UGS Etzel EGL (Equinor Storage Deutschland)	Ripalta	Fos Cavaou LNG Terminal	UGS Alkmaar	Yela	PMG Strachocina	
N-8	UGS Bierwang	Sabbioncello	Lussagnet	EemsEnergy LNG Terminal	Mugardos LNG Terminal	Brońsko gas field	
N-9	Norpipe	Bordolano	Izaute	Groningen gas field	Serrablo	PMG Brzeźnica	
N-10	UGS Epe Uniper L-Gas	Cortemaggiore	Gournay-sur-Aronde	UGS Nüttermoor H-1	Gavota	BMB gas field	
N-11	UGS EWE-Zone L	FSRU LNG Toscana	Manosque	Q10-A gas field		Przemyśl gas field	
N-12	UGS Etzel Erdgas Lager EGL	Panigaglia LNG	Saint-Illiers-la-Ville	Nes gas field		PMG Swarzów	
N-13	UGS Peckensen	Greenstream	Fos Tonkin LNG Terminal	A12-FA gas field		Kościan S. gas field	
N-14	UGS Jemgum H (astora)	Brugherio	Tersanne	L05a-D gas field		Lubiatów gas field	
N-15	UGS Epe Trianel	Collalto	Germigny-sous-Coulombs	A18-FA gas field		Paproć gas field	
N-16	Wilhelmshaven LNG Terminal 1 (FSRU)	Cornegliano	Beynes profond	D12-B gas field		Paproć W gas field	
N-17	UGS Enschede - Epe (Nuon)	San Potito & Cotignola	Céré-la-Ronde	E17a-A gas field		Zalesie gas field	
N-18	Stade LNG Terminal (FSRU)	Cellino	Soings-en-Sologne	G14-A&B gas field			
N-19	UGS Breitbrunn		Saint-Clair-sur-Epte	Warffum gas field			
N-20	UGS Etzel ESE (OMV)		Beynes supérieur	K05a-A gas field			
N-21	Baltic Energy Gate LNG Terminal (Lubmin)(FSRU)						
N-22	UGS Epe (KGE)						
N-23	UGS Uelsen						

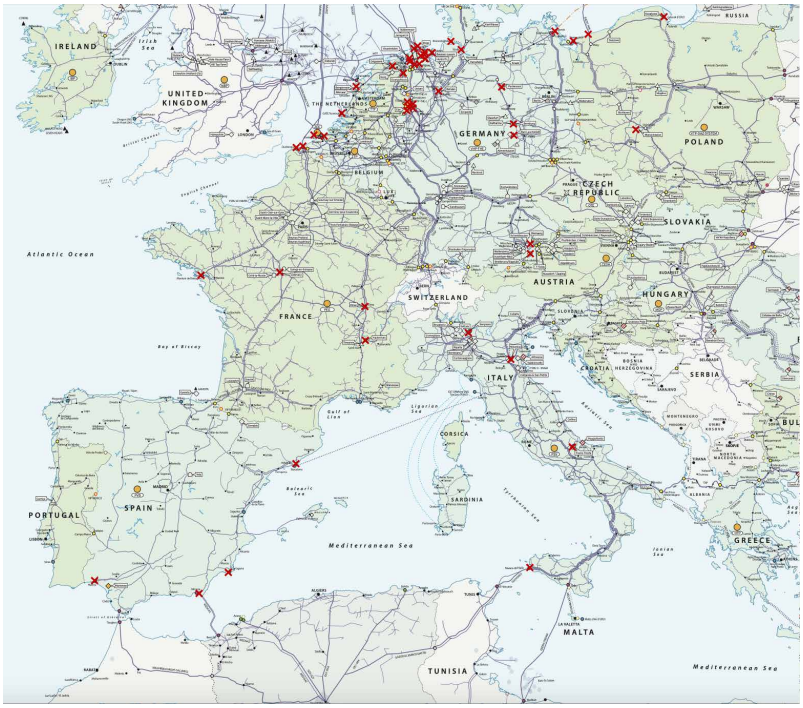
*Degree of gas system's redundancy.

Note: pipelines (marked in orange), LNG terminals (blue), and storage facilities (grey) that must be sabotaged or cease to work to make it impossible meet protected consumers' needs during two weeks of extremely low temperatures.

Source: prepared by PEI.

Ranking the types of infrastructure excluded from the system from the most necessary to the least necessary allows us to conclude that the "gas seven" countries differ significantly, not only in terms of the resistance of their infrastructure, but also in the types of elements key to its proper functioning. **Most of the countries base their security on single gas pipelines supplying gas from Norway (or, in the case of Spain, gas from Algeria) and the largest gas storage facilities.** For smaller consumers, Spain, Poland and France, an attack on LNG terminals is more dangerous, mainly due to these countries' small storage capacity. Unfortunately, the isolation of the infrastructure named here from the rest of the gas transmission system is in many cases an illusion; it cannot function if other elements — gas pipelines, compressor stations and block-and-relief units — are sabotaged, which makes it much more difficult to protect countries against these kinds of actions.

Map 8. Scenario 5. Crisis. Excluding this infrastructure makes it impossible for the "gas seven" countries to cover the needs of protected customers and critical gas-fired power plants during two weeks of extremely low temperatures, despite gas reserves at storage facilities



Note: a red "x" denotes the infrastructure being removed. The results of our analysis were applied to the ENTSOG / GIE System Development Map 2021/22 (ENTSOG, 2021b).

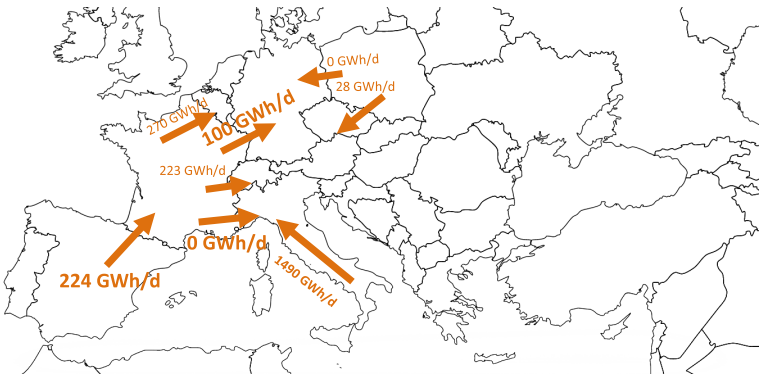
Source: prepared by PEI.

With full storage facilities, Germany — Europe's largest consumer and storage operator — is able to fulifill the needs of solidarity protected customers even when 22 elements of its gas infrastructure are sabotaged, while most "gas seven" countries are no longer able to supply more than 80% of their solidarity protected customers and critical gas-fired power plants. **If six infrastructure facilities in a given country are sabotaged, the distribution of surpluses from Germany enables the consumption reduction among protected consumers in other countries to be almost halved.** In this situation, the additional infrastructure will be interconnectors connecting Germany with Belgium, Poland, France, the Netherlands and connections with Austria and Switzerland (enabling gas transit to Italy). Therefore, the solidarity mechanism in Regulation 2017/1938 applies not only in the event of failure or extreme weather conditions. It also allows gas to be shared in the event of a coordinated attack on gas transmission, storage and extraction infrastructure, increasing the security of the "gas seven" countries and the EU.

Condemned to solidarity? The costs and benefits of cooperation

The simulations above make it possible to identify the main bottlenecks in the European gas transmission system. The top limitation in the system is the inability to make full use of the Spanish LNG terminals' regasification capacity during the winter. The lack of a France-Italy interconnector means that gas transit via Switzerland from France and Germany is very important, too. The low capacity of the France-Germany connection (100 GWh/) means that gas has to flow via Belgium in the absence of Russian supplies and makes it difficult to transfer surplus gas from the Belgian Zeebrugge LNG terminal to Germany. In the extreme situations described in Scenario 4, a limitation is Poland's inability to send gas directly to Germany (the Yamal pipeline is a transit pipeline and only enables gas to be sent from the Russia-Belarus direction), forcing it to send gas to Germany via the Czech Republic and Slovakia.

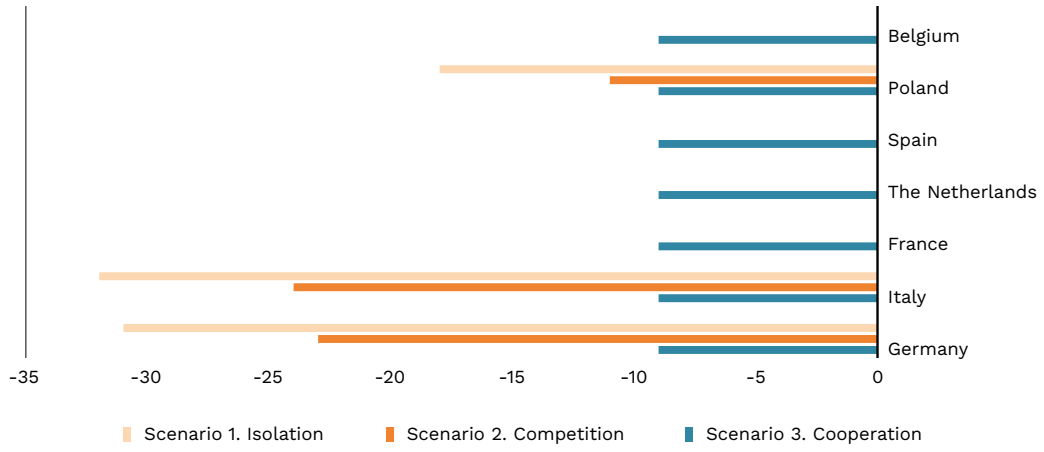
Map 9. Bottlenecks in the European transmission system (GWh/d)



Source: prepared by PEI based on its analysis.

Cooperation between all the countries in the "gas seven" (Scenario 3) would make it possible to avoid significant reductions in demand in Germany and Italy and limit the reduction of demand in Poland, but it requires France, the Netherlands, Spain and Belgium to partially sacrifice their own particular interests and limit consumption. While isolation (Scenario 1) does not pay off for any of the countries, their attitude to competition (Scenario 2) and cooperation (Scenario 3) is much less clear. Countries which, with their own LNG terminals and storage facilities, can meet demand without reducing consumption must choose to reduce demand in a coordinated way, which will increase gas prices for consumers, especially industrial ones. One solution would be financial compensation. However, it is difficult to assign a value to risks with a low probability of occurrence and very high, but unspecified costs. The effects of high prices and top-down demand reduction would require in-depth analysis. However, for France, the Netherlands, Spain and Belgium, top-down demand reduction is certainly much more costly than counting on market-based reduction. Market reduction, like that in the power sector in 2022, does not have to occur because the demand for energy products is not always elastic. In the scenarios above, the position of Poland — which could avoid a reduction in consumption in Scenarios 1 and 2 if it managed to increase the use of the Baltic Pipe gas pipeline to 90% and stabilise gas imports through the Lithuanian terminal in Klaipeda at a level of at least 30 GWh/d.

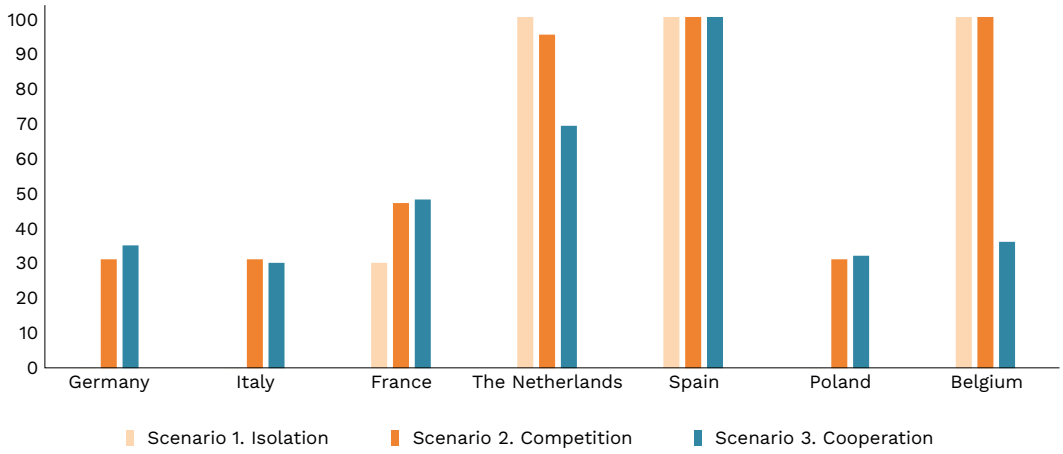
Chart 19. Required reduction in gas consumption in the "gas seven" countries during the November-March period compared to average consumption in 2021/2022 (%)



Source: prepared by PEI.

Compared to a collective reduction in demand, it could be even more difficult for the Netherlands, Belgium and Poland to coordinate giving up some of the reserves that constitute their energy security. Reducing the reserves could mean that the crisis will drag on for the next few years. However, in this situations and others, EU countries' decisions should, in accordance with the Treaty, be made in a spirit of solidarity (TFEU, Art. 194(1)). One of the key elements of solidarity between Member States is the fair sharing of burdens and responsibilities between all of them in crisis situations (CJEU, 2017a). Solidarity is not an abstract principle, but one of the fundamental values of the EU, and it "regulates the entire Union policy in the field of energy" (CJEU, 2019a). Cooperation, not competition, makes the EU values real within the "gas seven" in the winters to come.

Chart 20. Filling of storage facilities in the "gas seven" countries at the end of March 2024 in individual scenarios (%)



Source: prepared by PEI.

Juxtaposing the results of the simulation with the plans to create new regasification capacity at LNG terminals allows us to determine the time horizon of the main challenges faced by the "gas seven" countries and Europe in the face of limited Russian supplies. The rapid construction and expansion of LNG terminals in 2023-2027 will allow the EU countries to gradually reduce the need to lower consumption. The total value of the new regasification capacities that will be built in Germany and Italy by 2027 (2024 in a more optimistic scenario) significantly exceeds the necessary reductions, which means that Europe can emerge from the crisis by expanding the necessary infrastructure.

Table 3. Average daily reduction in gas consumption required during the November-March period (GWh/d) and planned addition of new LNG regasification capacity in 2023-2027

Country	Scenario 1. Isolation	Scenario 2. Competition	Scenario 3. Cooperation	New LNG regasification capacity by the end of 2024	New LNG regasification capacity by the end of 2027
Germany	-1172 (31%)	-870 (23%)	-340 (9%)	354	925
Italy	-951 (32%)	-713 (24%)	-267 (9%)	1823	1823
France	N/A	N/A	-176 (9%)	127	197
The Netherlands	N/A	N/A	-109 (9%)	43	43
Spain	N/A	N/A	-108 (9%)	227	274
Poland	-130 (18%)	-80 (11%)	-65 (9%)	78	254
Belgium	N/A	N/A	-61 (9%)	0	0

Source: prepared by PEI.

Recommendations

The "gas seven" countries need each other, especially in times of crisis. Isolation is bad for everyone, but the choice between competition and cooperation can be much more difficult. In any crisis, there is a risk that the group will be dominated by cynical "free riders" who use collective effort to achieve particular goals, and the only solution available to the group is to punish or ignore them (Straffin, 1993). However, research shows that if managing common goods meets certain conditions — such as clearly defined boundaries, legitimate and proportional rules, jointly agreeing on actions, monitoring actors, gradable penalties, conflict resolution mechanisms and the ability to embed solutions in a broader institutional context — cooperation can survive and the collapse of the community is not inevitable (Ostrom, 2015). Cooperation between the "gas seven" countries will limit the effects of the crisis if it is based on these kinds of mechanisms, deeply rooted in European solidarity. The recommendations below seek to introduce mechanisms in the European gas supply security system that would streamline and support cooperation in a systemic manner.

Recommendations for adapting the European gas sector to the current crisis:

- Gas consumption should be permanently linked to the security level of the gas supply system. Mechanisms should be created at the national level to permanently link the increase in the consumption of strategic raw materials, such as natural gas, to the development of infrastructure for diversifying supplies and storage; for example, through the adoption of additional minimum security requirements, adopting indicators permanently linking the increase in consumption with the increase in the possibility importing and storing gas during a specific timeframe (such as a ratio of at least 0.9 within 5 years). Countries subject to EU sanctions should not be considered an optimal partner in the process of diversifying supplies.

- High gas prices, which were felt by customers, turned out to be an effective incentive to reduce consumption in 2022. Any interference in the functioning price mechanisms should take into account the challenges related to the security of gas supply, in particular its availability, which the Member States will face in the coming years. Direct support programmes for protected customers should take into account the negative effects of transfers, which increase consumption and reduce the security of gas supply for all customers. An alternative course of action are programmes that support a long-term reduction in energy consumption, primarily by increasing energy efficiency.

- In the coming years, efforts should be made to gradually reduce gas consumption by solidarity protected customers and critical gas-fired power plants. The high share of gas in the energy mix significantly limits the ability to meet other consumers' needs in a crisis.

Recommendations concerning gas infrastructure:

- LNG terminals were the main way to replace Russian gas in 2022. The development of LNG infrastructure in Central Europe in 2023-2028 sets the timeframe for the EU's emergence from the energy crisis. **These projects should have the highest priority in the coming years.** Efforts should be made to ensure that potential barriers that might hamper these plans, such as difficulties in obtaining permits or challenges relating to financial liquidity, do not cause delays in construction and expansion.

- The experience of 2022 shows that, while RES are the key to a sustainable future, they are unable to replace enough gas rapidly enough due to the time it takes to complete new projects. Even assuming that the process of granting RES grid connections, environmental permits, and other administrative and regulatory measures could be made as simple as possible, **in the short term (2023-2027), the potential of existing fossil and nuclear fuels should be used to achieve full independence from commodities from Russia and ensure energy security. However, the implementation of the target decarbonisation model should not be forgotten.**

- The analysis above enabled us to identify the bottlenecks in European gas infrastructure. **The Spanish-French interconnectors' insufficient capacity, the lack of a France-Italy interconnector and the low capacity of the French-Swiss, French-German, French-Belgian and Polish-German interconnectors** prevent LNG from being used to its full potential during the crisis and reduce Europe's energy security.

- Electricity transmission using existing infrastructure could potentially be a partial, albeit imperfect, substitute for gas transmission; for example, to Italy, which uses gas intensively to produce electricity. Increasing this transmission should be the subject of joint analysis and cooperation between the transmission system operators and governments of France, Spain, Germany and Italy.

Recommendations concerning EU security:

- Almost half the infrastructure crucial for European security of gas supply is located in the southern part of the North Sea. Developing cooperation between Belgium, France, the Netherlands and Germany when it comes to gas infrastructure security will have a significant impact on the stability of the energy sector throughout the EU.

- The decrease in imports of Russian gas via pipelines should not be replaced by an increase in imports of Russian LNG. Member States should make every effort to replace imports of Russian gas, which Moscow is using to finance the invasion of Ukraine, with gas from other sources.

- Due to its relative territorial dispersion, central location and significant capacity, Germany's storage infrastructure will play an important role if European gas infrastructure is sabotaged *en masse*. Its importance — not only for Germany, but also for most of the "gas seven" countries— may be an additional incentive to improve its protection.

Recommendations concerning cooperation between EU Member States and solidarity-based support mechanisms:

- The solidarity between Member States should be a fundamental principle for the "gas seven" countries, not only in emergencies, but also when planning, developing and managing infrastructure for regasification, gas transmission and storage. Projects that violate this principle, such as Nord Stream 2 in the past, should not be implemented at all, as they lower Europe's gas security. Identifying and analysing potential risks to energy security should be systematically included in the process of building key gas infrastructure at the regional level.

- In our model, **cooperation between the "gas seven" countries has a more positive impact on the security of gas supply than competition, which is itself much more beneficial than Member States' isolation.** Not all countries benefit from cooperation in the same way, which may become a barrier to cooperation in a crisis. **A realistic solution may be transfers of benefits, compensating the countries with the most developed infrastructure for importing LNG and non-Russian gas for the opportunity costs, in proportion to their impact on Europe's gas security.**

- The implementation of the European Commission's plan for filling storage facilities has shown that **less ambitious, but measurable, binding and enforced targets are better than soft commitments and suggestions.** Gas security, including in the area of joint purchases, should be developed while enforcing minimum security requirements for EU countries, presented as transparent indicators that can be understood by the public.

- The adoption of basic requirements at the EU level concerning security of supply is more effective than relying on bilateral arrangements between Member States.

- Countries should consider using solidarity mechanisms and binding commitments to reduce consumption and foster cooperation, already when filling storage facilities, to anticipate a potential crisis during the winter.

- The security of gas supply in the EU is now largely dependent on effective cooperation with Norway and Switzerland. Including these countries in the European gas supply security system as fully as possible or developing

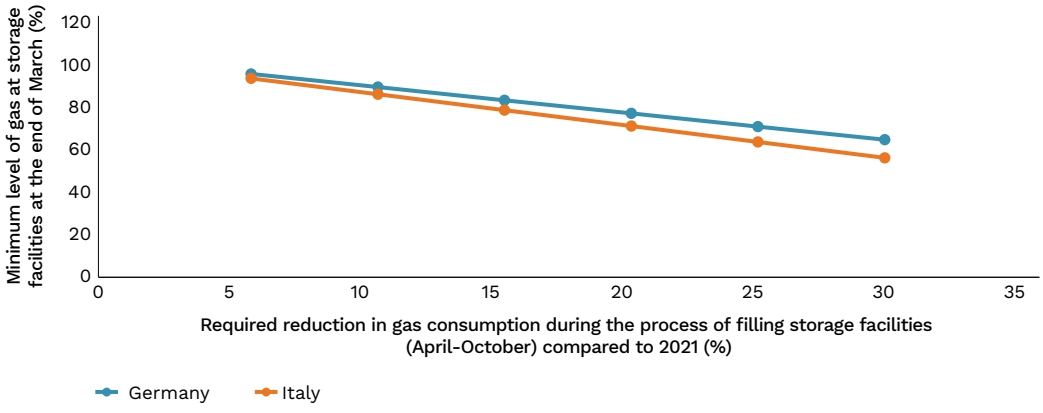
infrastructure limiting this dependency should be the next step after becoming independent from Russia. A potential way to further strengthen the security of supplies in the EU may be cooperation with Britain, provided that its storage capacity is increased.

Appendix

Required level of reserves at storage facilities at the end of the heating season

Filled gas storage facilities are fundamental to energy security, providing additional resources in the event of high demand or supply disruptions (EC, 2022e). Apart from Spain, which has a significant surplus when it comes to LNG terminals' regasification capacity, the "gas seven" countries cannot meet demand in the winter months unless they amass reserves over the summer. The mild winter of 2022/2023, the reduction in consumption in 2022 (13% y/y), and the continuation of some supplies from Russia meant that ensuring that storage facilities are 90% full on 1 November 2023, up from 55.6% at the end of March, should be less demanding than usual. However, the opportunities to fill storage facilities during the summer are not unlimited. **Reserves should not be used completely during the heating season. For individual countries, an exceptionally low level of gas in storage facilities can be defined; the Commission suggests a level of 30% for the entire EU). Going below this level at the end of March may make it very difficult to reach 90% at the start of November.** Determining the minimum level to which storage facilities should be filled at the end of the winter determines what percentage of reserves can safely be used during the heating season.

Chart 21. Minimum level of gas in storage facilities in the "gas seven" countries at the end of March 2024 that would enable them to be 90% full on 1 November 2024 in the absence of gas transfers between countries (%)



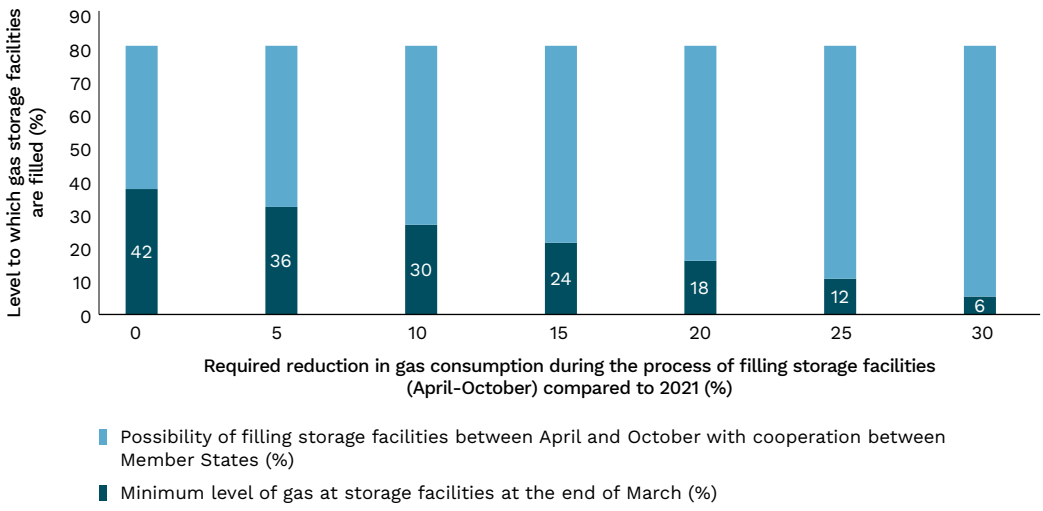
Note: France, The Netherlands, Spain, Poland and Belgium will be able to fill their storage facilities without having to reduce demand.

Source: PEI's analysis based on AGSI GIE, ALSI GIE, Eurostat and ENTSOG data.

Most of the countries are able to go from gas storage levels of 0% in March to 90% in November without cooperating with their neighbours. **Until the LNG infrastructure for Germany, Italy and Poland is expanded, their storage facilities can only be filled through cooperation with Belgium, the Netherlands, France and Switzerland.** For Germany and Italy, an alternative to cooperation is a radical reduction in consumption (above 30%).

In the case of Poland, an alternative to reducing gas consumption would be to import gas imported through the Lithuanian LNG terminal in Klaipeda via the Poland-Lithuania pipeline and increase the use of the Baltic Pipe gas pipeline. Increasing the latter to 90%, combined with gas imports of 30 GWh/d from Lithuania, during the period when storage facilities are filled would mean a minimum level of gas at storage facilities at the end of March of 32% for Poland (without reducing consumption) — or 20% (with a 5% reduction) or 8% (with a 10% reduction). In other situations, not only Germany and Italy, but also Poland are definite beneficiaries of both business exchange and cooperation between Member States when filling gas storage facilities.

Chart 22. Minimum level to which storage facilities in the "gas seven" countries are filled at the end of March 2024 enabling them to be 90% full on 1 November 2024, with cooperation between Member States (%)



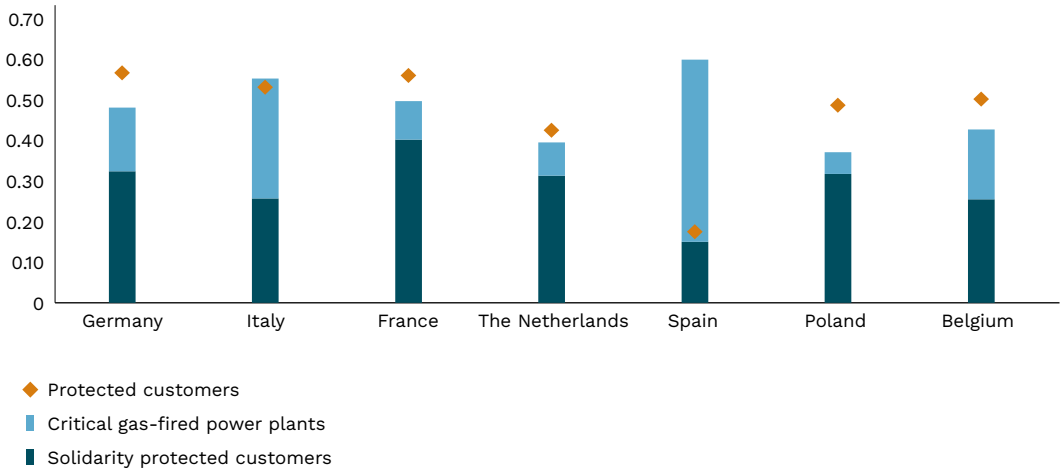
Source: prepared by PEI based on AGSI GIE, ALSI GIE, Eurostat, ENTSOG.

Cooperation between the "gas seven" countries and a joint commitment to reducing gas consumption by 10% enable all the countries to meet the 90% target for the level of gas at storage facilities by the end of October. This reduction is slightly lower than that achieved in 2022 (13%), for which

the minimum level of gas at storage facilities is 27%. In the model, we assumed a minimum level of 30% at the end of March for Member States.

The "gas seven" countries represent a very different approach to the problem of security of supply and protecting of the most vulnerable groups of recipients. The definitions of protected customers (defined by each member state) and solidarity protected customers (in theory, a common definition within the EU) are set out in countries' Preventive Action Plans and Emergency Plans (EC, 2017). Some countries define protected customers relatively broadly, including SMEs (which consume around 15-20% of gas), but this is not always the case (Spain). Most countries (France, The Netherlands, Poland and Italy) make consumer protection dependent on a certain maximum level of consumption, which is inconsistent with the current CJEU case law (2016b). In their analyses, countries also include critical gas-fired power plants (EC, 2017), where demand for gas was determined depending on the structure of electricity generation in individual Member States (EC, 2022b). **Differences in the share of the most protected customers and gas power plants in gas consumption range from 37% (Poland) to 60% (Spain), and the share of gas in the electricity generation mix is of fundamental importance.** The estimated share of solidarity protected customers and critical gas-fired power plants in gas consumption was used in Scenarios 4 and 5.

Chart 23. Estimated share of solidarity protected customers and critical gas-fired power plants in gas consumption in the "gas seven" countries



Source: prepared by PEI based on the preventive action plans and emergency plans of Germany, Italy, France, the Netherlands, Spain, Poland and Belgium, ENTSOG SoS simulation 2021, Regulation 2017/1938 and Regulation 2022/2576.

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