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THE EUROPEAN ENERGY CRISIS AND THE CONSEQUENCES FOR THE GLOBAL NATURAL GAS MARKET

by Simone Emiliozzi*, Fabrizio Ferriani* and Andrea Gazzani*

Abstract

The Russian invasion of Ukraine in February 2022 led to severe disruptions in the European gas market, with significant repercussions on a global scale. The conflict caused a surge in energy prices, a major reshuffling of global natural gas flows, and a shift in the policy-makers' agendas towards energy supply security. This paper describes the global gas market and analyses the consequences of the war, focusing in particular on the European gas market and on global LNG trade flows. We first review the characteristics of the gas market in terms of both pricing benchmarks and contractual terms. Next, we analyse the changes to LNG and natural gas production, consumption, and trade flows throughout the 2022-23 energy crisis. Finally, we review the main policy response to the energy crisis and present some considerations on the gas market outlook.

JEL Classification: L95, P28, Q35.
Keywords: natural gas, energy crisis, LNG, fragmentation.
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Contents

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1 Introduction [1]

The Russian invasion of Ukraine on February 24, 2022, constituted a significant breach of the global geopolitical order and of national sovereignty, with profound economic consequences that extended well beyond the direct effect of the war. These include, among others, a marked deterioration of the world macroeconomic outlook (Di Bella et al., 2022, Garicano et al., 2022, Guenette et al., 2022, Liadze et al., 2023), trade disruptions (Borin et al., 2022, World Bank, 2022, Darvas and Martins, 2022, WTO, 2023), and strong shockwaves on financial and commodity markets (Ferriani and Gazzani, 2023a, Boungou and Yatié, 2022, Adolfsen et al., 2022, Izzeldin et al., 2023).

In this study, we focus on one of the key consequence of the war on energy commodity markets: the reshaping of the global energy flows, with a specific emphasis on the changes in the global natural gas market. Before all else, it is crucial to first recognize the significance of Russia in the world energy market.[2] Russia is the world's second-largest natural gas producer after the United States and has the largest global reserves of natural gas. Moreover, it historically has surpassed all other nations as a gas exporter, with nearly double the exports of the second-ranking country, Qatar. In 2021, just before the start of the war, Russia's natural gas production reached 762 billion cubic meters (bcm), approximately 18% of the global output; its exports via pipeline amounted to approximately 210 bcm. In the same year, its exports of liquefied natural gas (LNG) were around 40 bcm. The prominence of Russia as a global energy player also extends to oil. The country stands among the top three global crude oil producers, alongside the United States and Saudi Arabia. According to data from the International Energy Agency (IEA), as of 2021 Russia's crude oil output

[1] We thank Riccardo Cristadoro, Filippo Favero, Andrea Stegher, Marco Taboga, Giovanni Veronese, and participants at Bank of Italy's internal meetings for their suggestions. The views expressed in the paper are those of the authors and do not involve the responsibility of the Bank of Italy.

[2] See the IEA website at https://www.iea.org/articles/energy-fact-sheet-why-does-russian-oil-and-gas-matter for further details.

amounted to 10.5 million barrels per day (bpd), accounting for roughly 14% of the global supply, of which around 4.7 bpd were exported abroad. Unsurprisingly, this pivotal role in the global energy markets holds significant implications for the Russian federal budget, given that approximately 45% of its revenues stem from oil and natural gas.

Global energy prices had been steadily rising in 2021, reflecting several factors. These include long-term drivers, such as the enduring under-investment policies in fossil fuels (IEA, 2022), as well as more cyclical drivers like energy market tightness following the post-pandemic recovery, and weather-related events affecting both electricity demand and generation in Europe. At the end of the summer 2021, as the first signs of Russia's weaponization of its natural gas exports to Europe materialized, gas prices rose rapidly amid concerns for adequate gas supplies for the winter season.[3] These concerns became more salient in response to the Nord-Stream II pipeline approval standoff, temporarily driving up EU gas prices, which spiked at record levels at the end of the year. The start of the conflict in February 2022 caused widespread disruptions in global energy markets (see Table 1 for a timeline of the key events related to the energy crisis), the effects of which immediately reverberated through energy prices. Following the invasion, Brent oil prices rose above 120 dollars per barrel and the European gas price benchmark TTF (Title Transfer Facility) surged to over 220 euros per MWh, with the latter figure being significantly higher than pre-2021 quotes but still far from the maximum of around 340 euros per MWh (Figure 1) reached during the summer of 2022.

The effects of the conflict, however, were not limited to energy prices; they also encompassed energy quantities and led to a geographical reconfiguration of global gas and oil trade flows. This was particularly evident in the European market due to its higher reliance on fossil fuel imports from Russia.[4] In fact, at the end of 2022, G7 countries and

[3] See `https://www.ft.com/content/82431e87-c8b9-435f-9bc6-482ed05ab535`

[4] In the rest of the paper, and without loss of generality, we will not explicitly differentiate the UK from the rest of the European Union Member States.

Date	Event
21/09/21	IEA urges Russia to ramp up gas supply to Europe
27/10/21	President Putin orders Gazprom to fill Europe's gas storage only after Russia completes the filling of its own stocks
22/02/22	Germany halts certification of Nord Stream 2 pipeline
24/02/22	Russia invades Ukraine
8-10/03/22	Canada, UK, US announce ban on oil and petroleum products from Russia
31/03/22	Russia introduces mandatory ruble payments for natural gas sold to "unfriendly" countries
27/04/22	Poland and Bulgaria are the first European countries cut off from Russian gas
18/05/22	EU launches the REPowerEU plan to reduce dependence on Russian fossil fuels, promote energy savings and accelerate clean energy transition
3/06/22	EU announces an import ban on Russian seaborne crude oil and petroleum products
8/06/22	Fire at Freeport terminal impairs US LNG export capacity
14/06/22	Gazprom implements a reduction of gas supply via the Nord Stream 1 pipeline to 40% of its capacity
11/07/22	Nord stream 1 interrupts flows for a 10 day period for annual maintenance
26/07/22	EU member states agree on a voluntary reduction of natural gas demand by 15% during the 2022/23 winter season
27/07/22	Gazprom announces Nord Stream 1 gas flows to drop to 20% of its capacity
26/08/22	European natural gas benchmark TTF reaches a record high value of 339 €/MWh
1/09/22	Gazprom announces indefinite shutdown of Nord stream 1 pipeline
26/09/22	Nord stream 1 and 2 pipeline explosions and gas leaks
5/10/22	OPEC+ announces a 2 mln barrels a day production cut
5/12/22	G7 countries introduces a 60 USD/barrel price cap on Russian seaborne crude oil
19/12/22	EU agrees on the introduction of a price cap for natural gas at 180 €/MWh
5/2/23	G7 countries introduce a 100 USD/barrel price cap for premium-to-crude products and a 45 USD/barrel cap for discount-to-crude products.
31/03/23	At the end of the European winter season, TTF benchmark quotes at 48 €/MWh, EU gas storage stands at 56%

Table 1: Timeline of the energy crisis.

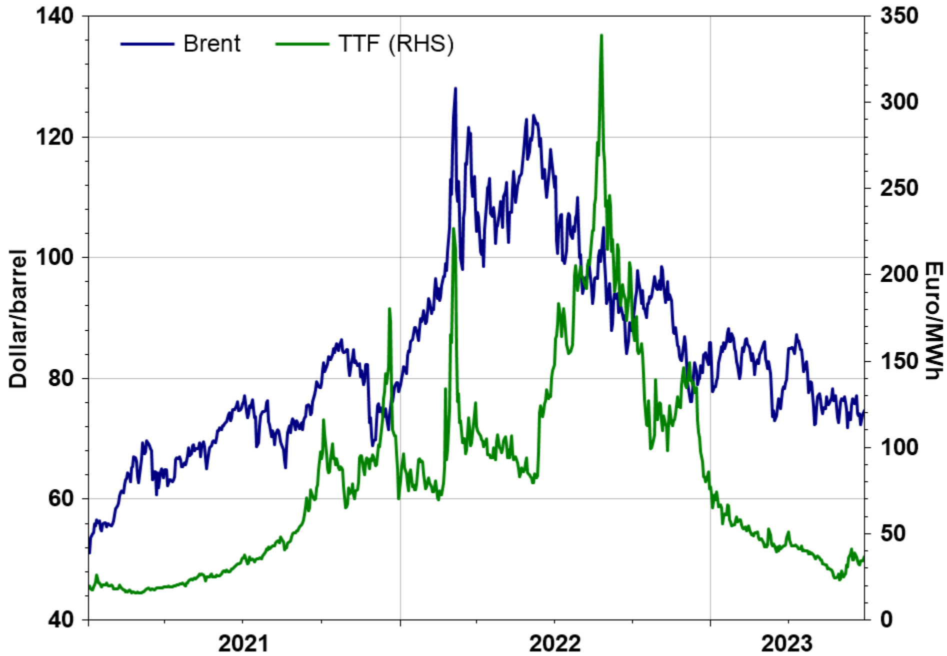


Figure 1: Energy prices dynamics, 01/01/2021-30/06/2023. Source: Refinitiv.

the European Union (EU) imposed an embargo on Russian seaborne crude oil, which was gradually redirected to other destinations, notably India, China, and Turkey. Regarding natural gas, the Russian supply toward its primary destination market, Europe, was gradually reduced in response to Western sanctions. At the same time, LNG emerged as a significant new player in the global gas market. It replaced a substantial portion of Russian pipeline exports to Europe, fundamentally changing the gas market from a regional and segmented structure into a more integrated global market (see Section 4 for further details).

Although the impact of the war on the energy market reverberated globally, it was particularly pronounced in Europe. In 2021, Russia was the primary European provider of both natural gas and crude oil imports, accounting for 44% and 28% of the total extra-EU imports respectively (Eurostat, 2023). This dependence exhibited significant heterogeneity across European countries, however, due to different energy mixes, the extent of energy commodity interconnection with Russia, the availability of alternative energy sources, and the degree of gas utilization in industrial production in each country (Ferriani and Gazzani, 2023a, Borin et al., 2022). Moreover, in Europe, the impact on the natural gas market also extended to the electricity market, owing to the use of natural gas as a marginal source for electricity generation and for price formation, given the auction mechanism for the final electricity price. Therefore, high prices in the natural gas market also inflated prices in the European electricity market, intensifying concerns about the competitiveness of European businesses in comparison to other regions with access to comparatively more affordable energy sources (European Commission, 2023, Bialek et al., 2023, Ferriani and Gazzani, 2023b). Considering these circumstances and maintaining a global perspective, this study will focus on the characteristics and consequences of the global reshaping of energy markets, with a specific emphasis on Europe, taking into account the acute impact of the energy crisis on the continent.

The rest of this paper is organized as follows. Section 2 introduces the structure of the natural gas market, including its main characteristics in terms of pricing benchmark and contractual features. Sections 3 and 4 respectively present recent trends in LNG production and LNG flows. Section 5 focuses on natural gas flows to Europe and Italy. Section 6 describes European natural gas consumption patterns during the energy crisis, and Section 7 concentrates on natural gas storage. Section 8 reviews the main policy response adopted to mitigate the effects of the energy crisis. Finally, Section 9 concludes by offering some policy implications.

2 Structure of the natural gas market

The global consumption of natural gas has increased six fold since 1965, twice as fast as that of coal and oil (Figure 2, left hand side panel), mainly because of competitive prices

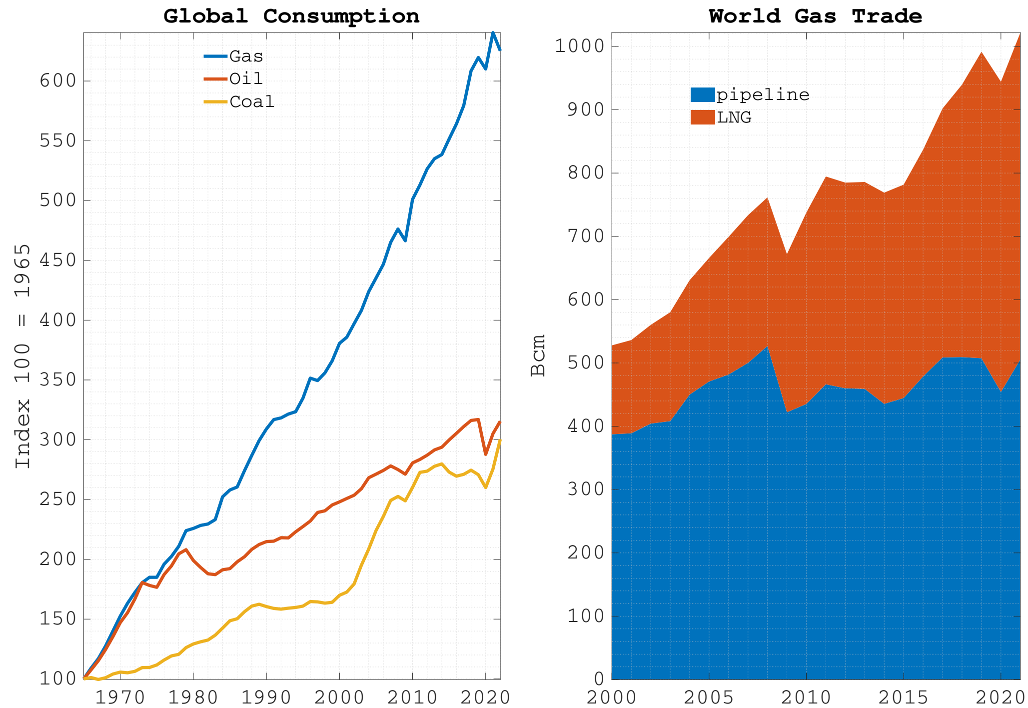


Figure 2: Natural gas consumption and trade. *Source:* Energy Institute (2023).

and a lower environmental impact.[5] Natural gas has a relatively low energy density – at normal temperatures the same volume of crude oil provides 1000 times more energy – and it can be moved via pipelines or as LNG. Whilst pipelines have dominated international gas trade for a long time, LNG exports - thanks to technological improvements in transport - have more than tripled since the beginning of the century and account nowadays for about half of total trade (Figure 2, right hand side panel). This has been driven by particularly strong growth in demand for gas in the East Asian markets (Japan and China). Gas trade by pipelines requires large initial capital investment (90-95% of total project costs) but it is then subject to large economies of scale since variable costs are minimal compared to the initial expenditure (5-10% of total project costs). Obviously, pipelines do not allow flexibility in redirecting gas flows according to market conditions, as the route is fixed. For this reason,

[5]For the same energy produced, the carbon dioxide produced by burning natural gas corresponds to 25-30% less compared to petroleum products and 45% less compared to coal, see https://www.eia.gov/environment/emissions/co2_vol_mass.php.

they were traditionally accompanied by long-term contracts that would protect the initial investment.

LNG has much greater versatility in directing flows according to market conditions. However, it requires cooling down methane to reduce its volume and to allow its loading on specialized LNG carriers that have to maintain a low temperature. The LNG value chain consists of three main stages: i) liquefaction; ii) transportation via dedicated LNG carriers; iii) regasification. The LNG market is characterized by three types of delivery options: a) free-on-board (FOB): when the delivery takes place at the loading port and the buyer carries the obligation and cost of transportation; b) delivery ex ship (DES): when the delivery takes place at the unloading port and the seller carries the obligation and cost of transportation; c) costs, insurance and freight (CIF): when the buyer takes title and risk of the LNG at the loading port, but the seller carries the obligation and cost of transportation. As costs increase disproportionately with distance for pipeline vis-à-vis LNG, the latter is typically employed for global trade while pipeline is confined to regional trade.

In recent years, the growth in fossil fuel consumption, especially for natural gas, has not been matched by investment in natural gas production. Figure 3 shows that after the shale revolution that led to a peak in oil and gas extraction in 2014, investment in fossil fuels dropped in the following years. There are several reasons for this. First, the green transition reduced the incentives for fossil fuel investment which, given the vast initial capital costs, requires assurance of long-term sustained demand. Secondly, in the aftermath of the oil price collapse of 2014-16, capital-constrained firms within the exploration and production sector in the US progressively reduced their capital expenditure, prioritizing balance sheet discipline and debt repayment (Ferriani and Veronese, 2022). Third, the Covid-19 containment measures negatively impacted investment by reducing maintenance activity and delaying the exploration of new gas fields.

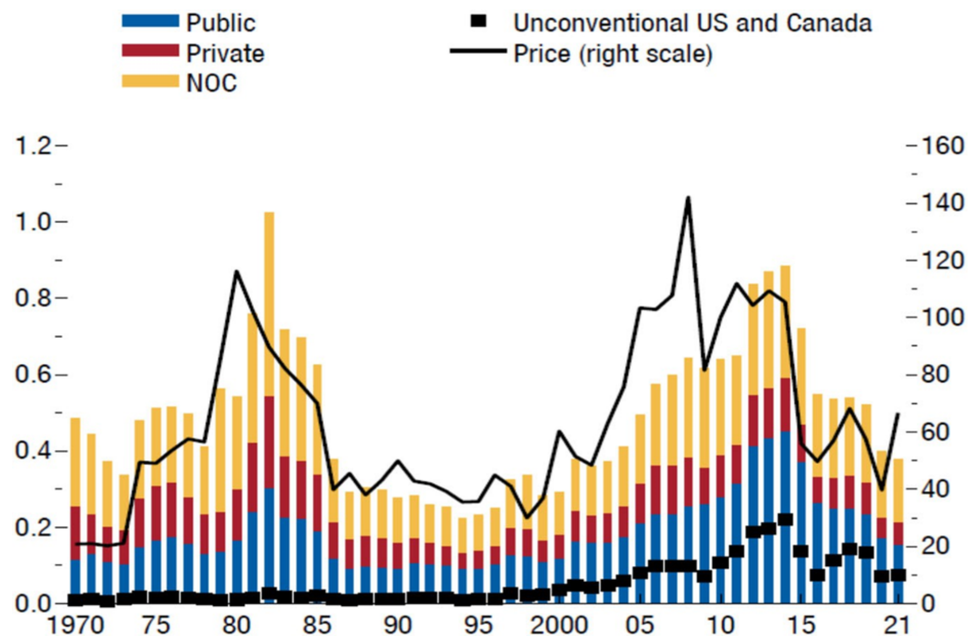


Figure 3: Investment in oil and gas as % of world GDP. *Source*: IMF, WEO Apr. 2022. *Note:* left scale = Percent (investment); right scale = price in USD/barrel.

2.1 The natural gas hubs

Gas prices are typically set in regional hubs, which are marketplaces where gas is exchanged, either in a grid (virtual) or in a physical hub (a single transit point). A *virtual gas-trading hub* provides a trading platform defined through a pipeline grid (interconnected pipelines with no point of origin or end) that can be country-specific or transnational and is typically adopted by countries or areas that mainly rely on imported natural gas. All gas within the virtual hub can be traded irrespective of its actual physical location. Individual buyers and sellers can book different quantities for entry and exit into the system without a predetermined destination, thus increasing the flexibility and ease of trading with respect to a physical hub. Conversely, in countries that mainly rely on domestic production for their consumption needs (i.e. the US), the gas market is structured in *physical hubs*, where several pipelines connecting buyers and sellers converge and serve as a transit point for transportation.

The Title Transfer Facility (TTF) in the Netherlands (EU), the Henry Hub (HH) in the

US, the National Balancing Point (NBP) in the UK are the most liquid hubs in the world. In Asia, a key benchmark is the Japan Korea Marker (JKM), a proxy calculated by commodity data provider *Platts* on the basis of trading activity. JKM reflects the spot market value of cargoes delivered ex-ship (DES) into Japan, South Korea, China, and Taiwan; the cost of liquefaction and transportation is covered by the seller. Deliveries into these locations used to represent by far the largest share of global LNG demand prior to 2021; however, since the start of the war in Ukraine, the EU has acquired an increasingly central role as LNG consumer and a European LNG benchmark has emerged (North West Europe LNG).

2.2 Arbitrage and spreads

Despite the increasing global dimension of the gas market, segmentation into regional markets driven by physical and contractual constraints remains a relevant feature. LNG trade flows can be constrained by the liquefaction capacity, the availability of dedicated LNG carriers, the presence of regasification terminals, and by the large share of the market already taken by long-term contracts on the LNG side (see Section 2.3). For natural gas, the pipeline capacity and its geographical position can also determine bottlenecks.

The price spread between regional hubs is related to these physical barriers that prevent gas flows from moving freely across regions. For instance, TTF and HH prices reflect different costs as the EU relies on imported gas - which entails LNG liquefaction, transportation, and regasification costs - whereas the US has become a large producer, but its export capacity is still limited to a fraction of its gas output (Figure 4, left panel): hence, HH prices are normally well below TTF. The TTF and BNP, typically very much aligned, also experienced divergence when the Interconnector (the pipeline connecting continental Europe to the UK) reached its maximum capacity (Figure 4, center panel). The UK has low storage capacity compared to continental Europe, but relatively high LNG regasification capacity, and has

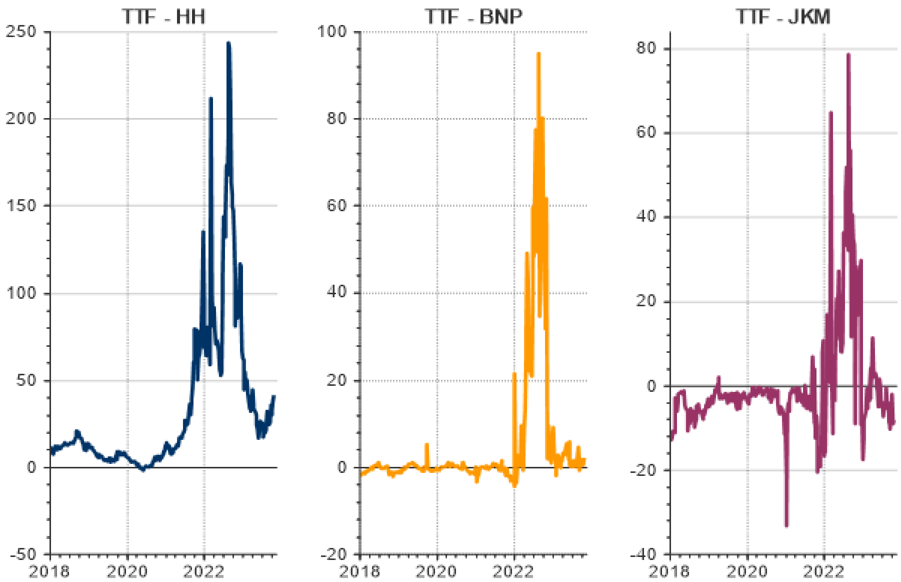


Figure 4: Natural gas spreads (in Euro/MWh). *Source*: Refinitiv.

thus been employed as an “LNG bridge” to regasify LNG and export it via the Interconnector to the EU. However, in spring 2022, when a supply glut hit the UK, the pipeline capacity limited the flows toward continental Europe, driving a wedge between TTF and BNP.

TTF and JKM comove strongly, but sizable spreads can emerge (Figure 4, right panel). Before the invasion of Ukraine, the EU market relied mainly on pipeline imports and played the role of residual absorber on the global LNG market, with the EU being able to absorb excess supply due to its significant storage capacity relative to Asian buyers. Thanks to this structural position, the TTF-JKM was typically negative. However, during 2022, the EU had to attract as many LNG cargoes as possible, faced with the reduction in pipeline flows from Russia; this led to a sizable positive spread. In 2023, with conditions in the European gas market normalizing, the spread began to oscillate between positive and negative territory depending on the relative market tightness in Europe vis-à-vis Asia.

Natural gas price spreads are also important from an LNG investment perspective as they are connected to the concept of netback price (or margin): the price an LNG seller receives minus the costs of liquefying the gas and of transportation (shipping) required to get the gas to the buyer. In this regard, expectations of persistently wide margins act as an incentive for the development of new projects.

2.3 Contractual features

Contracts in the natural gas market can be characterized along two dimensions: long-term versus spot-term (based on duration) and fixed-destination versus free-destination (based on destination). *Long-term contracts* typically span multiple years, even decades, and have traditionally dominated the natural gas market. These contracts provide security of supply, and often include price indexation to oil. On the other hand, *spot-term contracts* are short-term agreements that are typically priced according to current market conditions at the time of the transaction. In terms of destination, *fixed-destination contracts* require the gas to be delivered to a specific location, while *free-destination contracts* (mostly for LNG trade) allow for flexibility in choosing the delivery location.

Contract duration. Historically, the bulk of EU total natural gas demand, ranging from 80% to 90% annually, has been met by long-term contracts. In the LNG market, traditionally dominated by Asian buyers with long-term contracts, the share of short-term contracts is projected to rise in the coming years (Figure 5). This trend is shaped by the expanding role of Europe-US LNG spot trading. During the energy crisis, the US LNG suppliers quickly adjusted their export destinations and diverted shipments originally intended for non-European destinations to profit from higher prices in Europe. This was possible due to the flexible terms of US LNG contracts, which often do not specify a fixed destination for the cargo. The swift redirection of LNG supplies helped to mitigate the impact of the supply shock in Europe and demonstrated how the global LNG market can adapt to sudden changes in supply and demand, providing a buffer against unexpected disruptions. In this

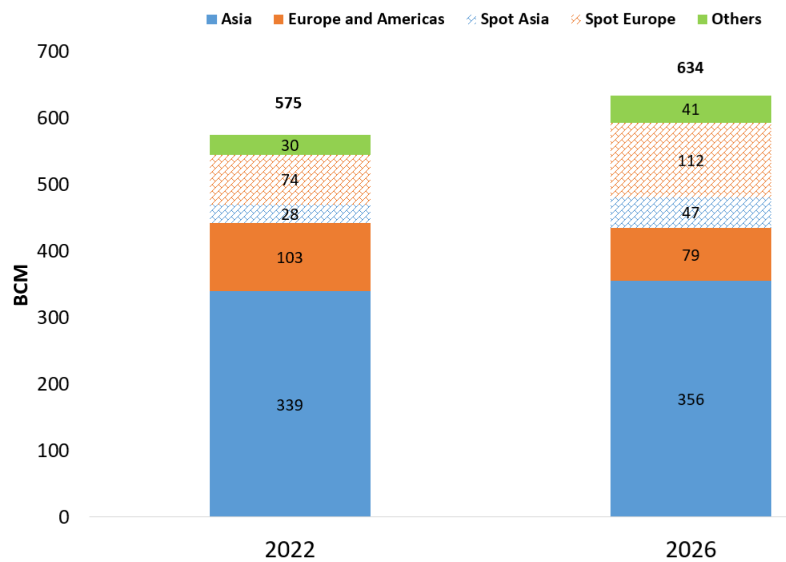


Figure 5: Global LNG supply by type of contract. Shaded areas indicate spot contracts (million metric tons). Source: our elaborations on multiple data sources.

context, a major role was played by the so called "portfolio players" who enhanced short-term supply flexibility by reselling long-term LNG supplies on short-term or spot basis, increasing their share of LNG contracts from 26% in 2016 to over 41% in 2022.[6] These companies acquire LNG from various sources tailoring supply to customers' needs through term and spot contracts. Their role has become increasingly critical in meeting the escalating demand for flexibility in both LNG volume and destination. As to Asia, in 2022 the area was still largely relying on long-term LNG contracts, although the share of spot contracts is expected to increase in the next years (IEA, 2023a).

Contract destination. The increasing share of spot-contracts also implies a larger share of free destination agreements. While in 2020-21 fixed-destination contracts largely dominated the market, accounting for about 78% of newly contracted volumes, in 2022 this share dropped to around 50%. Notably, free destination contracts found particular favor among

[6]A portfolio player in the LNG market refers to a company that has a diversified and comprehensive presence in various aspects of the LNG value chain (production, liquefaction, transportation, trading and distribution). The major portfolio players in the LNG market are companies such as Shell, Exxon Mobil, Chevron, to name a few.

portfolio players (75% of total new destination-free contracts) and European buyers (25%). In contrast, Asian buyers relied mainly on destination-fixed contracts, with China alone accounting for 40% of newly signed ones in 2022.

The upcoming expiration of a large volume of LNG contracts will undoubtedly add to the ongoing transformation of the global gas market. Between 2023 and 2026, approximately 150 bcm of active LNG contracts are set to expire, with an additional 120 bcm expiring between 2026 and 2030 (IEA, 2023a), potentially leading to a profound reshaping of the contractual features of the global LNG market in terms of duration, destination, and price indexation. While this offers opportunities for more flexible and market-responsive contract terms, it also poses challenges related to price volatility and the stability of energy supplies. A shift towards a more flexible LNG market based on spot-contracts would yield a more efficient and liquid market, absorbing regional excess demand/supply by rapidly reshuffling LNG trade flows. However, a party previously relying on long-term contracts, when shifting to spot-trades, may find itself subject to more intense price volatility. Finally, individual countries, especially low-income ones such as Pakistan and Bangladesh, may suffer from an energy security perspective as they may find difficult to compete on the global spot-market with richer economies when the global LNG balance is particularly tight (IEA, 2022).

3 Global LNG production: regasification and liquefaction trends

This section describes current and future developments on the LNG supply side, exploring trends in liquefaction and regasification capacity, and in transport vessels. Seaborne natural gas is transported in liquid state because its volume decreases by about 600 times compared to its gaseous state. This process, known as liquefaction, involves

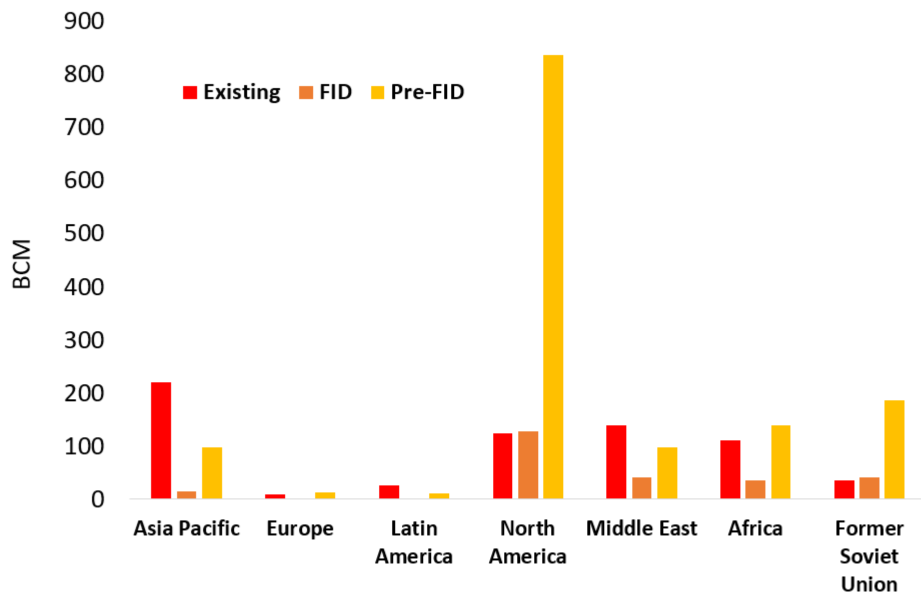


Figure 6: Global liquefaction capacity by region and status. *Source*: International Gas Union (2023).

cooling the gas to approximately -162°C, causing the gas to condense and become liquid.[7] Once shipped to destination and before being conveyed through the pipeline network, the LNG is regasified, typically in the imports terminals, via heating. Onshore regasification is a common method where LNG is received from an LNG carrier and is stored in large onshore tanks and regasified at the import terminal. Alternatively, a floating storage regasification unit (FSRU) can be used to store the LNG before regasification onshore. Onshore terminals provide higher efficiency in terms of regasification and larger storage capacity when compared with offshore terminals.[8] On the other hand, FSRUs have lower initial investment, faster deployment, and higher flexibility, but they have lower efficiency

[7]There are three main technologies used for the liquefaction step: the Cascade Liquefaction Process, the Expander Liquefaction Process, and the Mixed Refrigerant Liquefaction Process. All these methods aim to efficiently convert natural gas into a liquid form for easier transportation and storage; however, they differ in their operational complexity, energy consumption, and cost-effectiveness. The Cascade Liquefaction Process is energy-intensive but effective for large-scale LNG production; the Expander Liquefaction Process can save energy and costs for gas transportation and storage, but it has higher operational costs due to its higher energy consumption; the Mixed Refrigerant Liquefaction Process is more complex but offers a more efficient and flexible operation with reduced power consumption.

[8]Onshore LNG terminals are more versatile than FSRUs as they are able to handle a wider range of operations such as reloading of LNG feeders, bunkering of vessels, and LNG tanker truck loading systems.

and higher variable costs for gas regasification (Hafner and Luciani, 2022).

Liquefaction trends. According to annual data from the International Gas Union (2023), in 2022 the global liquefaction capacity increased by 4.3% (an addition of 27.6 bcm) bringing the worldwide total to 660 bcm.[9] Remarkably, an important share of this additional capacity was developed within the United States, which by 2022 had grown to have the world's largest operational liquefaction capacity, reaching 121.5 bcm (around 22% of global LNG supply). At the end of 2023Q3, the liquefaction capacity in the pre-FID phase at the global level is expected to reach 1386 bcm.[10] A large share of this future capacity expansion (around 61%) resides in North America (Figure 6). The remaining expected expansion in global liquefaction capacity[11] is distributed across Russia, Africa, the Middle East and Asia Pacific (14%, 10%, 7% and 6.9% respectively). In 2022 Russia's liquefaction capacity experienced only modest growth of around 4% reaching 37.2 bcm (from 35.8 bcm in 2021), partly due to restrictions and technology export controls resulting from sanctions imposed by the UK, US, and Europe (International Gas Union, 2022, International Gas Union, 2023). Nevertheless, certain joint ventures on LNG projects with the UK, France, China, and Japan continued to operate (McWilliams et al., 2023).

Regasification trends. As described above, this is the final step in the LNG value chain. The latest available data indicates that the global regasification capacity surged to around 1355 bcm in mid-2023 (International Gas Union, 2023). Asia and Asia Pacific[12] contribute

[9]Liquefaction capacity is not always fully utilized, due to various factors such as maintenance, outages, gas shortages, and weather conditions. Therefore, the actual LNG export of a country may be lower than the full liquefaction capacity. The average global utilization rate of liquefaction plants was 89% in 2022 (80.4% in 2021; International Gas Union, 2023).

[10]The Final Investment Decision (FID) is the point in a large-scale energy project where the project owners or investors commit to the project and authorize the expenditure of funds. It is the last step before the project enters the construction phase. In contrast, the pre-FID status refers to the preliminary stage before the FID, characterized by planning, feasibility studies, and risk assessments to evaluate the project's viability and alignment with organizational goals.

[11]This includes both new plants and the expansion of existing capacity.

[12]The Asia region comprises, Afghanistan, Bangladesh, Brunei, Cambodia, Iran, Kyrgyzstan, Lao's, Mongolia, Myanmar, Nepal, Pakistan, Sri Lanka, Tajikistan, Turkmenistan, Uzbekistan and Vietnam, while the Asia Pacific region includes Australia, China, India, Indonesia, Japan, North and South Korea, Malaysia,

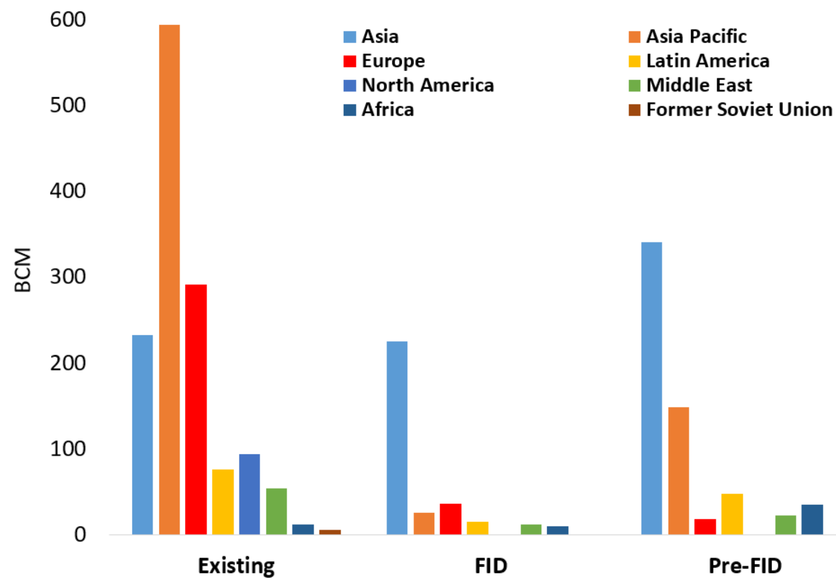


Figure 7: LNG regasification capacity by status and region. *Source*: International Gas Union (2023).

approximately 61% of total world regasification capacity, followed by Europe with 21% (Figure 7). Current global regasification capacity is thus about twice the global liquefaction capacity. The reason for the disparity may be related to the market structure, where LNG producers have arguably greater market power than importers.[13] Moreover, countries that have access to LNG supplies may want to have excess capacity in order to compensate alternative energy sources with LNG imports when the former are scarce.

Asia and Asia Pacific countries mainly rely on onshore regasification terminals because they have historically been the main LNG importers for years. Conversely, Europe has increasingly adopted FSRUs in 2022 to rapidly activate infrastructure in order to compensate as quickly as possible the foregone Russian gas flows via pipeline. In 2022, Europe witnessed the largest capacity addition, with an increase of about 7.4% in annual terms (equivalent to 20 bcm) in regasification infrastructure followed by Latin America,

New Zealand, Pakistan, Papua New Guinea, Philippines, Singapore and Thailand.

[13]The main four LNG producers account for about 70% of total supply, where the main four LNG consumers weight for about 50% of global consumption.

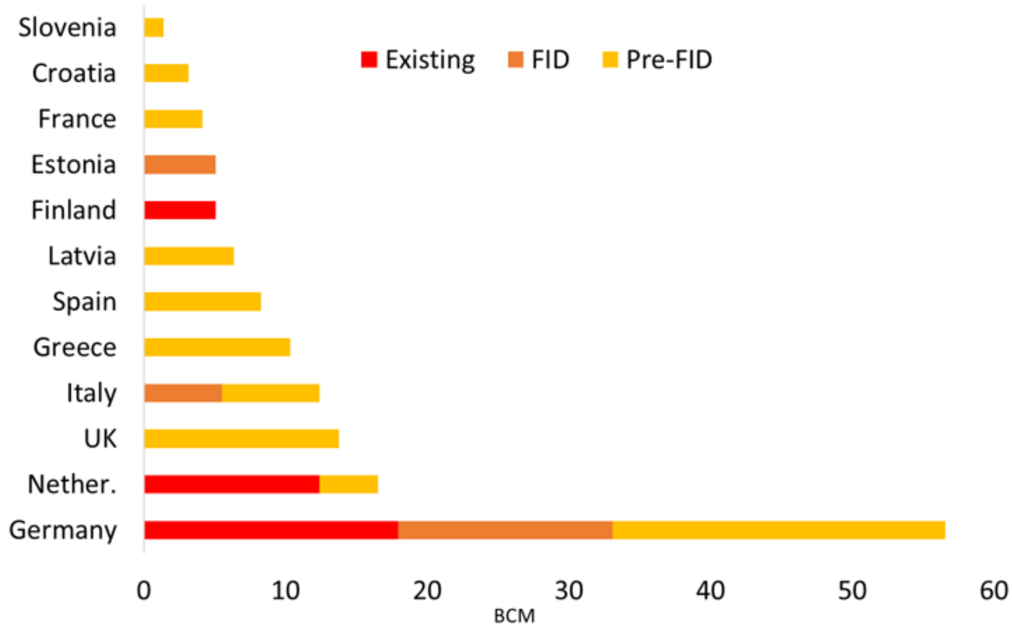


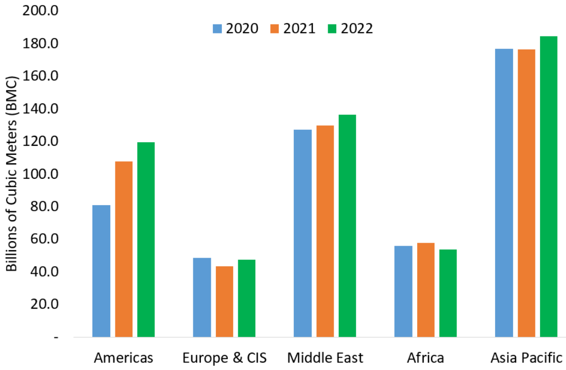
Figure 8: Europe regasification construction plans proposed in 2022, by status and country. *Source*: International Gas Union (2023).

Asia and the Asia Pacific region (4.1, 3.7 and 2%, respectively), see Figure 7.[14] In Europe the increase in LNG regasification capacity was particularly remarkable in Germany, which had no regasification terminal prior to the invasion of Ukraine. Similarly to Germany, several other European countries, including Italy, started or accelerated the development of new LNG import terminals in 2022.[15] Figure 8 illustrates the significant expansion of regasification capacity in Europe during 2022 together with future programmed expansions. According to IEA (2023a), new FSRUs and the expansion of existing regasification terminals will allow Europe to have 25% more regasification capacity in 2023 compared to 2021.

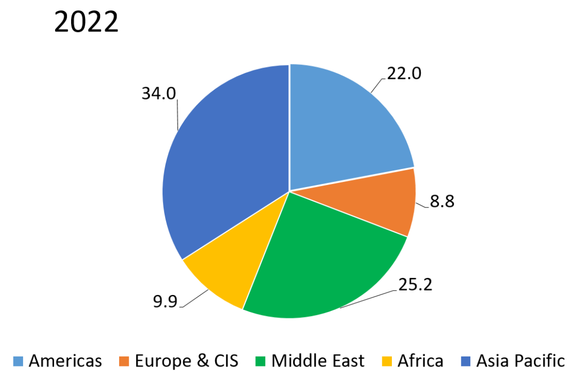
LNG vessels and shipping. Between 2021 and 2022 there was an increase in the LNG carrier fleet mainly due to Europe's strategic efforts to bolster its LNG imports, primarily

[14]In absolute term the regasification capacity addition was of 11.7 bcm in Asia, 8.3 bcm in Asia and 2.8 bcm in Latin America.

[15]Italy for instance, activated a new FSRU (Golar Tundra in Piombino) which started operations in July 2023.



(a) LNG exports by world region, *Billions of Cubic Meters, BCM.*



(b) LNG export shares in 2022 by world region.

Figure 9: LNG exports by world region. *Source*: Energy Institute (2023).

driven by energy security concerns. Between January and December 2022, 27 new vessels were added to the global LNG fleet that reached a total of 657 active carriers (a 4% expansion in the global fleet size; International Gas Union, 2023). The global number of LNG trade trips increased by 2.7% in 2022, reaching a total of 6,888. Asia was still the main destination for LNG, but Europe in particular saw a significant rise in LNG trips, which grew strongly by 44.8% to 2,079 in 2022, following the reduction in Russian piped gas. As of April 2023, there were 312 vessels under construction in the global LNG market, suggesting that ship-owners are anticipating a growing demand for LNG, driven by the expansion of liquefaction capacity, especially in the US.

4 Global LNG trade flows

This Section describes recent developments in global LNG trade, discussing the geographical distribution of LNG exports and imports.

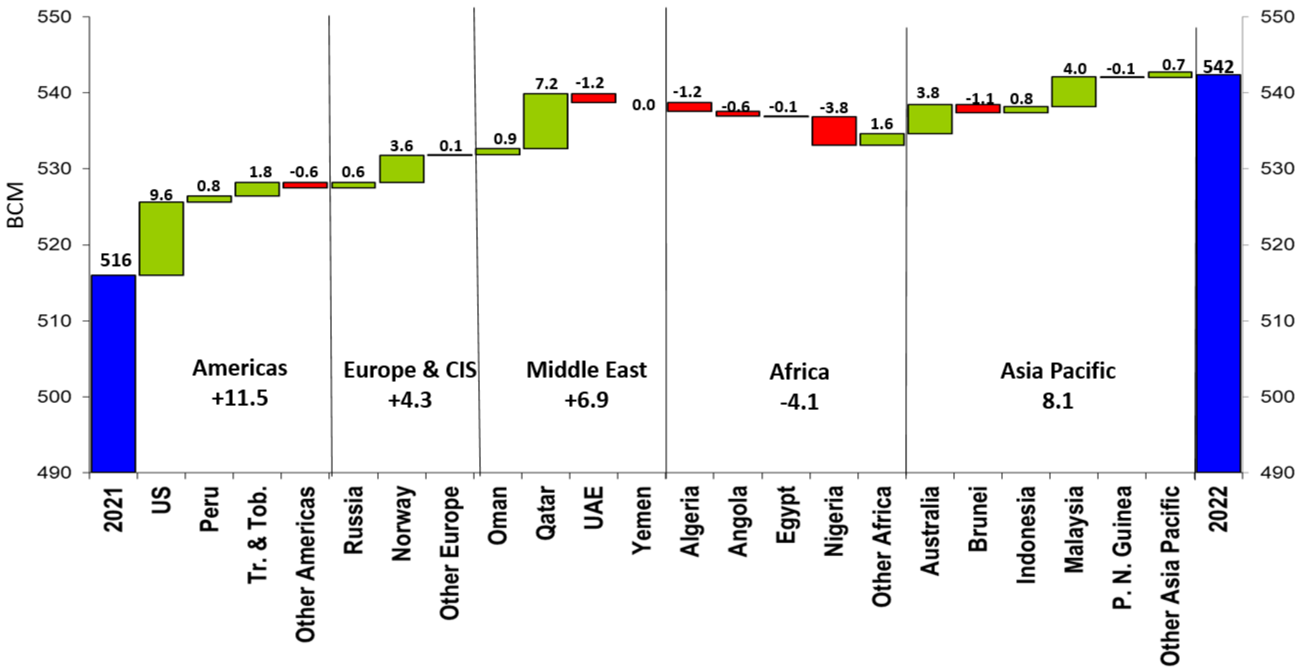
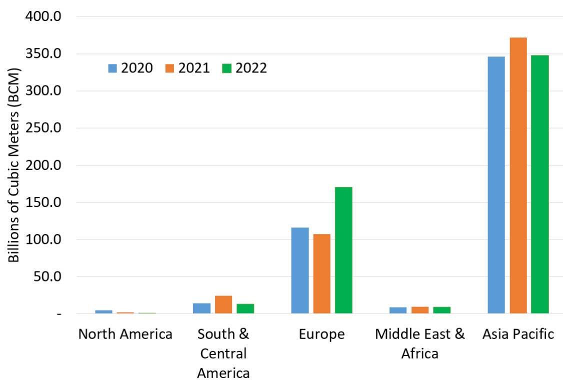


Figure 10: LNG exports by world region, 2021-2022 variation. *Source*: Energy Institute (2023).

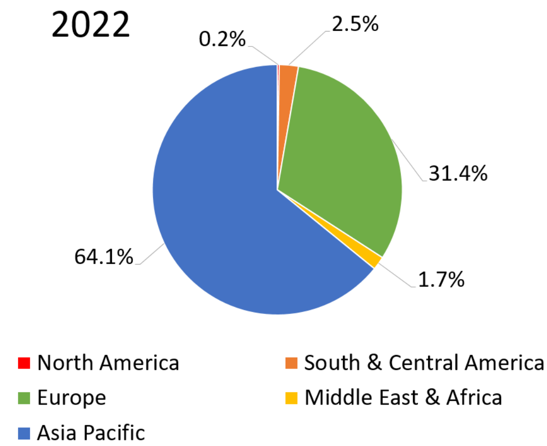
4.1 LNG exports

In 2022, global LNG trade grew by 5% and reached 542 bcm, from 516 bcm in 2021, according to the Energy Institute (2023). Figure 9a and 9b respectively show the geographical breakdown of LNG exports in terms of LNG flows and export shares. The Asia-Pacific, region accounted for the largest share of exports in 2022 (184.7 bcm; 34% of global supply), followed by the Middle East (137 bcm; 25.2%), the Americas (119.5 bcm; 22%) and Europe together with CIS (47.7 bcm; 8.8%).[16] LNG supply is extremely concentrated. In 2022 Qatar, Australia, the United States, Russia, and Malaysia collectively accounted for 75% of the world's total supply. Qatar, United States, and Australia exported similar quantities of LNG in 2022 (about 110 bcm); Russia exported a lower, albeit sizable, volume (40 bcm).

[16]CIS stands for Commonwealth of Independent States and includes former Soviet countries: Armenia, Kazakhstan, Turkmenistan, Azerbaijan, Moldova, Ukraine, Belarus, the Russian Federation, Uzbekistan, the Kyrgyz Republic, and Tajikistan.



(a) LNG imports by world region, *Billions of Cubic Meters, BCM.*



(b) LNG import shares in 2022 by world region.

Figure 11: LNG imports by world region. *Source*: Energy Institute (2023).

In 2022, there were significant increases in LNG exports from various LNG producers (Figure 10). The largest increases occurred in the United States (+10%), which shipped 70% of its exports to Europe, with France, the United Kingdom, the Netherlands and Spain being the top European importers. As a result, in the past year Asia's share of US LNG decreased from 48% to 23%. Qatar exports also surged (by 7.2 bcm, i.e. +7% year-on-year), with China, India, South Korea and Europe as the main destinations. Conversely, Russia experienced only a modest increase in LNG supply with respect to 2021, with China, Japan, France, Belgium and Spain as the main destinations.

4.2 LNG Imports

In 2022 the global LNG trade satisfied approximately 14% of the global gas demand (Energy Institute, 2023). In 2022, the high TTF prices in EU, driven by a very tight European gas market, attracted sizable LNG quantities and crowded out the LNG demand from other areas. Despite this, in 2022, the Asian region remained the primary importer, attracting 348 bcm of LNG shipments (Figure 11a), approximately 64% of the global LNG supply (Figure

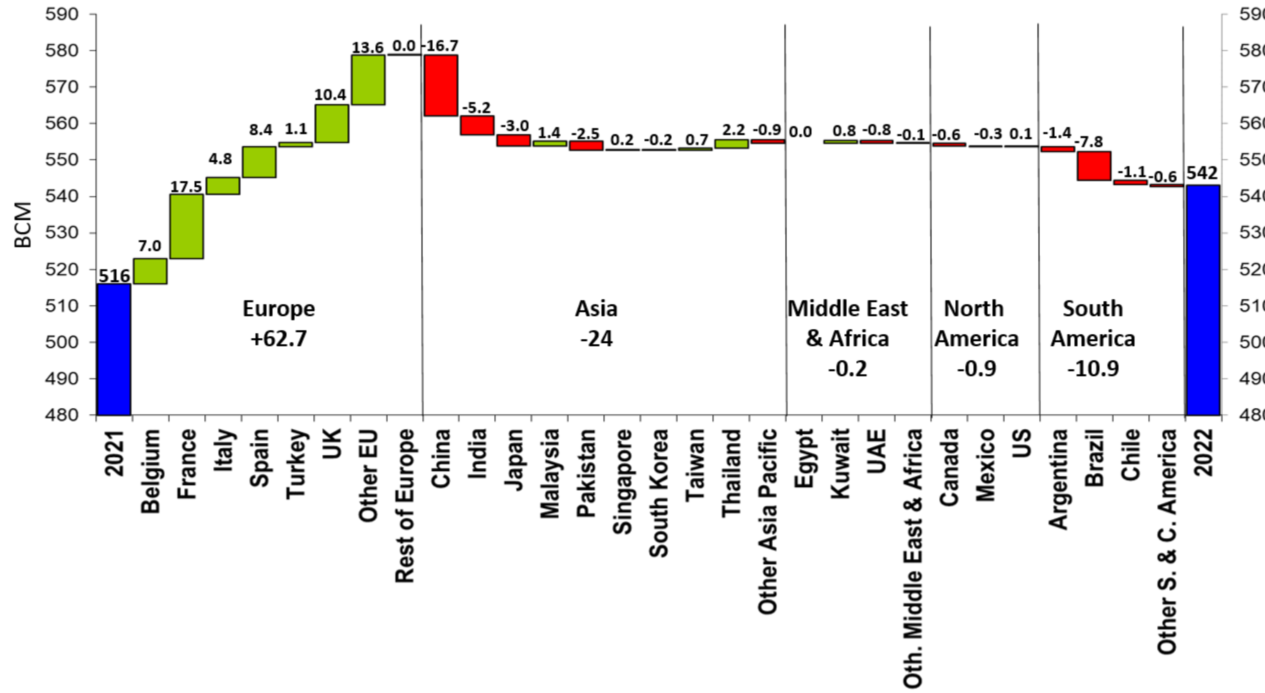


Figure 12: LNG imports by world region and major importer nation. *Source*: Energy Institute (2023).

11b). In terms of overall LNG imports for Asia, in 2022 Japan, South Korea, and Taiwan accounted for 35% of global LNG demand, China 17.2% and India 5.2%. Figure 12 shows the variation from 2021 to 2022 in LNG imports at the country level. The decrease in Asia LNG imports with respect to 2021 (-24 bcm equivalent to -6.4% in annual terms) was mainly driven by China, due to the Covid-19 restrictions that were lifted only at the beginning of December 2022, followed by India, Japan, and Pakistan.

In 2022, Europe imported 170 bcm of LNG (approximately +60% year-on-year), satisfying about 34% of its gas consumption (up from 19%).[17] Between 2000 and 2019 LNG accounted on average for 20% of European gas supplies, reaching 53% in 2022, see Figure 13. The share of European LNG imports over global LNG imports soared from 21%

[17]During the energy crisis in 2022, average utilization rates at European regasification terminals spiked to 65% against a global average regasification capacity of 41% for the same year (International Gas Union, 2023). In order to avoid capacity constraints and bottlenecks during the regasification process, it is important to have enough spare regasification capacity, especially in time of stress for the gas market.

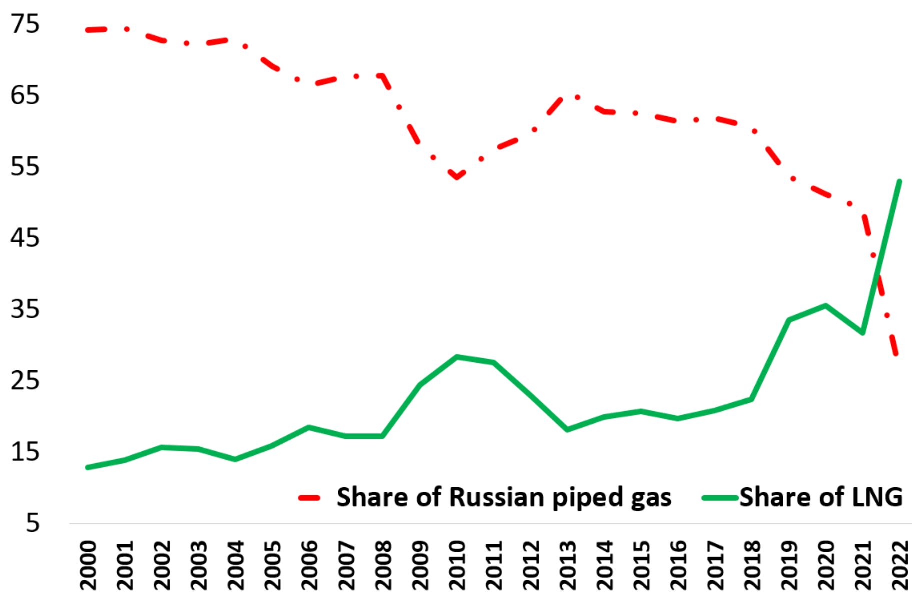
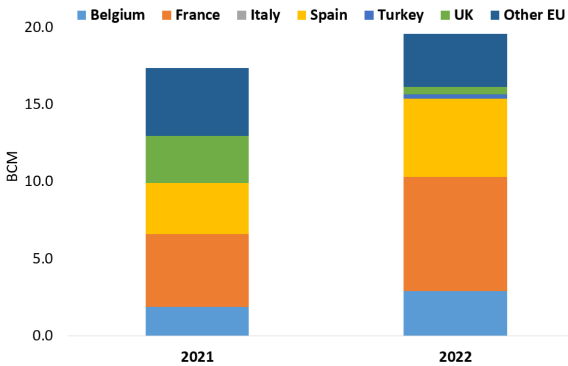


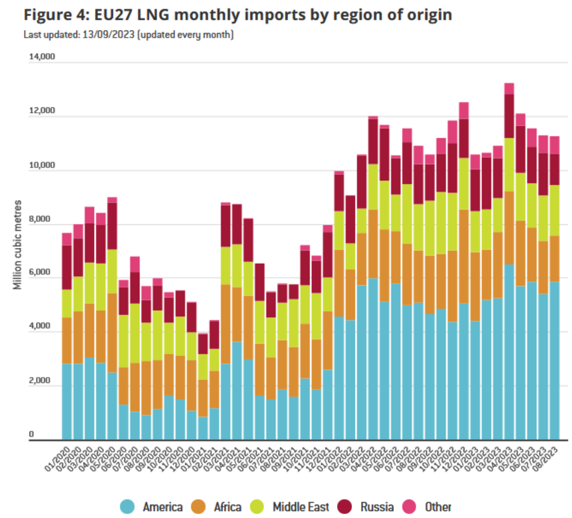
Figure 13: Share of total LNG and Russian piped gas in Europe over total gas imports (2001-2022). *Source*: Energy Institute (2023).

in 2021 to more than 31% in 2022; Belgium, France, Italy and Spain collectively accounted for 53% of European imports. France witnessed a notable surge of 17.5 bcm in LNG imports, in response to both lower Russian gas flows as well as to the low electricity production from nuclear and hydro-power, constrained by the maintenance of nuclear reactors and water scarcity throughout 2022. Italian and Spanish LNG imports rose by 4.8 bcm and 8.4 bcm with an increasing role of the United States as a supplier. In the UK, LNG inflows surged by 10.4 bcm with the United States being the major contributor (+9 bcm). In The UK, LNG was then regasified and transferred by pipeline to the EU, so that the UK was a net exporter to the EU due to its role as "LNG bridge".

Despite the geopolitical tensions, Europe also witnessed a surge in imports of LNG from Russia in 2022 (20 bcm against 17.4 in 2021, roughly 12% of total LNG imports), see Figure 14a. In the first seven months of 2023, EU member states had already purchased approximately 22 billion cubic meters of LNG from Russia, (Figure 14b), with Spain and Belgium emerging as the second and third biggest customers of Russian LNG respectively,



(a) EU imports of Russian LNG 2021-2022; . *Billions of Cubic Meters, BCM.*



(b) EU LNG imports by source in 2023. *Millions of Cubic Meters, MCM.*

Figure 14: LNG imports in Europe . *Source*: Energy Institute (2023) and Bruegel.

after China.[18]

5 Gas flows to Europe and Italy

This Section reviews the dynamics of natural gas flows to Europe and Italy throughout the energy crisis of 2022/2023.

5.1 Europe

The EU as a whole meets its energy demand primarily through oil and natural gas, accounting for 33.5% and 25.0% of primary energy consumption, respectively.[19] Between 2021 and 2022,

[18]Most of the Russian volumes imported in Europe come from the Yamal LNG joint venture, which is majority-owned by the Russian Company Novatek, while other stakes in the project are held by France's TotalEnergies and China's CNPC. In this case, the partnership with other countries limits the ability of Russia to weaponize its energy supplies. Although data on LNG contracts are not publicly available, some analysts have suggested that, despite geopolitical tensions with Russia, persistent European imports of Russian LNG may be explained by the existence of long-term offtake contracts, which compel European companies to purchase a certain gas volume to avoid violating the contracts, see McWilliams et al. (2023).

[19]Data refers to 2021. Primary energy consumption measures the total energy demand of an economy, encompassing consumption by end-users and the energy sector itself, as well as energy distribution. Besides

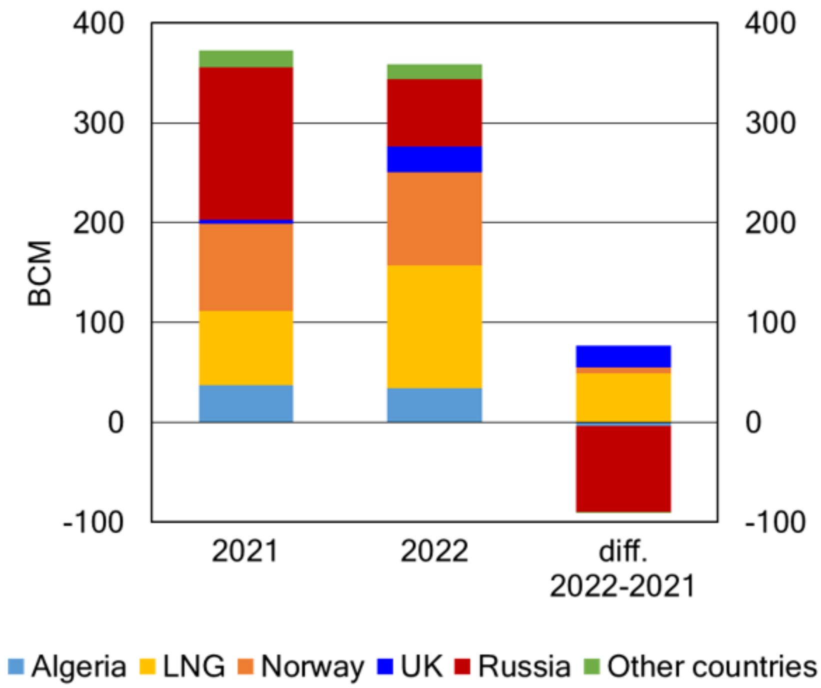


Figure 15: Gas imports in Europe by country of origin, billions of cubic meters (BCM). Source: Eurostat.

Russia progressively reduced its pipeline gas supplies to the EU (Figure 15); this ongoing reduction culminated in September 2022 with the closure of the Nord Stream pipeline, the main transportation channel of natural gas from Russia to Northern Europe. As a result, by the end of 2022, the gas supply via pipeline from Russia had decreased by 80 bcm compared to 2021, with Russian market share in Europe for pipeline-delivered gas dropping from more than 40% before the gas crisis to 20% in 2022.[20] In the first eight months of 2023, Russian pipeline flows were stable, at approximately 70 million cubic meters per day (MCM/d), equivalent to approximately 25 bcm per annum, significantly lower than the

oil and natural gas, other sources used to meet the EU's energy demand include coal (12.2%), nuclear (9.7%), hydroelectric (7.4%), and all renewable sources (12.3%).

[20] Russia faces challenges in redirecting the gas piped towards Europe (-80 bcm) to alternative locations, notably China due to pipeline constraints. The existing infrastructure, known as the Power of Siberia pipeline, has a maximum capacity of around 38 bcm. Moreover, the logistics of transporting the gas to the starting point of the Power of Siberia pipeline represent another significant hurdle. While plans were underway for an additional pipeline called Power of Siberia 2 with a larger capacity of around 50 bcm, this infrastructure is still at the planning stage.

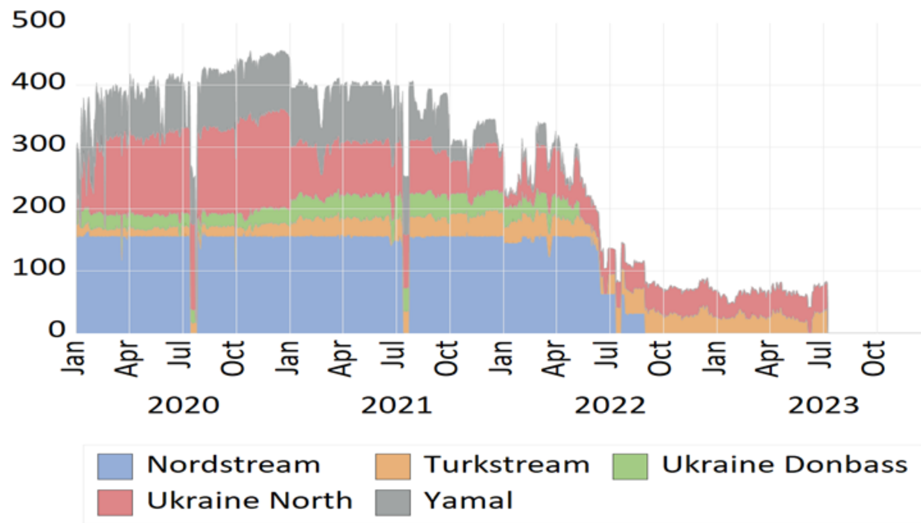


Figure 16: Gas flows from Russia in Europe (millions of cubic meters per day, MCM/d). Source: own elaborations from multiple data sources.

168 bcm recorded in 2021, see (Figure 16). In 2023, natural gas flowed towards Europe via Ukraine and via the Turkstream pipeline to South-East Europe, while Nord Stream remained closed.[21] Russian flows via Belarus to Poland and Germany (Yamal pipeline) also remained at zero. In contrast, robust Norwegian pipeline flows to Europe (around 58 bcm in the first eight months of 2023) played a crucial role in supplying the European market and in managing the energy crisis.

In order to compensate for the loss of gas channeled via pipelines, a major reshuffling of LNG flows from traditional Asian destinations to Europe occurred throughout 2022 (Figure 17), mainly facilitated by high prices in the European market, the drop in Asian LNG demand, and by the enhanced integration of LNG supplies in global energy routes, with the US emerging as the main global player in this market. In 2022, the EU imported around 62 bcm more of LNG compared to 2021, shipped mainly from the United States, Qatar, Egypt and Norway (+41.3, +5.5, +3.9 and +3.5 bcm, respectively), see Figure 18.

[21]Future gas transit across Ukraine towards Europe remains a concern, since the current contractual agreements between Russia and Ukraine are expected to expire at the end of 2024 (OIES, 2023).

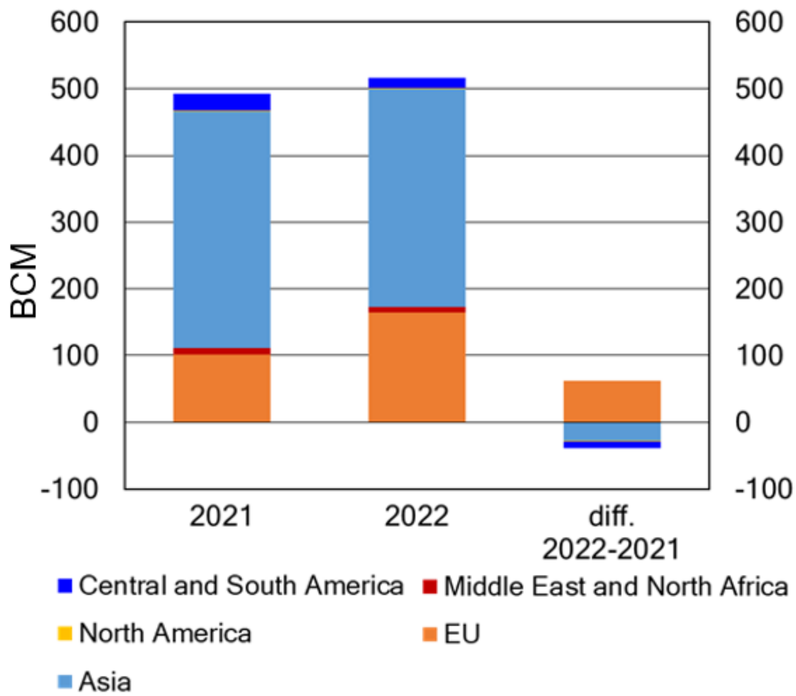


Figure 17: LNG imports in 2022 by world region, billions of cubic meters (BCM). Source: Energy Institute (2023).

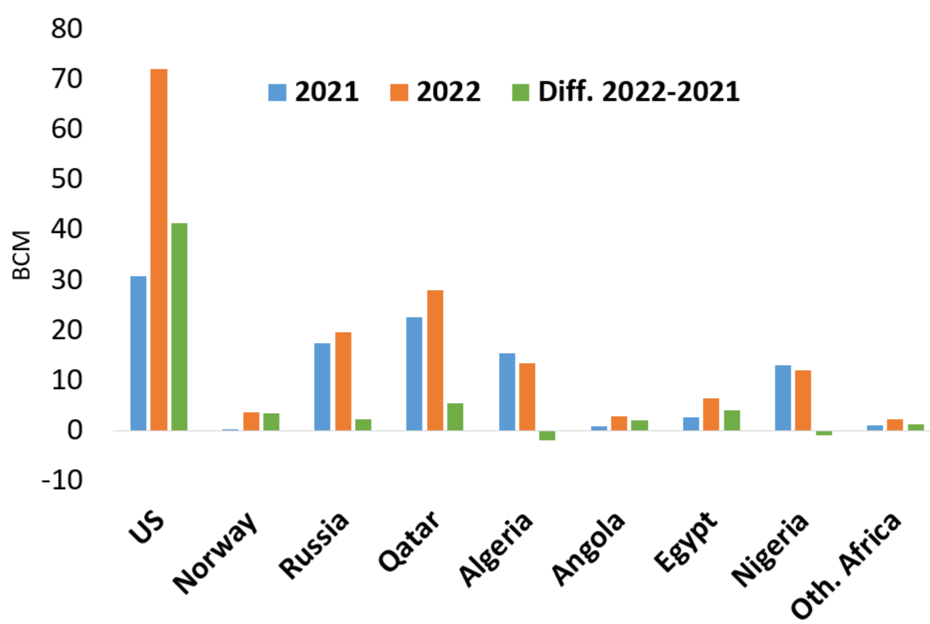
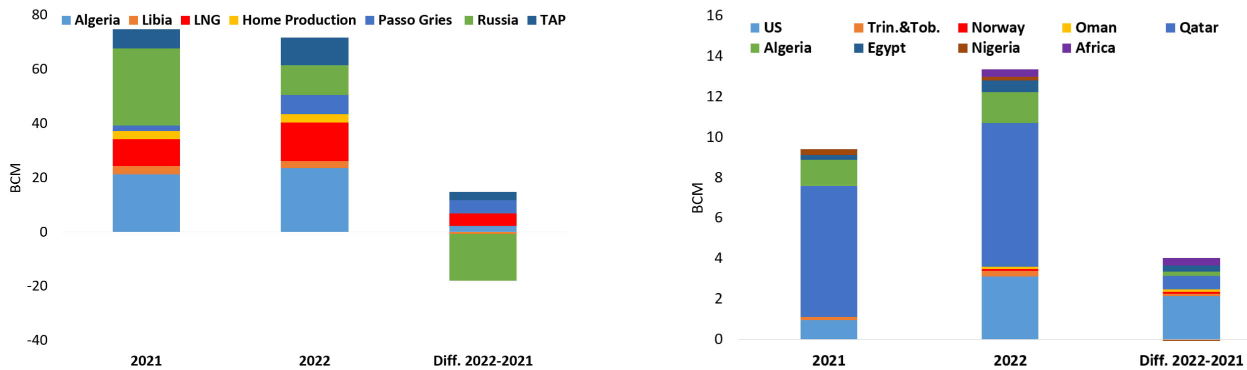


Figure 18: EU 27 gas imports in 2022 and 2021 in LNG by supplier (billions of cubic meters, BCM). Source: Energy Institute (2023).



(a) Supply to the Italian market, *Billions of Cubic Meters, BCM*

(b) LNG imports in Italy, *Billions of Cubic Meters, BCM*

Figure 19: Gas (pipeline) and LNG imports in Italy. *Source*: Energy Institute (2023) and our elaboration on multiple data sources.

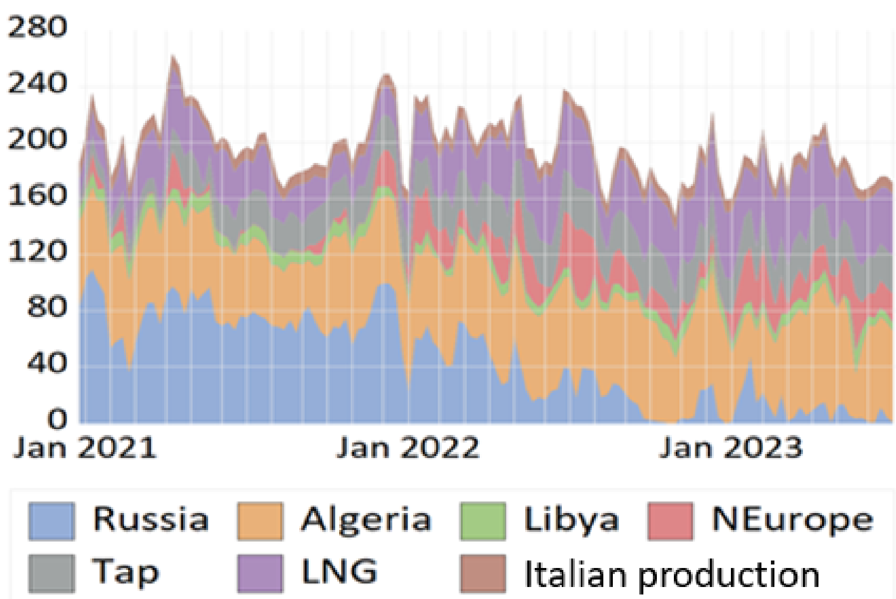


Figure 20: Gas flows to Italy (millions of cubic meters per day, MCM/d)

5.2 Italy

Italy relies on natural gas for about 40% of its energy needs (Energy Institute, 2023). Gas flows to Italy changed significantly between 2021 and 2022. In 2021, Russia was the largest supplier of natural gas to Italy, accounting for about 38% of total gas imports. However, following Russia's invasion of Ukraine, gas flows from Russia to Italy decreased significantly;

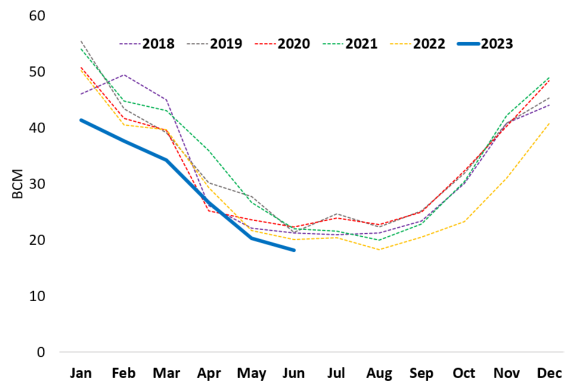
at the end of 2022, they had fallen by 17.3 bcm, a reduction of 25% of Italian total gas supply in 2022 (Figure 19a). In order to diversify its gas imports, Italy increased pipeline flows from Northern Europe via Passo Gries (around +5 bcm between 2021 and 2022), the Transatlantic Pipeline (TAP) which brings natural gas from Azerbaijan (+3 bcm), Algeria (+ 2.4) and most importantly, LNG imports surged by 4.8 bcm, accounting for about 7% of total gas imports (Figure 19a). The main sources of LNG imports to Italy were the United States (+2.2 bcm) and Qatar (+0.7), see Figure 19b.[22] In the first eight months of 2023, Russian flows to Italy via the Tarvisio pipelines have remained at historically low levels at around 10 MCM/d, amounting to less than 5% of the overall gas supply to Italy, equivalent to an annual gas flow of 3.7 bcm (it was approximately 28.1 bcm in 2021, see Figure 20).

6 Gas consumption in Europe and Italy

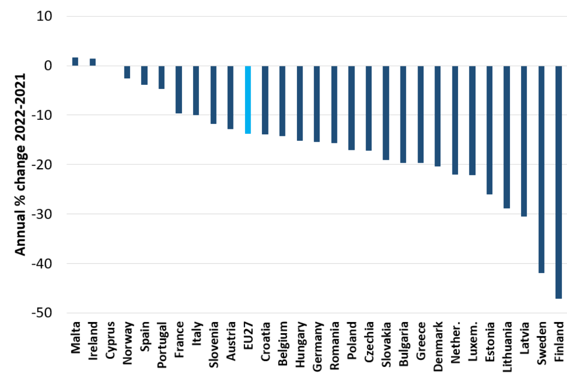
In 2022, European total natural gas consumption dropped by 13% compared to the previous year (equivalent to approximately 55 bcm; Figure 21a) as a result of the unprecedented price spikes. This overall reduction was split approximately equally between household consumption and the industrial sector, see International Energy Agency (2023). The demand destruction differed across the EU. Considering the four largest countries in the EU area, based on Eurostat data, total gas consumption fell by -3.8% in annual terms (-1.2 bcm) in Spain, by -9.9% (-7.6 bcm) in Italy, by -9.6% (-3.9 bcm) in France, and by a substantial 15.3% (-14.4 bcm) in Germany (Figure 21b). The heterogeneous response of gas consumption can be ascribed to both structural features, such as differences in the power generation mix or in industrial demand, and to idiosyncratic factors, such as climatic conditions as well as to differences in the policy responses.

For the largest EU countries, Figure 22 summarizes the contribution of the household,

[22] According to Energy Institute (2023), Italy did not import Russian LNG in 2022.



(a) Gas Consumption in Europe, Billions of Cubic Meters, BCM

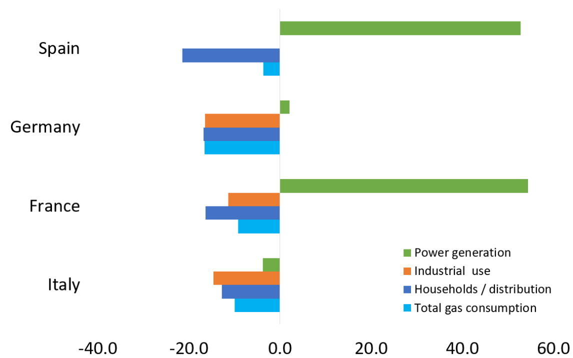


(b) Gas Consumption in EU27 countries, 2022 on 2021 % variation

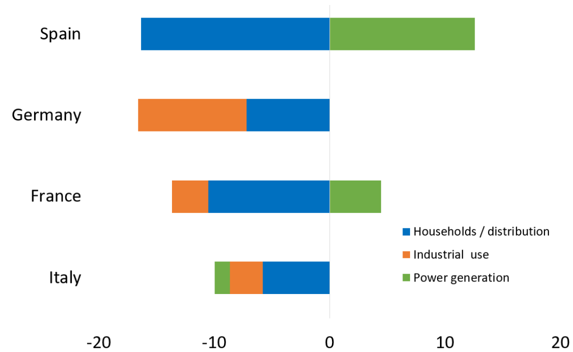
Figure 21: Gas consumption in Europe. *Source*: Eurostat.

industrial and power sectors to the total fall in gas consumption between 2021 and 2022.[23] In Italy the household sector experienced a significant fall in gas consumption (-12.8% in annual terms, see Figure 22a) contributing for more than half of the total reduction recorded in 2022 (Figure 22b). The industrial sector contributed for approximately one third to the decrease (-14.7% in annual terms), while the power generation by one tenth (-3.8%). The abrupt increase in gas prices and the subsequent demand destruction contributed to the slowdown of the industrial production index and a strong increase in producer prices; see Accetturo et al. (2022) and Corsello et al. (2023) for an analysis of the economic impacts of the energy crisis in Italy. In France the household sector was the main contributor to the fall in gas consumption (-16.3% in annual terms) followed by the industrial sector (-11.4%); however, gas used for power generation increased strongly by 54.4% in order to compensate the significant reduction in nuclear and hydro power generation due to maintenance of the nuclear reactors and water scarcity, contributing positively to overall gas consumption by almost 5 percentage points (p.p.). In Germany, the decline in total gas consumption was

[23]See Alessandri and Gazzani (2023) for an analysis of the impact of gas supply shocks on the European economy. They find that negative supply shocks are stagflationary and that their effects materialize over far longer horizons than those of oil supply shocks, with peaks (troughs) in core inflation (industrial production) that follow the shock by two years or more.



(a) Gas consumption by household/distribution, industrial and power generation sectors for Italy, France, Germany and Spain, (% change 2022-2021).



(b) Contribution (weight of the share of a given sector on total gas consumption times the annual growth rate) to the growth rate of gas consumption by sector for Italy, France, Germany and Spain between 2022 and 2021.

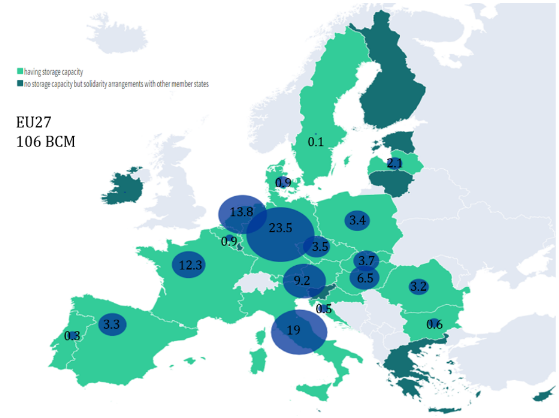
Figure 22: Gas consumption in Italy, Germany, France and Spain by sector. *Source*: Our elaboration on multiple data sources. For Spain it is not possible to disentangle gas consumption of the industrial sector from the household one.

driven by a sharp contraction both in demand from the industrial sector (which resulted in a strong contraction of industrial production in the gas intensive sectors, see Bachmann et al., 2022, Cook et al., 2022) and from the household sector. As to Spain, the strong fall in gas usage by industry and households (-21.4% in annual terms), accounting for -16.3 p.p. of the total decrease, was only partly compensated by the strong increase in the power generation sector (+52%) that contributed positively by 12.6 p.p..[24]

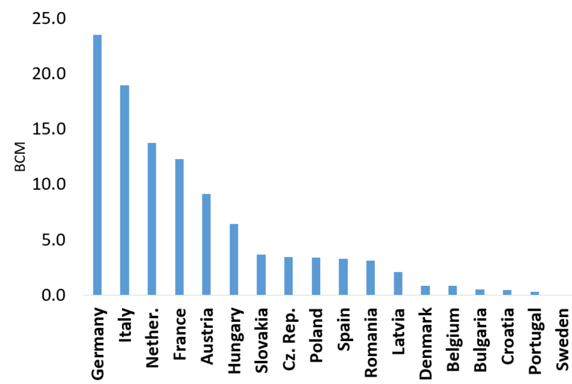
7 Gas storage in Europe and Italy

Gas storage plays a crucial role in ensuring energy security, and the replenishment of gas reserves has become as a key policy target for the EU during the energy crisis. Moving

[24]This significant growth of electricity produced via gas in Spain was mostly driven by a fiscal relief measure consisting in a price cap ("tope al gas") applied exclusively to gas for power generation. This initiative aimed to subsidize gas and coal-fired power plants when wholesale electricity prices exceeded 50 euro/MWh. Its objective was to reduce wholesale electricity prices and it was funded by the so-called "windfall profits" generated by infra-marginal green technologies, which could produce electricity at lower costs compared to fossil fuel plants. After the introduction of the measure in April 2022, Spain became a net electricity exporter with power being mainly exported towards France (Hidalgo Pérez et al., 2022).



(a) Map of gas storage in Europe, Billions of Cubic Meters, BCM.



(b) Gas storage in European countries, Billions of Cubic Meters, BCM.

Figure 23: Gas storage in Europe. *Source*: Refinitiv and Gas Infrastructure Europe (GIE).

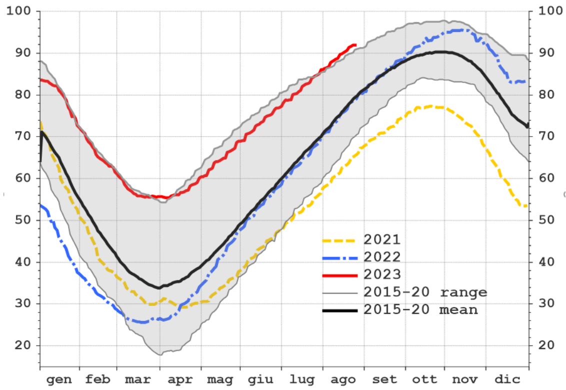
forward, its significance is set to increase with the EU gas market deemed to depend more on LNG imports. In the EU, gas storage typically can cover around 30% of the gas consumed during the winter months.[25] At the beginning of 2023 gas storage capacity amounted to approximately 106 bcm in the EU27 (Figure 23a). Some countries have considerably higher storage capacity: Germany (23.5 bcm; 30% of national gas consumption in 2022); Italy (19 bcm; 29% of national gas consumption in 2022); the Netherlands (13.8 bcm; 51% of national gas consumption in 2022); and France (12.3 bcm; 32% of national gas consumption in 2022), see Figure 23b.

Figures 24a and 24b show the monthly evolution of EU gas storage levels for years 2021, 2022 and the first eight months of 2023, compared to the range of levels recorded in the years 2015-2020.[26]

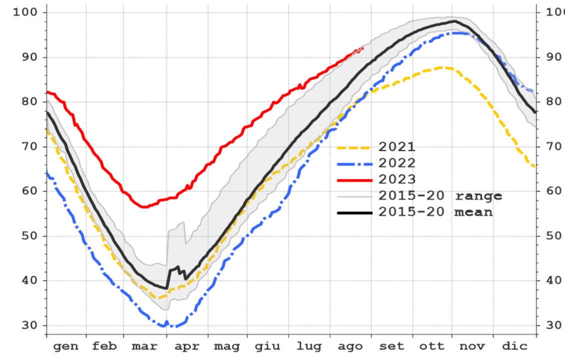
At the beginning of the 2021/22 winter season, EU storage levels were at historical lows, leaving Europe in a vulnerable position. The EU swiftly enacted a range of measures to strengthen gas storage, ensuring heating for citizens and maintaining business continuity

[25] See https://energy.ec.europa.eu/news/eu-reaches-90-gas-storage-target-ahead-winter-2023-08-18_en.

[26] Cyprus, Estonia, Finland, Greece, Ireland, Lithuania, Luxembourg, Malta and Slovenia do not have gas storage facilities.



(a) Gas storage in Europe, % of available capacity.



(b) Gas storage in Italy, % of available capacity.

Figure 24: Gas storage time series in Europe and Italy. *Source*: Refinitiv and Gas Infrastructure Europe (GIE).

(see Section 8). The EU ultimately succeeded in reaching an average 80% filling rate of its storage by the end of August 2022; however, this accomplishment came at the cost of substantial pressure on natural gas prices, marked by historically high peaks in TTF prices recorded during the summer of 2022.

During the 2022/2023 winter, the average filling rates remained robust (more than 80% of the storage capacity). Even in December 2022, the rates remained above 85%, almost 30 percentage points above levels recorded in the same period of 2021. This was due to exceptionally mild weather that postponed the start of the heating season in Europe, strong demand destruction driven by the elevated prices in the European gas markets, and substantial LNG inflows during the second half of 2022.

In 2023, the strong supply of LNG has enabled both the EU as a whole and Italy in particular to maintain gas storage at historically high levels. The minimum gas storage target of 90%, mandated by European regulations for each heating season starting from 2023, was achieved by the end of August, exceeding the 5-year average replenishment rate by several percentage points, see Figure 24a and Figure 24b respectively. In mid-2023, Ukraine also declared its willingness to supply Europe with an additional storage capacity of up to

10 bcm if the EU were to attain full capacity of its storage.[27] While high storage levels are important to ensure energy security, recent events such as maintenance works in Norway gas plants or the risks of strikes at Australian LNG fields, highlighted two important facts. First, that high storage levels alone may not be sufficient to shield Europe from renewed natural gas hikes. Second, even disruptions in locations not immediately linked to the European gas market, such as Australia, may have global implications as increased LNG flows have led to a greater level of integration.

8 Policy response

This section reviews the policy responses to the energy crisis, maintaining our primary focus on the measures adopted in Europe.[28] We will classify interventions into two categories: structural measures - including both regulatory interventions as well as other policy measures addressing issues related to natural gas consumption, supply, and storage - as opposed to fiscal relief measures, primarily intended to support firms and households affected by surging energy prices.

Structural measures. On March 11, 2022, the EU Heads of State issued the Versailles Declaration which outlined the primary pillars of the EU's response to the energy crisis, aimed at reducing the EU's dependence on Russian fossil fuels, diversifying energy supplies, increasing gas storage, accelerating the adoption of renewable energy sources, and improving energy interconnections within the EU. These principles were later incorporated into the EU Commission's REPowerEU plan (May 18, 2022), which serves as the central policy framework for the EU's energy strategy. The plan has a dual objective. First, to rapidly reduce Europe's

[27]Europe began using Ukrainian storage facilities in the third quarter of 2023, see https://www.reuters.com/business/energy/foreign-traders-build-up-gas-reserves-ukrainian-storage-kyiv-2023-09-13/

[28]For some cross-country perspectives on policy response to the energy crisis, also beyond the European boundaries, see IEA (2022), Sgaravatti et al. (2022), Sgaravatti et al. (2023b), Garcia-Muros et al. (2023), Ari et al. (2023), Checherita-Westphal and Dorrucci (2023), and Bank of Italy (2023a), among many others.

reliance on Russian fossil fuels, aiming for a complete abatement by 2027.[29] Second, to ensure the long-term sustainability and stability of the EU energy system incorporating a combination of short and medium-term measures focused on reducing energy demand, diversifying suppliers of conventional fuels, and expediting the transition to renewable energy sources.[30] The principles articulated in the REPowerEU plan were further translated into dedicated regulatory interventions, starting from Regulation 2022/1032 (June 2022) that established binding targets for the EU's storage capacity before the start of each heating season (1 November); the targets were set at 80% of the EU's storage capacity for 2022 and increased to 90% for subsequent years. Regarding demand reduction measures, Regulation 2022/1369 introduced voluntary targets aimed at reducing gas consumption by 15% between August 1, 2022, and March 31, 2023, in support of gas storage efforts. This intervention was further bolstered by Regulation 2022/1854, which introduced a mandatory 5% reduction in peak electricity consumption, accompanied by a voluntary 10% reduction in overall electricity consumption from December 2022 to March 2023.[31]In December 2022, Regulation 2022/2576 created a mechanism for joint gas purchasing among Member States and, in the same month, Regulation 2022/2578 introduced a market correction mechanism (the so-called "gas price cap") to limit gas price fluctuations and prevent the occurrence of episodes of high volatility,

[29]Natural gas is not directly targeted by sanctions imposed by the EU against the Russian energy sector, contrary to both coal and oil. Coal came to a complete embargo in August 2022 as part of the EU's fifth sanctions package, whereas an almost complete embargo on seaborne crude oil imports was included in the sixth's EU package measure, applying to crude oil imports from 5 December 2022 and to refined oil products from 5 February 2023. Similar measures were adopted by jurisdiction outside the EU bloc, in particular Canada, UK, and the US, see (Dunn and Neely, 2023) and (Bank of Italy, 2023b) for further details.

[30]See the official REPowerEU web page at https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en or Bank of Italy (2022) and https://fsr.eui.eu/first-look-at-repowereu-eu-commission-plan-for-energy-independence-from-russia/ for details. The REPowerEU plan also introduced 2030 targets of renewable energy capacity and set the stage for European regulatory interventions aimed at simplifying tender procedures and facilitate the roll-out of renewable energy production.

[31]The same regulation also introduced a mandatory cap on market revenues obtained from electricity production and the provision of their use to finance measures in support of final electricity customers to mitigate the impact of high electricity prices.

such as the ones recorded in the summer of 2022.[32] Structural measures were not limited solely to regulatory interventions but also encompassed several initiatives to exert stronger influence on the gas market and ensure uninterrupted supplies within the EU bloc. Among these measures, EU countries took action to enhance their LNG capacities and expand import terminals (see Section 3).[33] Furthermore, both the EU and its Member States actively pursued diversification of natural gas suppliers and solidified partnerships with non-Russian counterparts (e.g. the United States, Norway, and Qatar) to increase LNG imports or to augment the volume of natural gas transported through pipelines (e.g. EU agreement to increase the pipeline capacity from Azerbaijan or new contracts with Algeria and Libya signed by the Italian Government).

Fiscal relief measures. As a second line of intervention, several fiscal measures were adopted to counter the impact of soaring energy prices for households and firms. Different types of measures were implemented, including the reduction of energy taxes, the introduction of energy price caps for both retail and industrial customers, government transfers to vulnerable groups, and government support to companies. In some circumstances, direct interventions, such as nationalizing struggling energy companies, were also implemented.[34] While fiscal measures have undoubtedly played a crucial role in shielding consumers from spikes in energy prices, they have also placed a significant burden on government finances.[35] According to data compiled by the Bruegel think tank,[36] European countries allocated over 650 billion euros between September 2021 and January

[32]The mechanism came into effect on 15 February 2023, and has not been utilized thus far. The mechanism activates when two conditions are met simultaneously: (a) the price of one-month gas futures traded on the TTF market exceeds 180 euros per megawatt-hour, and (b) the spread between the price of one-month gas futures and the average price of LNG cargoes delivered in Europe exceeds 35 euro per megawatt-hour.

[33]Historically, these terminals were concentrated in Spain, Portugal, and North-Western Europe.

[34]See for example the German government decision to nationalize Uniper in 2022.

[35]In several countries, some of these fiscal measures were funded through the implementation of windfall taxes on energy producers.

[36]The dataset is available at https://www.bruegel.org/dataset/national-policies-shield-consumers-rising-energy-prices.

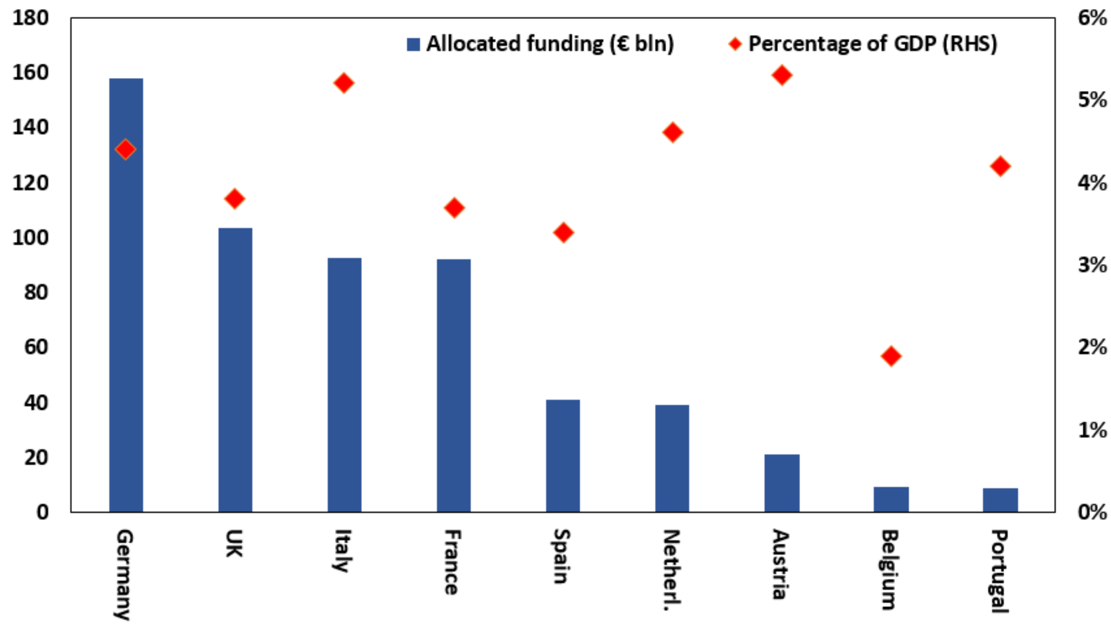


Figure 25: Government response to the energy crisis among selected European countries. Data for the period September 2021 to January 2023 from Sgaravatti et al. (2023b).

2023 to address the impacts of the energy crisis.[37] The lion's share of this sum was put in place in Germany, which adopted fiscal measures for around 158 billion euros, while Italy and France each allocated approximately 90 billion euros, see Figure 25. At the Euro–area level, the implemented fiscal interventions for the year 2022 amounted to roughly 2% of the bloc's GDP (Checherita-Westphal and Dorrucci, 2023). These interventions primarily comprised non-targeted energy measures, meaning they were not specifically designed to make energy prices more affordable for low-income households and the most-affected industries. In addition to reflecting the severity of the energy shock's impact, these measures were also contingent on the available fiscal space, see Bank of Italy (2023a) and Marchese (2023) for a review. In turn, this has raised concerns about how the absence of a

[37]Another dataset on the government support to tackle the impacts of the energy crisis has been developed by the IEA and is available at https://www.iea.org/reports/government-energy-spending-tracker-2; according to IEA (2023b), the EU was responsible for around two-thirds of government affordability support worldwide.

coordinated EU energy policy and the lack of harmonized support schemes could potentially exacerbate competitive challenges in the EU and undermine the fairness of the EU single market (Sgaravatti et al., 2023c, Sgaravatti et al., 2023a).

9 Conclusion

The Russian invasion of Ukraine exposed the world to an unparalleled energy crisis, with themes such as energy security and the interconnectedness of energy markets retaking center stage in both the academic and policy debate. Though the crisis reverberated globally and across various energy commodities, Europe stood at the epicenter of the shock, with massive spikes in natural gas prices being the most apparent consequence of the energy turmoil. Already under strain by the post pandemic recovery, energy prices were further exacerbated by Russia's increased weaponization of its gas supplies, leveraging on its pivotal role as a major exporter of fossil fuels. Consequently, the macroeconomic outlook deteriorated markedly, with reduced growth prospects, mounting inflationary pressures, and severe strain on global value chains amid increasing geo-economic fragmentation.

The conflict led to a significant transformation of the global energy trade landscape with a notable impact on the European gas market. Historically a locally integrated area with heavy reliance on a primary supplier, the EU evolved into a macro hub much more integrated with global gas flows. The transformation of the European gas market spanned across several dimensions with the energy security paradigm being the underlying fil rouge. Measures such as diversification of energy suppliers, energy saving initiatives, and shifts in contractual terms to ensure both destination and duration flexibility were put into action to cushion the impact of the crisis. In this context, LNG emerged as the key enabling factor to close market-imbalances across geographical areas, significantly enhancing the integration of

Europe within the global gas market.

A wide range of policy interventions combined with sizable demand destruction and exceptionally mild temperatures in Europe also played a role in ensuring energy supply continuity during the winter of 2022/2023. However, this achievement came at great costs. First, governments in Europe swiftly committed to substantial fiscal support to shield vulnerable households from rising energy prices, ensure firms business continuity, and secure alternative energy sources. Second, the increased contract flexibility, while it effectively mitigated risks of excessive dependence on a single supplier and encouraged supply diversification, also heightened the sensitivity of natural gas inputs to unexpected market shocks. Third, despite dropping significantly from their peak in August 2022, gas prices in 2023 stood persistently higher than their pre-crisis levels, reflecting the increased costs of LNG supplies in comparison to pipeline gas and the persistently tight market conditions ensuing from Russian export reductions.

Going forward, the outlook for the natural gas market remains subject to high uncertainty. The market equilibrium appears fragile, and a potential resurgence of price volatility and threats to energy supplies could arise from various factors: weather-related conditions impacting both power generation or heating demand, high capacity utilization at LNG facilities, further halts to Russian gas deliveries to Europe, or increasing pressures in the global LNG market - especially if China's demand were to fully recover.[38] Upward risks to natural gas prices may also arise from new threats and disruptions to European energy infrastructures, as was the case in October 2023 with a relatively minor gas pipeline, the Balticconnector.

The 2022/23 energy crisis, beyond its significant social and economic costs, has also underscored to policymakers the vital need to invest in a clean energy transition to ensure

[38] See Corneli et al., 2023 for an analysis of the effects of China economic developments on global commodity prices.

accessible and affordable energy supplies, and align economic paths with the commitment to decarbonize and hasten the shift towards a more sustainable growth paradigm (Birol, 2023, Sgaravatti et al., 2023c, Cevik and Ninomiya, 2023). In the case of Europe, future actions in this regard have a dual significance. On one side, persistently higher energy costs compared to other geographical areas with relatively cheaper energy inputs could have material implications for European firms' competitiveness (Ferriani and Gazzani, 2023b, Bialek et al., 2023, European Commission, 2023). They could also impact the EU internal market if uncoordinated energy policies and support schemes persist amid new energy market turbulence (Faiella and Mistretta, 2020, González and Alonso, 2021). On the other side, as Europe moves towards a clean-energy paradigm to enhance its energy security and efficiency, it should not only increase renewable energy investments substantially but also pursue a long-term strategy to address potential vulnerabilities arising from critical minerals necessary for the transition, particularly those related to the geographical concentration of both upstream and downstream activities of the critical material supply chain (Leruth et al., 2022, Kowalski and Legendre, 2023). This approach is crucial to prevent a recurrence of the vulnerabilities experienced during the natural gas crisis while transitioning to electrification.[39]

[39] On this, see the EU Commission proposal for a Critical Raw Materials to address the risks of critical raw materials supply disruption and the structural vulnerabilities of EU critical raw materials supply chains.

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