The European gas market

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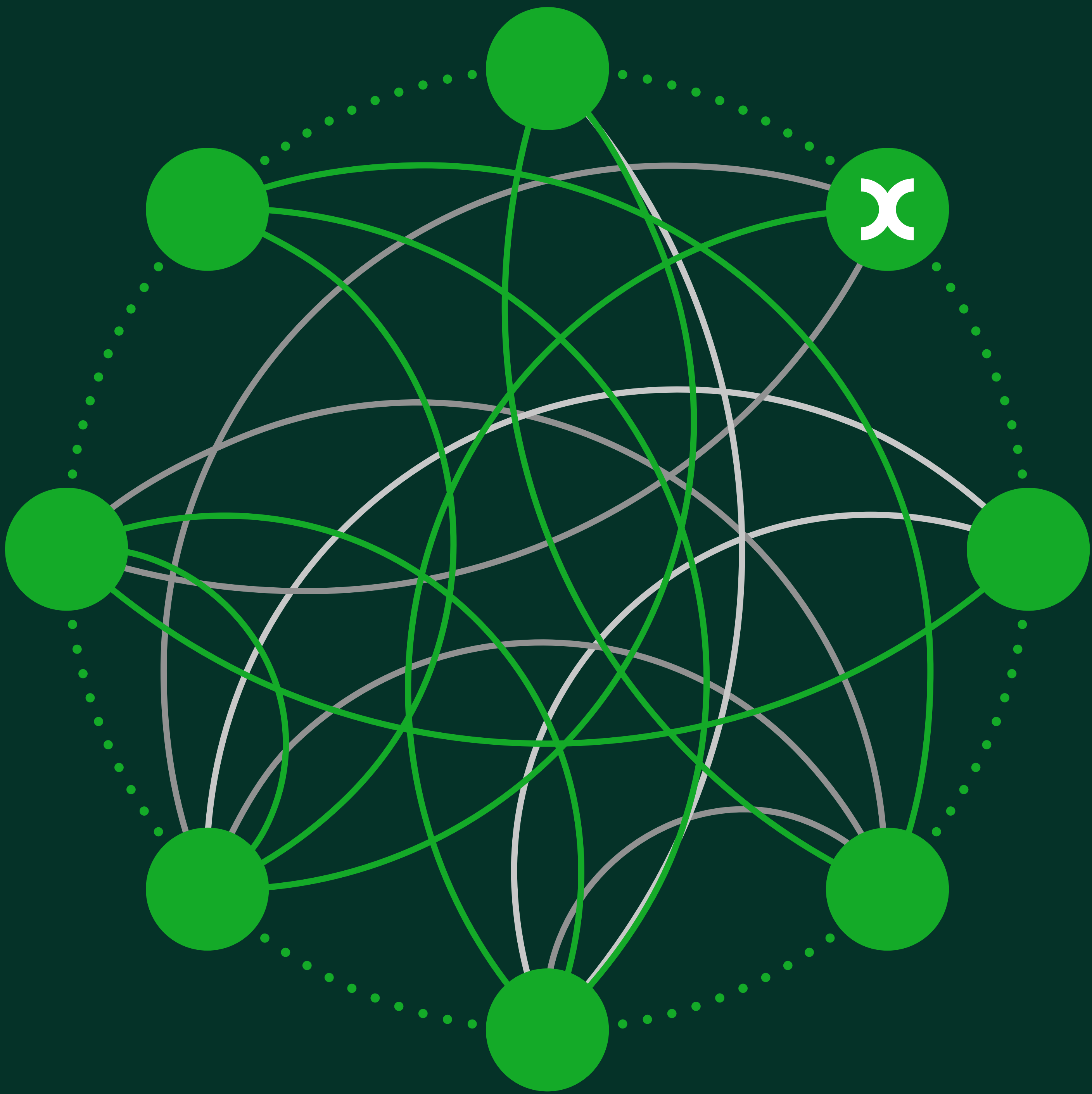
Report prepared for ICE

13 December 2022



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Executive summary

Energy prices in Europe started rising in autumn 2021. Energy demand had increased as the COVID-19 pandemic receded, which coincided with a tight liquified natural gas (LNG) market and relatively low gas storage volumes going into winter 2021/22. In early 2022, Russian aggression towards Ukraine and the corresponding reduction in Russian gas supplies to Europe fuelled further price increases, with gas prices increasing tenfold relative to the previous year. Prices at the Dutch Title Transfer Facility (TTF), the largest and most liquid gas hub in Europe, were particularly high, and price differentials with other market areas and LNG prices also increased over 2022.

This led to concerns about the impact on electricity prices and the wider impacts of inflationary pressures building in the economy. Alongside this, concerns were raised about greater gas price volatility and whether the TTF continued to be representative of market conditions elsewhere in the EU.

In light of these developments, the Intercontinental Exchange (ICE) has commissioned Oxera to analyse the functioning of the gas derivatives market. Our findings are as follows.

Gas markets

Gas hubs and exchange-based derivatives trading bring significant benefits to market participants.

There are various ways in which natural gas can be traded and priced. Over the past decade there has been a shift from prices in Europe being based on oil indexation to market-based pricing through greater competition between gas sources. Prices, especially in north-western Europe (NWE), continue to be driven by gas supply and demand dynamics and are actively traded on gas hubs. In the last few years the TTF has become the largest and most liquid of these hubs by a significant margin. This consolidation of trading on a mature hub brings numerous benefits to traders and consumers. Market participants across Europe use the TTF to hedge their positions even when the underlying asset is not gas for delivery in the Netherlands but at other locations. The growth of the TTF market demonstrates that market participants continue to choose to hedge by trading on the TTF market rather than on local hubs (thereby accepting a basis risk[1] because of the superior liquidity of the TTF). Effective hedging provides price certainty and thereby reduces the cost of capital, which in turn reduces costs to consumers.

Trading can occur on exchanges or over the counter (OTC). Exchanges are generally more easily accessible to all market participants and provide transparency. They are also subject to a range of financial

[1] A basis risk arises when, for example, the price of a TTF hedging instrument is not perfectly correlated with prices in another location. While this increases the risk of a price differential (or 'basis') between TTF and another location, this risk needs to be considered alongside the higher cost of trading in a market that is less liquid.

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and energy market regulations to prevent market abuse—more so than with OTC trading.

The physical gas situation since late 2021

While Europe is aiming to reduce its reliance on natural gas in the long term in order to reach 'net zero',[2] natural gas is currently an essential good, which is difficult to substitute in the short run. The recent drop in supply—caused primarily by Russia significantly curtailing pipeline gas exports to Europe—cannot be easily compensated via demand reductions alone, and replacement gas from other sources continues to be essential for balancing the European gas market. The alternative gas sources available are pipeline imports from other countries, such as Norway, or LNG, which is transported from overseas and arrives at terminals in Europe where it needs to be re-gasified and then transported (usually by pipelines) to its final destination. Our analysis finds that infrastructure bottlenecks have limited the gas flows and imports of LNG at certain times, leading to greater divergence between prices in some locations. In particular:

Price developments since late 2021 can be explained largely by market fundamentals, such as infrastrucutre constraints.

- many of the LNG terminals in NWE were running at or close to full capacity in 2022. This means that, while LNG is available, there are limits to how much of it can be injected into the NWE pipeline system;
- where terminals are not at capacity (for instance, in the UK), transport bottlenecks have arisen on the interconnectors between countries, limiting the transportation of gas to some European countries.

These infrastructure bottlenecks in physical markets largely explain the high gas prices in 2022 and why price differentials have opened up between TTF prices, other hubs and LNG price indices.

The relatively high prices that have developed as a result of these physical infrastructure constraints play an important signalling role. First, higher prices suppress demand, which in turn alleviates pressure on prices. Second, higher prices provide investment signals to motivate the expansion of capacity for infrastructure that causes bottlenecks. Indeed, Germany, for instance, decided to construct new LNG terminals soon after the Russian invasion of Ukraine.[3] Moreover, in the Netherlands Gasunie subsidiary EemsEnergyTerminal started using an additional floating LNG terminal in September 2022 in response to gas supply insecurities and a desire to be less dependent on Russian gas. Finally, gas prices also provide long-term investment signals for other technologies (e.g. renewable and low-carbon gases such as biomethane and hydrogen).

[2] The EU aims to be climate-neutral by 2050—that is, to become an economy with net zero greenhouse gas emissions. This objective is central to the European Green Deal and in line with the EU's commitment to global climate action under the Paris Agreement.
[3] Reuters (2022), 'Germany ramps up capacity for LNG imports to replace Russian gas', 5 May, https://www.reuters.com/business/energy/germany-ramps-up-capacity-lng-imports-replace-russian-gas-2022-05-05/ (accessed 1 December 2022).

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The gas derivatives market is functioning well overall, providing liquidity, resilience and price formation.

Given that the market is working largely as intended, the price cap proposed by the Commission is unlikely to be effective and may risk financial stability.

Derivatives markets since late 2021

Despite general agreement on the fundamental drivers of high prices, there have been some concerns around the TTF derivatives market, and a question over whether it is still functioning adequately. We have analysed indicators for resilience, liquidity and price formation[4] to assess whether the market is functioning well. Overall, the analysis has shown a well-functioning market, with:

- **a diverse trading base** including utility firms, oil and gas companies, trading houses, financial participants, buyside, and liquidity providers;
- **stable open interest** values. Due to high prices, the value (as opposed to volume) of trades has increased. This is in line with information obtained from traders that market participants are credit-constrained (and therefore cannot do the same amount of trading as before the crisis at current prices). The price developments have also caused a shift in the composition of traders, with investment funds having largely ceased trading in the gas market, while trading by commercial undertakings has continued. This suggests that a certain level of trading is required for these commercial companies to continue their core operations;
- **stable relative bid–ask spreads**, in line with historical trends;
- **no evidence of excessive speculation** driving prices or volatility.

Gas market interventions

In response to high gas prices, the European Commission ('the Commission') put forward proposals to intervene in the gas market, including a market correction mechanism that would effectively establish a price cap on certain TTF derivatives.[5] This proposal may lead to adverse unintended consequences that could have knock-on effects on the wider market (e.g. in terms of power or emissions), as follows.

- **Inefficient price signals**. Having a simple price cap makes it more likely that the market will not provide efficient price signals that would encourage gas users to reduce their demand, and incentivise producers or shippers to increase their supply.
- **A shift to OTC and other TTF derivatives markets, resulting in lower liquidity and higher hedging costs**. The Commission's price cap proposal applies to TTF contracts with specific maturities, including the front-month contract. This means that trades at higher prices can still happen in all other TTF futures markets, on all the contracts traded on the OTC (including the capped futures contract), and in the spot market. If the cap were triggered, this would therefore not

[4] Price formation refers to the process that determines market prices through the commercial decisions of market participants. While efficient price formation is enabled by markets having sufficient resilience and liquidity, it is also characterised by the breadth of the contracts and instruments that are available and traded, and the ability to absorb large orders without leading to a material change in price (i.e. 'depth').
[5] European Commission (2022), 'Commission proposes a new EU instrument to limit excessive gas price spikes', 22 November, https://ec.europa.eu/commission/presscorner/detail/en/ip_22_7065 (accessed 2 December).

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actually cap all wholesale gas transactions because contracts with similar characteristics can be traded on the OTC market or on other hubs. Moreover, an intervention that applies only to exchange-based trading means that trading is likely to shift to OTC if the cap is triggered. However, exchange-based trading has significant benefits relative to OTC. A shift to OTC would mean less transparency for the market and less liquidity in the TTF, because a not-insignificant number of market participants that trade on the exchange do not have access to the OTC. This, in turn, could make hedging more inefficient and costly for market participants, increasing costs to the consumer.

- **Reducing liquidity in the most important market**. The price cap is intended to apply to front-month energy-related commodity derivatives. These tend to be the most liquid markets, as they refer to futures with the closest maturity and are therefore used by hedging parties to adjust their positions. If the proposed regulations were to result in a drop in liquidity, this would jeopardise the ability of companies to adjust their positions in close to real time.
- **Risking financial (in)stability (trades might not be honoured and gas could remain in storage rather than being traded)**. In its opinion of 2 December, the ECB considers that the current design of the proposed market correction mechanism may, in some circumstances, jeopardise financial stability in the euro area. The mechanism's current design may increase volatility and related margin calls, challenge central counterparties' ability to manage financial risks, and may also incentivise migration from trading venues to the non-centrally cleared over-the-counter (OTC) market.[6] If price caps on TTF futures prices were introduced, this would affect the existing positions of companies trying to hedge. A recent paper by the Oxford Institute of Energy Studies showed how a cap below the market price would be likely to lead to trades not being honoured, potentially leading to large financial losses.[7]
- **The long-term impact on futures markets**. In the long term, fossil fuels, including natural gas, are planned to be phased out. Unless other measures are introduced to mitigate their effects, wholesale market interventions that lead to lower levels of liquidity and less efficient price signals could therefore have spillover effects, for instance on investment signals for renewable and low-carbon gases, as recognised by European energy regulators.[8]

[6] European Central Bank (2022), 'OPINION OF THE EUROPEAN CENTRAL BANK of 2 December 2022 on a proposal for a Council regulation establishing a market correction mechanism to protect citizens and the economy against excessively high prices (CON/2022/44)', 2 December, https://www.ecb.europa.eu/pub/pdf/other/en_con_2022_44_f_sign~6183314e58.it.pdf?03da916dda2e61d4a50b7132bfafd961 (accessed 12 December).
[7] Oxford Institute for Energy Studies (2022), 'The Consequences of Capping the TTF Price', October, https://a9w7k6q9.stackpathcdn.com/wpcms/wp-content/uploads/2022/10/The-Consequences-of-Capping-the-TTF-Price.pdf (accessed 20 November).
[8] Council of European Energy Regulators (2022), 'Input on the revision of EU rules on market access of gas networks: CEER feedback note for the European Commission', 12 April, p. 2.

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Given these risks, the Commission's price cap proposal is unlikely to achieve its intended effect of reducing market prices for gas.

In addition to not being effective, the Commission's price cap is likely to significantly distort the trading of TTF derivatives. For example, a key concern is that liquidity providers (which do not have access to OTC derivatives) will see the price cap as limiting their ability to close out their short positions, thereby increasing their trading risks substantially. Anticipating this, liquidity providers may withdraw from the market, thereby undermining the TTF's liquidity, which is currently the most liquid gas market in the EU.

Notwithstanding these concerns, there remains a rationale for a package of measures that could reduce energy prices in the short term. Such a policy package would be targeted at reducing the impact of high energy prices on consumers as well as limiting the risk of business closures in the EU and the relocation of industrial capacity away from the EU. For example, such a package of measures could involve additional incentives to increase LNG imports through joint procurement, direct subsidies or other competitively tendered out-of-market payments (as seen in the electricity sector and elsewhere), as well as demand reduction and fuel-switching incentives.

In theory, a time-limited cap on prices could also be part of such a policy package, but it is not clear that a price cap would necessarily be the least costly or least distortive measure available. Also, any price cap applied to the wholesale gas market will require a high level of coordination between member States and different players, especially if implemented EU-wide. Therefore it might be administratively challenging to implement. Other measures such as targeted support to residential or industrial users might be administered more easily.

Ultimately, the design of any policy package to address the current energy price crisis should consider the benefits, costs and risks of different measures.

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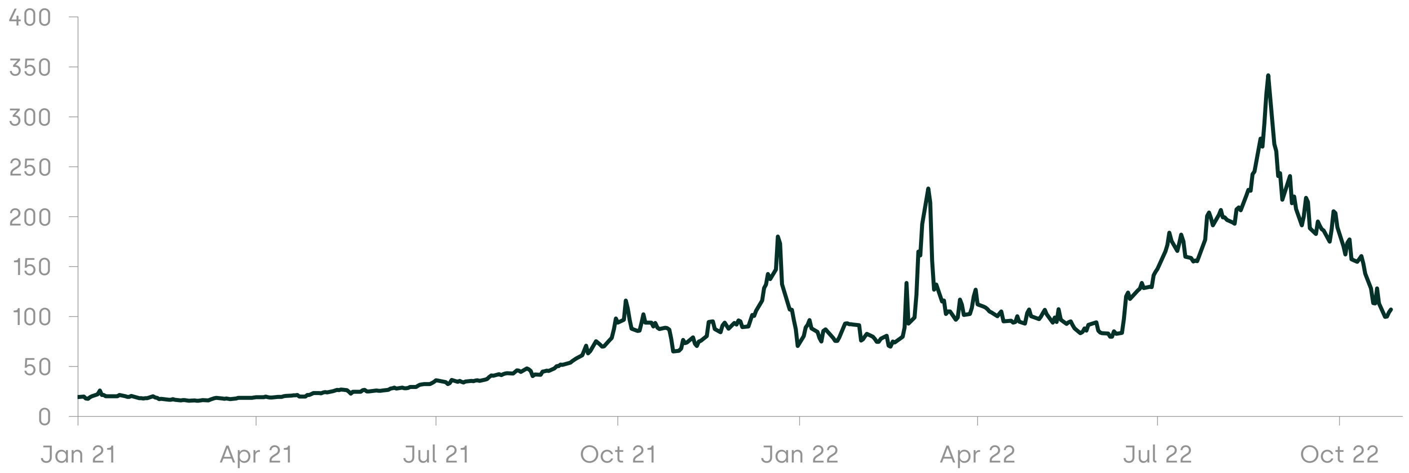
1 Introduction

1.1 Context

Over the past year, macroeconomic and political developments have had a major impact on European gas prices, with prices rising to unprecedented levels. In particular, the reduced supply of natural gas following Russia's invasion of Ukraine and the subsequent decline in gas exports to the EU has driven up prices since spring 2022. This is shown in Figure 1.1. Gas prices have been affected by these developments, including the Dutch Title Transfer Facility (TTF), which is the most liquid gas 'hub' (or market pricing area) in Europe.[9]

Figure 1.1 European gas prices (TTF front-month) since 2021 (€/MWh)



Source: Bloomberg.

To combat the impact of high gas prices on consumers and businesses, the European Commission (the 'Commission') has put forward proposals to enable future gas wholesale market interventions. These include a market correction mechanism that would establish a maximum 'dynamic' price above which transactions pertaining to certain TTF futures contracts cannot take place on European commodities exchanges under specific conditions—that is, a price cap.[10,11]

[9] Formally, TTF is the virtual trading point ('VTP') located in the Netherlands established by Gasunie in 2003 that allows its users to trade gas—or otherwise exchange through centralised notifications of transfers of gas—held within the gas transmission system operated by Gasunie Transport Services. TTF enables its users to access pipeline, LNG, storage, and ancillary services.
[10] European Commission (2022), 'Proposal for a COUNCIL REGULATION: Enhancing solidarity through better coordination of gas purchases, exchanges of gas across borders and reliable price benchmarks', 18 October, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52022PC0549 (accessed 25 November).
[11] European Commission (2022), 'Commission proposes a new EU instrument to limit excessive gas price spikes', 22 November, https://ec.europa.eu/commission/presscorner/detail/en/ip_22_7065 (accessed 20 November).

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1.2 Research questions

In light of this, the Intercontinental Exchange (ICE) commissioned Oxera to analyse the gas derivatives market and determine:

- the drivers of the current energy crisis and to what extent prices are attributable to the underlying market fundamentals;
- the role of market mechanisms in transitioning to low-carbon energy sources;
- the benefits of derivatives markets and the economic value of energy derivatives exchanges, including an analysis of the functioning of the gas derivatives market during the events of 2022.

1.3 Structure of the report

- Section 2 sets out the fundamentals of gas trading and the role of the TTF.
- Section 3 examines the role of derivatives and derivatives exchanges in the European gas market.
- Section 4 analyses the functioning of the TTF derivatives market, including evidence of market resilience, liquidity and price formation.
- Section 5 looks at the fundamental drivers behind recent gas price developments, how TTF and LNG prices are related, and how gas prices and derivatives trading are related. It also analyses speculative trading in the gas market.
- Section 6 discusses policy implications and concludes.

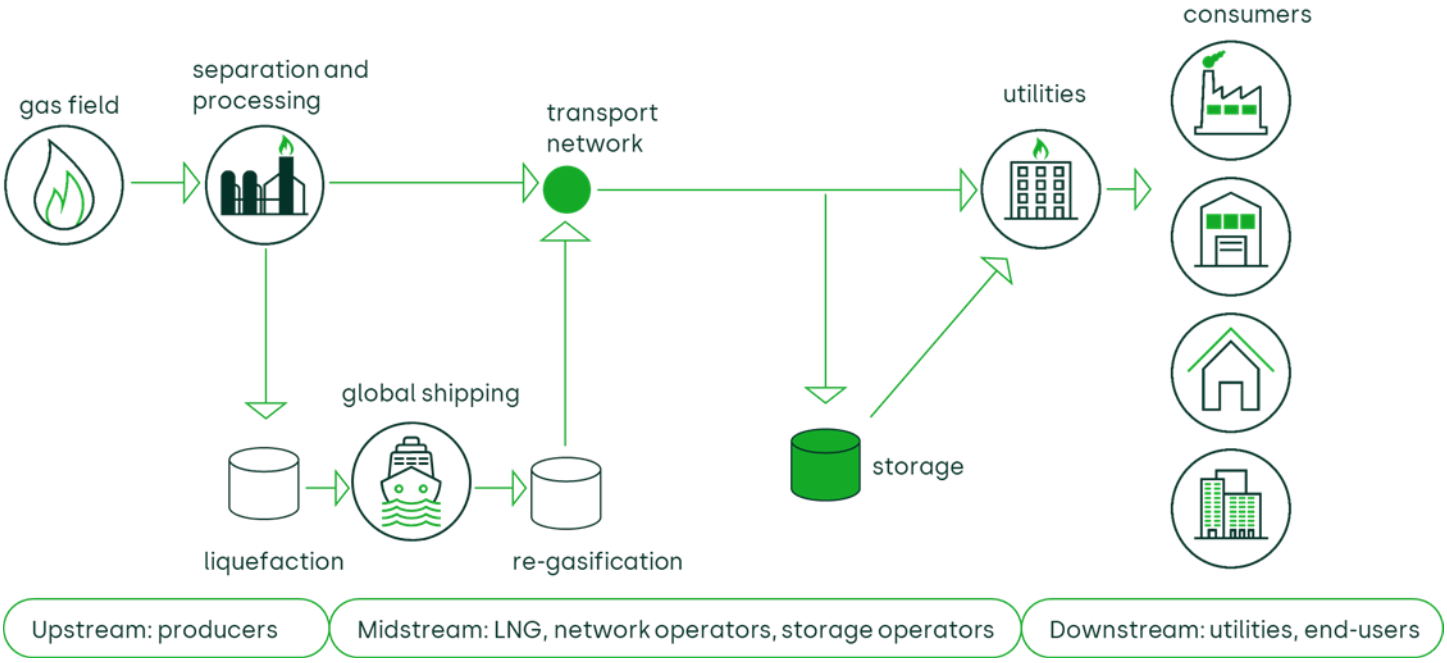
2 The fundamentals of gas trading

Before discussing the role of financial instruments related to the gas market, this section first sets out the background of the gas market. Natural gas is a fossil fuel comprised mainly of methane and can be found in natural gas fields, obtained as a by-product of oil production, or found in coal or shale formations. Natural gas can be burned to produce heat or used to generate electricity, and it is also a key industrial feedstock (e.g. for the production of hydrogen, ammonia and methanol). The extraction, processing and transportation of gas, is described in section 2.1.

2.1 The gas supply chain

The natural gas supply chain can be categorised into three segments: 'upstream', 'midstream' and 'downstream'.

Figure 2.1 The gas supply chain



Source: Oxera.

2.1.1 Upstream

The first stage in the natural gas supply chain involves the upstream location and extraction of raw natural gas from wells or shale rock formations.

Once raw natural gas is extracted, it is processed to prepare it for final use. This involves eliminating contaminants and separating out other by-products (e.g. natural gas liquids).

The majority of gas consumed within the EU is produced in gas fields in Russia, Norway, North Africa and the Caspian region. Historically, Russia has been the largest supplier of gas to the EU, accounting for over 40% of total imports in 2020 (see also Figure 5.3).[12] A relatively small, and declining, share of gas consumed in the EU is produced in the region. In 2020, the Netherlands was the largest EU producer, though this comprised less than 5% of EU inland demand.[13]

2.1.2 Midstream

Midstream activities include the transportation, processing and storage of natural gas. This segment includes many independent transportation operators.

Gas can be transported in two ways:

- **pipelines** are the primary means of transporting natural gas from the source to consumers. For example, Russian pipelines enter Europe through Germany, Poland, Ukraine and Turkey. Similarly, Norwegian gas enters via pipelines to Germany, the Netherlands, Belgium and the UK. In EU member states, the infrastructure associated with transporting natural gas through pipelines is owned and operated by transmission system operators (TSOs), such as Gasunie Transport Services (GTS) in the Netherlands;
- **LNG** is natural gas cooled down to -160˚C and then transported via specially designed ships in a liquid state. Before LNG can be fed into a pipeline system or used by consumers, it must be converted back to a gaseous state. This 're-gasification' process takes place at large import terminals where the liquid gas (which arrives in batches) is stored in tanks and subsequently transferred into pipelines over a period of time.

2.1.3 Downstream

The downstream companies manage the sale and marketing of gas. These companies include large industrial users, gas-fired power plants, fertiliser producers and retailers selling gas to end-consumers.

2.1.4 Price formation

There are three main regimes for pricing natural gas regardless of whether it is being delivered by pipeline or via LNG transport:[14]

(i) hub pricing, also referred to as 'gas-on-gas competition' or 'market-based pricing'. Hub pricing represents a framework where natural gas is priced based on the interplay between gas demand and supply;
(ii) oil indexation, which involves contractually pricing natural gas using the price of crude oil and potentially other fuels or other relevant price indices;

[12] International Monetary Fund (2022), 'Natural Gas in Europe: The Potential Impact of Disruptions to Supply', 19 July, https://www.elibrary.imf.org/view/journals/001/2022/145/article-A001-en.xml (accessed 25 November).
[13] Eurostat (2022), 'Natural gas supply statistics', April, https://ec.europa.eu/eurostat/statistics-explained/SEPDF/cache/10590.pdf (accessed 3 December).
[14] Categories (with some categories combined or omitted) based on International Gas Union (2022), 'Wholesale Gas Price Survey 2022 Edition', https://www.igu.org/resources/2022-wholesale-price-report/ (accessed 30 November).

(iii) regulated prices determined by governments.

Over the last two decades, gas prices in the EU have gradually moved towards gas-on-gas competition and away from oil indexation,[15] with gas-on-gas pricing accounting for 77% of gas volumes in 2021.[16] There are significant regional differences within Europe: in north-western Europe (NWE) gas-on-gas pricing was by far the most used price mechanism in 2021 accounting for 95%, whereas the Mediterranean price formation relies more heavily on oil indexation (54% in 2021).[17] Gas trading mainly occurs at different hubs, with local market conditions, transmission capacity availability, gas storage capacity, gas balancing rules, supply-side diversity and network tariffs[18] typically driving the price differentials between market hubs.[19]

In this context, the EU gas wholesale market can be seen as being comprised of the physical infrastructure, trading platforms, and regulatory arrangements that enable hub prices to be established and which help to ensure efficient gas production, importation, transportation, storage, and consumption.[20] As set out in section 3.1, the EU gas wholesale market also encompasses multiple interrelated markets for trading of standardised products for balancing (i.e. daily or within day) volumes as well as volumes required for the next day or in future months and years. These temporal markets are also replicated across different market pricing areas.

As the EU gas market has developed, competition has improved, and prices have increasingly reflected the underlying demand and supply drivers. In turn, this has been associated with increased market liquidity and exchange-based trading. Indeed, as ACER concluded in 2021, the EU gas market demonstrated its resilience during the COVID-19 pandemic as the market remained competitive and liquid.[21]

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[15] International energy agency (2021), 'Despite short-term pain, the EU's liberalised gas markets have brought long-term financial gains', 22 October, https://www.iea.org/commentaries/despite-short-term-pain-the-eu-s-liberalised-gas-markets-have-brought-long-term-financial-gains (accessed 25 November 2022).
[16] International Gas Union (2022), 'Wholesale Gas Price Survey 2022 Edition', p. 54, https://www.igu.org/resources/2022-wholesale-price-report/ (accessed 30 November).
[17] International Gas Union (2022), 'Wholesale Gas Price Survey 2022 Edition', p. 56, https://www.igu.org/resources/2022-wholesale-price-report/ (accessed 30 November).
[18] Transmission tariffs enable the transmission operators to recover the allowed revenues which are usually based on the efficient costs for operating the network, including an appropriate return on network investment.
[19] Enrico, T., Conti, T. and Cervigni, G. (2022), 'High Gas Prices in Europe : A Matter for Policy Intervention?', 12 January, https://fsr.eui.eu/publications/?handle=1814/73596 (accessed 25 November).
[20] Since 2015, EU and national authorities have developed and pursued the implementation of the 'Gas Target Model'. See ACER (2015), 'European Gas Target Model review and update', January, https://documents.acer.europa.eu/Events/Presentation-of-ACER-Gas-Target-Model-/Documents/European%20Gas%20Target%20Model%20Review%20and%20Update.pdf (accessed 3 December 2022).
[21] ACER (2021), 'Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2020', 14 July, p.10, https://www.ceer.eu/documents/104400/7244444/ACER+Market+Monitoring+Report+2020+-+Gas+Wholesale+Markets+Volume/ad47592a-d769-9950-3dc6-740c0300e72e (accessed 3 December).

The market fundamentals affecting recent gas price developments are discussed in detail in section 5.1.

2.2 The role of the TTF

In Europe, as of 2021, there were 28 gas trading hubs with TTF and the National Balancing Point (NBP, the gas hub in Great Britain, 'GB') recognised as being the two 'mature' European hubs—that is, where gas trading markets are widely considered as transparent, liquid and deep.[22] Four hubs were classified as active, five as poor and the remaining ones as inactive.[23]

The TTF is by far the largest hub by both number of available products and volumes traded. In 2019 the volumes traded on the TTF accounted for 79% of total traded volumes in Europe.[24] The TTF grew rapidly due to its attractiveness for market participants who are not only looking to hedge their exposure to natural gas in Europe but also seeking to arbitrage global LNG supplies. This is in part because the TTF is the only European hub with significant liquidity in the medium- to long-term price curve. Due to this high liquidity, market participants across Europe use the TTF to hedge their positions even if the underlying asset is not necessarily gas in the Netherlands but in other locations. This means they choose to hedge using the TTF rather than local hubs (thereby accepting a basis risk over a liquidity risk). Historically, prices on all other European hubs have been highly correlated with the TTF price. This is because the TTF serves as the key European gas price benchmark with a significant number of LNG cargoes and other hubs pricing against it. Figure 2.2 shows the development of one-year ahead futures across different global hubs. With the exception of the US-based Henry Hub, prices have developed very similarly over time.

[22] Liquidity is the feature of a market that enables a buyer or seller to complete a transaction quickly without causing a material change in the price of the commodity. Market depth refers specifically to the ability of the market to absorb large orders without having a material change in price. Liquid and deep markets are typically characterised by having a large number of willing buyers and sellers trading with each other frequently and where buy and sell orders for significant volumes are broadly evenly distributed around the prevailing market price.
[23] Oxford Institute for Energy Studies (2021), 'European Traded Gas Hubs: German hubs about to merge', July, p.2.
[24] Heather, P. (2020), 'European traded gas hubs: the supremacy of TTF', OIES, May, p. 4.

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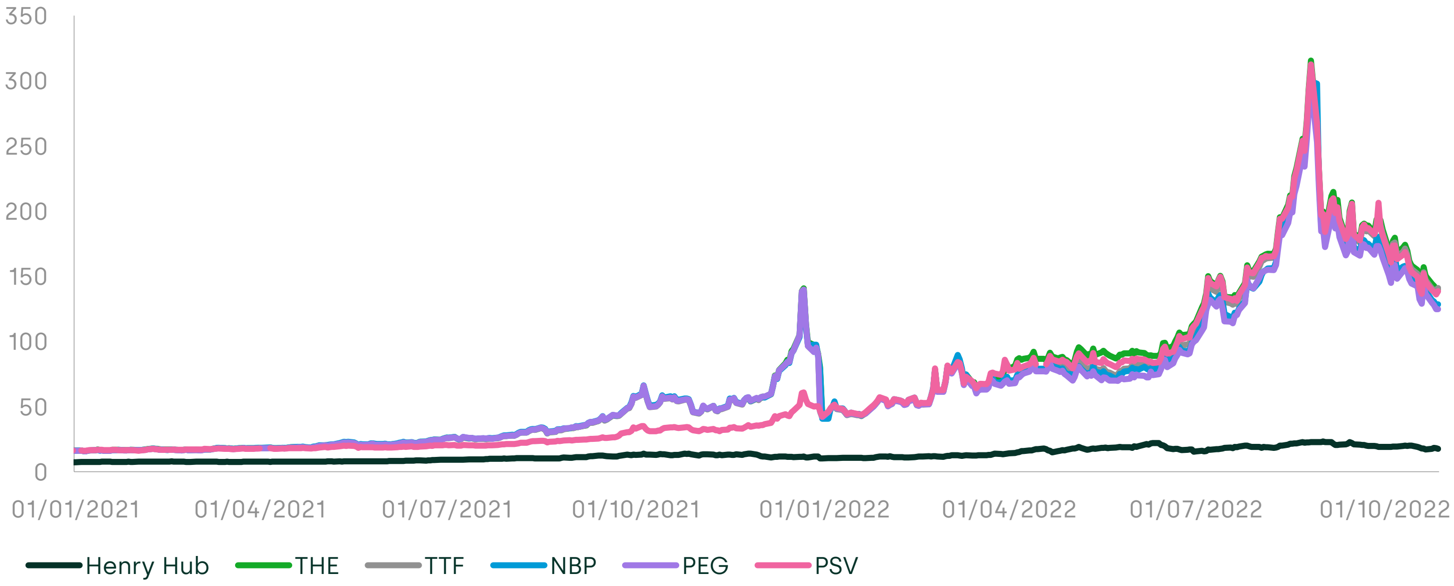
Figure 2.2 Prices for futures on different gas hubs (€/MWh)



Source: Oxera analysis based on Bloomberg data.
Note: THE, Trading Hub Europe (based in Germany); NBP, National Balancing Point (based in the UK); PEG, Point d'échange de gaz (based in France); PSV, Punto di Scambio Virtuale (based in Italy). Prices for futures contracts with delivery in 2023.

There are significant economic benefits to concentrating trading activities on a single or a few hubs, such as the TTF; the key ones being improved price formation and increased liquidity. Liquidity, especially beyond the spot market, allows market players to hedge and otherwise manage the risks of their gas portfolios, lowering costs and bringing benefits to end-consumers. The TTF offers significant liquidity beyond short-term futures. Hence, participants in markets without physical access to the TTF may still opt to take advantage of the liquidity not available in their local hubs and to hedge at the TTF. Given the high correlation of prices, these participants may hold the hedge until an alternative becomes available in the local market closer to the time of physical delivery.

The TTF's development as a key European gas trading hub has occurred due to a combination of market demand for a concentrated, liquid and transparent hub, unique infrastructure, good management, and flexibility in adapting to changing market conditions. Established in 2003, the TTF has seen exceptional levels of growth since 2007, when it began its ascension to become the primary European and global gas hub. Several factors and key developments underpinned its growth.

First, its location in the Netherlands provided access to a unique intersection of gas infrastructure and industry knowledge. The TTF and market participants on the TTF have access to a developed Dutch gas infrastructure, including domestic production, LNG facilities, storage facilities and, importantly, its geographic location in the 'heart' of Europe, where the main consumption area is.

Second, in 2009 the TTF was one of the first gas trading hubs that allowed for quality conversion—i.e. trading gas as energy in MWh rather than a specific quality or type of gas. This has become increasingly important since the transition of the gas market price formation from being mainly oil-linked to increasingly being based on gas-on-gas competition. These developments have significantly simplified the balancing regime by allowing the two separate grids with different quality specifications (related to their calorific values) to operate as if they were one.

Third, in 2011 the TTF introduced a 'market balancing regime', which has allowed participants to balance their positions in real time. This has greatly improved liquidity and transparency, leading to a more robust discovery of 'real' prices, further attracting market participants to trade on the TTF.

Additionally, due to its geographic location and sound infrastructure, the TTF has benefited significantly from the increased integration of the European gas markets, through the establishment of both new cross-country interconnectors and common European network codes and guidelines. The connectivity and access to both pipeline and LNG gas have meant that market participants could arbitrage any excess price differences not related to physical constraints, further aiding price discovery at TTF. Moreover, prices at the TTF are denominated in euros, which has helped it gain market share compared to the NBP, which uses pence/therm.

The above shows that the success of the TTF has not been random; rather, the TTF has grown by being perceived by market participants as the most suitable gas trading hub, due to its liquidity, transparency and maturity.

As a result, traded volumes on the TTF have more than doubled, from around 1,000TWh in 2017 to over 2,000TWh in 2019.[25] At the same time, trading on the second-largest European hub, the NBP, has decreased, from a similar starting point of around 1,000TWh in 2017 to around 500TWh in 2019.[26] The market is therefore consolidating around the TTF as the most liquid gas hub.

[25] Heather, P. (2022), 'European traded gas hubs: the supremacy of TTF', Oxford Institute for Energy Studies, May.
[26] Heather, P. (2022), 'European traded gas hubs: the supremacy of TTF', Oxford Institute for Energy Studies, May.

3 The role of derivatives and derivatives exchanges in the context of gas trading

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3.1 Derivatives in gas markets

A derivative is a financial instrument whose value depends on, or is derived from, the change in value of an underlying asset, benchmark, commodity, or other instrument, and through which the associated financial risks can be traded between parties.

While natural gas can be traded for immediate or very near-term delivery (referred to as the spot market), a significant amount of trading activity takes place using derivatives covering a wide variety of timeframes across relevant market areas.

This means that there is no single price for TTF but rather a system (or 'complex') of interrelated markets and associated prices. A key concept here is the 'forward curve', which defines the prices at a given point in time at which gas available in the TTF can be bought today for delivery at various points in the future. These delivery points can range from the next hours to years ahead. For the purposes of this report, the derivatives contracts of interest are those based on gas available at the TTF as the underlying commodity. However, it is important to recognise that there are many types of financial instruments used in gas markets, including futures, forwards, options and swaps:

- **TTF Gas futures**—these are agreements to buy or sell natural gas for delivery at the TTF at a certain future time for a pre-agreed price. Futures contracts which are held up to their expiry, result in the physical delivery of natural gas through the transfer of rights at the TTF Virtual Trading Point operated by Gasunie Transport Services (GTS), the TSO in the Netherlands. These contracts are standardised, traded on exchanges and centrally cleared.
- **TTF forwards**—these contracts also represent agreements to buy or sell TTF for delivery in the future. However, there are important differences in the market structure and regulatory treatment of forwards. In particular, TTF forward contracts: tend to be more bespoke agreements than futures; are traded in over-the-counter (OTC) markets; and are not formally classified as derivatives contracts under MiFID. The latter means that TTF forward contracts are subject to a separate regulatory regime to other derivatives contracts.[27]
- **TTF options**—a call (put) option gives the holder the right, but not the obligation, to buy (sell) the underlying TTF futures contract at a certain date for a certain price (known as the 'exercise' or 'strike price'). As with futures and forwards, options contracts traded and cleared on exchange are subject to different regulatory requirements to those traded in OTC markets.

[27] Derivatives with electricity and natural gas as underlying that must be physically settled and are traded on an Organised Trading Facility (OTF) are not classified as financial instruments under MiFID II, and are instead regulated by REMIT. This is sometimes referred to as the "REMIT carve-out". See: Directive 2015/65/EU, Annex I, Section C(6).

- **TTF swaps**—these are OTC financially settled contracts that allow two parties to exchange periodic payments that are related to the gas market price, such as the exchange of a fixed cash flow for a variable cash flow based on the outturn spot price.

Box 3.1 summarises the key aspects of the main TTF Gas futures contract offered by Endex.

Box 3.1 TTF Gas futures and options

Endex TTF futures

- TTF futures are contracts for physical delivery through the transfer of rights in respect of natural gas at the TTF Virtual Trading Point, operated by GTS. Delivery is made, equally each hour, on each gas day of the delivery period, from 06:00 to 06:00 (CET) on the following calendar day.
- Contracts represent 1MW of gas per hour per day in the contract period.
- Trading in TTF futures is available in contracts with delivery periods from 1 day-ahead up to 156 consecutive months in the future.
- Participants can trade contracts representing full calendar quarters, seasons and full-years as strips of monthly contracts.
- TTF futures contracts are priced in euros per MWh

Source: ICE (2022), 'Dutch TTF Natural Gas Futures', https://www.theice.com/products/27996665/Dutch-TTF-Gas-Futures, accessed 18 November 2022.

Derivatives play three key roles in gas markets.

(i.) They facilitate the transfer of risks from one entity to another, and in doing so help to improve the efficiency of markets. For example, a firm can purchase derivatives to have certainty over future gas prices rather than being exposed to spot market prices.
(ii.) Derivatives markets also play a major role in enhancing transparency by contributing to market participants' assessments of future gas pricing. In doing so, they contribute to long-term sustainability objectives and provide price signals to market participants and policymakers—e.g. regarding where and when to invest in infrastructure such as storage or import capacity based on price spreads between different market areas and through time.
(iii.) Efficient allocation of capital. A wide range of market participants use energy derivatives market to allocate capital to those asset classes where the risk-adjusted rate of return is commensurate with their risk-appetite.

The ability to hedge lowers these companies' funding costs by reducing the uncertainty of their cash flows.[28] As summarised in Table

[28] In a frictionless market, individual investors can hedge themselves. If the assumptions of a perfect capital market are violated (e.g. if investors do not have perfect

3.1 below, several academic papers show that, by reducing the volatility of these cash flows, hedging can have a tangible impact on the cost of capital. This research indicates that the ability to hedge can reduce the cost of debt by around 19–54 basis points (bp) and the cost of equity by around 24–78bp.

Table 3.1 Studies estimating the impact of hedging on the costs of financing

Study	Finding
Bartram et al. (2011)	The use of hedging can reduce betas by 15–31%, which can translate into a cost of equity reduction of 75bp[1]
Campello et al. (2010)	A change in hedging intensity by one standard deviation reduces loan spreads, lowering the cost of debt by 54bp
Carter et al. (2006)	Jet-fuel hedging increases airline firm value by around 12–16%
Chen and King (2014)	The cost of debt of hedgers is lower than that of non-hedgers by 19.2bp for investment-grade rating and by 45.2bp for speculative-grade rating
Gay et al. (2011)	Derivatives users have a cost of equity financing that is between 24bp and 78bp lower than that of non-derivatives users

Note: [1] The cost of equity reduction estimate is based on a market risk premium of 5%. Source: Bartram, S.M., Brown, G.W. and Conrad, J. (2011), 'The effects of derivatives on firm risk and value', *The Journal of Financial and Quantitative Analysis*, **46**:4, pp. 967–99. Campello, M., Lin, C., Ma, Y. and Zou, H. (2010), 'The real and financial implications of corporate hedging', NBER Working Paper No. 16622. Carter, D.A., Rogers, D.A. and Simkins, B.J. (2006), 'Does hedging affect firm value? Evidence from the US airline industry', *Financial Management*, **35**:1, pp. 53–86. Chen, J. and King, T.D. (2014), 'Corporate hedging and the cost of debt', *Journal of Corporate Finance*, **29**, pp. 221–45. Gay, G.D., Lin, C.M. and Smith, S.D. (2011), 'Corporate derivatives use and the cost of equity', *Journal of Banking & Finance*, **35**:6, pp. 1491–506.

3.2 The role of derivatives exchanges

Trading in gas derivatives takes place on derivatives exchanges (Regulated Markets) and in OTC markets (usually through platforms called Organised Trading Facilities).[29]

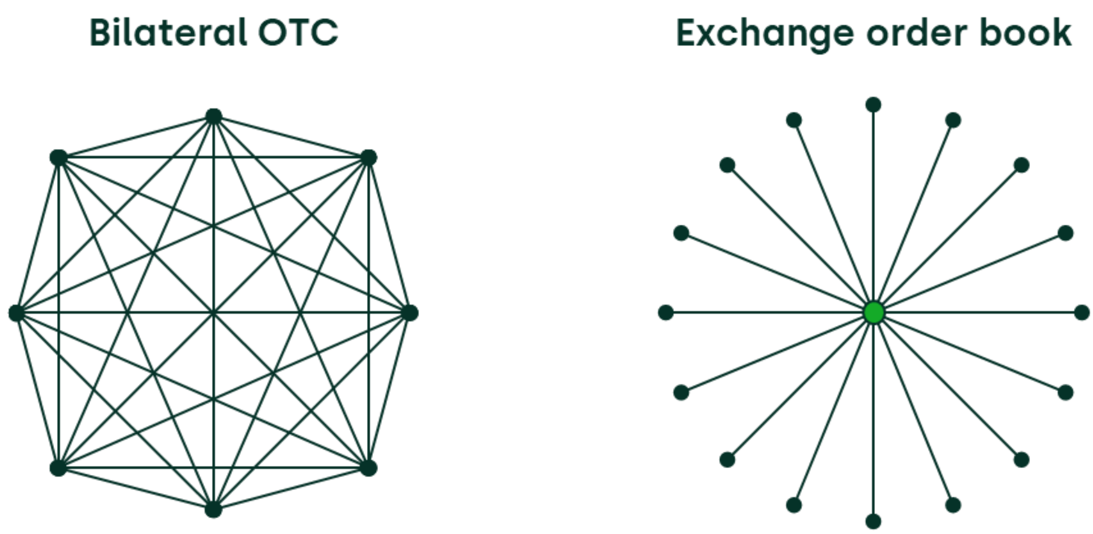
OTC markets usually comprise decentralised networks of buyers and sellers, with a small number of highly interconnected financial institutions (brokers) that intermediate a large proportion of the trading activity. OTC trading can also take place bilaterally, whereby the counterparties have direct relationships with each other.

In contrast, exchange trading takes place on a single centralised order book and on a multilateral basis (i.e. all buyers and sellers interact with each other at the same time). The OTC and exchange trading models are illustrated in Figure 3.1 below.

information or access to the same hedging instruments), firm-level hedging can increase shareholder value.

[29] Regulated Markets and Organised Trading Facilities are recognised trading venues under MiFID II.

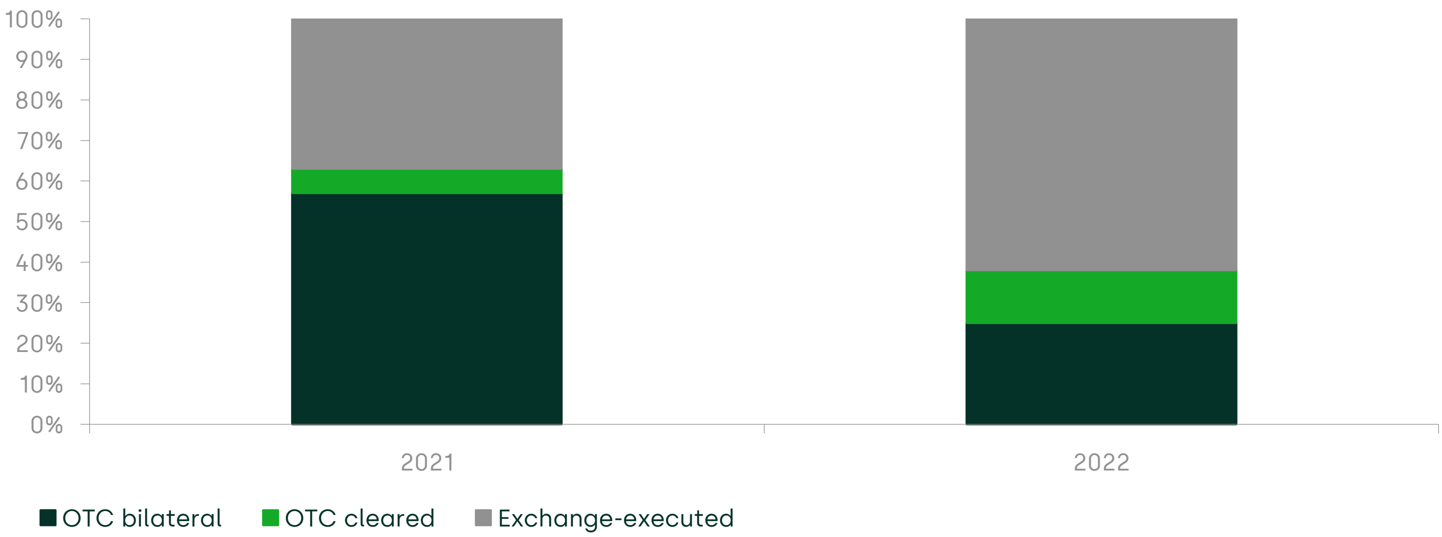
Figure 3.1 Different models of trading



Source: Oxera.

European gas trading has seen a shift from OTC to exchange-based trading with standardised contracts. In 2022 the share of exchange-executed trading on European gas hubs was 62%.[30] Figure 3.2 shows the composition in 2021 and 2022.

Figure 3.2 OTC and exchange-executed trading on European gas hubs, 2021 and 2022



Source: European Commission (2022), 'Quarterly report on European Gas Markets', *Market Observatory for Energy*, **15**:2, p. 37.

This transition of gas trading towards a centralised, liquid and transparent market has relied in part on the coordination role played by the derivatives exchanges themselves. As part of this role, exchanges undertake activities that facilitate price formation and trading, which include the provision of the electronic platform

[30] European Commission (2022), 'Quarterly report on European Gas Markets', *Market Observatory for Energy*, **15**:2, p. 37.

infrastructure and setting the rules by which orders interact, as well as ongoing activities such as monitoring and surveillance (see Box 3.2 below).

The transition of gas trading from OTC to exchange-based trading has had important implications for the overall development of the European gas market.

- First, compared to OTC markets, exchange trading can reduce barriers to entry for participants and make trading more accessible for a wider group of participants. Trading participants do not have to establish bilateral trading, credit, and settlement relationships with incumbent participants. Instead, traders can access an exchange's platform through a single point of entry: the exchange. This access also means that a trader can execute against all counterparties posting prices on an exchange, in comparison to broker venues, where the trader can trade only with counterparties with which it has established a trading and credit agreement.
- Second, exchange trading rules facilitate non-discretionary, anonymous and multilateral trading. The non-discretionary nature of an exchange order book means that orders are matched automatically on a price–time basis. Therefore, in order to trade, participants must provide competitive quotes (i.e. lower ask prices or higher bid prices). Anonymity of trading can also bring benefits to participants by reducing the risk of information revelation and adverse selection.[31]
- Third, by opening up opportunities to a broader, more diverse group of market participants, exchanges facilitate the provision of liquidity, to the benefit of companies with significant gas demand. These companies will often need to purchase futures to manage risk in a cost-effective way.
- Fourth, exchange trading takes place in a highly transparent environment, where quotes (pre-trade information) and prices (post-trade information) are visible to all traders. Markets with a centralised price-formation mechanism (combined with market surveillance and enforcement) tend to be less susceptible to price manipulation than markets characterised by opaqueness and price dispersion (i.e. identical assets trading at different prices at the same time).
- Fifth, central counterparty clearing can reduce the level of credit risk between participants by allowing trading members to enter positions with the central clearing counterparty (CCP) rather than with each other. The CCP can then net off all the offsetting positions held by its members, meaning that collateral margins can be determined based on a trader's overall position, thus improving capital efficiency.[32]

[31] Knowing the identity of the participant may provide information with respect to the direction (buying or selling) of the trade, and the pricing available may therefore be framed differently.
[32] Absent CCP clearing, a trader buying and selling a derivatives contract from different parties would eliminate market risk (i.e. risk that the price moves in an unfavourable direction), but could increase counterparty credit risk (due to the exposure to both parties). In such a case, the trader may need to post collateral on both positions.

Box 3.2 Activities undertaking by exchange platforms to facilitate trading

To facilitate a reliable and efficient price-formation process in the trading of gas futures and options, a derivatives exchange undertakes several activities, some of which provide direct benefits, while others are more indirectly beneficial, but still important.

The range of activities can be divided into the following groups.

1. **Providing highly resilient trading infrastructure**

To facilitate trades, the first requirement is that market participants have access to a forum where they can meet and indicate their intentions. Derivative exchanges, such as ICE, provide this through online platforms that allow users to specify their price and volume conditions anonymously and be matched with others who are willing to trade on those terms. ICE, for example, grants free, non-discriminatory access to its trading platform via WebICE to market participants who meet its authorisation requirements. By vetting potential participants, derivatives exchanges ensure that their members hold the licences, permits, necessary expertise and other requirements to conduct business on the relevant exchange.

2. **Attracting a good mix of participants**

Derivative exchanges aim to achieve trading flows on both sides of the market, and therefore seek to attract the right sorts of users to the platform and facilitate a healthy mix of participants. As noted above, one way of maintaining quality control is by making sure that potential members meet authorisation requirements. In the exchange model, all participants enter the market via a single point of access, and trading takes places on a multilateral basis. As well as reducing search frictions associated with trading on a bilateral basis, centralised trading platforms can reduce the cost of trading through increased competition and liquidity provision.

3. **Setting the rules of the game**

Another activity undertaken by derivatives exchanges is the setting of rules that dictate the price-formation process. Exchanges have a responsibility to publish and provide rules on many aspects of the trading process, including, for example, establishing order quantity limits, price reasonability limits, interval price limits and settlement periods. Further information on price reasonability and interval price limits is provided in Box 3.3.
By creating a rule book to establish acceptable trade practices, exchanges can maintain fair and orderly markets and protect property rights, as well as reducing the transaction costs associated with trading.

4. **Monitoring and enforcement**

In addition to setting the rules that traders must follow on the platform, derivates exchanges must monitor and enforce the rules and, more generally, the EU's Market Abuse Regulation (MAR) rules. The process of monitoring and enforcement is self-regulated but is also often conducted in collaboration with government regulators. Surveillance and detection tools alert exchanges to unusual behaviour. Exchanges establish conditions which, when met, trigger alerts. Upon notification of a surveillance alert, the exchange can conduct an investigation, which could result in a Suspicious Transaction Report (STOR) being sent to the relevant national competent authority. Alert conditions can be set to detect price or volume spikes or to alert the exchange to more specific suspicious user behaviour. Furthermore, since all exchange orders and transaction activity is observable on an anonymous basis, market participants could raise STORs with the relevant national competent authority if they observe any anomalies.
Another example of monitoring and enforcement activities conducted by exchanges is the use of interval pricing limits. These limits act as temporary circuit breakers that reduce the likelihood of short-term price spikes or outsized market movements. Interval pricing limit parameters can vary over time based on market conditions, but are intended to be triggered only in

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the case of extreme price movements over short periods of time. See Box 3.3 for more information about interval pricing limits.

Source: Oxera, based on interviews with ICE and traders.

3.3 Regulatory framework governing gas derivatives trading

Gas derivatives trading is subject to financial regulation, including the Market Abuse Directive (MAD) and Market Abuse Regulation (MAR), the European Market Infrastructure and Regulation (EMIR), and the Markets in Financial Instruments Directive (MiFID II and MiFIR). TTF gas futures and options of such futures traded on ICE Endex are considered critical or significant commodity derivatives and are therefore subject to MiFID position limits which are imposed by the AFM.[33] These regulatory frameworks are supervised by the European Securities and Market Authority (ESMA) and the national competent authority in each EU member state.[34] Exchanges assist with compliance with these Regulations and Directives by monitoring and surveying the activity on their exchange.

In addition, gas derivatives trading is subject to regulations specifically designed for the energy market, including the Regulation on Wholesale Energy Market Integrity and Transparency (REMIT) that is supervised by the Agency for the Corporation of Energy Regulators (ACER). Under REMIT, all market participants must report to ACER through a registered reporting mechanism (RRM) their fundamental data, orders to trade and transactions. This reporting may be performed by the exchange or the market participants themselves.[35] ICE uses Trade Vault Europe (TVEU), a wholly owned subsidiary of ICE, as its designated RRM.[36]

Therefore, the trading of gas is subject to certain rules aimed at enhancing market transparency and integrity, as well as preventing market manipulation and market abuse.

Box 3.3 summarises the market surveillance activities that ICE carries out in relation to gas trading.

Box 3.3 ICE Endex's market surveillance activities in its gas derivatives contracts

ICE considers that systems and controls are important in reducing the likelihood of orders being entered in error, preventing the execution of trades at unrepresentative prices, and reducing the market impact of such trades. ICE has implemented proactive and reactive measures to ensure that its gas derivatives trading markets function well and limit the likelihood of erroneous trades.

[33] Position limits specify clear quantitative thresholds for the maximum size of a position in a commodity derivative that persons or groups of undertakings can hold.
[34] Hiemstra, L. (2021), Energy trading and the exchange of information between supervisors: effectiveness of fragmented supervision and information sharing', *Journal of Energy & Natural Resources Law*, **39**:2, pp. 159–182.
[35] Ibid.
[36] ICE (2020), 'REMIT Transaction Reporting FAQs', December, p. 5, https://www.theice.com/publicdocs/futures/REMIT_FAQ.pdf,(accessed 26 October).

Examples of proactive activities (ex ante interventions) include the following.

- **No cancellation ranges**: a component of ICE's market integrity policy is the assurance that, once executed, except in exceptional circumstances, a trade will stand and will not be subject to adjustment or cancellation. ICE therefore sets parameters above or below an exchange-set anchor price for each contract within which a disputed trade will stand, even if executed in error.
- **Price reasonability limits**: the ICE platform incorporates a price reasonability limit to prevent 'fat finger' type errors. The limit is the amount, set by the exchange, that the price may change in one trading sequence from the anchor price.
- **Interval price limits**: these provide functionality to limit large price movements from occurring within a given timeframe. For each enabled contract, ICE sets a limit (the interval price limit) within which prices can move within a set timeframe, known as the 're-calculation time'. If a bid or offer attempts to breach the interval price limit, the market will enter a hold period preventing any further trading beyond the limit until the end of the hold period.
- **Position management controls**: the exchange monitors developments in open interest on an ongoing basis and sets accountability levels in the spot month and in other months when it deems it is necessary to prevent and address disorderly trading, support orderly pricing and settlement conditions, and ensure the efficiency of markets. Position management considers positions held by position holders, and any risks that these may present to market order, in the context mainly of: pricing and price trends in the relevant markets; the nature of the position holder; the positions in related markets; concentration; position development over time; seasonality; open interest; activity in related underlying financial instruments; incentive scheme participation; and the extent and quality of engagement with the exchange and response to enquiries.
- **Other measures**: ICE can set volume reasonability limits that prevent volumes above a certain level being either designated for trading or traded. Furthermore, ICE offers optional pre-confirmation messages that appear to market participants before the execution of all trades. The platform also provides the option to limit the quantity that a user can trade rather than trading the total quantity that is available to be traded at a specific price.

Examples of reactive activities (measures applied ex post) include the following.

- **Trade adjustment policy**: any trade executed at a price within the price reasonability limit but outside of the no-cancellation range for that contract, if notified to the exchange within the designated time period of eight minutes from the time of the original trade, will be investigated by market supervision. ICE Future Europe's Trade Adjudgment and Cancellation Policy Guidance document details the factors considered when investigating a trade.
- **Trading alerts**: a dedicated market surveillance team within ICE monitors the trading platform to detect market anomalies and market abuse. This team also works closely with market participants to identify trends in market behaviour and conduct investigations where needed.

ICE Endex undertakes these activities in close collaboration with the Authority for the Financial Markets (AFM). For example, ICE Endex provides monthly market conduct reports to the AFM, which contain all triggered alerts and the actions taken. There are also regular meetings between the ICE Endex Market Supervision team and the AFM, where these alerts and actions are discussed in more detail.

Source: Oxera analysis based on ICE internal and public information. See ICE Endex 'Policy –Price Adjustment and Trade Cancellation', https://www.theice.com/publicdocs/endex/ICE_Endex_Trade_Cancellations_Price_Adjustment.pdf, accessed 21 November); ICE Endex 'No Cancellation Ranges, Reasonability Limits and Interval Price Limits', https://www.theice.com/publicdocs/endex/ICE_Endex_NCR_Reasonability_Limits.xlsx (accessed 21 November) ; and ICE Endex 'Position Management Controls Policy'; ICE Endex, 'Trade Adjustment and Cancellation Policy', https://www.theice.com/publicdocs/futures/Trade_Adjustment_Policy.pdf (accessed 21 November).

3.4 Trading strategies—who trades and why

As noted above, exchange trading can attract a diverse range of participants to derivatives markets. This is particularly the case in the trading of TTF futures and options.

At a high level, there are:

- **arbitrageurs**, which take offsetting positions in two or more financial instruments to lock in a profit.
- **hedgers**, which use derivatives to reduce the risk they face from potential future movements in a market variable. The variable in this case is likely to be the price of gas, but it could also be a related energy price;
- **liquidity providers**, which trade derivatives to bridge the needs of the demand– and supply–sides of the market in the short term. These traders manage their risks by opening and closing both short and long positions in response to market requirements and typically hold their positions for periods lasting from a few hours to a few days. Liquidity providers are natural counterparties of hedgers;
- **speculators**, which use the instruments to accept risk by taking a position on the future direction of a market variable.

In practice, some institutions may undertake a mix of these activities. For example, a trading entity may engage in a combination of arbitrage, speculative and/or hedging strategies, depending on their specific strategy and risk appetite.

It is important to draw a distinction between speculation and market manipulation. Speculation is taking on a position that exposes the trader to profit or loss depending on price movement—e.g. if a trader considers prices to be low, they buy in anticipation of a future price increase. Speculation is a normal market practice, it is allowed and it is an important part of ensuring the well-functioning of a trading market. Market manipulation is market behaviour to deceive other market participants by controlling or artificially influencing the price. Market manipulation is illegal and impairs market functioning. As described in Boxes 3.2 and 3.3, exchanges have systems, controls and practices to prevent market manipulation.

In the specific case of gas trading, hedgers are often firms that have a need for the underlying physical commodity, i.e. natural gas. They could be energy companies needing gas for their gas-fired power plants, industrial companies needing natural gas for their processes (e.g. fertiliser production), and utilities that have already sold gas on to final customers. These firms typically buy gas to meet their own requirements, using derivatives to hedge. This can be done by buying gas at spot prices, putting it in storage and selling it forward to lock in a certain price.

Table 3.2 Trading strategies of different market participants

Category of institution	Examples	Motivation(s) to trade	Typical trading strategy
End-users	Commercial entities in power and heat generation as well as other industrial sectors, and utilities	Hedging against price and volumes risk	Buy futures to meet a proportion of expected demand Adjust position closer to real time
Producers and shippers	Oil and gas companies	Hedging to avoid exposure to spot prices	Sell futures in line with expected volumes of gas produced
Investment firms or credit institutions	Banks	Market-making (to profit from the difference in the bid–ask spread) Market access for commercial entities	Mix of long and short positions
Investment funds	Exchange traded funds (EFTs), pensions funds, insurance companies, collective investment schemes	Exposure to derivatives as an asset class Hedging against inflation risks Seeking potential diversification due to historically low correlation to traditional asset classes	Predominantly buy futures
Other trading houses	Algorithmic trading firms, commodity traders	Market-making (to profit from the difference in the bid–ask spread) Seeking arbitrage opportunities Taking positions	Mix of long and short positions

Source: Oxera based on interviews with traders and KYOS (2010), 'Energy derivatives and hedging strategies', https://www.kyos.com/wp-content/uploads/2010/12/Book-Chapter-Energy-Derivatives-and-Hedging-KYOS.pdf, accessed 21 November); Guggenheim, 'Asset Class Correlation Map', https://www.guggenheiminvestments.com/mutual-funds/resources/interactive-tools/asset-class-correlation-map (accessed 22 November).

Box 3.4 and Box 3.5 below provide Illustrative examples of trading strategies, showing how users and producers of gas can hedge to lock in a price, rather than being exposed to spot prices.

Box 3.4 Case study: gas plant operator hedging using futures

Consider a gas power plant operator that generates electricity from natural gas and sells this to consumers. The plant operator needs to generate 5GWh of electricity from its gas plant and requires the corresponding gas volume in order to run the power plant.

Once the utility knows how much gas it will need in the following year to cover its electricity production, it has a choice: wait until the following year and purchase the necessary gas on the spot market; or secure the required volumes now on the futures market for its production in the following year.

Even if the utility has no knowledge about whether future gas prices are going to increase or decrease, it might still choose to purchase the gas at the known futures cost in order to lock in a price, thereby minimising risk exposure and helping it to provide greater certainty to its clients on their electricity prices and to have greater certainty over its future margins.

It is worth noting that the same principle would apply with regard to the other prices to which the gas power plant is exposed, namely the price of electricity and the price of carbon. In this case the power plant operator would also sell an electricity future and purchase an emission allowance future. This series of three futures trades is sometimes referred to as a 'clean spark spread'.

Box 3.5 Case study: gas producer hedging using futures

Consider a producer wanting to hedge its gas production for the following year. It could sell (short) a year-ahead gas future on the TTF (e.g. for €100/MWh). When the contract reaches maturity, the seller does not want to make delivery of the futures contract so it buys back the contract at prevailing market prices. If these prices are now €110/MWh, the seller would receive this amount for its gas but make a loss of €10/MWh on the futures contract. If instead market prices were €95/MWh, the seller would receive this for its production but make a gain on the futures contract of €5/MWh. In both cases, it would in effect sell the gas for the €100/MWh it has locked in using the futures contract.

Source: Oxera based on Mercatus Energy, 'The Fundamentals of Oil & Gas Hedging – Futures', https://www.mercatusenergy.com/blog/bid/86597/the-fundamentals-of-oil-gas-hedging-futures (accessed 22 November).

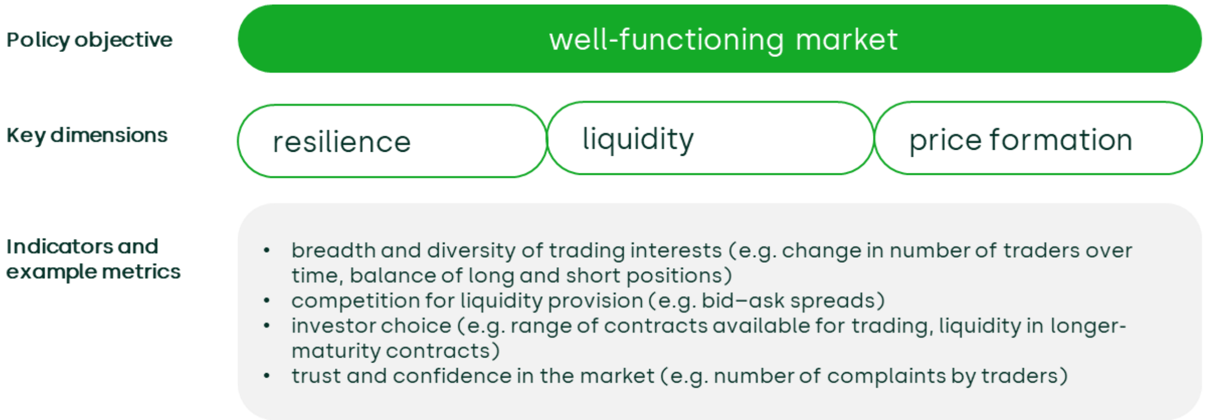
4 Evidence of market functioning

A well-functioning financial market is one that delivers a high-quality, trusted price-formation process, and provides liquidity during normal market functioning and in times of stress, while remaining resilient to manipulation and abusive practices.

Markets that satisfy these core functions provide important benefits to users—for example, by providing trusted, reliable pricing signals, as well as risk management tools.

When assessing whether a market is performing these functions well, a number of metrics are useful to consider, as shown in Figure 4.1.

Figure 4.1 Economic framework for assessing the functioning of financial markets



Source: Oxera.

Our findings indicate that:

- TTF prices have increased significantly over the past year, which has led to an increase in the overall value of trading activity and a reduction in the number of contracts traded. This can be explained by traders being able to hedge the same value of risk with fewer contracts;
- after continuous growth, the number of position holders and commitment of trade has now dipped, but it is still around the 2018 levels;
- the composition of traders has changed, with financial players being less active recently. The activity of commercial undertakings has decreased but then stabilised, suggesting that a significant level of trading is still necessary for firms requiring gas to continue operating;
- while absolute bid–ask spreads have increased, these spreads relative to the price have remained relatively stable, in line with historical trends;
- prices have started to rise again since their decrease in September 2022.

4.1 Resilience

'Resilience' in this context refers to the ability of the market to absorb, rather than amplify, shocks and to remain free from manipulation and

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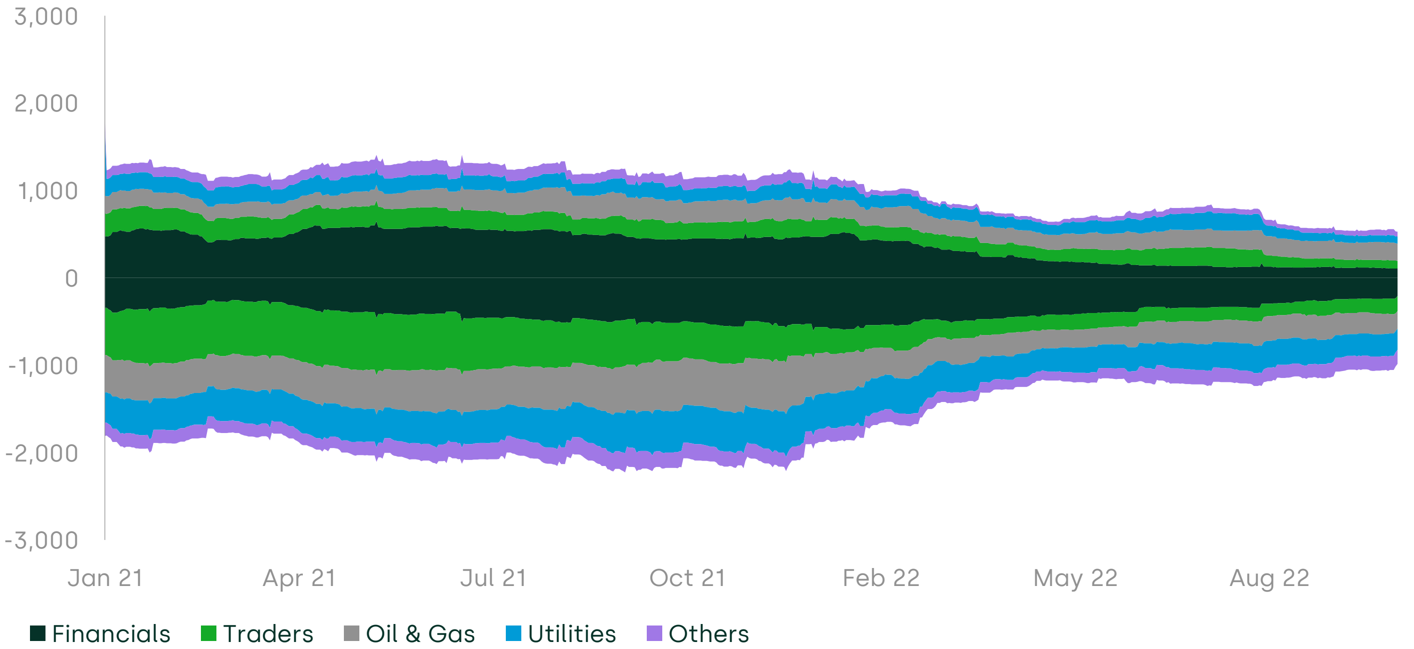
abusive practices. As noted by The International Organization of Securities Commissions (IOSCO), this is particularly important in commodities derivatives markets, where the supply of the underlying asset is limited.[37] Limits in the supply of a commodity to be delivered can result in market congestion, squeezes, cornering or other disruptions,[38] all of which can lead to a poorly functioning derivatives market.

Figure 4.2 shows the number of open positions in TTF Gas futures held by type of market participant. The grouped categories of participants include financials, traders, oil & gas companies, utilities and others. There is a clear decrease in the total number of held positions in 2022 compared to the 2021 levels, particularly those held by financial institutions, traders and other participants, with a smaller decrease in positions held by utilities and oil & gas companies proportionally.

It is important to note that Figure 4.2 shows that only the number of positions held went down, while the total monetary value of held positions has increased due to the higher prices.

Figure 4.2 Long and short positions by type of holder (TWh)



Note: Financials include banks, brokerages and buy-side firms; traders include property traders and trading companies; 'Others' include other and unclassified position holders.
Source: Oxera analysis based on ICE data.

Despite a decrease in the number of total positions held, Figure 4.3 shows that the total number of TTF Gas futures position holders

[37] IOSCO (2021), 'Principles for the Regulation and Supervision of Commodity Derivatives Markets', November, https://www.iosco.org/library/pubdocs/pdf/IOSCOPD689.pdf (accessed 25 November).
[38] A market 'corner' or 'squeeze' describes a situation where the underlying asset or commodity necessary for delivery upon expiry of a futures contract is held by one or more market participants acting in concert and constitutes a substantial proportion of the quantity of underlying commodities eligible for delivery against the contract. See IOSCO (2021), op. cit.

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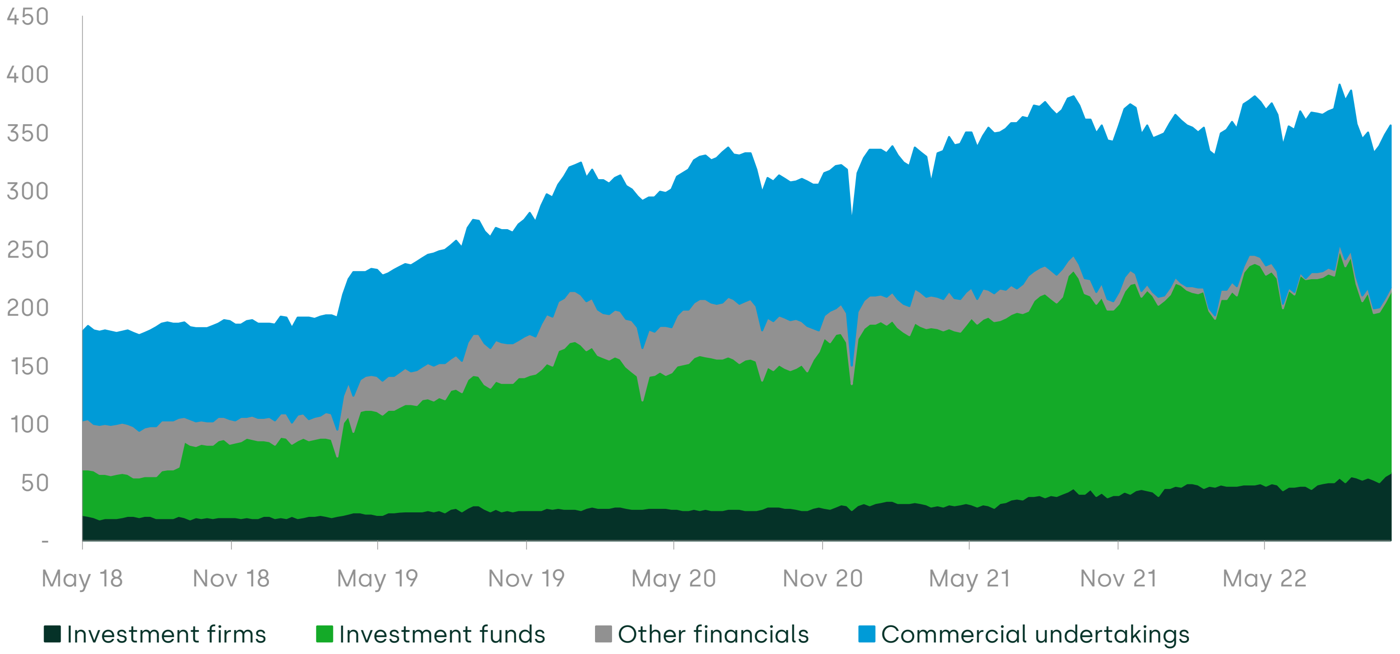
increased from about 180 in 2018 to around 350 in 2022. Most categories (investment firms, investment funds and commercial undertakings) have increased over the period while other financials decreased from the second half of 2021.

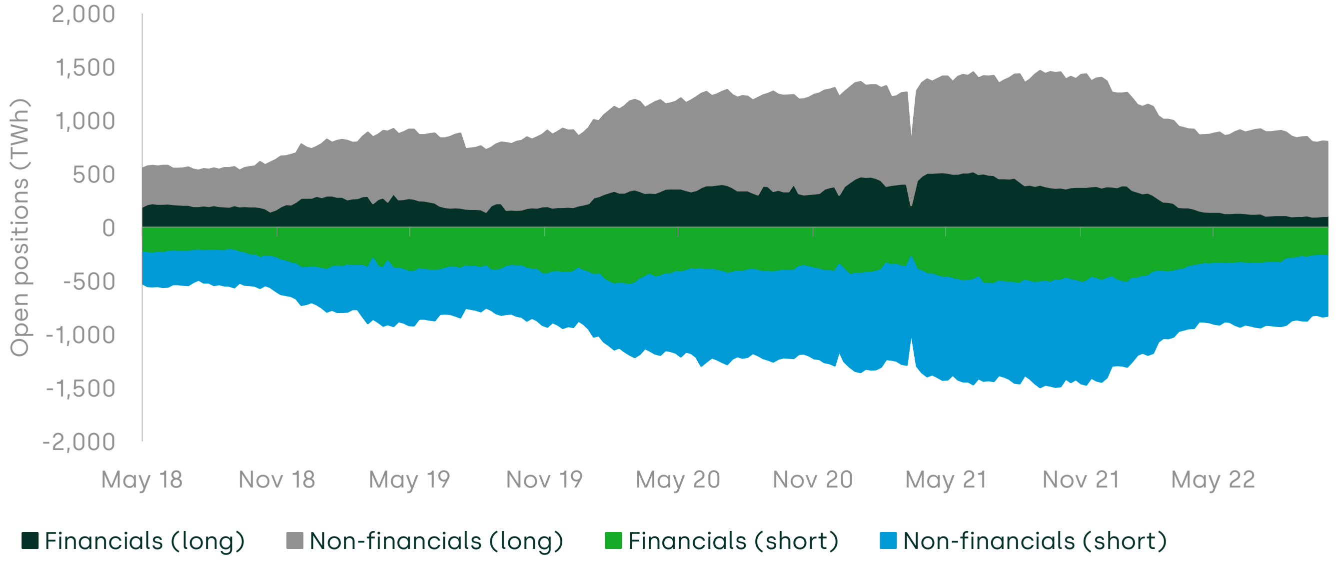
Figure 4.3 Number of position holders



Source: Commitment of traders (COT) data from ICE.

Figure 4.4 below provides further insight into commitments in TWh held by financial and non-financial firms in the market. While the total volumes of both long and short commitments have decreased from the 2021 levels, they are still in line with the average levels over a longer period of time. Since 2018 there has been a noticeable decrease in the volume of long positions held by financial firms, while both long and short positions held by non-financial market participants have increased.

Figure 4.4 Commitment of traders for financial and non-financial firms

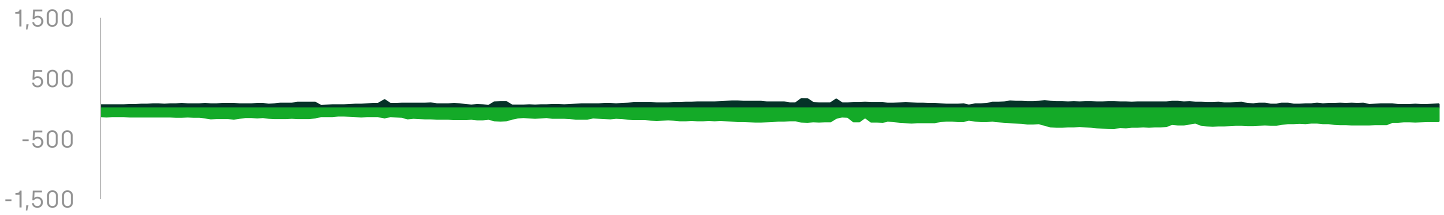


Note: Financial firms consist of investment firms, investment funds and other financial firms. Non-financial firms consist of commercial undertakings.
Source: COT data from ICE.

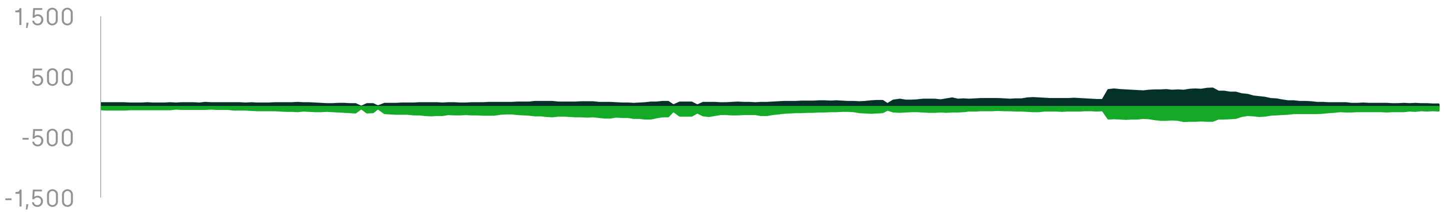
Figure 4.5 gives a further breakdown of long and short positions in TWh held by type of firm. In 2022, positions held by investment funds decreased significantly, while there has been only a modest decrease in the positions held by investment firms and commercial undertakings.

Figure 4.5 Open positions by different firm types (TWh)

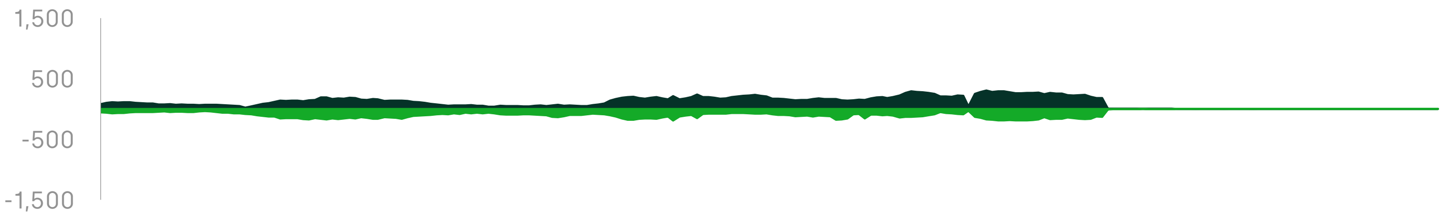
Investment firms



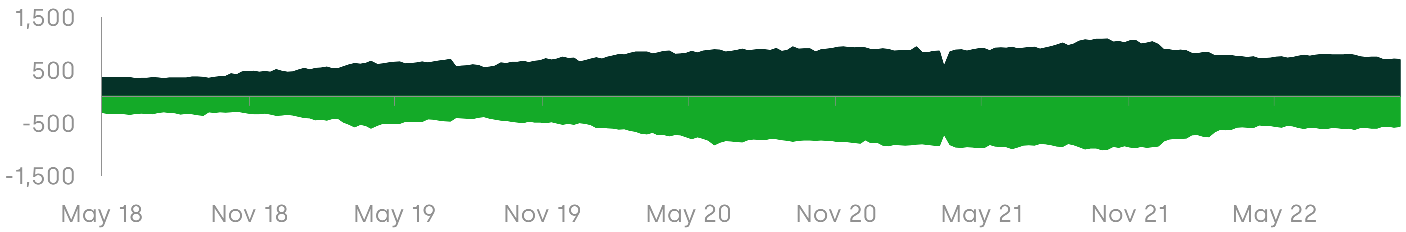
Investment funds



Other financials



Commercial undertakings

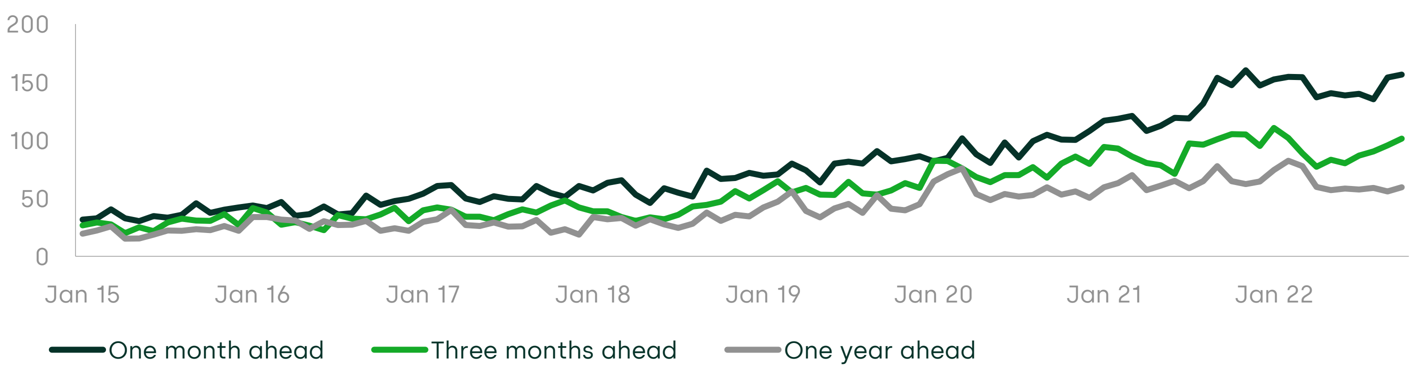


Note: The abrupt change between investment funds and other financials in autumn 2021 is likely to be due to a recategorisation.
Source: COT data from ICE.

Overall, there appears to be a consistent trend of a slight decrease in the volume of positions held by financial market participants in 2022. Changes in positions held by non-financial market participants have been less significant. These trends do not include price effects; hence, given the considerable increase in price, the total value of held positions has increased.

In view of the decrease in the volumes of positions, it is useful to analyse the number of traders to understand whether there may be concerns around dominance in the market. Figure 4.6 shows the distinct number of trading company names over time. This measure has trended upwards since 2015.

Figure 4.6 Distinct number of trading company names over time

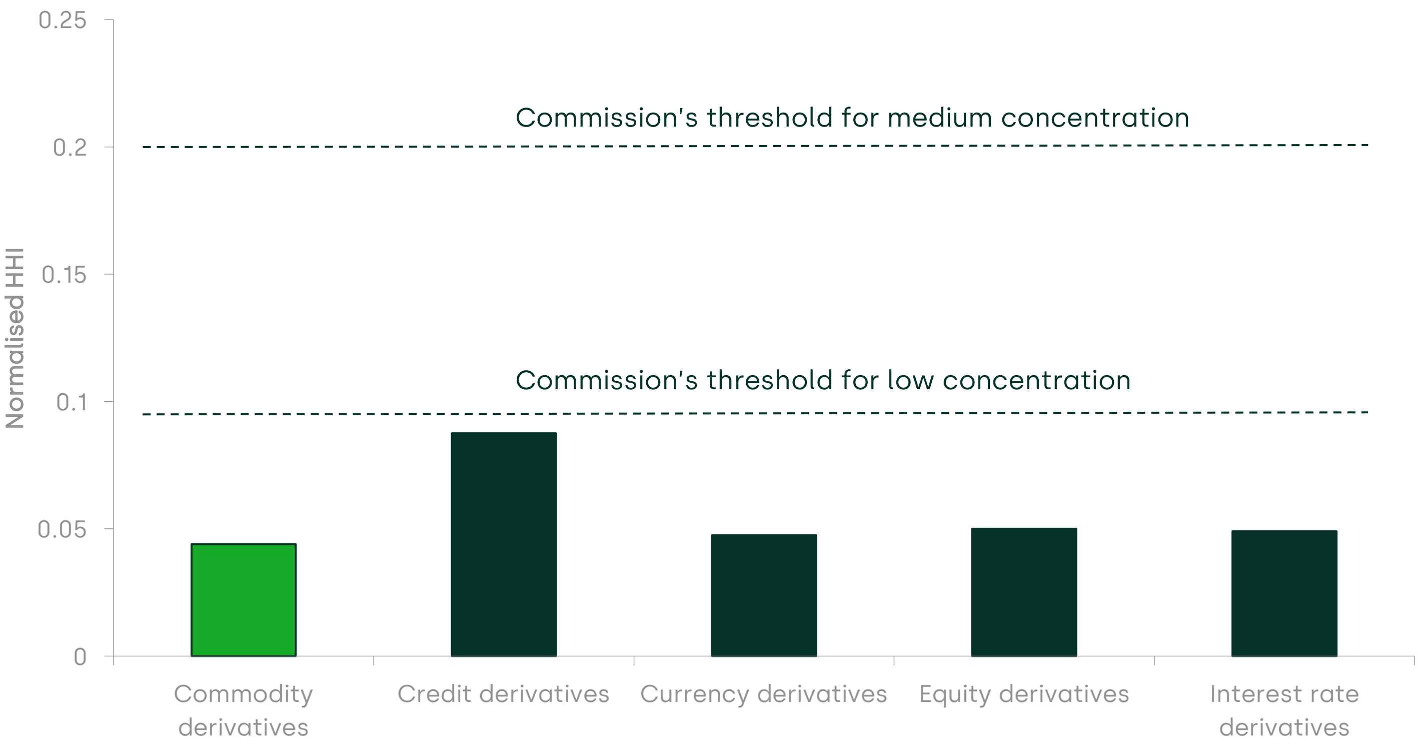


Source: Oxera analysis based on data provided by ICE.

There was a clear dip in early 2022, particularly on the three-month ahead and one-year ahead contracts. This brings the number of traders back to the level it was at in mid-2021. The size of the drop is comparable to a decrease at the start of 2020. Overall, the numbers do not lead to concerns around market concentration.

It is also useful to compare the concentration of commodities to other types of derivatives. ESMA calculated the Herfindahl–Hirschman index (HHI, a common measure of market concentration) of derivative exposures in 2020 and found low concentrations across all asset classes. Figure 4.7 shows that commodity derivatives have the lowest concentration, well below the European Commission's threshold for low concentration.

Figure 4.7 Market concentration



Note: HHI normalised between 0 and 1. HHI values taken from ESMA analysis of derivatives exposures for Q4 2020 in its 2021 Annual Statistical Report on the EU derivatives market. ESMA noted that the HHI metrics in Q4 2020 were similar to those of a year earlier across all assets. According to ESMA and the European Commission's guidelines (in the context of competition law) an HHI value of below 0.1 indicates low concentration and an HHI value of between 0.1 and 0.2 indicates medium concentration.
Sources: ESMA (2021), 'EU Derivatives Markets: ESMA Annual Statistical Report 2021', 17 December 2021, ESMA-50-165-2001;. European Commission, (2004), 'Guidelines on the assessment of horizontal mergers under the Council Regulation on the control of concentrations between undertakings', 2004/C 31/03,.

The data shows a breadth of traders holding long and short positions in the TTF market. While there has been a dip in the volumes of positions, as well as the number of traders, there is still depth and diversity of traders, pointing to a resilient market.

4.2 Liquidity

In addition to measures of resilience, an important indicator of a well-functioning market is liquidity. A liquid market is one with many buyers and sellers, allowing trades to be executed quickly because demand and supply can be matched.

A common measure of liquidity is the bid–ask spread, which measures the difference between the prevailing best buy and best sell prices. A large body of academic literature shows how bid–ask spreads in a competitive market are determined by various trading frictions, such as the costs of: order processing (e.g. the fees and overheads associated with executing and settling trades); inventory holding (when risk-averse traders holding a position are exposed to unfavourable fluctuations in prices); and adverse selection (the risk of trading with a more informed participant).[39] These costs are borne by market-makers and other liquidity providers which, in response to an increase in these costs, will demand greater compensation through a wider bid–ask spread and/or reduce their propensity to trade (resulting in less market 'depth'). In markets with barriers to entry for trading participants, bid–ask spreads can also be wider due to limited competition between liquidity providers.

Figure 4.8 shows the daily bid–ask spread for one-month ahead TTF futures expressed as a percentage of their price. It shows that the spreads have remained moderately stable relative to the price from 2018, with the typical value of the spread around 0.5% of the corresponding price. Despite a slight increase in the spreads since late 2021, they are still in line with the general trend over the past five years. The spikes in late 2017 occurred shortly after two incidents where key gas infrastructures were damaged (a North sea pipeline and an Austrian gas import facility).[40]

[39] The first paper to relate bid–ask spreads to inventory risk was Stoll (1978). Glosten and Milgrom (1985) is a key paper relating to the adverse selection component of bid–ask spreads. Stoll, H. (1978), 'The supply of dealer services in securities markets', *Journal of Finance*, **33**:4, pp. 1133–1151; and Glosten, L.R. and Milgrom, P.R. (1985), 'Bid, ask and transaction prices in a specialist market with heterogeneously informed traders', *Journal of Financial Economics*, **14**:1, pp. 71–100.
For a discussion of the theory and literature, see Foucault, T., Pagano, M. and Roell, A. (2013), *Market Liquidity: Theory, Evidence, and Policy*, Oxford University Press.
[40] See *Financial Times* (2017), 'Gas prices jump in Europe after double blow to key infrastructure', December, https://www.ft.com/content/bf8732be-df27-11e7-a8a4-0a1e63a52f9c.

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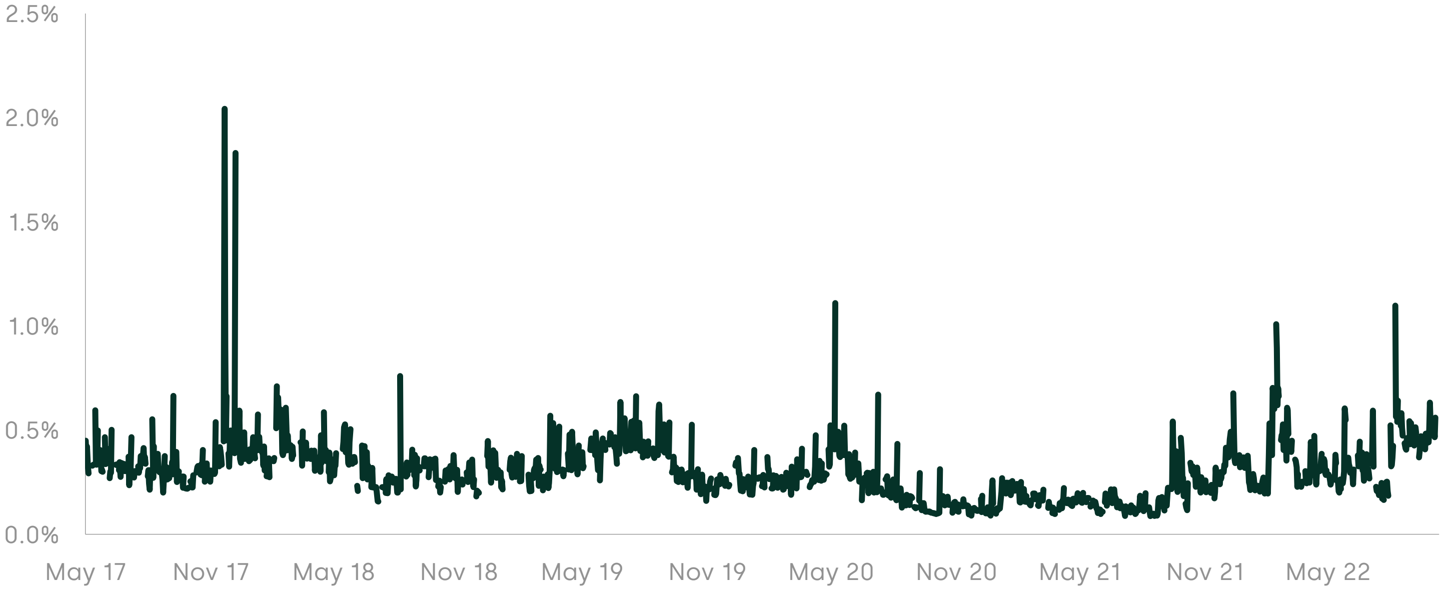
Figure 4.8 Median daily bid–ask spread of TTF month-ahead gas futures as a percentage of price

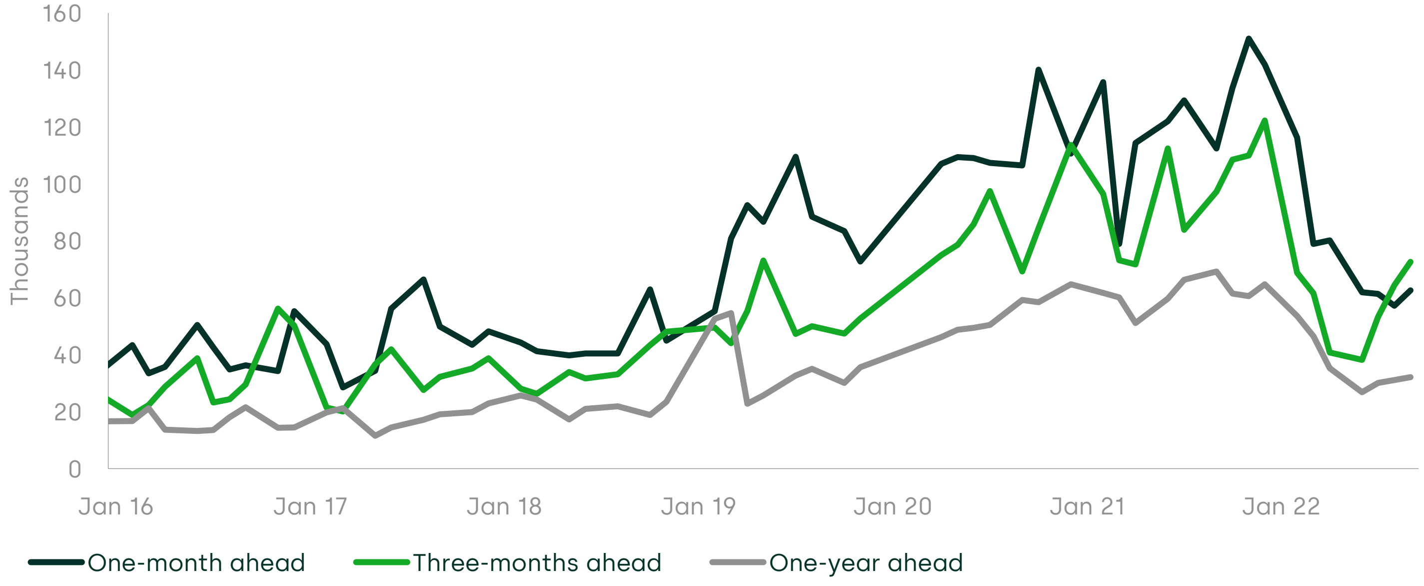


Note: Data refers to the median quoted bid–ask spread each day, based on a sample of snapshots taken at two-minute intervals throughout the day.
Source: Oxera analysis based on data provided by ICE and Bloomberg data.

Another measure of liquidity is open interest. This refers to the number of derivatives contracts that are outstanding (i.e. that have not been settled) at a given point in time. Open interest is an indicator of the level of commitment of traders in a given market.

Figure 4.9 shows the volume of open interest over time. It increases fairly steadily but then decreases from late 2021 onwards. Recently, it has increased again.

Figure 4.9 Open interest volume



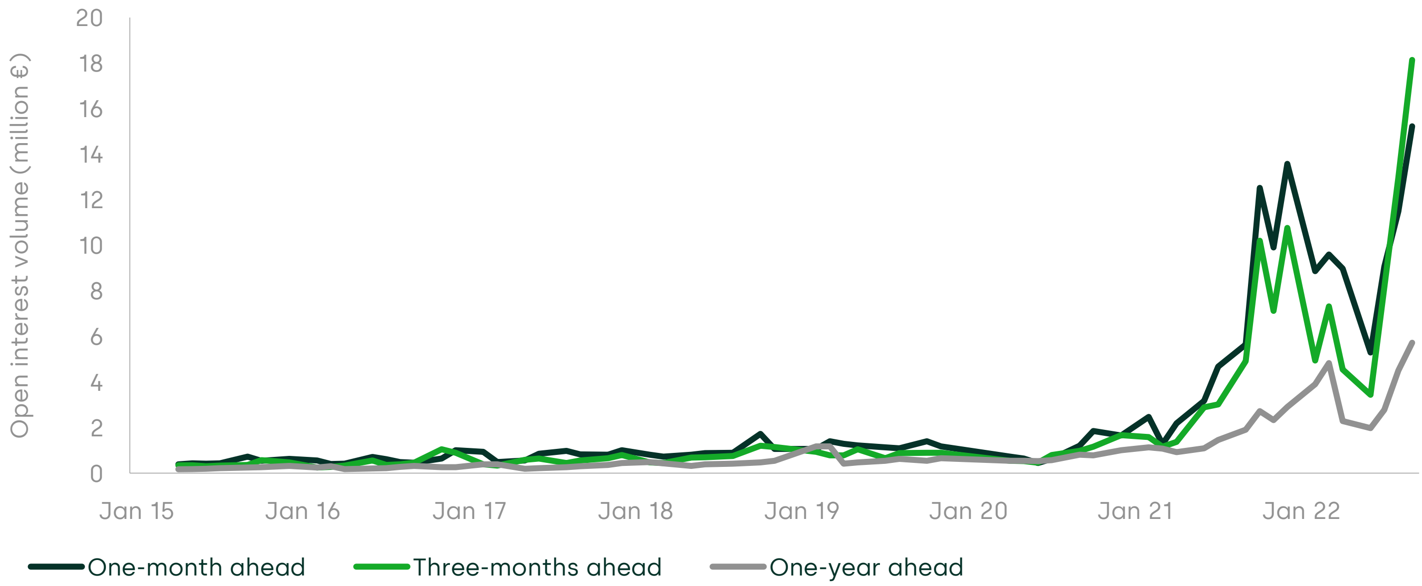
Source: Oxera analysis based on data provided by ICE.

The decrease in open interest came at a time of rising gas prices, and a possible explanation for this decrease is that traders were facing higher collateral requirement. At higher prices and volatility, margin requirements increase and traders with such constraints may simply not be able to trade a futures product due to credit costs. In addition, with prices rising to all-time highs, variation margin calls were also increasing for traders with short positions.[41]

Figure 4.10 below shows the value of open interest (i.e. volume multiplied by price). It shows a sharp increase in open interest throughout 2021 when prices started rising. The value in open interest then decreases sharply, but only to a level significantly above any values seen prior to 2021. Recently, the value of open interest rose again.

[41] Margin calls occur when brokers ask for additional securities to be held in an account in order to manage the risk associated with the traded derivative.

Figure 4.10 Open interest value



Source: Oxera analysis based on data provided by ICE.

The trend in open interest volumes and values is therefore to be expected given price developments in the market. Despite the significant increase in prices, leading to a decrease in open interest volume and an increase in open interest value, the bid–ask spreads have remained relatively stable as a proportion of price. This suggests that the TTF remains an efficient and liquid market for gas futures.

4.3 Price formation—breadth and depth of the market

Another indicator often associated with a well-functioning market is the breadth of contracts available along the futures pricing curve. Price signals for gas futures reflect the market's expectation of demand and supply fundamentals in the future, and are an important tool in allowing companies to manage risk through hedging strategies. The further out transparent and liquid contracts are available, the more informed the price-discovery process is. At the same time, liquidity in nearer-time products is particularly important to ensure that companies can adjust their positions close to physical delivery.

Figure 4.11 below shows the number of cleared lots for different types of futures contracts in 2018, 2020 and 2022. Overall, there has been a significant increase in cleared lots across most contracts over time, despite the reduction in trading in 2022. Six-month ahead contracts are the exception, for which the number of cleared lots in July 2022 decreased compared to July 2020. However, this figure is still more than twice as high as it was in July 2018. While trading more than four years ahead does not seem to be particularly common, ICE is now offering contracts for futures that are further ahead, with some volumes across four- to six-year-ahead contracts.

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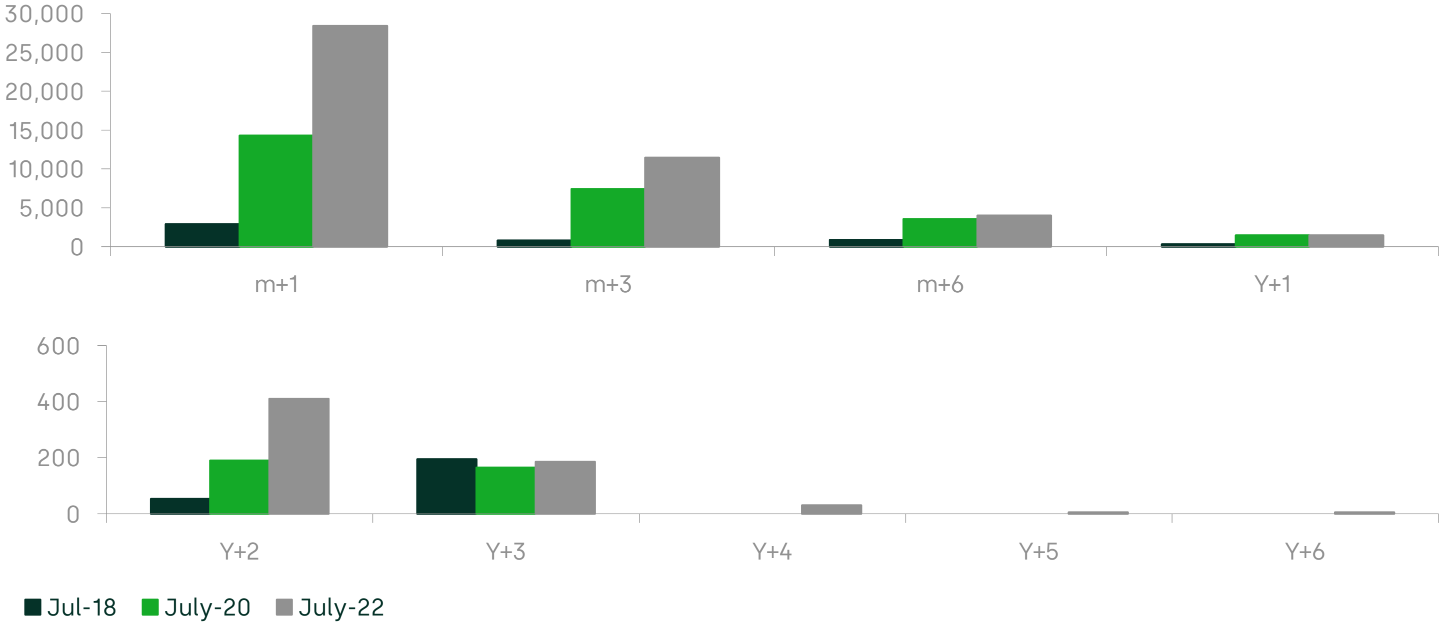
Figure 4.11 Cleared lots by type of futures contract



Note: Numbers are averages as at the first trading day of a given month.
Source: Oxera analysis based on data provided by ICE.

The breadth and depth of TTF gas contracts offered and traded suggests that the market is functioning well in terms of providing effective price formation.

The overall evidence on the gas market in terms of resilience, liquidity and price formation indicates that the TTF remains a well-functioning market.

5 Gas market fundamentals and the link to derivatives markets

The IOSCO report on the principles of commodity derivatives markets states the following on derivatives exchange trading:[42]

> Some of the principal economic purposes of organized trading of commodity derivatives such as futures contracts are to manage price risk and facilitate the discovery of possible future commodity prices. To be an effective economic tool for hedging and price discovery, **commodity futures contracts must accurately reflect the characteristics and operation of the referenced underlying physical commodity market**, and not contain factors which may inhibit or bias the delivery process. [Emphasis added]

This section therefore begins by examining the fundamental drivers behind recent gas market developments before turning to the derivatives market.

5.1 Physical developments since late 2021

As set out in section 2.1.4, the drive towards a market-based gas system has led to increased exposure of gas prices to demand and supply developments. This section sets out the market fundamentals underlying recent gas price developments.

Figure 5.1 below shows the developments of TTF front-month prices since the start of 2021 and a number of events that have taken place over this timeframe that affected gas prices. As is evident from the price peaks, the market seems to have 'over-reacted' to specific news at times, resulting in extreme prices for limited periods of time. In our analysis, we do not assess whether the market reaction to the news was adequate or appropriate, but rather focus on the trend in prices once they have stabilised again. We understand that an immediate over- or under-shooting is to be expected in a stressed and uncertain market environment.[43]

[42] IOSCO (2021), 'Principles for the Regulation and Supervision of Commodity Derivatives Markets', November, p. 14, https://www.iosco.org/library/pubdocs/pdf/IOSCOPD689.pdf (accessed 25 November).
[43] For instance, on 20 September 2022 when the German government informed the market that its gas storage facilities were 90% full ahead of the winter, the TTF prices decreased.

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Figure 5.1 Timeline of events and TTF front-month prices (€/MWh)

Source: TTF prices based on Bloomberg.

In the remainder of this section, we discuss the following fundamental drivers of TTF prices in the period since autumn 2021:

- demand increase post-COVID 19 from autumn 2021, as well as low storage levels;
- reduction in gas supplies from Russia following the Russian invasion of Ukraine in spring 2022;
- lack of alternative supplies due to:
  - pipeline gas from other sources, such as Norway, already running at maximum capacity;
  - constraints for LNG coming into Europe, especially into NEW;
- gas storage facilities post-Russian invasion being filled up by TSOs at all costs.

This list of drivers of TTF prices is not exhaustive. Additional factors, such as lower availability of hydro powered electricity generation (due to low seasonal rainfall) and the maintenance closures of nuclear power stations in France, are also widely considered to have added to an already increased gas demand in Europe.[44]

[44] Reuters (2022), 'French nuclear woes stoke Europe's power prices', 24 August, https://www.reuters.com/business/energy/french-nuclear-woes-stoke-europes-power-prices-2022-08-24/ (accessed 4 December).

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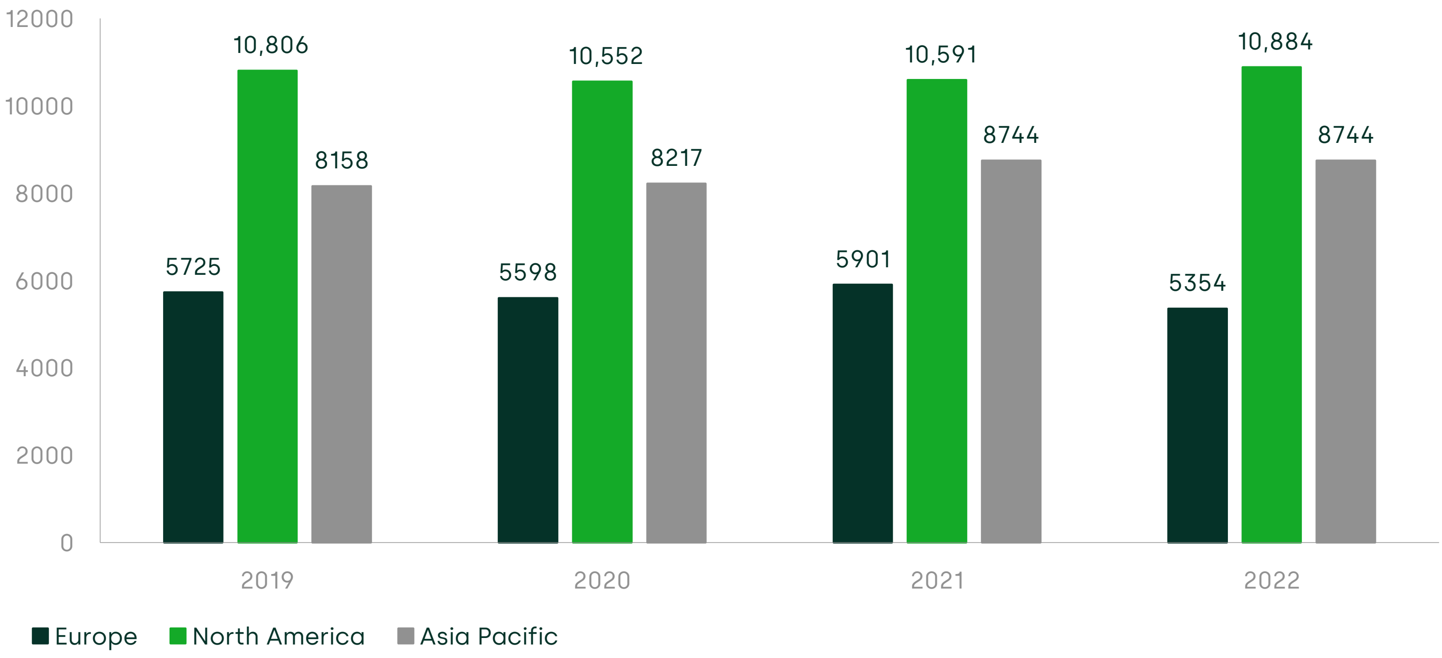
5.1.1 Post-COVID 19 recovery in 2021

Economic activity in 2021 bounced back after the COVID-19-related drop in 2020. Global GDP growth in 2021 was 5.8% compared to -3.3% in 2020.[45] This affected global gas demand, which increased significantly in 2021 compared to the previous year, as shown for Europe, North America and Asia Pacific in Figure 5.2.

Figure 5.2 Natural gas demand in Europe, North America and Asia Pacific (TWh)



Source: IEA (2022), 'Gas Market Report, Q4-2022', p. 75, https://iea.blob.core.windows.net/assets/318af78e-37c8-425a-b09e-ff89816ffeca/GasMarketReportQ42022-CCBY4.0.pdf

This, in addition to tight supply, contributed to rising gas prices in Europe.

At the same time, storage levels in 2021 were lower than in previous years, with an average EU storage fill of 71% in September 2021 compared to 93% and 95% in the two years before. This meant that gas from storage could be used only to a limited extent to serve the additional demand.

5.1.2 Reduction in gas supplies from Russia

Since late 2021 and in particular since the start of the war in Ukraine, there has been increased uncertainty about gas supply and prices in Europe due to concerns about the future role of Russian gas in European markets. Following the responses of the EU member states and Russian cuts to gas supplies, the share of Russian gas in the extra-

[45] The World Bank (2022), 'GDP growth (annual %)', https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG (accessed 8 November).

EU imports fell from 39.7% in 2021 to 22.9% in Q2 2022.[46] Figure 5.3 shows the change in the sources of natural gas imports into the EU market. Following the decrease in the share of Russian imports in the EU, gas imports from other partners increased significantly. For example, the EU gas import share from Algeria increased from 8.2% in 2021 to 17.4% in Q2 2022; and from the USA from 7.2% to 14.8% over the same period. As the sources of EU gas imports adapted to the reduced availability of Russian pipeline gas supplies, the gas flows across the EU gas network also changed significantly. In particular, the increase in LNG imports required additional pipeline capacity to transport gas eastward from the LNG terminals in NWE.

Figure 5.3 Extra-EU natural gas imports by partner

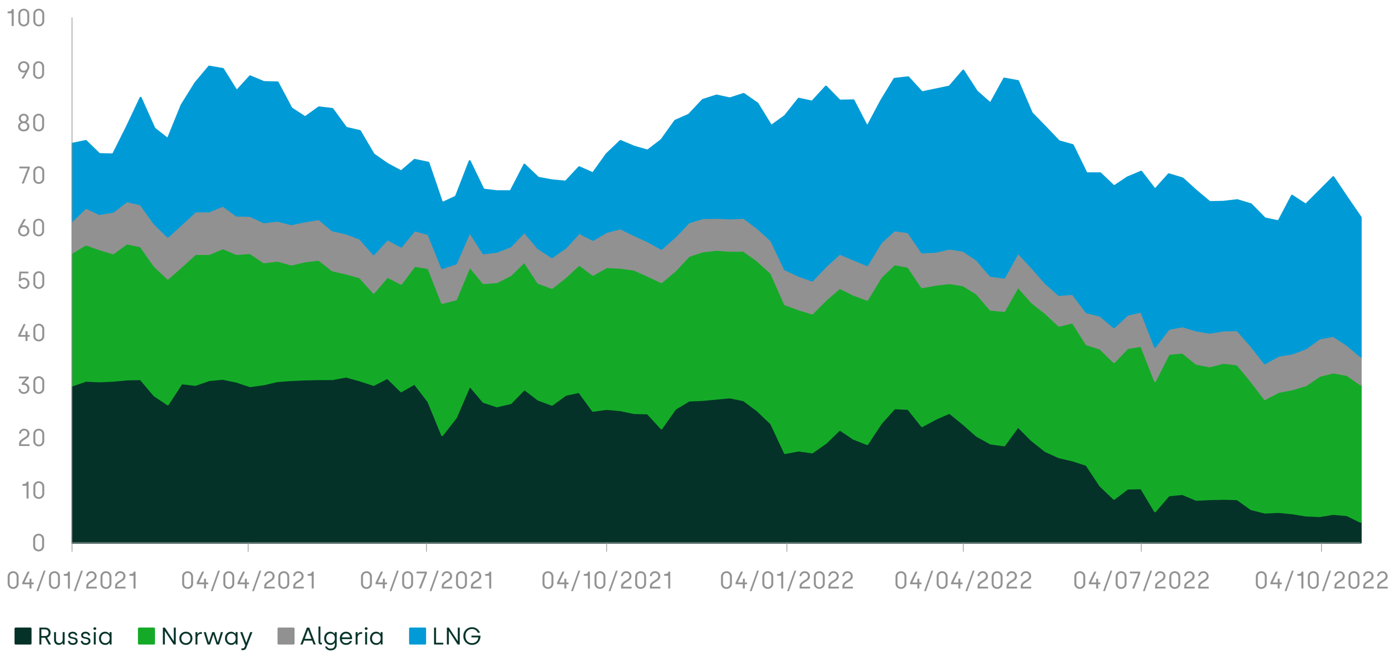
Source: Eurostat data.

5.1.3 Lack of alternative gas supplies and infrastructure constraints

As a result of the sharp decrease in Russian gas imports, the overall available supply of pipeline natural gas has decreased. This can be seen in Figure 5.4 below, which shows the decline in Russian gas imports.

[46] Eurostat (2022), 'EU imports of energy products - recent developments', 7 October, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=EU_imports_of_energy_products_-_recent_developments (accessed 17 October).

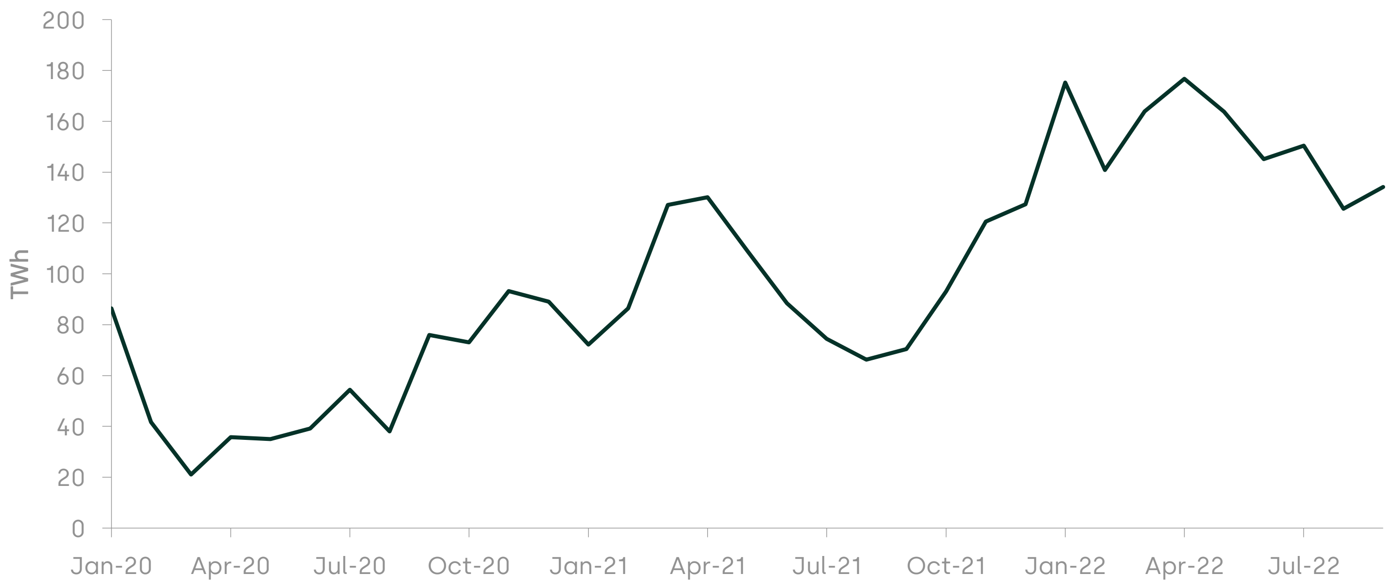
Figure 5.4 Weekly EU+GB gas imports by source (TWh)



Source: Oxera analysis based on Bruegel dataset.

To counteract this decline, gas needed to be imported from other sources, leading to a 49% year-on-year growth in EU LNG imports in Q2 2022.[47] Figure 5.5 shows a clear trend of an increase in the physical entry of LNG into the EU, with growth slowing down in 2022.

Figure 5.5 EU physical LNG entry (TWh)



Source: European Network of Transmission System Operators for Gas (ENTSOG) data.

[47] European Commission (2022), 'Quarterly report on European Gas Markets', *Market Observatory for Energy*, **15**:2, p. 15.

This change in the gas import flow patterns has revealed physical infrastructure constraints, such as:

- LNG terminals running at or near full capacity;
- interconnectors between certain countries running at or near full capacity;
- reverse flows, where gas flows from west to east, rather than the other way around. This causes a need for additional infrastructure, such as compressor capacity.

In a well-functioning market, these physical infrastructure constraints would be expected to have a direct impact on prices, signalling supply-side constraints. Price spikes and widening price differentials between market areas reflecting these constraints in turn provide arbitrage opportunities that strongly incentivise traders to utilise alternative transport routes where possible and also provide investment signals for infrastructure expansion.

We now examine in turn each of these physical constraints.

Figure 5.6 depicts the utilisation of different LNG terminals in the EU over time. It shows an increase in utilisation over the course of 2022. The figure shows monthly average of daily LNG capacity utilisation levels, which may underestimate the overall level of congestion, as having single days with low flow levels due to a new shipment coming in depresses the average. Average EU capacity use compared to the maximum capacity increased to over 60% in 2022 compared to 30–50% in the previous year.

We note that the data may be too conservative because other sources show the EU average utilisation rate going up to 90% in 2022.[48] The European Commission, in its quarterly report on gas markets, notes that European LNG terminals are now operating at or close to capacity, with an average utilisation rate well above 80% and at times exceeding 100% of nameplate capacity at terminals in France and Italy.[49]

[48] European Commission (2022), 'Quarterly report on European Gas Markets', *Market Observatory for Energy*, **15**:2, Figure 18.
[49] Ibid., p. 18.

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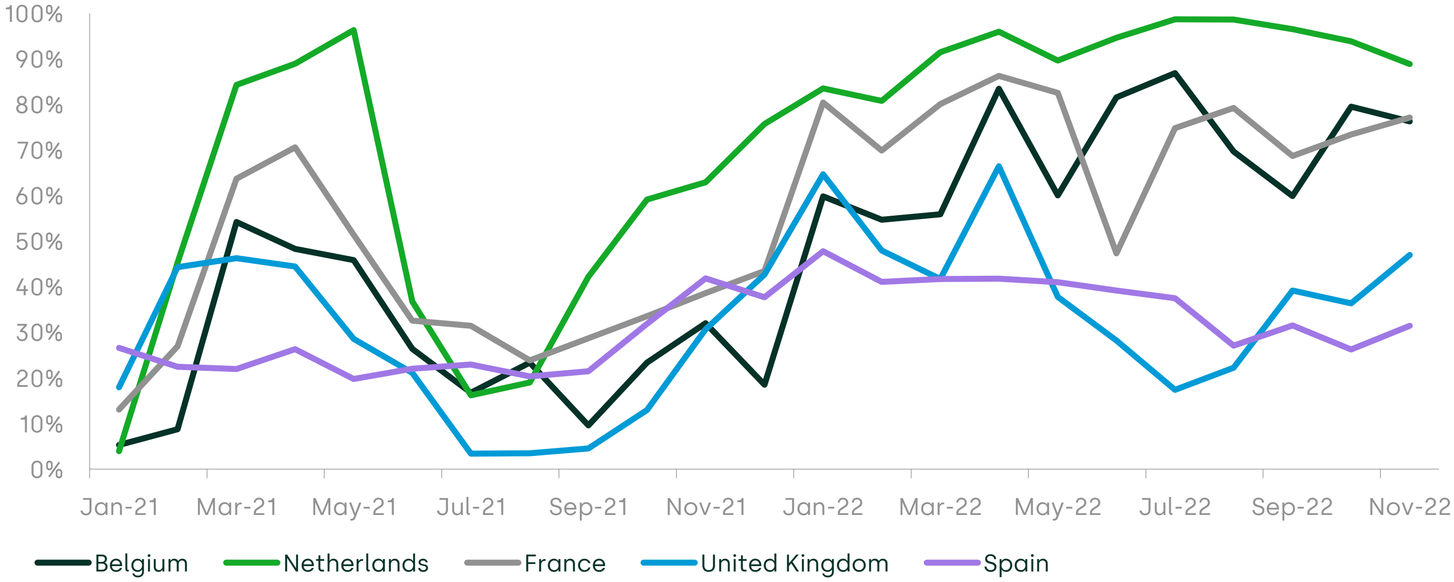
Figure 5.6 LNG terminals capacity utilisation by months



Note: At several points in the timeframe, utilisation of LNG terminals in France exceeds 100% of the nameplate capacity.
Source: IEA data, ENSOG data for the Netherlands

These constraints have a direct impact on gas prices. For example, the Commission notes that Spanish LNG has been trading at a discount to the TTF spot price due to grid bottlenecks impairing the flow of gas from south to north.[50] This is particularly important, as the reverse-flow capabilities of gas infrastructure may be limited in the short run and require significant investment and time to ramp up. Reverse flows and interconnector constraints for selected countries are shown in Figure 5.7.

[50] European Commission (2022), 'Quarterly report on European Gas Markets', *Market Observatory for Energy*, **15**:2, p. 28.

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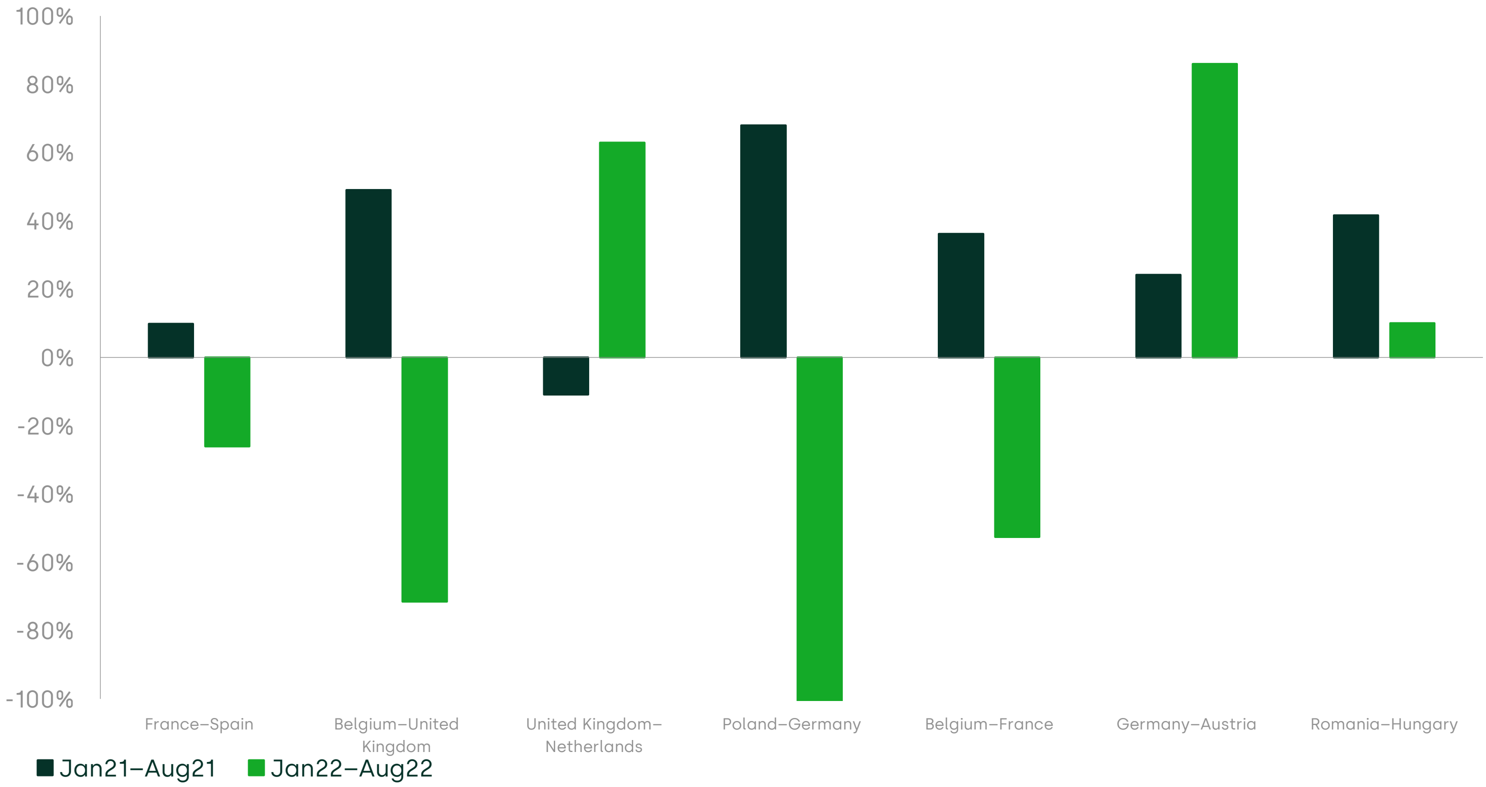
Figure 5.7 Interconnector use compared to maximum capacity



Note: The black bars show the flows at the interconnection points in 2021 (January to August), while the green bars show the flows for the same period in 2022.
Source: Oxera analysis based on IEA and ENTSOG dataset.

The data shows that:

- interconnectors are operating much closer to capacity in 2022 compared to 2021; for example, the Germany–Poland interconnection was running at full capacity during the time period in 2022;
- flows at almost all border points analysed have reversed in 2022 compared to 2021; for example, in 2021 flows were largely running from Poland to Germany, while in 2022 gas is flowing from Germany to Poland.

This demonstrates physical constraints in transporting gas across Europe are likely to have contributed to the challenges of transporting the gas needed to replace Russian pipeline imports, thereby also contributing to rising gas prices at some hubs.

5.1.4 Gas storage

Another infrastructure constraint is the level of gas storage fill in the EU. The level of natural gas storage fill in 2022 significantly outpaces the level in 2021. In September 2022, EU gas storage facilities were at 85% of total capacity compared to 71% in 2021. Furthermore, storage in many EU countries was at or nearing full capacity in September 2022, with storage facilities in Denmark, France, Poland and Portugal

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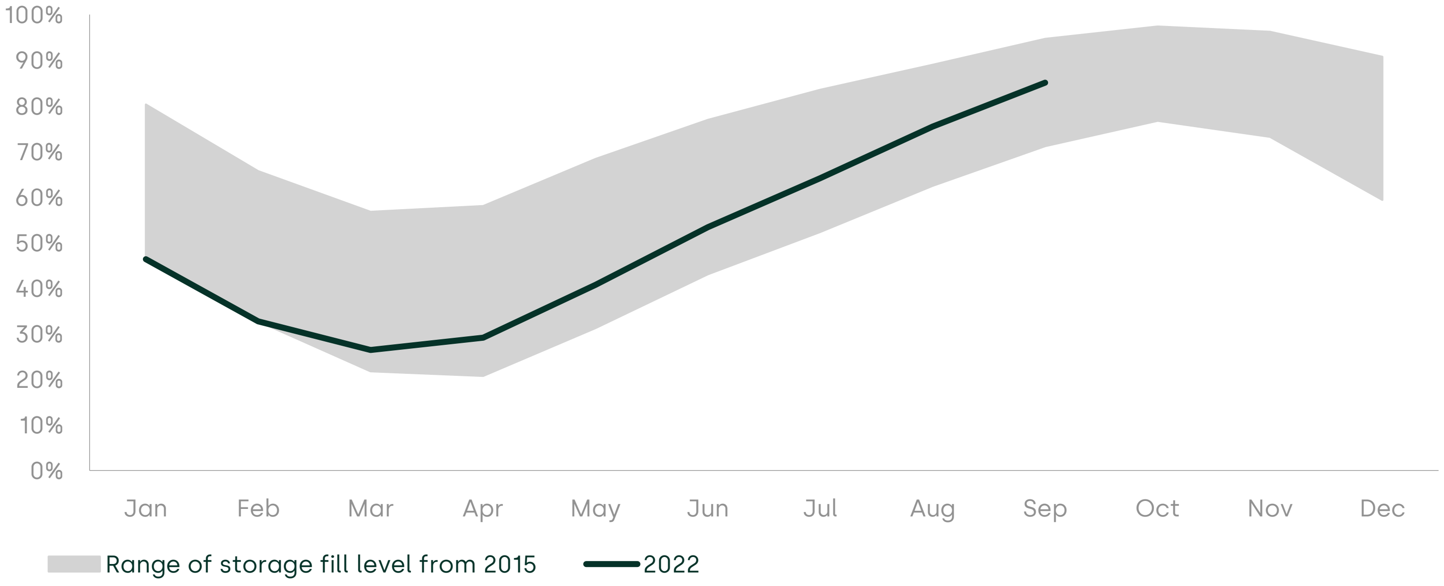
being more than 95% full. Figure 5.8 shows storage fill levels in 2022 compared to historical levels.

Figure 5.8 EU average storage fill



Note: The minimum/maximum fill levels are based on the average monthly fill levels of EU gas storage facilities from January 2015.
Source: Bruegel data.

Normally storage facilities are filled in the summer when prices tend to be lower and the stored gas is used up in winter when prices tend to be higher. The commercial case for gas storage can be analysed using winter–summer spreads, which reflect the difference between futures contracts for the winter season compared to the spot price or futures contract prices for the summer season. As prices tend to be higher in the winter, these spreads are usually positive, which means that a storage operator can make a profit by purchasing gas in the summer and selling it in winter.

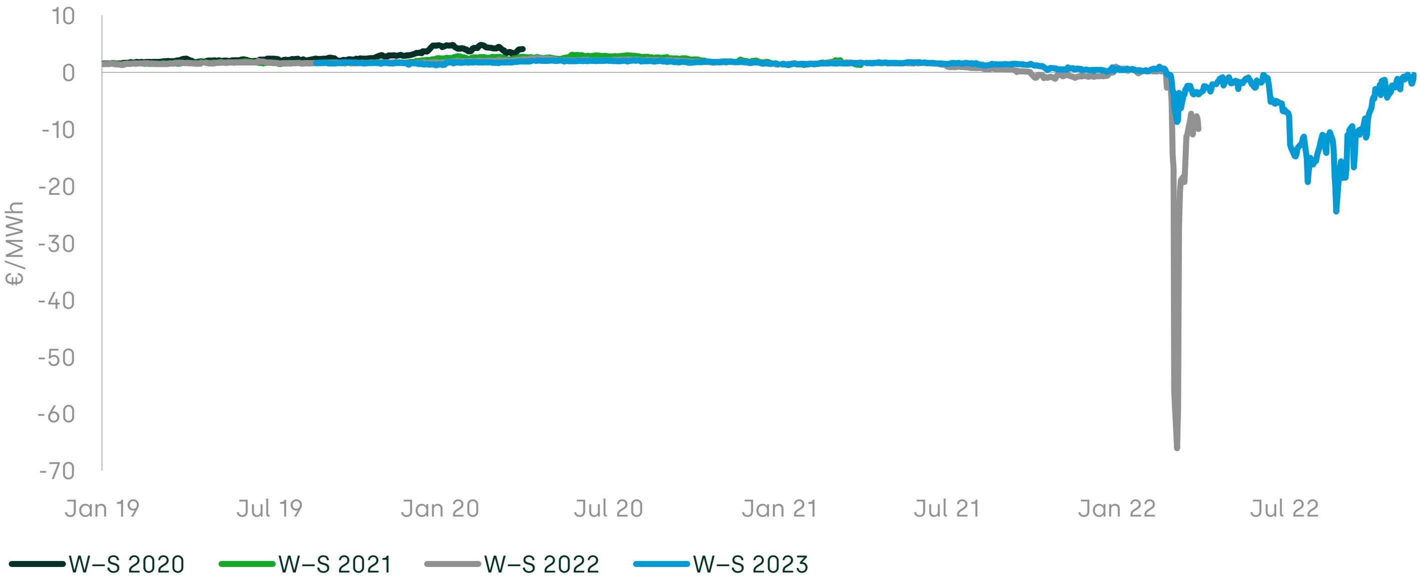
In light of the very high prices in 2022, governments have mandated certain minimum levels of gas storage fill. In late June 2022 the EU Council adopted a regulation requiring member states to fill storage sites to at least 80% of capacity by November 2022. Additionally, individual countries have their own rules. For instance, Germany and Italy mandated storage sites to reach 95% and 90% of capacity by 1 November 2022, respectively.[51]

It can be seen in Figure 5.9 that TTF winter–summer spreads were positive until late 2021, meaning that the winter price of gas was

[51] Bundesministerium für Wirtschaft und Klimaschutz (2022), 'Bundeswirtschaftsministerium stärkt weiter die Vorsorge für den Winter: Ministerverordnung zu Erhöhung der Speichervorgaben tritt morgen in Kraft', 28 July, https://www.bmwk.de/Redaktion/DE/Pressemitteilungen/2022/07/20220728-bundeswirtschaftsministerium-staerkt-weiter-die-vorsorge-fuer-den-winter.html (accessed 22 November); IEA (2022), 'Italy Natural Gas Security Policy', 18 October, https://www.iea.org/articles/italy-natural-gas-security-policy (accessed 22 November).

above the summer price of gas. In late 2021 the spreads turned slightly negative before becoming markedly negative spike at the start of 2022. This means that, in early 2022, the market was expecting summer prices to be above winter prices. Given the historically high prices seen in the first half of 2022 that were unprecedented at the time, this could have been a reasonable assumption. The market was therefore implicitly expecting gas supply to increase and/or demand to decrease leading to lower prices towards the end of 2022.[52] Negative winter–summer spreads mean that a rational storage operator would not have a strong commercial incentive to store gas in the summer. In the second half of 2022 the TTF winter–summer spread became significantly more negative, coinciding with TTF front month prices reaching new highs in August and September. At this time Russian gas supplies via Nordstream 1 were reduced further, then later suspended, and the pipeline was physically damaged.

Figure 5.9 TTF Gas futures winter–summer spreads



Note: W–S 2020 refers to the premium of the winter 2020/21 contract over the summer 2020 contract price; W–S 2021 refers to the premium of the winter 2021/22 contract over the summer 2021 contract price; etc.
Source: Oxera analysis of Bloomberg data.

In addition to contributing to price increases by adding to gas demand, the mandated filling of gas storages in 2022 had additional adverse effects on the futures market.

To illustrate this, we first set out how a typical commercial entity would use storage. In the summer, a company could buy gas at the spot price (e.g. €40/MWh) and place the volumes in storage to be used in the winter. However, it would also typically sell the gas on the forward market (e.g. at €60/MWh) in order to hedge its market risk and to lock in a profit (in this example, €20/MWh less storage costs). In contrast, some governments mandated that their national TSOs

[52] Changes to both supply and demand since then strongly suggest that the high prices earlier in 2022 have contributed to lower prices in late 2022.

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purchase gas to fill their storage facilities further in order to meet minimum filling targets. Given the already tight supply–demand balance in 2022, these purchases would have contributed to the higher prices seen in this period, and we understand also that these volumes were generally not hedged (i.e. sold forward as part of a commercial hedging or trading strategy) as they were intended to provide strategic gas stocks. To the extent that the criteria for the utilisation of these reserves and effectiveness of the withdrawal procedures remains unclear this could increase the perceived uncertainty of future supplies, thereby adversely affect forward trading and price formation.

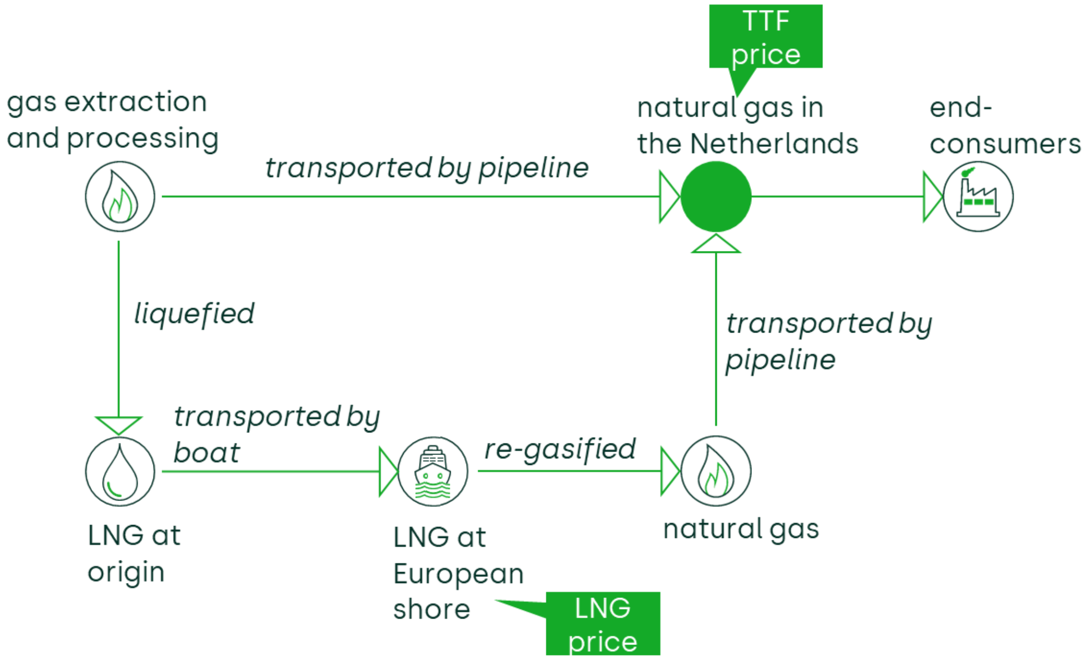
5.2 The link between TTF and LNG prices

In 2020 LNG accounted for approximately a quarter of gas imports to the EU, with the rest supplied by pipelines. The advantage of LNG relative to pipelines is that it can be flexibly imported from a wide range of supply countries, and hence it enhances security of supply. The disadvantage, however, is that supplies are often more expensive because the EU has to compete with Asian countries where LNG is the dominant source of natural gas norm and where pipeline infrastructure to natural gas producing countries is very limited if not non-existent. Moreover, countries in south-east Asia lack a 'single rulebook' for gas markets as is the case in the EU (third package of energy regulation) and US (CFC, inter-state gas transport and trade). The EU market is well connected to the global LNG market, with LNG trade having picked up since the USA lifted its export ban and more LNG facilities have been built.[53]

Figure 5.10 below illustrates the steps involved in bringing LNG into European pipelines. When analysing TTF and LNG prices, it is important to consider that the TTF is an index for the physical delivery of pipeline gas to the Netherlands. On the other hand, LNG deliveries arrive by cargo at different locations and prices are often quoted as 'landed prices'. The LNG then needs to be re-gasified in specific terminals before being transported to the final destination.

[53] For example, since 2019 several US LNG export terminals (Sabine Pass, Freeport, Corpus Christi, Cameron, and Elba Island) have nearly doubled US LNG export capacity. See Albrizio, S., Bluedorn, J., Koch, C., Pescatori, A. and Stuermer, M. (2022), 'Market Size and Supply Disruptions: Sharing the Pain of a Potential Russian Gas Shut-off to the European Union', IMF Working Paper, 19 July, and Fulwood, M. and Sharples, J. (2021), 'Why are gas prices so high?', Oxford Energy Comment, September, p. 4.

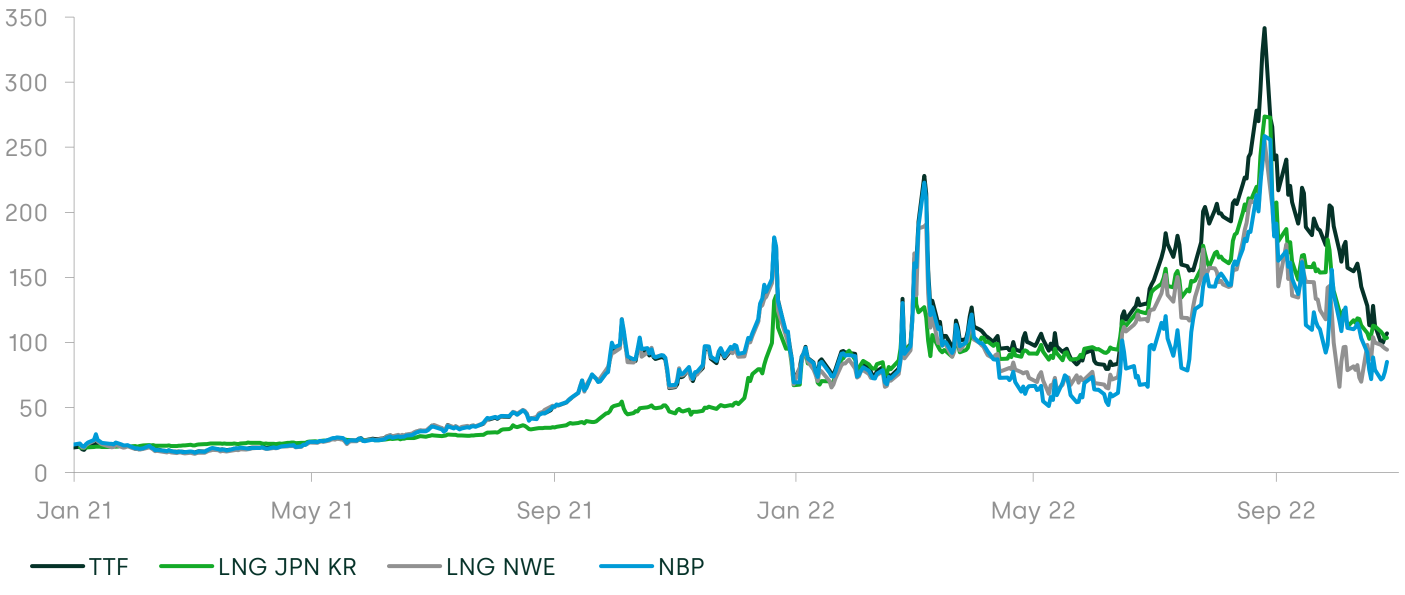
Figure 5.10 Value chain of pipeline gas and LNG



Source: Oxera.

The TTF, being the most liquid gas market in Europe, is commonly used as a pricing proxy for natural gas, including for LNG contracts.[54] Figure 5.11 shows TTF, European and Asian LNG prices in 2021 and 2022.

Figure 5.11 TTF, NBP and LNG prices (€/MWh)



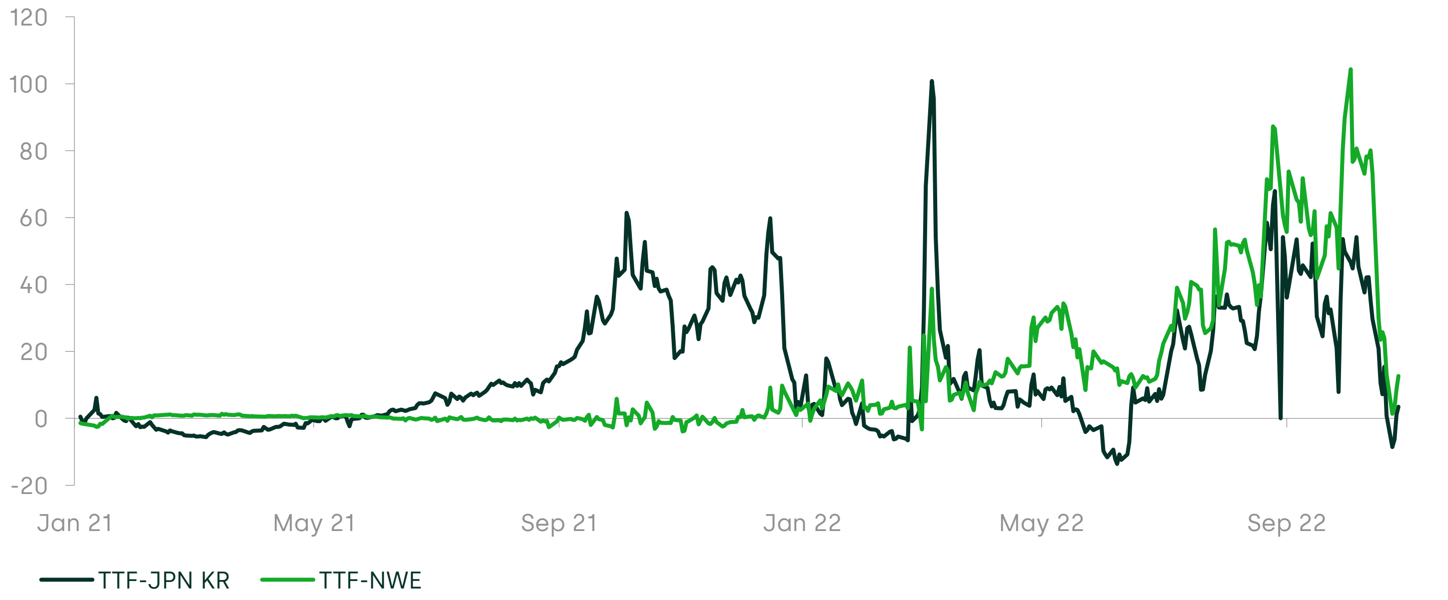
Source: TTF front-month prices, NBP front-month prices, LNG JPN KR prices from Bloomberg and LNG NWE prices from S&P Global Platts.

[54] See, for instance, Natural Gas Intelligence (2022), 'What is the TTF? Market Size and Supply Disruptions: Sharing the Pain from a Potential Russian Gas Shut-off to the European Union', *International Monetary Fund Working Paper*, July, WP/22/143, p. 5, https://www.naturalgasintel.com/ttf/ (accessed 20 November).

Figure 5.11 above shows that LNG and TTF price indices are closely correlated, which is not surprising given that LNG contracts are often priced with reference to the TTF.

Figure 5.12 below plots the difference between the JPN-KR LNG index, NWE LNG index and the TTF. Differences between the two series are to be expected for several reasons, such as changing LNG cargo transport costs, geographical differences, or infrastructure constraints on re-gasification terminals and interconnectors. Physical constraints and decrease in pipeline gas lead to an increased demand for LNG facilities, while the supply and capacities at these facilities remain inelastic in the short term. It follows that the price of gas shipment and regasification at the terminals increases until these constraints are eased.

Figure 5.12 Difference between TTF and LNG prices (€/MWh)



Source: TTF front-month prices and LNG JPN KR prices from Bloomberg and LNG NWE prices from S&P Global Platts.

The data shows that the TTF and LNG indices were very similar at the start of 2021, with JPN-KR LNG trading at a small premium. The relationship then reversed towards the end of 2021, when gas prices in Europe were increasing sharply compared to the JPN-KR index, which was trading at a discount to TTF and NWE LNG prices. The largest spikes have coincided with significant news events, as seen in Figure 5.1. The immediate reaction is more pronounced in the TTF prices rather than global LNG prices. This may reflect concerns among European market participants about the extent of gas availability in the upcoming weeks. The substantial price differential spikes subside quickly to a new equilibrium, as the market adjusts its expectations and potentially its supply mix. The higher average TTF price in 2022 compared to LNG is likely to be caused by LNG infrastructure constraints. This is further evidenced by the fact that LNG in NWE

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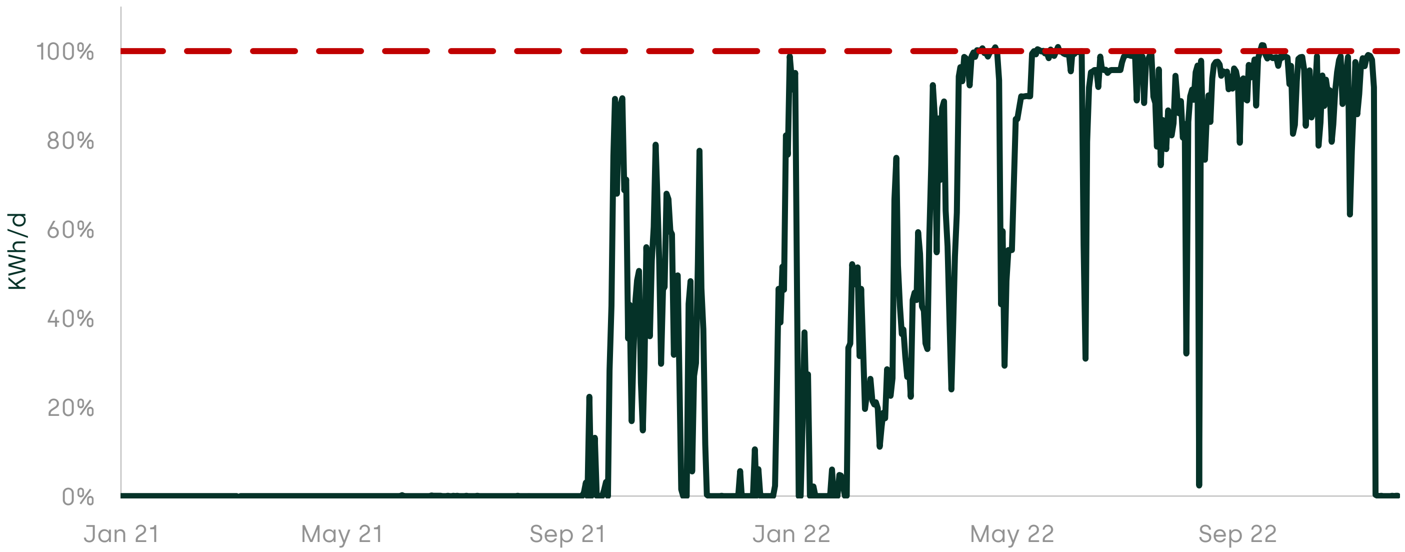
traded at a discount to the global LNG price, such as the Japan-Korea LNG price. The Commission notes in its quarterly gas report:[55]

> The TTF hub price, considered for a long time as price setter of LNG import contracts, showed an increasing premium to most the LNG import hub prices in Q2 2022, **owing to the abundance of LNG imports and grid bottlenecks** hampering flow of LNG from western European terminals to other parts of the continent. [Emphasis added]

Examining the spread between TTF and NWE is crucial for understanding the extent of physical constraints in the market. Given that NWE LNG is a price index for LNG delivered to the UK, Netherlands, Belgium or France, in a market without physical constraints it would be easy for a participant to arbitrage the TTF price difference.

As seen in Figure 5.6, terminals in the Netherlands, Belgium and France have been operating at very high levels of utilisation in 2022. Hence, the only terminals in this region that have spare capacity to import more LNG are those based in the UK. As a next step, the gas would need to flow into Europe. Figure 5.13 and Figure 5.14 below show the capacity utilisation of gas interconnectors between the UK and continental Europe, namely the UK–Netherlands interconnector and the UK–Belgium interconnector.

Figure 5.13 Physical flow of gas relative to the maximum interconnector capacity use (UK–Belgium)



Note: The y axis shows the physical flow of gas (KWh/day) from the UK to Belgium relative to the maximum technical capacity (KWh/day).
Source: Oxera analysis based on data from ENTSOG (2022).

[55] European Commission (2022), 'Quarterly report on European Gas Markets', *Market Observatory for Energy*, **15**:2, p. 31.

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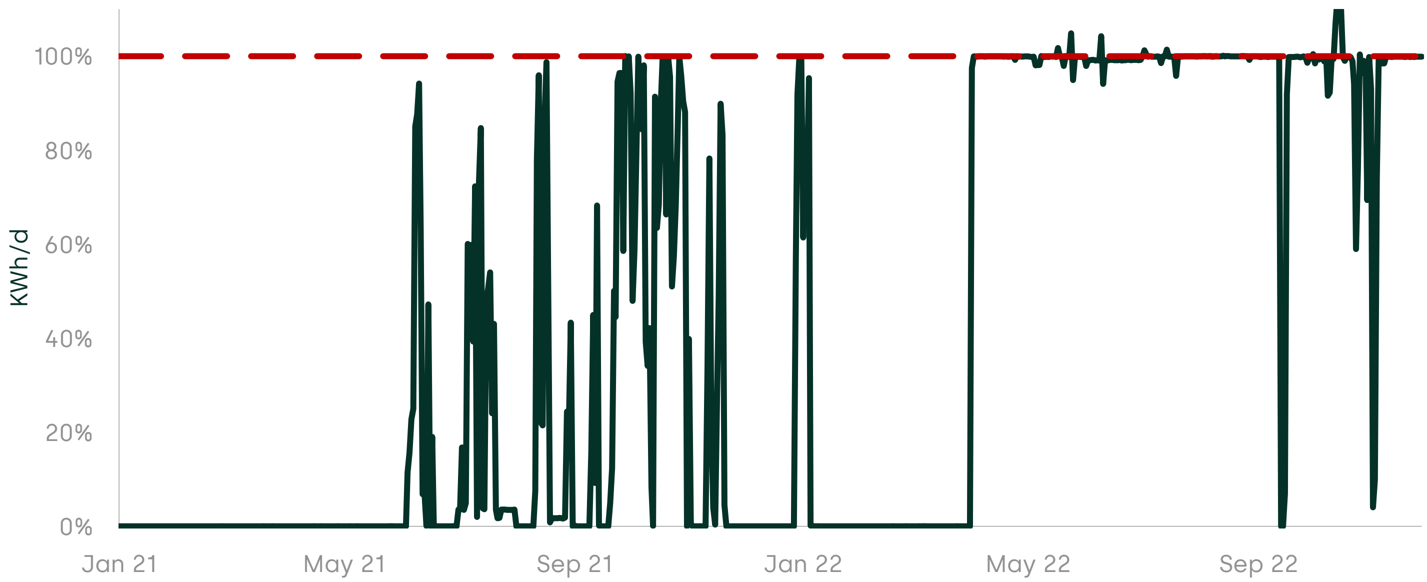
Figure 5.14 Physical flow of gas relative to the maximum interconnector capacity use (UK–Netherlands)



Note: The y axis shows the physical flow of gas (KWh/day) from the UK to the Netherlands relative to the maximum technical capacity (KWh/day).
Source: Oxera analysis based on data from ENTSOG (2022).

The figures show that both interconnectors have been operating near capacity for the most of 2022. Hence, despite a price premium of TTF to NWE LNG, there is not enough physical capacity to import and transfer more LNG through the region.

The above example highlights the physical constraints that may explain the significant price differential between LNG and TTF in the NWE region. It is clear that the price of LNG on tankers in the ocean is not equivalent to the value of gas to the consumers in Continental Europe unless that gas can be delivered cheaply and efficiently. The same logic is applicable elsewhere in Europe, as physical constraints anywhere in the system prevent efficient balancing of the price in Continental Europe and increased use of LNG. This is further evidenced by the spread of NWE and Mediterranean LNG indices seen in Figure 5.17.

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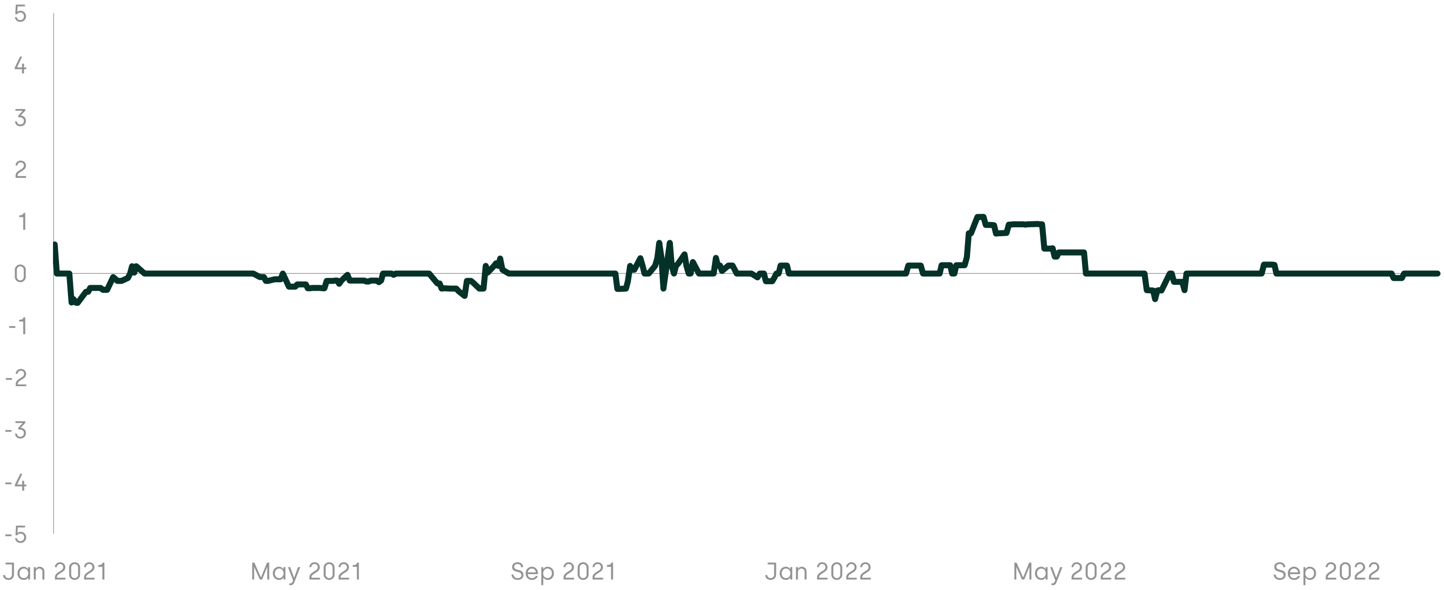
Figure 5.15 Difference between NWE LNG index and Mediterranean LNG index (€/MWh)



Note: Calculated as the NWE LNG price minus the Mediterranean LNG price.
Source: S&P Global Platts data.

The spreads between NWE and Mediterranean LNG prices have remained very low throughout 2022, being exactly zero for a large part of it. This is despite the significant TTF price differential and widely available LNG re-gasification capacity in Spain. Similarly, to the capacity in NWE, LNG capacity in Spain does not guarantee sufficient grid capacity downstream. For example, constraints in the Spain–France interconnection have been widely reported to cause considerable economic and political contention, with a new undersea pipeline agreed in October 2022.[56]

LNG and pipeline gas are both essentially the same good, with the only difference being that LNG is one step up in the supply chain. Once LNG has been re-gasified and transported into the main pipeline system, there is no difference between the two but the process has technical requirements and costs associated with it. A price differential reflecting infrastructure constraints is an important feature of a functioning market. It sends price signals to incentivise infrastructure investments. Once these investments have materialised and bottlenecks have disappeared, prices would be expected to converge again—though short-term differences in price developments would continue to occur.

5.3 The link between gas prices and the gas derivatives market

The prices shown so far have referred to the TTF spot price (or front-month contracts, which tend to be the most liquid). These are prices for the immediate purchase of gas (or, in the case of front-month contracts, for the future with the earliest expiration date). However,

[56] *Financial Times* (2022), 'Spain and France ditch contentious gas pipeline for undersea project', 20 October, https://www.ft.com/content/ac2c878a-0e57-40a8-ae07-09a9e8fc6a14 (accessed 1 December 2022).

as set out in section 3.1, trading derivatives, such as futures and options, allows market participants to achieve long-term price security by locking in certain future prices.

For storable commodities, the relationship between spot and futures prices is due to the possibility of arbitrage opportunities. According to financial theory, as the futures contract approaches maturity, the spot price and the futures price should converge, as the two contracts become economically identical. Before maturity, the price differential is driven by the opportunity cost of the money paid for the spot allowance and the possibility for arbitrage opportunities.

In the case of most commodities, this arbitrage opportunity is driven by the economics of storage (also called the 'cost of carry').[57] The owner of a commodity may benefit from owning the physical commodity and thereby having an easily accessible inventory (e.g. the ability to maintain production despite shortages or fluctuations in supply)—known as the 'convenience yield'.

When the futures contract price is above the spot price, the market is in 'contango'; when the futures contract price is below the spot price, the market is in 'backwardation'.

In the context of the gas market, future contracts are closely linked to weather forecasts, the supply and demand future balance, as well as inventory levels, as these factors influence expected future prices.[58] Changes in commodity prices tend to appear first in the futures market, as informed investors and speculators prefer trading in this market which is characterised by low costs and a high leverage effect.[59]

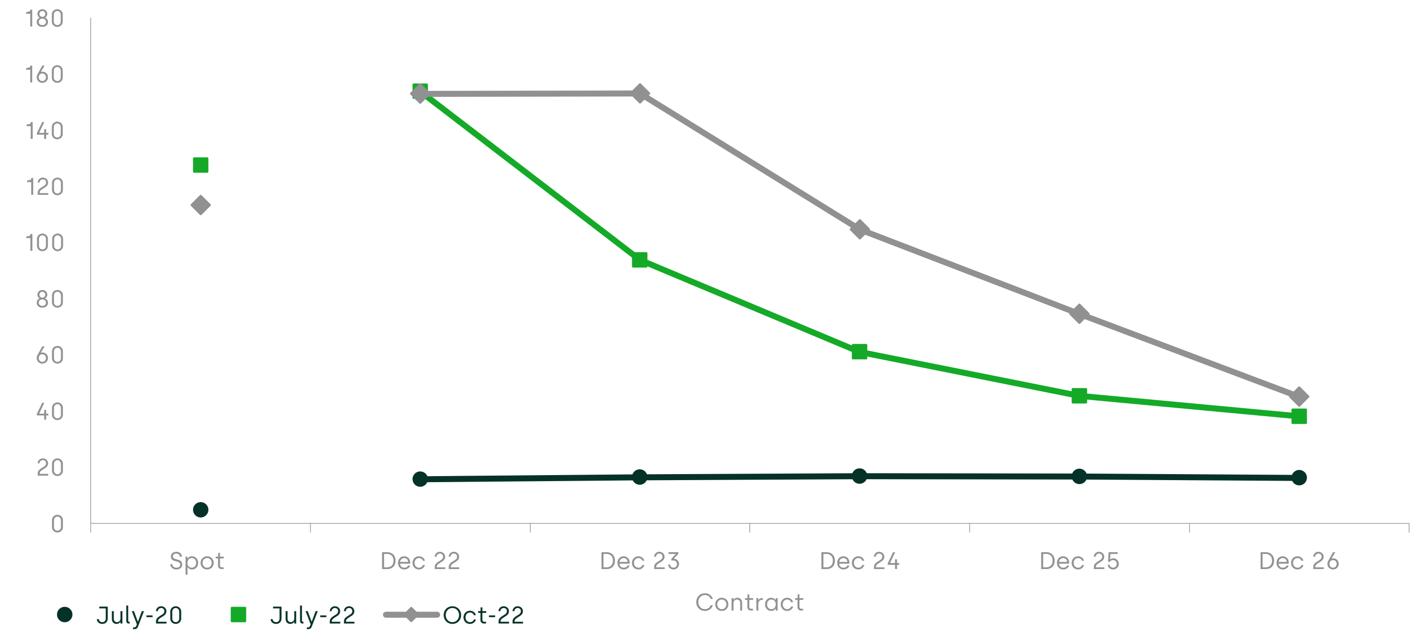
As shown in Figure 5.16 below, in July 2020, before the Russian invasion of Ukraine, futures prices had been relatively flat, albeit slightly upward-sloping. After the invasion, prices are shown to be in backwardation. This implies that market participants are expecting a steep decline in gas prices over the next four years. However, price levels are expected to remain significantly above what used to be expected before the current energy crisis.

[57] The arbitrage opportunity is as follows: the trader initially borrows money and uses it to buy an asset in the spot market and sells the commodity forward. The trader then stores the asset (for a fee) until the point when the futures contract expires. Upon expiry of the contract, the trader must pay back the borrowed money plus interest and storage costs. If the forward price exceeds the net amount owed, the trader would be able to make a risk-free profit. In such a case, traders would buy spot and sell futures such that the basis disappears. Assuming that it is possible to short the spot market, the same property holds in reverse.

[58] Florence School of Regulation (2021), 'Some reflections on current gas market price trends', 9 December, https://fsr.eui.eu/skyrocketing-energy-prices/(accessed 22 November).

[59] Ameur, H.B., Ftiti, Z. and Louhichi, W. (2022), 'Revisiting the relationship between spot and futures markets: evidence from commodity markets and NARDL framework', *Annals of Operations Research*, **313**, pp.171–189.

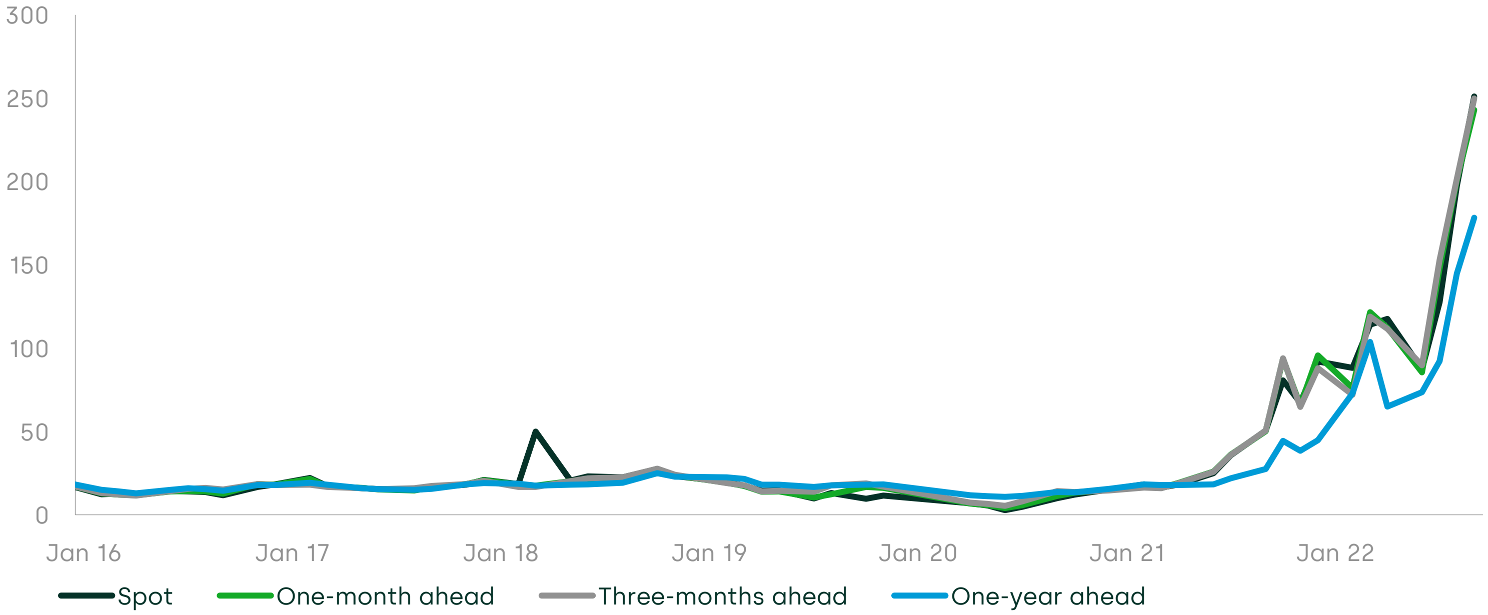
Figure 5.16 TTF Gas futures curve (€/MWh)



Note: The y axis unit is €/MWh hour of TTF gas. Prices as at the first trading day of a given month.
Source: Oxera analysis of ICE data.

In sum, as shown in Figure 5.17, the spot and futures market prices are closely linked. Both are predominately driven by gas market fundamentals (i.e. factors affecting the demand and supply of gas), with the recent rise being driven largely by uncertainty about the future supply of gas.

Figure 5.17 Historical time series of TTF gas spot and future prices (€/MWh)



Note: The Y axis unit is €/MWh of TTF gas. Prices as at contracts settlement date.
Source: Oxera analysis of ICE data.

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5.4 Impact of speculative trading on gas pricing

The above sub-sections discussed the fundamental reasons behind recent developments in gas prices. We now turn to the role of speculation, or more specifically, excessive speculation.

Speculators play an important role in gas markets by providing liquidity and taking the other side of the trade to hedgers. While commodity markets including the gas market cannot function without the presence of speculative trading, some concerns have been raised about the potential risk that 'excessive' speculation in gas futures has amplified the price and volatility in the market over the levels that can be justified by the underlying fundamentals alone.

One measure of speculation level in commodity futures markets is the Working's T-index.[60] A functioning market requires some degree of speculation to balance out the hedging demands. The Working's T-index aims to capture the level of speculation in excess of what is required in a balanced market for hedging purposes. In a market where long hedging positions exceed short hedging positions, the index is calculated as a ratio of 'other' long positions to total (long and short) hedging positions. Vice versa, in a market where short hedging positions exceed long hedging positions, the index is calculated as a ratio of 'other' short positions to total hedging.

A 'high' T-index does not by itself imply excessive speculation, but the index may provide a useful overview of the prevalence of speculation over time. Figure 5.18 presents Working's T-index values for the TTF Gas futures and shows that, despite the increased volatility in 2022, there has not been a significant increase in excessive speculation as defined by the index. Since the start of 2022, the T-index has fluctuated between 40% and 65%, well below the highs of over 150% seen in 2018.

[60] Working, H. (1960), 'Speculation on hedging markets', *Food Research Institute Studies*, **1**:2, pp. 1–36

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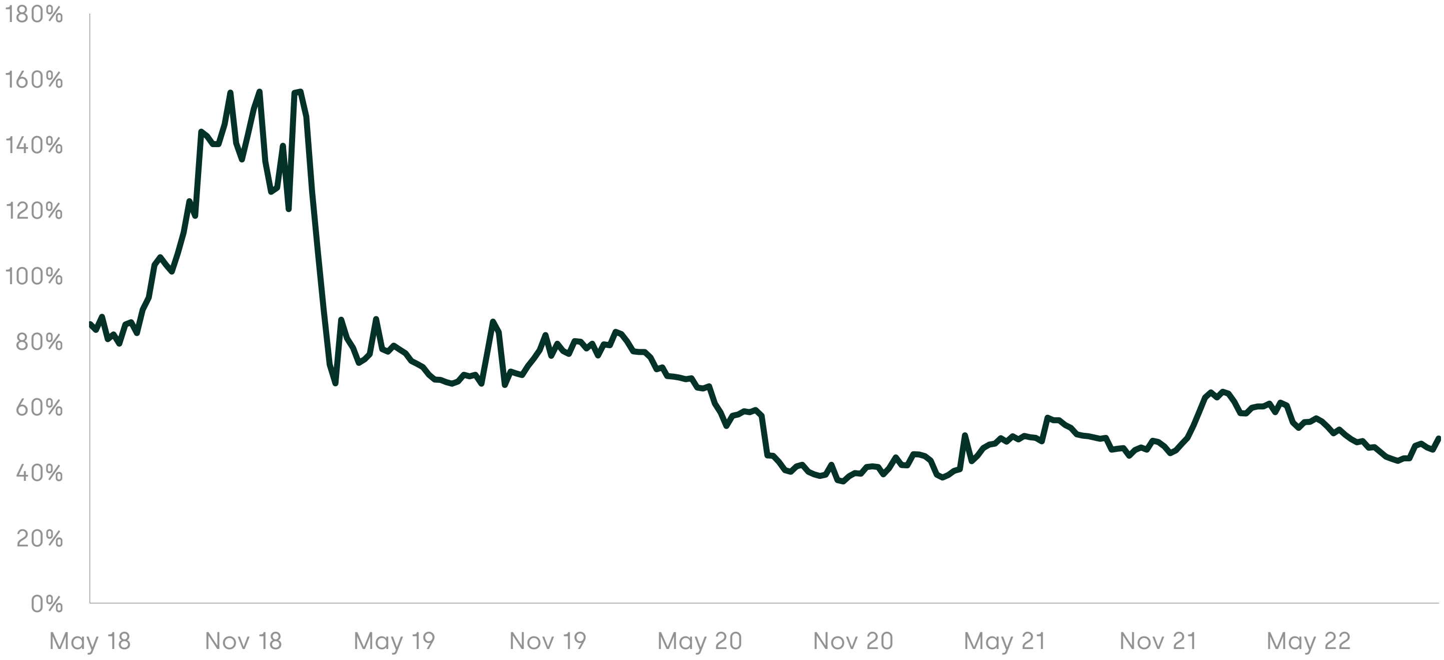
Figure 5.18 Working's T-index



Note: In TTF Gas futures, the balance of long and short hedging positions changes over time. Hence, in periods when long hedging outweighs short hedging, the T-index is calculated as the ratio of 'other' long positions over total hedging; whereas when short hedging outweighs long hedging, it is calculated as 'other' short positions over total hedging.
Source: Oxera analysis of ICE COT data.

5.4.1 How does speculative trading affect gas price volatility

Speculative trading (i.e. traders taking a position on the future direction of a market variable) may affect price volatility in one of two ways:

- speculators may trade primarily on the basis of proprietary information. This means that, due to their trading activity, prices adjust more quickly to reflect fundamental value drivers (i.e. the activity leads to lower volatility).[61] A naive speculator would go bankrupt very quickly;
- speculators entering the market increase competition for liquidity provision. Improved liquidity for a given asset may, in turn, lead to reduced volatility (for example, as incoming orders are less likely to absorb all the resting quotes on the other side of the order book).

Several academic papers have empirically tested the relationship between speculative trading and price volatility in commodity markets (see Table 5.1). Overall, much of this empirical literature suggests that speculators tend to dampen (not increase) price volatility (as well as contributing to liquidity).

[61] For a market microstructure model that shows how prices adjust to reflect the trading behaviour of informed traders, see, for example, Glosten, L.R. and Milgrom, P.R. (1985), 'Bid, ask and transaction prices in a specialist market with heterogeneously informed traders', *Journal of Financial Economics*, **14**:1, pp. 71–100.

Table 5.1 Literature review on speculators and price volatility

Paper	Key findings
Gilbert (2010)	Gilbert uses data on index fund positions in the US agricultural futures markets as a proxy for total index-related futures positions in all markets. Granger causality tests using this proxy measure suggest that index investors may amplify price movements driven by fundamentals.
Irwin and Sanders (2011)	Irwin and Sanders test whether the growth in index funds has increased price volatility in agricultural and energy markets. To do so, they conduct a Granger causality test between measures of traders' positions and speculation against volatility of returns. They find no evidence to suggest that index funds caused a price bubble in agricultural commodity markets.
Buyuksahin and Harris (2011)	Buyuksahin and Harris test the correlation between the Working T-index and daily price changes in the crude oil market. They report a near-zero correlation between the two series.
Brunetti, Buyuksahin and Harris (2011)	Brunetti et al. consider specific categories of traders, and test whether positions taken by each cause changes in volatility in oil prices. They conclude that the results are consistent with speculators providing liquidity and responding to market conditions, rather than the opposite.
Alquist and Gervais (2013)	Alquist and Gervais find that financial firms' positions did not cause oil price fluctuations during 2007/08. They use the Working T-index to examine the importance of financial firms in driving oil price volatility, and find no empirical evidence to suggest a strong relationship between the position of speculators and price changes.
Bohl, Putz and Sulewski (2021)	Bohl et al. conduct a fixed-effects panel regression across 20 commodity markets. This model finds no evidence of a significant relationship between speculative activity and the degree of informational efficiency, after controlling for volatility and liquidity.

Source: Gilbert, C. (2010), 'Speculative influences on commodity futures prices, 2006-2008', UNCTAD Working Paper; Irwin, S.H. and Sanders, D.R. (2011), 'The impact of index funds in commodity futures markets: a systems approach', *Journal of Alternative Investments*, **14**, pp. 40–49; Buyuksahin, B. and Harris, J.H. (2011), 'Do speculators drive crude oi futures?', *The Energy Journal*, **32**, pp. 167–202; Brunetti, C., Buyuksahin, B. and Harris, J.H. (2011), 'Speculators, prices and market volatility', working paper; Alquist, R. and Gervais, O. (2013), 'The role of financial speculation in driving the price of crude oil', *The Energy Journal*, **34**:3, pp. 35–54; Bohl, M.T., Putz, A. and Sulewski, C. (2021), 'Speculation and the informational efficiency of commodity futures markets', working paper.

We have also analysed the volatility of TTF prices. Figure 5.19 below shows the annualised volatility of TTF front-month gas futures within a ten-day rolling window.

It can be seen that, historically, there have always been periods of high volatility. Since the start of 2022, these periods have been more frequent, with constant volatility, and the most recent spikes have shown to be more volatile than before. A more significant change can be seen in Figure 5.20 below, which shows the absolute monthly price variability for TTF front-month gas futures. Absolute monthly variability has risen from around €5–€10/MWh in the 2017–20 period to having spikes of over €150/MWh in 2022.

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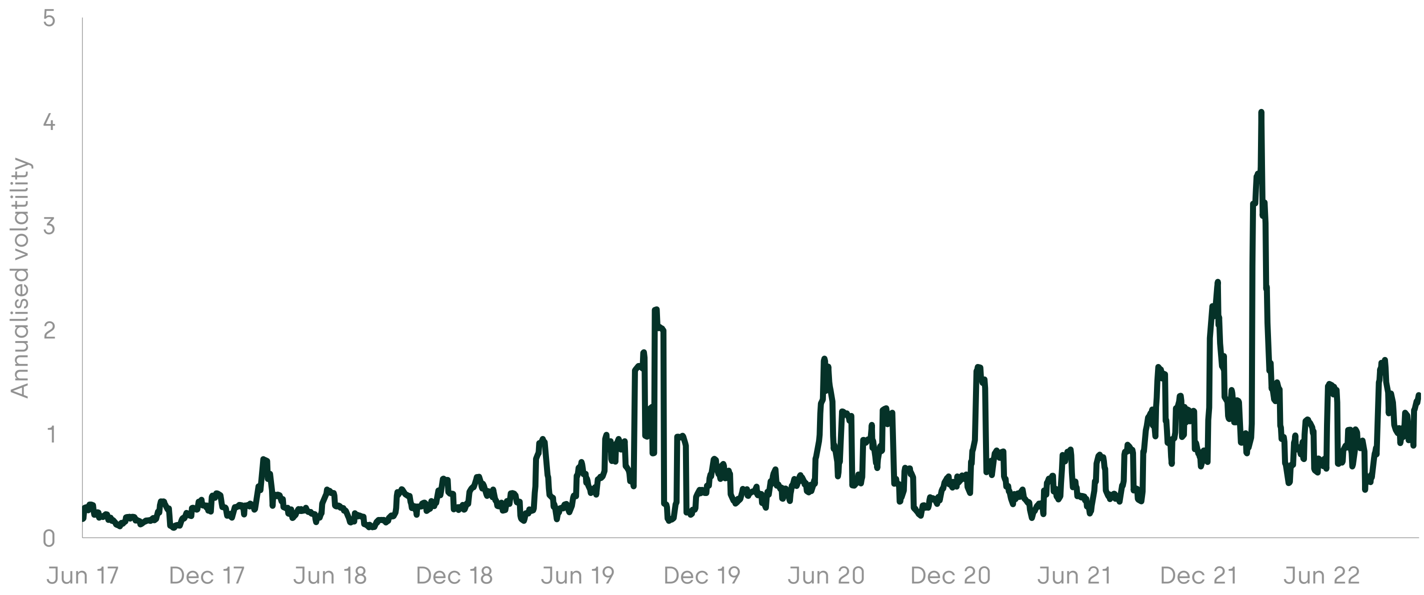
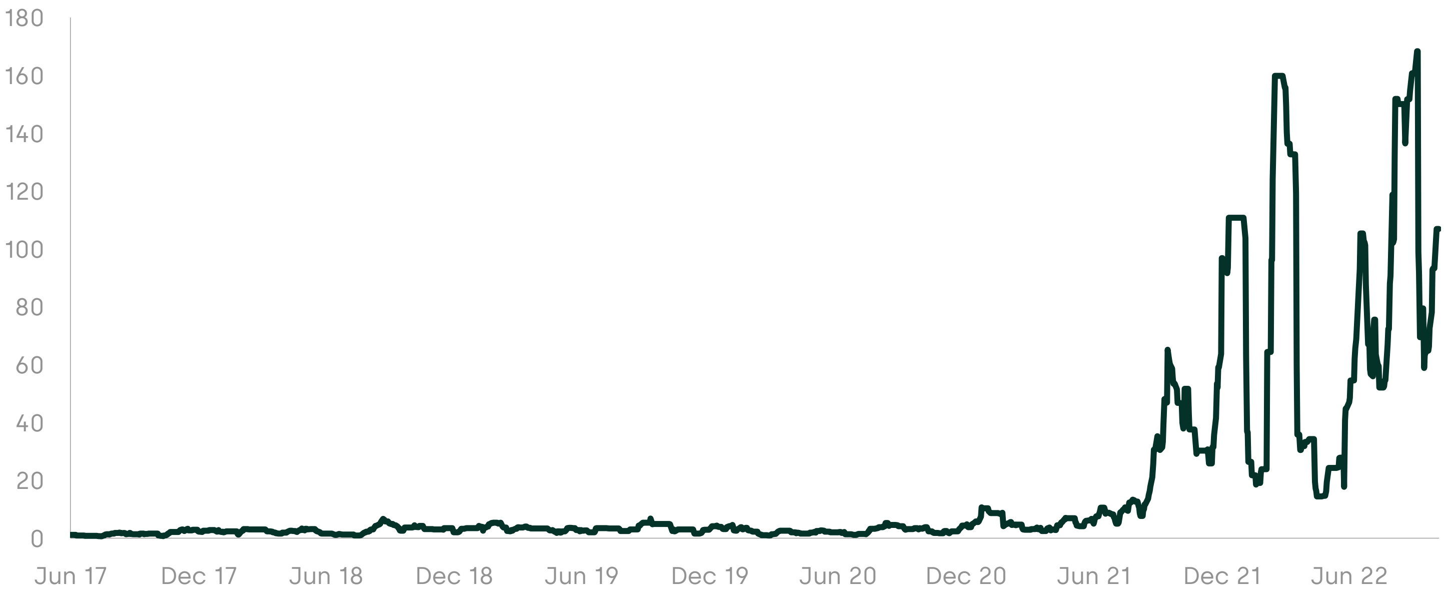
Figure 5.19 Annualised historical volatility for TTF front-month gas futures (ten-day rolling window)



Note: The annualised historical volatility is calculated by taking standard deviations of daily returns over a ten-day rolling window and annualising the daily values by multiplying by the square root of 252 (i.e. the average number of trading days in a year).
Source: Oxera analysis of Bloomberg data.

Figure 5.20 Absolute monthly price variability of TTF front-month gas futures (€/MWh)



Note: The absolute price variability is calculated for TTF front-month gas futures as the difference between the maximum and the minimum price over a 30-day rolling window.
Source: Oxera analysis of Bloomberg data.

High volatility can be problematic as it makes it more difficult for traders to assess future expectations accurately. It can also have practical risk-management implications. If the risk to which a company is exposed under a specific position changes sharply due to high volatility, this can lead to higher risk-management costs, for instance in terms of sudden (and high) margin calls.

Given the extremely uncertain circumstances surrounding the gas crisis, increased volatility is to be expected, as it reflects differing and changing views of the gas situation.

6 Policy implications

In light of the unprecedented developments in gas prices observed since late 2021, governments across Europe have discussed and implemented numerous policies to protect consumers and businesses. These range from one-off cash payments to consumers, to wholesale market interventions.

At the EU level, policymakers have also examined the role of the TTF, and on 18 October the European Commission published a proposed Council Regulation on measures to address the EU energy crisis.[62] Further details on the conditions required to trigger the wholesale gas market correction mechanism (i.e. a price cap) were published on 22 November.[63] This section discusses the price cap proposals put forward by the Commission.

This report has highlighted the key benefits of a liquid gas futures market, which allows market participants to effectively hedge their positions. Exchanges play an important role in this by allowing more traders to participate in the market and providing more transparency relative to OTC trading.

The analysis presented in this report also demonstrates that the EU wholesale gas market and its derivatives market are functioning well. This is supported by:

- demand and supply fundamentals being reflected in TTF market prices. While some price spikes could have been caused by the market over-reacting to specific news, a new equilibrium was quickly established (e.g. in March and August 2022). Section 5 set out fundamental drivers of gas prices, and showed that prices are caused largely by underlying physical factors affecting supply and demand;
- the TTF derivatives market being well functioning in terms of resilience, liquidity and price-formation for contracts and instruments with a variety of maturities. Even at times of stress in spring and summer 2022, key indicators, such as relative bid–ask spreads, the number of traders or the value of open interest, remained relatively stable.

Based on its proposal of 22 November, the Commission intends that its proposed price cap would only cover front-month TTF derivatives and would be triggered if prices exceed €275/MWh for two weeks and if TTF prices remain €58/MWh higher than the LNG reference price for ten consecutive trading days within any period of two weeks.[64]

[62] European Commission (2022), 'Proposal for a COUNCIL REGULATION Enhancing solidarity through better coordination of gas purchases, exchanges of gas across borders and reliable price benchmarks', 18 October.
[63] European Commission (2022), 'Commission proposes a new EU instrument to limit excessive gas price spikes', 22 November, https://ec.europa.eu/commission/presscorner/detail/en/ip_22_7065 (accessed 2 December).
[64] Ibid.

Wholesale market interventions such as pricing limits are typically proposed where the market is not functioning, for example where prices reflect a significant risk of market manipulation or other abusive trading practices. However, as shown in this report, the gas market is working broadly as intended, and indicators of market resilience, liquidity and price formation have generally improved in the last three to five years. There is also no evidence of excessive speculation. This view is supported by the AFM:[65]

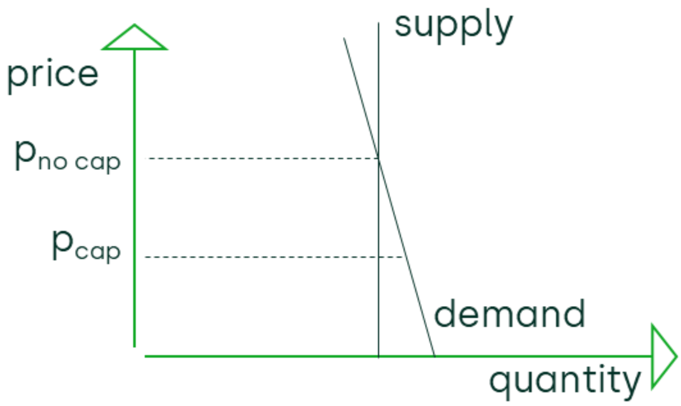
> Despite the exceptionally high gas prices and volatility, **it [the gas futures market] continued to function adequately**. The call for measures to lower gas prices is understandable, but technical measures in the gas futures market are not a solution to the resulting imbalance between supply and demand. The gas futures market will benefit most from measures that support efficient price formation and stable liquidity. **Generic interventions, such as setting a maximum price at which gas may be traded, can seriously disrupt the functioning of this market and have unintended negative consequences**. It would be more effective **to tackle the underlying problem by reducing the demand for gas** and organizing joint European gas procurement. [Emphasis added]

The Commission's price cap proposal may undermine the functioning of the gas market and increase the risk of adverse unintended consequences if there are no measures to mitigate these. Examples of these unintended consequences are summarised below.

Inefficient price signals. In the absence of any counter-measures to address the negative consequences of a price cap, it is likely that the market would not provide efficient price signals that would encourage gas users to reduce their demand, and incentivise producers or shippers to increase their supply. The effect of a price cap in a situation where supply cannot be rapidly and easily increased (as is the case in the short term when infrastructure capacity is limited) is illustrated in Figure 6.1 below. Supply is shown as a vertical line, as all import capacity is being used. Demand is downward-sloping but fairly inelastic. By capping the price at p_{cap}, demand would exceed supply as this is limited by the infrastructure bottleneck.

[65] AFM (2022), 'AFM: Kwetsbaarheid consumenten neemt toe, uitdagingen op de gastermijnmarkt', press release, 3 November, https://www.afm.nl/nl-nl/professionals/nieuws/2022/november/trendzicht-2023 (accessed 22 November).

Figure 6.1 Illustration of a simple price cap under limited supply



Source: Oxera.

This simple illustration highlights the potential unintended consequences of capping gas prices and not allowing proper price signals without additional measures.

We note that additional design elements could potentially be introduced to address these negative consequences by ensuring that: (i) demand-reduction incentives are in place that would need to be set administratively; and (ii) security of supply is preserved by designing a mechanism that allows incremental volumes of gas to be procured at market prices when necessary (rather than being limited to the price cap). However, it is not clear whether such design elements are being contemplated. That said, the recent proposals do envisage that the cap would be suspended if risks to security of supply or demand-reduction efforts were hampered.

A shift to OTC and other TTF derivatives, resulting in lower liquidity and higher hedging costs. The Commission's price cap proposal applies to TTF contracts with specific maturities, including the front-month contract. This means that trades at higher prices could still happen in all other TTF futures markets, all the contracts traded on the OTC (including the capped futures contract), and in the spot market. If the cap were triggered, this would therefore not actually cap all wholesale gas transactions because contracts with similar characteristics could be traded on the OTC market or on other hubs.

Moreover, an intervention that applies only to exchange-based trading means that trading is likely to shift to OTC if the cap is triggered. As set out in section 3, exchange-based trading has significant benefits compared with OTC. A shift to OTC would mean less transparency for the market and less liquidity in the TTF because a not-insignificant number of market participants that trade on the exchange do not have access to the OTC. This, in turn, could make hedging more inefficient and costly for market participants, thereby increasing costs to the consumer.

'Threshold effects' increasing liquidity providers' risks, leading to lower liquidity. An inevitable consequence of the Commission's proposal is that it would introduce a discontinuity in the incentives faced by market participants that could have unintended consequences for the behaviour of market prices as they rise and approach the cap. In general, the impacts of threshold effects can be difficult to predict as they are influenced by market participants' trading strategies and risk tolerance, and their expectations of the reactions of others to market developments.

One example of how the price cap could adversely affect the price dynamics of the TTF front-month contract relates to the incentives faced by financial institutions that pursue a trading strategy as liquidity providers. These traders typically do not have access to OTC derivatives as they are not interested in buying, selling or holding physical gas. As described in sections 3.4 and 4.2, liquidity providers typically hold a mix of short and long positions and seek to open and close these positions within a few hours or days to limit their inventory holding costs.

For liquidity providers, the price cap proposal could materially affect their trading risks and, therefore, their willingness to trade. For example, as the market price increases and approaches the level of the price cap, the risk that the price cap will be triggered will also increase. Once the price cap is triggered, no new buy or sell orders would be accepted at the market price (which would then be higher than the price cap). In turn, this would therefore limit the ability of liquidity providers to close out their remaining short positions as this would require an offsetting long position. Given that the market price might be expected to be materially higher than the price cap, there would be no incentive for holders of long positions to effectively sell these contracts at less than the market price. Rising market prices could therefore increase the pressure on liquidity providers by potentially 'forcing' them to close out their short positions to contain their risks.

Alternatively, to the extent that liquidity providers anticipate these risks, they may be more likely to withdraw from the market, leading to less liquidity in the market overall.

Risking financial (in)stability (trades might not be honoured and gas could remain in storage rather than being traded). In its opinion of 2 December, the ECB considers that the current design of the proposed market correction mechanism may, in some circumstances, jeopardise financial stability in the euro area. The mechanism's current design may increase volatility and related margin calls, challenge central counterparties' ability to manage financial risks, and may also incentivise migration from trading venues to the non-centrally cleared over-the-counter (OTC) market**.** [66]. If price caps on TTF futures prices

[66] European Central Bank (2022), 'OPINION OF THE EUROPEAN CENTRAL BANK of 2 December 2022 on a proposal for a Council regulation establishing a market correction mechanism to protect citizens and the economy against excessively high prices (CON/2022/44)', 2 December, https://www.ecb.europa.eu/pub/pdf/other/en_con_2022_44_f_sign~6183314e58.it.pdf?03da916dda2e61d4a50b7132bfafd961 (accessed 12 December).

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were introduced, this would affect the existing positions of companies trying to hedge. A recent paper by the Oxford Institute of Energy Studies showed how a cap below the market price would be likely to lead to trades not being honoured, potentially leading to large financial losses.[67]

A long-term impact on futures markets. In the long term, the intention is that fossil fuels, including natural gas, will be phased out. Wholesale market interventions that lead to lower levels of liquidity and less-efficient price signals could therefore have spillover effects, for instance on investment signals for renewable and low-carbon gases, as recognised by European energy regulators:[68]

> To foster the emergence of renewable and low-carbon gases, the re-examination of the current gas market regulatory framework should also ensure an integrated, liquid and interoperable EU internal gas market.

In summary, this section has highlighted that the Commission's price cap proposal is unlikely to achieve its intended effect of reducing market prices for gas because it applies only to selected TTF futures contracts, implying that, if or when the price cap is binding, transactions could instead transfer to other trading venues (e.g. OTC) and/or using other hubs (e.g. NBP). Either way, the risk is that the price cap would be bypassed, and that the price of gas will not be materially reduced.

However, if the Commission's price cap were applied more widely, potentially encompassing wholesale gas prices across the entire EU, this would greatly increase the risk that gas supplies would reduce, demand increase, unless additional policy measures were also applied to mitigate these risks. A significant increase in market distortions would be counterproductive.

In addition to not being effective, the Commission's price cap is likely to significantly distort the trading of TTF derivatives. For example, a key concern is that liquidity providers (which do not have access to OTC derivatives) will see the price cap as limiting their ability to close out their short positions, thereby increasing their trading risks substantially. Anticipating this, liquidity providers may withdraw from the market, thereby undermining the TTF liquidity, which is currently the most liquid gas market in the EU.

Notwithstanding these concerns, there remains a rationale for a package of measures that could reduce energy prices in the short term. Such a policy package would be targeted at reducing the impact

[67] Oxford Institute for Energy Studies (2022), 'The Consequences of Capping the TTF Price', October, https://a9w7k6q9.stackpathcdn.com/wpcms/wp-content/uploads/2022/10/The-Consequences-of-Capping-the-TTF-Price.pdf (accessed 20 November).
[68] Council of European Energy Regulators (2022), 'Input on the revision of EU rules on market access of gas networks: CEER feedback note for the European Commission', 12 April, p. 2.

of high energy prices on consumers as well as limiting the risk of business closures in the EU and the relocation of industrial capacity away from the EU. For example, such a package of measures could involve additional incentives to increase LNG imports through joint procurement, direct subsidies or other competitively tendered out-of-market payments (as seen in the electricity sector and elsewhere), as well as demand reduction and fuel-switching incentives.

In theory, a time-limited cap on prices could also be part of such a policy package, but it is not clear that a price cap would necessarily be the least costly or least distortive measure available. Also, any price cap that is applied to the wholesale gas market will require a high level of coordination between member States and different players, especially if implemented EU-wide. Therefore it could be administratively challenging to implement. Other measures such as targeted support to residential or industrial users could be more easily administered.

Ultimately, the design of any policy package to address the current energy price crisis should consider the benefits, costs and risks of different measures.

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