

April 2023

European gas demand fundamentals

2022 & Q1 2023 review and short-term outlook

Introduction

Gas prices have been on a rollercoaster since mid-2021. This article examines how this has impacted gas demand in Europe, focusing on the period from early 2022 to March 2023.¹ It also gives a view on some of the key factors to monitor over the coming months that will influence gas demand fundamentals in the region.

This article concludes that while gas demand collapsed in Europe in 2022 (down by 13 per cent year-on-year) and remained low in the first quarter of 2023 (down 14 per cent in Q1 2023 compared to Q1 2022), the fundamentals in the three main sectors seem to point toward a potential increase in gas consumption this year. Understanding gas supply and demand balances in the coming months will continue to be a complex puzzle with many moving pieces, but minimizing gas demand is likely to be necessary to ease storage filling this summer and to prepare for Winter 2023/2024 (and maybe even Winter 2024/2025) as suggested by the EU Commission's proposal to extend the voluntary gas demand cuts of 15 per cent for next winter.²

A word on methodology and definition: gas demand is driven by a combination of factors, and it is difficult to disentangle all the different drivers that influence it, including variations that may happen specifically as a result of price fluctuation, let alone access timely and consistent data to allow for accurate analysis and comparison between sectors and markets. The charts in this paper are based on various sources of publicly available statistics, and the author's assumptions and calculations from this data (to complete the missing statistics and allow for comparison between various sets of data).³ Because of the lack of granularity in gas demand statistics, additional data on temperatures, industrial production, and electricity generation is used to provide a clearer picture of the recent trends and key factors by sector (heating (represented by the residential and commercial sector), industry, and electricity generation). The conclusions and outlook presented here are based on the author's analysis of this data. Finally, unless otherwise specified, 'Europe' includes 28 countries: EU27 plus the UK.

¹ For more information about gas demand fundamentals in 2021, see Honoré A. (2022), Demand response to high gas prices in Europe in 2021 and early 2022, <https://a9w7k6q9.stackpathcdn.com/wpcms/wp-content/uploads/2022/06/Insight-117-Demand-response-to-high-gas-prices-in-Europe-in-2021-and-early-2022.pdf>

² <https://www.consilium.europa.eu/en/press/press-releases/2023/03/28/member-states-agree-to-extend-voluntary-15-gas-demand-reduction-target/>

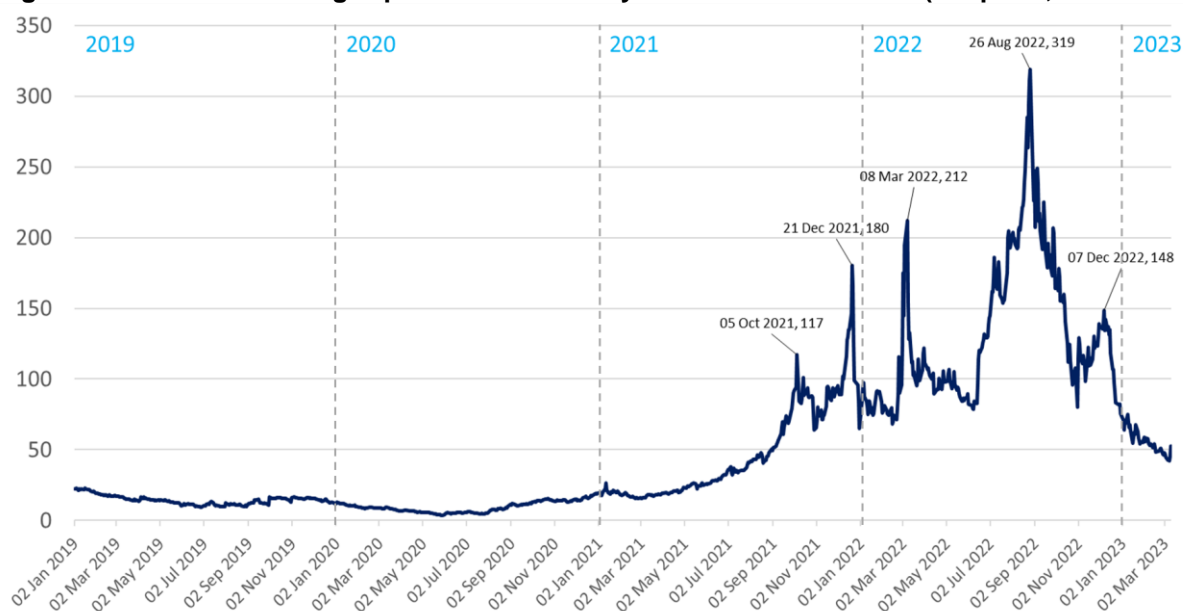
³ Gas demand data does not include storage filling. The terms "demand" and "consumption" are used interchangeably in this article.

Finally, in this fast-changing world, it is important to date the research: the text was finalised in early April 2023, with the data available in the public domain at the time covering 2019 (the last pre-COVID year) up to February/March 2023.

Gas and energy prices on a roller-coaster since 2021

European gas (and energy) prices have been on a roller-coaster since 2021. They climbed from very low levels in 2020 to record highs in 2021 and 2022 before declining again from December 2022, although they are still higher than pre-crisis levels as illustrated in Figure 1. These fluctuations have been analysed in a series of OIES papers and in our regular OIES Quarterly Gas Review series.⁴

Figure 1: TTF Front-Month gas prices from January 2019 to 10 March 2023 (midpoint, Euro/MWh)



Source: Data from Argus

Low gas prices in 2019-2020 were driven essentially by a combination of an oversupplied global LNG market, abundant LNG imports into Europe, and full storage across the region. The impact of the COVID 19 pandemic on gas demand, especially in Q2 and Q3 2020, intensified the oversupply and in May 2020, wholesale gas prices in Europe were down to EUR 4/MWh (TTF Front-Month price). As measures to combat the pandemic were gradually lifted from mid-2020, economic activity and consequently gas demand started to recover in Europe. On top of that, a cold winter kept demand for heating high in early 2021 and gas prices rose to EUR 26/MWh on 12 January. At the time, adequate levels of storage and increased withdrawals helped balance the market despite supply constraints.⁵ TTF prices then rose slowly in the first half of 2021. Continued supply constraints combined with strong demand recovery for LNG in Asia,⁶ as well as in Central and South America, did not allow the refilling of European storage sites at a normal rate. European prices continued to rise throughout the summer of 2021 and accelerated from September as the European winter approached. Following a drop in gas flows from Russia along the Yamal-Europe route, prices peaked at EUR 117/MWh on 5 October 2021. After a small and short-lived decline, prices soon surged again, reaching EUR 180/MWh on 21 December

⁴ OIES Gas Programme publications: <https://www.oxfordenergy.org/publication-category/gas-programme/>
OIES Quarterly Gas Review is available here: <https://www.oxfordenergy.org/publicationtopic/quarterly-gas-review/>

⁵ More details regarding the supply-side drivers in Europe can be found in the first chapter of the trilogy and more information about the factors that lead to the global LNG market tightness can be found in: Fulwood, M., 2022, Surging 2021 European Gas Prices – Why and How? January. <https://www.oxfordenergy.org/publications/surging-2021-european-gas-prices-why-and-how/>

⁶ Fulwood, M., 2021. Asia LNG Price Spike: Perfect Storm or Structural Failure? Oxford Energy Comment, February. <https://www.oxfordenergy.org/wpcms/wp-content/uploads/2021/02/Asia-LNG-Price-Spike.pdf>



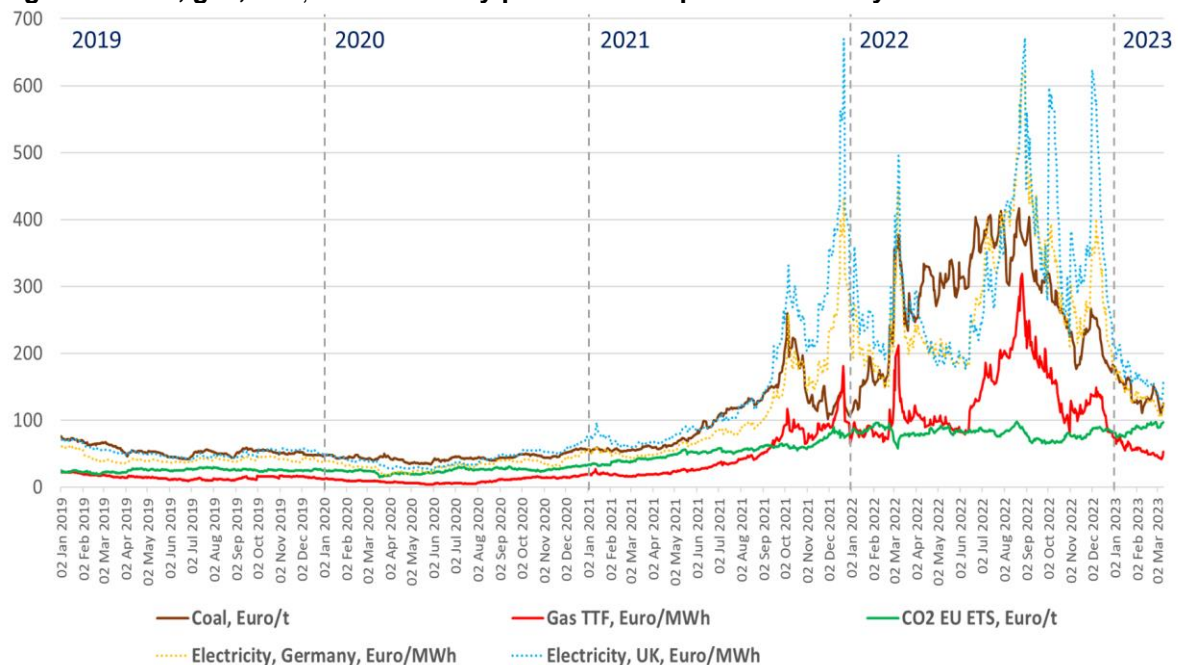
2021. Geopolitical concerns over the Russian military build-up around Ukraine’s borders and a tighter than expected global LNG market resulted in European prices remaining at record high levels.

This meant that by January/February 2022, prices were still twice their pre-2021 record when the Russian invasion of Ukraine on 24 February triggered another round of price increases, with the TTF month-ahead peaking at EUR 212/MWh on 8 March 2022.⁷ TTF prices seemed to settle down after the first few weeks following the invasion as flows from Russia continued at high levels, but by mid-June, prices began to surge again as Gazprom reduced flows significantly on Nord Stream, and prices peaked at EUR 319/MWh on 26 August 2022 as Nord Stream was closed completely. Thereafter, and even with much lower Russian pipe flows, prices began a gradual decline until late October as LNG imports into Europe continued at high levels, storage filled up and gas demand stayed low due to mild temperatures and price-led demand response. The rollercoaster resumed in November, when prices started rising again as the weather began to get cold and withdrawals from storage intensified, reflecting a tight market with significant uncertainties over both supply and demand. All in all, gas prices in 2022 have remained elevated on the back of Russia’s invasion of Ukraine and the subsequent gradual reduction in pipe imports into Europe from Russia.

Prices started to fall again in late 2022 thanks to mild weather and low LNG demand in Asia. At the time of writing in early April 2023, gas prices in Europe were down to about EUR 50/MWh, having fallen from mid-2022 record highs but nevertheless still about twice their early-2021 level. Reflecting a continuous tight market, various drivers could trigger another rapid price spike (a further cut in Russian supply, especially flows through Ukraine, a sudden increase in heating demand, a strong recovery in Asian gas consumption, or an unexpected LNG supply outage).

Soaring gas prices from the second half of 2021 also had a ripple effect on electricity prices, coal prices, and probably on the price of CO₂ emissions due to fuel substitution in favour of more polluting fuels like coal (and oil). This is illustrated in Figure 2.

Figure 2: Coal, gas, CO₂, and electricity prices in Europe from January 2019 to 10 March 2023



Source: Data from Argus⁸

⁷ Data from Argus

⁸ Notes: Coal: Coal ARA 6000kcal NAR cif, London close, Euro/t, midpoint; Gas: Natural gas TTF month 1, London close, Euro/MWh, midpoint; CO₂: CO₂ EU ETS prompt, London close, Euro/t, midpoint; Electricity: German OTC base load month 1, London close, Euro/MWh, midpoint and German OTC base load month 1, London close, GBP/MWh, midpoint

Dramatic levels of energy price increases prompted governments to put in place relief measures to mitigate the effects on consumers and businesses. In October 2021, the EU Commission also published a toolbox of measures⁹ that EU members could use without breaching competition rules. At a national level, a first wave of measures was introduced in September/October 2021, especially those aimed at helping vulnerable customers. There was a second wave in February/March 2022 directed at both businesses and vulnerable customers.¹⁰ As prices kept on rising, additional measures were decided in many countries with schemes particularly targeting non-domestic customers, such as businesses (including energy-intensive industries). Energy prices have a significant impact on household expenditures, industrial costs, and business competitiveness, and most of the support provided by national governments over the past 18 months has been directed toward short-term emergencies and focused on providing emergency income support for small and large consumers facing soaring energy bills, rather than implementing measures to prepare Europe to rapidly reduce its consumption of fossil fuels, as proposed in REPowerEU. More could have been done to conserve energy, renovate buildings, and switch to renewable and decarbonized sources (with measures targeting the rapid roll-out of energy-efficient heat pumps and/or the development of district heating, for instance). Improvements in 2021 and 2022 in terms of efficiency, energy savings, and switching to renewables have nonetheless been remarkable, but so far largely price driven rather than as a result of national government policy. With gas prices at about EUR 50/MWh, stronger focus on policies to help consumers lower their energy demand can be expected, but for the rest of 2023, minimizing gas demand is likely to be necessary to ease storage filling this summer and to prepare for Winter 2023/2024 (and maybe even Winter 2024/2025).

Gas demand collapsed in 2022, confounding early expectations

Gas demand was surprisingly resilient in 2021 despite soaring gas prices in the second half of the year and much weaker economic recovery in Q4.¹¹ By contrast, gas demand collapsed in 2022 to 427 bcm on the back of mild temperatures, high gas prices, and changes in consumer behaviour. This represented a sharp decline of 13 per cent year-on-year (-62 bcm)¹² as illustrated in Figure 3, a fall of 42 bcm compared to 2020, the year of pandemic that led to lockdowns and reduced economic activity.¹³

As an aside, gas demand in the EU27 was down by 59 bcm in 2022, well below the initial target of 38 bcm gas demand reduction set in the first draft for the REPowerEU package, published in March 2022.¹⁴ The target was achieved and exceeded, though mainly for different reasons than those envisaged in the initial REPowerEU document. The reduction was to be achieved through a combination of large-scale wind and solar power generation, rooftop solar power generation, heat pumps, and 'EU-wide energy saving', and although all these factors contributed, lower gas demand in 2022 was in fact largely

⁹ https://ec.europa.eu/commission/presscorner/detail/en/IP_21_5204

¹⁰ Governments opted for at least one, and sometimes several, measure(s) such as reduced energy tax, regulating retail and wholesale prices, support to vulnerable consumers, regulating or taxing windfall profits, etc. More details by country: <https://www.reuters.com/business/energy/europes-efforts-shield-households-soaring-energy-costs-2022-02-03/>

¹¹ For an analysis of gas demand response in Europe in 2021, see Honoré A. (2022), Demand response to high gas prices in Europe in 2021 and early 2022, <https://a9w7k6q9.stackpathcdn.com/wp-content/uploads/2022/06/Insight-117-Demand-response-to-high-gas-prices-in-Europe-in-2021-and-early-2022.pdf>

¹² Sources: Data from IEA, Eurostat, Entso-g, GRTgaz, Terega, NCG, Gaspool, SNAM, Enagas, NationalGrid, author's assumptions and calculations

¹³ For more information on European gas demand in 2020, see Honoré A. (2020), Natural gas demand in Europe: The impacts of COVID-19 and other influences in 2020, <https://a9w7k6q9.stackpathcdn.com/wp-content/uploads/2020/06/Natural-gas-demand-in-Europe-the-impacts-of-COVID-19-and-other-influences-in-2020.pdf>

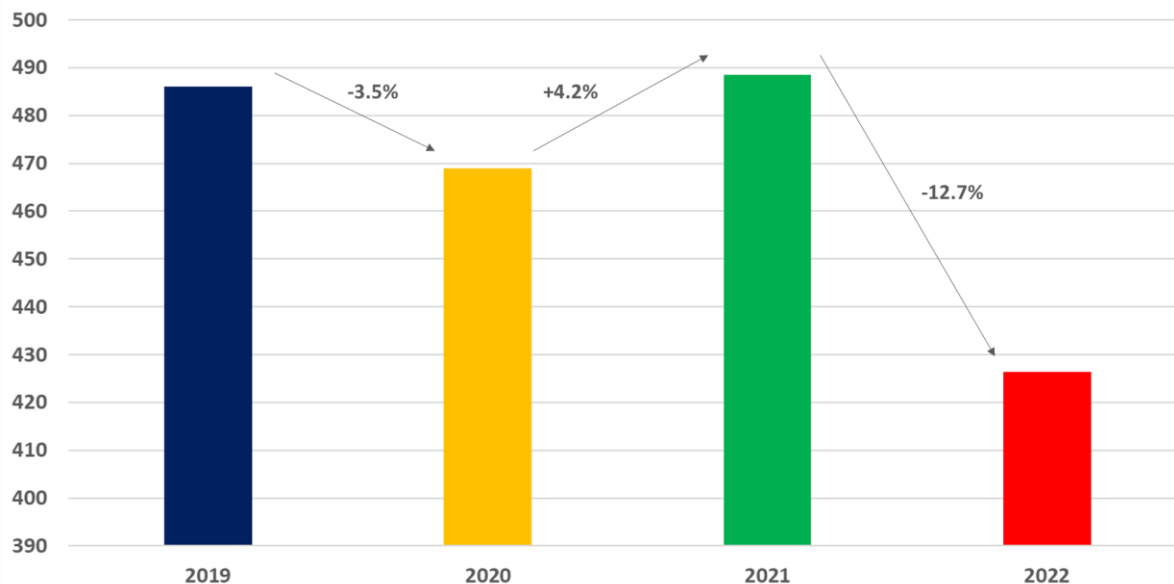
¹⁴ For more information on the initial proposal of REPowerEU published in March 2022, see Fulwood M., Honoré A., Sharples J., and Hall M. (2022), The EU plan to reduce Russian gas imports by two-thirds by the end of 2022: Practical realities and implications, <https://a9w7k6q9.stackpathcdn.com/wp-content/uploads/2022/03/Insight-110-The-EU-plan-to-reduce-Russian-gas-imports-by-two-thirds-by-the-end-of-2022.pdf>

For the final REPowerEU document published in May 2022, see REPowerEU: https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131

For a comment on the proposed measures for the short-term (2022) in REPowerEU, see Fulwood M., Honoré A., Sharples J. & Hall M., 2022. The EU plan to reduce Russian gas imports by two-thirds by the end of 2022: Practical realities and implications, <https://www.oxfordenergy.org/publications/the-eu-plan-to-reduce-russian-gas-imports-by-two-thirds-by-the-end-of-2022-practical-realities-and-implications/>

due to warm temperatures in the winter, a price-led reduction in demand and fuel-switching (most likely to oil products).

Figure 3: Evolution of annual gas demand in Europe between 2019 and 2022 (bcm)



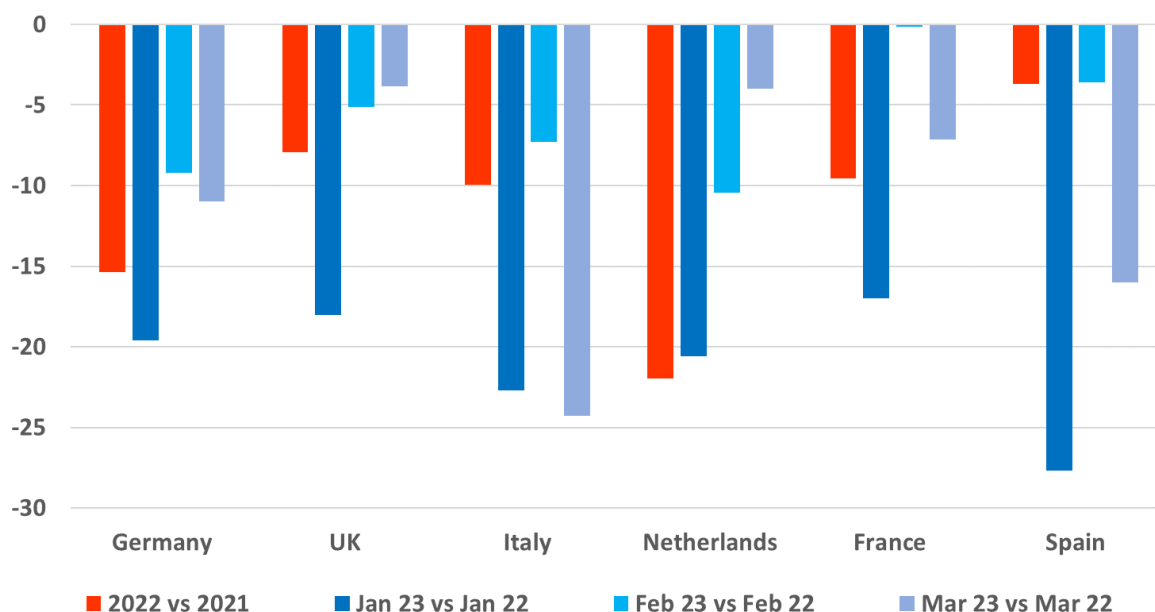
Source: Data from IEA, Eurostat, Entso-g, GRTgaz, Terega, NCG, Gaspool, THE, SNAM, Enagas, NationalGrid, author's assumptions and calculations

The main objective of this article is to provide an overview of gas demand at the regional level, but it is worth remembering that demand fluctuations at a regional level only show part of the story. Focusing on the six largest gas markets, which represent over 75 per cent of total demand, trends varied between a moderate 4 per cent year-on-year decline in Spain to a sharp 22 per cent year-on-year contraction in the Netherlands in 2022. Over the first three months of 2023, initial estimates show a decline in most countries compared to the same period last year with a notable exception (namely France in February) as illustrated in Figure 4.

While the main drivers were similar across Europe, the evolution of gas consumption has been diverse. These differences can be explained by several country-specific factors including the role of gas in the energy mix, access to alternative fuels, and the levels and extent of the support measures from governments to shield their national consumers from the worst impacts of high energy and gas prices. For instance, a cap on the price of natural gas used for electricity generation was agreed in May 2022 in Spain and Portugal.¹⁵ The aim was to lower the wholesale electricity price in the Iberian market (MIBEL) but this measure also triggered additional gas use for electricity generation, which partly explains why Spanish demand was down by only 4 per cent year-on-year in 2022 despite sharp declines in gas demand in its industrial and residential sectors.

¹⁵ <https://direct.argusmedia.com/newsandanalysis/article/2331351?keywords=cap%20price%20gas%20spain>

Figure 4: Changes in gas demand in the largest gas markets, in 2022 and over the first three months of 2023 (per cent)



Source: Data from IEA, Eurostat, EntsoG, GRTgaz, Terega, NCG, Gaspool, THE, SNAM, Enagas, NationalGrid, and author's calculations

A gradual erosion of gas demand in 2022, but changing trends in early 2023?

The sharp drop in European gas demand in 2022 was due to a combination of factors. Firstly, it follows the previous year when drivers favourable to high gas demand in the region prevailed. Several cold spells throughout Europe at the beginning of 2021 and a longer than usual winter increased the need for gas used for heating in buildings well into in April (the peak of the heating season is usually in the first three months of the year) as well as increasing heating-related electricity consumption. High gas prices started to have an impact on the industrial sector with some curtailment and even (temporary) closure of power-intensive manufacturing activities from September. In the power sector, high prices also eroded the competitiveness of gas plants in the mix. But in Q4 2021, and in spite of sky-high gas prices, there were signs of a strong rebound in gas demand, especially toward the end of the year due to a combination of gas use for heating during a very cold December, continued relatively strong demand in the industrial sectors and finally consumption of gas used for electricity generation due to low nuclear and hydro availability.

In 2022, gas demand was down every single month compared to 2021, and below the past five-year average since May as shown in Figure 5. The general trend throughout the year is one of continuous decline. The main drivers behind this evolution are analysed in detail below.

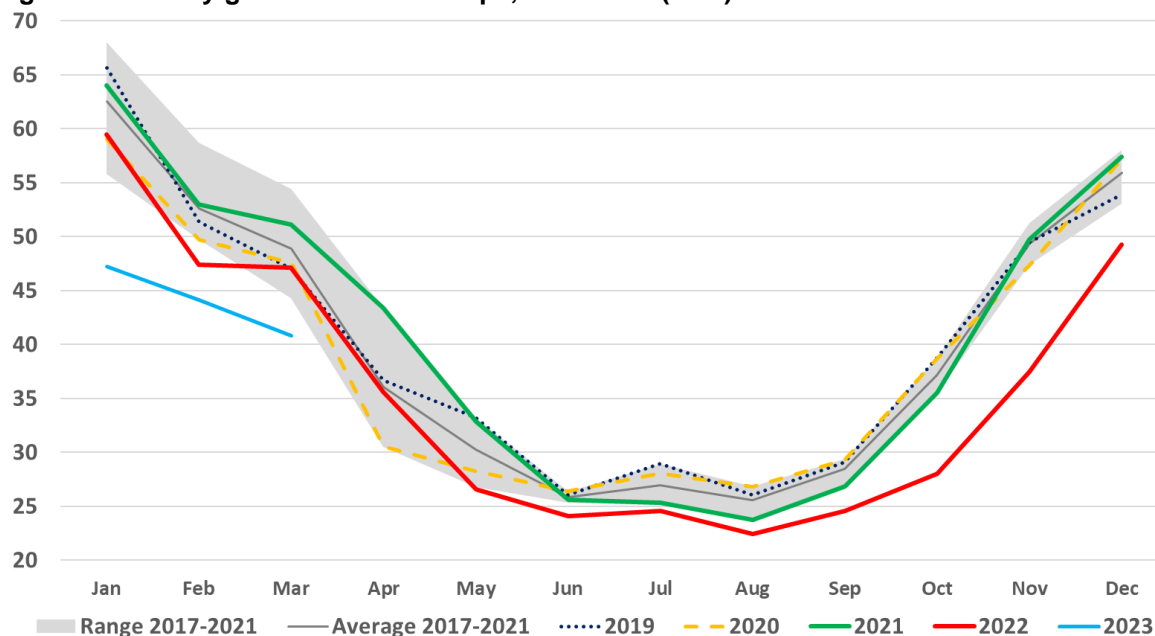
In July 2022, the EU published the Save Gas for Safe Winter proposal,¹⁶ which included a European Gas Demand Reduction Plan to reduce gas use in Europe by 15 per cent between 1 August 2022 and 31 March 2023 compared to the five-year average (equivalent to 45 bcm). The region reached and exceeded this target, with overall EU27 gas demand down by 18.6 per cent (equivalent to 56 bcm) compared to the previous five years.

In the first three months of 2023, estimated gas demand in Europe was down by 14 per cent (22 bcm) compared to the same period in 2022, continuing last year's trend and helped by unseasonably mild weather across most of Europe in January & March and higher availability of renewables (hydro, wind

¹⁶ https://ec.europa.eu/commission/presscorner/detail/en/ip_22_4608

and solar) in power generation. In January 2023, estimated gas demand was 21 per cent lower year on year (12 bcm), with daily data showing a slowly rising trend through the month, which seemed to have continued into February (7 per cent below 2022, representing 3.3 bcm). Gas demand in March was 13 per cent lower than 2022 (7 bcm) according to early estimates at the time of writing.

Figure 5: Monthly gas demand in Europe, 2019-2023 (bcm)



Source: Data from IEA, Eurostat, Entsog, GRTgaz, Terega, NCG, Gaspool, THE, SNAM, Enagas, NationalGrid, author's calculations

Natural gas in Europe is used in three main sectors: the residential and commercial sector (especially for residential heating),¹⁷ the industrial sector,¹⁸ and the power sector. Up-to-date consistent data on gas use per sector is not easily available,¹⁹ and this complicates a sector-focused analysis, but a cursory overview of temperatures (heating), manufacturing output (industry), and electricity generation from gas-fired plants (power) indicate that while all three sectors contributed to high levels of demand in 2021, conversely most of the demand reduction in Europe was concentrated in the industrial and residential and commercial sectors in 2022, while gas use for electricity generation went up, as illustrated in Figure 7.

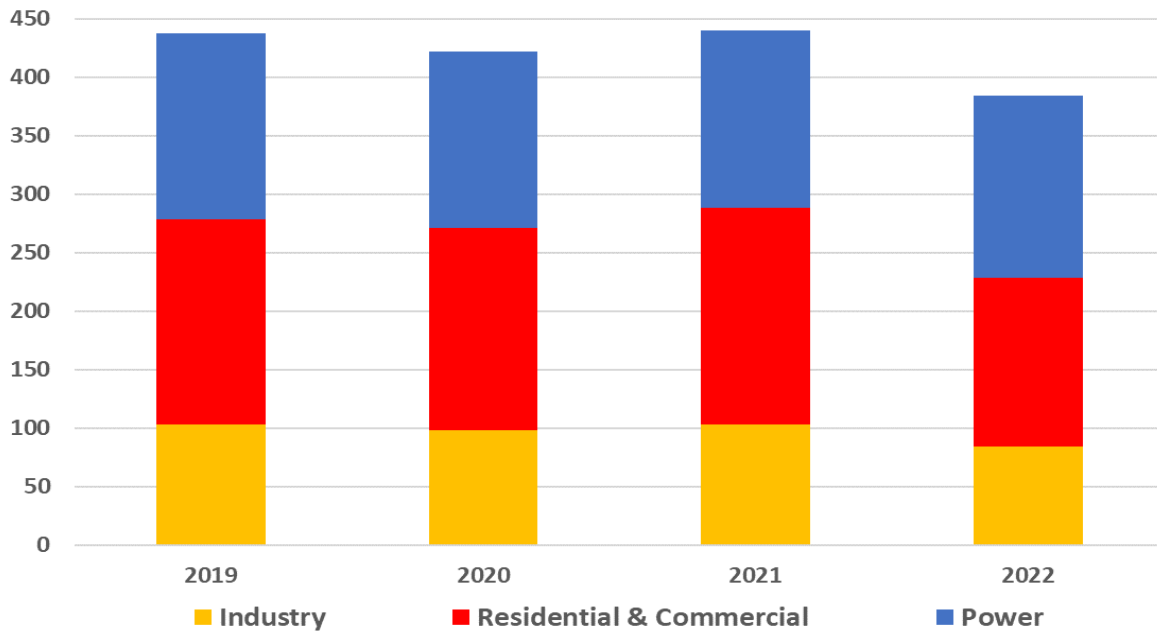
¹⁷ For more details on gas in the heating sector, see Honoré A. (2018), Decarbonisation of heat in Europe: implications for natural gas demand, May. <https://a9w7k6q9.stackpathcdn.com/wpcms/wp-content/uploads/2018/05/Decarbonisation-of-heat-in-Europe-implications-for-natural-gas-demand-NG130.pdf>

¹⁸ For more details on gas in industrial sector, see Honoré A. (2019), Decarbonisation and industrial demand for gas in Europe, May. <https://a9w7k6q9.stackpathcdn.com/wpcms/wp-content/uploads/2019/05/Decarbonization-and-industrial-demand-for-gas-in-Europe-NG-146.pdf>

¹⁹ Harmonized data at a regional level showing gas demand by country and by sector is made available with a time lag of several months (up to 18 months). Some national data provided by TSOs show gas demand with only a few days, weeks or 1-2 months' time lag, and some provide a split for gas demand from various groups of consumers. These different (and often unclear) definitions and methodologies make it very difficult, if not impossible, to compare the evolution in 28 countries in a timely way based on existing data alone.



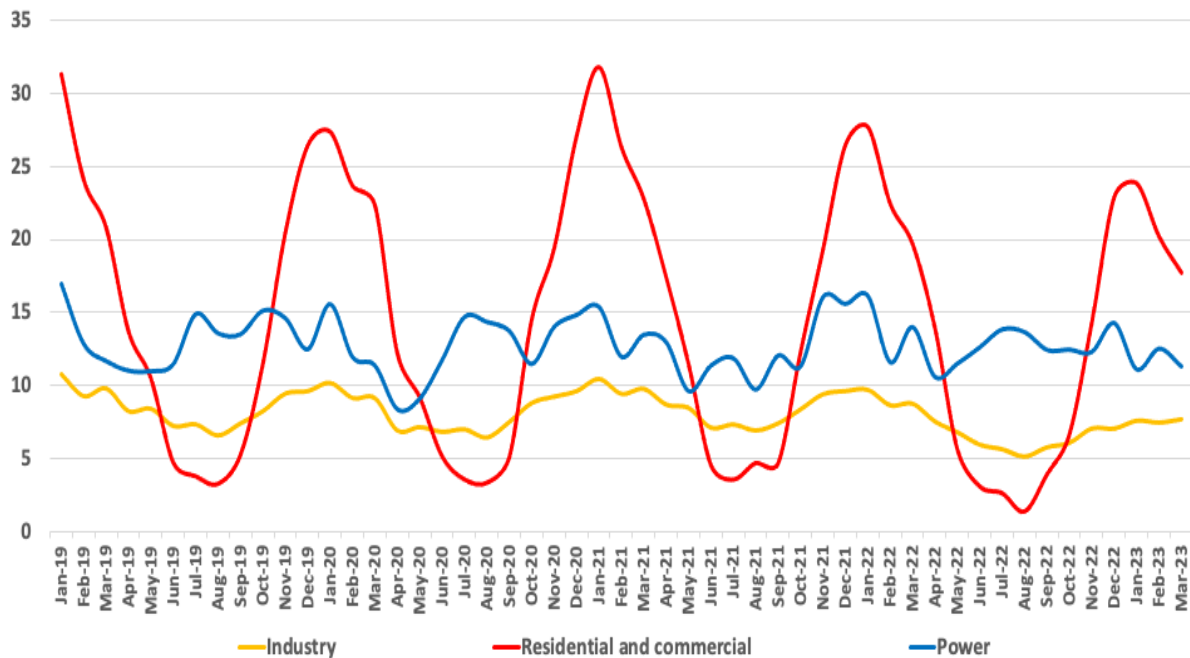
Figure 6: Annual gas demand in the main sectors in Europe, 2019-2022 (bcm)



Source: Author's calculations

Monthly estimates highlight the lower levels of gas use in the residential and commercial sector as well as the industrial sector from mid-2022 onward as seen in Figure 7.

Figure 7: Monthly gas demand in the main sectors in Europe, 2019-2023 (bcm)



Source: Author's calculations

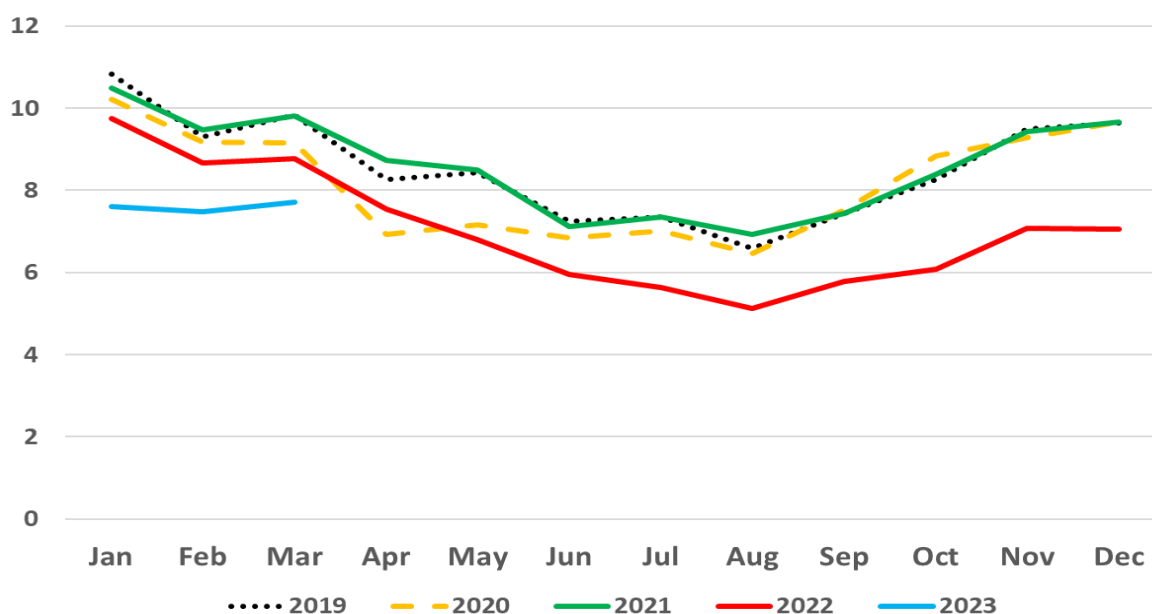
Industrial gas demand

The industrial sector traditionally covers just over 20 per cent of gas demand in Europe.²⁰ The extent to which gas use for industrial production can be affected by higher gas prices is not necessarily straightforward, as some companies may be less exposed to fluctuations on the spot market, depending on their contractual arrangements with suppliers. Similarly, companies' exposure to potentially higher prices can depend on their hedging arrangements and whether or not they have access to alternative sources of supply. Whether they are in direct competition with similar companies located in regions with lower (and/or subsidised) prices or whether they have the ability to pass on their rising costs to their consumers will also determine their demand response to high gas prices. Access to and the extent of government support can also be important.

An important factor explaining strong gas demand in 2021 was the economic recovery across Europe (from the second half of 2020), in particular the strong rebound seen in Q1 and Q2.²¹ However, by September, industries were expressing strong concerns over the impact of rising gas (and more generally energy) prices on their activities and demanded financial support from the governments to keep production levels steady. Nonetheless, industrial gas demand in 2021 is estimated to have increased by 5 per cent year-on-year.

In 2022, it appears that gas consumption in the energy-intensive industrial sector decreased by an impressive 18 per cent compared to 2021 (-19 bcm), with an even stronger slowdown in the second half of the year as illustrated in Figure 8.

Figure 8: Gas demand in the industrial sector in Europe, 2019-2023, bcm



Source: Author's estimates

Data granularity does not allow an analysis of the evolution of gas demand by sub-sector in 2022 and early 2023 at the European level, but looking at industrial production gives some indication of the short-term impact of rising energy prices.

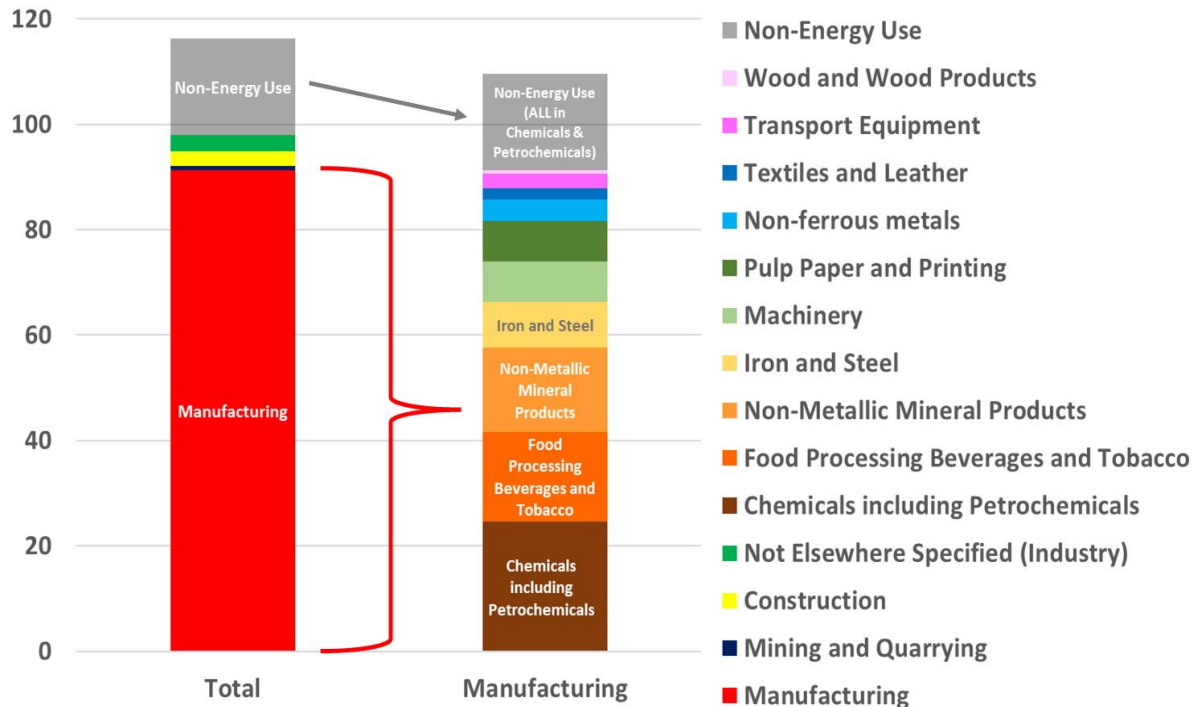
²⁰ Average share during 2015-2021. Calculated from Eurostat data.

²¹ Although the correlation between GDP growth and gas demand is not straightforward, countries with a large share of gas demand in their industrial sector (in Central and Eastern Europe for instance) can expect more total gas demand fluctuations due to GDP changes than countries where gas demand is concentrated in the building (space heating) sector and in the power sector (unless electricity generation comes mostly from gas plants) as both of these sectors show much less correlation with GDP growth.



The manufacturing sector represents over 90 per cent of industrial gas demand in Europe, with the main consumers being the chemical sector, the food, beverages and tobacco sector, and the non-metallic minerals sector. These three sectors alone represent over 50 percent of the gas use in the industrial sector as seen in Figure 9. In fourth place, there is the iron and steel sector. In the manufacturing sector as a whole, most of the gas is used for energy use (85 per cent) with the remainder as non-energy use (all in the chemicals and petrochemicals sector).

Figure 9: Gas demand in Europe in the main industrial sub-sectors, 2020, bcm



Source: Data from the IEA, Annual report

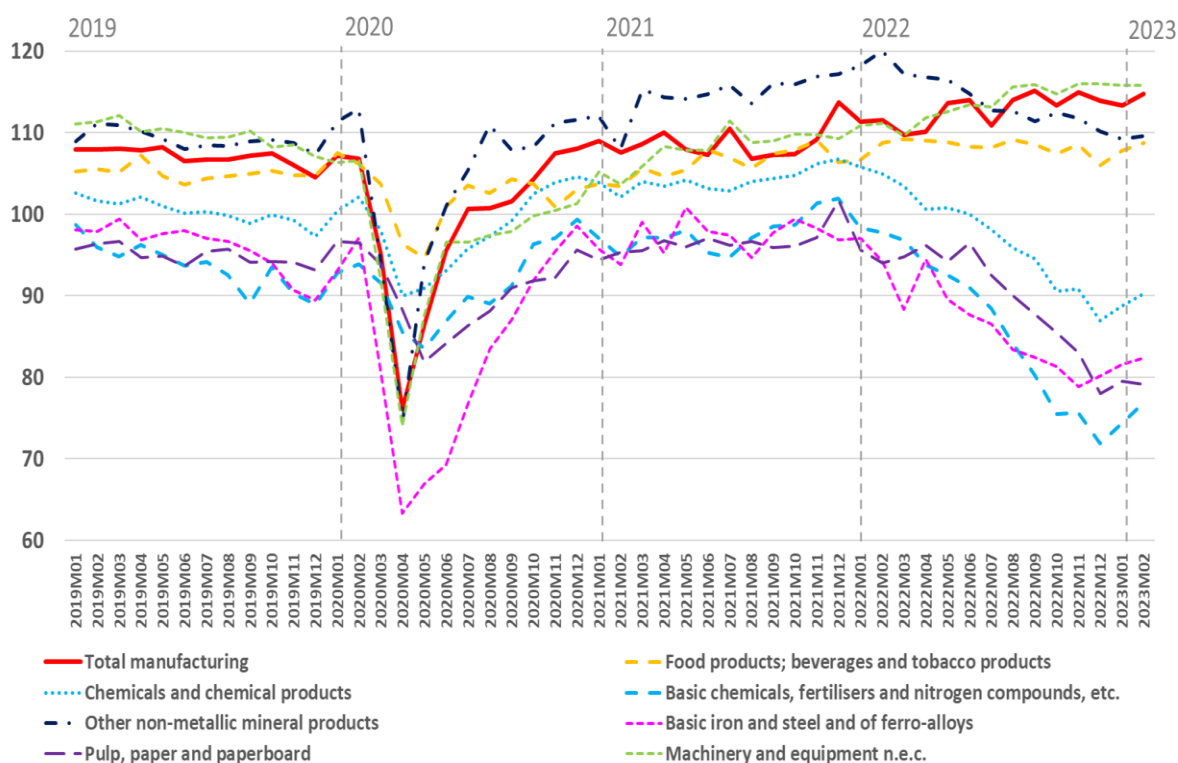
Looking at manufacturing industrial production, it appears that the EU27²² has maintained high volumes of manufactured goods production in 2021 and 2022, as illustrated in The chemical sector, the iron and steel sector and the pulp, paper and paperboard sector, have been a clear exception and seem to have been more affected than other sectors by the rise of gas (and electricity) prices as illustrated in Figure 11 with the example of the Netherlands. The erosion of competitiveness was one of the main factors given by BASF, one of the world's largest chemical companies, when it announced in October 2022 that it would 'permanently' downsize in Europe. Interestingly, industry regulation in the EU was also mentioned as another key contributing factor, begging the question whether such a decision would have been taken anyway, even without the Figure 10. It first peaked in July 2021 as the rollout of vaccines allowed for a wider reopening of the economy. A probable backlog of orders which were delayed in 2020, is likely to have contributed to the summer rise. In the second half of the year, supply constraints and higher prices affected production in energy-intensive industries in October, but interestingly, levels picked up rapidly in November and December 2021. In 2022, manufacturing output remained high. In other words, the remarkable reduction in the region's industrial gas demand does not seem to correlate with the decline in industrial output.

²² Eurostat stopped publishing data covering the UK in 2020, when the country left the EU. Therefore data on manufacturing output in this section only cover the EU27.

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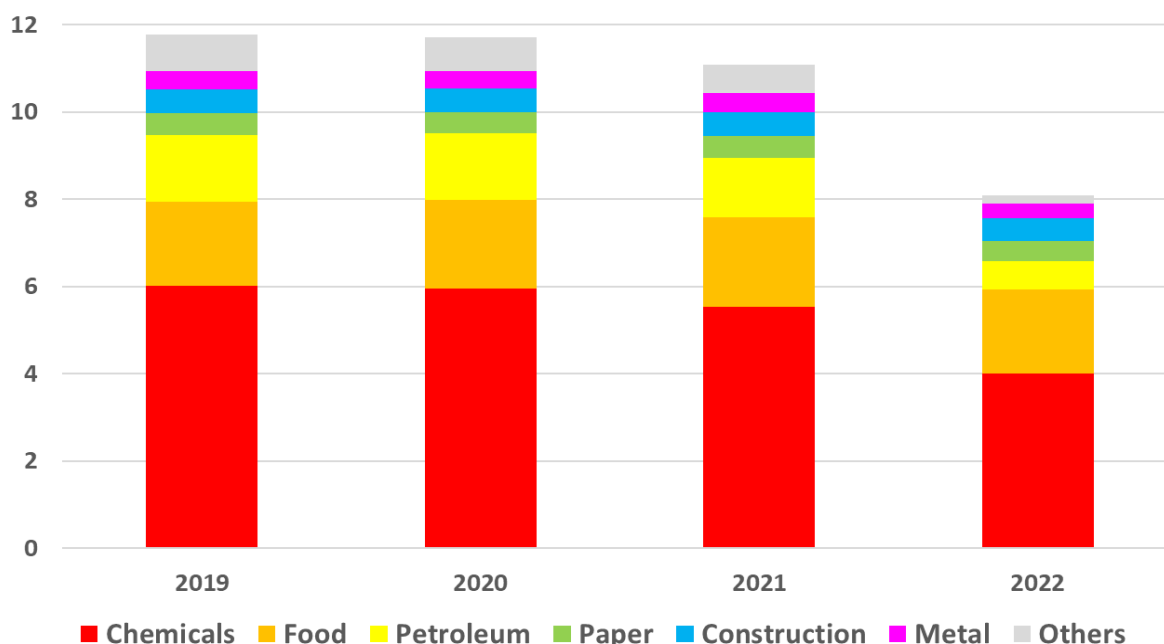
Figure 10: Volume index of monthly production, Manufacturing in EU27 from January 2019 to February 2023 (2015 = 100)



Source: Data from Eurostat, Seasonally and calendar adjusted data

²³ <https://www.ft.com/content/f6d2fe70-16fb-4d81-a26a-3afb93e0bf57>

Figure 11: Industrial gas demand in the Netherlands by sub-sectors, bcm



Source: CBS, GTS, author's calculations

For most manufacturing production, strong output suggests that record gas prices have not had as dramatic an impact as one could have expected, with significant switching to alternative energy sources (mostly oil products) and improved operational efficiency. A survey done by the ifo Institute for Economic Research in Germany and published in October 2022²⁴ showed that 75 per cent of industrial companies using gas in their production process had been able to reduce its use without having to cut production, although there were big sectoral differences. Even more interestingly was that nearly 40 per cent of respondents declared that they still had some potential to consume even less gas without reducing their output. After over a year of high prices, these were surprising declarations, though most of the 'low hanging fruit' is likely to have been harvested by now, so how easy it might be to further reduce gas use without reducing production is unclear as the survey does not provide insights into how factories have improved and could further adapt.

Other national surveys and data seem to show a similar picture at a European level for the industrial sector. There have been some instances of production being scaled back and factories shutting down, for instance in the ammonia industry, but it seems that the main trends have been toward significant fuel switching and efficiency improvements whenever possible.

Thanks to mild temperatures, there was no need for energy rationing in Winter 2022/2023 in order to divert supply to protected users. Had there been a need for rationing, the industrial sector would have been first on the list. This, in turn, would have caused widespread disruption to manufacturing production, though exactly which industries would have been targeted first remains largely unclear. But voluntary demand reduction and demand response have been sufficient. Nonetheless, governments have faced, and are still facing, the challenge of designing support measures that offer gas and electricity prices that are simultaneously low enough to prevent widespread closures and bankruptcies, and high enough to prevent a rapid increase in demand, and therefore risk undermining other policies aimed at reducing gas (and energy) consumption. With lower gas/electricity prices compared to 2022

²⁴ <https://www.ifo.de/en/press-release/2022-11-22/many-industrial-companies-germany-cut-gas-consumption-without-curbing>

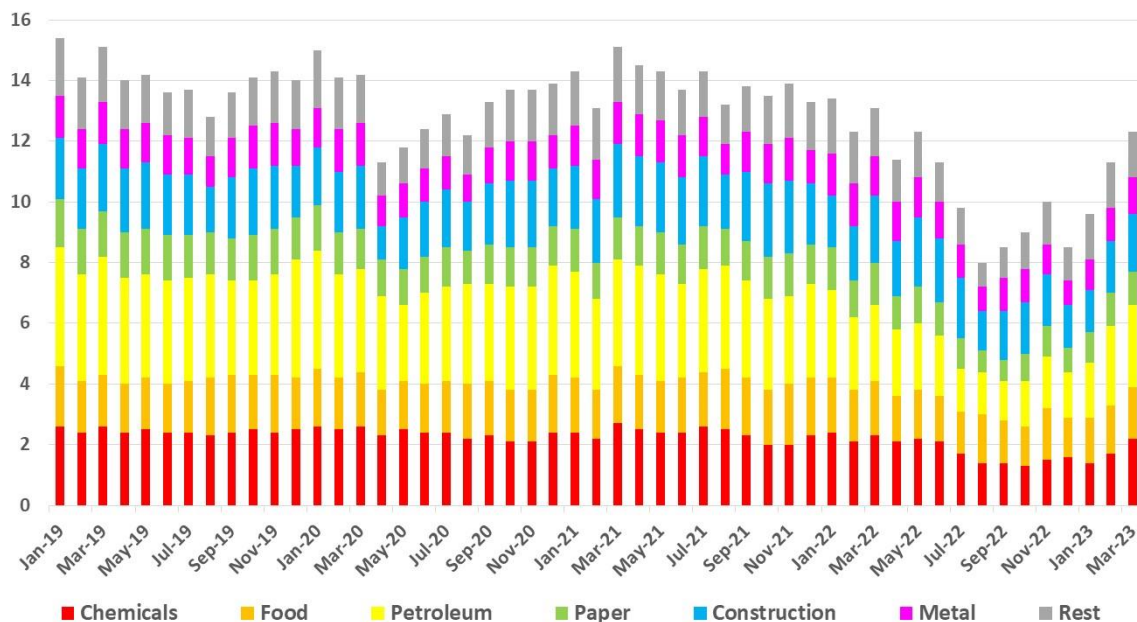


and a limited economic downturn,²⁵ European industrial gas demand could actually increase in 2023. The question then is how quickly and by how much?

The industrial sector was the main source of gas demand flexibility in 2022, and it is expected to continue playing that role to help balance gas supply and demand in Europe, but it may not be as straightforward in the future. Unfortunately, it is not yet possible to differentiate between what has been demand reduction (for example, fuel switching to oil products or curtailment of production, in other words, demand that could bounce back rapidly) and demand destruction (gas demand which will not return, i.e. improved operational efficiency, switching to renewables and heat pumps or relocation).

Relocation seems to have been fairly limited, with BASF being the only major company to announce its intentions to downsize, and while operational efficiency gains and additional investments to switch to renewables and heat pumps are likely to have happened as a result of record prices, it seems that most of the decline has come from reduction measures. The IEA has estimated that about half of the decline in industrial gas demand in the EU27 came from production curtailment, about 30 per cent from fuel switching (primarily from oil), and the rest from efficiency gains, import substitutions, and the effect of the weather.²⁶ In other words, based on this estimate, about 80 per cent of this demand reduction was a simple price-demand response in 2022, and when gas prices go down, be it as a result of the market rebalancing or as a result of support measures from governments, these volumes could come back rapidly. This is indeed what happened in October when gas prices reached their lowest levels in months and fertilizer producers restarted production in Europe. This is also what we are starting to see since mid-January 2023: a slow gas demand recovery seems to be happening in several sectors, both in sectors that were likely to have switched to other fuels (oil products) but also in sectors where curtailment of production and/or closures of plants happened in 2022 as illustrated in Figure 12 with the example of Spain.

Figure 12: Monthly industrial gas demand in Spain by sub-sectors, 2019-2023, TWh



Source: Enagas, author's calculations

Note: The definitions of the various industrial sectors are different from the ones in Figure 11.

²⁵ https://economy-finance.ec.europa.eu/economic-forecast-and-surveys/economic-forecasts/winter-2023-economic-forecast-eu-economy-set-avoid-recession-headwinds-persist_en#:~:text=but%20headwinds%20persist-,Winter%202023%20Economic%20Forecast%3A%20EU%20Economy%20set,avoid%20recession%2C%20but%20headwinds%20persist&text=The%20Winter%202023%20Interim%20Economic,from%20the%20Autumn%202022%20forecast.&text=In%202024%2C%20GDP%20is%20expected,1.5%25%20in%20the%20euro%20area.

²⁶ <https://iea.blob.core.windows.net/assets/227fc286-a3a7-41ef-9843-1352a1b0c979/Naturalgasupply-demandbalanceoftheEuropeanUnionin2023.pdf>, page 6

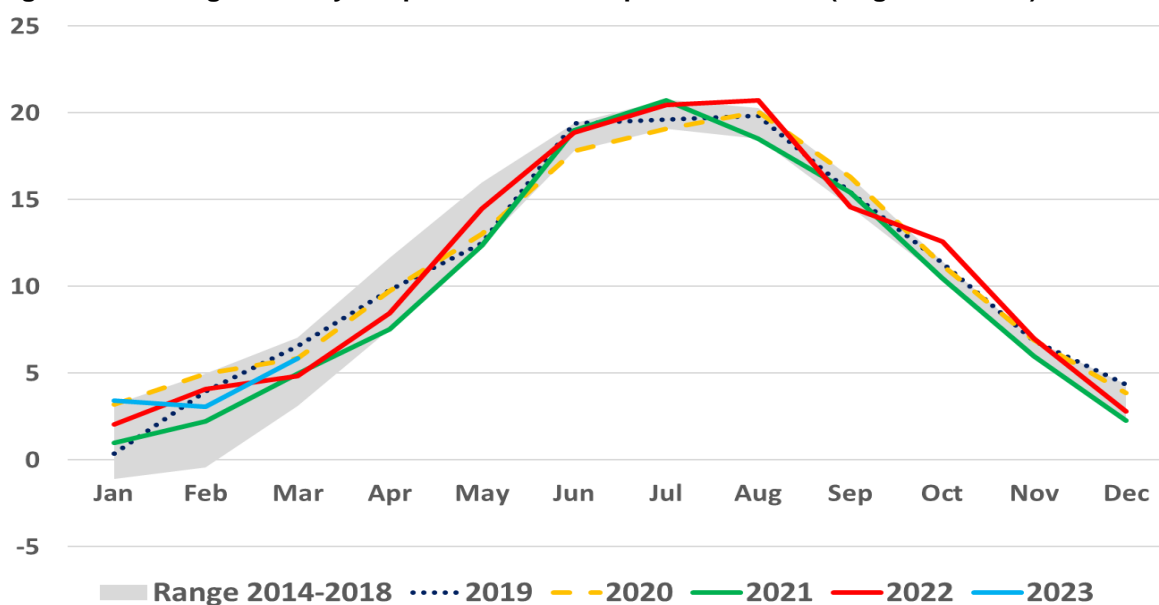
Using the IEA estimates of 80 per cent demand reduction, this means that up to 15 bcm of industrial gas demand could bounce back in the short term. This is potentially a warning sign for 2023 if Europe is counting on low industrial gas demand to balance its gas supply and demand in the coming months.

Gas demand in residential and commercial (heating)

Gas used in residential and commercial (primarily for space heating) represents 35-40 per cent of annual gas demand in Europe and is typically the most important driver of annual fluctuations. The weather is a key influence on demand in this sector: there can be a difference of +/- 20 to 25 bcm in demand year-on-year if the winter is milder or colder.²⁷

In 2021, the first four months (January to April) and December were much colder than the same periods in 2020, which contributed to a boost in demand for heating as illustrated in Figure 13. In 2022, the average temperatures in January, February, and April were warmer than the previous year, and March was relatively similar at a regional level, implying a lower need for heating in the residential and commercial sector. Warm temperatures in October and November then pushed the beginning of the heating season towards late November / early December. In other words, 2022 was an especially warm year, which came after a particularly cold one in 2021, and as a result, the mild weather alone is likely to have contributed to about 30 per cent of the entire reduction in gas demand in Europe last year.

Figure 13: Average monthly temperatures in Europe in 2019-2023 (Degree Celsius)



Source: Data from EU Copernicus programme, author's calculations

Note: Malta not included

In addition to the mild temperatures, which were an undeniable factor in keeping demand low, this combination of warmer weather and continued high gas prices seem to have facilitated an important demand response from small consumers as illustrated in Figure 14. This was an interesting evolution in what is usually a rather inelastic sector in the short term.^{28,29}

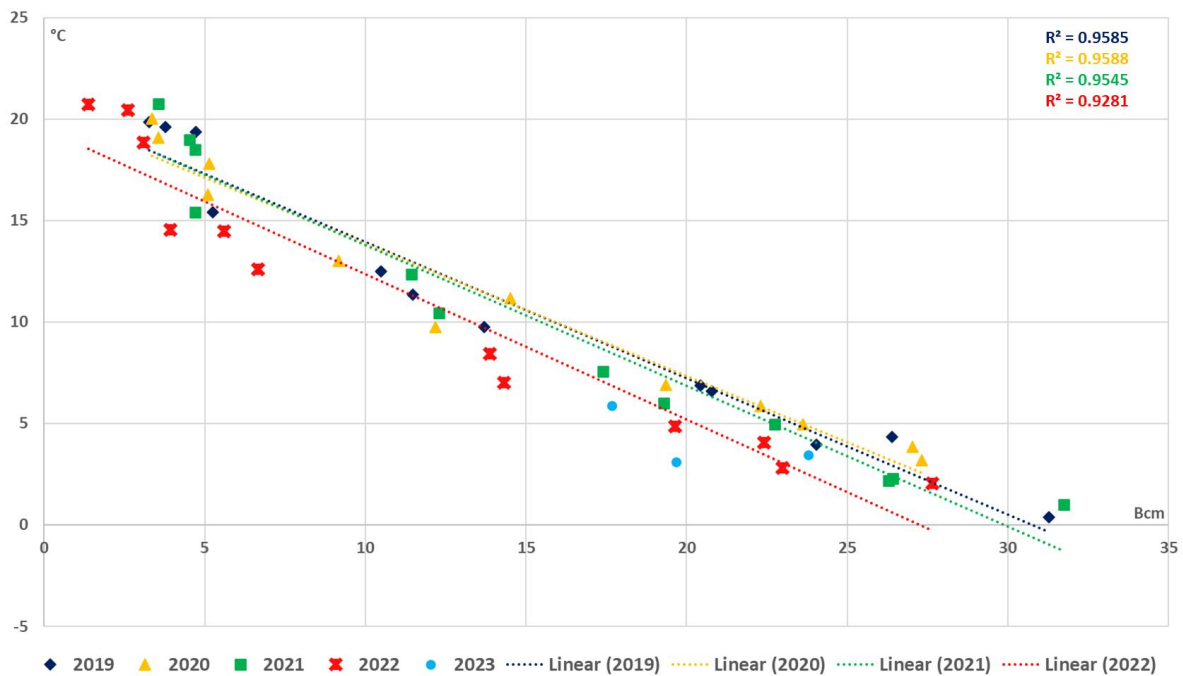
²⁷ Author's estimates

²⁸ For some examples, see Honoré, A. (2022), Demand response to high gas prices in Europe in 2021 and early 2022, <https://www.oxfordenergy.org/publications/demand-response-to-high-gas-prices-in-europe-in-2021-and-early-2022/>

²⁹ Space heating in buildings covers energy uses in the residential sector (the largest segment), in the commercial sector and in the industrial sector. This demand is very responsive to fluctuations in temperatures, but short-term price elasticity is relatively inelastic, or at best, fairly limited due to a combination of factors. First, consumers do not have easy access to alternative

Despite high gas prices in the second half of 2021, there was no strong evidence that gas demand was not in line with levels to be expected at various temperature levels, although there seem to have been signs of some initial demand response in December.³⁰ On the contrary, in 2022, data seem to indicate a much stronger price response in the form of lower production and fuel switching in small businesses and lower energy use in the residential and commercial sector (customers turning their thermostat down or switching their heating off earlier in the season). In the winter, gas demand was about 10 per cent lower in 2022 than in the three previous years as shown in Figure 14 (the colder the temperature, the smaller the difference).

Figure 14: Monthly gas demand in residential and commercial vs temperature variations in Europe in 2019 – 2023 (bcm and degree Celsius)



Source: Gas demand data from author's estimates; Temperatures data from EU Copernicus programme & author's calculations

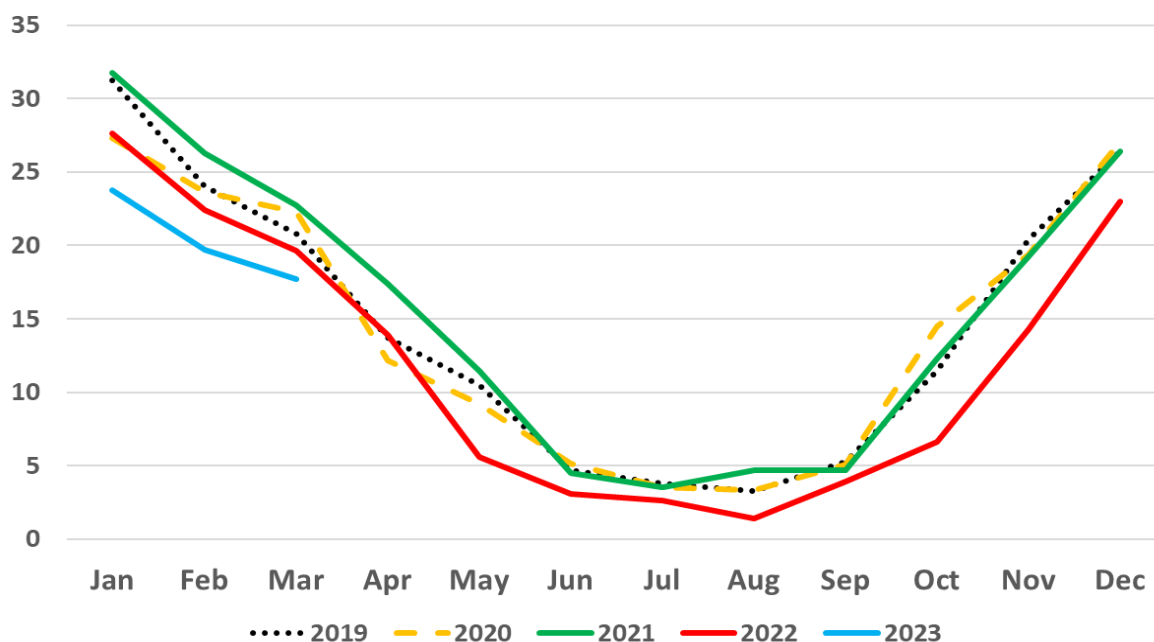
All in all, this author estimates that gas demand in the residential and commercial sector (essentially for heating) fell by 22 per cent in 2022 (-41 bcm). Gas use was consistently lower throughout the year compared to 2021 (but also 2019 and 2020, except for April 2020, a very warm and exceptionally sunny month) as seen in Figure 15.

options for heating. Second, in addition to these physical limitations, the degree to which end-use consumers would be affected by higher gas prices also depends on the type of contracts they have with their suppliers: contracts based on fixed tariff would not reflect fluctuations of wholesale prices quickly. It is also possible that even for contracts with variable rates, gas suppliers had not adapted their rates to reflect higher procurement costs by December 2021 (therefore not impacting the level of gas demand in the last months of 2021), though they probably had done so by the first months of 2022. Finally, the share of the energy bill relative to the customers' income would also play a role in this -nonetheless- rather inelastic price demand and this varies considerably across Europe

³⁰ In 2020, with widespread remote working, cooler weather is thought to have had a stronger impact on gas use than usual. This is likely to have benefited gas demand in Western countries with high volumes of gas used in residential heating, such as the UK, Italy, Germany, France, and the Netherlands

One example was reported by thermostat maker Tado based on its own consumers' behaviours. The company's analysis of more than 100,000 customers in Europe showed an increase of 9 per cent in heating energy demand in Germany in March and more than 40 per cent in Italy and Spain, where COVID restrictions started on 9 March and 14 March respectively, while outside temperatures differed by only 1°C on average from the previous year. <https://www.current-news.co.uk/news/lockdown-causes-british-households-heating-use-to-soar>

Figure 15: Gas demand in the residential and commercial sector in Europe, 2019-2023, bcm



Source: Author's estimates

Incentivising customers to turn down their heating, especially during the coldest days, while at the same time providing financial support to shield them at least partially from soaring prices was a tricky balancing act in 2022, but many policies did count on customers turning down their thermostats to save energy (and therefore gas) last winter.³¹ And it seems to have paid off with clear signs of behavioural changes, which helped reduce gas use in the residential and commercial sector probably by 10-15 bcm in 2022 (more or less 30 per cent of the total reduction in this sector).

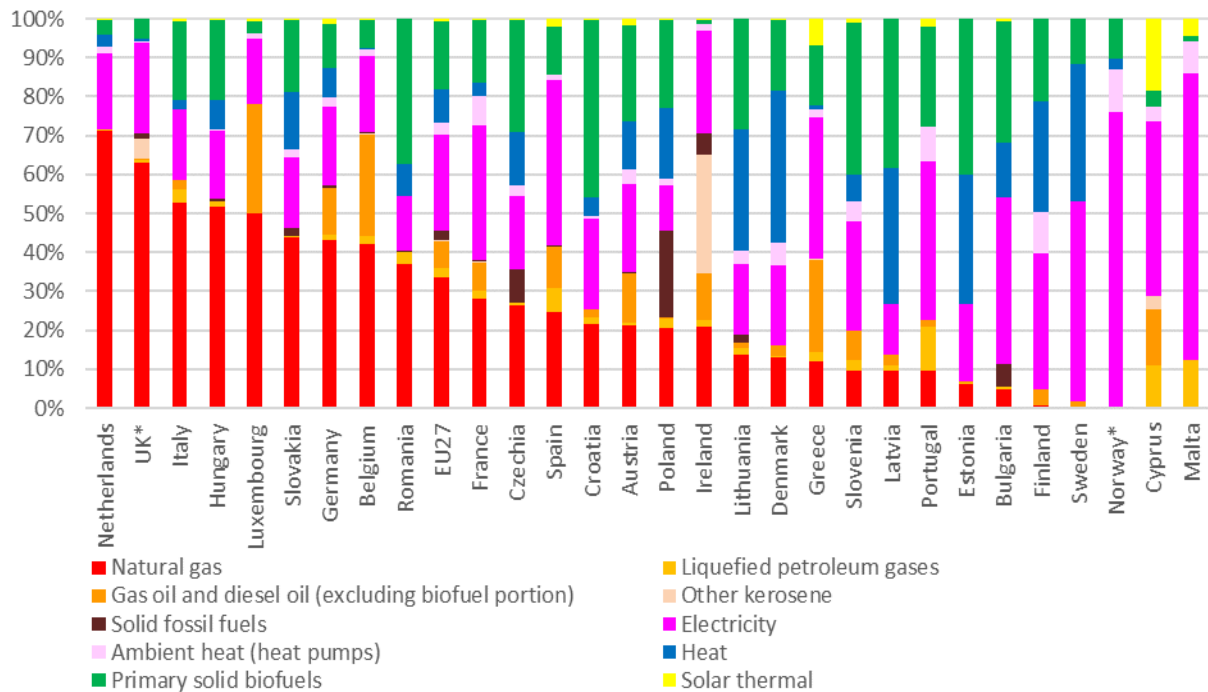
As gas is the largest single source of energy used for heating in the residential sector in Europe (37 per cent in 2021),³² continued participation of small consumers in demand saving measures is going to be essential in 2023 to keep gas consumption under control, and especially to limit a sudden surge in gas demand during the coldest days. However, consumers' willingness to reduce their energy for heating may erode when cold temperatures finally hit Europe as illustrated earlier with Figure 14. The early days of December 2022, when temperatures across Europe plunged below their 5-year average, also seemed to confirm this with a sharp rise in gas demand for heating in the residential and commercial sectors. This was again seen during the cold spell in the first half of February 2023. However, despite an increase in gas use for heating, requirements rose less than what was seen in previous winters,³³ though the impact was not, and will never be, uniform across Europe due to differences in weather and in the role of gas for space heating as illustrated in Figure 16.

³¹ For instance, the REPowerEU document published on 8 March 2022 by the European Commission mentioned that turning "down the thermostat for buildings' heating by 1°C [would save] 10bcm" (p.6). https://eur-lex.europa.eu/resource.html?uri=cellar:71767319-9f0a-11ec-83e1-01aa75ed71a1.0001.02/DOC_1&format=PDF The IEA also mentioned the measure in its 10-point plan to reduce the European Union's reliance on Russian natural (9th point): gas: <https://iea.blob.core.windows.net/assets/2db624be-ccda-4bc7-80a8-9bd3787efcd9/10PointPlanToReduceTheEuropeanUnionsRelianceOnRussianNaturalGasInfographic.pdf> Individual countries are also counting on customers' participation, for instance in the Netherlands: <https://www.rferl.org/a/dutch-reduce-russian-gas-campaign/31782700.html>

³² Around a quarter of energy used for heating in the residential sector in Europe comes from electricity, and in turn, gas covers about 20 per cent of Europe's electricity needs.

³³ <https://direct.argusmedia.com/newsandanalysis/article/2402159?keywords=netherlands%20industry%20consumption>

Figure 16: Final energy consumption in households by type of fuel in 2021 (shares in per cent)



Note: Data for Norway and the UK is for 2019

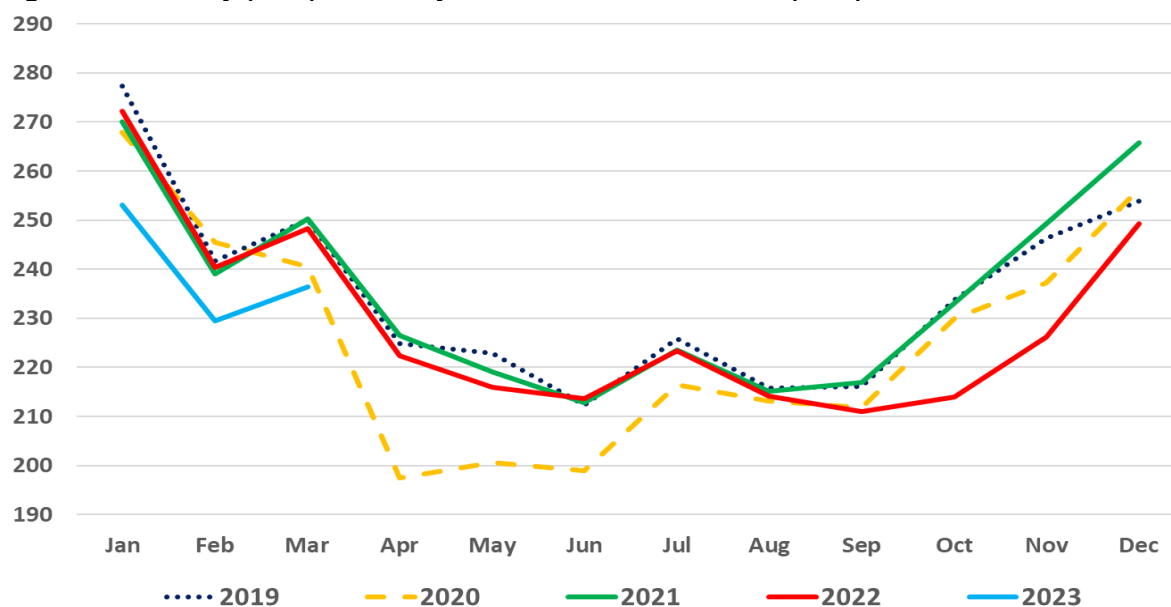
Source: Data from Eurostat. Graph by the author

Because 2022 was especially warm, both at the beginning and the end of the year, the probability that 2023 will be colder is important (although Q1 2023 was warmer than Q1 2022), with gas use for heating likely to be higher this year (10 to 20 bcm), coupled with some uncertainty on the extent of the demand recovery due to consumers' willingness to continue to save energy in a lower-price environment.

Power sector

In contrast to the trends observed in the industrial and heating sectors, gas used for electricity generation increased by almost 3 per cent (+4 bcm) year-on-year in 2022 despite aims to reduce gas consumption and high gas prices, which should have pushed the fuel down the merit order and favoured other sources. Three main elements influenced the need to use more gas in the generation mix. First, there was continued high electricity demand in the first eight months of the year, before energy saving measures and the economic slowdown finally started to have an impact from September onwards as illustrated in Figure 17. (Exceptionally mild temperatures in Q4 2022 also helped to limit the need for electricity demand.)

Figure 17: Monthly (total) electricity demand in the EU27 + UK (TWh)



Source: Data from Entsoe and Gridwatch. Calculations and graph by the author

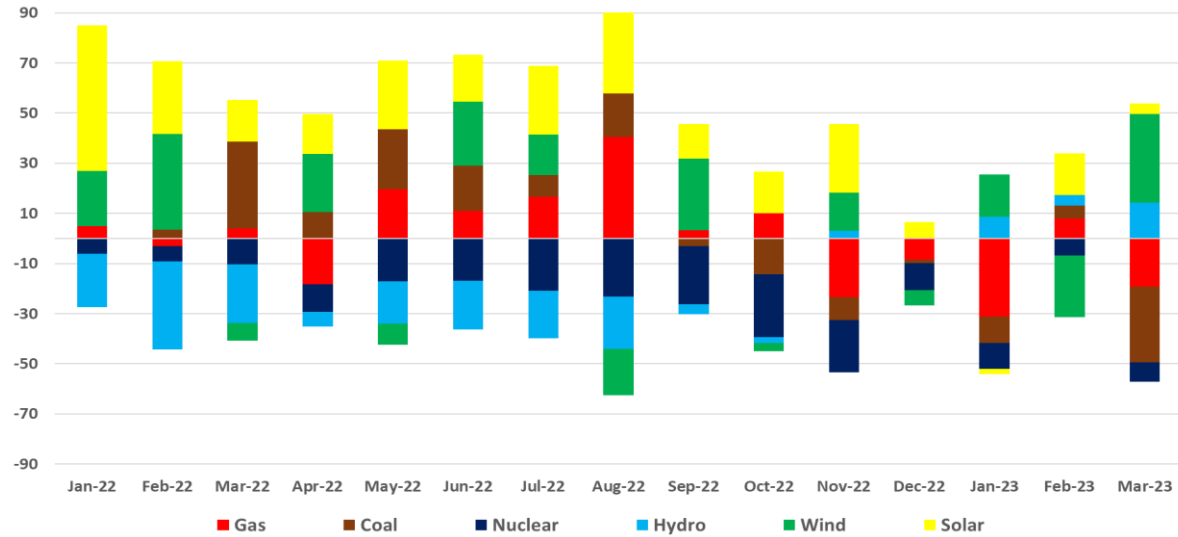
The second reason was low availability of nuclear power. Nuclear generation was down by 116 TWh (16 per cent year on year), with most of the decrease concentrated in May-November as seen in Figure 18. About 69 per cent of the decline (80 TWh) originated from France alone. The French utility EDF faced a wave of repairs caused by stress corrosion plus delays to its scheduled ten-year maintenance plan due to the COVID pandemic (as well as strikes in France in October 2022), which forced a record number of reactors offline for most of the year. As a result, French nuclear generation was down by 23 per cent in 2022, lifting thermal power generation in the country and in neighbouring markets.

Another important factor was the closure of three reactors in Germany at the end of 2021 as part of the country's phase-out process, which limited nuclear generation to 33 TWh in 2022 compared to 65 TWh in 2021 (this accounted for about 28 per cent of the total decline in nuclear generation in Europe last year).

Thirdly, the severe drought across Europe, especially in the south, depleted hydro stocks last year. Hydropower generation fell by 53 TWh (15 per cent), with the bulk of the year-on-year decline concentrated in the first nine months, although this result is also explained by existing very low hydro availability in Q4 2021.



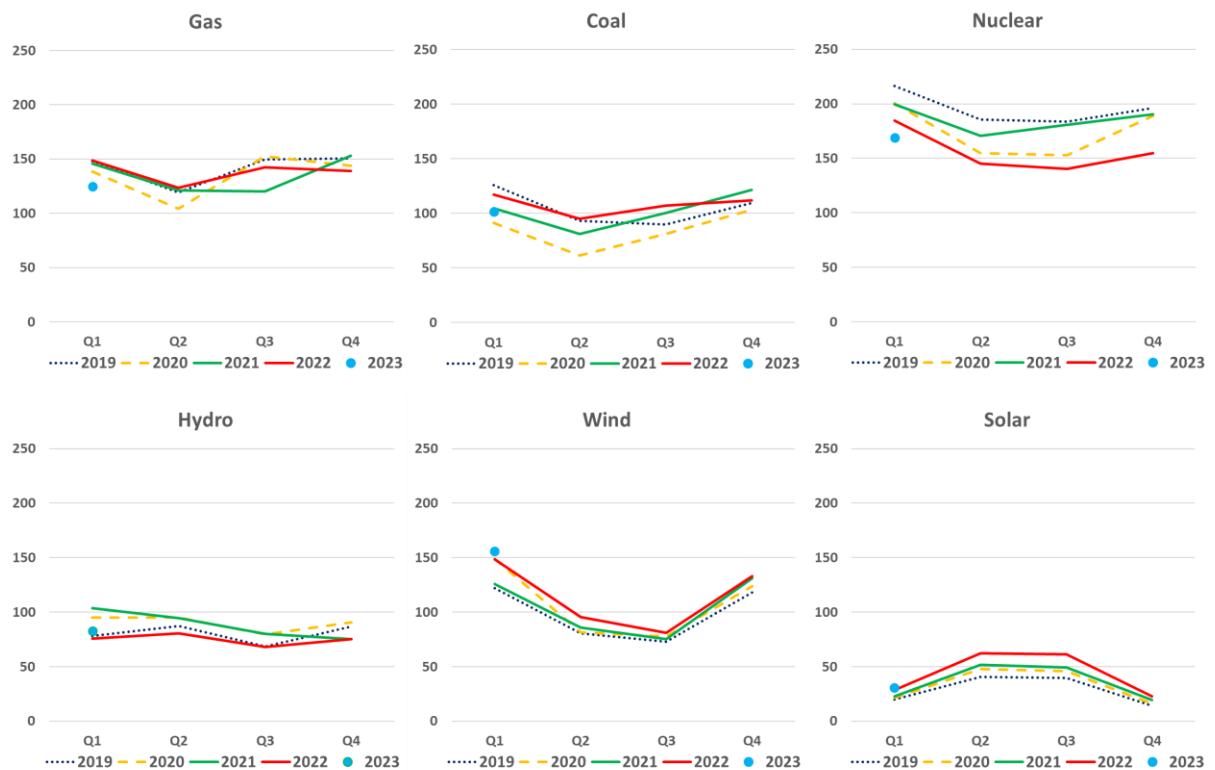
Figure 18: Changes in electricity generation in the EU27 + UK by sources, year on year (per cent)



Source: Data from Entsoe and Gridwatch. Calculations and graph by the author

The sharp fall in both nuclear and hydro generation was partly covered by lower electricity demand (70 TWh). Higher generation from renewables covered about two thirds of the gap, helped by additional installed capacity (wind 39 TWh and solar with an impressive growth of 32 TWh). Electricity from coal and gas made up for the rest (23 TWh and 14 TWh respectively) as seen in Figure 19.³⁴

Figure 19: Quarterly electricity generation in the EU27 + UK (TWh)



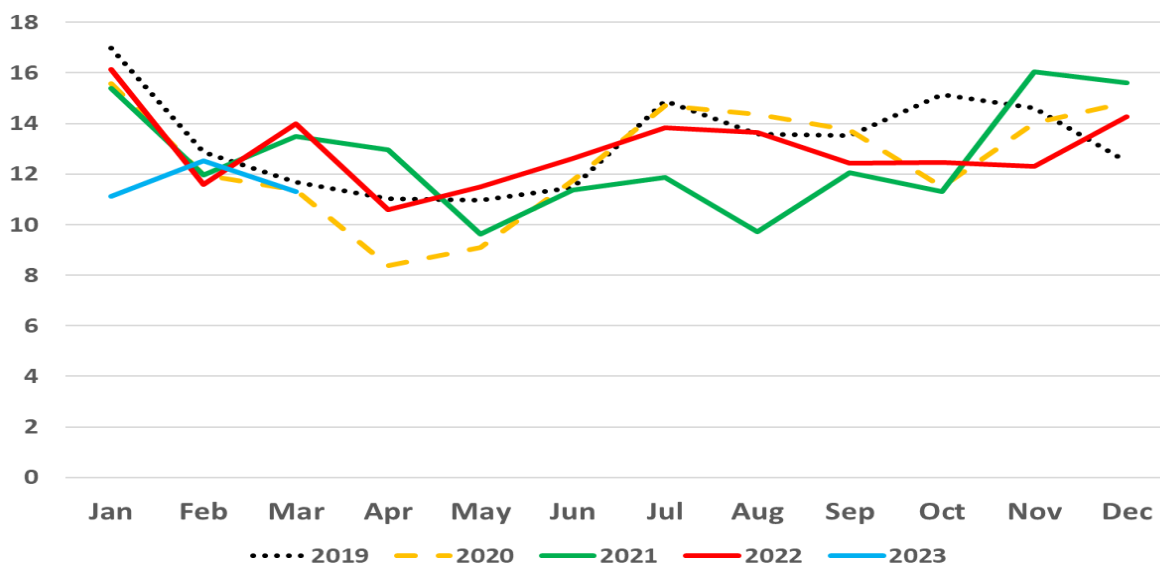
Source: Data from Entsoe and Gridwatch. Calculations and graphs by the author

³⁴ Smaller sources are not mentioned in this paragraph.

After a 2.6 per cent decline in 2020,³⁵ electricity generated from gas was up by 6.3 per cent in 2021, 3.6 per cent above even 2019 levels. Growth took place mostly during the first half of year and in November-December. The first explanation for this is the significant recovery in electricity demand which took place due to the post-pandemic strong economic rebound, especially in the first half of the year, headed by the industrial sector. Additionally, cooler temperatures in January-April and then again in November-December increased the demand for electricity in the heating sector. The second explanation for the high level of electricity generated from gas was the relatively low availability of nuclear in Q1 and Q2 2021, which was well below 2019 levels, low levels of wind in Q1, also well below 2020 levels, and finally low levels of hydro generation in Q4, when electricity demand was high.

In 2022, as already mentioned, gas use for electricity increased. The first three months were similar to the levels seen in 2021, although gas use in the electricity mix was down in April because of the economic slowdown and warmer temperatures. Continued low availability of nuclear and depressed hydro levels contributed to boost the need for high levels of both gas and coal in the mix. Most of the additional gas use for electricity generation was concentrated over the summer months as illustrated in Figure 20. This period was marked by concomitant low availability of nuclear and hydro and by lower clean dark spreads³⁶ that favoured gas-fired plants over coal-fired plants in late spring/early summer across Europe. Lower electricity demand, strong renewables, and the progressive return of French nuclear power limited the need for gas at the end of 2022. Whether this trend will continue in 2023 is far from certain.

Figure 20: Gas demand in the power sector in Europe, 2019-2023, bcm



Source: Author's estimates

In 2023, one of the key factors will be the availability of the French nuclear fleet. EDF raced against the clock last year to put as many reactors as possible back in service as soon as possible. At the beginning of winter 2022/2023, 30 out of 56 reactors were offline.³⁷ By the end of January 2023, EDF's nuclear power plant output was around 45GW. In March 2023, EDF confirmed its expectations for 300-330 TWh of nuclear generation for 2023 after submitting a revised inspections plan for the 16 reactors most at

³⁵ Luxembourg, Malta, Cyprus, Montenegro and Albania are not included. Author's calculations from ENTSOE data, transparency platform. For the UK (for 2021), Romania (for 2021) and Turkey (for 2019, 2020, 2021), alternative sources were used, author's calculations from Gridwatch data, Transelectrica data, Epias data.

³⁶ Coal prices reached record highs in Q2 and Q3 2022 (especially in July and August) as a result of strong demand in Europe and Asia, due to supply diversification away from gas in national energy mixes and coal supply diversification from Russian coal which tightened the global market. (The EU adopted sanctions prohibiting imports of coal, solid fossil fuels, and a range of industrial goods from Russia from August 2022).

³⁷ <https://energygraph.info/>

risk from stress corrosion.³⁸ This level of production would still be relatively low for the French nuclear fleet but around 18-19 per cent higher than 2022 levels.³⁹ However, uncertainties remain, and lower production is still a possibility (the company revised its predictions for nuclear generation downwards four times in 2022). First, EDF still needs to carry out stress corrosion protection maintenance on a few reactors this year. Second, the discovery of significant new fissures at three reactors in early 2023⁴⁰ has cast another shadow on the availability of the fleet if additional checks need to be carried out. Thirdly, low hydro stocks could limit the availability of some nuclear reactors over the summer, as seen in previous years in France.⁴¹ Finally, strikes in France in spring 2023 have also impacted the level of electricity generation. How long this situation will last remains to be seen.⁴²

There are therefore some uncertainties regarding estimates of the level of electricity which could be generated from the French nuclear fleet in 2023. Some other factors may also impact the need for continued high gas levels in the mix in the coming months. First, closures this year include Belgium's 1GW Tihange-2 reactor that was permanently shut down at the end of January (as planned as part of the previous policy to phase out nuclear by 2025), while the remaining plants in Germany (Isar 2 in the southern state of Bavaria, Emsland in north-western Germany, and Neckarwestheim 2 in the southwestern Baden-Württemberg state, which have a combined capacity of 4.2GW), that were initially due to be phased out by end-2022, were closed mid-April. These closures will only be partly counterbalanced by the start of commercial operations at Finland's 1.6GW OL3 reactor and Slovakia's new reactor (Mochovce-3, 440MW capacity). Secondly, while hydro stocks were showing signs of a slow recovery, with most countries starting 2023 with higher levels than the same period in 2022, the availability of hydropower is likely to stay low in 2023. Thirdly, higher gas prices over the past year have allowed even the least efficient coal-fired plants to operate in the market, but a combination of a return to lower gas prices and firm carbon prices should price out some coal-fired fleet for most of 2023. And fourthly, if industrial production picks up, it will contribute to increased electricity demand. The continued deployment of renewables will increase the availability of wind and solar and compensate for some of these shortfalls,^{43, 44} but these sectors are also facing uncertainties created by inflation, supply constraints in sourcing some materials, revenue caps, and looming market reforms, plus slow approval processes and supply chain disruptions. All in all, gas use for electricity generation is likely to stay high in 2023.

Conclusions and outlook for 2023

One of the conclusions of this analysis is that the contribution of gas demand to balancing the market at times of tight supply and high gas prices was important in 2022 (contrary to 2021). Gas demand in Europe declined by about 13 per cent in 2022 and by almost 19 per cent in August 2022 to March 2023 compared to the past 5 years, exceeding the EU's 'Save gas for a safe winter' target. Keeping gas demand low will be a key goal in 2023 in preparation for Winter 2023/2024. How much more could be reduced in the industrial and heating sectors is uncertain, at least without any major impact on economic activity and consumers' wellbeing. Gas demand remained low in the first quarter of 2023 (down 14 per cent in Q1 2023 compared to Q1 2022), but the fundamentals in the three main sectors seem to point toward a potential increase in gas consumption this year rather than a flat (or indeed a further decline) gas consumption.

All in all, the fundamentals point to an increase in gas demand in 2023, with a possible recovery of about five per cent (20 bcm). Key issues to watch closely for the rest of 2023 and 2024 include the pace

³⁸ Platts Power in Europe, Issue 891, 17 March 2023

³⁹ <https://energynews.pro/en/edf-maintains-its-2023-production-range-with-the-next-winter-as-its-target/>

⁴⁰ Platts Power in Europe, Issue 891, 17 March 2023

⁴¹ <https://www.ecologie.gouv.fr/secheresse-economiser-leau>

⁴² <https://www.reuters.com/business/energy/frances-nuclear-output-hit-by-strike-edf-2023-03-04/>

⁴³ After an impressive growth in 2022, the solar sector is set to continue its positive trend in 2023 with 53 GW of new installations after 41 GW in 2022 according to SolarPower Europe. EU Market Outlook for Solar Power 2022-2026 - SolarPower Europe

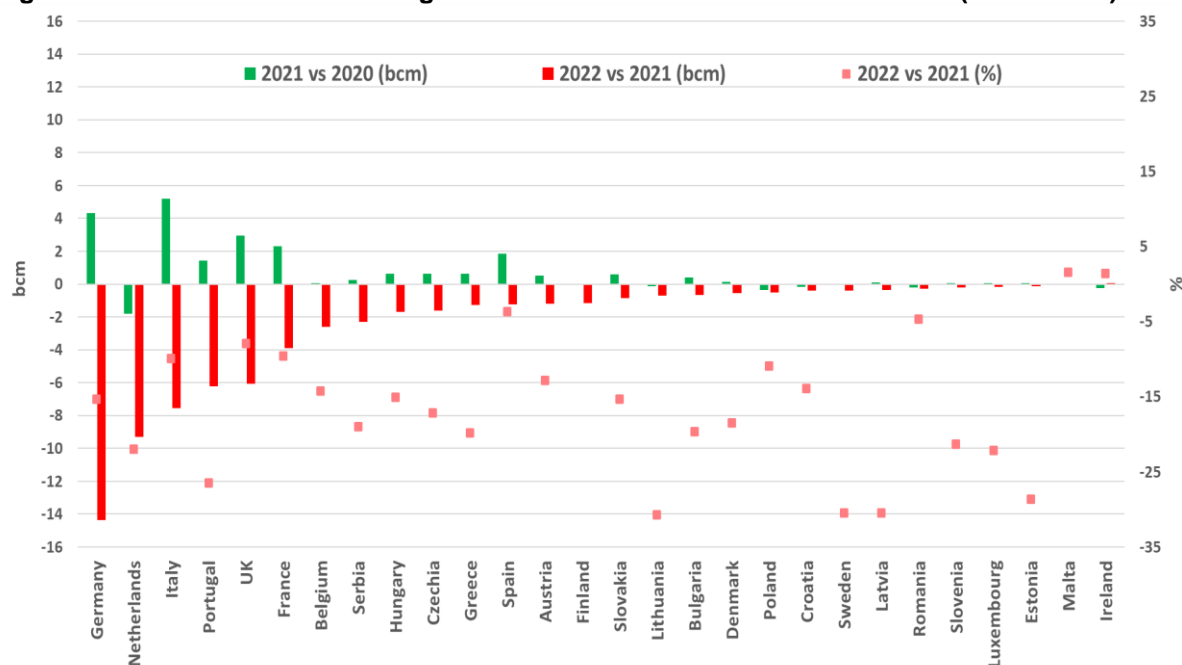
⁴⁴ <https://windeurope.org/intelligence-platform/product/wind-energy-in-europe-2022-statistics-and-the-outlook-for-2023-2027/>

of return of French nuclear reactors, but also coal-to-gas switching and the level of hydropower across Europe, both of which could (partly) counteract the effects of the French nuclear return. The willingness and ability of large and small consumers to continue to adapt their usual behaviour in order to use less energy (especially during cold days in the winter), and as a result, the level of temperatures, will be important: cold temperatures would likely derail most demand-response in the heating sector, though the trigger point and the impact are never going to be uniform across Europe due to differences in weather, buildings, and in the role of gas for space heating. The depth of an economic downturn (and which countries might be affected) and governmental interventions in subsidizing energy bills in particular, support measures for large energy intensive industries, will continue to be crucial drivers for gas demand in 2023/24, as well as, of course, the prices of gas but also electricity and the EU ETS allowances.

Annex 1: Annual fluctuations of gas demand in countries in 2020 and 2021

Gas demand decreased in all the European countries in 2022, except for Ireland and Malta, with the most noticeable decline (in volumes) by far in Germany (14 bcm), followed by the Netherlands, Italy, and Portugal as illustrated in Figure 21.

Figure 21: Annual fluctuations of gas demand in countries in 2020 and 2021 (bcm and %)



Source: Data from IEA, Eurostat, EntsoG, GRTgaz, Terega, NCG, Gaspool, THE, SNAM, Enagas, NationalGrid, author's calculations