Demand response to high gas prices in Europe in 2021 and early 2022

Introduction

This article is the third chapter of a trilogy entitled “A Series of Unfortunate Events” analysing the main supply and demand factors in the European gas market(s) that contributed to rising gas prices since the summer 2021 and culminating in -by then- record levels in Q4 2021. This article examines the demand response to the high gas prices, reviewing the main factors in 2021 and in the first four months of 2022. It concludes that, in 2021, high gas prices appear to have had a limited impact on demand, while other factors played a more important role and contributed to limit most price-response, especially in Q4. However, since the beginning of 2022, gas demand response seems to be happening more broadly: in heating with some -yet limited- change in consumer behaviour, in the industrial sector with apparent switching to other fuels and in the electricity generation sector with gas to coal switching in the mix. For the rest of 2022, what happens in the power sector is expected to be a major driver. Some possible coal to gas switching as a result of higher coal prices and the ban on Russian coal imports from August, (so-far) limited availability of hydro and most importantly, the lower than previously expected availability of French nuclear capacity are likely to increase the call on gas-fired plants for the rest of the year.

In the following paragraphs, unless otherwise specified, Europe includes 34 countries: EU27 plus Albania, North Macedonia, Norway, Serbia, Switzerland, Turkey and the UK. Because the flexibility of gas demand is an integral part of the measures proposed by the European Commission in the REPower EU initiative, we also provide some indications of gas demand trends for the EU27.


In this fast-changing world, it is important to date the research: the text was finalised in May 2022, with the data available in the public domain at the time covering 2019 to March/April 2022. Comparisons are made with gas demand in 2020, but also in 2019, the last pre-COVID year, to avoid overly optimistic conclusions being drawn from the year-on-year comparison between 2020 and 2021. Additional data on temperatures, industrial production and electricity generation is used to provide a clearer picture of the trends and key factors by sectors (heating, industry and power).

Record levels of gas and energy prices in Europe in Q4 2021 and Q1 2022

European gas prices climbed from very low levels in 2020 to record highs in 2021 and 2022 as illustrated in Figure 1. These fluctuations were analysed in great detail in a series of OIES papers and in our regular OIES Quarterly Gas Review series.

Low gas prices in 2019-2020 were driven essentially by a combination of an oversupplied global LNG market, abundant LNG imports in Europe and full storage stocks across the region. The impacts 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 where down to 4 EUR/MWh (TTF Front-Month price – a European benchmark).

As measures to combat the pandemic were gradually lifted from mid-2020, economic activity and, as a result, gas demand started to recover in Europe. In addition, cold winter spells kept demand for heating high in early 2021 and gas prices rose to 26 EUR/MWh on 12 January. At the time, adequate levels of storage and increased withdrawals helped balance the market despite supply constraints.

TTF prices then rose slowly in the first half of 2021. Continued supply constraints combined with strong demand recovery for LNG in Asia, as well as in Central and South America, did not allow the refilling at a normal rate of European storage sites. European prices continued to rise throughout the summer of 2021 and accelerated from September as European storage prices rose to 26 EUR/MWh on 12 January. At the time, adequate levels of storage and increased withdrawals helped balance the market despite supply constraints.

Following a drop in gas flows from Russia along the Yamal Europe route, prices peaked at 117 EUR/MWh on 5 October. After a slight and short-lived decline, prices soon surged again, reaching 180 EUR/MWh on 21 December. In a context of geopolitical concerns over the Russian military build-up around Ukraine’s borders and a tighter than expected global LNG market, European prices remained at record high levels. The Russian invasion of Ukraine on 24 February triggered another round of price increases, with the TTF day-ahead price peaking at 227 EUR/MWh on 7 March.

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3 26 May 2022
4 Contrary to the supply side, data on gas demand is not always available in a timely way. As a result, a combination of sources has been used, with the author’s calculations to harmonise data sets and making assumptions when the data was not available or was unsatisfactory. In addition, most of the gas demand data for March and April are based on this author’s calculations.
6 The Oxford Institute for Energy Studies Quarterly Gas Review is available here: https://www.oxfordenergy.org/publicationtopi...quent-gas-review/
7 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 Mike Fulwood’s paper: 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/
9 Data from Argus

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In reaction, the European Commission and most governments around Europe are looking to reduce their dependence on pipeline gas imports from Russia\textsuperscript{10} by using alternative sources of supply but also by reducing their total demand for gas in their energy mix thanks to lower demand (energy savings, customers actions) and by switching to other fuels.

Figure 1: TTF Front-Month gas prices from January 2019 to May 2022 (midpoint, Euro/MWh)

![TTF Front-Month gas prices from January 2019 to May 2022](image)

Source: Data from Argus

Governments are facing difficult choices and consumers difficult times. Soaring gas prices from the second half of 2021 also had a ripple effect on electricity prices, coal prices and probably on the prices of CO\textsubscript{2} emissions due to fuel substitution in favour of more polluting fuels like coal (and oil). This is illustrated in Figure 2.

Dramatic levels of energy prices prompted governments to put in place relief measures to mitigate the effects for consumers and businesses. In October 2021, the EU Commission also published a toolbox of measures\textsuperscript{11} that EU members could use without breaching competition rules. At the national level, a first wave of instruments started in September/October 2021, especially towards vulnerable customers.\textsuperscript{12} There was a second wave from February/March 2022 directed at businesses and again towards vulnerable customers.\textsuperscript{13} In the short term, the objective was to provide emergency income support for the consumers facing soaring energy bills. These measures seem to have supported energy (including gas) demand in Q4 2021, as shown in the subsequent sections.\textsuperscript{14}

\textsuperscript{10} The EC aims to reduce Russian gas imports from 2022 and stop by 2027 (REPowerEU); Lithuania, Poland, Bulgaria and Finland stopped Russian gas imports and others intend to stop in the coming months, for instance Estonia by end 2022, Latvia by early 2023, Netherlands by end 2022 (contract) and Italy and Germany by mid-2024.

\textsuperscript{11} https://ec.europa.eu/commission/presscorner/detail/en/IP_21_5204

\textsuperscript{12} We discuss the impact of support measures at the end of 4.1 and in 4.2

\textsuperscript{13} 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/

\textsuperscript{14} In the medium-term, the objective is to step-up investments in renewables and reduce dependence on fossil fuels.
Economic recovery slowdown in Q4 2021 and Q1 2022

High gas and energy prices were not good news for a post-2020 economy that was just starting to get back on its feet. After the dramatic impact that the lock-down and other measures had on many economies in 2020, economic activity started to recover in late 2020. In the first half of 2021, lighter COVID 19 measures and the roll out of vaccines allowed people to partially return to some normalcy and there was a gradual economic recovery across Europe. Fast rising energy prices from Q3, measures to limit the spread of the new Omicron variant in Q4 and the changing geopolitical context following the Russian invasion of Ukraine have weakened the momentum of economic recovery as illustrated by the evolution of GDP in EU27 in Figure 3.

Annual GDP estimates in the EU27 show a 5.3% growth in 2021\(^{16}\) (-1% compared to 2019) but with important disparities between countries as seen in Figure 4. GDP growth in Q4 2021 was consistently lower in all countries than the annual growth, confirming a slowdown of economic recovery (and even a contraction in five countries) in October-December 2021. Data for Q1 2022 was still limited at the country level at the time of writing, though early estimates are shown in Figure 4.

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\(^{15}\) 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

\(^{16}\) Eurostat data: https://ec.europa.eu/eurostat

Data for the whole of Europe (which includes Turkey and the UK) was not available for Q1 2022 at the time of writing, but GDP growth for 2021 was 6% compared to 2020 and 1.6% compared to 2019. Data from Eurostat and the ONS for the UK: https://www.ons.gov.uk
Figure 3: Evolution of Gross Domestic Product (GDP) in EU27, Q1 2019 to Q1 2022 (% change from previous quarter)

Sources: Data from Eurostat (volume, index 2015 = 100, seasonally and calendar adjusted data)

Figure 4: Evolution of Gross Domestic Product (GDP) in European countries, annual growth in 2021 and quarterly growth in Q4 2021 and Q1 2022\(^\text{17}\) (% change from previous period)

Sources: Data from Eurostat (volume, index 2015 = 100, seasonally and calendar adjusted data), Office for National Statistics (UK)

\(^\text{17}\) Q1 2022 only available for Austria, Finland, France, Germany, Italy, Lithuania, Netherlands, Norway, Romania, Slovakia, Slovenia, Spain, the UK and the EU27
Despite soaring gas prices, gas demand was surprisingly resilient in 2021, but started to collapse in early 2022

Despite high gas prices from September and much weaker economic recovery in Q4 2021, annual gas demand increased by 6% year-on-year (about 32 bcm) in Europe and by 4.2% (almost 17 bcm) in EU27 as illustrated in Figure 5.

When compared to 2019, the last year before the repercussions of COVID-19, total gas demand was 3.2% higher (17 bcm), though only about 1.4% higher in EU27 (less than 6 bcm) without the impact of Turkey (see Figure 6).

In the first 4 months of 2022, estimated gas demand was down by about 8.9% in Europe and 9.2% in the EU27 compared to the same period in 2021. This represented a sharp decline of 21 bcm in Europe and 16 bcm in the EU27. If this demand reduction (even probably some demand destruction) carries on, the EU27 could well meet their initial target of 38 bcm less gas demand in 2022 compared to 2021, though for very different reasons than those envisaged in the initial REPowerEU document published in March 2022.

Figure 5: Evolution of gas demand in Europe and in EU27 between 2019 and 2022 (bcm)

Sources: Data from IEA, Eurostat, OECD, TSOs, author’s calculations for March & April 2022 estimates

Fluctuations of gas demand at the regional level only provide a partial story. The energy mix of each European country is unique, gas uses vary from one country to another and as a result, gas demand trends may significantly diverge across Europe at the national level. The objective of this article is only

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18 Sources: Eurostat, IEA and author’s assumptions
19 Gas demand in the UK in 2021 was lower than in 2019, so the largest non-EU gas market did not contribute to the increase in gas demand in Europe in 2021. Sources: Eurostat, IEA and author’s assumptions
20 Sources: Eurostat, IEA and author’s assumptions
to provide an overview of what happened to gas demand at the regional level, how and why it supported high gas prices in 2021 and what the expectations for 2022 are.

A general overview shows that gas demand increased in 24 countries in 2021, with the most noticeable growth (in volumes) by far in Turkey, followed by Italy, Germany, the UK, France and Spain as illustrated in Figure 6. In the first quarter of 2022, first estimates show a decline in most countries compared to the same period last year with some notable exceptions in Turkey, Spain, Slovenia and, to a lesser extent, Italy as shown in Figure 7.

Unsurprisingly, most of the gas demand growth in Europe in 2021 happened in the first half of the year, as illustrated in Table 1 and in Figure 8, when gas prices were still relatively low. In Q1 2021, gas demand in Europe rose by an impressive 8.1% year on year, but it compared to a previous winter 2019-2020 that was mild, wet and windy, a combination of factors not favourable to high gas demand in the region. On the contrary, at the beginning of 2021, several cold spells throughout Europe increased the need for gas used for heating in buildings as well as heating-related electricity consumption. In March, gas used in power generation surged in Europe; and gas demand in Turkey also appears to have been especially strong, marking the beginning of rapidly rising gas demand in this country in 2021.

**Figure 6: Annual fluctuations of gas demand in European countries in 2020 and 2021 (bcm and %)***

![Annual fluctuations of gas demand in European countries in 2020 and 2021 (bcm and %)](source)

Sources: Data from the IEA, Eurostat, OECD, TSOs and author’s calculations
which boosted demand for gas in residential heating in April (the peak of the heating season is usually in the first three months of the year); and gas use in electricity generation was also especially strong.

The trend turned in Q3. In the summer, gas demand in Europe is traditionally at its lowest point, but in 2021, it was even below the two previous years. In 2019 and 2020, low gas prices encouraged (higher) storage injections, but this did not happen in the high-price environment of 2021. From September, high gas prices also started to have an impact on industrial gas demand with some curtailment and (even temporary) closure of power-intensive manufacturing activities. In the power sector, high prices also eroded the competitiveness of gas plants in the mix.

In Q4, and despite sky-high gas prices, estimates show 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, also in the industrial sectors and for electricity generation, as detailed in the subsequent sections.

Figure 8: Monthly gas demand in Europe and in EU27, 2019-2022 (bcm)

In the first four months of 2022, provisional data shows a sharp decline of gas demand due to a milder winter in early 2022 and demand response to high gas prices, especially in the industrial sector. Demand was 8.9% lower than in 2021 and about 2.8% lower than in 2019 as shown in Table 2 (although this smaller difference between 2022 and 2019 can be explained at least partly by the impact of heating. In other words, temperature-corrected data would likely show gas demand in January-April 2022 being much lower than the same period in 2019).


Table 2: Evolution of quarterly gas demand in Europe in 2021 compared to the same periods in 2020 and 2019 (%)

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Sources: Data from IEA, Eurostat, OECD, TSOs, author’s calculations for 2022 estimate

Overview of the main drivers by sectors for gas demand in 2021 and 2022

Natural gas in Europe is used in three main sectors: the buildings sector (especially for residential heating), the industrial sector and the power sector. The following paragraphs shed some lights on the main trends for 2021 in all three sectors, and how higher gas prices might have influenced demand levels, especially in Q4 2021 and Q1 2022.

Up-to-date data on gas use per sector is not easily available, but a cursory overview of temperatures (heating), manufacturing output (industry) and electricity generation from gas-fired plants (power) indicate that all three sectors contributed to high levels of demand in 2021, while conversely, also all contributed to declining levels in 2022.

Strong gas demand for heating across Europe in 2021, much lower in 2022

Gas used for space heating represents about a third of annual gas demand in Europe and is the most important driver of annual fluctuations. The influence of temperatures on gas use can easily represent a plus or minus 20-30 bcm yoy difference between a mild and a cold winter.

In 2021, the first four months (January to April) and December were colder than the same periods in 2020, which contributed to boost demand for heating. Except for January 2021, these periods were also colder than the same ones in 2019 as illustrated in Figure 9. In 2022, the average temperatures in January, February and April were warmer than the previous year, and March was relatively similar at the regional level, implying a lower need for heating in the buildings sector.


26 Harmonized data at the regional level showing gas demand by country and by sector will be 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. However, different (and often unclear) definitions and methodologies make it very difficult, if not impossible, to compare the evolution in 34 countries in a timely way.

27 Author’s estimates
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 inexistent, or at best, fairly limited due to a combination of factors. First, consumers do not have easy access to alternative 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.  

All in all, throughout 2021, there is no strong evidence at the European level that gas demand was not in line with levels to be expected at various levels of temperatures as illustrated in Figure 10, although there seem to have been signs of some initial demand response in December. Provisional data for 2022 also seem to indicate some price response during mild temperatures, especially at the end of winter, which could be signs of customers turning their thermostat down or switching their heating earlier in the season.

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28 End-users in Luxembourg, Belgium, Austria and Ireland paid the smallest share of their income for gas bills, while consumers in Bulgaria, Portugal and Czechia were at the other end of the spectrum. [https://www.iwkoeln.de/presse/iw-nachrichten/christoph-schroeder-bulgaren-zahlen-eu-weit-am-meisten-fuer-energie.html](https://www.iwkoeln.de/presse/iw-nachrichten/christoph-schroeder-bulgaren-zahlen-eu-weit-am-meisten-fuer-energie.html)

29 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% in heating energy demand in Germany in March and more than 40% in Italy and Spain, where 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](https://www.current-news.co.uk/news/lockdown-causes-british-households-heating-use-to-soar)
Figure 10: Monthly gas demand vs temperature variations in Europe* in 2010 – 2022 (bcm and degree Celsius)

Sources: Data from IEA (demand) and Climate Data Store (temperatures)
* Europe = 25 countries in this chart (OECD Europe minus Switzerland)

Since most of the policies considered for next winter to ensure security of supply in case of a tight market are counting on customers turning down their thermostat to save energy (and therefore gas), these could be important and encouraging signs. However, how to incentivise customers to turn down their heating, especially during the coldest days, while at the same time providing financial support to shield customers at least partially from soaring prices is a tricky balancing act, as seen in December 2021 for instance.

Some demand response seems to have happened in the Netherlands, a country where over 80% of residential heating comes from gas. Demand for the distribution networks (which covers essentially buildings, SMEs and horticulturists) in December 2021 was 3.4% lower than in December 2019, but temperature corrected data shows that it was actually 5.4% lower. Figure 11 illustrates these findings, using heating degree days. Gas demand for the distribution networks still increased with colder temperatures, as expected, but it did not follow the same trends in 2021 as in 2020 and also in 2019. One -logical- explanation could be the repercussions of higher prices in December 2021 that were passed on to consumers in the Netherlands and which impacted end-users' behaviour (in other words, consumers turning their thermostats down). Other factors may also have played a role, such as

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30 For instance, the REPower EU document published on 8 March 2022 by the European Commission mentioned turning that “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 Russia natural (9th point): gas: https://iea.blob.core.windows.net/assets/2db624be-ccda-4bc7-80a8-9bd3787efcd9/10PointPlantoReducetheEuropeanUnionsRelianceonRussiaNaturalGasInfographic.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 Author’s calculations. Data for gas demand in the distribution sector from ENTSOG (based on data from Gasunie) and data on Heating Degree Days from Argus Media
improvement in insulation between 2019/2020 and 2021 and/or consumers switching to other fuels (heat pumps, district heating…) for instance. In the later scenario, it would mean gas demand destruction rather than just a temporary reduction. In other words, even in the case of lower gas prices in the future, this demand will not come back.

**Figure 11: Daily gas demand in the distribution networks vs heating degree days in the Netherlands in December 2019, 2020 and 2021 (Horizontal axis: GWh and Vertical axis: HDD)**

![Graph showing daily gas demand vs heating degree days](image)

Sources: Data from ENTSOG (demand) and Argus (HDD)

Preliminary data (at the time of writing) seems to indicate that different trends can be seen around Europe and the Dutch example may not necessarily reflect what happened in other countries as shown in Figure 12 with the examples of France and Italy. In 2020, lockdowns, working from home and uncertainties relating to future income make analysing gas demand for heating tricky. But a comparison between 2019 and 2021 is quite telling.

In France, warmer temperatures in 2021 triggered much less demand than in 2019. However, as temperatures got cooler and closer to zero, gas demand looks more similar to 2019 as people turned on their heating. Gas demand in France for the residential and commercial sectors rose by 3.3% compared to 2019, but temperature corrected data shows that it was actually 3.1% higher in 2021 than it could have been based on 2019 demand. In other words, there seem to have been no impact of high gas prices on residential and commercial consumers in December 2021, possibly a result of the measures taken by the French government from October 2021 to shield retail customers from high energy prices.

In Italy, patterns were similar in 2021 and in 2019, but gas demand in 2021 was higher at similar temperatures. Demand rose by 16% compared to 2019, but temperature corrected data shows that it could have been higher, indicating a change in consumers’ behaviour likely due to high gas prices.

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33 Author’s calculations. Data for gas demand in “consumption on public network” from GRTGaz and data on Heating Degree Days from BizEE Degree Days. station LFPO used (Paris-Orly)

34 Author’s calculations. In 2021, demand was 3.4% lower than it could have been without consumers’ change in behaviour, likely delaying switching up their thermostats or/and lowering the temperature at which they are set. Data for gas demand in “local distribution networks” from SNAM and data on Heating Degree Days from BizEE Degree Days, station LIRF used (Roma-Fiumicino)
Support measures at the time were less important than in France, but more than in the Netherlands, which showed a stronger demand response. In the Netherlands, patterns were similar in 2019 and 2021, like in Italy, but in contrast, as shown earlier, gas demand in 2021 was much lower than in 2019.

**Figure 12: Daily gas demand in the distribution networks**\(^{35}\) vs temperatures in France, Italy and in the Netherlands in December 2019, 2020 and 2021 (Vertical axis: temperatures in degree Celsius; Horizontal axis: gas demand, in GWh for France and the Netherlands, mcm for Italy)

![Figure 12: Daily gas demand in the distribution networks](image)

**Strong industrial gas demand in 2021 followed by a collapse in 2022**

Another factor explaining strong gas demand in 2021 was the economic recovery across Europe from the second half of 2020, and even more so, the strong rebound seen in 2021 (at least in Q1 and Q2).\(^{36}\) However, by September, industries were expressing strong concerns on 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.

The extent to which gas use for industrial production can be affected by higher gas prices is not necessarily straightforward. Depending on their contractual arrangements with their suppliers, some companies may be less exposed to fluctuations on the spot market. Similarly, they may be more or less exposed if they have hedged their risks or if they have (or lack) access to and have (or lack) the possibility to use 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. And maybe the most important factor in 2021, is if they had access to government support.

In Europe, the largest volumes of industrial gas demand are used in the manufacturing sectors as illustrated in Figure 13.  

\(^{36}\) 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.
Reports on manufacturing production give some indication of short-term impacts on rising energy prices in Q4 2021 and Q1 2022. After a drop in 2020 during the first lockdowns, production gradually recovered in the second half of the year. In 2021 and even in early 2022, the production level remained strong. It first peaked in July 2021 as the rollout of vaccines allowed for wider reopening of the economy. A probable backlog of orders— which were delayed in 2020— are 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 and in February 2022 in EU27 as illustrated in Figure 14.

Turkey is not an EU member state but is counted in the “Europe” region in this paper. The Turkish market, which is the third largest industrial gas market, registered very strong growth of its manufacturing output in 2021 and in 2022 [Figure 15], which certainly contributed to its strong gas demand at the national level and is likely to have also had an impact at the regional level. Similarly, the UK, the sixth largest industrial gas market in Europe, saw its manufacturing output rise by almost 7% in 2021.


39 Data from the Office of National Statistics (ONS), Dataset Output of the production industries. https://www.ons.gov.uk/economy/economicoutputandproductivity/output/datasets/outputoftheproductionindustries
For the other four major markets (Germany, France, Italy and Spain), gas demand remained low post summer and dropped in October before a relative pickup in November-December [Figure 16]. In 2022, there seem to be fairly strong indications of switching from gas to other fuels as the manufacturing outputs appear to be similar or above the levels in 2021 while gas demand is showing sharp declines in all four countries.
Figure 16: Industrial gas demand in Germany, France, Italy and Spain from January 2019 to March/April 2022 (bcm)

Strong electricity generation from gas, even in Q4 2021 and Q1 2022 despite record prices

After a 2.6% decline in 2020, electricity generated from gas was up by 6.3% in 2021, and even 3.6% above the 2019 level. Growth was essentially during the first half of year and in November-December as illustrated in Figure 17. In 2022, the first three months were similar to the levels seen in 2021, though gas use in the electricity mix was down in April.

The first explanation is a strong electricity demand recovery, which increased by 3.7% in 2021 after a decline of 2.6% in 2020 [Figure 18]. The main drivers, as already mentioned, were the strong economic rebound, especially in the first half of the year, headed by the industrial sector; and cooler temperatures in January-April and then again in November-December, which increased the demand for electricity in the heating sector. In the first four months of 2022, electricity generation was slightly down by 0.4%, because of the economic slowdown and a warm winter.

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40 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.
The second explanation for the high level of electricity from gas despite record-high gas prices is the relatively low availability of nuclear in Q1 and Q2 2021, which was well below 2019 levels, low levels of wind in Q1, well below 2020 levels, and finally low levels of hydro generation in Q4, when electricity demand was high as illustrated in Figure 19. In 2022, continued low availability of nuclear and low hydro levels contributed to boost the need for high levels of both gas and coal in the mix.
The third factor is, once again, the role of Turkey as seen in Figure 20. This market alone represented almost 60% of the incremental volumes of electricity generation from gas in Europe in 2021 as low rainfall reduced hydro generation while low coal plant availability meant Turkey had to call on its gas-fired plants to meet soaring demand. Fourteen other countries also registered higher generation from gas in 2021, including the UK, Italy and Greece, though 12 countries saw a decline, including the Netherlands, Germany and Belgium.

41 Author’s calculations from data from EPIAS
Figure 20: Annual changes in electricity generation from gas-fired power plants in European countries in 2021 (TWh and %)

Gas to coal switching, but only to a certain extent, at least in 2021

Price elasticities vary for a number of reasons, the most important for short-run elasticities being the availability of alternative sources of energy to replace gas. This explains why the most price responsive segment of gas demand has traditionally been the power sector which has the ability to (relatively easily) switch between coal and gas. And indeed, gas demand in the electricity sector fluctuates with the level of gas prices, but only to a certain extent.

The past few months (especially in the second half of 2021 and in Q1 2022) have been a perfect example. With the rollercoaster that gas prices had been on in 2021 and 2022, one could have expected extensive gas to coal switching. It happened, but only to some degree.

Looking at simple spreads calculated with assumed efficiency of gas plants at 55% and coal plants at 38%, clean spark spreads were above clean dark spreads for most of 2019, 2020 and the first half of the 2021 (except for short periods during winter peaks), which supported the use of gas plants before coal plants.

In Q3 and Q4 2021, increasing gas prices impacted the profitability of the gas-fired power plants. The clean dark spreads stayed consistently above clean spark spreads, with record differences by the end of December. In other words, gas plants became less competitive against coal plants in most countries as illustrated in Figure 21 with the examples of the Netherlands, Italy and the UK.

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42 It is important to distinguish between short and long-run elasticities. The former relates to the behavioural changes in response to price and the latter takes into account the effect on gas demand of any investments that would happen in response to prices, for instance if prices were to remain high for a sufficient amount of time.

43 Clean spark and clean dark spreads measure the gross margin of gas and coal-fired plants respectively from selling electricity minus the input fuel and the EU ETS price.

44 This is based on assumed efficiency of gas plants at 55% and coal plants at 38%
Figure 21: Relative gas vs coal power plants profitability: clean spark minus clean dark spread, from 2019 to May 2022 (Euros/MWh)

As shown in Figure 22, electricity generation from coal increased the most in Germany, Poland and the Netherlands, three countries where electricity from gas declined in 2021, showing clear signs of gas to coal switching. On the other hand, due to limited availability of coal plants, some coal to gas switching happened in Turkey, even if modestly.\textsuperscript{45}

In 2022, the invasion of Ukraine pushed gas prices to record highs, but coal prices have also risen dramatically, especially in March/April following a strong demand and a rush to secure supply ahead of the EU’s Russian coal embargo in August as seen previously in Figure 2. (Russia typically accounts for over 45% of the EU’s coal imports\textsuperscript{46}). However, gas prices have been so high that there was still a large incentive to switch to coal where possible in Q1, and this has been especially noticeable in countries like Germany, the Netherlands and Turkey. In other countries facing more limited possibilities to switch to coal, such as Spain, Italy and France and in recently coal-free countries like Portugal and Austria, gas use in the mix has even increased compared to the same period in 2021 as seen in Figure 23.

\textsuperscript{45} Though prices were not the only explanations
\textsuperscript{46} 46% of the coal imported into the EU27 in 2020 came from Russia. It represented over 45% in Germany and 70% in Poland, the two largest users of coal in electricity generation, potentially creating some additional tensions in energy systems for the second half of the year. Source: Eurostat data
Figure 22: Changes in electricity generation from gas and coal in European countries in 2021 vs 2020 in volume (TWh)

Sources: Data from ENTSOE transparency platform, Gridwatch, Transelectrica, Epias, author’s calculations

Figure 23: Changes in electricity generation from gas and coal in European countries in January-April 2022 vs January-April 2021 in volume (TWh)

Sources: Data from ENTSOE transparency platform, Gridwatch, Transelectrica, Epias, author’s calculations
In 2021, a combination of coal, gas and nuclear made up for most of the increase in electricity generation, while in 2022, it was wind and coal as illustrated in Figure 24. Should nuclear and hydro availability remain low, additional volumes of electricity generated from both coal and gas are likely to be needed on low-wind availability days. Meanwhile the impacts of higher coal prices and possibly the EU embargo on Russian coal from August 2022 could also increase the need for gas in the mix in the coming weeks and months as countries struggle to replace Russian coal with coal from other sources. All this at a time when the EU and individual countries are looking at options to quickly reduce their gas demand to limit the need for Russian gas imports from 2022 onward.

Figure 24: Changes in annual electricity generation in Europe by fuel source in 2020 and 2021 (TWh)

<table>
<thead>
<tr>
<th></th>
<th>2020 vs 19</th>
<th>2021 vs 20</th>
<th>Jan-Apr 2022 vs 2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>(60, 80)</td>
<td>(20, 40)</td>
<td>(10, 30)</td>
</tr>
<tr>
<td>Gas</td>
<td>(40, 60)</td>
<td>(20, 40)</td>
<td>(10, 30)</td>
</tr>
<tr>
<td>Other fossil</td>
<td>(20, 40)</td>
<td>(10, 20)</td>
<td>(5, 15)</td>
</tr>
<tr>
<td>Nuclear</td>
<td>(50, 70)</td>
<td>(30, 50)</td>
<td>(20, 40)</td>
</tr>
<tr>
<td>Hydro</td>
<td>(30, 50)</td>
<td>(10, 20)</td>
<td>(5, 15)</td>
</tr>
<tr>
<td>Wind</td>
<td>(10, 20)</td>
<td>(0, 10)</td>
<td>(0, 5)</td>
</tr>
<tr>
<td>Solar</td>
<td>(5, 10)</td>
<td>(0, 5)</td>
<td>(0, 2)</td>
</tr>
<tr>
<td>Other REN</td>
<td>(0, 5)</td>
<td>(0, 2)</td>
<td>(0, 1)</td>
</tr>
</tbody>
</table>

Sources: Data from ENTSOE transparency platform, Gridwatch, Transelectrica, Epias, author’s calculations

Conclusions

Gas demand is driven by a combination of factors. It is not easy to isolate the reasons behind a decline (or a growth) in gas consumption that may happen specifically as a result of price fluctuation. In other words, it is difficult to disentangle all the different drivers that influence gas demand, let alone access timely data to allow for accurate analysis and a comparison between sectors and markets.

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 rather limited in 2021. In other words, demand did not react/decline in response to supply limitations and high prices as one could have expected in such a context. We could identify some demand-response to record-level prices, but this only happened at the margin. In general, gas demand appeared to be rather inelastic in the short term (days, weeks, even a

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47 The availability of the French nuclear reactors is especially uncertain due to a corrosion issue detected on various reactors that prompted French state-controlled utility EDF to revised its nuclear output targets downwards for this year. EDF’s nuclear generation estimate for 2022 now stands at 280-300TWh, down from a previous target of 295-315TWh and the initial target of 330-360TWh. As French nuclear represents about 47% of the electricity generated by nuclear in Europe, this could increase the call on gas-fired plants for the rest of the year. EDF Press Release, 19 May 2022, Update on the stress corrosion phenomenon and adjustment of 2022 French nuclear output estimate, [https://presse-edf.fr/download?n=PR-EDF1-PDF&picid=3051](https://presse-edf.fr/download?n=PR-EDF1-PDF&picid=3051)

few months or until other fuel sources can be used or energy demand can be reduced), or better said, gas demand in 2021 was also driven by other factors that contributed to limit any price-response in Q4.

Colder temperatures in February-April and again in November-December 2021 boosted gas and electricity use for heating. The economic recovery led by the industrial sector, including energy intensive industries, also contributed to high gas and power demand. Relatively low availability of nuclear throughout the year, low wind in Q1 and low hydro in Q4 supported both gas and coal use in 2021. In Q3 and Q4, increasing gas prices impacted the relative profitability of the gas-fired power plants against coal-fired plants but high electricity demand meant that both coal and gas plants were needed in the mix, limiting gas demand-side response to higher prices.

In 2022, gas demand response seems to be happening more broadly, in all the three main sectors of gas demand: heating with some -yet limited- change in consumer behaviour, industrial sector with apparent switching to other fuels and in the electricity generation sector with gas to coal switching in the mix. For the rest of 2022, attention should be paid to what happens in the power sector. Coal to gas switching as a result of higher coal prices and the ban on Russian coal imports from August could increase the call on gas-fired plants for the rest of the year. The availability of hydro and most importantly, the availability of (French) nuclear capacity will also be important drivers for gas demand in Europe in the coming months. Any signs of colder weather in November & December could tighten the market dramatically. Governmental support measures for end-use consumers and businesses (and possible curtailment if need be during the winter, in other words rationing of gas supply which would cause industrial production to be shut down) will also be crucial drivers for gas demand in 2022, and maybe even more so during the winter 2022/23.49

49 Other drivers will also play a role, including how much scope there is for gas to coal switching, the impact of Russian coal ban from August 2022 and the level of carbon prices in the EUETS (and the UKETS) for the rest of the 2022. These will be addressed by Fulwood M., Honoré A. and Sharples J. in a forthcoming OIES comment.