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COMMISSION STAFF WORKING DOCUMENT

Analysis of coordinated demand reduction measures for gas

Accompanying the document

REPORT FROM THE COMMISSION TO THE COUNCIL

review on the functioning of Regulation (EU) 2022/1369 on coordinated gas demand reduction

{COM(2023) 173 final}

I. Executive Summary

In this Staff Working Document, the Commission provides an analysis of the gas demand reductions since August 2022, a scenario-based analysis of storage filling projections under different potential demand reduction extensions and a deep-dive into past reductions and upside and downside risks for 2023-2024.

In the course of 2022, Russia used gas supplies as a political weapon. In this context, the EU adopted the emergency Council Regulation (EU) 2022/1369 in August 2022, to reduce gas demand by 15% until 31 March 2023 in a coordinated manner to ensure security of supply. The implementation of the Regulation proved to be a success, as the EU reduced its natural gas demand by 19.2% (or 41.5 bcm) between August 2022 and January 2023, compared to the average of the previous five years. Estimations indicate that in the August-December 2022 period, households and industry each accounted for around one-half of the total gas demand reduction, while the power sector made only small savings due to low availability of hydropower and nuclear capacity. In the absence of official data submitted by the Member States to Eurostat, the analysis is based on national statistics. A more frequent (i.e. monthly) monitoring of the gas consumption, with more sectoral detailed reporting (industry, electricity, residential and tertiary sector), could allow for a better understanding of the nature of the reductions and possibly identify any sector-specific challenges.

The analysis on storage filling projections is based on the following scenarios resulting from the potential demand reduction extensions:

1) If demand reduction is not extended, gas storage levels would be fully depleted by February 2024.
2) In case demand reduction obligation are extended by the same 8-month period (August 2023 to March 2024), storages would be filled too slowly, reaching only 80 bcm by the end of October 2023 resulting in security of supply concerns.
3) In case of an extension only for the summer (April to October 2023), storages would be sufficiently filled by the end of this summer (95% by the end of October 2023), but depleted by the end of next winter causing security of supply concerns.
4) If the 15% demand reduction is extended by 1 year until March 2024, storage levels reach 95 bcm by the end of October 2023 and 43 bcm by the end of March 2024.

Current gas prices and the market expectations until the end of next winter are around 3 to 4-times lower than the prices observed during the autumn of 2022. Therefore, gas demand reductions in the residential, industry and power sector (coal-to-gas switch) will be significantly more difficult to achieve and will require targeted actions. Furthermore, demand reductions remain necessary to minimise the risk of price spikes.

A continuation of the 15% reduction applied to the average annual gas consumption in the reference period 1 April 2017 to 31 March 2022 amounts to 60 bcm that needs to be saved in the period from 1 April 2023 to 31 March 2024.

There are additional downside risks to consider. These include the weather conditions affecting energy demand of households. In the power sector, consumption of gas strongly depends on the water levels for hydropower and the availability of nuclear capacity.

Natural gas price spikes that reached levels above 300 EUR/MWh[1] reflected infrastructure bottlenecks and market uncertainty in the aftermath of Russia's aggression against Ukraine. However, very high price levels well above global prices did not lead to more LNG arriving at EU's ports. A methodic management of the refilling season from private actors and Member States is key to avoid future price spikes, by avoiding Member States outbidding each other without any additional volumes arriving in the EU. This would guarantee full storages at the lowest cost.

[1] Historical and future TTF prices can be found here: Dutch TTF Natural Gas Futures | ICE (theice.com)

II. Demand Reduction achieved so far

The gas demand regulation foresees a voluntary demand reduction of 15% for the period August 2022 to March 2023, relative to the average of the previous five years.

Table 1 summarises the demand reductions achieved so far by the EU and its Member States.

Table 1: Gas demand reductions August 2022 to January 2023

Member State	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Aug.-Jan.
EU27	**-13.5%**	**-14.0%**	**-24.4%**	**-25.0%**	**-12.4%**	**-22.2%**	**-19.2%**
Austria	-26.7%	-11.3%	-24.0%	-16.9%	-13.6%	-23.9%	**-19.2%**
Belgium	-1.0%	-6.0%	-20.5%	-29.7%	-9.8%	-18.3%	**-16.0%**
Bulgaria	-14.9%	-17.8%	-32.7%	-21.2%	-21.8%	-29.4%	**-23.9%**
Croatia	-21.7%	-23.1%	-20.0%	-25.6%	-27.6%	-24.2%	**-24.1%**
Cyprus	-	-	-	-	-	-	-
Czechia	-15.0%	-9.1%	-22.9%	-18.8%	-10.9%	-24.0%	**-17.7%**
Denmark	-21.7%	-23.3%	-31.1%	-33.4%	-13.7%	-26.5%	**-24.9%**
Estonia	-37.1%	-31.7%	-46.9%	-32.3%	-32.4%	-38.0%	**-36.2%**
Finland	-35.7%	-57.4%	-62.6%	-58.3%	-65.1%	-63.1%	**-58.5%**
France	1.6%	-2.5%	-27.8%	-29.3%	-8.3%	-19.2%	**-17.1%**
Germany	-28.0%	-14.7%	-28.6%	-28.3%	-4.7%	-18.6%	**-19.4%**
Greece	4.5%	-26.3%	-42.0%	-23.0%	-12.6%	-36.7%	**-22.7%**
Hungary	-18.7%	5.0%	-33.9%	-19.8%	-17.5%	-27.4%	**-21.0%**
Ireland	11.3%	2.1%	-8.8%	-10.3%	9.5%	-4.3%	**-0.3%**
Italy	-5.2%	-14.0%	-19.8%	-22.7%	-18.5%	-22.7%	**-18.6%**
Latvia	-42.6%	-52.7%	-72.7%	-15.2%	0.9%	-37.0%	**-31.8%**
Lithuania	-43.6%	-45.0%	-50.8%	-46.0%	-11.9%	-51.5%	**-40.5%**
Luxembourg	-36.4%	-26.1%	-35.5%	-33.2%	-17.5%	-25.0%	**-27.7%**
Malta	4.6%	-1.1%	-11.2%	43.6%	27.0%	21.9%	**+12.1%**
Netherlands	-29.7%	-32.6%	-33.3%	-35.1%	-17.5%	-32.2%	**-29.5%**
Poland	-26.7%	-25.4%	-23.7%	-8.3%	-5.3%	-12.0%	**-14.9%**

Portugal	-10.7%	-17.0%	-12.0%	-8.9%	-18.6%	-34.9%	**-17.1%**
Romania	-25.2%	-20.7%	-27.5%	-21.8%	-15.9%	-21.0%	**-21.2%**
Slovakia	10.6%	5.5%	2.1%	-2.7%	23.6%	-7.8%	**+4.6%**
Slovenia	-13.7%	-10.9%	-22.2%	-11.7%	-12.4%	-14.7%	**-14.2%**
Spain	2.6%	0.7%	-6.2%	-21.8%	-24.4%	-23.9%	**-13.7%**
Sweden	-27.3%	-35.7%	-41.8%	-51.0%	-38.0%	-41.9%	**-40.2%**

Note: Change in gas consumption 2022 cf. 2017-2021 average. Cyprus does not use natural gas.

Source: ENER/CET calculations based on Eurostat series NRG_CB_GASM, sub-series IC_CAL_MG in TJ (GCV) as of 7 March 2023, 11:00.

The EU has reduced its natural gas demand by 19.2% or 41.5 bcm from August 2022 to January 2023, compared to the average of the previous five years. It has thus so far exceeded its target of 15%, which would correspond to 32.5 bcm for the same period. Moreover, it has already achieved more than 90% of its overall target of just over 45 bcm reduction for the entire period of August 2022 to March 2023.

All Member States except Ireland, Malta and Slovakia[2] (all three of which benefit from exemptions) have achieved or almost achieved the 15% target. In addition, Poland, Slovenia and Spain have almost achieved the 15% target. Cyprus does not use natural gas. The remaining 20 MS have all achieved the 15% reduction target so far.

The next section analyses the outlook for the remainder of 2023 and next winter; while the following section analyses the nature of the reductions achieved so far and the implications this has for the immediate future, in terms of upside and downside risks for the EU gas market.

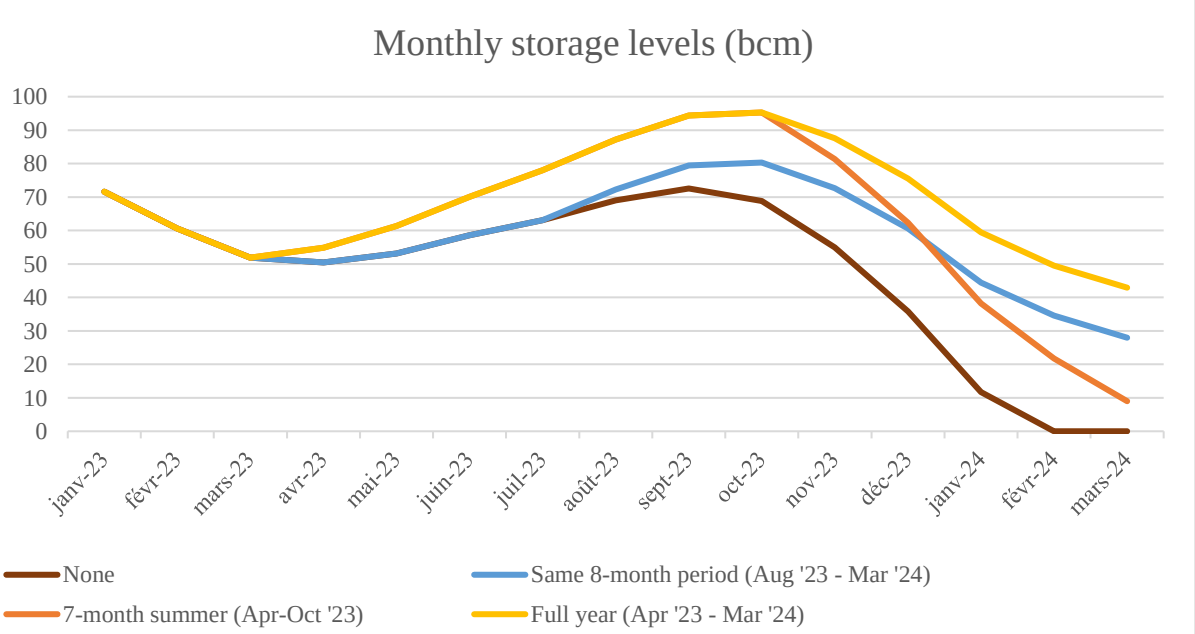
[2] It is important to note that EUROSTAT data for Slovakia are currently under review.

III. Outlook for gas consumption between 1 April 2023 and 31 March 2024

1) Gas balance projections up to the end of the 2023/24 filling season

Figure 1 presents storage filling projections under different potential demand reduction extensions, based on the latest available market intelligence and data.[3]

Figure 1: Monthly storage levels depending on the extension of the demand reduction



Source: ENER/CET calculations.

Figure 1 shows the following:

- Scenario A: **No extension:** If instead there were no demand reduction, storage levels would only reach **69 bcm**[4] by the end of October 2023, **significantly below the 90% (89.4 bcm) storage obligation**. In addition, storage levels would be fully depleted by

[3] Assumptions:
- Storage levels as of 7 March 2023 (58.5 bcm at the end of 5 March).
- Non-Russian pipeline supply equal to the average of the last seven months of 2022.
- LNG supply equal to the average of the last seven months of 2022, plus 15 bcm/a (1.25 bcm/month) from Apr. 2023.
- No gas from Russia via pipeline.
- Average demand of the reference period, applying percentage reductions as stated.
- Exports to Switzerland as in 2021 (latest data available; 2.2 bcm/a, of which 1/3 in summer and 2/3 in winter).
- Exports to Ukraine and Moldova of 0.5 bcm/month.

[4] Storage levels in percent are almost equal to the storage levels in bcm since the EU has a storage capacity of 99.3 bcm, i.e. almost 100 bcm.

February 2024, implying **serious security of supply concern**s for the winter 2024/2025.

- Scenario B: **8-month extension from August 2023 to March 2024:** In this scenario, **storages would be filled too slowly**, reaching only **80 bcm** by the end of October 2023, significantly below the storage obligation. In addition, storage levels would drop to **below 30% by the end of next winter** (28 bcm) at the end of March 2024), causing **serious security of supply concerns** and making it difficult to fill storages sufficiently for the following winter 2024/2025.
- Scenario C: **7-month extension for summer only; April to October 2023:** In this scenario, storages would be sufficiently filled by the end of this summer (95 bcm by the end of October 2023, reaching the 90% storage obligation). However, because demand even in a normal winter is twice as high as in summer, storages would be **almost fully depleted by the end of next winter** (9 bcm by the end of March 2024). This implies **extremely serious security of supply concerns** and makes it very difficult to fill storages sufficiently for the following winter 2024/2025.
- Scenario D: **1-year extension:** With a continued 15% demand reduction, storage levels reach **95 bcm** by the end of October 2023, **reaching the 90% storage obligation.** The storage levels would be around 43 bcm by the end of March 2024.

Table 2 summarises these findings.

Table 2: Monthly storage levels depending on the extension of the demand reduction

Scenario assumptions **Storage (bcm) at the end of:**	**Oct. 2023**	**Mar. 2024**
A: No extension	69	0
B: Extension for August 2023 to March 2024	80	28
C: Extension for April 2023 to October 2023	95	9
D: 1-year extension from April 2023 to March 2024	95	43

Source: ENER/CET calculations.

There are additional downside risks to consider, such as increased global LNG demand, a certain rebound of industrial gas demand driven by lower prices, or increased gas demand from the power sector due to low availability of hydro and nuclear and a reversal of the gas-to-coal switch experienced in 2022. A particularly significant uncertainty is the weather. According to ENTSOG, a very cold winter occurring with a probability of 5% would increase demand by **24 bcm**.[5]

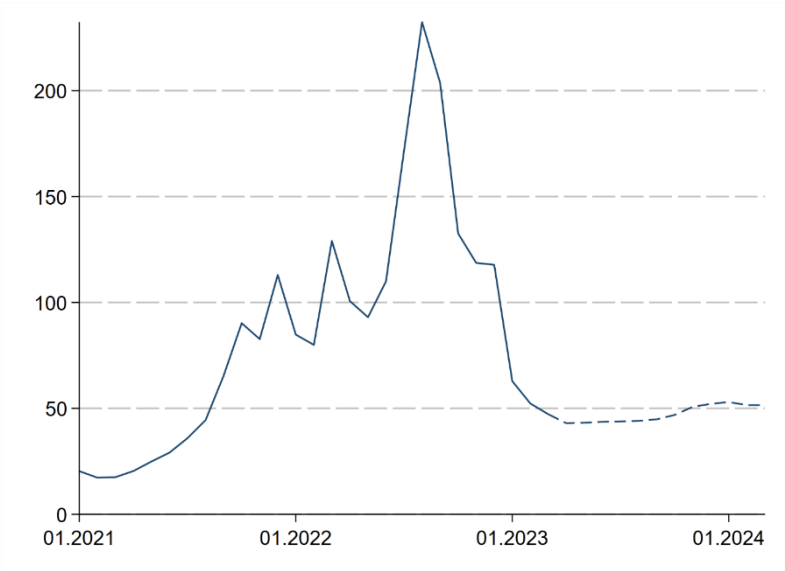
[5] Figure 1 (with an assumed 15% demand reduction) in ENTSOG's winter supply outlook 2022/2023, available at: https://entsog.eu/sites/default/files/2022-10/SO0038-22_Winter%20Supply%20Outlook_2022-23_2.pdf. This is in line with ENER/CET calculations of **28 bcm** additional demand for the entire year in case the 15% demand reduction is applied not to the average demand of the past 5 years but to the highest demand of the 2014-2021 period for each month (monthly data are not available for earlier years).

Conclusion 1:

This analysis calls for a continuation of an identical and proportionate gas reduction in the period from 1 April 2023 to 31 March 2024. Applying 15% to the average annual gas consumption in the reference period 1 April 2017 to 31 March 2022 amounts to 60 bcm that need to be saved in the period from 1 April 2023 to 31 March 2024.

2) What are the price expectations?

Figure 2: Natural gas prices – historic and futures (€/MWh)



Source: ENER/CET using ICE data (futures) and Platts data (historic)[6]

Two observations become apparent from this chart.

First, current prices and the market expectations until the end of next winter are around 3-times to 4-times lower than the prices observed last autumn due to the higher storage levels, the demand reduction, the start of the removal of infrastructure bottlenecks, the lower uncertainty and the limits for Russia to further weaponise energy.

Gas demand reductions will thus be significantly more difficult to achieve and will require targeted actions. This price effect will impact all sectors (see also section IV.2):

- Households have less of an incentive to save energy.
- Some of the industrial demand destruction may be undone.
- The gas-to-coal switch in power generation that occurred in the face of high gas prices may be reversed.

[6] Historic data is the monthly average of daily TTF month-ahead prices provided by Platts (for Jan. 2021 to Mar. 2023). Futures data is TTF from ICE as of 6 March 2023 (for Apr. 2023 to Mar. 2024): https://www.theice.com/products/27996665/Dutch-TTF-Gas-Futures/data?marketId=5519350
Technical note: data for February and March 2024 were not available and were thus inferred from the Jan. 2024 and Q1 2024 data, as $p_{Feb} = p_{Mar} = p_{Jan} - ½ * (p_{Jan} - p_{Q1})$.

Second, the price expectations show that the market expects no physical shortages this year internalising the continuation of the current path on demand reduction, but the price increase by about 10 €/MWh in early 2024 indicates a likely tightening of the market next winter. This, as well as the downside risks mentioned in section III.1, indicates that demand reductions remain necessary to minimise the risk of price spikes with their destructive effects on vulnerable households and industry.

IV. Deep-dive into past reductions and upside & downside risks for 2023-2024

1) Weather

Last autumn and winter were relatively mild, leading to lower gas demand for space heating. According to Eurostat data, there were **8.3% fewer heating degree days** (HDD) in Aug.-Dec. 2022 compared to the 2017-2021 average.[7]

The Commission has estimated the impact that this has had on EU gas demand. Of the 18.2% total gas demand reduction Aug.-Dec. 2022 (compared to Aug.-Dec. 2017-2021; January 2023 HDD data are not yet available), **around one-sixth was temperature induced**. Put differently, gas demand was **3.0%-3.2%** lower because of milder weather, with the remaining approx. 15% reduction being independent of weather.[8] This corresponds to just over **5 bcm** (out of a total demand reduction of 30 bcm Aug.-Dec.) being temperature-induced.

In other words, even if next winter were just an "average" winter, demand would be approx. **5 bcm** higher next August to December compared to last year, other things equal. A very cold winter occurring with a probability of 5% would increase demand by a further **24 bcm** for the entire winter season according to ENTSOG.[9] This is similar to our calculations of **28 bcm** additional demand in case the 15% demand reduction is applied not to the average demand of the past 5 years but to the highest demand of the 8-year period 2014-2021 for each month.

While HDD are a key driver of gas demand in winter, the weather affects gas demand in several other ways. First, it affects the demand for electricity for cooling, as measured by cooling degree days (CDD), thereby indirectly affecting the demand for gas for power generation. Second, it affects the availability of alternative power sources, in particular hydro (through water reservoir levels) and nuclear (through river levels and river temperatures, for those nuclear power plants that are cooled using river rather than sea water).[10] The latter is analysed in section of this note; the former is the subject of the next paragraph.

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[7] ENER/CET calculations based on Eurostat series NRC_CHDD_M. Note that Eurostat states a HDD reduction of 4.1% for the EU27. However, this EU-total is calculated as the space-weighted (geographic) average of the data for the individual member states. In the context of the present analysis, such a weighting is inappropriate. We have therefore re-calculated an EU total as the average of the individual member states, weighted by their gas consumption in households and the public and commercial sector in 2021 (latest year available; series FC_OTH_HH_E and FC_OTH_CP_E respectively; as these are the sectors in which gas is used for space heating).

[8] Technical note: The relationship was estimated by one OLS regression per MS with heteroskedasticity-robust standard errors of gas consumption on HDD, with month fixed effects, GDP and Population as control variables, for the period Aug-Dec only, for all years with available Eurostat data. This coefficient was then multiplied by that MS's difference in HDD Aug-Dec 2022 compared to the average of the previous 5 years.

[9] Figure 1 (with an assumed 15% demand reduction) in ENTSOG's winter supply outlook 2022/2023, available at: https://entsog.eu/sites/default/files/2022-10/SO0038-22_Winter%20Supply%20Outlook_2022-23_2.pdf

[10] The weather also affects power generation from solar and wind power, but this while this is highly variable in the short term, it is less variable at an annual level as the variations average out. Moreover, it is more difficult to forecast. This analysis therefore focuses on nuclear and hydro.

Last summer was hot by historical standards. Partly this is due to global warming, which makes summers nowadays generally hot by historical standards. But even compared to the previous 5 years, CDD were **23% higher** in August-December 2022.[11] However, there is no clear link in the data between CDD and gas demand.[12] Therefore, we are unable to reliably quantify the impact this has had on gas demand. Nonetheless, last summer's heat wave is likely to have increased power demand. Gas demand for power generation could thus be somewhat lower next summer than last summer, if next summer sees average temperatures. However, the low availability of alternative power sources (see section IV.3) may outweigh this effect and lead to higher overall gas demand for power generation.

In the power sector, weather conditions also have a significant impact on gas demand driven not only by the influence on electricity demand (heating/cooling) but increasingly also on variable renewable energy generation (wind, solar and hydropower). To assess the impact of different climatic conditions, the Commission[13] modelled the effect of historical profiles[14] for demand, wind, solar and hydropower generation on the projected gas demand for power generation in 2023. The analysis shows a projected average annual gas consumption of 98 bcm for 2023. The effect of climatic conditions on gas consumption for power generation results in an average monthly range of 5 bcm and experiences seasonality, with moderatly a wider range in winter months.

2) Break down by demand sector and type of reduction

Currently, Eurostat publishes the monthly gas consumption (NRG_CB_GASM) with a delay of 55 days after the reference period. The sectoral detail is currently only reported annually, one year after the reference period. Without a frequent publication of sectoral gas demand, in-depth analyses of gas demand reduction remain challenging.

[11] ENER/CET calculations based on Eurostat series NRC_CHDD_M. Note that Eurostat states a CDD increase of 15.6% for the EU27. However, this EU-total is calculated as the space-weighted (geographic) average of the data for the individual member states. In the context of the present analysis, such a weighting is inappropriate. We have therefore re-calculated an EU total as the average of the individual member states, weighted by their respective population in 2021.

[12] The reason we find no link may be due to the fact that unlike HDD, CDD affect gas demand only indirectly, via electricity demand. In addition, CDD are likely correlated to other sources of power supply. Finally, CDD are negatively correlated to HDD, and HDD are a strong driver of gas demand. Technical note: We again ran one OLS regression per MS with heteroskedasticity-robust standard errors of gas consumption on CDD, with month fixed effects, GDP and Population as control variables.

[13] DG Joint Research Centre together with ENER/CET, based on the METIS electricity model.

[14] Historical weather years (1982 to 2016) were used to perform Monte Carlo simulations on the EU 2023 electricity market.

Conclusion 2:

A more frequent, monthly reporting of the gas consumption, including the reporting of the sectoral detail (industry, input to electricity and heat production, households and services sector), should allow the Member States and the European Commission to better understand the nature of the reductions, possibly identify any challenges, and design more targeted measures if necessary.

The more frequent and more detailed monitoring and reporting would incur additional costs for the national statistical and other reporting authorities. However, these would be outweighed by the benefits to achieve more efficiently the objectives of this proposal.

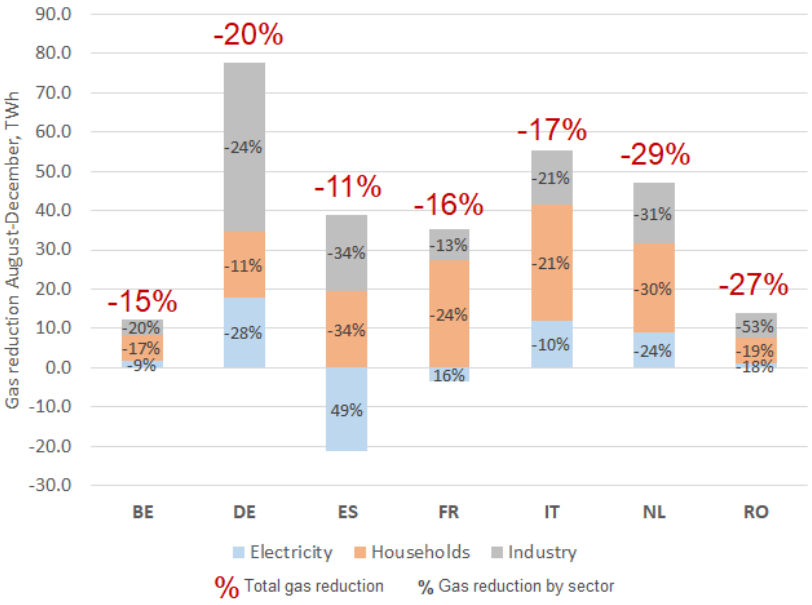
For this SWD, the Joint Research Centre (JRC) conducted an analysis based on Eurostat data and national statistics from the gas transmission system operators. Further, external publications[15] were used to underpin the work by the JRC.

Breakdown by demand sector

In the absence of official data submitted by the Member States to Eurostat, the JRC estimated the demand reduction per sector in August to December 2022 compared to the 5-year average based on data from Eurostat and the national gas transmissions system operators (***Figure 3***). It is important to note that the analysis focusses on seven Member States which together consume 78% of gas in the EU: Belgium, Germany, Spain, France, Italy, the Netherlands, and Romania. The estimates indicate that the residential sector was the biggest contributor to demand reduction in the EU (50%), followed by industry (43%). In relative terms, Spain contributed high shares of demand reduction in the industry (34%), only exceeded by Romania (53%). The German industry faced the highest reduction of gas consumption in absolute terms (around 40 TWh or 4 bcm). The power sector was responsible for 7% of the total demand reduction, a relatively low figure as gas-fired electricity generation in Spain significantly increased.

[15] Bruegel (2023): European natural gas demand tracker European natural gas demand tracker (bruegel.org)
IEA (2023): Natural gas supply-demand balance of the European Union in 2023 Background note on the natural gas supply-demand balance of the European Union in 2023 – Analysis - IEA

Figure 3: Gas demand reduction by member state and sector in the period August-December 2022



Source: JRC using Eurostat and ENaGaD database (based on national gas TSO data)

Bruegel (2023)[16] and IEA (2023)[17] also estimated the split of gas demand reduction by sector using auxiliary data from ENTSOG, EMBER and national transmission system and market operators.

According to Bruegel, only the data to separate the gas consumed by electricity was available while the exact distinction between industry and residential cannot be disentangled for all Member States based on the mentioned data sources. Overall, gas demand decreased by 12% in the EU compared to the average of 2019-2021. The demand decreased by 15% in the residential sector, by 15% in the industry sector and by only 2% in the power sector. In summer months, most of the overall gas demand reduction was driven by the industry while the residential sector contributed in October and November due to warmer than average weather.

According to the IEA, gas demand decreased by 13% or 55 bcm in comparison to 2021. About half of the decline was attributable to the residential and commercial sector (28 bcm), the other half to industry (25 bcm). Gas consumption in the power sector remained relatively flat.

JRC, IEA and Bruegel use different reference periods for comparison, so direct comparisons are challenging. However, all three agree that gas demand in the EU residential/commercial sector accounted for about 50% of the total gas demand reduction in 2022, while industry was responsible for somewhat below 50%. While gas demand in the power sector was only mildly affected in IEA and Bruegel estimations, the JRC estimated that 7% of the total reduction came from the power sector.

[16] Bruegel (2023): European natural gas demand tracker
[17] IEA (2023): Natural gas supply-demand balance of the European Union in 2023

However, the power sector is the one sector for which recent official Eurostat data are available for all Member States. Using these data, we find that the gas demand of the power sector decreased by 2.1% or 0.8 bcm, thus accounting for only 2.6% of the total gas demand reduction of 30 bcm between August to December 2022.[18]

What type of reduction?

The type of gas demand reductions can be subdivided into savings (behavioural changes and energy efficiency), fuel-switching to carbon-intensive or clean fuels and demand destruction (production curtailment and energy poverty[19]). Those types are either structural or non-structural. Energy efficiency measures that lead to an overall decrease in energy demand and fuel-switching from carbon-intensive to clean energy are structural demand reduction types which will remain while a fuel-switch to a more carbon-intensive fuel is non-structural as carbon prices will make them unprofitable. Production curtailment is either structural, as production plants have been closed or relocated, or non-structural, as lower energy prices offset production curtailment in some industries. Gas demand reductions by households due to warmer than average weather are also non-structural as changes in weather conditions might reverse the reductions.

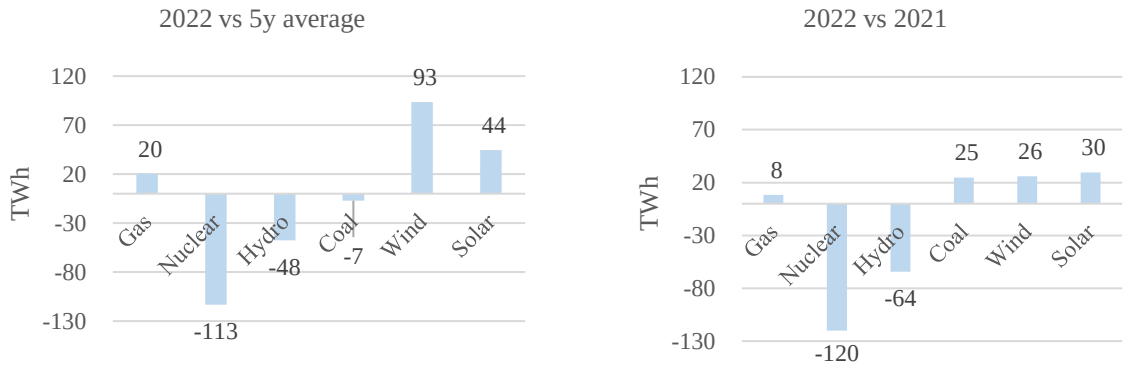
According to the IEA (2023)[20], around half of the gas demand reduction compared to 2021 in industry occurred due to production curtailment while further reduction was achieved by fuel-switching and energy efficiency measures. According to Enerdata (2023)[21], the effect of structural energy efficiency measures in the industry is small while fuel switching, and production curtailment accounted for most gas demand reduction in the industry. However, energy efficiency measures take time to materialise, so the impact might increase in the coming years. Further, low energy prices in the beginning of 2023 already led to a rebound of industrial production (month-on-month) in Germany[22].

[18] Eurostat series NRG_CB_GASM, subseries TI_EHG_MAP. This refers to both electricity and heat generation; no distinction is made between these two.
[19] Many vulnerable households kept their homes cold, or switched from gas to more polluting fuels.
[20] IEA (2023): Natural gas supply-demand balance of the European Union in 2023
[21] Enerdata (2023): Gas supply shock: how EU's final consumers adapted?, https://www.enerdata.net/publications/reports-presentations/gas-prices-impact-europe.html
[22] According to Destatis, the production of chemical products increased by 13% from December 2022 to January 2023.

3) Power sector

In the power sector, despite high gas prices, gas-fired electricity generation increased by 20 TWh in 2022 compared to the 5-year average (**Figure 4**). The increase can be explained by the low availability of nuclear capacity (-113 TWh) and low hydropower generation (-48 TWh). The French nuclear capacity suffered from reactor outages for maintenance due to corrosion which resulted in the lowest nuclear output since 1988. Droughts in summer 2022 resulted in significantly less hydropower generation.[23] Notably, coal-fired generation decreased by 7 TWh in comparison to the 5-year average due to a reduction in coal capacity in the past years, while generation increased by 12 TWh in comparison to 2021.

Figure 4: Annual change in electricity generation by selected fuel in 2022 vs. the 5-year average and vs. 2021



Source: ENER/CET using ENTSO-E Transparency Platform
Note: Generation by solar energy does not account for behind-the-meter generation

In 2023, there are a variety of risks and uncertainties in the power sector affecting gas consumption:

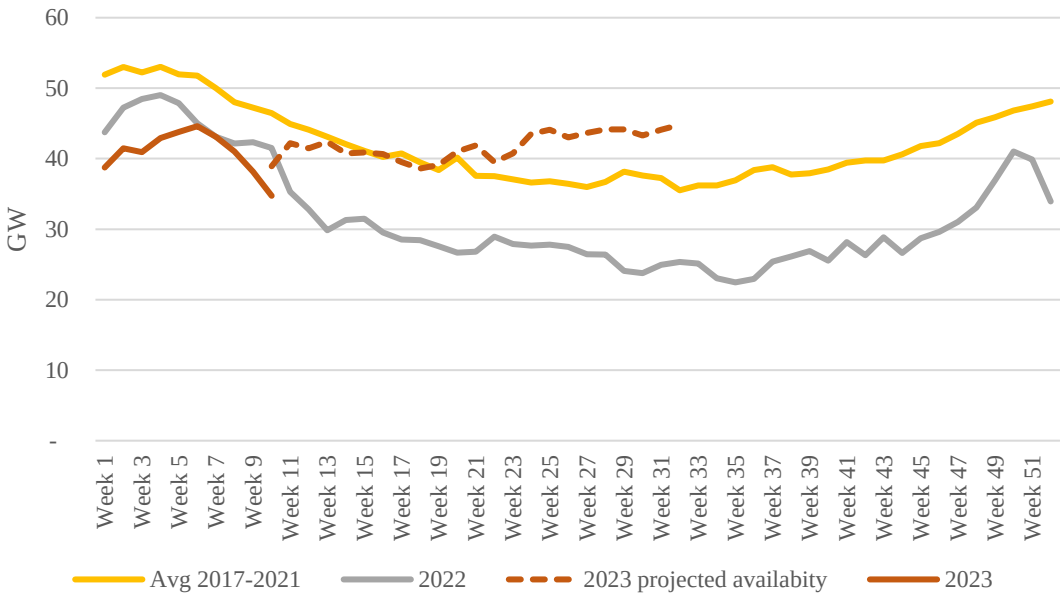
Nuclear capacity

Nuclear output in France reached 45 GW in early February 2023 but is still significantly below the average of the last five years (**Figure 5**). The 2023 maintenance cycle has just started, causing capacity to drop to about 8 GW below the 5-year average and 4 GW below 2022. According to the French transmission system operator RTE, the projected availability of the nuclear fleet reaches the 5y average already in mid-March and will even significantly start overshooting it in summer 2023. A potentially higher availability of nuclear capacity would reduce the use of gas in the power sector. However, in 2022, the expected availability of RTE was overly optimistic as it is difficult to clearly predict if new corrosion cases will arise and when the corrosion repairs will be carried out.[24] In addition, uncertainties also remain about the river levels and river temperatures, which affect the generation capacity of river-cooled nuclear

[23] DG Energy (2023): Quarterly report on European electricity markets, market observatory for energy, volume 15 (issue 3, covering the third quarter of 2022)
[24] RTE (2023): Réactualisation des perspectives pour le système électrique pour l'hiver 2022-2023 (février 2023)

power plants. Therefore, any predictions about a higher availability of nuclear energy capacity should be treated with caution.

Figure 5: French historical nuclear dispatch and projected availability (weekly average)



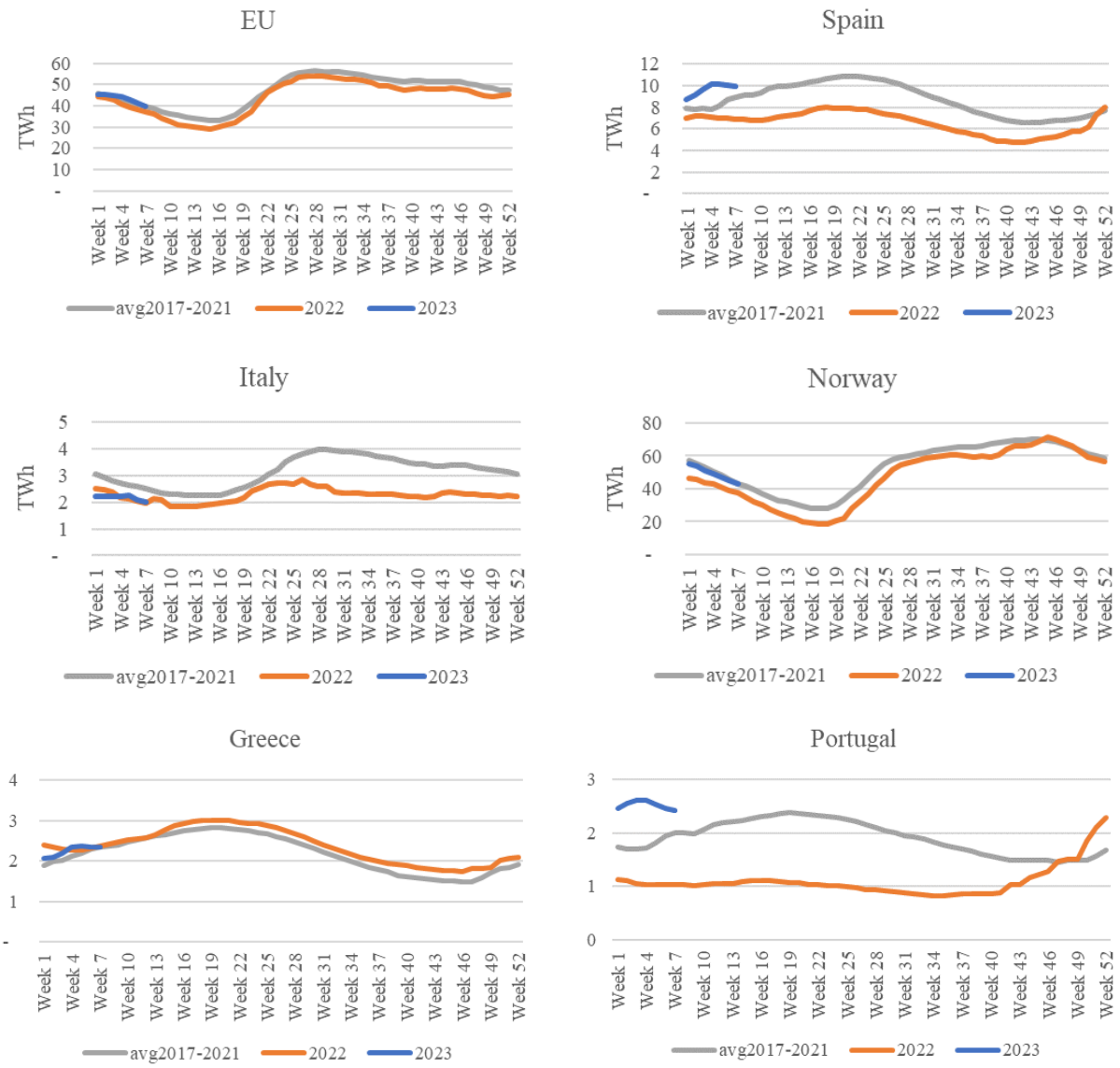
Source: ENER/CET using ENTSO-E Transparency Platform, RTE (retrieved from energygraph.info on 06 March 2023)

Hydropower

Current filling rates of water reservoirs and hydro storage plants in the EU are close to the 5-year average and slightly above 2022 figures (**Figure 6**). In Spain and Portugal, filling rates in the first weeks of 2023 were 1 to 2 TWh and 0.5 to 1 TWh, respectively, above the 5-year average.

In Italy, water levels in water reservoirs and hydro storage plants are following las year's low filling rates. Early indications point to a developing drought in some areas, especially in the Northern region of the country due to only little rain and snowfall over the winter 2022/23. Norway is an important exporter of hydropower to the EU and was facing significantly lower water levels last year. Despite higher fill rates in early 2023, Norway remains vigilant and could reduce electricity exports if water levels continue to fall.

Figure 6: Aggregated filling rate of water reservoirs and hydro storage plants of EU and selected countries (weekly)



Source: ENER/CET using ENTSO-E Transparency Platform

**including EU Member States that have a significant amount of reservoir and hydro storage plants: Austria, Bulgaria, Spain, Finland, France, Croatia, Italy, Lithuania, Latvia, Portugal, Romania, Sweden, Slovenia and Greece*

Coal-to-gas switch

While high gas prices in 2022 pushed coal-fired generation ahead of gas turbines in the merit order, the current drop in gas prices likely increases gas consumption due to a coal-to-gas switch in the power sector, i.e., electricity generation in a combined-cycle gas turbine (CCGT) is becoming cheaper than in a coal-fired power plant. The marginal costs depend on fuel prices and the prices for emission allowances. High prices for allowances benefit CCGTs versus coal-fired generation due to a high emission factor of the latter. In order to reflect the interaction of

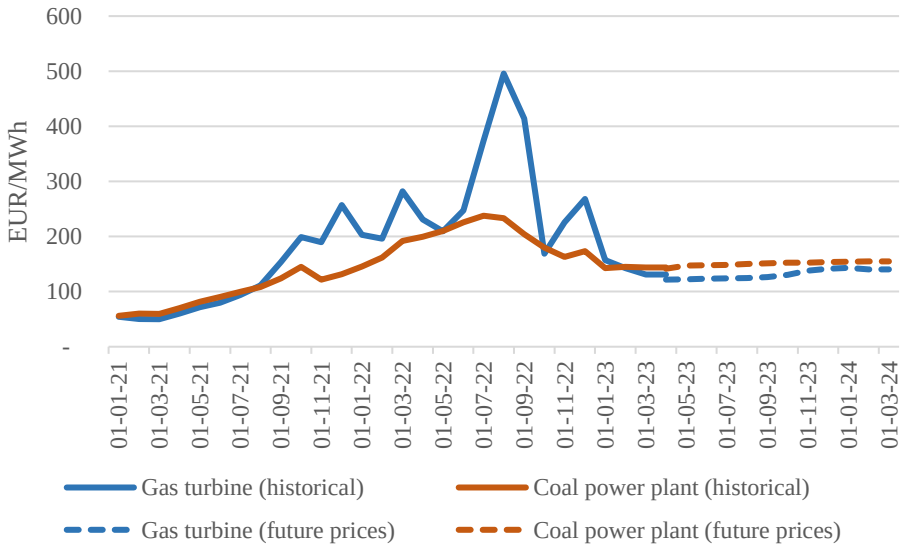
the three price components, Table3 depicts the price setting fuel as a function of coal and gas prices and a price for emission allowances of 93 EUR/tCO2 (as of 06 March 2023). At the current commodity price level – gas TTF price at 42 EUR/MWh and coal price at 132 EUR/t – CCGTs are cheaper than coal-fired power plants.

Table 3: Fuel being used first assuming a ETS price of 93 EUR/tCO2

		Coal price (EUR/t)						
		120	130	140	150	160	170	180
Gas price (EUR/MWh)	30	Gas	Gas	Gas	Gas	Gas	Gas	Gas
	40	Gas	Gas	Gas	Gas	Gas	Gas	Gas
	50	Gas	Gas	Gas	Gas	Gas	Gas	Gas
	60	Coal	Coal	Coal	Coal	Coal	Gas	Gas
	70	Coal	Coal	Coal	Coal	Coal	Coal	Coal
	80	Coal	Coal	Coal	Coal	Coal	Coal	Coal
	90	Coal	Coal	Coal	Coal	Coal	Coal	Coal

Source: ENER/CET using TTF Natural Gas price, CIF ARA Coal price and EUA prices from Bloomberg (as of 06 March 2023). Note: median efficiency of a CCGT is at 50%; median efficiency of a coal-fired power plant is at 34%

Figure 7: Marginal cost of gas- and coal-fired power generation based on historical and future prices



Source: ENER/CET using historical prices from S&P Global Platts, future prices from Bloomberg (as of 03 March 2023) for CIF ARA Coal and EUA and the future price from ICE (as of 06 March 2023) for TTF Natural Gas
Note: median efficiency of a CCGT is at 50%; median efficiency of a coal-fired power plant is at 34%

Historical prices for the three components indicate that a coal-to-gas switch already happened in January 2023. Future prices for coal, gas and carbon (EUA) suggest that CCGTs will remain

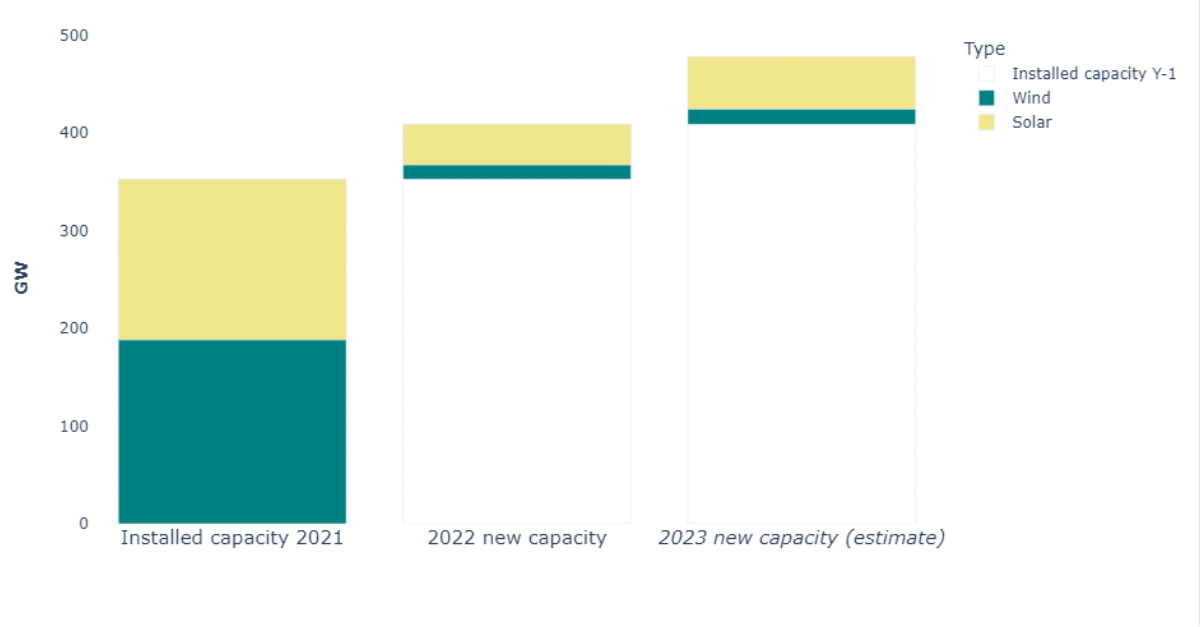
cheaper than coal-fired power plants in 2023 (**Figure 7**). In winter, gas prices are expected to increase again to 53 EUR/MWh, reducing the gap of the technologies' marginal costs. In general, the elasticity of gas-fired generation to the gas price depends on the availability of other flexibility providers, such as oil- and coal-fired generation.

Renewables

High energy prices and dedicated policy measures already had a measurable effect on the deployment of renewable energy. In 2022, 56 GW of wind and solar capacity have been installed in the EU (15 GW and 41 GW_{DC} of wind and solar respectively). This represents a 16% increase from 2021 installed capacity (353 GW) saving approximately 11 bcm of gas[25].

In 2023, new installed capacity is estimated at around 69 GW (16 GW for wind and 54 GW_{DC} for solar), increasing further installed capacity by 17% and displacing approximately 13 additional bcm of gas.

Figure 8: Wind and solar capacity in EU27



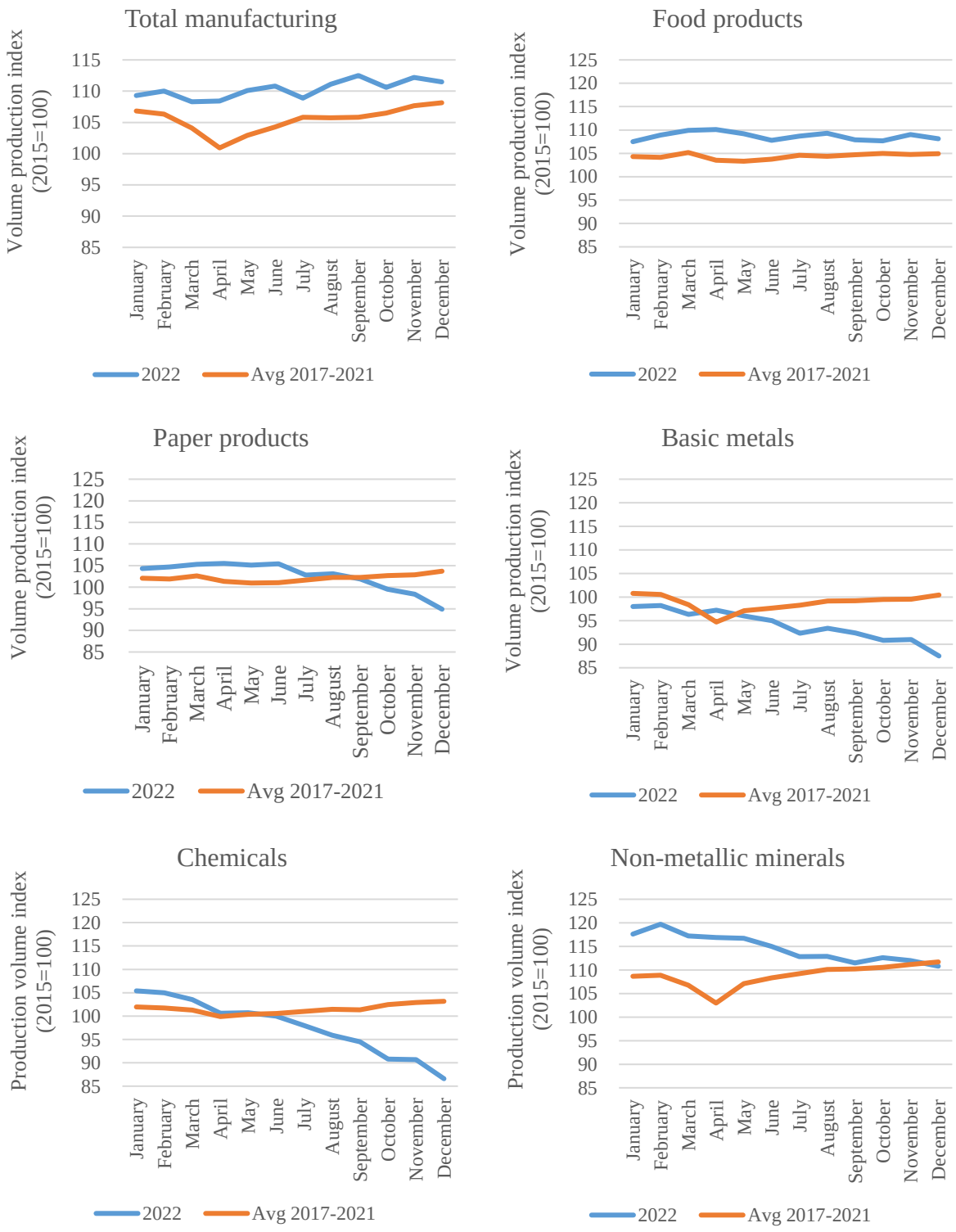
Source: ENER/CET using Eurostat, WindEurope, Solar Power Europe

4) Industry

The diagrams in Figure 9 compare industrial output for different sectors 2022 to the 2017-2021 average.

Figure 9: Manufacturing output in the EU27; 2022 vs. 2017-2021 average

[25] Gas equivalent saved are estimated assuming a gas power plant efficiency of 55%, an utilisation rate for solar and wind of 1 GW respectively equivalent to around 1 TWh and 2 TWh of electricity generation annually, gas power generation can be replaced only 80% of the time.



Source: ENER/CET using Eurostat series STS_INPR_M, as of 3 March 2023, 19:00.

The diagrams show that on the one hand, total manufacturing output and the output of some sectors, such as food processing, remained stable. Indeed, the high energy prices have so far not caused a general recession. On the other hand, the output of some energy intensive sectors, such as paper products, basic metals, chemicals and non-metallic minerals, decreased significantly since the beginning of 2022.

According to the ECB[26], producers in energy-intensive sectors started substituting own production with cheaper imports. However, imports increased especially for intermediate products (rather than the final products). This helped companies to continue to produce final products domestically, thereby limiting the negative impact of the energy price rise (notably on employment).

As regards gas markets, two conclusions follow from this analysis:

- First, it is important to stabilise prices in order to allow energy-intensive industries in Europe to recover their recent production losses in order to maintain employment and economic stability.

- Second, to the extent that firms in energy-intensive industries reduced production or switched fuels (rather than closing or moving permanently or investing in energy efficiency; see also Section IV.2 above), one can expect gas demand from industry to bounce back as gas prices stabilise.

Both of these conclusions call for continued demand reductions wherever possible.

5) Did higher natural gas prices induce higher LNG imports in 2022?

Conclusion 3:

A methodic management of the refiling season from private actors and Member States is key to avoid future price spikes, by avoiding Member States outbidding each other for no additional volumes. This would guarantee full storages at the lowest cost.

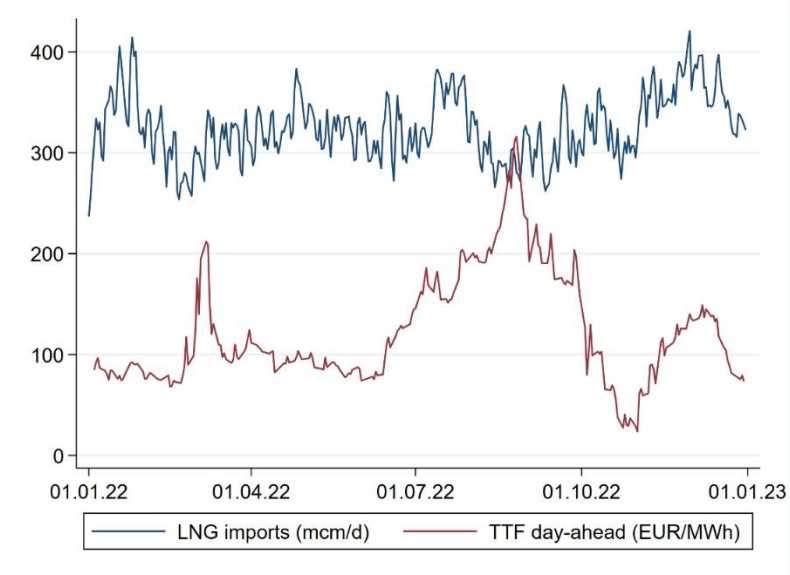
Natural gas prices in Europe spiked in March 2022 and September 2022, briefly reaching levels above 300 €/MWh compared to a historic norm of around 10-20 €/MWh. These very high prices reflected both actual scarcity due to reduced Russian supplies and uncertainty about the future. In addition, there was a concern that high prices were necessary in order to attract LNG to the EU in the context of a global market where European buyers were competing with other, mostly Asian, buyers. However, even in the face of a high willingness to pay for gas in order to ensure security of supply, the physical capacity to import LNG was limited. It is therefore questionable whether these extremely high prices actually led to substantially higher imports of LNG.

By comparing the evolution of prices and LNG import volumes over time, one can analyse whether imports of LNG increased during periods of high prices and decreased during periods of lower prices.

[26] ECB (2023): Update on economic, financial and monetary developments, Economic Bulletin Issue 1, Economic Bulletin Issue 1, 2023 (europa.eu) (accessed 08 March 2023)

Figure 10 plots daily day-ahead prices at Europe's TTF hub as well as daily imports of LNG into the EU.

Figure 10: Daily data, day-ahead prices and LNG imports[27]



In conclusion, higher gas prices significantly above global prices did not seem to have attracted higher import volumes of LNG.

Essentially, the price signal at the ports seems not to have an impact on supplies. Instead, the spike in gas prices can likely be attributed to intra-EU competition for gas in the face of limited supply, constrained by infrastructure bottlenecks. Ultimately, higher prices might not have led to additional supplies, but benefited only those trading the assets.

The global gas market will likely remain tight in 2023 while no physical shortages are to be expected if the demand reduction is extended. In order to prevent price spikes from happening again, major private actors and Member States should avoid buying in a rush at any price.

[27] The analysis in this section is based on LNG import data from the JRC and TTF prices from Platts. The diagrams display import volumes and prices on the same axis, but they are in different units (as per the legend).

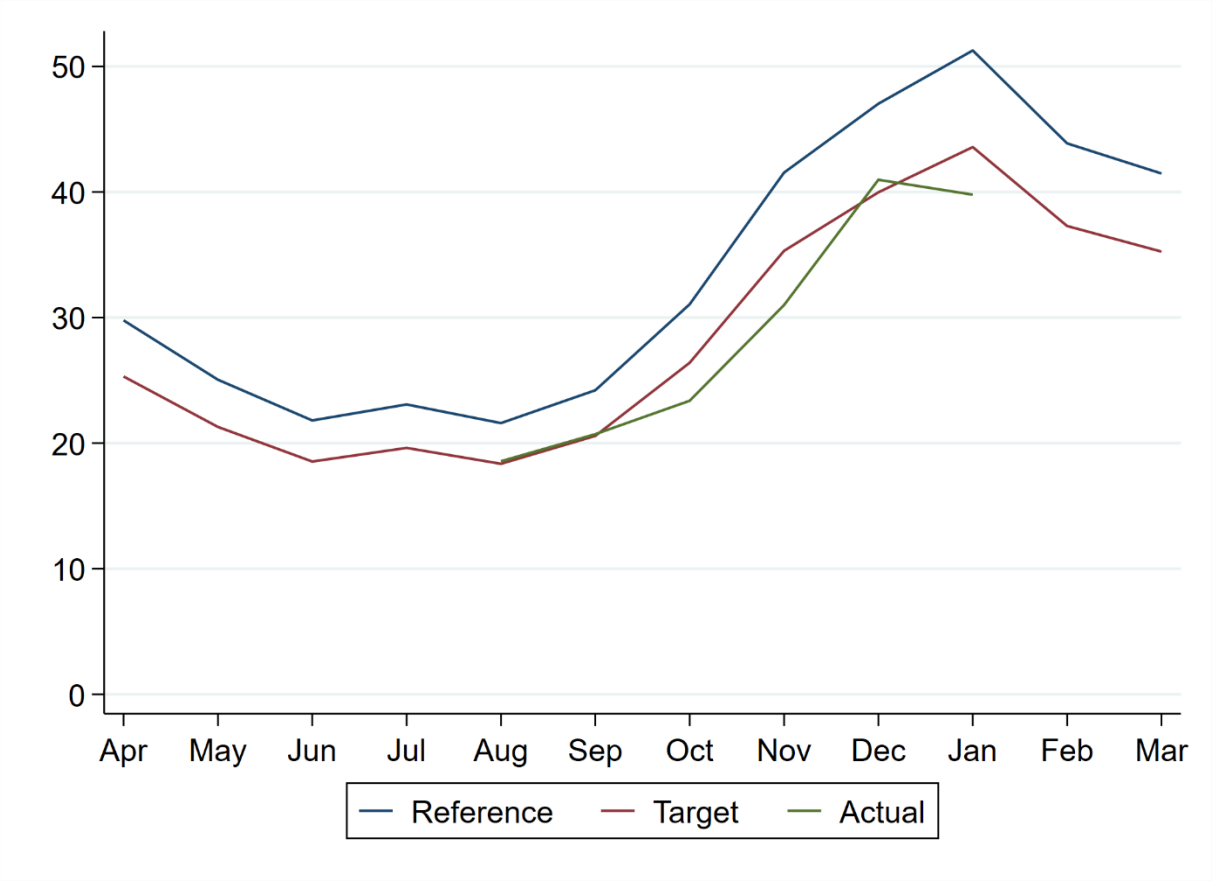
V. ANNEX I – Gas demand in the reference period

Table 4: Average gas consumption per MS, per month and for the Aug.-Mar. existing reference period and Apr.-Mar. proposed reference period (bcm)

Month: MS	4	5	6	7	8	9	10	11	12	1	2	3	8-3	4-3
EU27	**29.8**	**25.1**	**21.8**	**23.1**	**21.6**	**24.2**	**31.1**	**41.5**	**47.0**	**51.3**	**43.9**	**41.5**	**302.0**	**401.8**
Austria	0.7	0.5	0.4	0.4	0.4	0.5	0.8	1.0	1.1	1.2	1.0	1.0	**7.1**	**9.1**
Belgium	1.4	1.2	1.0	1.0	1.0	1.1	1.4	1.9	2.1	2.3	2.0	1.8	**13.6**	**18.1**
Bulgaria	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.4	0.4	0.3	0.3	**2.3**	**3.1**
Croatia	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.3	0.3	**2.3**	**3.0**
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	**0.0**
Czechia	0.6	0.5	0.4	0.4	0.4	0.4	0.7	1.0	1.1	1.2	1.0	1.0	**6.8**	**8.7**
Denmark	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.3	0.3	**2.2**	**2.9**
Estonia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	**0.4**	**0.5**
Finland	0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	**1.8**	**2.4**
France	3.0	2.3	1.8	1.8	1.6	2.0	3.1	4.9	5.5	5.9	4.9	4.5	**32.4**	**41.3**
Germany	6.8	5.8	4.4	4.6	4.2	5.0	7.1	9.9	10.4	12.0	10.6	9.9	**69.0**	**90.6**
Greece	0.4	0.4	0.4	0.5	0.5	0.4	0.4	0.5	0.5	0.6	0.5	0.5	**3.9**	**5.5**
Hungary	0.7	0.5	0.4	0.4	0.4	0.5	0.8	1.1	1.4	1.5	1.3	1.2	**8.4**	**10.5**
Ireland	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.4	0.5	**3.6**	**5.4**
Italy	5.1	4.3	4.2	4.7	4.0	4.7	5.3	7.2	9.0	9.7	8.0	7.5	**55.5**	**73.8**
Latvia	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	**1.0**	**1.2**
Lithuania	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.2	0.2	**1.6**	**2.3**
Lux.	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	**0.6**	**0.8**
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.2**	**0.4**
Netherl.	3.3	2.9	2.4	2.6	2.5	2.7	3.3	4.3	4.9	5.3	4.6	4.3	**31.8**	**42.9**
Poland	1.7	1.5	1.2	1.3	1.3	1.4	1.8	2.1	2.4	2.5	2.2	2.2	**15.9**	**21.6**
Portugal	0.4	0.4	0.5	0.6	0.5	0.6	0.5	0.5	0.5	0.5	0.4	0.5	**4.0**	**6.0**
Romania	0.8	0.6	0.6	0.6	0.6	0.6	0.9	1.2	1.6	1.6	1.5	1.3	**9.3**	**11.8**
Slovakia	0.4	0.3	0.2	0.3	0.3	0.2	0.4	0.5	0.5	0.6	0.5	0.6	**3.7**	**4.9**
Slovenia	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	**0.7**	**0.9**
Spain	2.4	2.3	2.4	2.6	2.5	2.5	2.7	3.2	3.2	3.5	2.9	2.8	**23.3**	**33.0**
Sweden	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	**0.8**	**1.1**

Source: ENER/CET calculations based on Eurostat series NRG_CB_GASM, sub-series IC_CAL_MG in mcm as of 7 March 2023, 11:00.

Figure 11: Reference consumption, target consumption (i.e., reference -15%) and actual consumption (Aug. 2022 – Jan. 2023); EU27 (bcm)

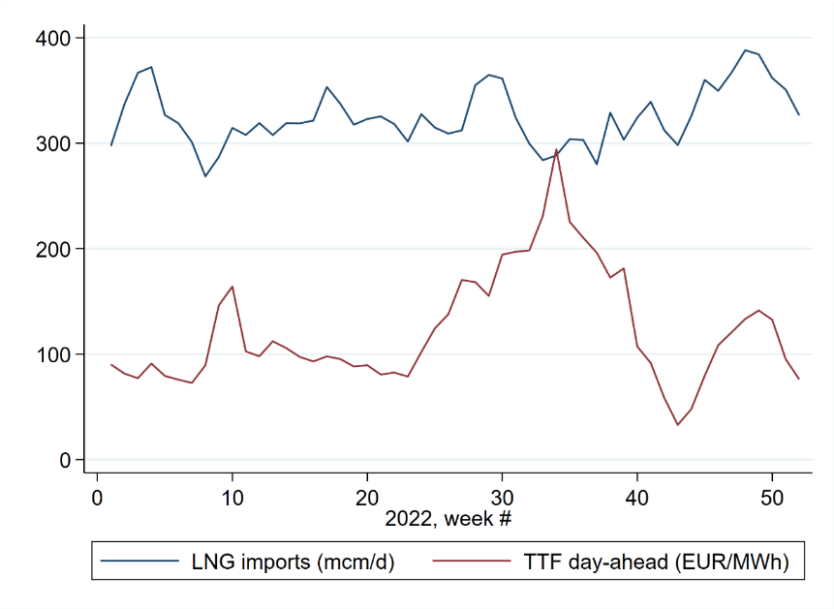


Source: ENER/CET calculations based on Eurostat series NRG_CB_GASM, sub-series IC_CAL_MG in mcm as of 7 March 2023, 11:00.

VI. ANNEX II – Sensitivities and statistical analysis of the relationship between gas prices and LNG imports

Figure 12 plots the same data as Figure 11, but using weekly averages to remove some of the noise.

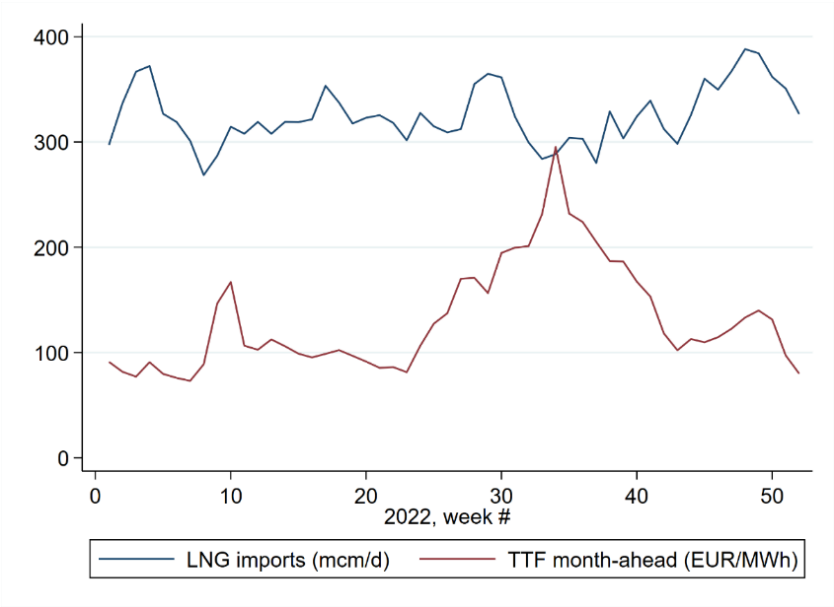
Figure 12: Weekly data, day-ahead prices and LNG imports



Still, LNG imports did not appear to increase in response to high prices.

Figure 13 plots month-ahead prices instead of day-ahead prices to account for the time it takes to place and deliver an order, again using weekly averages.

Figure 13: Weekly data, month-ahead prices and LNG imports



The figure shows that also higher future prices did not induce additional LNG imports.

A statistical tool to estimate whether two data series increase and decrease at the same time is the correlation coefficient, which can take values between -1 and +1. A correlation coefficient of +1 means that two series move in parallel; whenever one increases, the other one does too. A correlation coefficient of -1 means that two series move in opposite direction; whenever one increases, the other decreases. A correlation coefficient of 0 means that two series are uncorrelated, meaning the movement of one series does not influence the movement of the other.

An absolute correlation coefficient below 0.5 is generally considered to indicate low or moderate correlation, while an absolute correlation coefficient below 0.2, 0.25, or 0.3 is generally considered to indicate negligible or no correlation, though there are no clear dividing lines on the continuum of possible values between -1 and 1.

The correlation coefficient is close to zero (and in fact slightly negative, with values between -0.22 and -0.16) for all three pairs of series analysed in the main text and this Annex. This indicates negligible correlation, meaning that LNG imports did not increase in response to higher prices.