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European Natural Gas through the 2020s: the Decade of Extremes, Contradictions and Continuing Uncertainties

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ABSTRACT

The European gas system has entered a structurally volatile phase defined by post energy crisis overbuild, dislocated demand trajectories, and a decoupling mandate under REPowerEU. This paper interrogates the contradictions between fossil lock-in through LNG import capacity and overcontracting, and policy-driven demand reduction. The EU's pivot to flexible LNG procurement exposes pricing to global volatility, while decarbonisation hinges on electrification, demand-side retrofits and hydrogen feasibility—each encumbered by cost, infrastructure lag, and political friction. We assess Europe's gas outlook through the decade's

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residual volatility, policy ambivalence, and the emerging global LNG oversupply regime — a clash with geopolitical energy security imperatives, domestic backlashes against capital-intensive green technologies and market inertia. We argue that Europe's energy system now operates in a zone of structural ambiguity—where security, sovereignty, economy and climate ambition remain deeply entangled, but as yet far from operationally aligned.

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Keywords: Natural gas trade; LNG; European energy scenarios; European energy security; RePowerEU

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List of Abbreviations

ACER: Association for the Cooperation of Energy Regulators
APS: Announced Pledges Scenario
BAU: business as usual
BCM: billion cubic meters
BECCS: bioenergy with carbon capture and storage
CBAM: Carbon Border Adjustment Mechanism
CCS: carbon capture and storage
CHP: combined heat and power
CO_2: carbon dioxide
COP: Conference of Parties
CORSIA: Carbon Offsetting and Reduction Schemes for International Aviation
CCGT: combined cycle gas turbine
DES: delivered ex-ship
DESNZ: Department for Energy Security and Net Zero
DH: district heating
DPS: Declared Policy Scenario
E3G: Third Generation Environmentalism
EED: Energy Efficiency Directive
EHPA: European Heat Pump Association
EJ: exajoule
EO: Energy Outlook
ESABCC: European Scientific Advisory Board on Climate Change
ESR: Effort Sharing Regulation
ETD: Energy Taxation Directive
ETS: Emissions Trading System
EU: European Union
EUR: Euro
FOB: Free on Board
FR: flexibility requirement
FSRU: floating storage and regasification units
GIE: Gas Infrastructure Europe
GHG: greenhouse gas
GWP: global warming potential
GW: gigawatt
GWh: gigawatt-hours

IEA: International Energy Agency
IEFFA: Institute for Energy Economics and Financial Analysis
IPCC: Intergovernmental Panel on Climate Change
Kg: kilogram
kW: kilowatt
l: litre
LNG: liquified natural gas
LULUCF: Land Use Change and Forestry
MMTCO2: million metric tonnes of carbon dioxide
Mt: million tonnes
MtCO2e: million tonnes of carbon dioxide equivalent
Mtoe: million tonnes of oil equivalent
MW: megawatt
MWh: megawatt-hour
NBP: National Balancing Point
NECP: National Energy and Climate Plan
NZwthCCS: Net Zero with Carbon Capture and Storage
OIES: Oxford Institute for Energy Studies
PHES: pumped hydro energy storage
PPA: power purchase agreement
PV: photovoltaic
Q: quarter
RED: Renewable Energy Directive
RFNBO: renewable fuel of non-biological origin
RRF: Recovery and Resilience Facility
STEPS: Stated Policies
TJ: terajoule
TWh: terawatt-hour
UK: United Kingdom
US: United States
USD: US dollar

TWH EQUIVALENT ENERGY CONVERSIONS

1 bcm of natural gas ≈ 10.6 TWh
1 bcm of biomethane ≈ 10.6 TWh
1 Mt of hydrogen ≈ 33.3 TWh

EXECUTIVE SUMMARY

The European gas industry has seen wild variations throughout the first half of this decade, and faces contradictory forces which suggest continuing strategic uncertainty and potential volatility. The European Green Deal in 2019 and it's '*Fit-for-55*'[i] package made decarbonisation central to the EU's industrial policy for the following decade, with levels of ambition clearly implying structurally reduced gas consumption.

After some years of low gas prices, in 2020, demand and prices collapsed globally under the impact of COVID-19. Subsequent rebound of demand and growing concerns about supply adequacy led to prices rising sharply in 2021, towards the tenfold increase in the energy crisis of 2022, driven by Russia's invasion of Ukraine and sharp drop of Russian gas imports to Europe. The economic damage from the price shock, subsequent sabotage of pipelines, and strategically declining European gas reserves (along with climate concerns), helped to cement political determination in Europe to deliver its combined geostrategic objectives through decoupling Europe's economy from natural gas. This was embodied in the REPowerEU package, aiming to halve the EU's natural gas demand from the pre-Covid level (2019) by 2030.

That prospect itself is now under pressure, from multiple directions, some associated with the contradictory imperative in 2022 for rapid investments in non-Russian sources of gas. The signs are growing that much of the oil & gas industry not only does not want the stated ambitions of REPowerEU, they also do not expect them to be delivered.

This paper examines in detail the interrelationships between the EU's concerns, its energy policies, and the resulting challenges and uncertainties facing European gas through the rest of the decade, and beyond.

Russia's invasion of Ukraine prompted EU responses with inevitable contradictions.

With surging gas prices (Figure ES.1) and need to reduce dependence on Russian gas, the EU set a highly ambitious goal to rapidly reduce EU gas demand by 15%. That goal was surpassed the same year, and so far, sustained, with gas consumption down by 20% in 2024.

This was partly driven by reactions and policy measures in the residential and industrial sectors, with more rapid uptake of renewables, and heat pump record sales reaching 3 million in the EU in 2022. However, it also reflected significant industrial exit in the face of existential energy prices, directly conflicting with other European economic objectives. Also, the rapid surge of heat pump installations (some mandated) strained

[i] Intended to deliver a 55% reduction in the EU's greenhouse gas emissions by 2030, compared to 1990 levels.

supply chains and faced political backlash, particularly in Germany; heat pump installations have since slowed rather than accelerated.

Given virtual cutoff from Russian pipeline gas, it was inevitable that Europe sought new gas supplies as fast as possible, with huge expenditure in both floating and new port LNG terminals, along with investment in new pipelines and capabilities for more flexible gas flows across Europe. The floating terminals delivered what was needed during the gas crisis. By early 2023, the EU managed to stabilise LNG supplies, and, in combination with 2 mild winters, the prices fell to the levels of June 2021 (briefly below 30 EUR/MWh, then oscillating around 40-50 EUR/MWh: Figure ES.1).

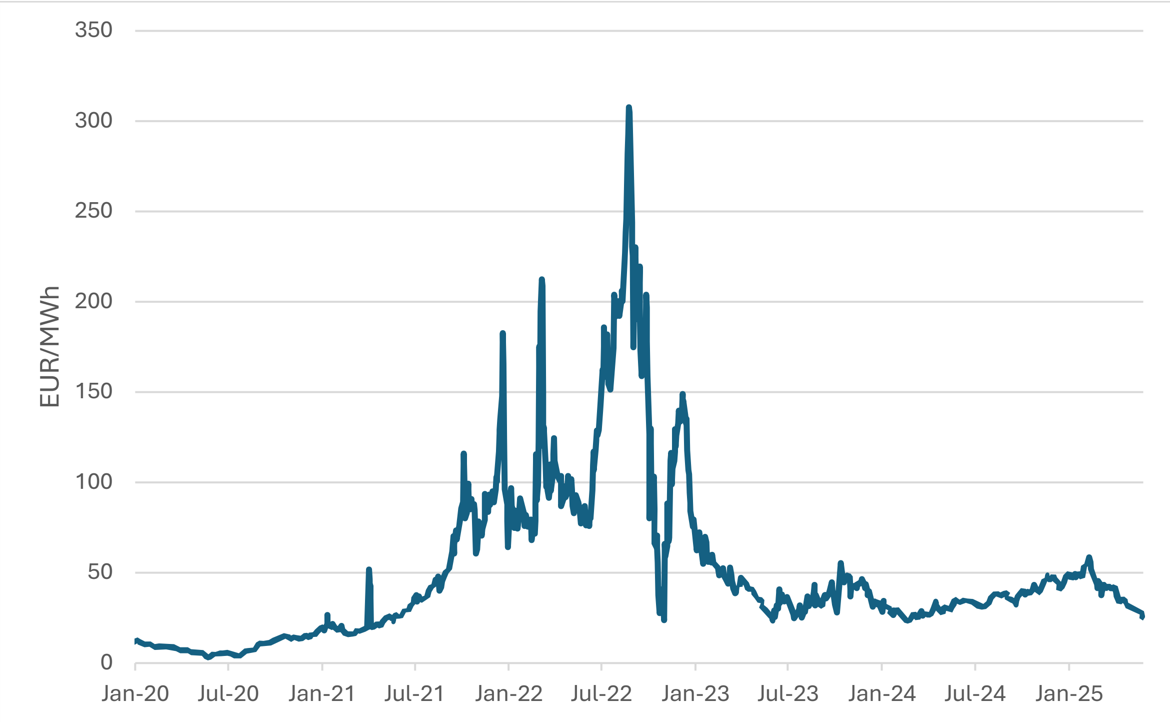


Figure ES.1: TTF day-ahead natural gas spot price; 2nd January 2020 to 30th April 2025[ii]

Source: Data provided by Independent Commodity Intelligence Services (ICIS)

However, cutting demand whilst boosting supply has inevitable implications. Most of the LNG import terminals commissioned during the gas crisis are expected to be completed by 2026, but their utility remains to be seen; continued low gas consumption has reduced LNG imports and LNG terminals' utilization. Belatedly, seven LNG terminal projects have been cancelled or suspended as of February 2025, but gas import capacity will still substantially exceed the RePowerEU goals.

[ii] The Title Transfer Facility (TTF) is a virtual trading point for natural gas in the Netherlands, serving as the primary benchmark for European gas prices

Getting back on track: three courses of action to achieve RePower's targets

REPowerEU seeks more resilient energy security through a more rapid uptake of renewables by 2030, and enhanced energy efficiency in buildings and industry, complemented by an ambition to extend carbon pricing into buildings and transport under the 'EU ETS-2'. Funds of over EUR 650 billion have been mobilised, primarily channelled through the Recovery and Resilience Facility (RRF), including over EUR 350 billion in grants and EUR 290 billion in loans. Together with implementation by Member States and related EU legislation, the aim is to reduce 2030 natural gas demand by 52% from the 2019 level.

Specific options to cut emissions and fossil fuel use can broadly be grouped into three categories: structural changes, end-use efficiency including electrification, and supply side transformation:

1) ***Structural changes.*** Industrial emissions had already been declining pre-crisis, but largely due to sectoral contraction in steel, chemicals, and non-metallic minerals rather than genuine decarbonisation. Gas demand has continued to fall, but mainly due to reduced industrial activity driven by high prices. Whilst a shift toward a more service-based economy (with continuing outsourcing / relocation of energy-intensive industries abroad) could help reduce EU territorial emissions, it risks simply offshoring pollution and increasing dependence on global supply chains.

   To build economic resilience and strategic autonomy, the Draghi Report urges the EU to enhance domestic supply chains and green jobs as part of accelerating innovation in low-carbon manufacturing. This can support the energy transition, stabilise key sectors, and protect against future fossil fuel shocks, consistent with the Clean Industrial Deal adopted in February 2025. Electric vehicles manufacturing, to reduce emissions and dependence on international oil markets, is one prime target. However (re)building internal manufacturing capability takes time, irrespective of energy prices, so needs to be fashioned around longer-term prospects.

2) ***End-Use efficiency and electrification.*** In buildings, the biggest gains come from upgrading existing stock combined with, where viable, rolling out heat pumps (including, combined with district heating), and integrated (e.g. rooftop) solar. In buildings and industry, direct electrification where feasible, including industrial heat pumps, contributes not only to utilising renewables but offers intrinsically higher energy efficiency. However, the EU is far off track from its goal of 60m heat pumps by 2030.

   While capital-intensive, these upgrades offer long-term benefits: energy security, lower costs, and emissions reductions. This reduces gas use at source and limits future need for hydrogen, biomethane, or other non-electric renewables. Residual gas demand could over time be met through phased hydrogen deployment and targeted boiler phaseouts, with social protections for vulnerable groups.

3) ***Supply-side transformation.*** Shifting to renewables, and low-carbon gases such as hydrogen and biomethane, allows for indirect electrification but requires major investment. Biomethane is a mature technology and can utilise existing gas infrastructure but requires access to (somewhat limited) feedstock and pipelines, making it geographically dependent. Hydrogen supply requires major retrofits and new infrastructure, particularly given the need to move beyond 'grey' hydrogen (from unabated natural gas). The policy push for 'green' hydrogen (from renewables) continues, but multiple delays and high costs mean that by 2030 the EU is only likely to secure a small fraction of its targeted 20 Mt supply.

   Green hydrogen faces an exceptional degree of 'chicken-and-egg' challenge - lack of investments in guaranteed offtake is reciprocally hindered by insufficient, and high cost, production, partly reflecting as-yet limited availability of cheap surplus renewable energy. All this is hindered further by the need for hydrogen-capable infrastructure. This conundrum could potentially be partly resolved by use of low-carbon hydrogen ('blue' from natural gas with CCS; or electrolytic nuclear-powered) but with a high degree of uncertainty. However, without such transitional routes, widespread adoption of green hydrogen before 2035 is unlikely due to costs, infrastructure gaps, and supply chain constraints.

Politically, support for decarbonisation and the REPowerEU agenda persists across the EU and UK, but recent elections and geopolitical developments indicate with weakening mandates and increased contestation. Economic and security concerns, exacerbated by global instability and US policy shifts, have pushed fiscal and security priorities to the fore, straining the consensus on long-term climate commitments and de-coupling from natural gas.

Moreover, and critical to short- and medium-term outlooks, the EU will remain highly dependent on gas almost regardless of the scale of demand reductions achieved under REPowerEU.

GAS PRICES: RESILIENCE WILL REQUIRE MAINTAINING DECARBONISATION THROUGH A LIKELY TROUGH OF SOFTER (BUT STILL UNCERTAIN) MID-TERM GAS PRICES OVER THE NEXT FEW YEARS

2025 gas prices in 2025 have to date sustained well above pre-COVID levels, predominantly due to requirements to maintain and fill gas storage for the following winter, along with retirement of old coal plants. Ultimately, its price in the year ahead depends on weather, economic and geopolitical pressures, whilst the EU grapples with the uncomfortable contradiction that it has built infrastructure to deliver more of precisely what it has committed to phasing out.

Global as well as EU LNG capacity is projected to exceed demand through the 2020s, likely pushing prices down, although historical 'boom-bust' cycles suggest future volatility remains likely. European gas prices will increasingly be tied to global LNG markets, especially spot prices, due to the EU's preference for flexible contracts. In the medium-term, the EU and UK will remain highly dependent on imports as their gas reserves continue to deplete, but the extent of dependence depends on the scale of demand reductions.

The shift from pipeline to LNG means that EU gas demand has become a more significant share of the global LNG market, especially the ‘spot’ market (distinct from long-term contracts, which dominate the growing Asian demand). So even modest demand changes could have significant price impacts. Elevated EU demand (e.g. falling well short of halving gas use by 2030 but below the 2022-2024 levels), would tend to increase global prices and increase the risk and/or impact of future supply crises. This underlines a **strategic role of decarbonisation to ensure longer-term resilience, in relation to both gas market volatility (avoiding repeated long-term boom-bust-boom ‘supercycles’), as well as climate change.**

THE ELECTRICITY NEXUS

Moreover, gas demand volatility, especially in winter, may persist or worsen, particularly if progress on electrification and heat pump deployment stalls. Seasonal spikes in gas use, amplified by electricity demand during low renewable output periods, may increase instability despite falling average demand.

The economic and social impact of price instability is amplified by the fact that fossil fuels largely drive the EU electricity price, despite now comprising less than half of its generation. The result is that the majority of European energy prices – across gas and electricity – will be driven by a few percent of overall demand, associated with spot-market LNG imports.

Whilst the Draghi report called for restructuring the electricity market to avoid this, the Clean Industrial Deal draws back from this and suggests that Member States should use a combination of other (fiscal) mechanisms and long-term power-purchase agreements to deal with the consequences of any gas-driven electricity price shocks.

MEETING THE EU’S GAS DEMAND WILL NECESSITATE STRATEGIC RISK-TAKING

Finally, the extent of the EU’s exposure to energy and price risks will depend on its sourcing of imports. In its recently adopted Action Plan for Affordable Energy, the EU explicitly points to ‘trusted’ and ‘reliable’ suppliers, partly reflecting geostrategic considerations. In principle, beyond the immediate neighbourhood of Norwegian and North African pipelines, Europe has three main sources of international gas/LNG supply– and all raise different risks and challenges.

- **Russia** remains politically toxic after the weaponisation of energy trade after its invasion of Ukraine. Infrastructure damage and contested data about methane leakage further impede major resumed imports, an idea anyway contingent on major geopolitical shifts and accountability.
- **US LNG** is abundant and contract-flexible, but carries high lifecycle emissions and growing geopolitical unreliability. US pressure on the EU to increase purchases, given Trump’s general approach to tariffs, increasingly raises concern about exposure to US economic and political leverage.
- **Qatar** is expanding LNG production and positioning its gas as climate friendlier. However, its insistence on long-term take-or-pay contracts conflicts with EU decarbonisation timelines, and corporate concerns about the risk of ‘stranded contracts’.

POLICY IMPLICATIONS

The logic driving the EU goals to reduce GHG emissions and gas dependence is now set in a new context. With dominant focus on security and competitiveness, the logic of energy transition needs to expand to wider industrial transition, focused on where investment and innovation can sustain the combined European goals.

Given slow progress on green hydrogen production (and CCS), and limits on biofuels, the main delivery opportunity to 2030 lies at the intersection of energy efficiency and electrification. Mandates (e.g. for heat pumps) have a role but risk consumer backlash if poorly handled. Response to the energy crisis underlines that *prices matter*. Alongside existing policies:

- the likely near-term decline in gas prices, if realised, offers an opportunity to **rebalance energy system charges and taxation away from electricity onto gas**, to support electrification;
- **electricity market reform could reduce the aggregate dependence of European energy costs upon gas volatility,** if it can disentangle overall electricity costs from marginal fossil fuel prices, potentially with direct access to renewables.

However, electrification – including, a holistic electric vehicle strategy to reduce oil dependence and transport emissions – implies need for more clean electricity generation, and could imply even greater variability in gas demand:

- **Rapidly expand renewables production, along with gas storage capabilities**, in the North Sea, Mediterranean, and Eastern Europe to combine offshore renewables with depleted gas reservoir storage where feasible
- Especially given their relatively modest utilisation, **encourage gas terminal LNG infrastructure procured during the crisis to enhance roles for gas storage and potentially hydrogen-related developments**

Finally, competitiveness and global decarbonisation align only if policy accounts for emissions 'embodied' in traded goods. Europe needs to encourage import diversity (of sources, geographies and contract structures) in ways that are consistent with global net-zero pathways:

- **Establish and publish parallel consumption-based emission accounts** for both industrial products (e.g. associated with CBAM) and natural gas, with methane accounting (and ideally, GHG pricing) throughout the supply chain of all EU gas consumption.
- Given the likely disproportionate impact of EU demand on spot LNG prices, **consider a moderate role for target-consistent longer-term contracts,** in which Qatari LNG may be seen as the 'least-bad' option economically and environmentally. Given the corporate risks arising from the inherent contradictions in EU gas policy noted, this may require public guarantees linked to commitments to accelerate hydrogen capabilities.

Given the obvious strategic risk of enhanced dependence, these prospects may again focus minds on delivering the strategic goal of reducing the EU's gas dependence, for combined reasons of environment, economy, and security.

INTRODUCTION

The EU's response to Russia's invasion of Ukraine in February 2022 and the subsequent Nord Stream gas pipeline sabotage meant the EU had to turn to a more expensive liquified natural gas (LNG) on spot markets, while LNG import terminals quickly reached their regasification capacity, with dramatic impact on prices (Figure ES-1). Europe had already committed to reducing its greenhouse gas emissions by 55% (from 1990 levels) by 2030, with major implications for fossil fuels. The energy crisis turned the spotlight from coal to gas, and turbocharged Europe's ambition to become free of fossil fuels.

When the gas supply crisis hit, the EU set an ambitious near-term target to cut gas demand by 15%, which was delivered (Section 2), driven mainly by the residential and industrial sectors. The energy crisis also induced more rapid uptake of renewables in 2022, and heat pumps reached 3 million in annual sales, their highest record in the EU. Even though over 70 bcm[iii] of LNG terminal capacity has been deployed in the EU since 2022, the EU's natural gas demand trends suggest that supply will remain tight until at least 2026 when most of the new LNG terminal projects are due to be commissioned. By early 2023, the EU managed to stabilise LNG supplies, and, in combination with a mild winter, prices fell to the levels of June 2021, below 30 EUR/MWh.

At the policy level, the EU revisited its decarbonisation agenda, adopting the REPowerEU policy package, a more ambitious plan compared to Fit-for-55, which was initially developed as part of the European Green Deal. REPowerEU envisions a more rapid uptake of renewables by 2030, more resilient energy security, and enhanced energy efficiency in buildings and industry, complemented by an ambition to introduce EU ETS 2 for buildings and transport. The combined measures of REPowerEU and EU legislation set a 52% natural gas demand reduction target by 2030 from a 2019 baseline. To support this agenda, the EU has mobilised funds of almost EUR 650 billion, primarily channelled through the Recovery and Resilience Facility (RRF), including over EUR 350 billion in grants and EUR 290 billion in loans.

The re-election of Commission president Ursula von Leyden, formal architect of the Green Deal, would seem to sustain the Commission's effort, but implementation also depends on the support and actions of EU Member States, and wider public. Elections in Germany and France did not derail the formal support of those countries, but it left both weakened, with the political drive for decarbonisation further eclipsed by the rise of military and economic concerns in the light of the Russian invasion of Ukraine, and now the Trump presidency. In theory, the EU's commitment to the REPowerEU goals remains, but it also faces financial as well as technical challenges. This paper examines: **to what extent in practice, given the legacy of the energy crisis, can and will Europe sustain its efforts for decarbonisation, and what may be the implications for natural gas?**

Note: this report assumes that 1 bcm of natural gas ≈ 10.6 TWh

1. Review of the EU's core decarbonisation and gas policies

This section explores the evolution of the EU's climate agenda, the adoption of REPowerEU in the aftermath of Russia's invasion of Ukraine, and the recently adopted Clean Industrial Deal as a response to recent geostrategic turmoil and competitiveness considerations. It also discusses the effect on fossil fuel subsidies and energy taxation.

Before the global energy crisis in 2022 and Russia's invasion of Ukraine, the EU Green Deal served as the foundation for mainstreaming decarbonisation and environmental sustainability while also addressing economic and social policies [1]. This policy package targets climate neutrality by 2050 while transforming the economy with market opportunities that consider social and justice concerns.

As a Union of 27 countries, much of the EU's core policy-making is shaped initially by setting goals, intended to orient complex patterns of implementation shared between central EU and Member State areas of formal competence. Within energy and climate change, the key guiding documents include the Renewable Energy Directive (RED III), the Energy Efficiency Directive (EED), the Effort Sharing Regulation (ESR), the Land Use, Land Use Change and Forestry (LULUCF) Regulation and the Energy Taxation Directive (ETD). Also, the EU's 8th Environmental Action Programme proposes a phase-out of fossil fuel subsidies by the Member States by 2025.

Whilst these outline objectives at the EU level, operationalisation will depend on National Energy and Climate Plans (NECPs). Updated NECPs were due from each Member State by June 2024, but by February 2025, 5 countries still had not submitted their final NECPs.[2]

1.1 Evolution of the EU's climate agenda

The EU's climate ambitions began with a 20% GHG reduction target from 1990 levels by 2020, achieved 3 years ahead of schedule.[3] This was followed by a new target of 40% GHG reduction by 2030, set in 2014, including a 43% reduction for the EU Emission Trading System (ETS) and 30% for the ESR. The EU Green Deal in 2020 raised this target to a 55% reduction by 2030, increasing the EU ETS and ESR targets to 61% and 40%, respectively.

This rising ambition requires doubling the pace of GHG reduction compared to the average of 2005-2022, reducing emissions by 141 MtCO_2 eq/year through to 2030 and 106 MtCO_2 eq/year between 2030 and 2050. [4] Since 2005, most GHG emission reductions have been attributed to energy supply, industry, and buildings, with marginal changes in transport and agriculture, as well as a reduction in LULUCF's carbon sink level, absorbing almost 30% less CO_2e in 2022 (Figure 1.1).

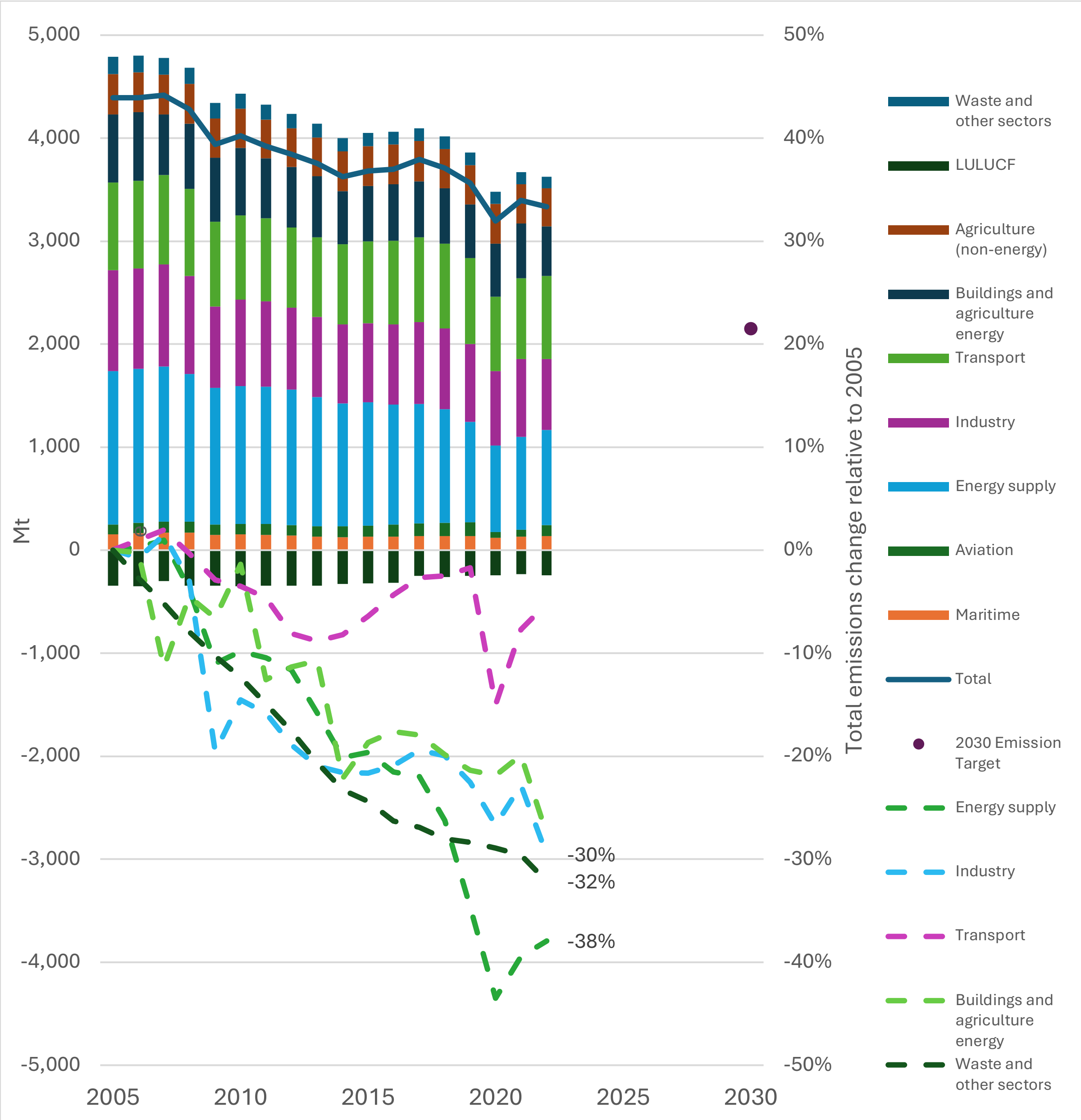


Figure 1.1: The EU's progress on key decarbonisation targets 2005-2022[iv]

Source: adapted from ESABCC (2024).[5]

The Fit-for-55 package was the policy response to the increased ambition of a 55% emission reduction compared to 1990 levels, supported by at least 30% of the EU's 2021-2027 budget.[6] The economy-wide package covers agriculture, transport, biodiversity, resource efficiency, forestry, chemicals, just transition, climate adaptation, and more. Moreover, this strategic document underscores the critical role of decarbonising energy production and use, which contributes to 75% of GHG emissions across the bloc.

[iv] % change for land, waste and other sectors not shown as these are small in total with uncertain data quality. The data available indicate a change in land use net (increase, i.e. reduction in the scale of net negative contribution) close to 30% over the period.

Building on the success of the EU ETS, under which the emissions cap on energy and industrial emissions has been reduced by 47% since its launch in 2005, the EU also aims to reform and expand it. The expanded scope will include maritime transport and Carbon Offsetting and Reduction Schemes for International Aviation (CORSIA). Along with the creation of a self-standing ETS (so-called EU ETS 2) for buildings, road transport and fuels, this means 62% of the bloc's emissions will be covered by ETSs. An important envisioned reform is the gradual phase-out of free allowances, particularly in industrial hard-to-abate sectors, along with protection for the increased costs from the EU's Carbon Border Adjustment Mechanism, set to be fully operational in 2026.

1.2 Energy sector and gas in Fit-for-55 and REPowerEU

1.2.1 Renewable energy and energy efficiency targets

In the power sector, Fit-for-55 proposes an increase in the share of renewable energy sources in the overall energy mix to at least 45% by 2030,[v] almost twice the contribution in 2023. A significant element also is the target to reduce 2030 final energy consumption by 11.7% compared to 2020, as reducing energy demand makes it easier for supply to reach any % target. For example, the renewables ambition implies annual incremental growth of 1.1%/yr, from 2026 - 2030 for electricity from renewables in heating and cooling.

The package also addresses the sustainability of grey hydrogen, which is already used in some sectors (mainly oil refining and chemicals production). It states that hydrogen should come at least 35% from renewable fuels of non-biological origin (RFNBO) by 2030 and 50% by 2035 – thus, excluding hydrogen from biomass and nuclear power. The energy efficiency goal is set in terms of *final energy consumption,* at an annual rate accelerating from a 1.3%/yr reduction from 2024, to 1.5%/yr from 2026 and 1.9%/yr from 2028 to 2030.[vi]

1.2.2 Policies for the use of gases

The Fit-for-55 package aims to track and reduce methane emissions by 30% in the energy sector by 2030 compared to 2020 levels, as outlined in the EU Methane Strategy.[7] However, while this strategy addresses upstream emissions from the exploration, transportation, and import of fossil fuels (making their use more scrutinised and less environmentally harmful), it does not imply an overall reduction in the use of fossil fuels.

Another ambition is to decarbonise the gas market.[8] A proposal envisions moving away from natural gas by developing a regulatory framework and directive for 'renewable' and 'low-carbon' gases and hydrogen, repurposing existing gas infrastructure and providing tariff rebates of 100% and 75%, respectively. To support gas market decarbonisation, the package proposes capping the length of long-term contracts of *unabated natural gas* by

[v] i.e. energy generation (not installed capacity) as % of final energy consumption, including transport, buildings and industry rather than just electricity generation alone.

[vi] These reductions mean 2030 EU energy consumption should not exceed 8,870 TWh for final energy consumption and 11,500 TWh for primary energy (European Parliament, 2023).

2049. The overall ambition is to develop robust regulation for network development plans for hydrogen, electricity and natural gas.

1.2.3 REPowerEU policy package

In spring 2022, following Russia's invasion of Ukraine, a global energy crisis was largely triggered by the cut-off of natural gas imports to the EU, which had broader implications for global energy trade. As a result, the REPowerEU Plan was developed with three objectives: 1) enhancing energy efficiency; 2) diversifying energy supplies; and 3) further expanding clean energy.[9] This includes more ambitious targets for renewables deployment and higher hydrogen and biomethane production and consumption targets. The revised policy targets adopted in REPowerEU are further presented in Section 3.

To support this agenda, the EU has mobilised nearly EUR 650 billion, primarily through the Recovery and Resilience Facility (RRF), including over EUR 350 billion in grants and EUR 290 billion in loans.[10] Figure 1.2 presents a summary of key EU policies and proposals regarding gas demand reduction targets by 2030.

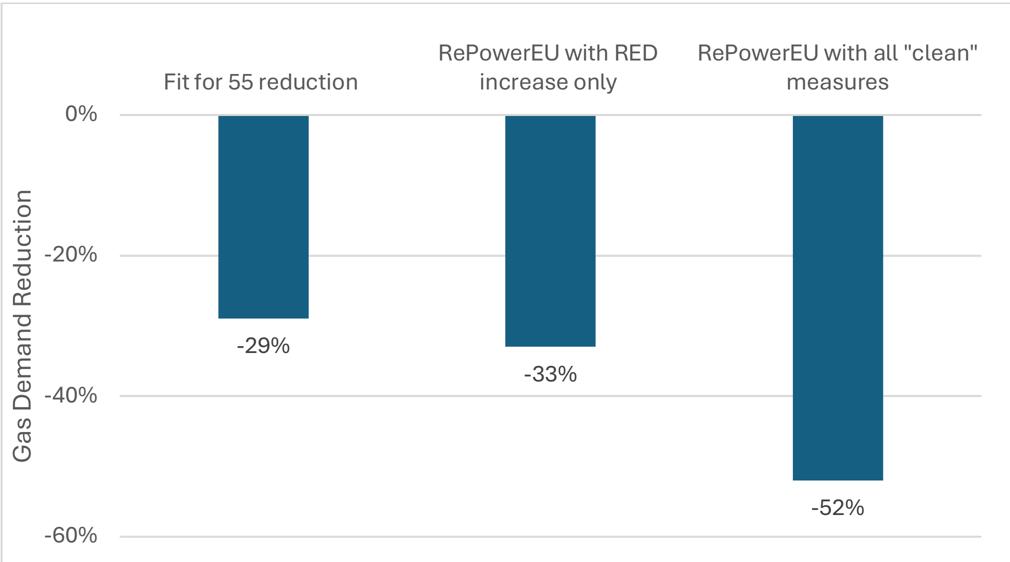


Figure 1.2: EU gas demand reduction targets by 2030 across EU's key policy documents[vii]
Source: adapted from E3G (2022).[11]

In addition to Fit-for-55 and REPowerEU, the EU has put its climate ambition on an even steeper curve. In February 2024, it proposed a legislative increase in the net emission reduction target to 90% by 2040, up from 55% by 2030.[12] The proposal entails almost full decarbonisation of the energy sector by 2040, with buildings and industry accelerating decarbonisation after 2025 and 2030, respectively. This partly reflects a short-term policy priority for heat pump deployment, while electrification and green hydrogen are expected to play a more significant role after 2030-2035. As of spring 2025, no official decisions on the 2040 plans had been announced.

[vii] Note: % compared to 2019, RED: Renewable Energy Directive

1.3 CLEAN INDUSTRIAL DEAL

The recent series of geopolitical events, both the war in Europe and global trade wars[viii], and elections in the EU and the US, have further reinforced the need for the EU to develop its ‘strategic autonomy’, the term coined in the recent Draghi Report.[13] Building on the objectives of greening the economy in the European Green Deal and accelerating the decoupling from fossil fuel dependency in the REPowerEU policy package, the newly elected European Commission adopted the Clean Industrial Deal in February 2025.[14]

The Clean Industrial Deal aims to mainstream green economy and climate action and achieve this by enhancing the EU’s global competitiveness and economic resilience. The policy primarily aims to address the competitiveness of energy-intensive industries and associated energy costs, as well as the rollout of clean technologies, inducing innovation, and circularity in the industrial sector. Energy affordability will be central to this, and decarbonisation of industry envisions significant electrification levels, as part of the EU’s wider ambition to increase electrification from 23% in 2024 to 40% in 2030.[15] Decoupling from natural gas in balancing the power grid is also proposed to be addressed through enhancing interconnection, investments in electricity storage, and incentives for demand-side flexibility (see also Section 3). Beyond that, the Clean Industrial Deal underscores the role of NECPs as ‘strategic investment plans’ aimed to foster market development, investments in and innovation for clean technologies rather than be seen as isolated decarbonisation guidance by Member States.

To this extent, decoupling from volatile fossil fuels will be paramount for industrial electrification and competitiveness, and so will the need to reform the electricity markets and deploy new infrastructure, as outlined in the subsequent Action Plan for Affordable Energy. At the same time, the policy document suggests the benefits of long-term offtake security for renewables through power purchase agreements (PPAs) with industry. These, in turn, can benefit both from low electricity costs and long-term price stability, isolating it from price spikes in wholesale electricity markets, often driven by gas as a marginal technology in the incumbent market design.

In contrast to REPowerEU and associated measures, the recently created Gas Market Task Force proposes to ease gas storage refilling requirements for the Member States, while creating more holistic safeguards to ensure that potential gas price spikes can be appropriately cushioned without distorting market-based pricing. Yet, as with previous measures, the European Commission has doubled down on demand aggregation and joint procurement of natural gas. On the other hand, the EU approach to LNG sees the need to look for ‘trusted’ producers and ‘reliable’ suppliers, partly pointing to geostrategic considerations. Beyond this, the Action Plan for Affordable Energy also proposes not only considering long-term purchase options and liquefaction rights but also incentivising private investments in LNG export infrastructure abroad.

[viii] Primarily involving China, the US and the EU

1.4 Fossil-fuel subsidies and energy taxation

Energy subsidies are a complex area, not least because they are usually defined relative to prevailing international energy prices and hence were wildly unstable over 2022-23. Annex A summarises data on energy subsidies before, during, and since the crisis.

Another important area of the European Green Deal is energy taxation. To incentivise energy efficiency and reduce pollution, reforms to the Energy Taxation Directive were proposed during the drafting of Fit-for-55, envisioning taxing energy content (e.g. kW) rather than volumetric measures (e.g. l, kg).[16] The proposal suggests grading minimum taxation rates for fuels based on their emissions and purpose (Figure 1.3).

As of Q2 2024, the minimum rates for coal, natural gas, and electricity used for heating are around 0.5 EUR/MWh. The new proposal increases the rates on coal and natural gas at 3.24 EUR/MWh, with a 2.16 EUR/MWh transition period for natural gas. Electricity taxation would remain unchanged at 0.54 EUR/MWh, incentivising a switch from fossil fuels to electrification. Although, these reforms are still being debated, the Clean Industrial Deal has recently reaffirmed the need to eliminate fossil fuel subsidies and ensure the balance of taxation between gas and electricity does not inadvertently disincentivise electrification.[17] For low-carbon and renewable fuels, a minimal rate of 0.53 EUR/MWh is proposed for advanced biogas, biomass, green hydrogen. In contrast, it is expected that for blue hydrogen the rate would triple after the proposed transitional period. The proposal discourages food and feed-crop biogas and non-sustainable biogas as heating fuels by putting their rates at that of natural gas after the end of the transitional period. The process of reforming these subsidies is still underway.

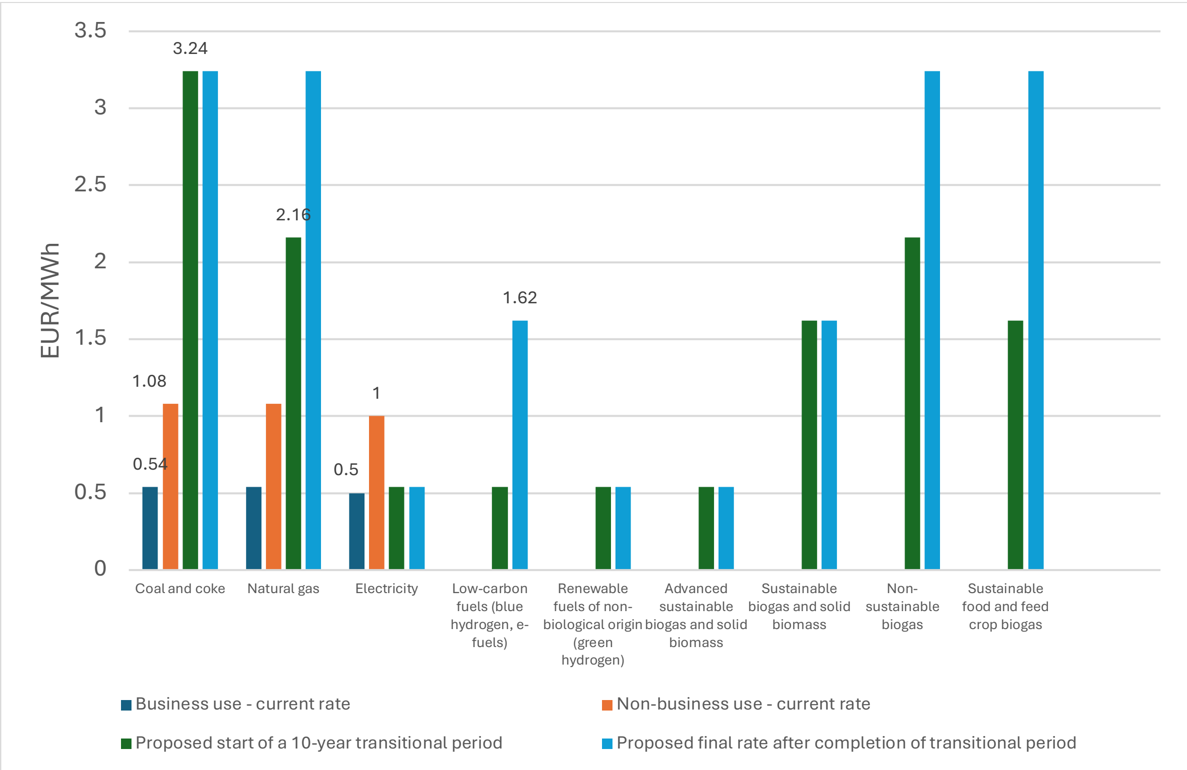


Figure 1.3: Minimum levels of taxation applicable to heating fuels

Source: adapted from European Parliament (2024).[18]

1.5 KEY TAKEAWAYS

The overall vision for EU decarbonisation is to prioritise electrification and energy efficiency primarily through renewable power sources, with low-carbon gases (including biomethane and low-carbon hydrogen) implemented where alternatives are limited or economically unfeasible. [19] When Fit-for-55 and especially REPowerEU were implemented, coupling energy security and decarbonisation was deemed to be of considerable political importance. While decarbonisation is no less urgently needed today, attention to climate goals has been overtaken by concerns of European security more broadly. As other countries (most notably the US) walk back on their climate targets, and political challenges to green policies have mounted, the EU has been pushed to reconsider its climate ambitions.

While it has publicly reaffirmed its commitment to its sustainability goals through the Clean Industrial Deal, there has been growing discussion about how to balance climate goals with other EU priorities. To this extent, the Clean Industrial Deal aims to integrate the decarbonisation agenda with the emerging notion of 'strategic autonomy' – through mainstreaming industrial competitiveness and economic resilience, and so ensuring energy affordability, job creation and ever-heightened energy security requirements. The subsequent sections will explore progress towards the EU's decarbonisation target while examining what this shift means for EU natural gas demand.

2 THE EU'S RESPONSE TO THE GLOBAL ENERGY CRISIS AND THE EFFECT ON NATURAL GAS

This section addresses the EU's specific elements of the Fit-for-55 and REPowerEU targets and their effect on specific sectors, as well has the evolution of the EU's gas consumption since the start of the energy crisis.

2.1 THE EU'S POLICY RESPONSE TO NATURAL GAS SUPPLY CRISIS

The energy crisis of 2022 (predominantly a European crisis with much wider global repercussions, especially on gas) was reflected in an unprecedented gas price shock (Figure ES-1). The direct impacts, followed by the EU's coordinated response to head off the subsequent winter peak, led to a decline in gas demand of 18% between August 2022 and March 2024, exceeding the 15% reduction goal set early in the crisis.[20]

Overall, annual gas demand fell from 413 bcm in 2021 to 356 bcm in 2022, 330 bcm in 2023, and 332 bcm in 2024. This equated to reductions of 20% to 2022, 7% to 2023, and an increase of 1% to 2024.[21] This demand reduction (combined with pipeline imports from Norway and expanded LNG imports from Qatar, the United States (US), and North Africa) carried Europe through the crisis and reduced EU average wholesale gas price, which began to stabilise between 20 and 60 EUR/MWh in 2024 and Q1 2025, compared to a peak of over 300 EUR/MWh in 2022.[22]

2.1.1 Natural gas demand reduction target

The EU has extended its recommendation to 'encourage' Member States to reduce natural gas consumption by at least 15% until March 2025, compared to the average annual consumption of 401 bcm between Q1 2017 and Q1 2022.[23] The well-coordinated Member State efforts in 2022-2023 exceeded the targets further in 2024, reaching an average gas consumption reduction of 20% between 2021-2024.[24] The reasons behind this are multifaceted rather than solely geopolitical. One factor is the ongoing recovery of global energy demand since COVID-19, with gas markets expected to be tight due to limited deployment of new LNG facilities before 2027. Another factor is the expiry of the Russia-Ukraine gas transit agreement in December 2024. Additionally, reducing natural gas consumption shields consumers from high price volatility, which has become even more apparent in recent years. The implications of significant gas demand reduction for LNG infrastructure developments are further discussed in Section 4.

However, the extended target suggests an increase rather than a decrease in consumption for Q1 2024 - Q1 2025 (

Figure 2.1).[25] One reason for this is switching from coal to gas. In its Recommendation on continuing coordinate demand-reduction measures for gas 26, the EU states that such a shift can align with its decarbonisation targets and the Conference of Parties (COP) 28 Global Stocktake, and *'should not disincentivise…from continuing to switch from coal to gas, for instance for electricity generation, if…switching …achieve[s] … decarbonisation objectives' (p. 8)*. However, this short- to medium-term strategy of coal to gas switching could risk carbon lock-in, stranded assets, and exposure to geopolitical shocks.

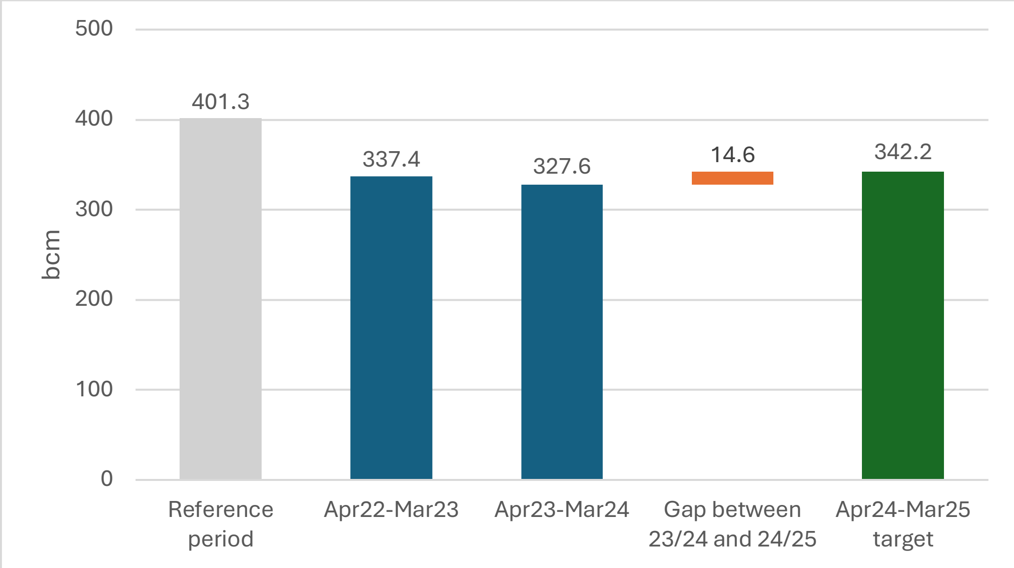


Figure 2.1: EU gas consumption and voluntary reduction target
Source: adapted from IEEFA (2024b) .[27]

2.1.2 Coordinated procurement of natural gas

On the supply side, the EU reviewed its import sources to enable significant gas storage refilling. The global energy crisis also nudged the bloc to develop the EU Energy Platform, which aims to enhance the procurement of natural gas.[28] The platform is intended to coordinate demand aggregation, enhance gas infrastructure usage (especially of LNG), and ensure competitive bidding to maximise value for the bloc's energy consumers by leveraging its global political and market weight.

The AggregateEU initiative aims to enhance gas trade within the EU by mitigating the risks of price volatility through a procurement bidding process. However, the mandate is limited, requiring Member States to aggregate demand for 15% of gas storage needs (13.5 bcm per year), with further participation voluntary.

The proposed mid-term tenders will take place on a 6-month seasonal basis between April 2024 and October 2029, starting from 1,800 TWh for LNG and 30 TWh for NBP[ix]. The first trial tender took place in February 2024, where international supply almost tripled the demand-side bids of 34 bcm. Apart from this, the EU has also run short-term tenders since 2023. Through March 2025, the EU Energy Platform has allocated 100 bcm out of the 119 bcm of natural gas demand from industry, attracting 191 bcm in bids from international suppliers.[29]

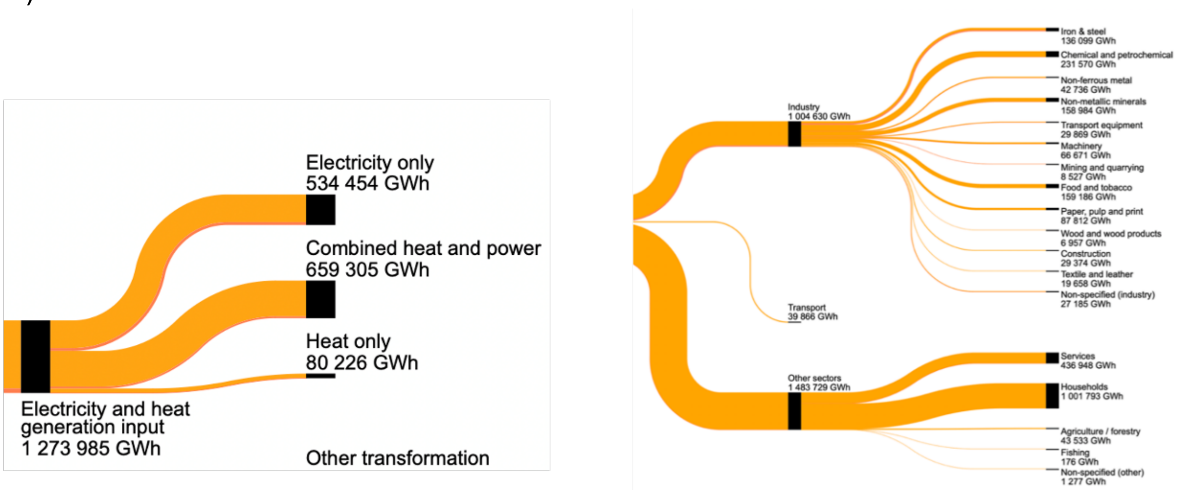
[ix] The National Balancing Point, a UK-based virtual natural gas exchange

Despite initially being a temporary measure during the energy crisis, the EU doubled down on the demand aggregation approach to gas imports in the recently adopted Action Plan for Affordable Energy [30] going forward. Furthermore, leveraging lessons learnt from this instrument, the EU also put forward a proposal to use a similar approach, including joint procurement, to boost hydrogen and biomethane market growth.

2.2 STRUCTURE OF EU GAS CONSUMPTION AND IMMEDIATE RESPONSE TO THE ENERGY CRISIS

2.2.1 Natural gas role in the EU prior to the energy crisis

Prior to Russia's invasion of Ukraine, natural gas use was divided between the energy transformation sector (mainly electricity and heat production), industry, and other (mainly household) sectors, each accounting for between 95 and 145 bcm/year[x] (Figure 2.2).



a) Transformation sector (electricity and heat production)

b) Direct final consumption

Figure 2.2: Sectoral consumption of fossil gases in 2021

Source: own calculations based on Eurostat (2025).[31]

Gas inputs to energy transformation reached over 120 bcm (19% of the total electricity and heat production). Just over half of this was used for combined heat and power (CHP), while most of the remainder was for electricity-only generation. Natural gas provided the highest contribution of 39% to CHP, but its 12% contribution to electricity-only generation was below even that of coal. Since 2018, renewable energy sources, primarily solid biomass, have overtaken natural gas in heat-only production, reflecting a shift towards district heating, and biomass boilers in commercial and utility-scale applications. In final energy consumption, natural gas contributed significantly to industry and households, exceeding 95 bcm. It accounted for 42% of space and water

[x] Eurostat energy balance does not use bcm, instead we present this data in TWh: 1 bcm = 11.1 TWh. Typically, modern combined cycle plants have conversion efficiency of 50-60%; on average across the European fleet however, more than 50% of the gas input to power is lost in conversion to electricity.

heating in buildings, with over 95 bcm consumed in the residential sector and over 41 bcm in services.

2.2.2 Immediate response to the energy crisis: changes from 2021-2022

Zooming out, the EU reduced overall final energy consumption from 10,918 TWh in 2021 to 10,493 TWh in 2022. Natural gas consumption dropped by 13.5% (406 TWh) between 2021 and 2022 (Figure 2.3), with end-use sectors already outperforming the target with a 15.1% (324 TWh) decline. *Electricity & Heat* reducing by 7.4% (82 TWh). Across final energy consumption, households achieved the highest absolute reduction of 130 TWh (15%), followed by industry (128 TWh or 15.6%). Both *CHP* and *Heat only* reduced natural gas consumption by around 20% or 119 TWh.

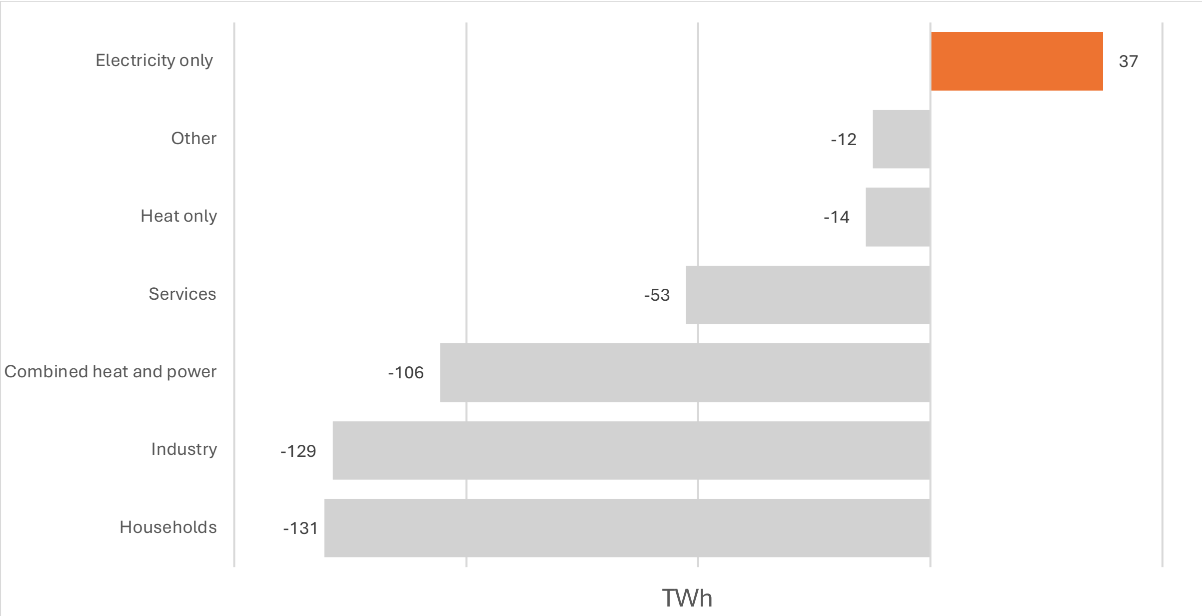


Figure 2.3: Natural gas consumption change in the EU in 2022 relative to 2021, TWh

Source: own calculations based on Eurostat (2025).[32]

Electricity only was responsible for an increase of 7.1% or 37 TWh (3.5 bcm) in gas consumption, partly offsetting the overall reduction. A significant reduction in nuclear, primarily driven by maintenance at French nuclear plants, and droughts reducing hydropower generation, partly offset a more dramatic increase natural gas usage. In other Member States, coal generation was ramped up but limited by the high cost of using coal due to the EU ETS. Remarkably, the shortage of natural gas was partially offset by the increase in oil consumption for non-transport purposes, mainly by households and industry, with marginal additions to the electricity and heating sectors.

Additionally, the reduction in natural gas consumption was partly offset by the deployment of heat pumps (Figure 2.4), which saw record sales of over 3 million in 2022. The highest heat pump deployment in 2022 was in industry, with a 14.7% increase in consumption from heat pumps, followed by households (10.3%) and the commercial sector (7%). Solid biomass, which is sometimes considered a sustainable fuel, also saw a decline in consumption across most sectors (apart from industry).

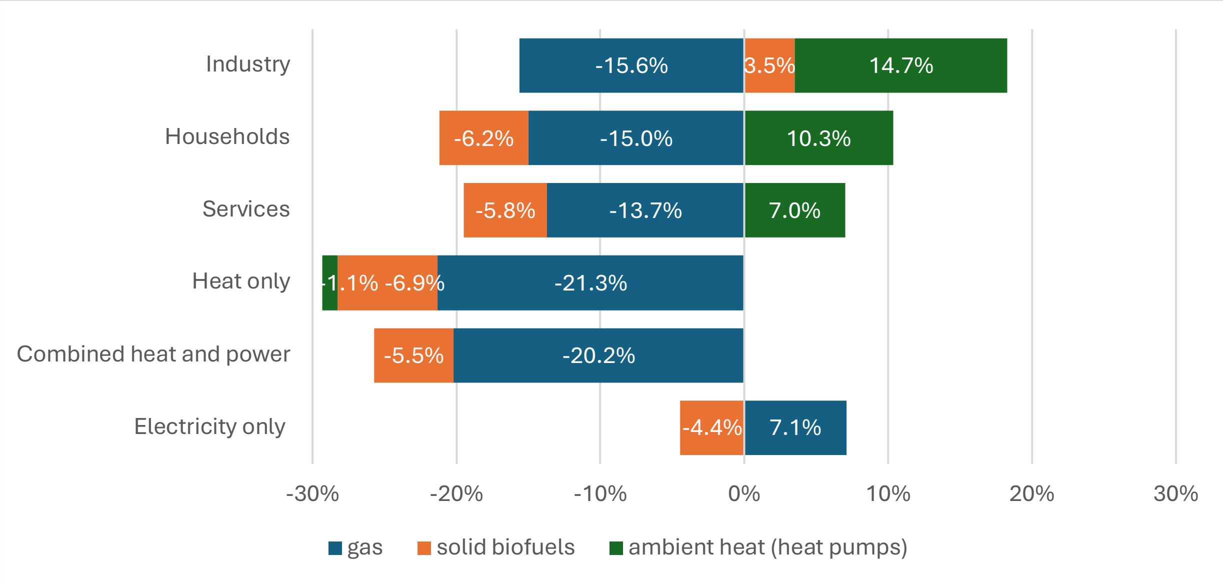


Figure 2.4: Relative consumption change of natural gas, solid biofuels and ambient heat (heat pumps) in 2022 to 2021

Source: own calculations based on Eurostat (2025).[33]

Overall consumption of bioenergy has also declined, which can be attributed to the reduction of biomass used by CHP, utility-scale and individual heat boilers, despite a rebound in industry (where natural gas consumption declined amidst soaring energy prices). The overall CHP and heat-only energy consumption reduction can be attributed to a milder winter and the energy demand reduction measures of 2022.

Figure 2.5 provides a more comprehensive outlook of changes in energy consumption as a response to the 2022 energy crisis. The import of natural gas increased by 28 bcm to 373 TWh in 2022. However, this was primarily driven by re-exports rising by 24 bcm, while domestic production declined by another 3 bcm. This makes a net increase of 0.5 bcm in imports, as re-exports offset the reduction in domestic production. Overall, the achieved reduction of natural gas consumption in 2022 reduced import dependency by 11.2%. EU gas trade dynamics are unpacked further in Section 4.

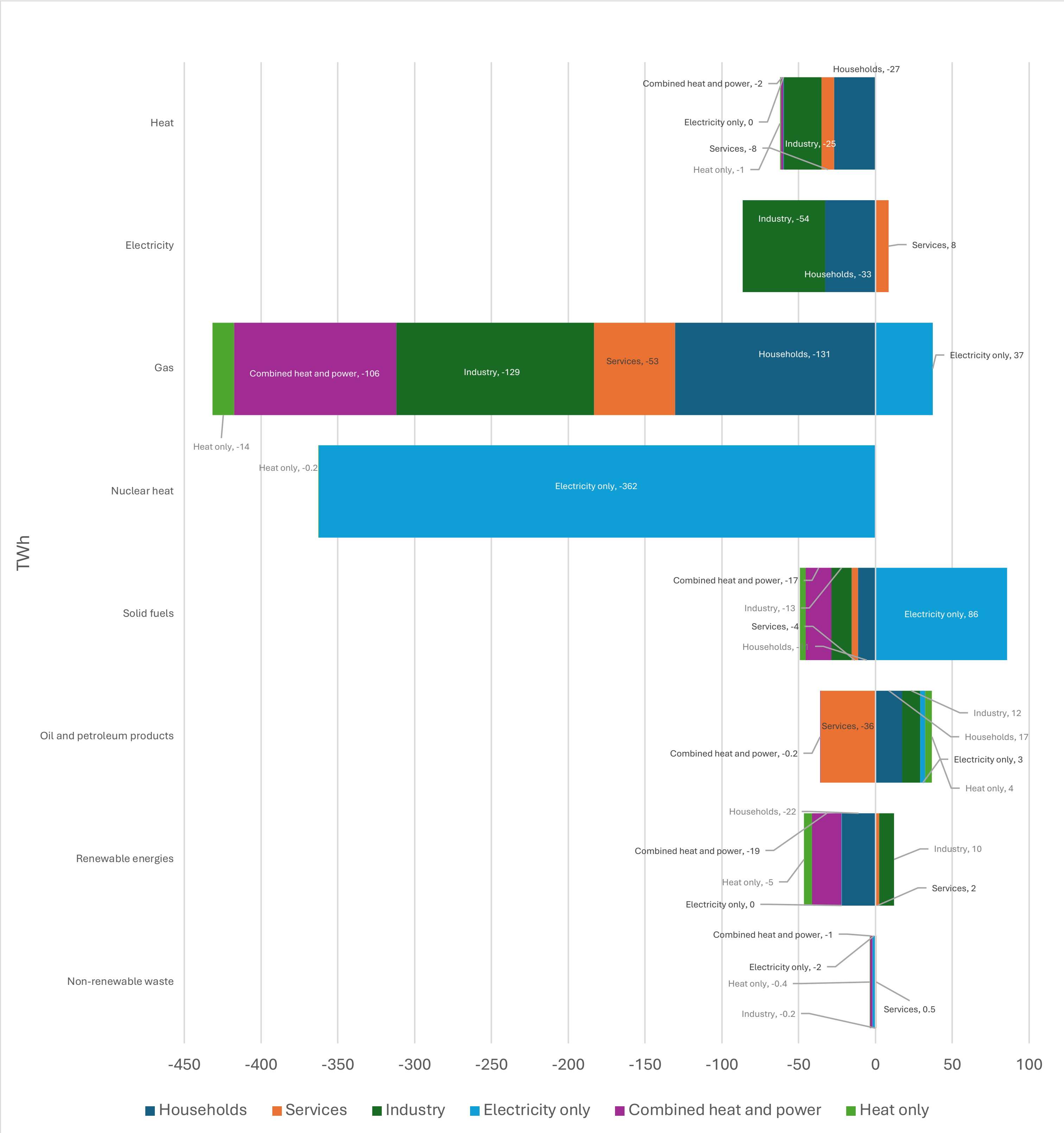


Figure 2.5: Change in fuel and energy consumption in electricity & heat, industry, households and services, 2021 to 2022

Source: own calculations based on Eurostat (2025)[34]

2.2.3 Gas response 2023 to today

While in 2022 energy suppliers sought any available energy carriers, prompting the reopening of mothballed coal and gas power plants, 2023 provided an opportunity to respond on a more managed footing. This entailed not only stabilising energy prices to pre-2022 levels but also reducing coal and gas consumption and achieving record levels of renewables (44% of generation). Wind generation exceeded that of gas for the first time in the EU in 2023, partnered with a record fall in coal and gas use, trends which were sustained in 2024 (Figure 2.6).

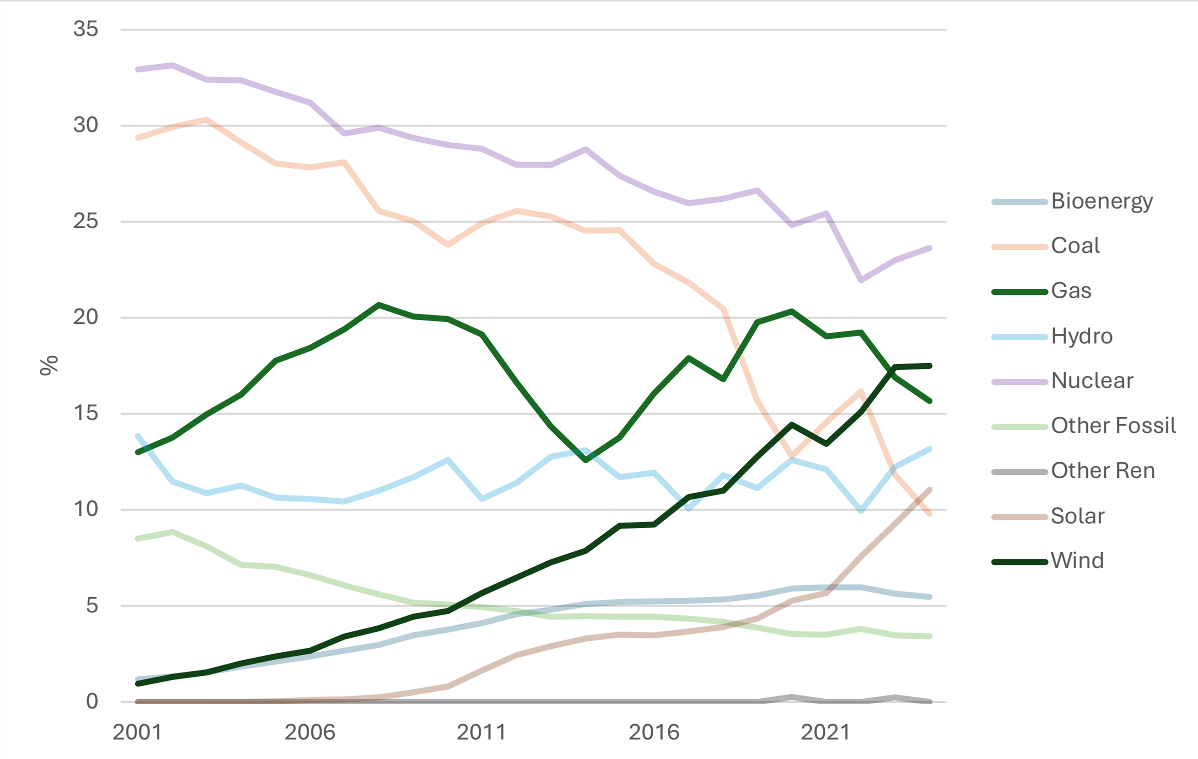


Figure 2.6: Share of electricity generation in the EU 2000-2024

Source: Replicated from Ember (2025b)[35]

In 2023, final energy consumption continued declining to 10,157 TWh.[36] While many sectors continued to see decreasing demand, these declines were not as dramatic as in 2022. Total natural gas consumption dropped by 7% (14 bcm) from 2022 to 2023, while final energy consumption from households, for example, dropped by 9% (7.5 bcm) in the same period, compared to a 15% drop the year prior.

Out of 209 TWh of reduced fossil fuel power generation up to 2023, almost 40% can be attributed to the deployment of renewables, another 40% to electricity demand reduction, and the remaining to the recovery of nuclear and hydropower generation.[37] Falling electricity demand in the EU can be attributed to a combination of factors: behavioural change, energy efficiency, milder winters, and nearly 2% in 2023 was related to structural changes in industrial consumption, discussed further in Section 3.

Early evidence suggests EU gas consumption remained flat in 2024.[38] EU gas demand for electricity decreased by 8%, although it is not yet clear how consumption changed in other sectors.[39] However, 2024's pace of reduction was slower than in 2022 and 2023, mirrored by slowing rates of electrification. Thus, while reductions have been sustained (despite the easing of supply and price constraints), the declining pace makes it unclear how consumption may evolve in future. Section 3 will explore how these declines were achieved in various industries in greater depth and how their consumption patterns may shift in future.

2.3 Key takeaways

At the beginning of the energy crisis, there was a rapid response across the EU to quickly reduce dependency on Russian pipeline gas, both by switching to other fuel sources and by demand reduction targets. A major factor was the direct impact of the extreme gas prices seen during this period, coupled with a political narrative about European consumers avoiding funding Russia's war efforts through Russian gas imports. The relative contribution of the three different factors on price impacts (including on industry), consumer mobilisation and decarbonisation policies cannot realistically be disentangled.

The impacts have endured, yet slowed. Gas prices remain elevated above 2020 levels, however as they have declined, signals to reduce or shift demand have become muted. As such, progress on deploying technologies like heat pumps (explored further in Section 3) has slowed, as has attention to energy efficiency more broadly.

EU energy demand will also play an important role in the bloc's ability to meet the REPowerEU targets. While much of the success in decreasing natural gas dependency has been achieved through demand reduction, the EU's industrial competitiveness strategy as outlined in the Clean Industrial Deal would, if successful, return industrial energy demand to at least pre-crisis levels, if not more. If achieved using electrification and through the deployment of low-carbon gases, industrial competitiveness and the energy transition could be achieved in tandem. For that, another crucial pillar is harnessing the potential of cheap renewables, as outlined in the recently adopted EU Action Plan for Affordable Energy. However, demand growth, along with more muted signals for consumers, could also risk the ability to meet REPowerEU's demand reduction targets. Section 3 will explore the response of several industries to the energy crisis and indicate how these sectors may contribute to REPowerEU goals in future.

3 Structural and regional aspects of EU natural gas demand

This section illustrates the demand for gas in different sectors, how these demand levels have changed since the energy crisis, and what this means for the sectors' long-term decarbonisation. The section is broken into four subsections relating to households, industry, the power sector, and low-carbon gases.

The energy crisis has significantly impacted the stability of the EU's energy supply, requiring new sources of gas, such as LNG, and extending trade agreements or forging new partnerships. While 'changing the taps' is feasible for now, the crisis could act as a springboard for a long-term and more sustainable solution, addressing both the security of supply and net-zero targets. This can be achieved by moving towards variable renewable energy, improving energy efficiency, and increasing electrification in end-use sectors. Investment decisions on LNG infrastructure greatly influence this future, risking either carbon lock-ins that could jeopardise net-zero targets or the stranding of these assets.

At the outset of the global energy crisis, EU industry, along with households, demonstrated the highest gas consumption reduction, by 125 TWh (12 bcm) and 156 TWh (14.9 bcm), respectively, in 2022.[40] In industry, a significant share of natural gas consumption reduction occurred due to production curtailment and fuel switching, with marginal contributions from efficiency improvements. In buildings, weather is considered to be the most significant factor (18 bcm), while behavioural change, fuel switching and energy efficiency also facilitated this reduction (10 bcm).[41] This trend maintained in 2023, with households and industry reducing by a further 4.8 bcm and 7.6 bcm, respectively.

Going forward, the EU must consider to what extent these natural gas demand trends should be maintained, and what the implications would be for energy security and net zero targets. Fit-for-55 and REPowerEU envision significant electrification and energy efficiency measures. In hard-to-abate areas, where electrification is impractical, the use of gases can be justified, and existing fossil gases, i.e. natural gas, are targeted for replacement with zero- and low-carbon alternatives such as hydrogen and biomethane.

3.1 Households

Gas consumption in the EU buildings sector has remained stable over the last decade, fluctuating between 150-200 bcm/year, with direct household gas consumption oscillating around 125 bcm (Figure 3.1).[42] Gas is the most widely used energy carrier for space and water heating in the EU, making demand highly seasonal and dependent on climate, weather variation and social factors that vary between EU Member States.[43]

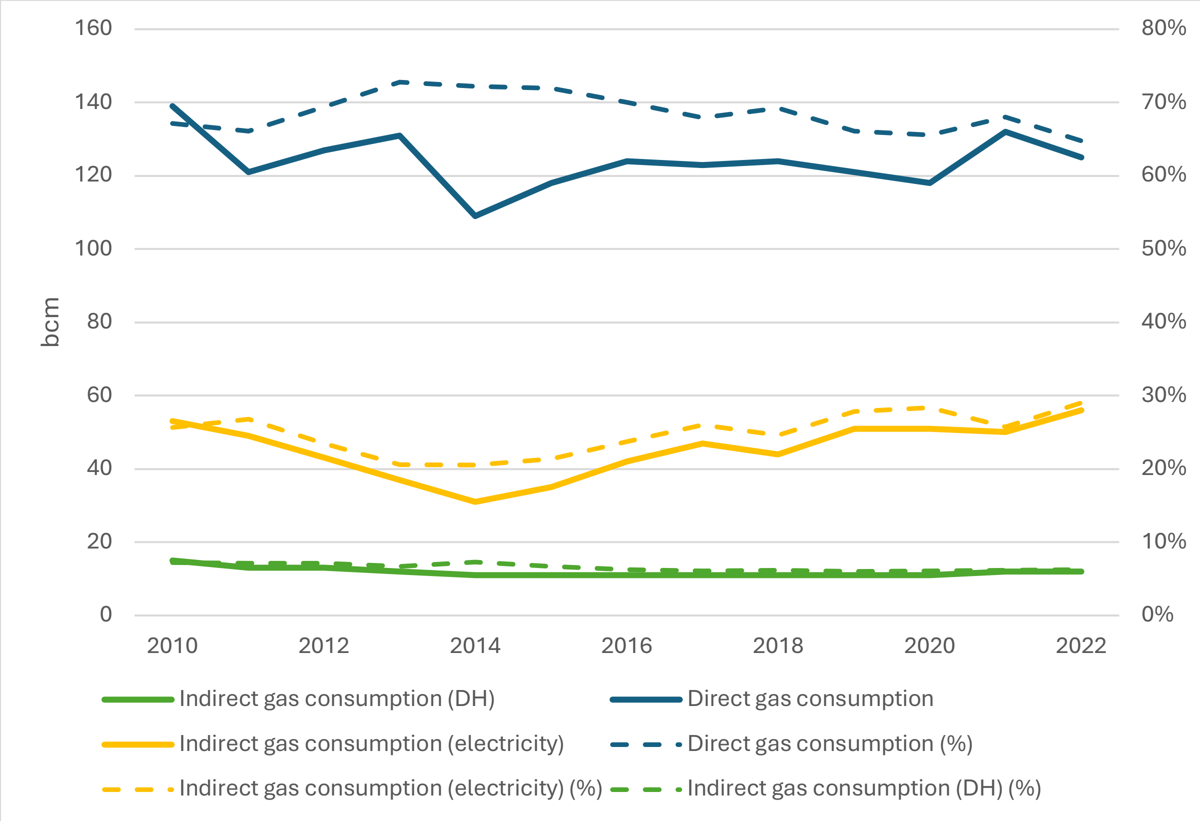


Figure 3.1: EU gas consumption in buildings, by source[xi]
Source: Reconstructed from IEA (2023b)[44]

Natural gas is the largest energy source in the EU residential sector, accounting for 31% of final consumption, with over 40% of households connected to gas networks, 68 million gas boilers and 18 million oil boilers installed.[45] This, along with the low penetration of district heating (less than 10%), means a large volume of individual heating systems must be decarbonised, posing a significant technical challenge.

Reducing gas demand through energy efficiency and heat decarbonisation requires tailored policies due to differences in energy carriers and heating systems across Member States. Table 3.1 organises countries into four main groups:

(i) High gas use with particularly high residential natural gas consumption, e.g. the Netherlands, Hungary, Slovakia and Italy
(ii) Strong district heating, e.g. Nordic-Baltic states
(iii) Reliance on solid fuels, e.g. Poland and Czechia
(iv) Heavy oil dependence, e.g. Ireland, Greece and Cyprus.

[xi] DH stands for district heating

Table 3.1: Final energy consumption in the residential sector by fuel, EU, 2022

Fuel clusters	Country	Natural gas	Electricity	Renewables and biofuels	Oil and petroleum	Heat	Solid fossil fuels
	EU-27	31%	25%	23%	11%	8%	2%
High gas use	Netherlands	**66%**	22%	8%	0%	3%	0%
	Italy	**50%**	19%	24%	6%	2%	:
	Hungary	**49%**	18%	23%	1%	8%	1%
	Slovakia	**41%**	19%	25%	0%	13%	2%
District heating	Denmark	12%	20%	24%	4%	**40%**	:
	Estonia	5%	18%	42%	0%	**35%**	:
	Sweden	0%	49%	12%	2%	**36%**	:
	Latvia	9%	13%	40%	5%	**33%**	0%
	Lithuania	13%	18%	33%	4%	**29%**	2%
Solid fuels	Poland	21%	12%	26%	3%	18%	**20%**
	Czechia	23%	19%	35%	0%	13%	**9%**
Oil	Ireland	20%	26%	4%	**41%**	0%	4%
	Cyprus	0%	42%	28%	**30%**	0%	:
	Belgium	**39%**	19%	11%	**30%**	0%	0%
	Greece	11%	33%	26%	**30%**	1%	0%
	Luxembourg	**47%**	18%	7%	**28%**	0%	0%
	Austria	20%	25%	30%	**13%**	12%	0%

Source: adapted from Eurostat (2024a).[46]

Decarbonising and reducing natural gas use in district heating ultimately depends on system design and fuel sources. For example, Germany relies heavily on natural gas in district heating systems, though primarily from CHP rather than utility-scale boilers. Austria, Czechia, France, Italy, Poland and Slovakia also use substantial coal and gas in their district heating systems.

Alongside traditional energy efficiency measures like insulation, EU policies on gas consumption in buildings also target the rollout of heat pumps and, separately, behavioural changes. It is estimated the first category will save 37 bcm of natural gas and latter will save a smaller, but more immediate, 13 bcm.[47] In October and November 2022, household gas demand was 30% below average across a range of EU countries,[48] but long-term behavioural changes remain limited. Surveys from households in Germany, the Netherlands, Greece and Poland find reported behavioural changes from the price shock only amounted to a 2-3.5% reduction in gas demand, unlikely to make a significant contribution to the 13 bcm target.[49] Price caps, such as in Germany, shielded consumers and blunted important price signals for behavioural changes.

3.1.1 Progress on REPowerEU Targets

In its hierarchy of decarbonisation approaches, the EU prioritises energy demand reduction and end-use electrification wherever practical and economical. For heating, heat pumps are considered to play a central role given their intrinsically higher energy efficiency and ability to draw on solar and wind electricity. Where they are infeasible, alternatives such as hydrogen and biomethane must be considered.

The European Commission's RePowerEU policy package targets imply a need to replace at least 21 bcm (233 TWh) of natural gas using heat pumps in buildings, equivalent to 42.5% of the EU's 2022 natural gas use for CHP production.[50] The package also targets renewables gaseous fuels, aiming for 20 Mt of green hydrogen and 35 bcm of biomethane by 2030, providing approximately 660 TWh[xii] and 370 TWh[xiii], respectively. Combined, these renewable gases would substitute 47% of final fossil gases used in 2022. Together with the electrification of industry and additional uptake of renewables, these could substitute at least 130 bcm/yr of natural gas by 2030, as summarised in Table 3.2.

Table 3.2. Natural gas saving targets from REPowerEU[xiv]

REPowerEU Plan	Natural gas saving, bcm	Equivalent in TWh
Residential sector: energy efficiency and heat pumps	37	392
Industry: energy efficiency and electrification	12	127
Renewable hydrogen 20 Mt	25-50	265-530
Solar and wind	21	223
Biomethane	17	180
Total	**112-137 bcm**	**1187-1452 TWh**

Source: own calculations based on ACER (2024a)[51]

3.1.2 Transition to gas in the heating sector

The transition from coal to gas is also prevalent in the heating sector, where coal plays a key role, especially in CHP, in Central and Eastern Europe and Greece (Figure 3.2). However, the regions' high share of district heating (20-42%, second only to the Nordics) compared to Western and South European Member States (below 10%), offers a scalable opportunity for accelerated decarbonisation through utility-scale heat pumps, bypassing the shift to natural gas.[52] Countries at the top of Figure 3.2 (high coal %) can aim to leapfrog those in the middle (high gas %), to achieve levels of renewables seen in countries at the bottom of the figure. Additionally, households in Eastern Europe have a higher vulnerability to energy prices, providing an opportunity to reallocate direct and indirect fossil fuel subsidies towards heat pumps.

[xii] 1 Mt of hydrogen contains approximately 33 TWh
[xiii] 1 bcm of biomethane contains approximately 10.6 TWh
[xiv] Note: Mt stands for metric tonne

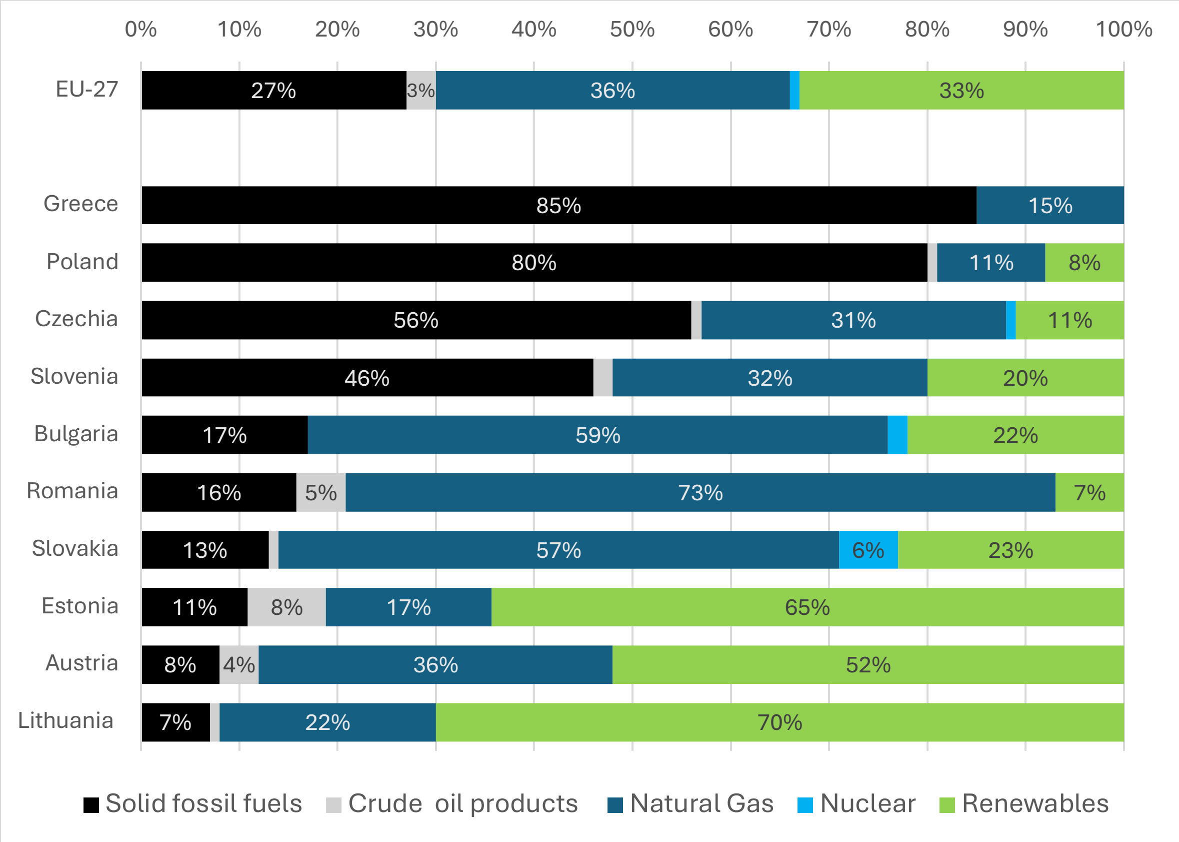


Figure 3.2: Heating by fuel (%) in Central, Eastern and Southeastern EU member countries, 2021

Source: adapted from GIE and Deloitte (2023)[53]

3.1.3 Heat pumps

Around 80% of final energy consumption in households is used for space and water heating, a demand that is predominantly met by natural gas. To reduce this dependency, the European Commission anticipates at least 21 bcm (233 TWh) will be substituted by heat pumps by 2030, a 23% reduction from 2021 levels (see also Figure 5.6).[54] with the Action Plan for Affordable Energy underscoring that heat pump adoption along with energy efficiency measures could avoid fossil fuel spending of EUR 60 billion by 2030.

Despite relatively limited market uptake, heat pumps generated 192 TWh of electricity in 2022 (Figure 3.3), just 6.6% less than the amount of electricity generated by the EU's solar PV capacity that year. Moreover, the growth of heat pump electricity generation accelerated in 2023, increasing year-on-year from 8% in 2022 to 12% in 2023, even as some reports indicated a decline in sales during the same period.

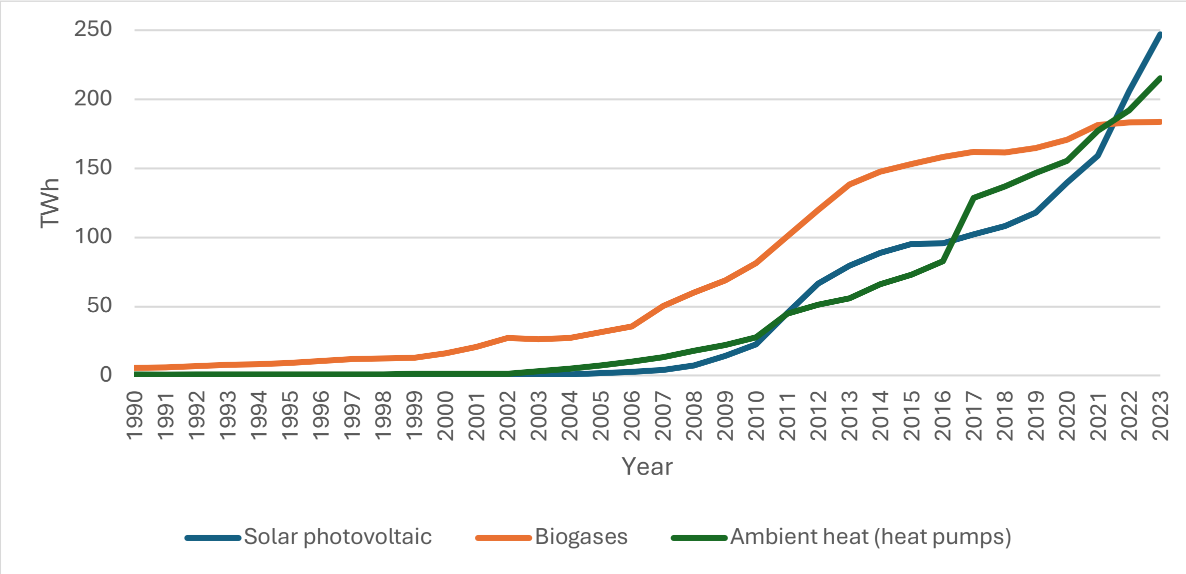


Figure 3.3: Energy generation by heat pumps in the EU, biogases and solar PV, GWh
Source: own calculations based on Eurostat (2024)[55]

Under the REPowerEU strategy, the EU aims to deploy 60 million heat pumps between 2020 and 2030,[56] with 5% of this target reached in 2022 alone. This ambition is closely linked to the phase-out of new gas boiler installations by 2029, as stipulated in the proposed eco-design rules under the Green Deal Industrial Plan.[57] However, the successful implementation of this policy direction depends on finalising the EU Heat Pump Action Plan, which was originally scheduled for release in 2023 but has faced repeated delays due to disagreements among Member States.[58]

These delays have become increasingly problematic as heat pump uptake in the EU has slowed, from the record 3 million in 2022, to just 2.2 million in 2024.[59] This deceleration of deployment can be attributed partially to supply chain bottlenecks and financial barriers. Although government incentives remain in place, the falling cost of energy has reduced the relative appeal of heat pumps, whose high upfront costs continue to pose a major hurdle.

However, even before the slowing of heat pump uptake, the EU was already off-track to meet the REPowerEU targets, especially in deploying large heat pumps for district heating systems and industrial high-temperature heat pumps.[60] Large heat pumps currently account for 1% of district heating capacity but investment plans suggest this figure could nearly double by 2030.[61] In industry, the potential market for high-temperature heat pumps (up to 200°C) is substantial (estimated at 730 TWh), however, only 2,618 units were sold in 2022, accounting for just 0.09% of total heat pump sales.

Additionally, EU decarbonisation scenarios require the expansion of district heating grids, with analysis showing that 40% of the EU's heat demand is in regions with high potential for implementing district heating.[62] Currently, the largest district heating markets are in Germany and Poland, where large amounts of coal and gas are being used, and in Nordic countries, where higher shares of bioenergy are utilised. In the residential sector, replacing utility-scale fossil-fuel boiler systems with heat pumps can accelerate decarbonisation. While heat pumps have higher upfront costs than gas boilers, superior energy efficiency can make them cheaper to run. However, this is heavily dependent on the electricity-to-gas price ratio (Figure 3.4), which is shaped in part by the higher taxation and levies imposed on electricity relative to natural gas (Figure 3.4). Empirical evidence suggests that, to make the economic benefits of heat pumps clear to consumers, the electricity-to-gas price ratio should not exceed 2.[63]

Countries such as Sweden (with a high adoption rate) and France (with high absolute numbers of installations) illustrate this point. In both cases, widespread adoption has been facilitated by relatively low electricity prices, largely due to renewable and nuclear energy. By contrast, uptake is more limited in countries where electricity and gas prices are more closely aligned. To address this barrier, the newly adopted *Action Plan for Clean Energy* recommends lowering electricity taxation and removing non-energy cost components from electricity bills.

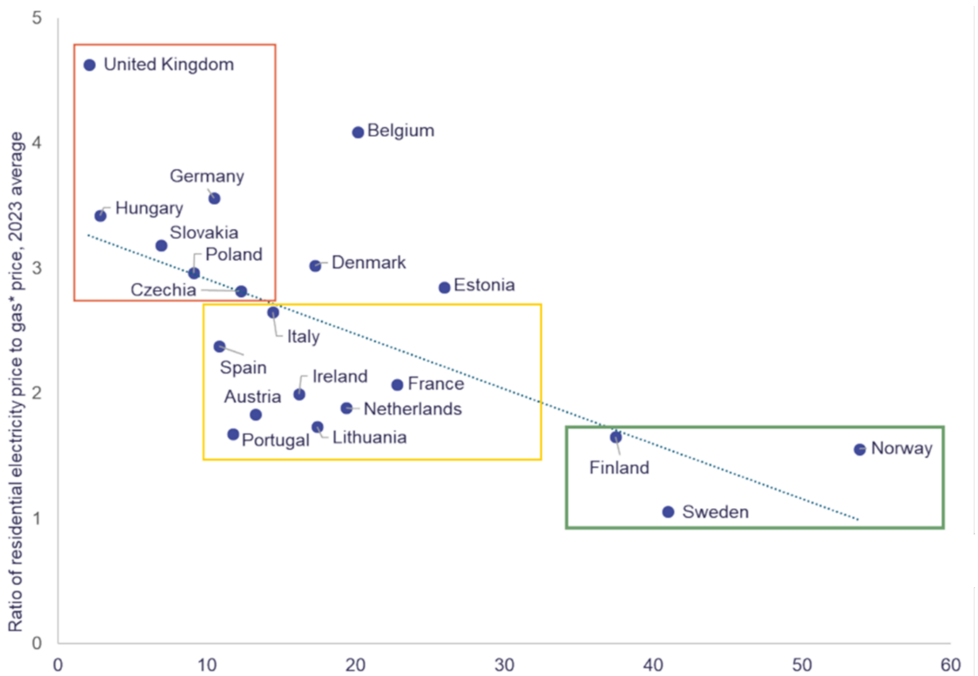


Figure 3.4: Heat pump adoption relative to the electricity-to-gas price ratio

Source: EHPA (2024)[64]

3.2 Industry

3.2.1 Decarbonisation progress and targets in industry

From 2005 until the global energy crisis, EU industry has reduced GHG emissions by 30% while growing value by 33%.[65] Decarbonisation goals imply that, to be climate-consistent by 2030, industry must reduce final energy use by 3.5 bcm/year, and annual GHG emissions by 29 $MtCO_2eq$. Yet, industrial energy use increased annually by 0.8 TWh between 2017 and 2021, while GHG emissions have decreased annually by 17 $MtCO_2eq$ between 2005 and 2022.

Steel, chemicals and non-metallic minerals account for the highest share of emissions in EU industry. In the steel sector, GHG emissions have fallen by 21% since 2008, however, emission intensity fell by only 5% (Figure 3.5, secondary y-axis, on the right), implying an absolute reduction in production levels rather than a significant improvement in efficiency. A similar trend is observed in the chemicals sector where production emission intensity has declined by 5% since 2013, while GHG emissions fell by 14% in the same period.

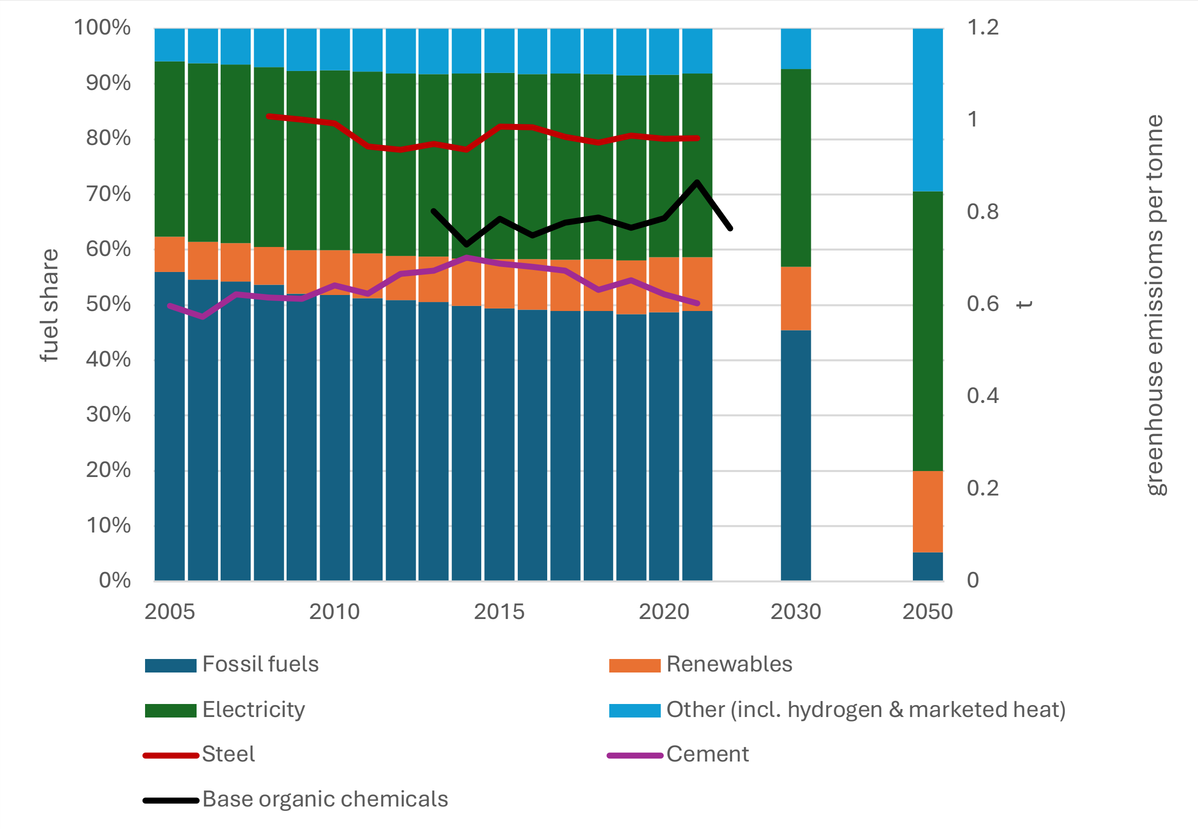


Figure 3.5: Relative fuel shares in EU industrial final energy use, and Greenhouse gas intensity of steel, cement and base organic chemicals, 2005-2022, and fuel share targets[xv]

Source: adapted from ESABCC (2024)[66]

In the scenarios for Fit-for-55 and REPowerEU, the role of industrial decarbonisation is marginal until after 2030, when fossil fuel use declines significantly through to 2050 (Figure 3.5, primary y-axis, on the left). In fact, gas consumption reduced significantly in 2022 (-15%, 12 bcm). Further industrial decarbonisation is likely to depend on electrification, which should reach at least 50% of final energy use by 2050, with renewables between 15 and 20%, and fossil fuels marginal at c. 5%.

[xv] 2030 and 2050 values are based on Climate Target Plan MIX Scenario. X-axis not to scale. Bar charts represent fuel shares (left y-axis); lines – carbon intensity (right y-axis). CO_2 e: carbon dioxide; t – tonne.

3.2.2 Gas-intensive industries

EU industry maintained net growth in 2022, however, this required a significant increase in coal production (21%) and mining services (13%), whilst primarily natural-gas-intensive industries declined. Growth was mainly seen in higher value-added sectors that are often less dependent on natural gas.[67]

During the first year of the energy crisis, major consumers of natural gas, such as chemicals, metals, oil & gas declined by 4-6% on an annual basis, and, to a lower extent, paper and pulp. Others, such as food & beverages and machinery, saw production increases.

In 2023, the decline in gas-intensive industries was largely maintained, with chemicals, iron and steel, and paper and pulp being the most affected, decreasing by over 20% (Figure 3.6). The severity of the energy crisis's impact was partly cushioned due to previously secured hedges and contracts. However, these expired towards the end of 2022, and in 2023 the industry became much more exposed to soaring energy prices.[68] Subsidies provided to energy-intensive industries also played a positive role though the impact was rather modest (2-3%).

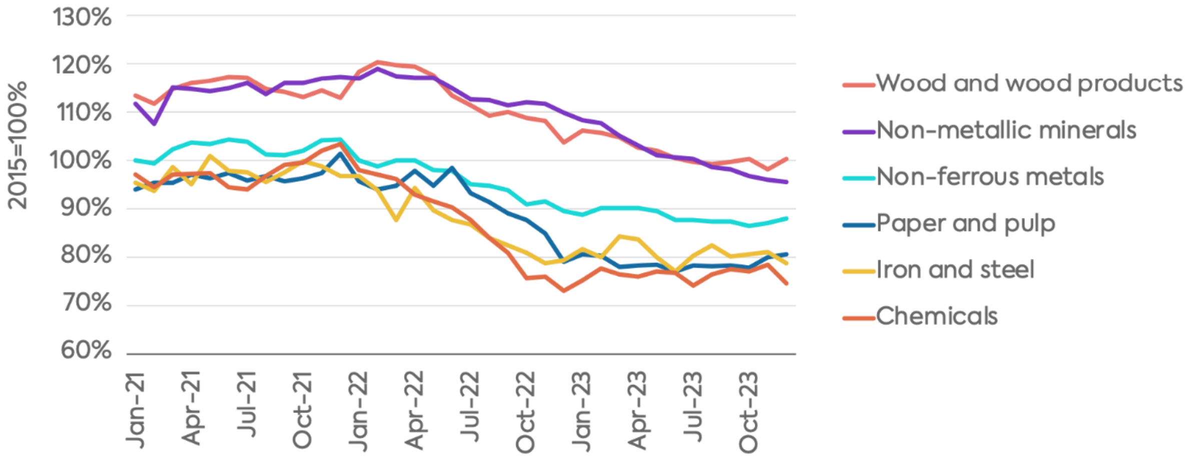


Figure 3.6: Industrial output in the worst-affected EU gas-consuming sectors since the start of the 2021 global energy crisis
Source: Losz and Corbeau (2024)[69]

3.3 Power Sector

3.3.1 Short term responses across Member States

In 2021, prior to the global energy crisis, electricity and heat production consumed about 50bcm, less than half of that used by industry or households. Both these end-use sectors significantly reduced natural gas consumption in the first year of the energy crisis, but electricity initially did the opposite.

Power sector decarbonisation requires the consideration of geographical factors and energy technology profiles. Natural gas and coal play various roles across EU countries, as displayed in Figure 3.7.[70] In Ireland, Italy, the Netherlands, and Greece, gas contributes significantly to power generation. Other Member States, like Poland, are phasing out coal, partly compensated by gas generation, with similar aspirations in Romania and Cyprus reflected in their NECPs. Where coal use is minimal, natural gas plays a crucial role in meeting peak demand alongside renewables and/or nuclear. Transitioning from coal to cleaner energy in countries like Poland, Czechia, Bulgaria, Germany and Slovenia may increase demand for natural gas unless significant zero-carbon balancing capacity is deployed (such as novel energy storage or pumped storage hydropower).

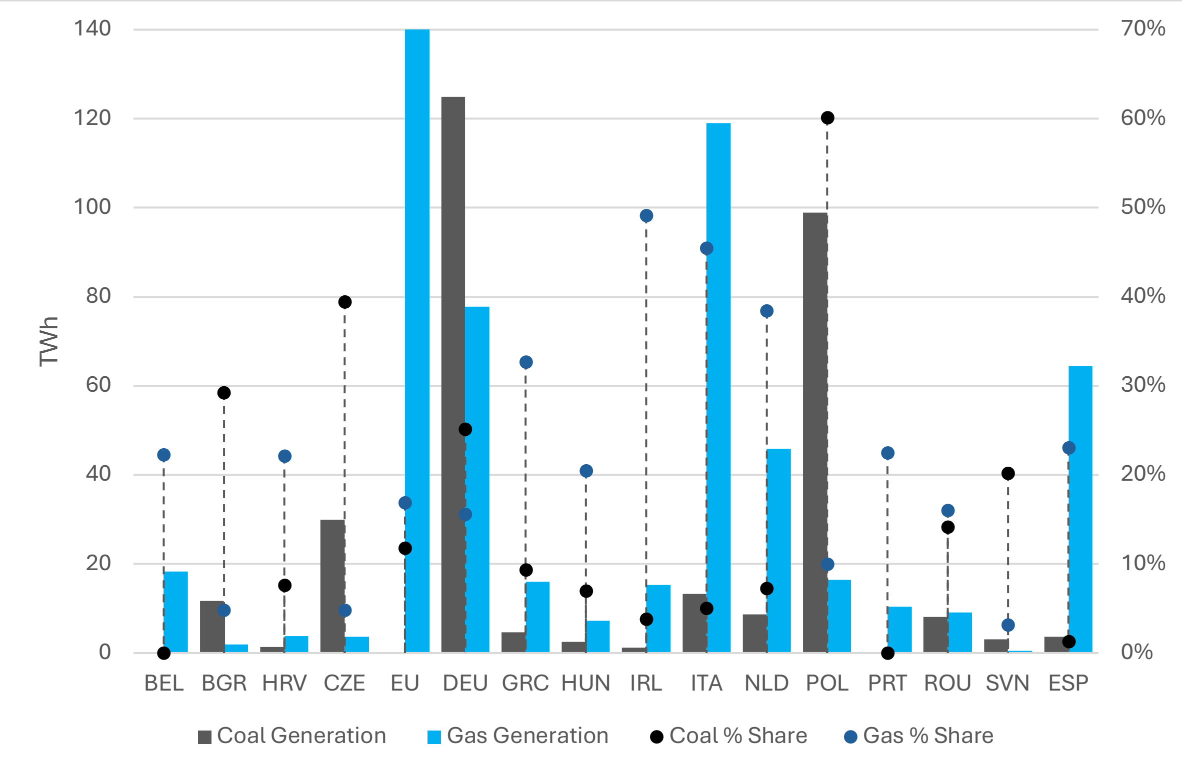


Figure 3.7: Coal and gas power generation across EU Member States, 2023[xvi]
Source: adapted from Ember (2024)[71]

In 2023 and 2024, natural gas consumption trends reversed compared to 2022, when power consumption rose by 3.5 bcm (37 TWh) (Figure 3.8). In 2023, the highest-ever annual reduction in natural gas consumption in the EU occurred, at 8 bcm (82 TWh). Only Poland had a significant increase in natural gas generation (3.4 TWh), due to coal phase-out (-22 TWh in that year), uptake of renewables, and lower energy demand due to efficiency improvements and stagnated economic activity.

[xvi] Country acronyms (in order from left to right): Belgium, Bulgaria, Croatia, Czechia, EU, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, Romania, Slovenia, Spain.

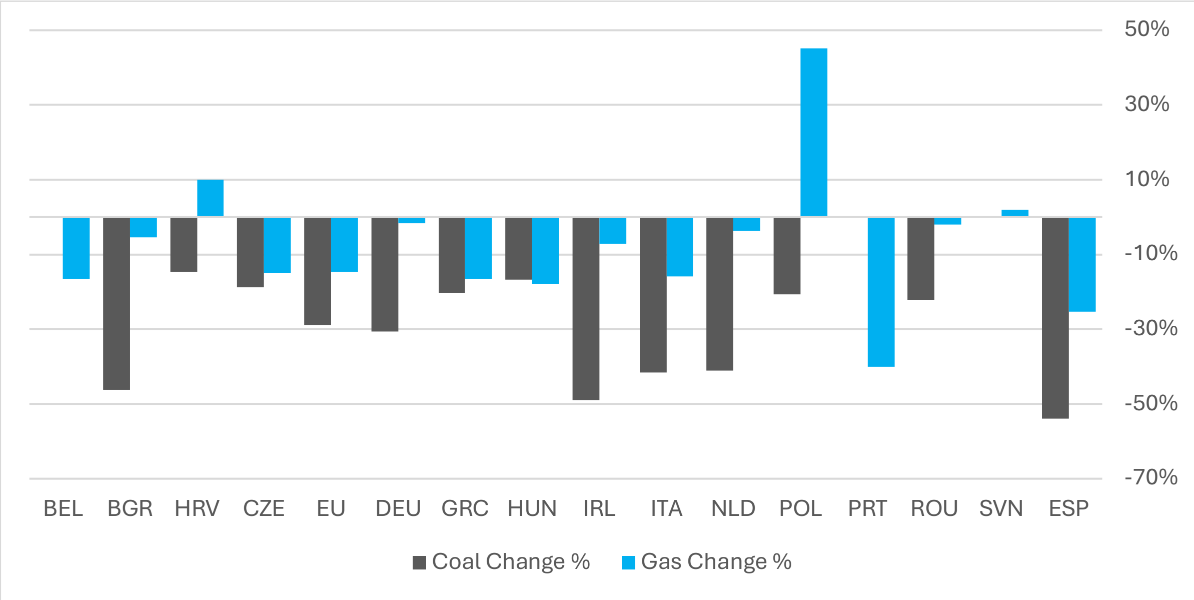


Figure 3.8: Change in coal and natural gas electricity generation from 2022 to 2023 in selected EU Member States[xvii]

Source: adapted from Ember (2024)[72]

Decreases in gas and coal consumption can be partly attributed to France ramping its nuclear capacity after repairs in 2022, renewables seeing accelerated growth, and electricity demand declining due to improved energy efficiency and stagnant economic activity. Additionally, enhanced electricity interconnection across the EU improved consumption efficiency,[73] and a mild winter in Europe lowered natural gas demand in buildings. As a result, natural gas and coal consumption declined by 69 TWh (7.8 bcm) and 118 TWh in 2023, respectively (Figure 3.9), with a further reduction of 29 TWh and 37 TWh in the first half of 2024.[74] This implies a less congested natural gas market, helping lower prices.

[xvii] Country acronyms (in order from left to right): Belgium, Bulgaria, Croatia, Czechia, EU, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, Romania, Slovenia, Spain.

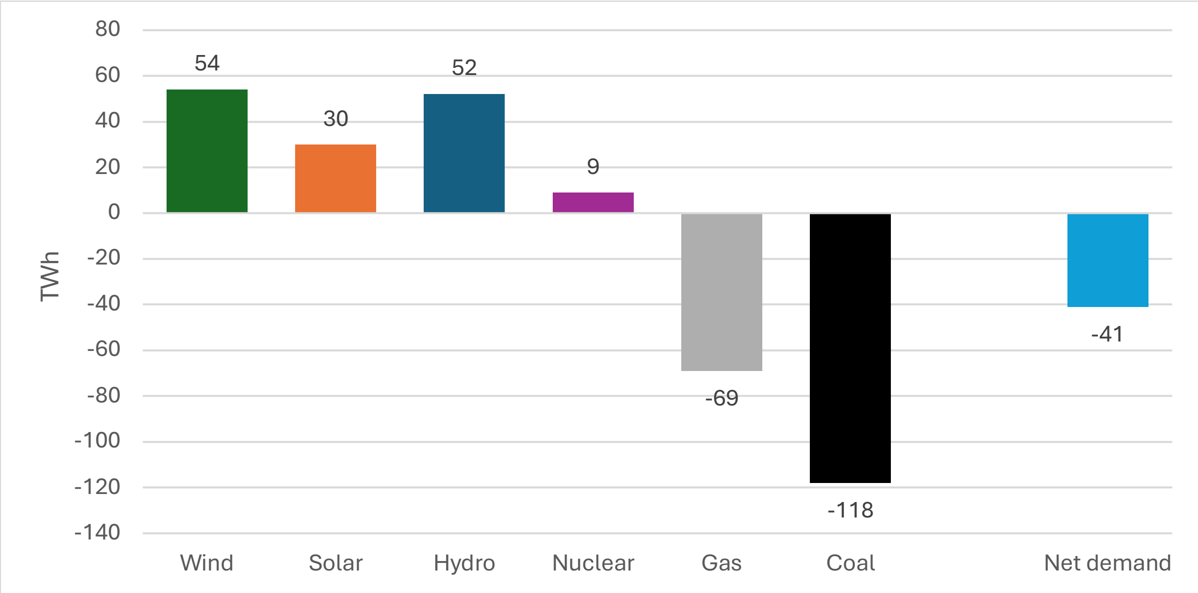


Figure 3.9: Power generation changes by technology, and demand, in the EU, 2022-2023

Source: adapted from ACER (2024a)[75]

3.3.2 Investment pipeline in gas power generation

Despite the EU's ambitious agenda for natural gas reduction by 2030, new investments in combined cycle gas turbine (CCGT) power plants are already in the pipeline, with over 30 GW in pre-construction and construction stages, while another 8 GW are still mothballed (Figure 3.10).[76] It is expected that by 2025 almost 11 GW of new gas power plants will be commissioned in the EU.

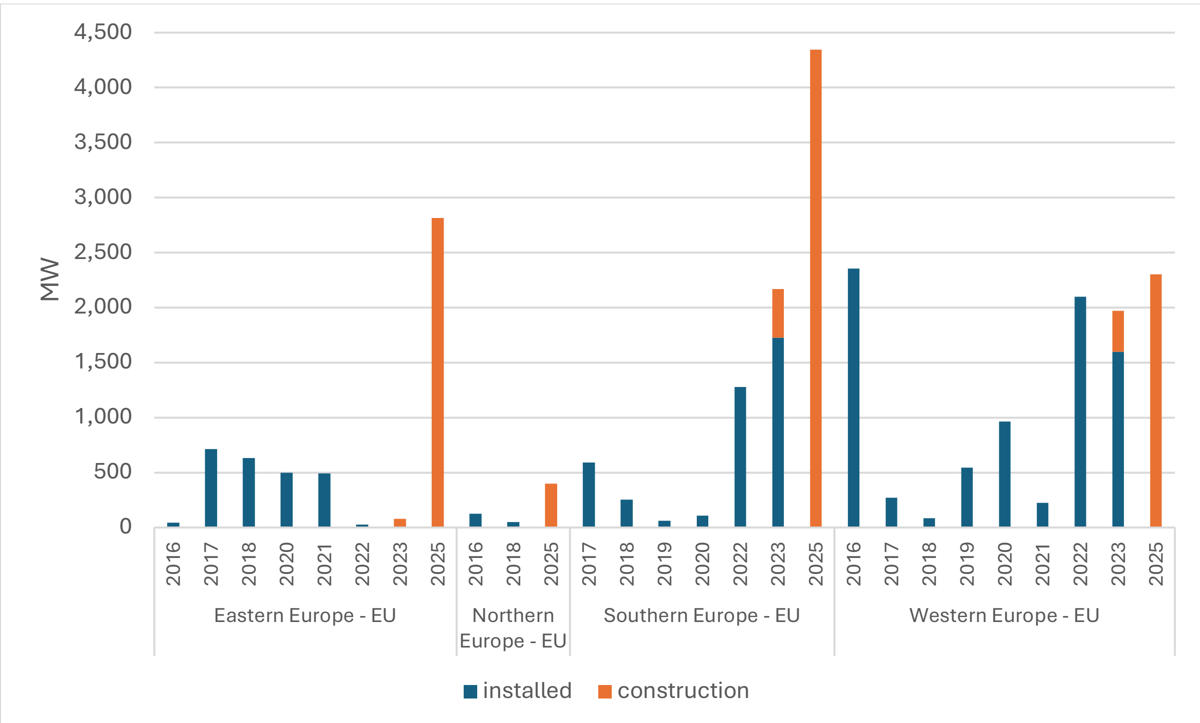


Figure 3.10: New additions of gas generation capacity since 2016 (COP21) and 2022 (energy crisis)

Source: own calculations based on Global Energy Monitor (2023)[77]

Investments in new gas generation are also central to the transition from coal, especially in dependent countries such as Germany and Central-Eastern European Member States. Over 12 GW of new gas generation is planned to manage peak demand and balance the grid in regions lacking sufficient energy storage. Countries such as Poland, Hungary, and Slovakia are committing to nuclear investments to provide baseload generation, [78] although this increases reliance on fuel and technology maintenance.

In contrast, nuclear-averse Germany planned to commission 25 GW of 100% hydrogen CCGT and hydrogen-ready natural gas CCGT plants, mostly to replace coal generation, and partly to meet new demand.[79] The collapse of the German government in late 2024 has cast doubt on the likelihood of the government securing funding to commission these power stations.[80]

3.3.3 Emerging challenges in the power sector: EVs, flexibility, and market structure

3.3.3.1 Electric vehicles: shifting from oil to more electricity

Alongside electrification as a route to decarbonise industry, the European Green Deal has also flagged its growing role in the transport sector as a route to reduce Europe's dependence on international oil markets. This objective was also underscored by the energy crisis, in part because oil prices soared (though less dramatically than gas), but also because it proved hard to implement sanctions on Russian oil, much of which found its way through other routes to international energy markets.

Whilst the performance of electric vehicles has improved substantially, the European car industry has lagged behind the progress in China, where electric vehicles are typically cheaper to buy, operate and maintain. This poses a complex challenge for the goal of European industrial competitiveness, but the direction of travel towards transport electrification is clear.
This will drive up electricity demand and, for some years to come, mean that some of the EU's oil demand shifts towards gas in power generation, albeit with much higher overall efficiency of use. EVs connected to the grid may contribute somewhat towards system flexibility, but only to a limited degree, and for limited durations.

3.3.3.2 Grid flexibility and electricity storage

REPowerEU raises the renewable energy ambition to 42.5% of the total energy mix. The European Commission envisions that the electricity grid should be able to absorb at least 69% of variable renewable energy supply by 2030 and 80% by 2050.[81] This requires enhanced flexibility through energy storage, supply-side adaptability, demand response, and interconnection. The grid's flexibility requirements are expected to increase from 11% of electricity demand in 2021 to 24% (288 TWh) in 2030 and 30% (2,189 TWh) in 2050 (Figure 3.11).[82] If not properly addressed, grid management costs are expected to increase from EUR 5.2 billion to over EUR 26 billion in 2030. Apart from domestic investments in grid infrastructure, the EU also put forward a target to increase interconnection in Member States by 15% by 2030. According to the Agency for the Cooperation of Energy Regulators (ACER), interconnection in the EU and with and between its neighbouring markets [xviii] should increase by 64 GW by 2030 from 93 GW in 2023.

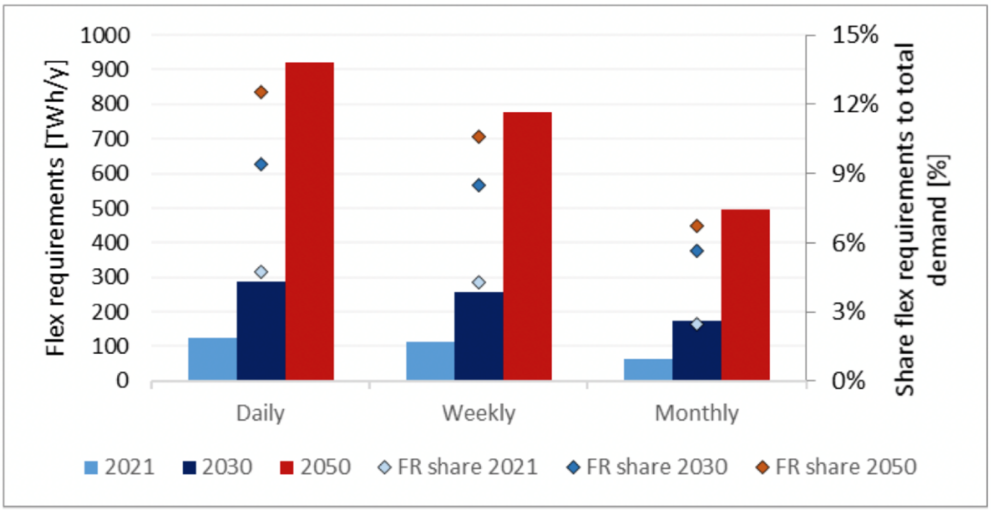


Figure 3.11: Flexibility requirements in the EU in 2021, 2030 and 2050
Source: European Commission (2023b)[83]

Pumped hydro energy storage (PHES) remains the EU's main energy storage solution, with nearly 45 GW of installed capacity.[84] While there is still some potential to renovate existing projects, there is limited capacity to develop more PHES projects. Utility-scale battery energy storage reached 5.2 GW in 2024,[85] with total European battery capacity [xix] reaching 36 GWh (around 16 GW) in 2024.[86] Utility-scale battery storage will likely play an important role in providing grid flexibility and delaying the need for transmission upgrades. Residential and industrial battery storage is also growing significantly and will reduce some strain on the transmission system.

Yet, up to 200 GW of electricity storage is expected to be required by 2030, and batteries – whether stationary, or in EVs – can only contribute a portion of this.[87] The shift towards distributed renewables requires grid redesign, with the EU Action Plan on Grids suggesting over EUR 580 billion is needed in grid upgrades and expansion by 2030, 65% of which is for distribution networks.[88] With the growing presence of variable renewables, and additional demand driven by electrification, the requirement for dispatchable generation will also grow. On the other hand, enhancing demand-side flexibility can help reduce EUR 2.7 billion in avoided peak generation that is often met by natural gas, though cost uncertainty remains due to gas price volatility.[89]

[xviii] A geographical scope including EU borders and borders with and among Albania, Bosnia and Herzegovina, Montenegro, North Macedonia, Norway, Serbia, and Switzerland. Further borders with non-EU countries include Egypt, Israel, Tunisia, Türkiye and the United Kingdom.

[xix] Including residential, industrial, and utility-scale

3.3.3.3 'Decoupling' and electricity market structures

The Draghi report [90] notes that *'Europe's electricity market rules pass on [gas price] volatility to end users and may prevent the full benefits of decarbonising power generation from reaching them'* (p.44), noting that in 2022, natural gas set the electricity price 63% of the time, despite making up only 20% share of the EU's electricity mix.

The Action Plan for Affordable Energy[91] states *'The Commission will step up efforts under the electricity market rules to decouple electricity bills from price volatility'* (p. 8), shifting the emphasis to *'boosting the uptake of long-term electricity supply contracts'* (p.8), but implicitly, within the current market structure, rather than considering distinct market structures specifically designed for renewables.[xx]

The Clean Industrial Deal [92] itself steps back even from this, stating that *'natural gas is overall expected to remain the main price-setter for electricity in the next years in the EU*…[but that]… *the Commission stands ready to support Member States when designing State aid measures …. based on proven models in emergency situations'* (p.4). Given the complexity of the EU energy market development over decades, it is not surprising that the EU remains wedded to the simple economic idea of a single electricity market with price defined by the 'marginal' generator. So, the electricity price will remain predominantly set by fossil fuels (except for periods when there is surplus zero carbon generation driving prices to near zero). In turn, this implies that for much of the time, energy consumption in Europe will in practice be driven by a relatively small sliver of the EU's energy market – one aspect of a fuel that Europe is in principle committed to largely phasing out, namely its international LNG imports (see Section 4).

3.3.4 Gas infrastructure

Achieving REPowerEU targets affects gas infrastructure, as projected demand reduction and network usage will require retrofits to accommodate lower load factors. Some decommissioning will also likely be required. There is no common agreement on the potential for converting gas infrastructure to hydrogen. A study in Central Eastern and Southeastern Europe acknowledges that retrofits are possible without significant investment, but suitable only for blending hydrogen with natural gas in the range of 2-10%.[93] However, this is not endorsed by the EU, acknowledging technology lock-in and stranded asset risks. Biomethane injections are seen to be more suitable for gas infrastructure, though they require reverse flow facility investments. The considerations for the future role of gas networks and LNG infrastructure are further discussed in Section 4.

[xx] For a detailed discussion of these issues in the UK context, including the economic principles and some alternative approaches, see our series on *Navigating the Energy and Climate Crises*, specifically Working Papers 3 and 4.

3.4 LOW-CARBON GASES

3.4.1 Biomethane

The RePowerEU biomethane target of 35 bcm by 2030 could lead to the replacement of 370 TWh of fossil-fuel gases in heating, industry and transport. Achieving this requires EUR 48 billion to build 4,000 medium-sized plants and another EUR 35 billion for 1,000 large-scale plants.[94,95]. Biomethane is a purified form of biogas with a higher methane content, which provides many benefits over biogas. Once purified, it can be fed into the existing grid or liquefied, traded and transported like LNG. This can be especially useful in hard-to-abate industrial sectors and the residential sector, as neither applications require adapting existing infrastructure.[96] However, relying on biomethane risks carbon lock-in and indirectly inducing natural gas extraction. Biogas cannot be substituted like biomethane can and is primarily used for power and heat in CHPs.

However, discrepancies exist in classification, making it difficult to distinguish between biogas and biomethane. For instance, ACER tracks progress across biogas as a whole,[97] whilst European Biogas Association makes a distinction, separating results for biomethane out from biogas.[98] Unlike electrolytic[xxi] hydrogen, biogas and biomethane are mature technologies in the EU market. Since 2008, biogas, including biomethane, production has more than tripled, reaching almost 20 bcm in 2022.

In 2022, biogas production was 4 times higher than biomethane, making the distinction crucial for REPowerEU target progress. Official communications, however, vary in clarity. The European Commission's website states *'biomethane production, either as biogas or its upgraded version',*[99] whilst REPowerEU documents reference *'boosting sustainable biomethane production to 35bcm by 2030'*;[100] the Biomethane Action Plan similarly states, *'boost[ing] biomethane production to 35 bcm by 2030'*.[101]

Achieving the 35 bcm target by 2030 requires a significant production increase. As of June 2024, Europe as a continent had over 1,500 biomethane facilities and a capacity of 6.4 bcm (5.2 bcm of which is in the EU, up 37% from 2022-2023[102] compared to 20% growth

[xxi] Can qualify as 'green' hydrogen if powered by 100% renewables

in non-EU countries).[103] This is above the required annual growth rate identified by the European Biogas Association (Figure 3.13).

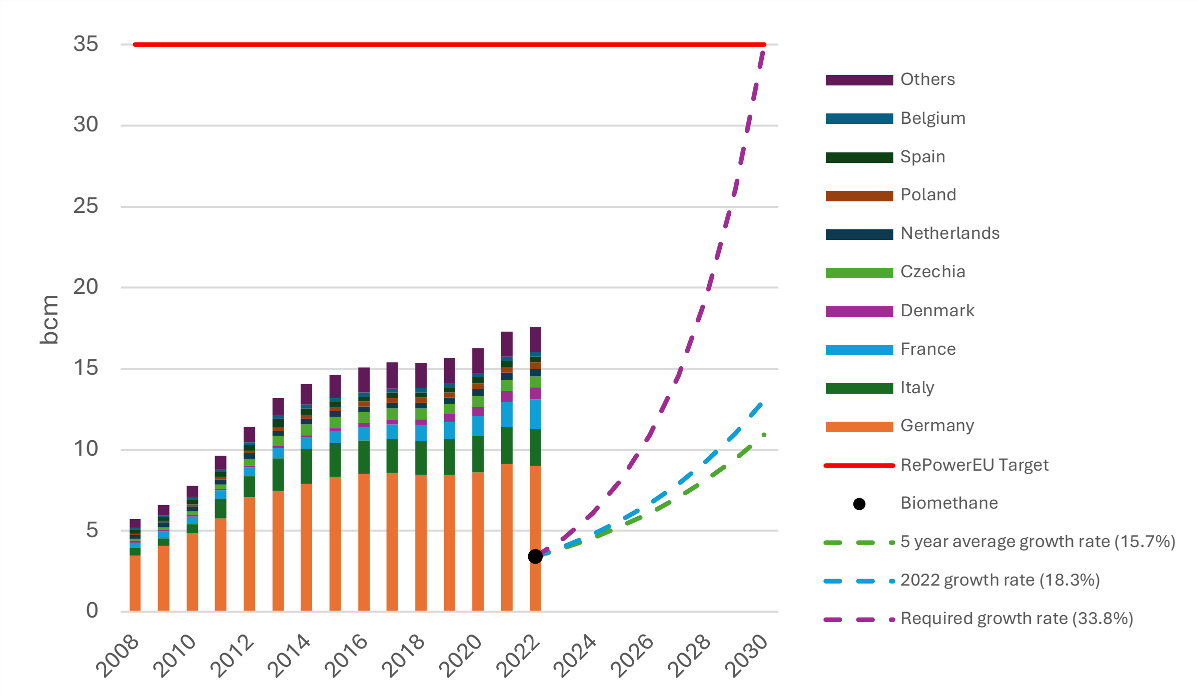


Figure 3.12: EU biogas production 2008-2022, alongside 2022 biomethane production level and required growth rates[xxii]

Source: For biogas – indigenous production of biogases (TJ) from Eurostat (2025)104 and conversions from European Biogas Association (2024a).[105] For biomethane levels and growth rates, European Biogas Association (2023).[106]

Figure 3.12 illustrates biogas production across EU Member States. Separately, current biomethane production levels and growth rates are shown, emphasising the substantial increase required for *biomethane only* to meet the 35 bcm target. This growth rate must almost double from its existing value to around 34%. Final NECPs from 22 EU Member States envision just 25 bcm of biomethane production,[107] off track from the REPowerEU target. Acknowledging these challenges, in its recently adopted Action Plan for Affordable Energy the EU aims to boost supply by demand aggregation and joint procurement strategies for biogas and biomethane.[108]

Current biogas production and biomethane upgrading costs range from 54-91 EUR/MWh, varying by plant capacity and feedstock.[109] These estimates assume a natural gas price of 44 EUR/MWh, rising to 64 EUR/MWh with EU ETS, making most biomethane (apart from that produced in the largest plants) uncompetitive. In contrast, in 2024 and Q1 2025, EU gas prices were often below 40 EUR/MWh.

[xxii] Bars depict 'biogas' production levels, whereas dots and lines depict 'biomethane' production levels and required growth rates.

3.4.2 Hydrogen

3.4.2.1 The ambition

The EU hydrogen market is currently about 8Mt (265 TWh), almost fully met by unabated fossil-fuel-derived (grey) hydrogen and is primarily used in the oil and gas industry for refining (4Mt, 132 TWh), ammonia (2.5 Mt, 83 TWh) and methanol (1Mt, 33TWh) production. The review of RED III (Renewable Energy Directive) in November 2023 established criteria for hydrogen to qualify as green, labelled a RFNBO.[110] The Directive targets 42% RFNBO use in industry by 2030, 60% by 2035, and mandates 5.5% RFNBOs or advanced biofuels for transport and energy by 2030. The establishment of criteria for renewable hydrogen helps resolve the bottleneck that was delaying investment and project development. The additionality criteria specify that renewables should not be installed earlier than 36 months prior to the commissioning of an electrolyser, though transitional by-laws apply. Alternatively, if powered from a combination of energy sources, including the grid, the GHG emission threshold must be 70% of the 'fossil fuel comparator' to qualify as an RFNBO.

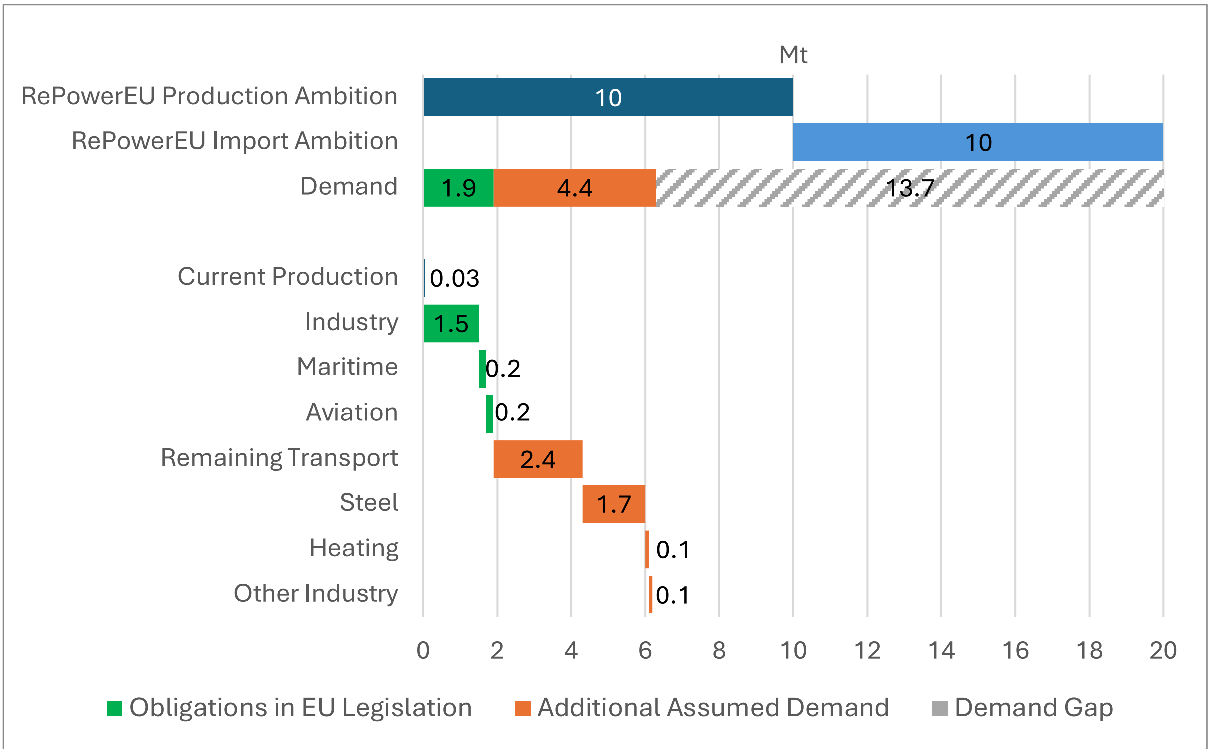


Figure 3.13: REPowerEU ambitions for green hydrogen (RFNBO) in 2030, compared with legislative obligations and targets[xxiii]

Source: adapted from Hydrogen Europe (2023)[111]

[xxiii] Obligations for green hydrogen demand (green) are generated from the following: 42% H2 used in 'Industry', 1% of fuels supplied at ports in 'Maritime', 1.2% synthetic fuels used in 'Aviation', 1% of transport fuels for 'Remaining Transport'. Additional assumed demand (orange) taken from source; the remainder accounts for demand gap (grey). Demand to be met by a balance of domestic production and imports.

REPowerEU aims to expand green hydrogen use, targeting 20 Mt (660 TWh) of green hydrogen by 2030,[112] 10 Mt from domestic production, and 10 Mt from imports using shipping in the near term and the pipeline import closer to 2030. However, discrepancies exist between REPowerEU and other legislative obligations and targets. Hydrogen Europe highlights a projected demand of approximately 6.3 Mt (208 TWh) (Figure 3.13),[113] which overlooks the existing demand of c. 8 Mt (264 TWh) in refining and ammonia. Additionally, while off taking capacity should be sufficiently developed, green hydrogen cannot be significantly ramped up in the short term, with the installation of blue hydrogen facilities more plausible. However, there are no indicative targets developed for blue hydrogen, which could stimulate demand. In September 2024, the European Commission launched a consultation on low-carbon hydrogen criteria, although it is not yet clear what the results of this consultation will be, as the final delegated act must be adopted by August 2025. [114]

However, domestic production and import targets for green hydrogen are not legally binding for Member States, and some have not incorporated them into their draft NECPs. Even the 16 Member States who have addressed green hydrogen in their NECPs indicate targets aggregating close to 50 GW of electrolyser capacity, while actual national strategies point to less than 40 GW.[115] Additionally, technical inconsistencies exist in the requirements for 10 Mt (330 TWh) of green hydrogen, with estimates ranging from 80 GW to 140 GW of electrolyser capacity required to deliver this quantity of hydrogen across policy documents and papers. This cascades uncertainty into investments in electrolysers, additional renewable capacity and supporting infrastructure.

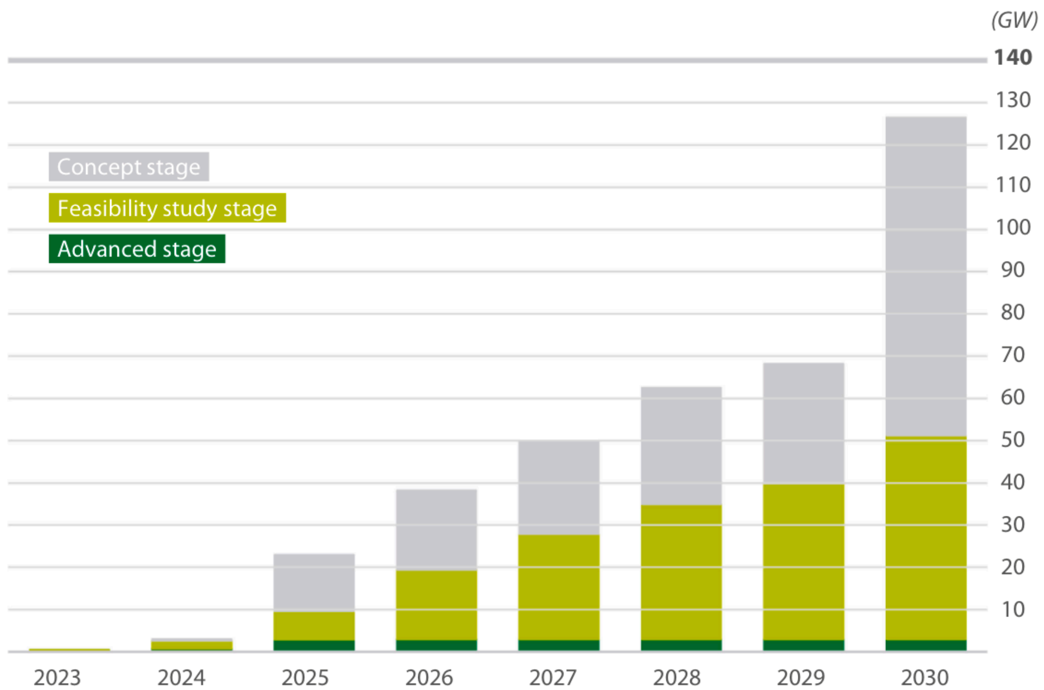


Figure 3.14: Electrolyser capacity of projects announced by stage and projected year of entry into operation[xxiv]

[xxiv] Advanced stage includes projects that are operational, or where the stage is 'under construction', or for which a final investment decision has been taken.

Source: Court of European Auditors (2024)[116]

The Court of European Auditors (Figure 3.14) reports green hydrogen project development is mostly off-track relative to REPowerEU targets. Only 0.1 GW is operational or under construction. Given lead times of up to 7 years from commissioning, it is very plausible the 10 Mt (330 TWh) target of domestic production will be delayed until at least 2035.

There also exists a final mismatch between the proposals for hydrogen projects in NECPs and key demand centres. The Court of European Auditors notes that Poland has a significant concentration of hard-to-abate industries, however, it does not have any projects in advanced stages and does not benefit from existing funding for hydrogen initiatives. Similarly, Romania has significant renewables potential but is not involved in any hydrogen storage projects or hydrogen-derived synthetic fuels. It is thus unclear whether, even if sufficient green hydrogen capacity is developed, it will be located close enough to demand centres to be feasibly implemented to replace natural gas.

3.4.2.2 Investment needs for hydrogen infrastructure deployment

As of 2023, the EU had 160 MW of electrolyser capacity, which allowed the production of 0.3 Mt (10 TWh) of electrolytic [xxv] hydrogen, though not necessarily powered by renewables.[117] Meeting the 10 Mt (330 TWh) domestic production target will require 80-100 GW of electrolyser capacity, a 500-fold increase and 150-210 GW of additional renewable capacity. The European Commission estimates this will require investments of EUR 335-471 billion, with EUR 200-300 billion (60%) allocated to additional renewable energy, and EUR 50-75 billion (15%), for electrolysers.[118]

Remaining investments in hydrogen infrastructure will require EUR 34-49 billion, including EUR 28-38 billion for pipelines and EUR 6-11 billion for storage. Whilst feasibility studies indicate that repurposed gas networks could make up 85% of hydrogen infrastructure in the Netherlands and 60% in Germany, the entire hydrogen network will require investments of EUR 4.5 billion and EUR 19.8 billion, respectively.[119] Importing an additional 10 Mt (330 TWh) could require up to EUR 500 billion in supply chain investments.

Currently, green hydrogen has a premium of 3-5 EUR/kg compared to fossil-fuel derived[xxvi] hydrogen due to high production costs, low deployment and lack of sufficient transportation and storage infrastructure. With scaling, the European Commission expects 10 Mt (330 TWh) of green hydrogen will cost EUR 90-115 billion to produce.[120]

To address investment challenges, the EU established the European Hydrogen Bank, a dedicated facility to providing support for investments in green hydrogen through fixed

[xxv] Produced from water through electrolysis
[xxvi] Produced from hydrocarbons, mainly natural gas, through steam methane reforming

premium 10-year contract auctions. The first round allocated EUR 800 million in autumn 2023 and EUR 720 million in the second round in autumn 2024.

3.5 KEY TAKEAWAYS

The dramatic drop-off in heat pump uptake presents a particular challenge to meeting REPowerEU targets, while also illustrating how significantly the context around decarbonisation has shifted since 2021. In 2024, Germany passed an ambitious plan to fully decarbonise heating by 2045.[121] Yet, there are now signals the country may weaken some of its interim targets given pressures facing the newly government to redirect its attention from decarbonisation to other sectors (e.g. industry and defence).

The barriers to transitioning to electric heating are largely financial alongside supply chain bottlenecks, which, while challenging are not insurmountable. There is also the twin challenge of ensuring that the electricity provided to users is both low-carbon and affordable. This ambition will require significant investment in grid infrastructure, low carbon generation and storage. These issues are addressed in the recently adopted EU's Clean Industrial Deal and Action Plan for Affordable Energy that underscores that electrification of the economy will require affordable energy, harnessing the potential of cheap renewables, if electricity market design is accordingly reformed.

In contrast, decarbonisation via hydrogen and other gases depends on technical innovation, with persistent uncertainties around the costs and timelines for transportation, distribution, and storage to support the production, imports, and consumption of these gases. Given the long lead times to deploy alternate gases (especially hydrogen), slow movement in this area, coupled with declining rates of electrification, could potentially risk the ability to meet REPowerEU targets. On the other hand, directing strategic investments into industrial electrification might overall reduce demand for green hydrogen, hence, lowering capital-intensive hydrogen production industry.

The introduction of the Clean Industrial Deal also underscores the need to shift the EU economy towards industrial transformation. Instead of moving energy-intensive industries abroad, the bloc's vision is to increase industrial competitiveness and enhance economic resilience: an important element of the EU economy. This entails reforming energy markets to make industrial electrification more affordable and create a level-playing field for renewable and low-carbon gases. Learning from the lessons of the AggregateEU platform used for natural gas procurement during the energy crisis, the EU also aims to boost supplies of green hydrogen, biogas and biomethane by demand aggregation and joint procurement strategies.

4 LNG INFRASTRUCTURE IN THE EU AND GAS CONTRACTING

The following section addresses two issues. Firstly, European investment in LNG and gas infrastructure to replace Russian gas and, secondly, gas contracting and the effect both contracting and investment could have on the EU's gas

Despite the challenges posed by the energy crisis to maintaining EU gas supply, domestic gas production has declined. Planned closures of gas fields have continued, with domestic production declining from 54 bcm in 2020 to 38 bcm in 2023.[122] This mirrors a broader trend of European gas production declining, mainly due to gas field depletion and environmental concerns, including subsidence.

Prior to the 2022 energy crisis, 41% of the EU's gas imports came via pipelines from Russia, 39% came from other pipeline suppliers, and 20% as LNG. Following Russia's invasion of Ukraine and the sabotage of the Nord Stream gas pipelines, the EU faced an urgent need to diversify imports, compounded by the planned closure of a major gas field in Groningen, the Netherlands. The EU mobilised its financial and political resources to fast-track the expansion of LNG infrastructure and targeted a 15% reduction in gas consumption.

By 2024, Russia still supplied 18% of the EU's natural gas imports (through a mix of pipeline and LNG), however this was a dramatic reduction from 41% in 2021.[123] The gap was filled by US LNG and Norwegian pipeline gas: 25% and 50% respectively, with the remainder coming from North Africa and Azerbaijan. LNG imports increased from 80 bcm in 2021 to 130 bcm in 2022,[124] making the EU the largest global LNG market.[125] The EU spent EUR 110.6 billion on LNG imports in 2022 and EUR 61 billion in 2023.[126]

The trade routes shift transformed transit countries like Romania, Hungary, Slovakia and Poland into endpoints in LNG value chains, reducing transit revenues for them and increasing LNG transportation costs.

Import volumes marginally rose to 134 bcm in 2023, with the average LNG price falling from EUR 851 per 1,000 cubic meters in 2022 to EUR 455 in 2024 as regasification capacity expanded by over 70 bcm. In 2024, LNG imports declined by 32 bcm, with the bloc spending EUR 35.9 billion on LNG in the first 11 months of 2024.

4.1 INVESTMENTS IN LNG AND GAS INFRASTRUCTURE

4.1.1 LNG investment pipeline

According to GIE,[127] the EU's LNG capacity was 193 bcm (2,019 TWh) before the energy crisis, with additions of 1.5 bcm (17 TWh) in 2022 and 62 bcm (650 TWh) projected for 2023-2024. By 2030, capacity is expected to expand by ~67%, reaching 322 bcm (3,373 TWh; Figure 4.1). Similarly, LNG infrastructure grew from 164 bcm in 2021 to 235 bcm by the end of 2024, following a 71 bcm increase during the energy crisis.[128]

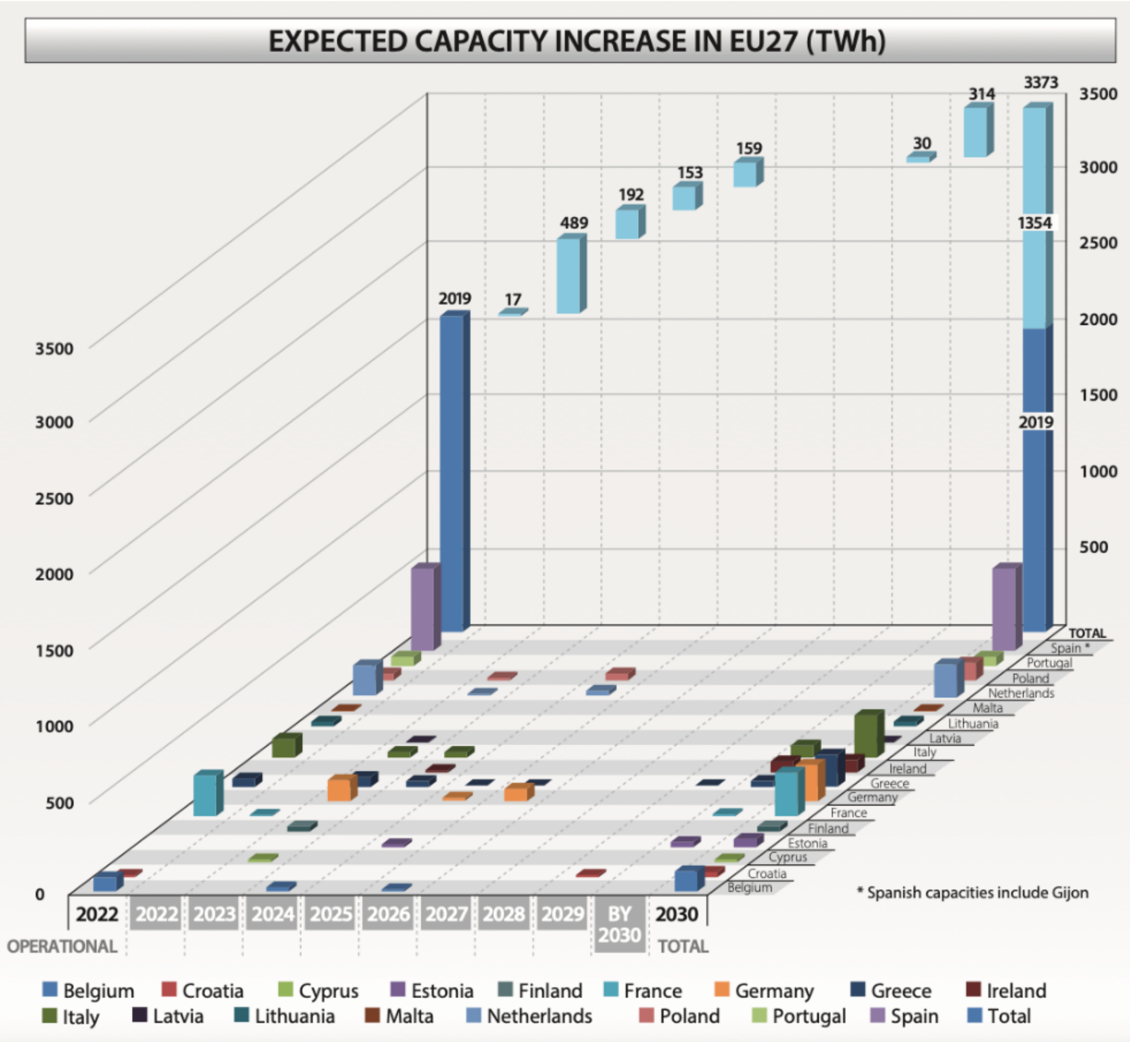


Figure 4.1: Expected LNG capacity increase in EU27 (TWh)

Source: GIE (2022)[129]

The EU's LNG capacity is projected to approach 300 bcm by 2030, while the projected/targeted demand may only be 50 to 100 bcm.[130] Depending on domestic natural gas production, this could leave nearly half of LNG terminal capacity underutilised depending on the time of year and current demand level. Additionally, storage injections, discussed later, allow for lower but more consistent utilisation rates. Most new LNG additions are floating storage and regasification units (FSRU), which can be relocated to other markets or repurposed for hydrogen derivatives like ammonia and methanol, reducing asset-stranding risks. REPowerEU anticipates importing 4 Mt (132 TWh) of hydrogen derivatives via shipping as a near-term solution before pipeline imports materialise.

Since the start of the global energy crisis, LNG investments have soared. Global Energy Monitor (Figure 4.2) reports USD 5 billion invested on LNG import terminals, with another USD 29 billion in the pipeline, potentially bringing total investment in excess of USD 93 billion.[131] In addition, USD 4.5 billion in gas pipeline projects are under construction, with another USD 60.1 billion in the investment pipeline.[132]

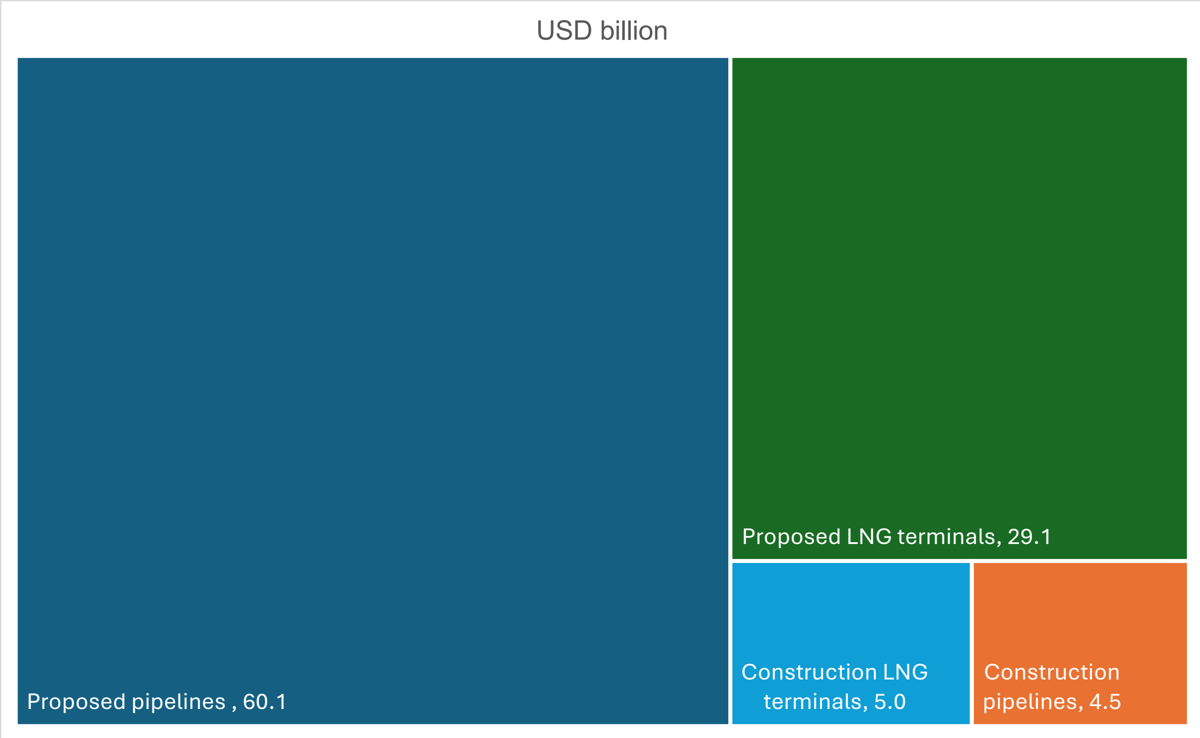


Figure 4.2: Under construction and proposed investments in LNG import terminals and gas pipelines in the EU in Q4 2023
Source: Own calculation based on Global Energy Monitor (2023)[133]

If all under construction and proposed LNG import terminals and gas pipelines are completed, investments would total USD 98.7 billion. This poses the risk of asset stranding unless they can be relocated to other markets or repurposed (e.g. for hydrogen transportation, if economically feasible). On top of this, investments in new gas power generation continue, reflecting the need for flexible generation and the retirement of some existing power plants. As of February 2024, the EU planned to invest in at least 17 GW of new gas power plants, mapped in Annex B, [134] which is also reflected in the need to invest in gas pipelines. New LNG and gas infrastructure investments by member state are shown in Annex C.

4.1.2 LNG terminals utilisation

Prior to the energy crisis, EU LNG terminals operated at about 40% capacity in 2021, when LNG accounted for about 20% of natural gas imports. Post-2022 investments aimed to increase LNG imports to compensate for the significant decline in Russian pipeline gas supply, address winter supply demand, and enable summer storage injections. However, conflicting efforts to decarbonise, reduce gas demand, and diversify supplies risk an overinvestment in LNG if successful.

During 2022, the spike in natural gas demand meant some LNG regasification terminals ran 100% or even over capacity, causing congestion. The addition of over 70 bcm since then has partly resolved congestion, with utilisation falling to 58% in 2023 and 42% in 2024 (Figure 4.3).[135] This demand is not evenly spread across all Member States, with Spain facing utilisation rates in the summer of 2024 as low as 18%, while the utilisation rate in Poland hovered above 80% for most of the year. Despite this variance in utilisation, Germany is pursuing the world's third largest LNG import build out.[136]

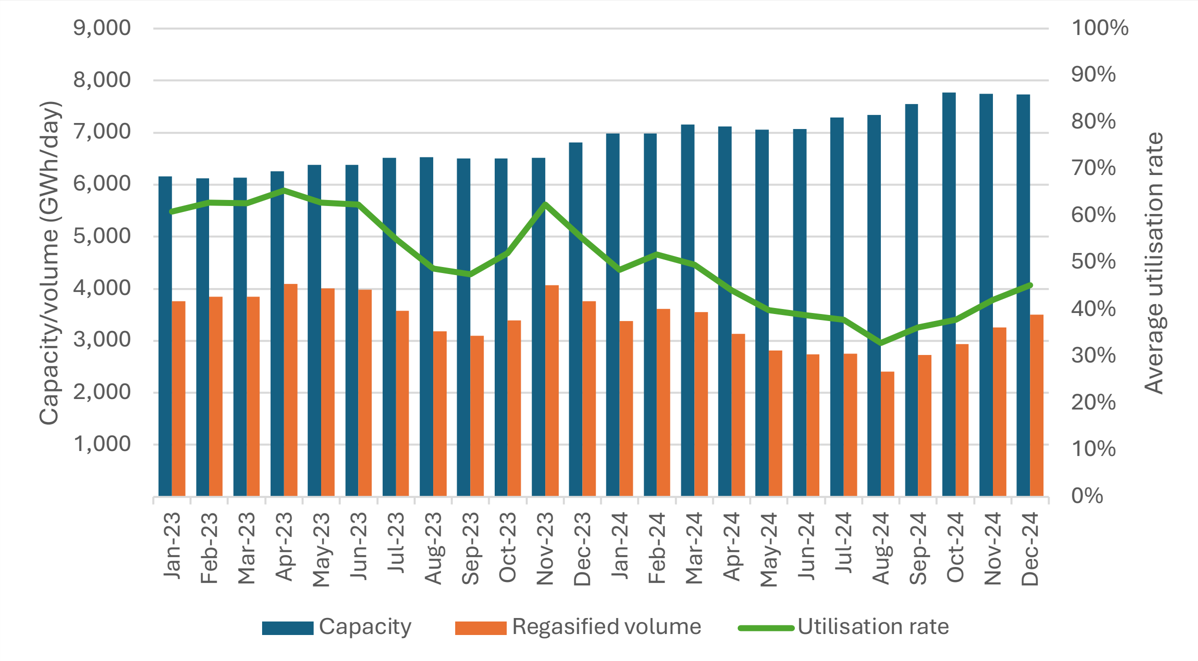


Figure 4.3: Monthly EU-27 LNG terminal capacity and utilisation rates in 2023 and 2024
Source: IEEFA (2025)[137]

EU LNG consumption fell over the 12 months to June 2024, with shipments from regasification terminals falling faster than imports, leading to stockpiles at import terminals.[138] Planned projects could increase import capacity by 55-67%. Therefore, utilisation rates are expected to fall further unless there is a boost to demand. With overall EU gas consumption continuing to decline (overall, by 20% from 2021-2024), LNG imports have also fallen, as has utilisation of LNG terminals, resulting in 5 LNG terminal projects being cancelled and 2 more suspended as of February 2025.

4.1.3 Gas storage

LNG imports are crucial for gas storage, which prevents capacity from being overwhelmed during peak winter demand. Consistent summer injections cause lower but more consistent utilisation rates. The EU's Gas Storage Regulation, adopted in June 2022, set a gas filling target of 80% by 1 November 2022, rising to 90% for November 2023 and subsequent years.[139] If full, the EU has enough storage capacity to meet 1/3 of its annual gas consumption,[140] although storage levels were higher before the crisis when the EU also had access to Ukrainian gas storage. Current storage levels cover about 30% of daily winter needs, reaching up to 50% on the coldest days of winter. Refilling patterns for 2023 and 2024 were highly similar, with slightly higher storage by the end of 2024 (Figure 4.4).

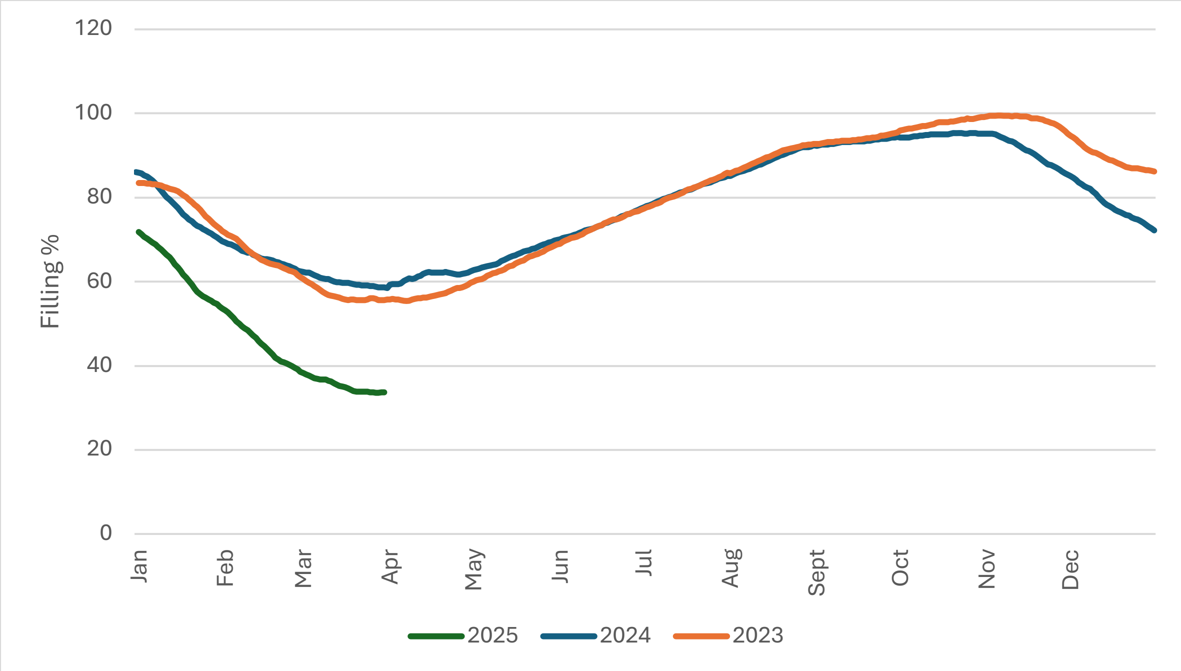


Figure 4.4: EU-27 gas storage stock levels in 2023, 2024, and Q1 2025 (bcm)

Source: GIE (2025)[141]

It could be argued that high gas storage levels played a critical role in natural gas price stabilisation during the energy crisis, reducing EU exposure to LNG spot market price spikes during winter. Yet, by 2025, different dynamics had emerged, as visible in Figure 4.4.[142] A cold winter, low power generation from wind, and the loss of additional Russian pipeline gas at the beginning of the year led to a much more rapid depletion of storage.[143]

There has also been growing evidence of the refilling requirement increasing summer gas prices due to the sheer volume needed to refill EU supplies. This means storage operators risk losing money, as they are required to charge during the summer but are then subject to lower market prices in winter as the storage levels are depleted.[144] An additional component of this is geographical dispersion. As illustrated by Figure *4.5*, countries like Germany, Italy, and the Netherlands have much greater storage capacity than others and are, therefore, more affected by the storage targets.[145] For this reason, these countries have begun calling on the European Commission to relax its refilling rules to reduce the spread between summer and winter prices.[146]

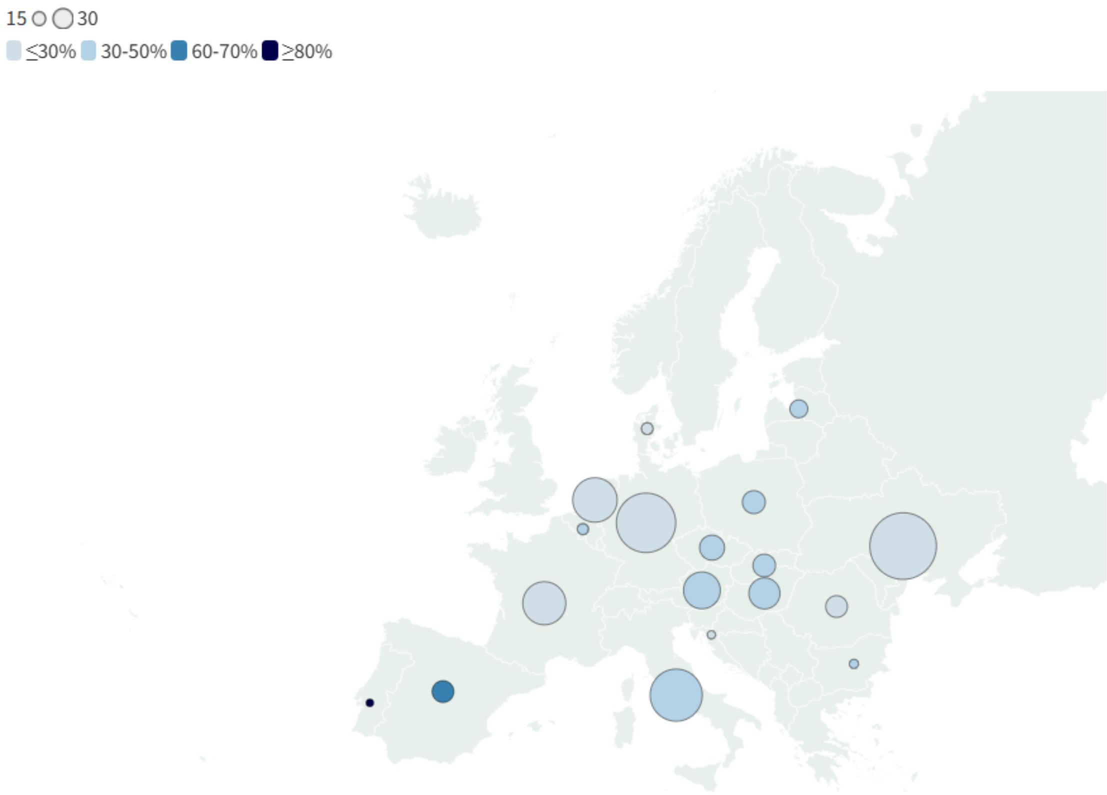


Figure 4.5: Gas storage capacity by country (TWh) and filling rate, March 2025
Source: Bruegel, 2025[147]

4.1.4 Natural gas trade with the UK

The UK has been a critical partner to the EU since the start of the global energy crisis, hosting a significant LNG regasification capacity of 48 bcm/yr. There are three gas interconnectors, connecting the UK with Belgium, the Netherlands, and the Republic of Ireland.[148] LNG imports into the UK can be converted into natural gas and sent into the EU with a total capacity of 25.5 bcm/yr to the continent and 13.3 bcm/yr to Ireland[xxvii]. Such connections are used primarily to export gas from the UK into the EU. A small percentage of this gas comes via pipeline with Norway, while the majority is supplied by the US (delivered via floating terminals).[149]

Such imports (along with electricity interconnectors) help the EU avoid bottlenecks, but as a proportion of gas imports, are much smaller than other deliveries. Trade was marginal before 2022, when it tripled. It has since reduced but remained twice as high as pre-crisis levels (Figure 4.6). These exports represent 10% and 8% of the EU's pipeline imports in 2022 and 2023, respectively.

[xxvii] comprising of Great Britain - Republic of Ireland, with a capacity of around 7.3 bcm/yr; and Great Britain - Northern Ireland, with a capacity of 6 bcm/yr.

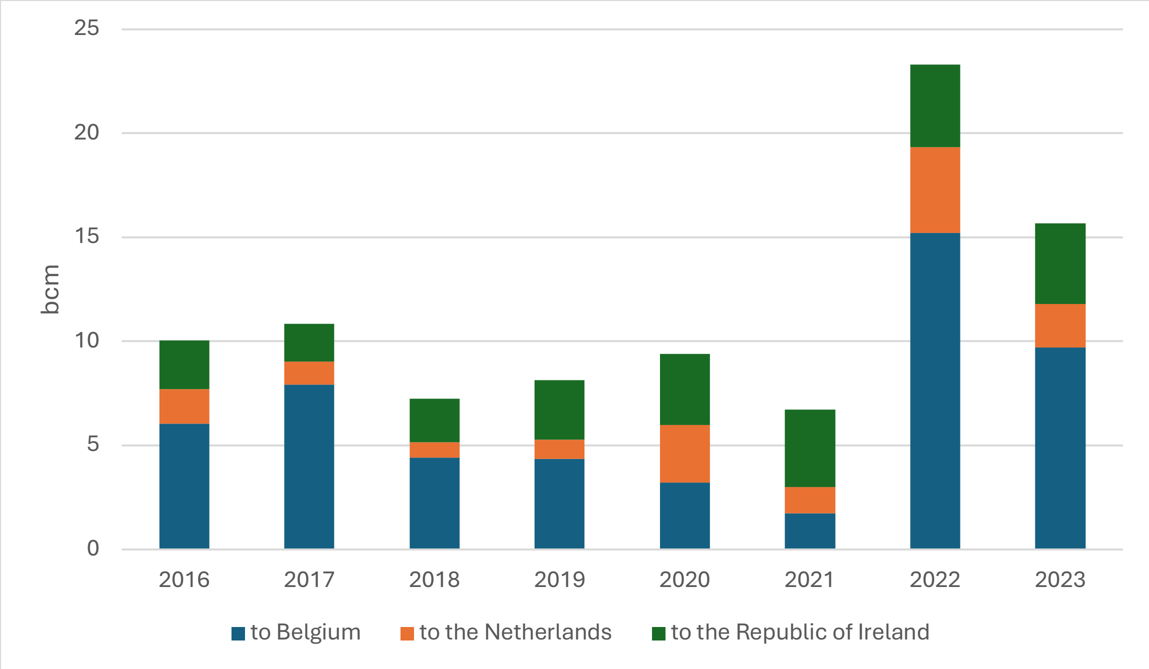


Figure 4.6: Exports of natural gas from the UK to the EU
Source: UK Department for Energy Security and Net Zero (2024)[150]

It is unclear how the arrival of the EU's Carbon Border Adjustment Mechanism (CBAM) will affect trade flows. CBAM, intended to reduce carbon leakage, adjusts imports with a carbon price. Yet the certificates which certify that UK power has been generated using renewable sources are not recognised by the EU, meaning that UK electricity will be charged as if entirely generated with fossil fuels.

Despite the UK's electricity carbon intensity being lower than the EU's, this could reduce trade that would otherwise be economic by 50-60% in the short term and 85-92% in the long term.[151] Consequently, the EU may require more dispatchable energy output[xxviii]. In the absence of sufficient energy storage capacity, this implies an increase in gas-fired electricity production, with short-term demand increases of 9-26 TWh annually under various scenarios. This issue is exacerbated if the UK, driven by North Sea wind expansion, decarbonises faster than the EU but cannot efficiently export surplus electricity.

4.1.5 US LNG trade with the EU

In response to the energy crisis, the EU turned to the US for LNG to offset Russian pipeline natural gas cuts. In 2022, the EU developed a plan to increase US imports by 15 bcm in that year, and a long term ambition to ensure stable demand for additional US LNG of 50bcm/annum until at least 2030.[152] Between 2021-2023, US LNG imports to the EU tripled, reaching 60 bcm (46% of EU LNG imports), with similar trends maintained in the first half of 2024.[153] EU-US LNG trade has surpassed EUR 90 billion since the crisis began,

[xxviii] Both generation and energy storage

as of June 2024. The EU has largely signed Free on Board (FOB) contracts, where contract flexibility allows the diversion of LNG cargoes to other markets.
Despite this strategic partnership, US LNG faces criticism for its environmental impact, heavily impacted by high fugitive emissions, their global warming potential (GWP), and carbon-intensive tanker transportation and liquefaction needs. Research by Howarth comprehensively analysed upstream and downstream carbon intensity of US LNG, finding it to have a 33% higher GHG footprint than domestically consumed coal, using the GWP 20-year scale and roughly equivalent using the GWP 100-year scale.[154]

Thus, US LNG could undermine net climate advantages if used for fuel switching in Europe. Additionally, when the EU first began to increase its US LNG contracting, the US was viewed as a key strategic ally, with this gas contributing to EU energy security. America's more volatile approach to security at the beginning of 2025 raises questions about the extent to which this dynamic has changed.

4.2 GAS CONTRACTING

During the global energy crisis, tight supplies drove up natural gas prices, curbing demand. However, expanded LNG infrastructure in the EU, the projected expansion of suppliers (especially the US), and reduced EU gas consumption pushed 2024 gas prices back down to 2021 levels, with LNG demand likely peaking in 2024.

4.2.1 LNG contracts and EU decarbonisation

LNG market demand will remain tight until 2026, when most new LNG infrastructure investments are set to be commissioned. After this, the supply-demand conundrum balances (Figure 4.7), but there is a risk of underutilisation. Targets under REPowerEU could render new infrastructure redundant or underutilised in a matter of years. For example, one ACER *REPowerEU* scenario indicates 30 bcm of LNG over-contracted in 2027, reaching 41 bcm in 2030.[155]

EU-driven LNG investment, coupled with weak EU demand, could mean the commodity becomes cheaper in global markets due to an expansion of supply. US desires to lower gas prices globally could also cause such an outcome. In terms of LNG demand and required contracts, the difference between Fit-for-55 and REPowerEU is huge, also displayed in Figure 4.7. The successful completion of new policy targets sees the EU flip from a period of under-contracting post-2026 to a period of over-contracting, based on already signed agreements.

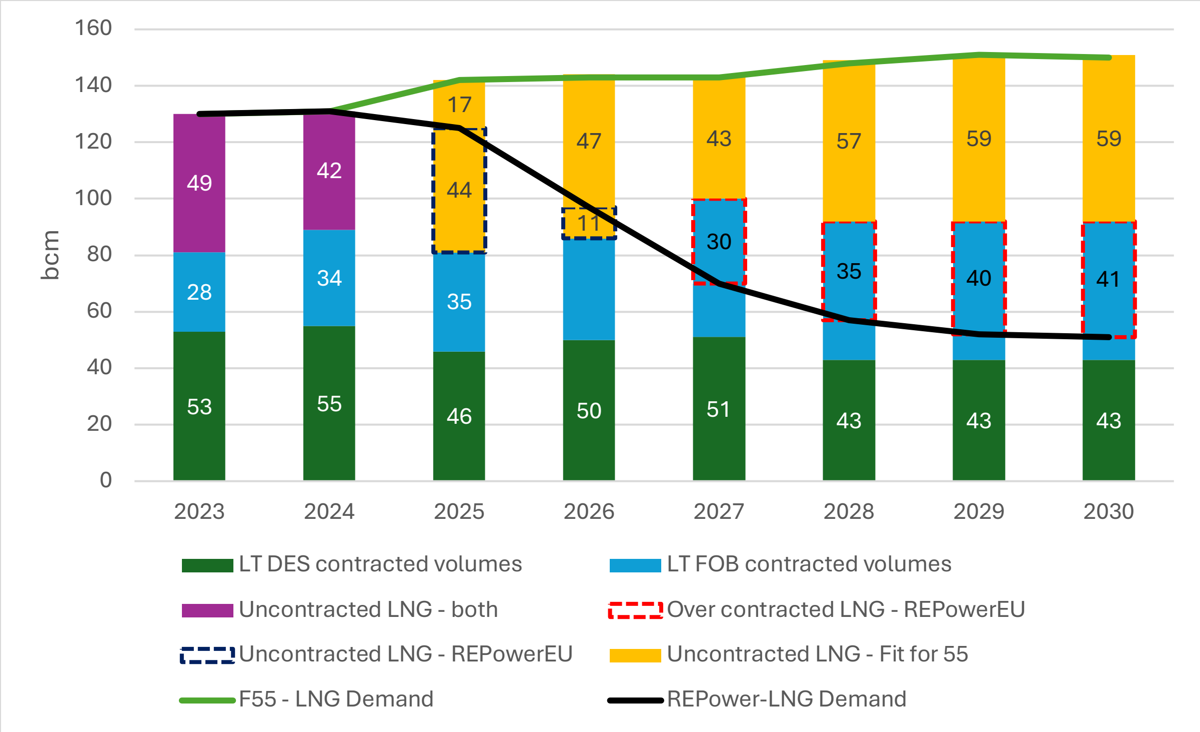


Figure 4.7: Uncontracted and over-contracted LNG under Fit-for-55 vs REPowerEU scenarios[xxix]

Source: adapted from ACER (2024a)[156] and dataset ACER (2024c)[157]

The EU remains reliant on long-term contracts, with spot LNG representing only 33% of the bloc's imports according to ACER.[158] Flexible FOB contracts and long-term contracts on DES (delivered ex-ship) are almost equally split, allowing the EU flexibility for changes in demand. This flexibility depends upon the supplier, however. Qatari gas contracts, for example, are fixed and require the EU to off-take the contracted gas.

FOB contracts (like those signed with the US) are highly liquid and can be sold on the spot market, mitigating LNG over-contracting risk. Securing long-term natural gas contracts is the foundation of the EU's energy security and investments in new LNG value chains. However, contracting is complex, as consumers prioritise near-term demand over a distant time horizon. Hence, contracted natural gas follows a downward trajectory, with existing contracted volumes expected to fall by one-third by 2030 compared to 2024 levels.

In the policy space, gas contracting has competing dynamics with the EU's decarbonisation and gas demand reduction targets, potentially leading to oversupply by 2026. If the EU is successful at meeting such targets, LNG may play a rather marginal role (Figure 4.8). Other factors to consider are the potential phase-out of domestic production and new pipeline gas contracts with Norway and North Africa.

[xxix] DES = Delivered Ex-Ship; FOB = Free-on-Board (long-term supply contracts entitles LNG off-takers full flexibility to set the final destination of the LNG deliveries), LT = long term.

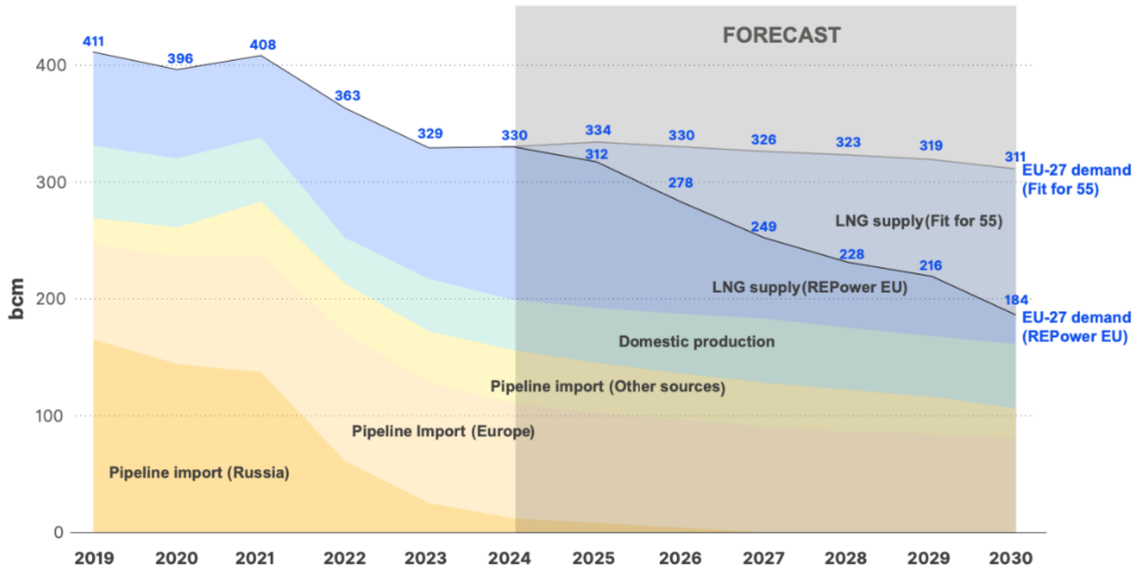


Figure 4.8: EU gas supply and demand projections and LNG demand in relation to Fit-for-55 and REPowerEU scenarios by 2030

Source: (ACER, 2024a)[159]

4.2.2 Methane intensity of natural gas and trade partners

EU natural gas imports may also hinge on the methane intensity of trading partners, as starting from 2026, they should comply with the EU Methane Strategy. Pipeline supply from Norway and LNG from Qatar offer low methane leakage in upstream supply chains and, if aligned with REPowerEU, these exporters can fully meet the EU's 2030 natural gas demand. According to the Global Methane Initiative and Bruegel, the average methane intensity of US LNG is higher by a factor of over 70 compared to Norwegian pipeline gas (Figure 4.9),[160] with their data sources indicating even higher intensity in the pipeline from Algeria to Europe and in both Russian LNG and pipeline gas.

Note that methane emissions are still inadequately monitored, and may be very site- and supply-chain dependent compared to CO_2 emissions which also occur throughout the supply chains; for a recent extensive review see Stern (2025). Figure 4.10 shows the very wide range of specific estimates for LNG 'well-to-tank' emissions (combining CO_2 and methane, not including end-use emissions); also given the critiques of US data noted above by Howarth,[161] this suggests that average GHG emissions from US and Russian LNG substantially exceed the EU's other main options.

This underscores the need for the EU to coordinate trade that addresses geopolitics, security of supply, and supplier reliability. If US LNG serves as a backup to Norwegian imports, significant investments and enhanced monitoring and verification will be needed to comply with the 2026 EU methane regulations. However, with recent changes in the US government, the Trump Administration may use tariffs as a bargaining tool, attempting to both circumvent the high methane emissions of its LNG and force offtake by the EU.

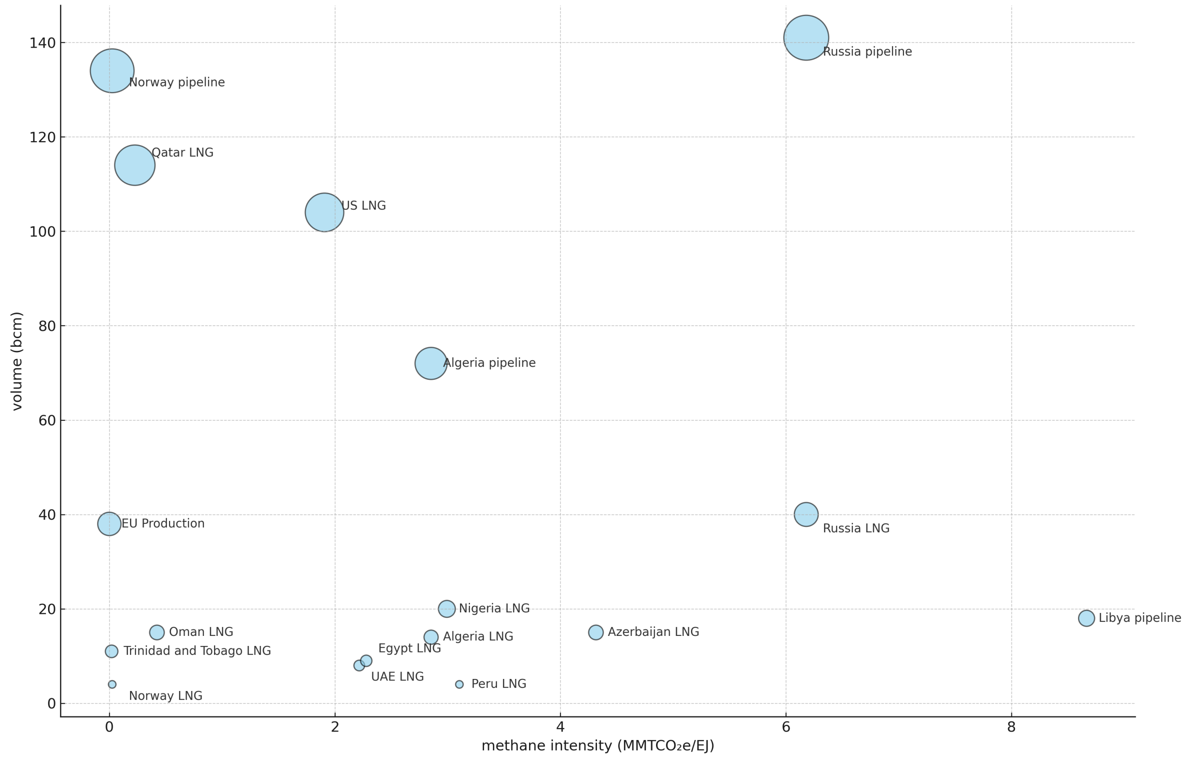


Figure 4.9: Natural gas exporters by methane intensity[xxx,xxxi]

Source: own calculations based on Bruegel (2024)[162] and Global Methane Initiative [163]

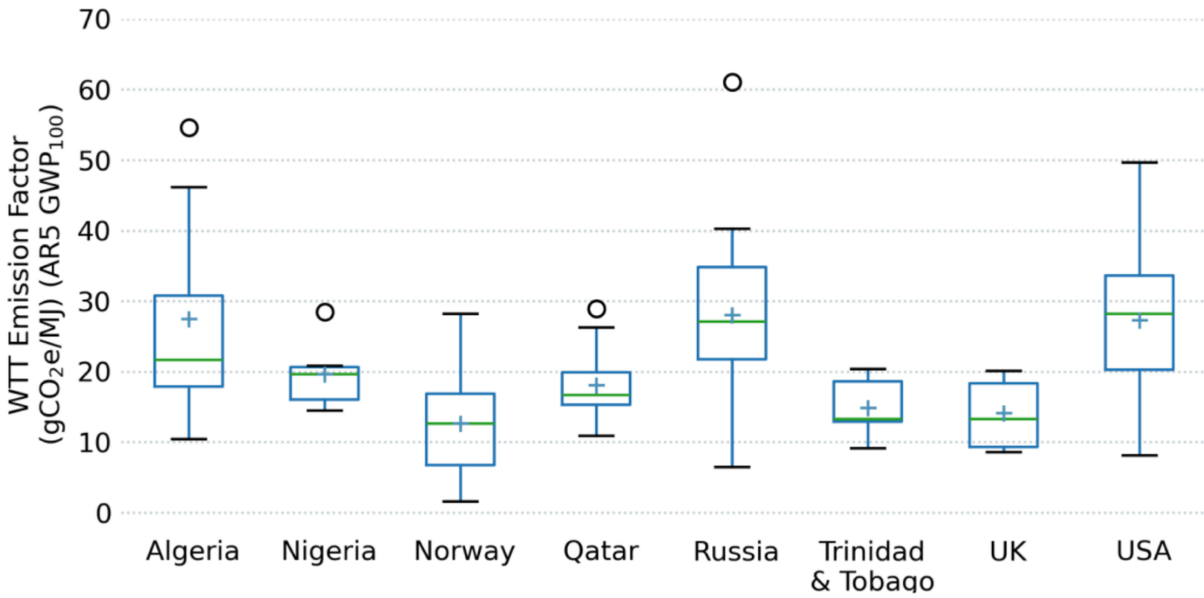


Figure 4.10. Overall greenhouse gas 'Well-to-Tank' (WTT) emissions of LNG exporters to Europe.[xxxii]

Source: Stern (2025)[164] and Carr et al. (2024)[165]

[xxx] MMTCO$_2$e: million metric tons of carbon dioxide equivalent

[xxxi] EJ: exajoule. 1 exajoule is equivalent to 277.8 TWh or 26-28 bcm of natural gas

[xxxii] Units: MMTCO2e/EJ (same as source, stated in the form gCO2e/MJ), conversion, methane converted at 100-year Global Warming Potential

4.3 KEY TAKEAWAYS

In the immediate aftermath of the energy crisis, the EU worked quickly to deploy additional gas transportation capacity. It is not entirely clear, however, that these investments will be required given the increasing deployment of renewable generation and energy storage. With overall EU gas consumption continuing to decline (overall, by 20% from 2021-2024), LNG imports have also fallen, as has utilisation of LNG terminals, resulting in 5 LNG terminal projects being cancelled and 2 more suspended as of February 2025. Questions also remain about how easily these investments can transition to carrying low-carbon alternatives, and the extent to which they might simply enable carbon lock-in.

EU gas contracting could also contribute to carbon lock-in. The EU faces a potentially challenging balance between flexible gas contracts (that would reduce the risk of over-contracting) and ensuring compliance with its Methane Strategy. US LNG is flexible, but high in methane emissions, whereas Qatari LNG is inflexible but meets EU methane standards. In addition to the physical concerns around purchasing this gas, there are also newly-emerging geopolitical considerations. The US, which was once viewed as a strategic gas ally, seems increasingly likely to dictate the purchase of US LNG to achieve political aims.

This raises questions more broadly about the degree to which the EU should be investing in gas infrastructure and purchasing gas overall. Ultimately, while additional investment in gas infrastructure was helpful at the beginning of the energy crisis, there is a significant discrepancy in the amount of gas capacity that is currently under development and what is needed to meet REPowerEU. While some capacity additions have already been cancelled, increasing deployment of gas infrastructure risks the bloc’s decarbonisation target through carbon lock-in. It could also push the EU to rely more heavily on alternate gases in order to repurpose this infrastructure, an outcome which may not be the most cost-effective means of achieving decarbonisation. Section 5 explores a range of scenarios for EU gas demand and their alignment (or misalignment) with REPowerEU.

5 GAS DEMAND OUTLOOK: REVIEW OF SCENARIOS

This section discusses economy-wide energy scenarios for the EU, developed since the start of the global energy crisis and the adoption of REPowerEU. Due to the uncertainty and scepticism around some EU-modelled outputs, in addition to differing opinions on the outlook for gas, we explore a full range of scenarios from a range of institutions. The aim is to understand how these scenarios compare to REPowerEU, to generate a credible range for gas demand by 2030, and to assess subsequent implications for ongoing investments in gas infrastructure and trade

Box 1 provides a high-level overview of the key literature on economy-wide energy scenarios in the EU that were developed since the start of the global energy crisis in 2022, and Table 5.1 summarises the key data. The following sub-sections then provide more detailed analysis of each scenario, ordered by institution. Pre-2022 scenarios are discussed in Annex D.

Box 1: Scenarios reviewed and key characteristics

Nikas et al. (2024): Explores three scenarios for replacing Russian gas: one prioritises energy efficiency, another focuses on domestic renewable expansion, and a third examines expanding gas imports to new trade partners.

Ah-Voun et al. (2024): Focuses on the impact of weather variability on REPowerEU policies, modelling how winter severity affects gas demand, renewables deployment, and exposure to LNG markets.

Agora Energiewende (2023): Proposes an *EU Gas Exit Pathway* scenario that contrasts with REPowerEU by prioritising direct electrification and minimising reliance on green hydrogen and biomethane. It examines a less immediate phase-out of natural gas by 2040.

Cambridge Econometrics (2023): Investigates how a slower energy price recovery would influence the adoption of heat pumps in buildings, emphasising the role of price signals in reducing gas demand and decarbonising the heating sector.

IEA (2023): Offers an opportunity to explore when REPowerEU targets are met through the *Announced Pledges Scenario (APS)*. *Stated Policies (STEPS)* offers a counterfactual where only enacted policies are considered, not pledges and targets.

Oxford Institute for Energy Studies (OIES) (2024): Presents scenarios assuming a delayed phase-out of natural gas with heavy reliance on CCS to meet emissions goals. These scenarios are more sceptical of the success of rapid climate policy action in influencing natural gas demand.

bp Energy Outlook (2024): Explores two scenarios: *Current Trajectory* assumes steady gas reliance and growing imports, while *Net Zero* envisions accelerated renewable energy adoption and reduced gas demand. However, its ambitions are less aggressive than REPowerEU targets.

Table 5.1. Key data from explored scenarios

2030 (unless stated)	Sector targets					Natural gas implications				
	Heat pumps	**Renewables**	**Biomethane**	**Hydrogen**	**Energy efficiency**	**Demand**	**Domestic Production**	**Pipeline imports**	**LNG**	**Uncontracted Imports**
REPowerEU Targets	60 million heat pumps	510 GW wind, 592 GW solar	35 bcm biomethane production	20 Mt (660TWh or 63 bcm) green hydrogen demand	13% lower final energy consumption	184 bcm				
REPowerEU compliant scenarios										
Ah-Voun et al.		71% of electricity consumption in *REPowerEU*				290 bcm (-68) in '*Normal' winter*; 348 bcm in '*Coldest' winter*			*'Hardest' winter:* 169 bcm	
IEA – APS						248 bcm (-110)	20 bcm	60 bcm contracted	45 bcm contracted	120-130 bcm
Climate compliant scenarios										
bp - Net Zero		3,889 TWh; including 1,111 TWh of wind 556 TWh of solar		10.9Mt (360 TWh) low carbon hydrogen demand by 2035		265bcm (-93)	36bcm for EU and 16bcm for UK	83bcm	146 bcm imported in EU and UK	
Alternative scenarios										
Nikas et al.					Up to -11% energy demand in *Energy Efficiency*	-40% in *Gas Import* scenario			40 bcm in *Gas Import* scenario, lower than 50bcm of REPowerEU	

2030 (unless stated)	Sector targets					Natural gas implications				
	Heat pumps	**Renewables**	**Biomethane**	**Hydrogen**	**Energy efficiency**	**Demand**	**Domestic Production**	**Pipeline imports**	**LNG**	**Uncontracted Imports**
Agora Energiewende	Both scenarios target around 60 million		Limited until 2040	200 TWh demand in *EU Gas Exit Pathway* half met by green sources	*EU Gas Exit Pathway* saves 175 TWh energy demand by focusing on electrification					
Cambridge Econometrics						-40% gas demand reduction in buildings under *Slow gas price recovery*				
IEA – STEPS						305 bcm (-53)	34 bcm	Approx 60 bcm contracted	Approx 45 bcm contracted	160-180 bcm
OIES - results for EUROPE						446 bcm in *NetZerow/CCS*, 456bcm in *Fragmented*, 471 bcm in *DPS*	106-132 bcm	45-76 bcm	204 bcm in *NetZerow/CCS,* 213 in *Fragmented* and 215 in *DPS*	

5.1 Scenario Deep Dive

5.1.1 Nikas et al. (2024): Energy Efficiency, Domestic Production and Gas Imports[166]

There is consensus that energy crises induce short-term supply-side emissions increases, as activities such as power & heat production turn to cheaper and more polluting energy sources, such as coal or oil. Nikas *et al* explores scenarios of energy efficiency, domestic gas production, and replacing imports of Russian gas. The implications of each scenario on final energy are displayed in Figure 5.1. The scenarios were modelled using a range of energy system models to understand how the models would affect the results.

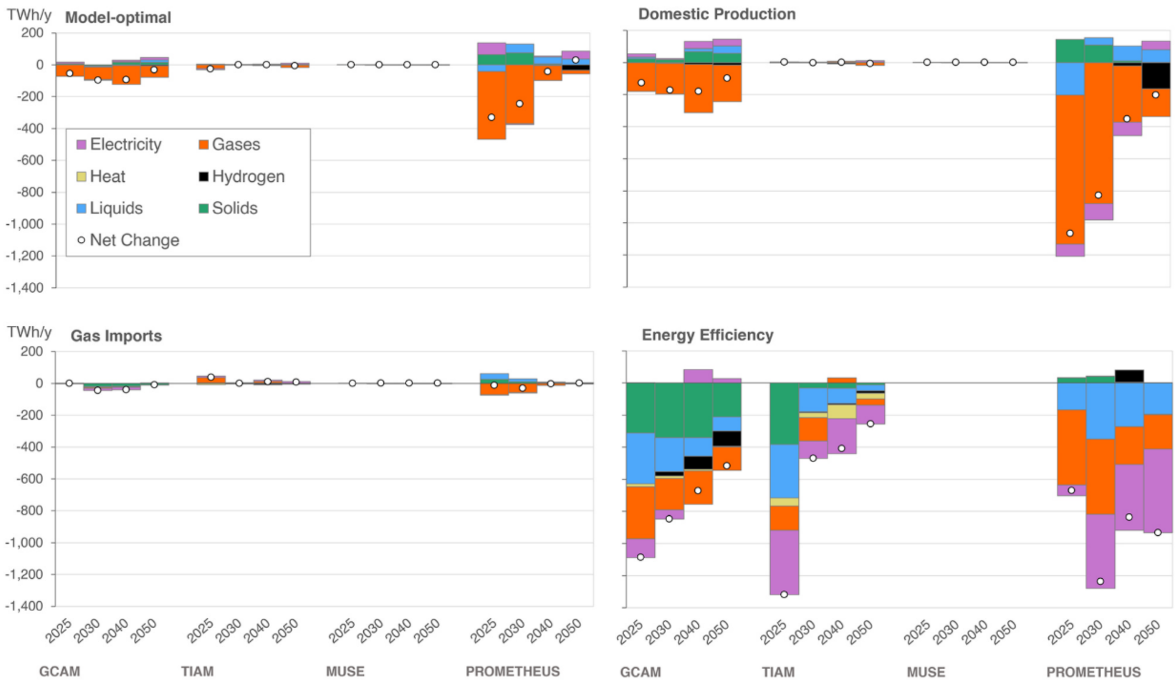


Figure 5.1: Absolute change of final energy per fuel in Energy Efficiency compared to the baseline scenario

Source: Nikas et al. (2024)[167]

The *Energy Efficiency* scenario focuses on retrofitting, demand-side response, and relocating emission-intensive industries overseas. This approach could reduce energy demand by 4-11% by 2030 and 2-5% annually by 2050. The less ambitious *Domestic Production* scenario focuses on accelerated electrification, the expansion of renewables, and increased hydrogen production, while imports remain unchanged. Modelled results show a 1-5% energy demand reduction by 2030 and 1-2% by 2050, supported by a significant uptake of heat pumps and more ambitious electrification.

In *Gas Imports*, changing gas trading partners can reduce energy demand, but only marginally, because the new trade sources (primarily LNG) are more expensive due to increased infrastructure and transmission costs. A caveat here is that oil and coal may become cheaper options for industry, inducing greater emissions, while households and services would see a marginal drop in emissions. In this scenario, the EU is on track to reduce gas demand by 40% by 2030 relative to 2020 levels (246 bcm to 155 bcm, or 2575 TWh to 1619 TWh). At the same time, the model sees the expansion of pipeline gas supply from other regions, primarily Norway and North Africa. LNG demand is expected to fall to about 40 bcm, even more than the 50bcm region predicted in REPowerEU. Norway pipeline gas has the benefit of low methane leakage. This is important because imported gas, especially LNG, requires thorough analysis to ensure compliance with the EU Methane Strategy, as discussed in Section 4.

The cost results vary across the models used due to their distinct compositions, assumptions, and data granularity, yielding no single conclusion (Figure 5.2). In the *Energy Efficiency* scenario is the most expensive until 2030 but becomes the cheapest thereafter due to a rapid phase-out of natural gas. However, this implies a considerable need for investment in end-use sectors and gradually ceasing capital investments in natural gas infrastructure. The PROMETHEUS model, however, concludes that replacing gas trading partners would be the most expensive scenario, assuming significantly higher gas prices from other importers, driven by LNG markets (although it similarly concludes that *Energy Efficiency* would be the cheapest post-2030).

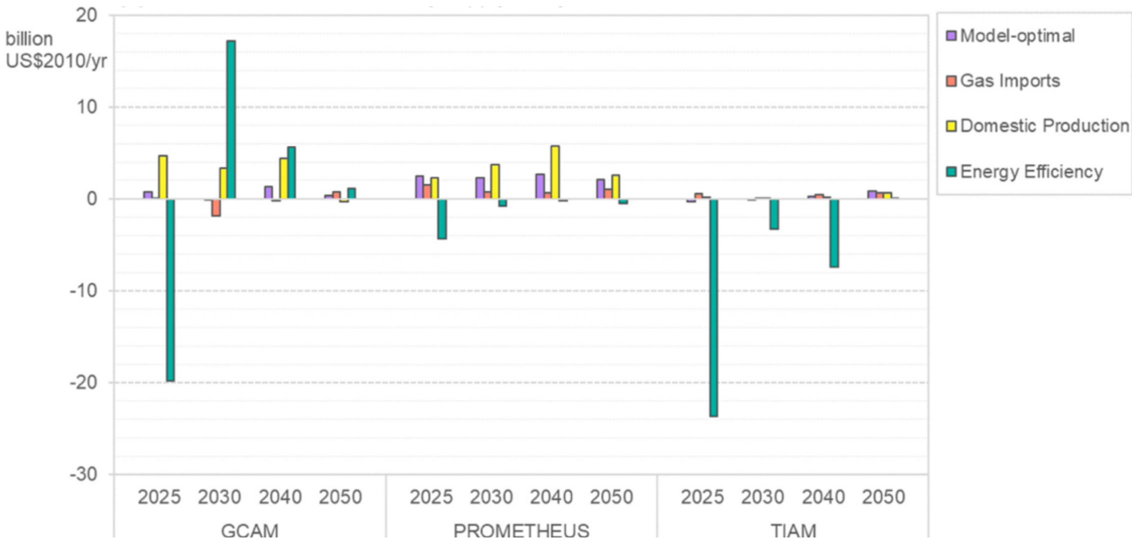


Figure 5.2: EU electricity supply annual investment costs (bn$/2010), compared to baseline
Source: Nikas et al. (2024)[168]

Post-2030, electricity prices in *Energy Efficiency* are modelled to be twice as low (20-30 EUR/MWh) as *Domestic Production* and *Gas Imports* (60-120 EUR/MWh). This will, however, have various regional implications due to energy mix profiles, available infrastructure, and gas import dependency across EU Member States. While energy efficiency investments, though substantial in the short term, look to be incredibly beneficial in the long run, it should be caveated that the possible macroeconomic and socioeconomic impacts on industrial demand require careful and holistic consideration outside of modelling.

5.1.2 Ah-Voun et al. (2024): Gas demand and LNG exposure of REPowerEU under weather variations

Ah-Voun et al.[169] model the policy packages of the 2019 NECPs and REPowerEU under various weather conditions, assessing natural gas demand before and after Russia's invasion of Ukraine. Scenarios *REPowerEU* and *NECP19* represent their respective policies using projections of generation capacity and electricity consumption (influenced by heat pump and EV roll-out) from these policy plans. In addition, there are four weather scenarios which alter electricity generation through capacity factors for renewable energy sources (with knock-on implications for natural gas demand for heating and industrial sources).

The *REPowerEU* scenario reduces dependence on natural gas through renewable generation in the power sector, the electrification of road transport, and the rollout of heat pumps in buildings. Results show a 72% decrease in natural gas consumption by 2030 in the power sector compared to pre-invasion plans, and renewable energy sources increase from 54% of total electricity consumption under *NECP19* to 71% (Figure 5.3). To meet its targets, solar and wind capacity must be installed at twice the *NECP19* rollout rate.

REPowerEU is tested under 4 weather scenarios, with the coldest winter (occurring twice a decade) expected to increase natural gas demand by 39 bcm. The power sector varies most widely between these scenarios due to changing natural gas demand (Figure 5.3). All temperature scenarios assume stable demand from the industrial sector and minor variations of 11 bcm in the commercial sector.

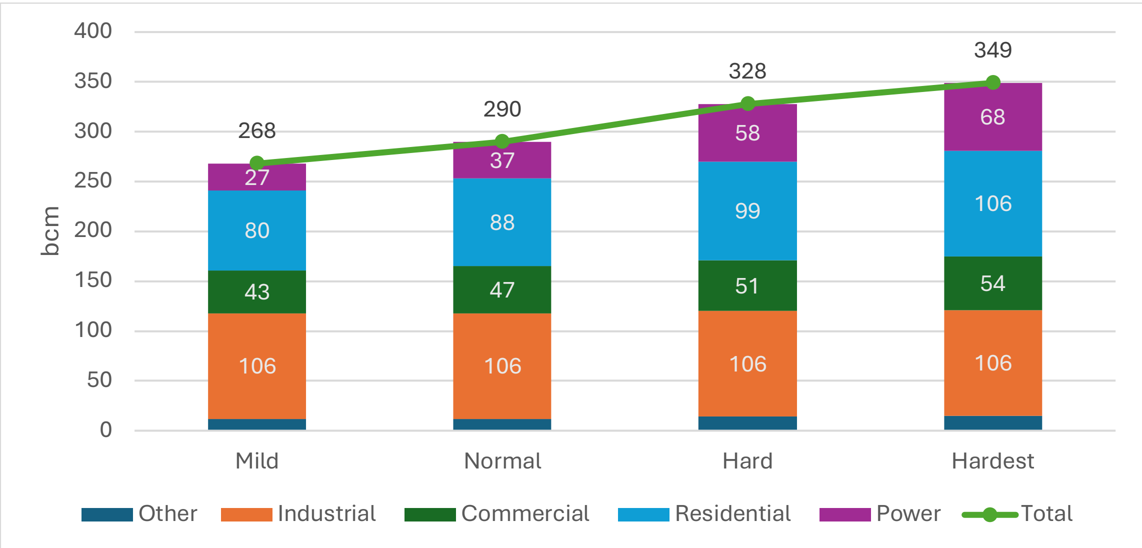


Figure 5.3: Total gas demand across temperature scenarios in Europe under REPowerEU, 2030.
Source: Ah-Voun et al. (2024).[170]

A simplified analysis of LNG demand assumes that domestic supply continues to shrink at the rate of the last decade, 12 bcm is exported to Ukraine and Moldova, and Russian gas is phased out by 2030. In *Hardest Winter*, with 2022 LNG supply levels, the

REPowerEU scenario has a natural gas shortage of 46 bcm in 2030, requiring a total of 169 bcm from LNG markets. In trade terms, the EU's dependence varies between 42%-64% of global spot markets depending on the scenario. However, the 46 bcm shortfall in the *Hardest Winter* scenario is much smaller than the current 90 bcm storage target.

Ultimately, 25% of extra global spot LNG demand is likely to drive prices up. However, if REPowerEU targets weren't met this would further cascade the price spikes. In such a scenario, modelled results show the EU could potentially require 78% of the global spot market if the targets fall short even by 25%. Completely missing the targets might lead to significant market stress, as demand would reach as high as 114% of the projected global spot LNG market in 2030.

This level of LNG imports is higher than previously explored forecasts,[171,172] highlighting the sensitivity to weather variation and the requirement for significant capacity to handle such events. However, results assume the 2022 supply composition negates the impact of new pipeline imports. Additionally, this level is already far off the near 300-400 bcm regasification capacity range projected in 2030 (discussed in Section 4). This reinforces concerns of overinvestment in and underutilisation of LNG infrastructure, even when faced with the coldest winter scenario.

5.1.3 Agora Energiewende (2023): the EU Gas Exit Pathway scenario[173]

Agora Energiewende modelled two scenarios: *EU Gas Exit Pathway* and *REPowerEU*. The *EU Gas Exit Pathway* models medium-range fossil fuel gas demand compared to Fit-for-55 and REPowerEU. It suggests longer use of natural gas compared to REPowerEU and Fit-for-55, justified by more aggressive efficiency gains through direct electrification and by minimising demand for green hydrogen, biomethane, and abated fossil gas.

5.1.3.1 Electrification

The *EU Gas Exit Pathway* envisions the deployment of heat pumps and electric transport, as opposed to indirect electrification such as power-to-hydrogen (which are less efficient and imply higher primary energy requirements and associated costs). This scenario contrasts with *REPowerEU*, which contains higher indirect electrification by a factor of three: 242 TWh of hydrogen demand compared to 71 TWh in *EU Gas Exit Pathway*.

In the longer term, *EU Gas Exit Pathway*, by definition, phases out fossil gases (mainly natural gas), but also low-carbon gases, in favour of electrification. Unlike *REPowerEU*, it envisions a higher use of natural gas, as a 'cleaner' substitute to coal or oil, and by 2040, the role of gases is almost negligible (Figure 5.4). Such a vision will require significant heat pump uptake. In this area, both scenarios are largely consistent with a target of about 60 million heat pumps deployed by 2030.

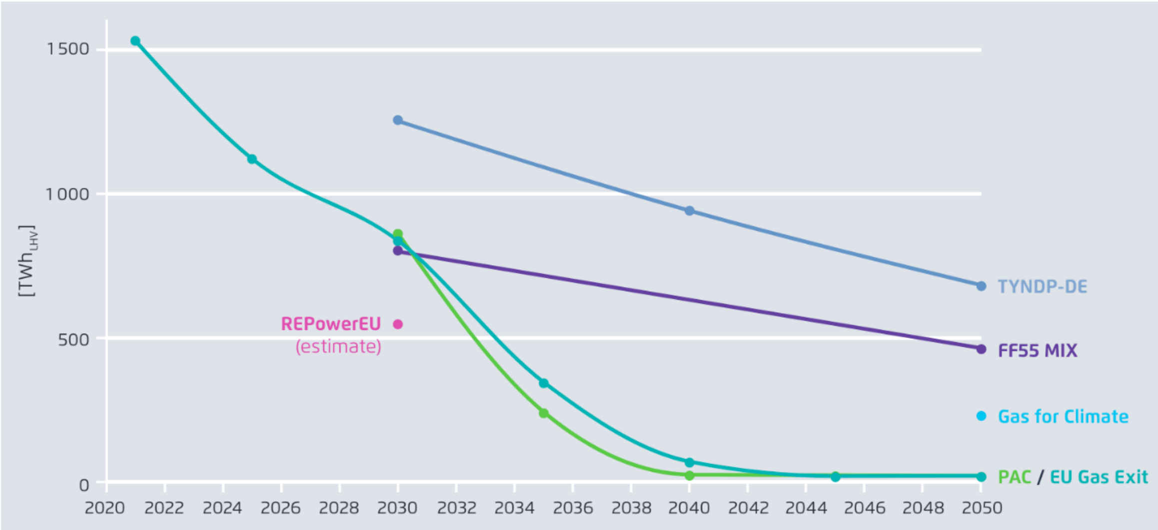


Figure 5.4: Scenario comparison of fossil and renewable gases consumption in buildings.
Source: Agora Energiewende (2023).[174]

On the sectoral level, *REPowerEU* considers significant uptake of hydrogen in transport and buildings, whereas *EU Gas Exit Pathway* views this technology as a 'last resort', used only in sectors with limited technological options (such as some hard-to-abate industries). Conversely, the direct electrification of transport and the use of heat pumps enhances energy efficiency, lowers demand for hydrogen production and requires less additional renewable capacity, reflected in the *EU Gas Exit Pathway*'s lower energy demand (by 175 TWh).

5.1.3.2 Fossil fuel consumption, gas contracting and energy independence

Unlike the *EU Gas Exit Pathway*, *REPowerEU* envisions lower fossil fuel consumption by 2030 (by 7.5 bcm or 79 TWh). However, due to higher indirect electrification, *REPowerEU* forecasts higher electricity consumption, met by higher use of coal (by 98 TWh), which results in higher net emissions (Figure 5.5). The major difference, however, is a more significant role of fossil gas in the *EU Gas Exit Pathway,* by 56 bcm (589 TWh) when compared with *REPowerEU*, which envisions higher coal (by 569 TWh) and oil (by 275 TWh) demand in 2030. This higher use of coal and oil risks delaying and potentially jeopardising the transition to net zero by 2050.

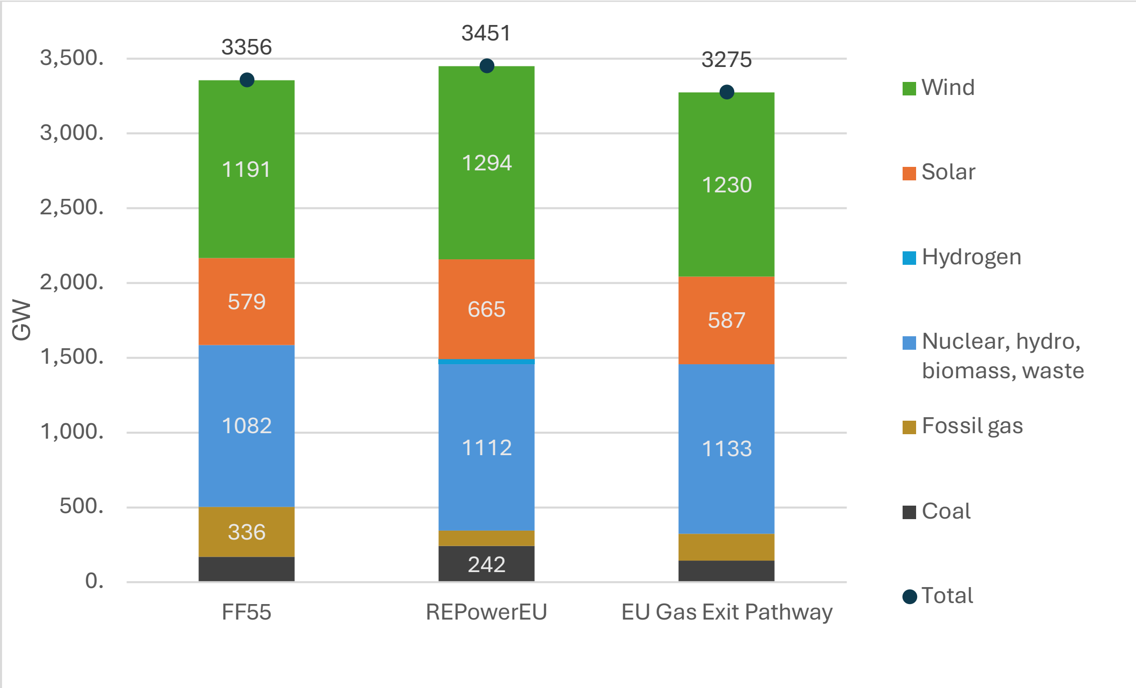


Figure 5.5: Electricity generation across Fit-for-55, REPowerEU and EU Gas Exit Pathway (excluding hydrogen), 2030

Source: Agora Energiewende (2023).[175]

A key aspect of the higher demand for fossil gas in *EU Gas Exit Pathway* is security of supply rather than carbon emissions. Import dependency (as a % of imports rather than absolute consumption) is expected to remain stable until at least 2035 and, therefore, more long-term gas contracting. The decline of gas contracting depends on key REPowerEU elements: electrification, renewables deployment, biomethane, and hydrogen plus its derivatives. In *EU Gas Exit Pathway*, the decline in domestic production of natural gas, combined with the gradual uptake of hydrogen and biomethane, reduces import dependence on gas by 2040. This timeline can be explained as a result of the model aiming to cost-optimise the transition. Direct electrification occurs in stages, reaching hard-to-abate sectors (where gaseous fuels are the most viable option) at the end of the transition.

5.1.3.3 Hydrogen, biomethane and heat pumps

Due to the cost-effectiveness and efficiency of direct electrification, hydrogen deployment is delayed until after 2035, contingent on technology, infrastructure, climate policy, and supply chain improvements making the technology feasible. *REPowerEU* sets the ambitious target of 20Mt (63 bcm or 660 TWh) of green hydrogen demand by 2030, met equally by domestic production and imports. In contrast, *EU Gas Exit Pathway* envisions ~200 TWh demand, and only half of this is electrolysis-based (possibly green if it complies with RED III) hydrogen, while the consumption of grey hydrogen will only slightly decline from the current levels but will still provide 50% of demand. Additionally, *EU Gas Exit Pathway* is more sceptical about green hydrogen imports, until at least 2035, with ~5 bcm (50 TWh) imported in 2030 (compared to *REPowerEU* levels of 32 bcm (330 TWh) in 2030).

Biomethane plays a limited role in *EU Gas Exit Pathway,* with significant contributions expected only by 2040 due to environmental and socioeconomic uncertainties, similar to other types of bioenergy. From biomethane and biogas production and imports of 20 bcm (~195 TWh), additional demand will rise by 390 TWh by 2040 to phase out fossil gas; another 278 TWh by 2040 to eliminate natural gas imports; and a further 135 TWh by 2050 to decrease imports of hydrogen.

5.1.4 Cambridge Econometrics (2023) scenario for buildings: Slow Energy Price Recovery[176]

Cambridge Econometrics' *Slow Energy Price Recovery* scenario is sectoral and focuses on the decarbonisation of buildings. Particularly, it looks at electricity and gas price recovery and their ratio. It assumes that gas prices will not fall rapidly back to pre-2022 levels but will instead gradually decrease from c. 20 EUR/MWh in 2022 to c. 15 EUR/MWh in 2030, compared to the REPowerEU scenario that already projects rapid recovery to c. 11 EUR/MWh in 2024. Similarly, *Slower Recovery* envisions that electricity prices will gradually fall from 25 EUR/MWh to c. 16 EUR/MWh in 2030. In contrast, REPowerEU assumes a more rapid decline to c.16 EUR/MWh by 2026. Hence, the study models how market signals can induce electrification in the heating sector and facilitate the deployment of heat pumps.

Slow Price Recovery suggests the accelerated deployment of heat pumps also means average savings in the range of 20% on heating bills (Figure 5.6), rising to 40% in countries like France. Additionally, emissions in buildings decline by 46% and gas demand falls by 40%. The study concludes that the transition towards heat pumps could be incentivised by a net benefit of EUR 60 billion in savings on fossil fuel imports cumulatively by 2030, including EUR 43 billion on gas imports.

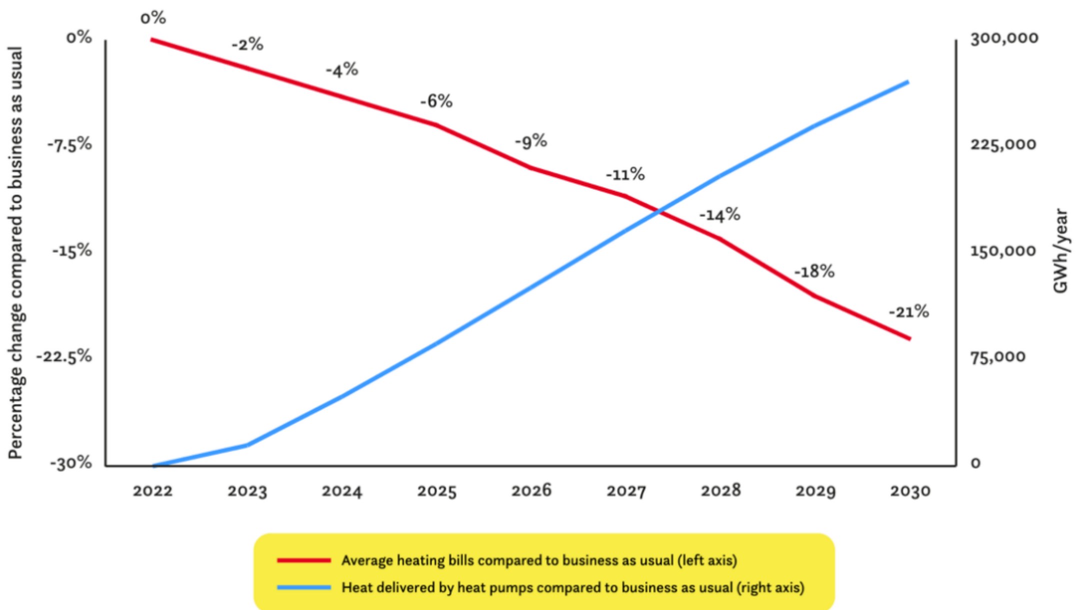


Figure 5.6: Heat pump deployment and heating bills (compared to EU reference scenario).
Source: Cambridge Econometrics (2023).[177]

5.1.5 International Energy Agency (2023)[178]

The World Energy Outlook 2023 sets out 3 distinct scenarios: *Stated Policies Scenario (STEPS)*, *Announced Pledges Scenario (APS)* and *Net Zero Emissions by 2050 (NZE)*. The *NZE* pathway limits the global temperature rise to 1.5°C above preindustrial levels by 2100. *APS* assumes that governments will meet all the climate-related commitments they have announced, including NDCs. In contrast, *STEPS,* has a more conservative outlook, charting only the trajectory of policies already in place.

Over the past 5 years, IEA's *STEPS* has continually downgraded its outlook for natural gas demand (Figure 5.7), from almost 5,500 bcm of projected demand in 2040 to below 4,300 bcm in the same year), largely due to upwards revisions of renewables capacity. The 2022 revision was significantly impacted by the Russian invasion of Ukraine. This led to lower demand in developed economies and slower-than-predicted demand in emerging economies.

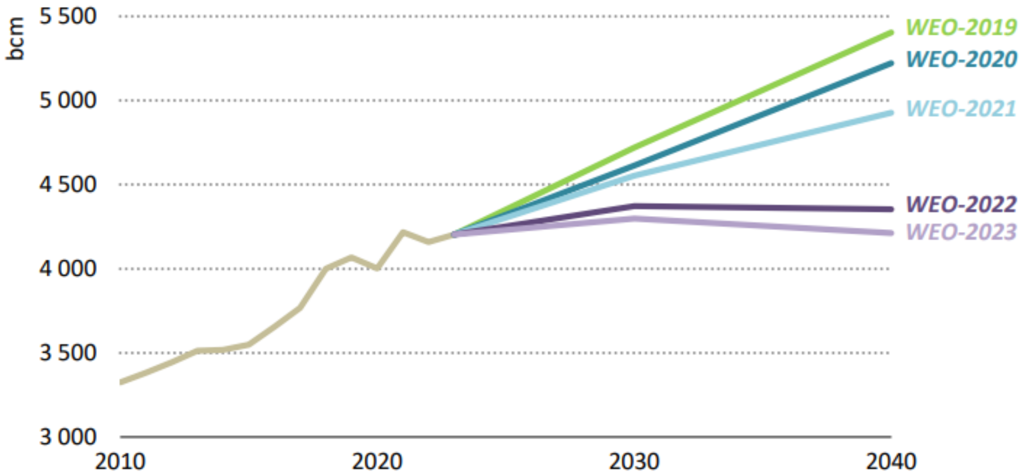


Figure 5.7: Global natural gas demand projections in the STEPS to 2040 in the World Energy Outlook editions between 2019 and 2023

Source: (IEA, 2023c).[179]

STEPS aims to represent the response of the EU to the energy crisis, increasing clean energy ambitions, and energy security concerns. APS takes this further, and assumes Fit-for-55 targets are largely met, as well as the REPowerEU goal of eliminating dependence on Russian gas. Both scenarios have electrification occurring in parallel with power sector decarbonisation and renewable deployment, strong retrofits and efficiency standards, and fuel switching incentives. To meet recent policy targets, these occur at faster rates in *APS* than in *STEPS*.

In *STEPS*, this causes the EU's natural gas demand to reduce by 50 bcm by 2030 (Figure 5.8), in *APS*, the acceleration of end-use electrification, efficiency and renewables expansion means demand is 110 bcm lower by the same date. However, the gap between the contracted supply of natural gas and import requirements lies between 160-180 bcm under *STEPS* assumptions. A similar gap (120-130 bcm) also exists in *APS* but narrows sharply after 2030. Even if these contract gaps are entirely met by LNG in 2030, the EU is projected to have a regasification capacity significantly above this level.

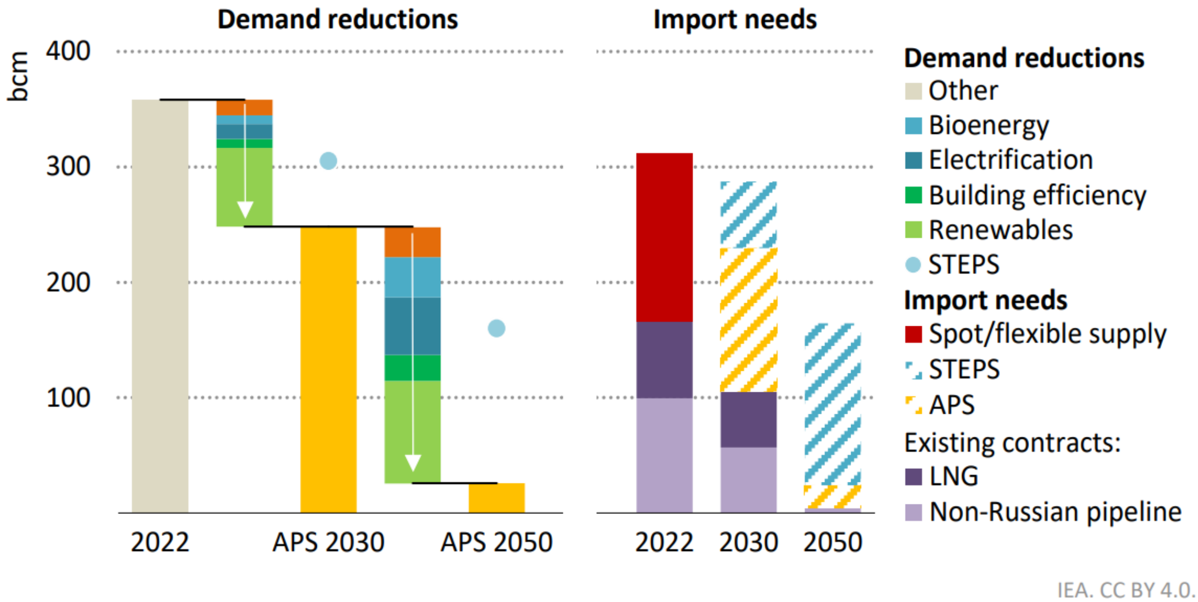


Figure 5.8: Drivers of natural gas demand reduction and import needs by scenario in the EU
Source: (IEA, 2023c).[180]

The IEA suggests a supply gap of 20 bcm in 2050 (assuming REPowerEU targets) meaning, as of 2023 projections, the EU can contract a small amount of natural gas without failing to meet its 2050 net zero target. The IEA also concludes that as global LNG markets look well supplied in the second half of the 2020s, no new projects are needed under *APS*, as gas can be sourced from existing projects. New EU contracts, therefore, that incentivise new supply-side projects risk net-zero targets.

What is clear is the need for gas contracting in the shorter term (by 2030). An important trade-off exists when signing flexible long-term FOB LNG contracts and investing in floating terminals. While these measures help mitigate the risk of entering the more expensive spot market during periods of high demand, they also leave investors exposed if global gas demand falls in line with the *NZE* scenarios. However, according to the IEA's scenarios, the investment costs in LNG infrastructure are relatively modest, and import LNG terminals and pipelines do not require high utilisation rates over long periods. In the *STEPS*, investment from 2022-2030 is projected at USD 55 billion, rising to USD 70 billion in *APS*.

The risk to investors of falling gas demand is amplified if the EU expands LNG capacity at a rate significantly higher than projected demand. Current plans will see regasification capacity at a level much higher than import demand in IEA scenarios, and total EU spending on LNG infrastructure, if all current plans are developed, is 93 USD billion,[181] exceeding the REPowerEU-consistent *APS* scenario.

5.1.6 Oxford Institute for Energy Studies (2024c): Energy Transition Scenarios - Impact on Natural Gas[182]

The IEA projects a significant decline in the use of natural gas, driven by falling renewable costs.[183] The Oxford Institute for Energy Studies (OIES) assumes that fossil gas will stay in energy systems for much longer, designing scenarios to reflect a *Delayed Phaseout* future for natural gas.

Their *Declared Policy Scenario (DPS)* is similar to the IEA's *STEPS* but relaxes the assumption of successfully implementing policies and targets. *Net Zero with Carbon Capture and Storage (NZwthCCS)* envisions continued gas use in industry and for blue hydrogen. In this scenario, electrification occurs but requires fossil fuels with CCS to handle intermittency. This net zero future overshoots a 1.5 degree rise by 2050 and relies on negative emissions to return to 1.5 degrees by 2100.

The *Fragmented (FRAG)* scenario relaxes the assumption that net zero is met by 2050, acknowledging *NZwthCCS* is not realistic across the board, and so envisions a fragmented world where OECD countries show the most commitment to decarbonisation, and other countries lag to varying degrees. *FRAG* has more fossil gas, fewer renewables, and lower electrification than *NZwthCCS* but still requires a high level of CCS. Both use the IEA's *APS* for energy demand. These scenarios take a more pessimistic outlook on the success of policy goals and the outlook for renewable energy, batteries as a storage technology, and end-use electrification, whilst taking an optimistic outlook on CCS.

The OIES study does not differentiate between the EU and Europe, so Europe is used as a proxy when looking at results. The power sector moves to renewables much slower than REPowerEU, where all 3 scenarios have a 40-44% renewable share in 2030. By 2050, the share of natural gas significantly declines in the power sector, industry and buildings in both *FRAG* and *NZwthCCS* scenarios. A key energy carrier in both scenarios is hydrogen, with both deploying above 5,000 PJ (~35 Mt)[xxxiii] with the share of blue and green varying depending on CCS assumptions (Figure 5.9).

[xxxiii] Assuming hydrogen energy density of 142 MJ/kg

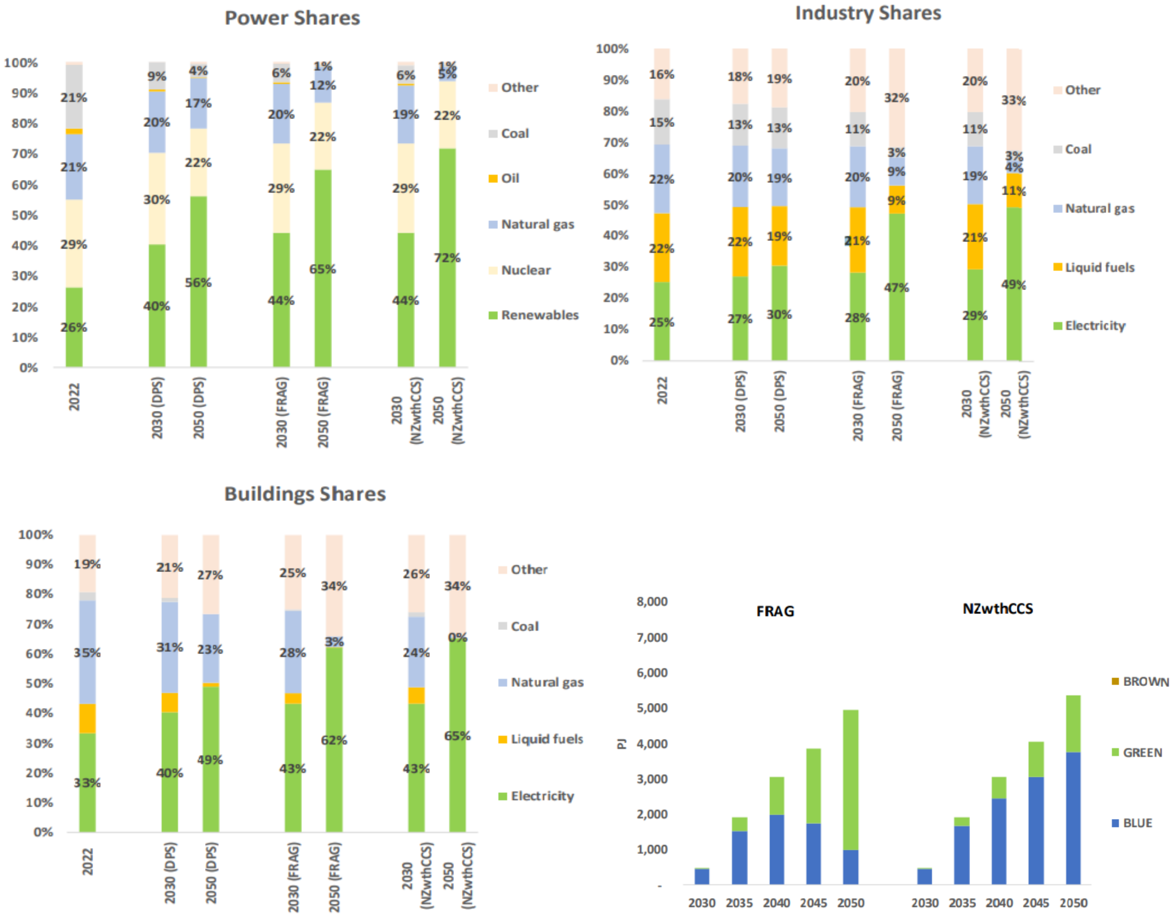


Figure 5.9: End use energy share by fuel, industry and OIES scenario

Source: OIES (2024c).[184]

Natural gas demand in all scenarios remains high in 2030, between 446-471 bcm, contrasting the levels of c. 410 bcm in 2021, c. 330 bcm in 2023 and the REPowerEU target of c.185 bcm in 2030 (Figure 5.10). Scenarios see LNG imports to Europe (as a single region) continuing to grow until 2030 in all scenarios, with inflows sitting between 204-215 bcm in 2030 compared to c. 90 bcm in REPowerEU. These results assume pipeline imports reduce. Both natural gas demand and LNG imports fall more significantly post-2030 in *NZwthCCS* and *FRAG* scenarios. Critically, the results of *DPS*, where REPowerEU's expansion of renewable energy and electrification are least represented, show much higher levels of LNG imports through to 2050.

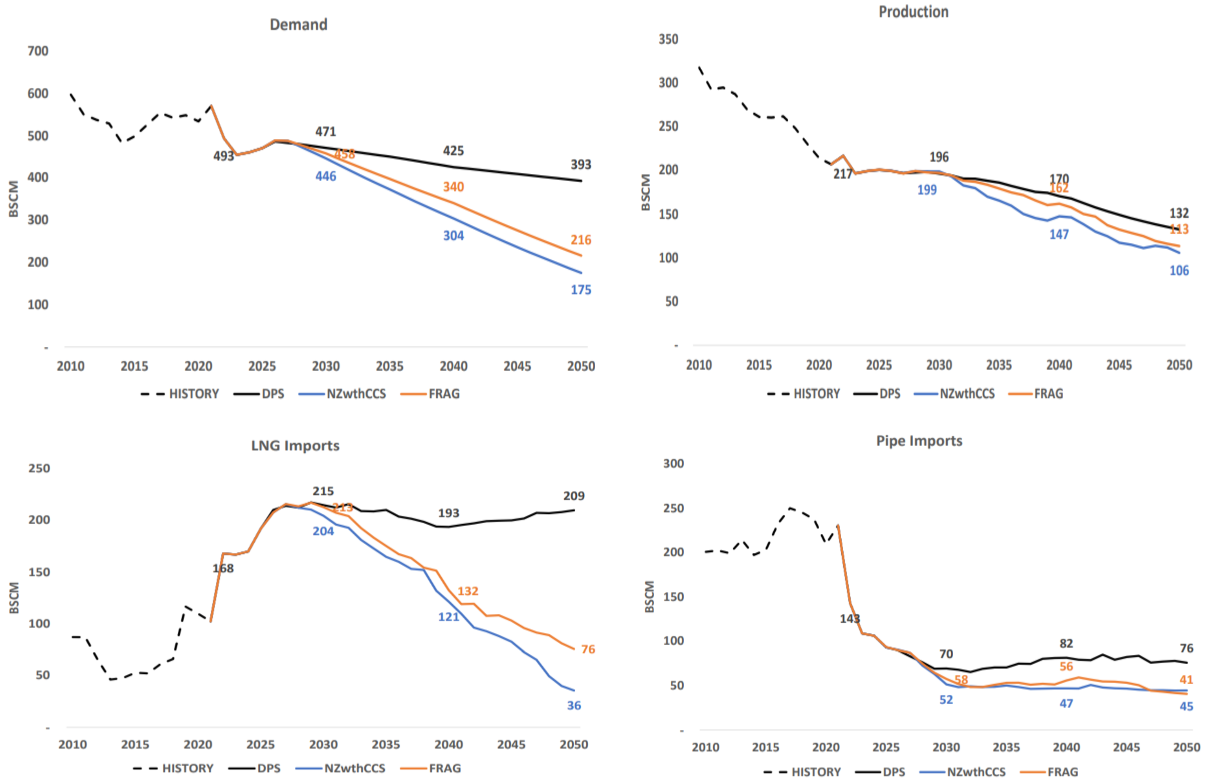


Figure 5.10: Natural gas and LNG demand, production and import levels under OIES scenarios
Source: OIES (2024c).[185]

Importantly, the OIES results also contain an examination of the variation between different projections of global gas demand and LNG imports (Figure 5.11). These contrasting studies represent the wide array of natural gas demand projections between institutions, where results depend significantly on key assumptions and expectations of the future. This analysis drives home the importance of understanding the assumptions that factor into any scenario.

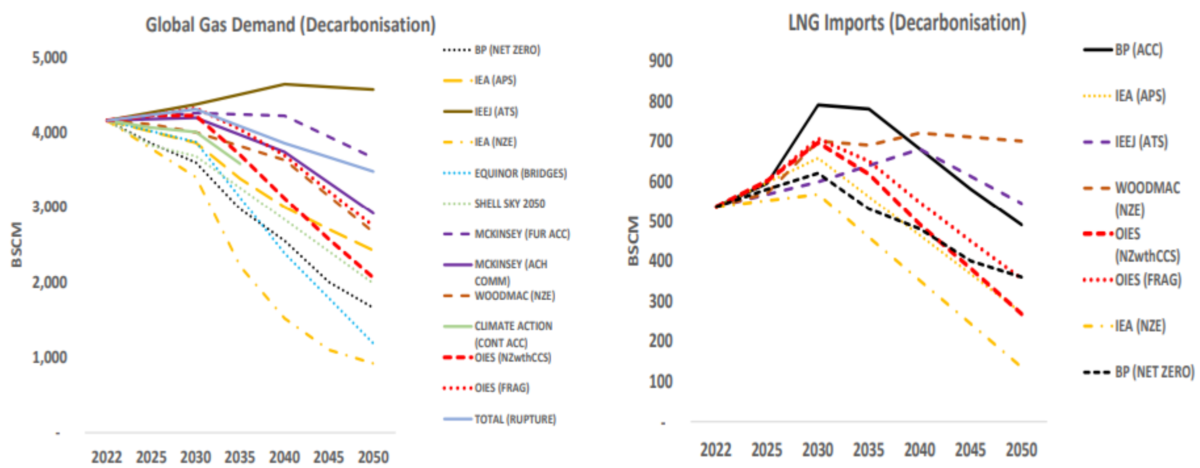


Figure 5.11: Variation in global natural gas demand and LNG imports by institution and scenario
Source: OIES (2024c). [186]

5.1.7 bp's Energy Outlook (2023, 2024)[187,188]

bp's Energy Outlook provides insight into industry expectations for EU gas demand, making for helpful comparison with academic assumptions and projections. Two scenarios from bp reports are analysed. The first scenario, *Current Trajectory,* incorporates only existing policies and pledges, with a significant temperature overshoot. The *Net Zero* scenario assumes a ramping up of climate policy and changes in societal behaviour that support energy efficiency gains and the accelerated adoption of low-carbon energy. This outcome is broadly in line with Paris Agreement-consistent IPCC scenarios, where global emissions fall by roughly 95% by 2050.

5.1.7.1 Energy Outlook 2023 - Revisions of EU gas demand projections

Energy Outlook 2023 (EO23) confirms EU oil and gas demand has likely peaked and concurs on the long-term decline of natural gas. Since at least its 2022 Energy Outlook (EO22) (bp, 2022), bp has expected the rate of decline of natural gas demand in the EU between now and 2030 to accelerate in all scenarios.

EO23 *Net Zero* saw the EU's natural gas demand 50-60 bcm lower in 2030 than estimated in EO22. In bp's EO23 *Net Zero* future, faster gains in energy efficiency, rapid uptake of renewables, and electrification of final consumption means EU natural gas demand in 2030 is around 50% (190 bcm) lower than 2019 levels, reflected in the lowest LNG import dependency and falling domestic production, and is compatible with the REPowerEU target of a 52% reduction.

5.1.7.2 Energy Outlook 2024 - Global gas demand and implications for EU LNG

The Energy Outlook 2024 (EO24) revises EU gas demand estimates up, in contrast to the reduction in the previous report, which was potentially due to the 2022-23 gas consumption reduction targets. Total demand in *Net Zero* is estimated to be 265 bcm in 2030, up from nearly 200 bcm in Energy Outlook the year before. This contrasting projection is much more conservative than the REPowerEU target of 184 bcm in 2030 (

Figure 5.12). The *Current Trajectory* scenario has demand as high as 358 bcm in 2030. Bp models net pipeline imports decreasing in *Net Zero,* but not in *Current Trajectory*.

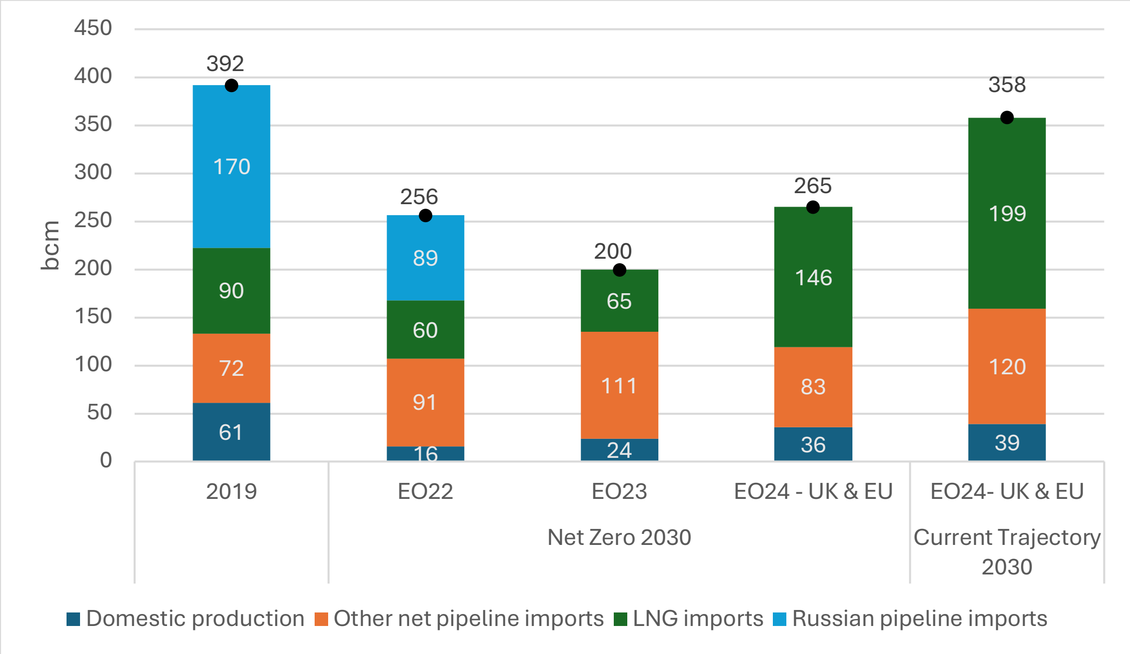


Figure 5.12: EU natural gas demand and sources of supply in 2030: evolution of projections

Source: Constructed using Energy Outlook 2023 and 2024 editions and datasets (bp, 2023, 2024).[189]

Both scenarios see global LNG trade volume increase to 2030, driven mostly by growth in emerging markets (Figure 5.13). In *Current Trajectory*, EU and UK LNG demand grows to 199 bcm by 2030 as the region continues to adjust to the phase-out of Russian imports. In *Net Zero*, there is a greater shift to alternative energy sources and energy efficiency, meaning by 2030, EU and UK LNG demand is 146 bcm (below 2022 levels but significantly higher than EO23 *Net Zero's* pre-invasion projections).

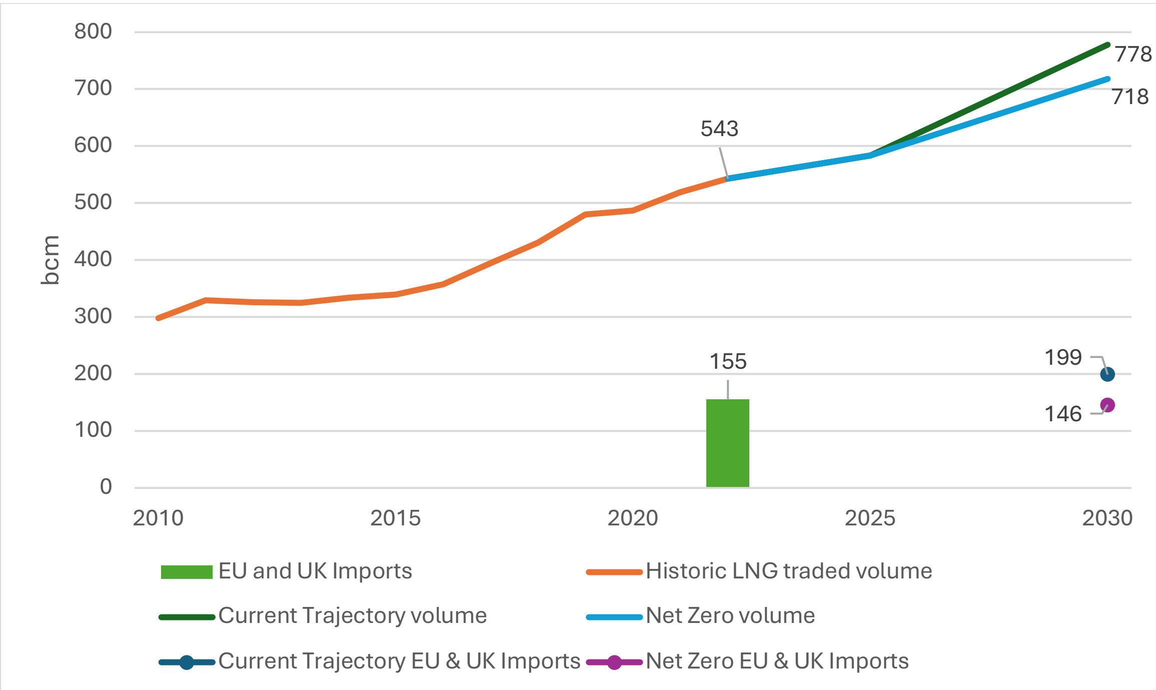


Figure 5.13: LNG trade volume and imports by bp scenario

Source: Constructed using bp (2024).[190]

Whilst predictions for 2030 LNG demand in Europe vary between scenarios, in both instances demand is significantly below LNG regasification capacity projections. The study also concludes that, under *Net Zero*, no new liquefication capacity beyond that under construction is required to meet climate targets.

While bp (2024) does not discuss EU sectoral gas demand projections, it does incorporate both green and blue hydrogen. In *Net Zero*, low-carbon hydrogen production increases significantly. By 2035, the increase in EU pure hydrogen demand from buildings, transport and industry is met by a combination of domestic production and pipelines from North Africa, parts of Northern Europe and Nordic countries. Bp assumes that the high cost of pure hydrogen transportation means trade is localised and regional, with the EU a main importer, and the US, Middle East and Australia the main exporters. The rest of demand is for hydrogen derivatives, such as ammonia used in shipping or derivatives used in green steelmaking.

Bp's estimates are more conservative than the 10 Mt domestic production and 10 Mt import targets of green hydrogen under REPowerEU. In total, bp's (2024) *Net Zero* scenario produces ~11 Mt of EU low-carbon hydrogen demand by 2035 and ~38 Mt by 2050 (Figure 5.14), significantly lower than the 20Mt targeted by REPowerEU by 2030. Whilst LNG infrastructure may be underutilised if bp's projections are taken, EU plans are more ambitious than bp scenarios on hydrogen, and the role of LNG capacity in facilitating this should therefore be considered alongside import demand.

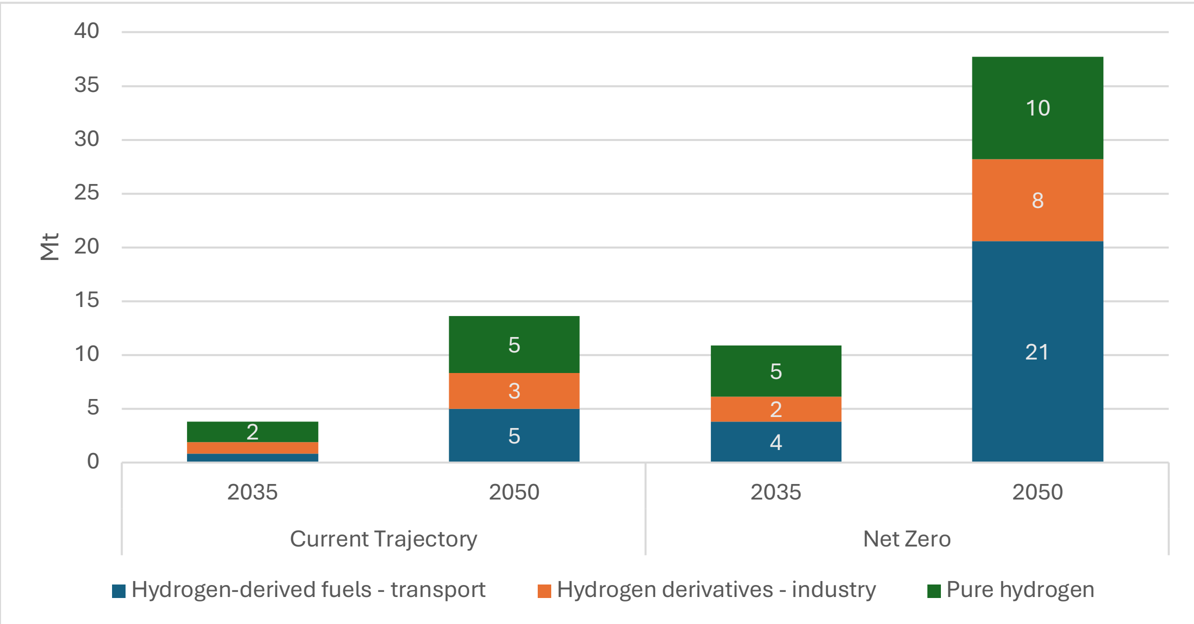


Figure 5.14: EU low-carbon hydrogen demand by bp scenario

Source: Constructed using bp (2024).[191]

One caveat to these results is that, while the 2025 Energy Outlook is not yet available, bp's recent 'fundamentally reset strategy' detailing a shift away from investments in renewables and towards investing in greater gas capacity suggests these scenarios may no longer align with the company's own plans and targets, much less the oil and gas industry's more broadly.[192] The degree to which this publicised change will affect the company's output and the broader international gas market is not yet clear.

5.2 SUMMARY OF SCENARIOS AND KEY TAKEAWAYS

Some of the explored scenarios explore how the key tenets of REPowerEU's targets (electrification and the deployment of heat pumps; a combination of biomethane and green hydrogen; and continued progress in enhancing energy efficiency) can be met. Achieving the EU's stated goals on climate and energy security by 2030 will require further reductions in gas demand, in the range of 68-110 bcm, or 19-31% from the 2022 level of 358 bcm.

The range of assumptions around EU natural gas demand has divergent implications for the likely trajectory of gas prices and European dependence on imports and LNG. An additional 40-60 bcm of natural gas is estimated to be required if REPowerEU targets are missed. This amount rises as scenarios align more closely with business as usual (BAU). Ah-Voun et al.'s results show the EU could require 78% of the global LNG spot market if the REPowerEU targets are missed by just 25%.[193] One caveat, however, is that these scenarios were created before US President Donald Trump stated his intention to increase US LNG output.[194] This injects uncertainty into estimates of the size of the global LNG spot market and, thus, the EU's market share.

Under 'target-compliant' scenarios like those from the IEA, in 2030 the EU will be procuring around 55-60 bcm of gas from existing non-Russian pipeline contracts and 20-36 bcm from domestic production.[195] Around 45 bcm is secured through existing LNG contracts, with a further need for 120-140 bcm through either new pipeline or LNG contracts. In Nikas *et al*, supplier expansion is met by increasing Norwegian and North African pipeline activity,[196] whereas in Ah-Voun et al.'s *REPowerEU,* and bp's *Net Zero* scenarios 146-169 bcm is required from LNG markets.[197] Depending on contracting direction and the success of policies, Europe could either have a substantial surplus LNG capacity or substantial influence over global prices.

What are the implications of this? Higher gas consumption scenarios imply not only that emissions goals would be missed without ample CCS, but the EU risks higher prices and dependence on volatile LNG markets. These high-gas scenarios amplify supply-chain emissions concerns, as the EU would need to procure gas with substantially higher life-cycle emissions (particularly in relation to methane released during the transportation process; Figure 4.9).

National plans currently indicate patchy implementation of the REPowerEU goals by EU Member States. There is, therefore, a broader question about whether the EU is likely to meet its short-term decarbonisation targets or what this would mean for the bloc's net zero target. For example, under scenarios such as those by OIES and Agora Energiewende (i.e. more aligned with BAU) [198,199] it becomes very challenging to meet net zero, with the OIES scenarios only achieving net zero with implausible rates of CCS deployment.

Other scenarios focus on specific drivers, aiming to explore factors affecting the ability to reduce natural gas consumption at the rates indicated in REPowerEU. For example, Ah-Voun *et al.*'s *Hardest Winter* could raise LNG demand to 169 bcm if REPowerEU targets are met and no new pipeline contracts are secured.[200] Yet, in Nikas *et al.*, a focus on energy efficiency over domestic production or new imports could lead to significantly lower electricity prices.[201]

Bp's results diverge most significantly from the REPowerEU targets, [202] potentially indicating the degree to which industry expectations align with high continued natural gas use despite European targets (also supported by Figure 5.11). Given recent tensions between decarbonisation goals and other economic and geopolitical factors facing the EU, it is important to consider what types of scenarios provide the most useful outlook for natural gas. While the significant range of assumptions in these scenarios highlights the necessity of examining more than simply target-compliant scenarios, the sheer range of outcomes indicates the challenges the EU faces from the oil and gas sector in meeting its decarbonisation targets.

This considerable range of scenarios also highlights the challenge of predicting natural gas prices or demand. While projections are included throughout this report, both COVID-19 and the energy crisis make clear how rapidly demand and prices can shift, and how this feeds through to long-term behaviour is equally uncertain.

The challenge of predicting natural gas prices also reaffirms why the EU should retain its focus on electrification. Amid calls to revisit the EED embedded in REPowerEU,[203] there are important questions about the extent to which modifying these targets would increase the EU's dependence on volatile natural gas prices. While electrification brings its own challenges, the European Commission has many of the tools to be able to mitigate these. While increasing dependence on international gas could give the EU considerable purchasing power, the EU should seriously question the extent to which it wishes to be exposed to the volatility of these markets and the original purpose of REPowerEU.

ANNEXES

ANNEX A: FOSSIL-FUEL SUBSIDIES

Fossil-fuel subsidies accounted for about EUR 50 billion a year in the EU before 2022 and have reached EUR120 billion during the global energy crisis.[204] The 8th Environmental Action Programme requires Member States to develop pathways to a complete phase-out of fossil fuel subsidies, which are inconsistent with Fit-for-55 and REPowerEU objectives and with the EU's Climate Law.

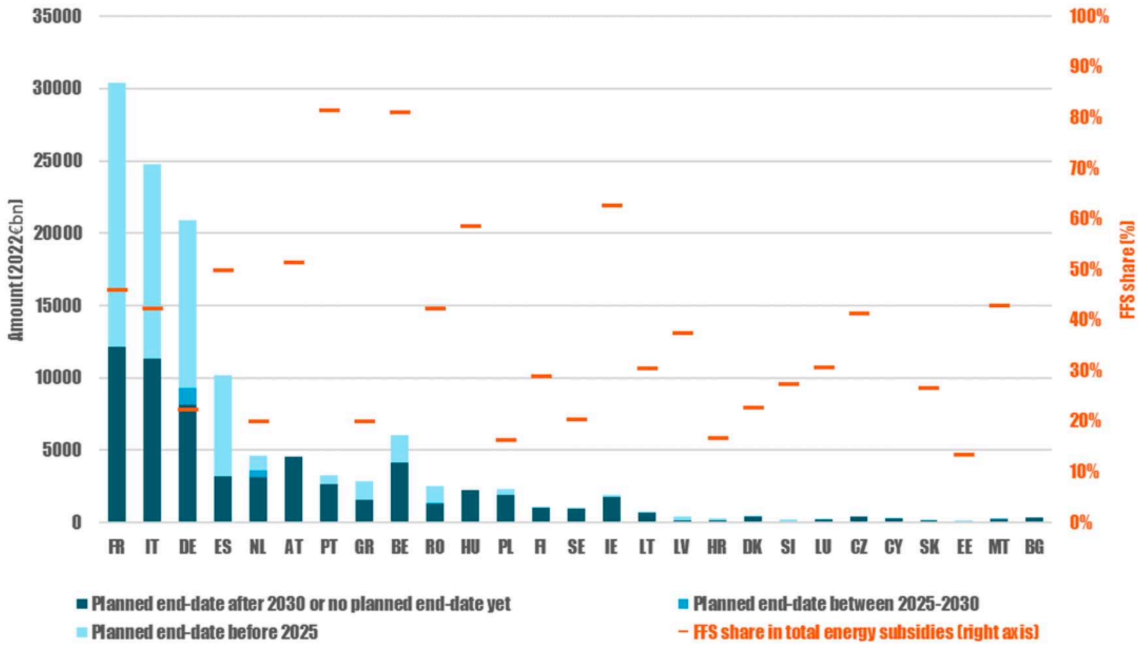


Figure A.1.Fossil fuel subsidies and their phase-out targets across the EU Member States.

Source: Enerdata and Trinomics (2023).[205]

Phasing out *energy* subsidies is an integral part of the NECPs that Member States have to finalize by 30 June 2024. Fossil fuel subsidies represent a significant share of the total energy subsidies. The European Commission set the provisional deadline to phase out 47% (EUR 58 billion) of the total EUR 123 billion by 2025.[206] Beyond that date, just 1% of the remaining fossil-fuel subsidies are expected to be ended by 2030, while another 52%, or EUR 64 billion, either do not have the end date or have it after 2030.

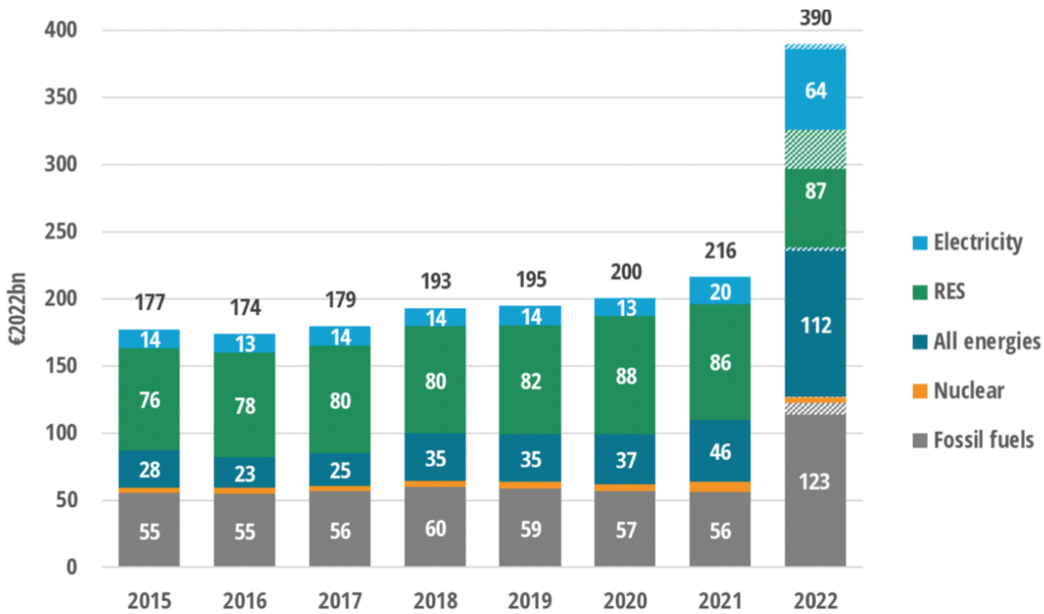


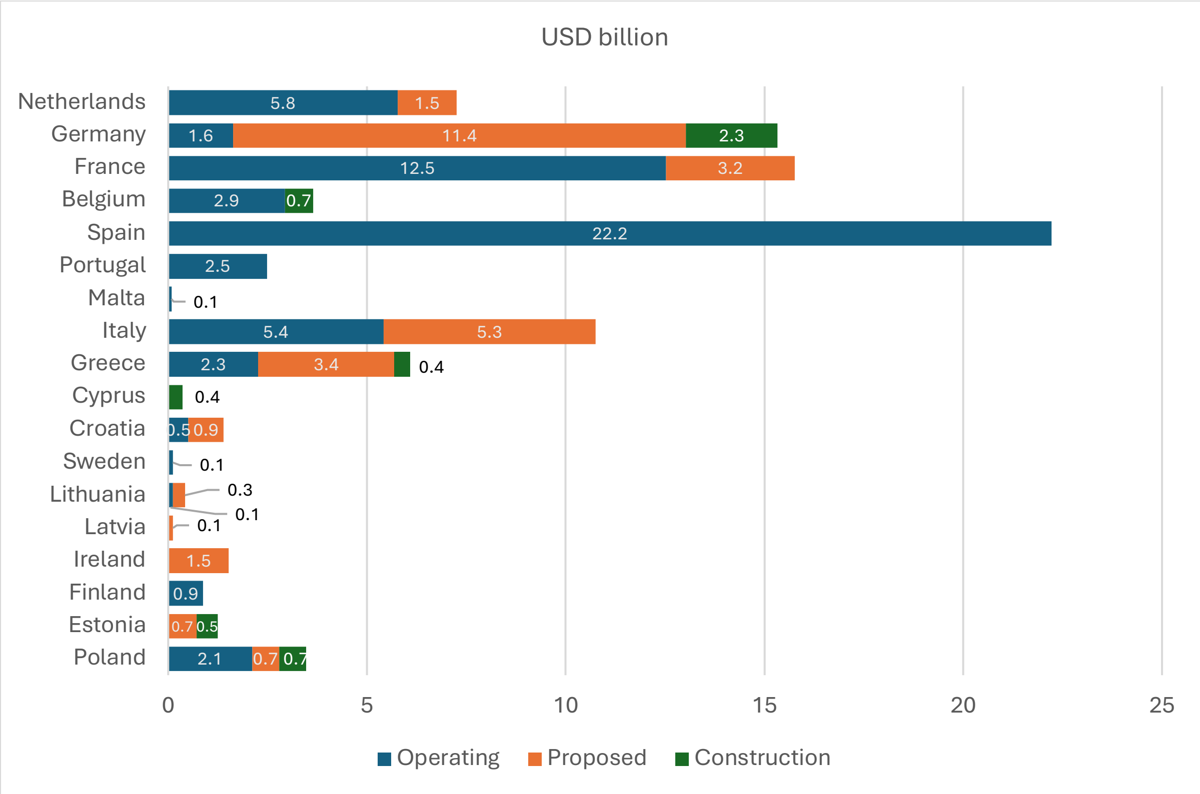
Figure A.2. EU energy subsidies by sector 2015-2022.
Source: Enerdata and Trinomics (2023).[207]

ANNEX B: INVESTMENTS IN NEW GAS POWER PLANTS IN EUROPE

Source: Global Energy Monitor (2024).[208]

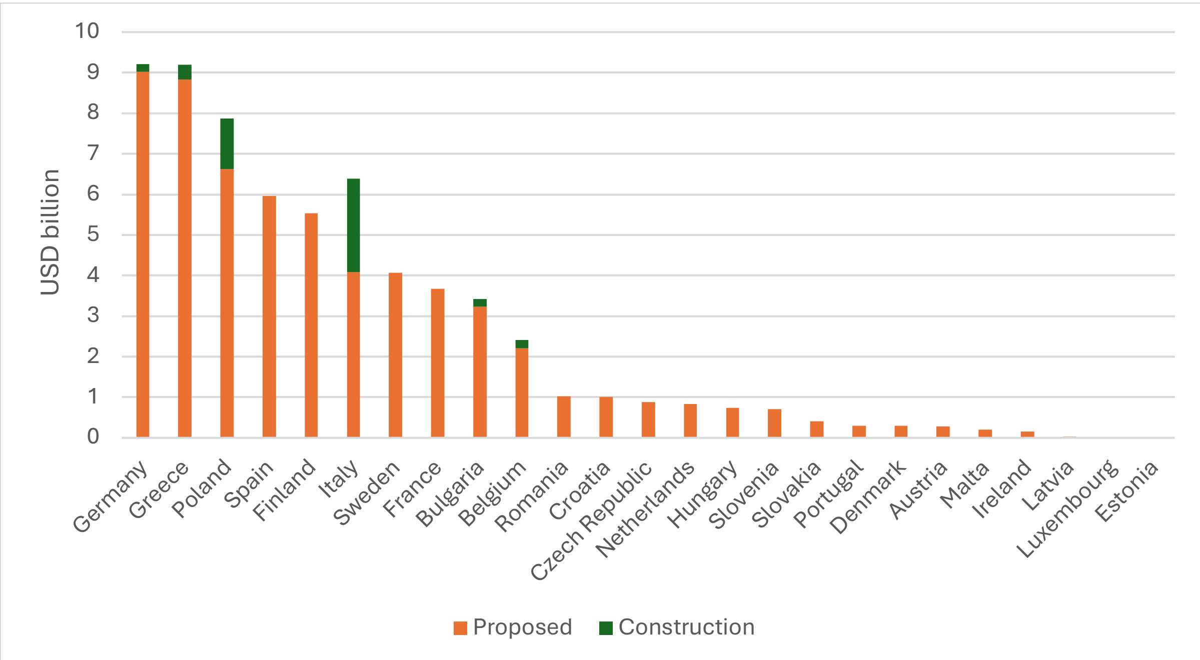
ANNEX C: INVESTMENTS IN LNG AND GAS INFRASTRUCTURE IN THE EU

a) Investments in LNG import terminals



Source: own calculation based on Global Energy Monitor (2023)[209]

b) Investments in gas pipelines



Source: own calculation based on Global Energy Monitor (2023)[210]

ANNEX D: EU'S ENERGY SCENARIOS PRE-2022

The results in this section do not incorporate energy market developments arising from the Russian invasion of Ukraine, they model the emission reduction targets of Fit-for-55 and price projections from before the conflict and excluding REPowerEU. These are covered to analyse energy system composition and gas demand in a future where pre-conflict policies are successfully met, offering a point of comparison for studies incorporating REPowerEU and developments due to the conflict.

Boitier et al. uses 7 models to explore how the EU policy path 'Fit-for-55' can be met in 2030, as well as Net Zero in 2050.[211] Two scenarios are run, the first, '*NZE Benchmark',* meets the two emission reduction targets in 2030 and 2050 by finding the lowest cost solution. The second scenario, '*NZE EU Policy Standard'* has the same climate objectives but includes the upgraded burden sharing of 61% for sectors covered by EU ETS and 40% by those covered by the ESR (as in Fit-for-55, and relative to 2005). When comparing the costs of the two scenarios, it is found that Fit-for-55 measures to increase ETS coverage are in line with a cost-optimal solution.

The seven models have varied coverage of key sectors, with only four economy wide models (EU-TIMES, GCAM, GEMINI-E3 and NEMESIS). Results from '*NZE Benchmark'* indicate strong declines in gas consumption in NZ scenarios in EU-regional models, this is less prevalent in GCAM and GEMINI-E3 due to heavy reliance on fossil fuel CCS and BECCS. However, in 2030, gas levels were projected to only be marginally lower than 2020 levels. All economy wide models had unabated gas on the decline in the power sector as generation is prioritised for decarbonisation in all models. The sector specific FORECAST model projects full decarbonisation of the building sector is possible by 2050, a key sector for gas demand.

Almost all models incorporate energy savings, but to varying extents. Between 2040 and 2050, models mitigate harder-to-abate sectors, EU-TIMES and NEMESIS project an increase in primary energy consumption due to high penetration of carbon free electricity. All models show renewable energy growing consistently, but at different shares depending on sources, and attest to the importance of an electrified end use sector.

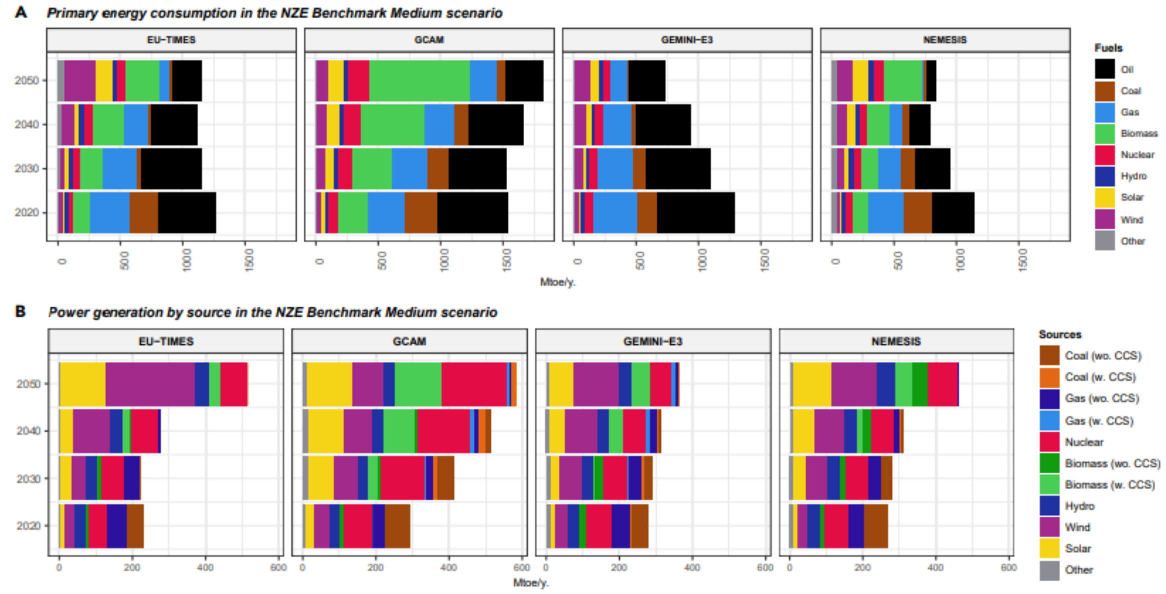


Figure D.1. Primary energy consumption (A) and power generation by source (B) in NZE Benchmark Medium.

Source: Boitier et al. (2023).[212]

Kigle et al. combines 4 final energy consumption sector models to investigate emission reduction in the scenario 'solidEU', which reflects both techo-economic and socio-political contexts of the region pre-Russian invasion of Ukraine.[213] This includes the 55% emission reduction target by 2030 set out in the European Commission's Green Deal. The result of this scenario reflects a similar outlook for gas to Boitlier et al.,[214] showing gas in final energy consumption declining dramatically by to 2050 (-87%) but less significantly by 2030 (-19%).

In this scenario, final energy consumption reduces due to efficiency measures and electrification, the rapid implementation of battery electric vehicles, the application of heat pumps, and industrial processes such as DRI. Electricity consumption increases from 3,100 TWh in 2020 to 5,000 TWh in 2050. Fossil gas's role in the energy mix decreases significantly, whilst hydrogen increases to approximately 800TWh by 2050, used primarily in industry and to substitute for gas for process heat provision.

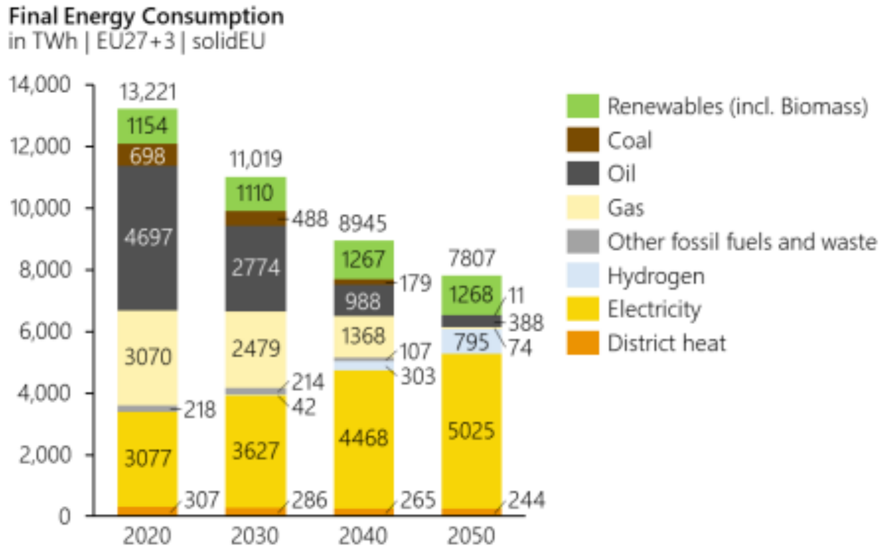


Figure D.2. Final Energy Consumption in EU 27+3 from 2020-2050.
Source: Kigle et al. (2022).[215]

In the residential sector, space heating demand decreases as a share of final energy consumption, this is due to increased retrofits and efficiency measures. A very small share of oil and gas remains in the energy mix due to some fossil fuel heating systems that have not reached end of life by 2050. The widespread adoption of heat pumps in the sector means electricity makes up over 60% of the residential energy mix in 2050.

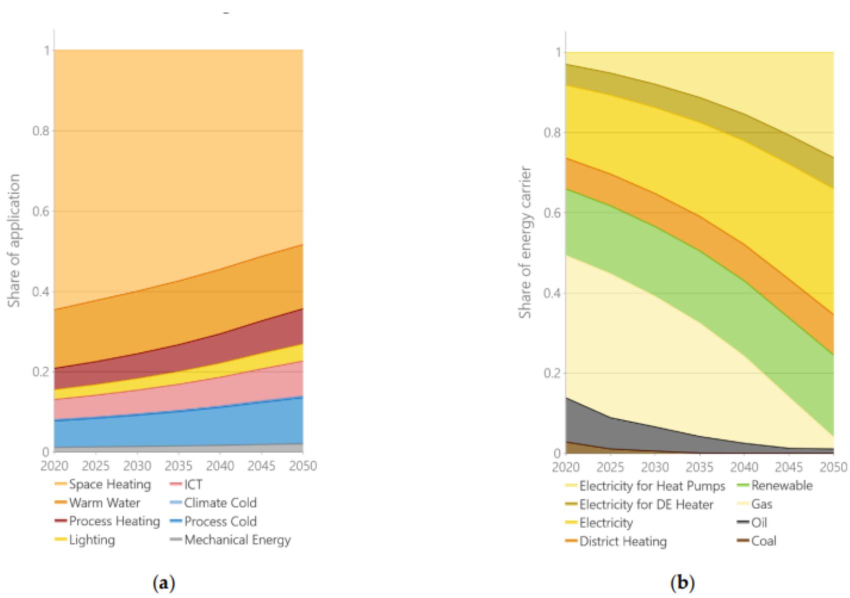


Figure D.3. Share of application (a) and share of energy carriers (b) in the FEC in the residential sector.
Source: Kigle et al. (2022).[216]

Pre-invasion scenarios indicate that to meet the EU's climate targets set before 2022, gas demand in most models reduced significantly, with assumptions around CCS, energy efficiency and electrification key drivers of such levels.

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