Pathways | EU | Energy, Buildings, Industry

BREAKING FREE FROM FOSSIL GAS

KEY MESSAGE

- **Fossil gas, no longer cheap and abundant, cannot be used any more as a 'bridge fuel'**, away from coal or oil to clean technologies such as renewable energies. **A reassessment of the European energy transition to 2050 is necessary** given the impacts from the 2022 energy prices and security crises.
- **A faster decline in fossil gas use is feasible, less costly and delivers faster greenhouse gas** (GHG) **emissions reduction**. Agora's EU Gas Exit Pathway shows fossil gas use in Europe can be **halved by 2030** and **completely phased out of energy systems by 2050** without disruptive behavioural changes, while maintaining industrial production at similar levels as today, and fully ensuring security of supply.
- The energy transition can be achieved with significantly **lower deployment of hydrogen, hydrogen derivatives and biomethane by 2030 than foreseen in the EU's strategy to wean Europe off Russian fossil gas, the RePowerEU plan**. It is much more cost-effective to prioritise direct use of renewable electricity and reserve hydrogen for **no-regret applications** where direct electrification is not an alternative in the industry, transport and power sectors.
- This pathway relies on a **fast scale-up of renewable energy capacity deployment** and **energy efficiency improvements**, as well as **electrification of applications** in the buildings and industry sectors.
- Through targeted measures, the EU could realistically **overachieve its current 2030 climate target of 55%** GHG emissions reductions relative to 1990 levels **by up to 5%**, aim for a new **2040 climate target of about 90%** and meet its legally binding, 2050 climate-neutrality target.

OVERVIEW

Context

In early 2022, the European Union (EU) responded to the **energy prices and security crises** with immediate and short-term actions to **lower the Union's fossil gas demand, diversify its fossil gas import sources** away from Russia and **contain energy prices** with the REPowerEU plan[1]. Europe developed complementary actions with the aim to improve Europe's **energy sovereignty** while addressing the climate crisis and fulfilling its **climate objectives**. The EU has a legally binding target to become **climate neutral by 2050**, which means to reduce greenhouse gas (GHG) emissions as much as possible and compensate for any residual emissions with carbon capture and storage (CCS)[2] or carbon sinks[3].

Fossil gas is still used across our economies, mostly in the energy, buildings and industry sectors to produce **electricity, heat** and as a **feedstock**[4] (see figure 1). Overall, Europe used the equivalent of around **4 000 TWh**[5], or **410 bcm**[6] of **fossil gas**

1 For more details see: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en#clean-industry ; https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2022:230:FIN

2 Carbon Capture and Storage refers to a set of technologies that aim to capture, transport and permanently store CO_2 that would otherwise be emitted into the atmosphere by industrial installations, such as cement or steel plants.

3 Carbon sinks mostly refer to forests and other ecosystems such as plants or soil that absorb carbon, thereby removing it from the atmosphere and offsetting CO_2 emissions. Certain human-induced sinks activities can be counted towards a country's emission targets.

4 For instance, chemicals production uses fossil gas as a feedstock to produce hydrogen and ammonia, for further transformation into fertilisers or methanol; the latter is used to produce plastics and solvents.

5 Terawatt hour (TWh) is a unit of energy used for expressing the amount of produced energy, electricity and heat. 1 TWh = 1 000 GWh = 1 000 000 MWh = 1 000 000 000 kWh.

6 Billion cubic meters of natural gas (bcm) is a measure for natural gas production and distribution based on volumes. Other measures may be based on energy content, as the calorific value of natural gas may vary. According to the International Energy Agency (IEA) standards

in 2021. In that same year, the EU produced around 44% of its available energy, while 56% was imported. Over two-thirds (70%) of Europe's energy mix came from fossil fuels, with 34% from oil, 23% from fossil gas and 12% from coal.[7]

Agora's EU Gas Exit Pathway is based on a structural reduction in fossil gas consumption and shows the feasibility of replacing fossil gas much faster than anticipated so far while remaining broadly aligned with the main energy security objectives of the EU (see figure 2).

Main levers to cut fossil gas use

- **Energy efficiency measures**, including renovation of buildings' thermal insulation and installation of more modern technology, such as heat pumps;
- **Direct electrification of heat generation** in buildings and industry, notably through the accelerated deployment of **heat pumps** and **electric boilers. Indirect electrification with renewable hydrogen for applications without more efficient alternatives**, especially in industry (e.g., chemicals);
- Increasing deployment of **renewable energy generation**, mainly **wind** and **solar**, and renovation and expansion of **district heating networks** in dense urban areas.

Pace of fossil gas phase-out

- Though increasing electricity consumption delays full divestment from fossil gas in the power sector until shortly before 2050, the **energy sector** sees the **largest early decline in fossil gas consumption.**
- The **buildings sector** is the **first to fully decarbonise,** through a combination of energy efficiency measures, accelerated deployment of heat pumps, solar thermal and expansion and renovation of district heating networks.
- The shift away from fossil gas in industry varies by sub-sector, with **large parts of industry** becoming **fossil gas free by 2040.** While increased efficiency and circular material flows play a role, most significant for the displacement of fossil gas are increases in direct electrification of industrial processes, starting with low- and medium-temperature process heating. Renewable-based hydrogen and bioenergy with carbon capture and storage (cf. BECCS[8]) are instrumental in the difficult-to-electrify high-temperature processes.

Ensured security of energy supply

- **Elimination of Russian gas imports by 2027** (about 40% less fossil gas demand relative to 2018), while avoiding demand destruction in industry;
- EU's **fossil gas import dependency declines** from 84% in 2020 to 71% in 2040, to full independence by 2045.
- If **all gases** are taken into account (fossil gas, biogas and biomethane, hydrogen and hydrogen derivatives), **EU's dependency improves** from 79% in 2023 **to 29% in 2040** and 17% in 2045, thanks largely to increases in domestic renewables-based hydrogen production. **By 2050,** the EU is projected to import more hydrogen derivatives and its all-gases dependency increases **to 26%.**

EU climate leadership

- **Increased climate ambitions** ahead of the **United Nations' Climate Change Conference of the Parties global stocktake** at the end of 2023 (COP28)[9] in Dubai;
- **Avoiding 3.3 gigatonnes of GHG emissions** compared to the EU's Climate Target Plan[10], a substantial further emissions reduction for Europe **from 55 to 60% by 2030**, mainly based on faster oil and coal demand reductions.

one unit is equal to 38.2 petajoules (1.06 x 1010 kWh) at 15°C and atmospheric pressure.

7 For details see Shedding light on energy - 2023 edition at https://ec.europa.eu/eurostat/web/interactive-publications/energy-2023#about-publication

8 BECCS refers to any energy production process where CO_2 is captured from a biogenic source (i.e., a natural source such as biomass or animal manure) and permanently stored.

9 The global stocktake of the Paris Agreement (GST) is a process for taking stock of the implementation of the Paris Agreement with the aim to assess the world's collective progress towards stabilizing global temperature rise at 1.5 degrees Celsius by 2100. Each stocktake is a two-year process that happens every five years.

10 The 2030 Climate Target Plan proposes to raise the EU's ambition on reducing greenhouse gas emissions to at least 55% below 1990 levels by 2030. For details see https://climate.ec.europa.eu/eu-action/european-green-deal/2030-climate-target-plan_en

AIMS & TARGETS

Agora's EU Gas Exit Pathway aims to fully address the challenge of quickly reducing European fossil gas dependency while effectively transitioning to climate neutrality by 2050 in a cost-optimal, fair, secure and sustainable manner. The phasing-out of fossil gas gives way to a rapid scale-up of renewable energy production, wide-ranging energy efficiency measures and electrification of applications and processes, as well as the targeted use of biogas, biomethane and renewable-based hydrogen for specific applications, especially in industry (see figure 3).

EU's 2040 GHG emissions reduction target

→ Agora's EU Gas Exit Pathway shows how to achieve a net domestic GHG emissions reduction of **60% by 2030**, 77% by 2035, **89% by 2040**, 96% by 2045 and 101% by 2050, compared to 1990 levels;

→ The resulting indicative EU GHG budget for the period 2030-2050 is of **14.3 gigatonnes**.

EU's 2030 hydrogen and biomethane targets

Our analysis shows that the EU's Hydrogen and gas markets decarbonisation package[11] and REPowerEU targets concerning hydrogen and biomethane deserve re-evaluation, especially ahead of the discussion on the Net Zero Industry Act[12], promoting investments in climate-neutral technology products manufacturing (see figure 5).

→ **By 2030**, only **116 TWh of renewable-based hydrogen and its derivatives would be cost-optimal**, in contrast with the RePowerEU's foreseen 666 TWh. Cost-optimising the supply and demand of hydrogen and its derivatives in Europe's transition to climate neutrality implies :

- **prioritising the use of hydrogen and its derivatives** for applications where no alternatives exists;
- **favouring direct electrification**, and when not feasible, indirect electrification (more costly);
- **favouring domestic hydrogen production** over imports (more costly).

→ **Biogas** and **biomethane** consumption remains **stable** at today's level at **196 TWh, or 20 bcm**, in contrast with the RePowerEU's targets of 35bcm, or 342TWh **by 2030**. Our Pathway takes into account:

- a limited uptake on a **cost** basis;
- the recognition of on-going debates on the **sustainable potential of biomethane** in the EU, relating to, among others, **competing demands** for biomass as a feedstock for industry and buildings materials, and on bioenergy for high-temperature industry applications in a carbon constrained world.

Preparing for a rapid decline in fossil gas demand while scaling up electrification and energy efficiency

The EU together with Member States must prepare for an accelerated decline in gas demand and avoid lock-ins with fossil gas infrastructure (transport and distribution grids) and fossil gas-based processes and applications (see figure 4). Both EU and national policy frameworks should therefore aim to:

→ **Scale up deployment of wind and solar** for:

- Electricity and heat generation;
- Renewable-based hydrogen production and its derivatives.

→ **Scale up** methods of **direct electrification**, in particular:

- Residential heat pump installations, manufacturing and training of skilled technicians;

11 Refers to the review and revision of the Gas Directive 2009/73/EC and Gas Regulation (EC) No 715/2009. The EU energy ministers agreed on a general approach on both proposals at the Energy Council in March 2023. Once an agreement is reached with the European Parliament, the legal acts can be formally adopted. For further details see https://energy.ec.europa.eu/topics/markets-and-consumers/market-legislation/hydrogen-and-decarbonised-gas-market-package_en

12 Refers to the Proposal for a regulation of the European Parliament and of the Council on establishing a framework of measures for strengthening Europe's net-zero technology products manufacturing ecosystem of March 2023. For details see https://single-market-economy.ec.europa.eu/publications/net-zero-industry-act_en and https://single-market-economy.ec.europa.eu/industry/sustainability/net-zero-industry-act_en

- Direct electrification of transport for energy efficiency, cost-effectiveness and increased grid flexibility in a carbon constrained world;
- Industrial heat pumps and electric boilers for industrial process heat up to 500 ° C, electric ovens or steam cracking above those temperatures.

→ **Scale up** deployment of **energy efficiency measures**:

- Renovation of district heating networks, alongside their expansion
- Thermal insulation of buildings, including in industry
- Installation of modern appliances and smart technology

Investments needs

→ Our analysis shows that both **public and private investment needs** across the buildings, industry and energy sectors are around **225 billion euros per year up to 2030**, increasing to 285 billion euros per year between 2031 and 2050. These capital expenditures would represent only around **1.6% of EU gross domestic product** (GDP) through 2050;

→ Until 2030, around **29.5%** of the total EU investment needs in all three sectors should be covered by **public funds** either as direct public investments or grants;

→ The **EU funds available** for the green transition before 2030 offer a **solid base** for closing the investment gaps identified. These funding instruments are the Multiannual Financial Framework (MFF), the Recovery and Resilience Facility (RRF), funding foreseen under the RePowerEU plan and revenues from the EU Emissions Trading System (ETS) – Modernisation Fund, Innovation Fund, Social Climate Fund. After 2026, national budgets will need to contribute a significantly higher share, unless additional EU funds become available by then.

POLICY INSTRUMENTS

The EU Gas Exit Pathway yields several insights and implications for EU and national-level policy-making.

2040 target and carbon budget proposal

→ The European Commission is to propose a **GHG emissions reduction target for 2040 by June 2024 latest, together with a projected indicative EU GHG budget for the period 2030-2050;**

→ Agora's EU Gas Exit Pathway shows that the EU should feel confident in setting its 2040 target at **90%** GHG emissions reduction compared to 1990 levels, with a resulting indicative EU GHG budget for the period 2030-2050 of **14.3 gigatonnes**[13].

Hydrogen, biomethane and methane emissions

→ The **2030 targets on hydrogen and biomethane** as indicated in the **Hydrogen and gas markets decarbonisation package** as well as in **REPowerEU** must be **revisited**;

→ **Market fundamentals**, that **have dramatically changed since 2022**, need to be reassessed with a **new impact assessment**, inclusive of any hydrogen and biomethane targets, while avoiding lock-ins to economically and environmentally unsustainable investments;

→ The consequent hydrogen and biomethane target adjustments need to be integrated into the discussions on the **Net Zero Industry Act Regulation**;

→ Methane emissions[14] from biogas and biomethane installations also need to be addressed to avoid most impacts from the biomethane supply chain by

13 The European Scientific Advisory Board on Climate Change 'recommends a 2040 target of a reduction in emissions in the range of 90–95% compared to 1990, corresponding to a budget of 11–14 Gt CO_2e in 2030-2050' in its Scientific advice for the determination of an EU-wide 2040 climate target and a greenhouse gas budget for 2030–2050 of June 2023. The Advisory Board has the mandate to serve as a point of reference for the EU on scientific knowledge relating to climate change. See https://climate-advisory-board.europa.eu/

14 Methane is not only the second most important GHG contributor to climate change following carbon dioxide, but also contributes to local air pollution and ozone formation.

including regulatory safeguards into the proposed **regulation on methane emissions reduction in the energy sector** [15] under discussion.

Energy infrastructure planning and long-term fossil gas contracts

- Governments and regulators must **prepare for an accelerated decline in gas demand** and its **impact on infrastructure planning**, with lower uptakes of hydrogen and biomethane together with lower imports of pipeline and liquified natural gas (LNG)[16] fossil gas than projected so far;
- Current **electricity and gas network planning** need to be urgently **stress tested** in terms of their analytical basis and assumptions in order to **avoid stranded assets**, especially with regard to **distribution grids** and **LNG supply infrastructure**;
- The on-going **review and revision of the Gas Directive**[17] is an opportunity to develop a regulatory and planning framework for an **accelerated decommissioning of existing gas assets**, as well as an **assessment of the sufficiency of existing and planned LNG supply infrastructure** and associated **long-term supply contracts**, which should be **limited to 2045** maximum;
- The EU's **Agency for the Cooperation of Energy Regulators** (ACER)[18] could be given an additional **regulatory role** to foster an optimised and cost-effective development of **LNG supply infrastructure and contracts** in line with both the EU's climate and security of supply objectives.

Fossil gas heating systems and cooking appliances phase-out

- The **sale** of **new fossil gas-burning equipment** in buildings must **end quickly** to prevent the lock-in of fossil fuel boilers and stoves. Nearly all existing fossil gas heating systems and cooking appliances must be **replaced by 2040**, with most buildings having undergone some form of **energy renovation** by that time;
- **Ambitious Minimum Energy Performance Standards** in the **Energy Performance for Buildings Directive** (EPBD)[19] are necessary;
- **Ecodesign standards** for space and water heating appliances[20] must be tightened **from 2027** to **restrict** the placement of **stand-alone fossil fuel boilers** in the EU;
- **Energy labels** for space and water heating appliances must be **rescaled from 2024-25** to reflect the necessary phase-out of stand-alone fossil fuel boilers in the EU;
- All **direct subsidies** for **fossil fuel heating appliances** must be **prohibited from 2024-25** in the EPBD;
- The **National Building Renovation Plans** foreseen in the revision of the EPBD[21] should be fully used by Member States to put in place the necessary policies and measures to effectively phase out fossil fuels in heating and cooling by latest 2040.

15 Proposal for a regulation on methane emissions reduction in the energy sector and amending Regulation (EU) 2019/942. For details see https://energy.ec.europa.eu/topics/oil-gas-and-coal/methane-emissions_en and https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:805:FIN

16 Liquefied natural gas, or LNG is fossil gas that has been cooled to a liquid state, at about -162°C, for shipping and storage. LNG necessitates special tankers and terminals, that are used to return LNG to its gaseous state.

17 See footnote 11 on the EU's Hydrogen and gas markets decarbonisation package.

18 ACER aims to 'foster the integration and completion of the European Internal Energy Market for electricity and natural gas'. For details see https://www.acer.europa.eu/the-agency/about-acer

19 For details see https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en

20 See https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/energy-efficient-products/space-and-water-heaters_en

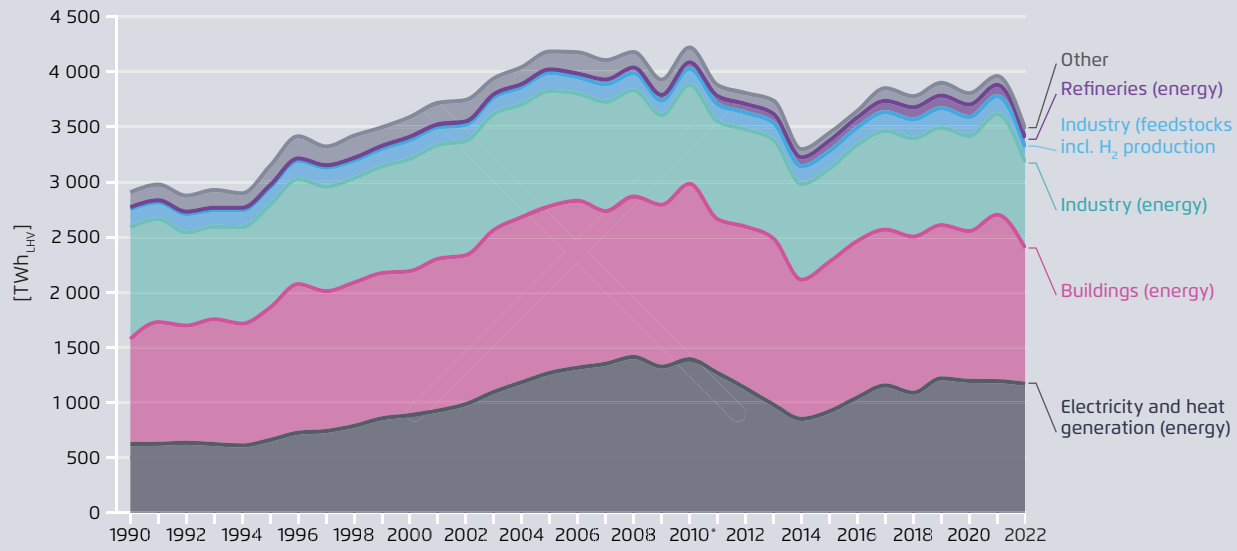
21 See https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/long-term-renovation-strategies_en

National Energy and Climate Plans updates

→ Member States must update their **National Energy and Climate Plans** in light of the recent crises in order to align them with the new energy transition developments and **prepare for the phase-out of fossil gas across all key sectors** (energy, industry, buildings);

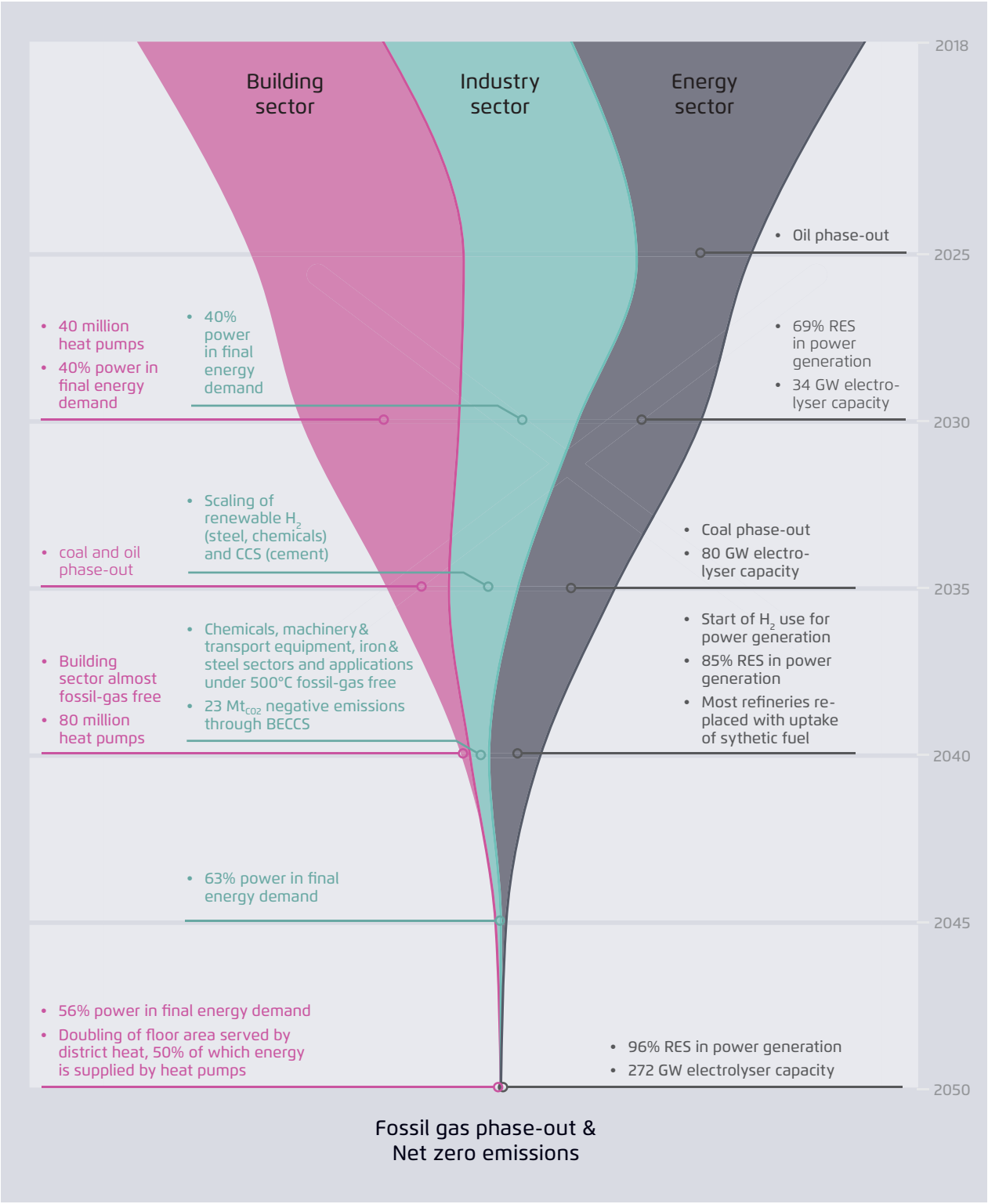
→ The already **scheduled formal updates** of existing NECPs must be **fully used**, with the final updates for the **period 2021-2030** to be submitted by mid-2024 and the updates for the **2031-2040 period** by January 2029.

Fossil gas consumption by sector 1990-2022 — Figure 1



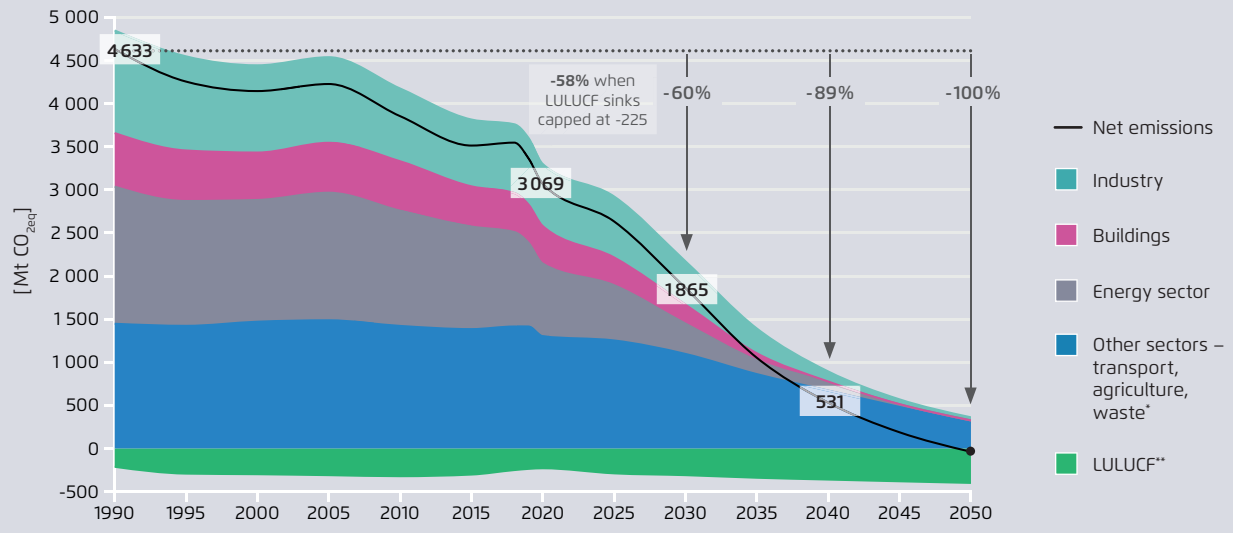
Historic data for 1990-2021 based on Eurostat complete energy balances (2023). Fossil gas demand for 2022 based on Eurostat (2023) monthly data. Sectoral split for 2022 estimated based on Bruegel (2023) and IEA (2023). *Historic peak fossil gas consumption.

EU Gas Exit Pathway: technological pathway towards a fossil gas phase-out, EU-27 Figure 2



Artelys, TEP Energy, Wuppertal Institute modelling (2023)

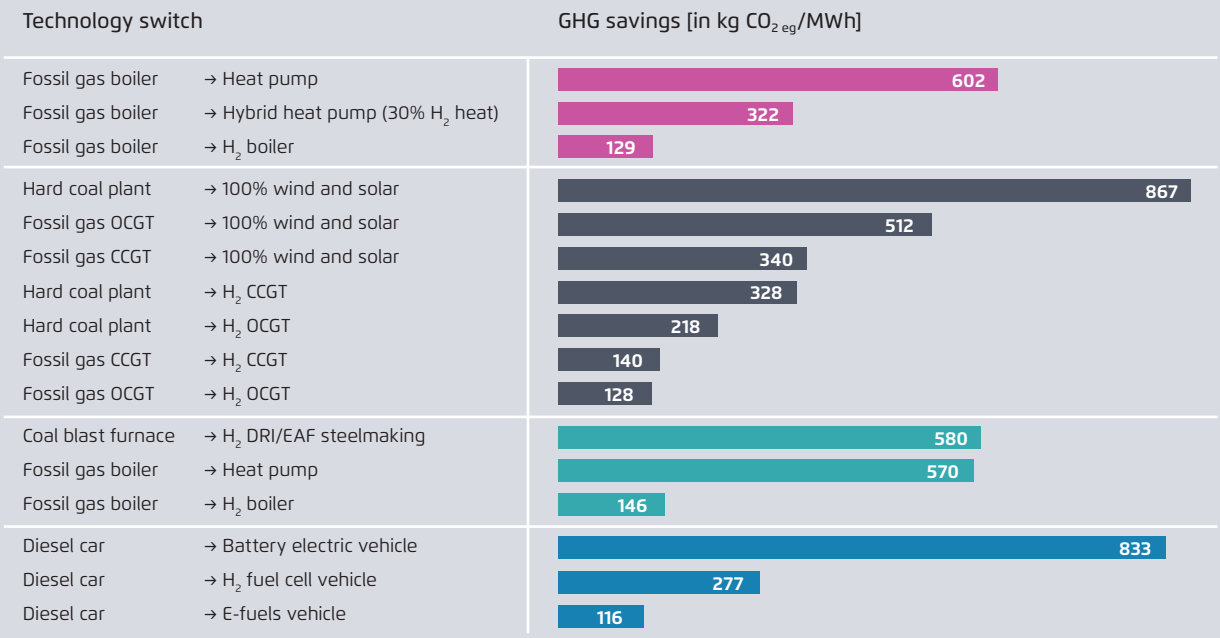
GHG emissions by sector 1990-2050 Figure 3



Eurostat, Artelys et al. (2023) *Based on scenarios by Transport & Environment (Transport) and the European Commission (Agriculture & Waste)
**Based on the LULUCF+ scenario from the EC Climate Target Plan impact assessment (assumes a five-year delay)

GHG emissions reduction in kg of CO_{2e} by technology when using 1 MWh of renewable electricity to substitute fossil fuels in different applications

Figure 4



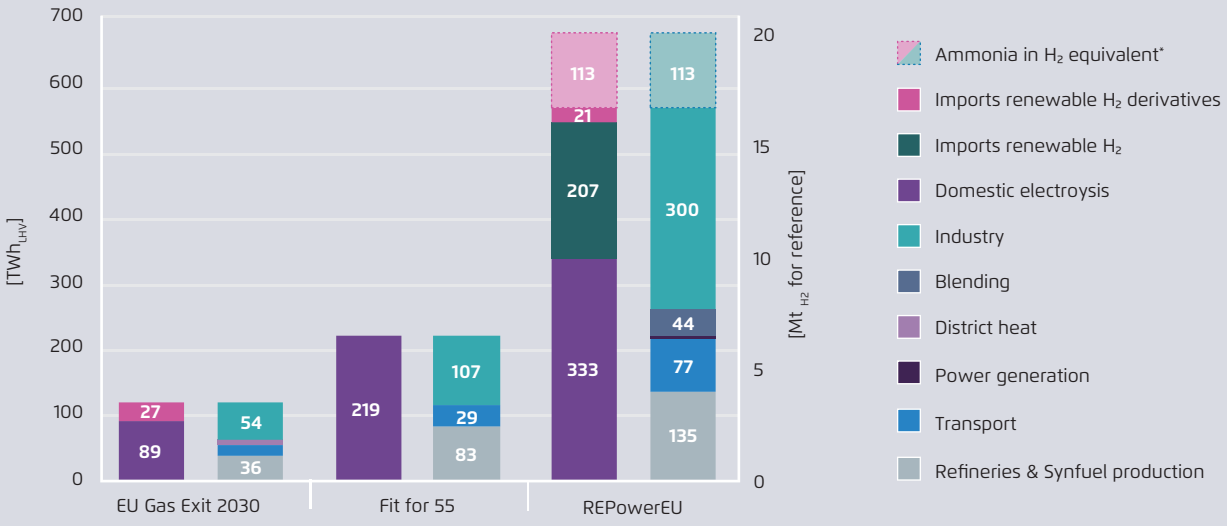
Efficiency assumptions

Buildings	Energy sector	Industry	Transport
Hybrid heat pump: 145% (HP 450%, Boiler: 90%) Heat pump: 300% Boiler: 90%	Hard coal plant: 39% OCGT: 39% CCGT: 59%	BF: 2t CO_{2eq}/t steel DRI/EAF: 3.4 MWh_{el}/t steel Heat pump: 300% Boiler: 95%	BEV: 18 KWh/100 km Fuel cell: 0.89 kg/100 km Diesel & E-fuels: 6 l/100km

* 1 MWh represents roughly the annual electricity production of 1 kWp solar PV
Emissions intensities (in g CO_2/kWhPE) = Hard coal (338.2), Fossil gas (200.8), Diesel (266.5)
HP = Heat pump, H_2 = Hydrogen, OCGT = Open cycle gas turbine, CCGT = Closed cycle gas turbine,
BF = Blast furnace, DRI = Directly reduced iron, EAF = Electric Arc Furnace, BEV = Battery electric vehicle

Agora Energiewende (2023)

Supply by source and sectoral demand for renewable hydrogen and derivatives Figure 5



Artelys, TEP Energy, Wuppertal Institute modelling (2023). Commission staff working document accompanying the REPowerEU plan (2022).
*Derivatives include ammonia and synthetic fuels. Ammonia has a lower calorific value than H_2. The REPowerEU plan seems to have used the same conversion rate for ammonia as for H_2 for its calculations in Mt. Assuming all of the 20 Mt hydrogen and derivatives in the REPowerEU plan are renewable.

Source

Agora Energiewende (2023):
Breaking free from fossil gas.
A new path to a climate-neutral Europe.
https://static.agora-energiewende.de/fileadmin/Projekte/2021/2021_07_EU_GEXIT/A-EW_292_Breaking_free_WEB.pdf

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