HEINRICH BÖLL STIFTUNG
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Deutsche Umwelthilfe

ECOLOGY

The future role of gas in a climate-neutral Europe

Report based on the discussions of an Expert Group convened by the Heinrich-Böll-Stiftung European Union and Environmental Action Germany (Deutsche Umwelthilfe)

Author: Julian Schwartzkopff

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Authorship

The Expert Group on the Future Role of Gas in Europe was jointly convened by the Heinrich-Böll-Stiftung European Union and Environmental Action Germany (Deutsche Umwelthilfe) from October 2020 to February 2022 to discuss key questions related to the management of the energy transition while phasing out fossil gas. It was made up of more than 20 high-level experts from six different European Union (EU) Member States and included specialists working within think tanks, academia, NGOs, and industry, as well as representatives of the European Commission and Members of the German Federal Parliament and the European Parliament. This final report and the associated policy recommendations are based on the discussions of these experts, who also contributed feedback on both documents. While we have aimed to faithfully reproduce the results of these discussions, ultimate responsibility for the content of this report lies with Environmental Action Germany (DUH) and the Heinrich-Böll-Stiftung European Union. The lead author of this report is **Julian Schwartzkopff**, who also acted as the rapporteur of the Expert Group. He has worked at Environmental Action Germany (DUH) as a policy advisor in its Energy & Climate department since 2019. Julian's work focuses primarily on EU energy policy, including issues of gas market regulation and energy efficiency. Previously he worked for climate change think tank E3G and the Institut für Europäische Politik in Berlin. He studied political science and international relations in Berlin, Cambridge, and Florence.

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ABSTRACT

It is clear that the European Union must put an end to unabated fossil gas use by 2050 at the latest to comply with its climate neutrality objective. To stay within the Paris Agreement target of 1.5°C, the use of unabated fossil gas would have to end significantly earlier – by 2035. The present report is based on the discussions of the Expert Group on the Future Role of Gas in Europe convened by the Heinrich-Böll-Stiftung European Union and Environmental Action Germany (DUH) from 2020 until 2022. It outlines the implications of this challenge for the management of the energy transition in a way that rapidly phases out Russian gas imports, protects security of supply and energy-poor consumers as well as the climate. The report finds that current EU policies run the risk of prolonging dependence on fossil gas rather than decisively moving towards alternatives, particularly in the heating sector, and recommends a much more active approach to phasing down fossil gas use as soon as feasible while building up a sustainable, carbon-free energy system.

Keywords: Energy transition, gas market regulation, hydrogen, security of supply

FOREWORD

When we launched the Expert Group on the Future Role of Gas in Europe in 2020, it was already clear that the rapid phasing-out of fossil gas and its replacement with the right alternatives constitutes the defining challenge of the energy transition. What we could not have foreseen was the extent to which the political context would change during the group's lifespan. Over the course of the project, the COVID-19 pandemic has had a lasting impact on European societies and economies and has changed the way we work. An enduring energy price crisis arose in 2021, highlighting energy poverty across Europe. Then, on 24 February 2022, Putin launched a full-scale military invasion of Ukraine.

Russia's brutal war of aggression against Ukraine is an attack on the European peace and security architecture. It has brought the geopolitical risks of fossil gas dependency and security of supply concerns to the forefront of the political debate. EU Member States' dependency on Russian energy imports has given the Putin regime tremendous power to blackmail and destabilise Europe and has ultimately financed Russia's war machine. In this context, it should be mentioned that the previous German governments deliberately ignored the extent of the threat posed by Putin's autocratic regime for decades – mainly out of economic and energy policy self-interest and against the clear and unmistakable warnings of EU partners and neighbouring countries in Central and Eastern Europe.

The deployment of renewables and energy-saving efforts across Europe is a crucial element of a sustainable and secure energy system. Despite increasing awareness of how vulnerable Europe has become due to infrastructure dependencies, there has been a renewed drive towards the construction of fossil gas infrastructure. This has been coupled with hesitation to impose strong regulation on the gas industry, revealing the persistence of a strong fossil gas-based mindset among decision-makers.

While it is clear that we need to radically phase out Russian gas imports in the short term, we must also recognise that, due to the ongoing climate crisis, all fossil gas use must first be radically reduced and then ended over the coming decades. With the Fit for 55 package, the Gas Package, and the REPowerEU plan, the EU institutions are currently working on a raft of measures that will shape European climate and energy policies for decades to come. More ambitious climate targets, as well as the accelerated deployment of renewables and energy efficiency, are welcome developments, but the Expert Group has also identified the serious risk that the current plans could lead to a fundamental misdirection of the EU's efforts, prolonging fossil gas dependence and putting the 1.5°C target out of reach.

With this report, which summarises the results of our discussions, we hope to contribute to the debate on the right gas policies for Europe at this devastating and critical moment in time.

We would like to thank the members of the Expert Group for their valuable contributions and efforts. Our special thanks also go to Julian Schwartzkopff, the lead author of this report, and our colleagues Ricarda Dubbert, Martin Keim, and Constantin Zerger for their excellent coordination of this joint project.

Brussels and Berlin, June 2022

Eva van de Rakt, Director
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Chapter 1: Securing the EU's energy supply in light of Russia's war of aggression against Ukraine

A new context for the energy transition

Throughout 2021, Europe experienced an **energy crisis with record high fossil gas and electricity prices**. Even before the Russian invasion of Ukraine, the European Central Bank estimated that energy price shocks would reduce 2022 GDP growth by 0.5%.[1] This situation was partly brought on by very low gas storage levels and historically low imports from Russia.

The war has transformed the scenario of a **complete stop of Russian fossil gas deliveries** from a thought experiment into a political reality. Such a situation might plausibly arise either due to EU sanctions or Russian supply cuts. Russia has a long history of using gas as a political weapon, while the EU, for its part, may decide to expand its current sanctions against Putin's regime to the energy sector, amid concerns that the bloc is essentially **financing the Russian invasion** by paying billions for oil and gas from Russian state-controlled companies. As of May 2022, Russia has already cut off gas supplies to Poland, Bulgaria, the Netherlands, Finland, and Denmark over refusals to comply with its demand that payments be made in roubles.

As **more than 40% of the EU's fossil gas consumption is supplied by Russia,** with imports totalling 155 billion cubic meters (bcm) in 2021, a complete supply stop would be a considerable shock to the EU's energy system and economy.[2] The current unprecedented situation has fundamentally changed the debate about the energy transition and energy security, now marked by **fears about gas shortages** leading to unheated homes in the winter, exploding energy bills, and rising production costs for energy-intensive industries already reeling from the 2021 price shock and high inflation rates. **Rising energy prices hit energy-poor households particularly hard** as they already spend a high proportion of their income on energy bills.

The **European Commission responded very quickly** to this difficult situation, publishing the REPowerEU communication on 8 March 2022, two weeks after Russia's invasion of Ukraine. This was followed by the launch of the REPowerEU legislative package and Action Plan on 18 May 2022, which puts forward far-reaching measures to achieve independence from Russian fossil fuel imports by 2027. Two thirds of the planned reductions should already be achieved by the end of 2022.

The **right strategy to achieve independence from Russian gas imports is still hotly debated**, however, and consequential decisions are currently being made under conditions of high uncertainty. As an end to Russian gas imports was seen as inconceivable prior to the invasion, **no detailed modelling existed** on how to supply countries that are currently reliant on Russian imports in the event of a disruption. The European Network of Transmission System Operators for Gas (ENTSOG), for instance, did not address this question at all in its 2021 security of supply modelling.[3] Systems modelling specialists Artelys have now produced a scenario study looking at infrastructure needs in the context of a possible phase-out of Russian fossil gas imports,[4] and ENTSOG was tasked with assessing infrastructure needs to inform to development of the European Commission's REPowerEU proposals, published on 18 May 2022. These produced widely diverging results, particularly concerning the extent of additional fossil gas infrastructure needed to ensure security of supply.

Overall, the political response of the EU and its Member States in terms of the transition towards climate neutrality has been ambivalent. On the one hand, it has **increased the momentum for renewables, efficiency, hydrogen, and heat pumps**, which are increasingly seen as crucial for protecting against energy price hikes and securing energy independence by reducing fossil gas consumption. On the other, it has **strengthened arguments for new fossil gas infrastructure** to diversify supply routes, new long-term supply contracts with non-Russian producers, and the postponement of the coal phase-out.

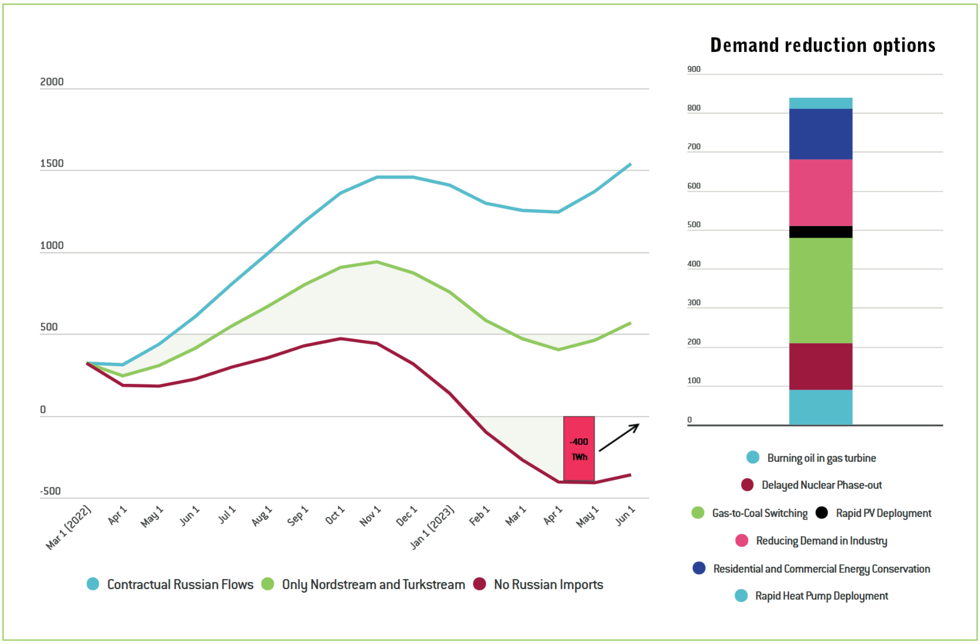
The fact that short-term solutions – i.e. how to manage next winter – and medium-term solutions – i.e. how best to use the next investment cycle – are often conflated in the political debate is unhelpful. In particular, there is a **high risk that the desire for independence from Russian gas will actually result in the EU's reliance on fossil gas being prolonged out of the need and urgency to become independent from Russia**. Investing in new gas pipelines or liquefied natural gas (LNG) terminals to obtain non-Russian supplies would introduce significant new carbon lock-in as these projects are typically financed on the back of long-term supply contracts, while providing no immediate relief to a potential supply crisis as a result of their long lead times.

Likewise, the **discontinuation of investments into new fossil gas heating systems and power plants does not feature prominently in the debate**, with many governments still actively promoting such investments, for instance by providing financing through the EU Recovery and Resilience Facility or the Cohesion Policy funds, or by including them in the EU Taxonomy for Sustainable Activities. While ensuring security of supply is paramount, little will be gained in the long run if Europe makes the climate crisis worse by investing limited funds into solutions that promote unnecessary carbon lock-in.

Solutions for the next winter

Analysis by economic think tank Bruegel shows that the **EU could in principle bear a complete Russian supply disruption** without Europeans freezing in their homes, power supplies being disrupted, or economic activity collapsing. This would, however, be financially costly and politically challenging as it would entail reducing fossil fuel demand by at least 10-15% (400 terawatt-hours (TWh)), possibly by rationing, and also importing LNG at record high prices (see Figure 1).[5] The situation would be more manageable in the event of a partial supply disruption, under which high prices would be more of a problem than actual physical shortages, but that is not an outcome the EU can afford to bet on.

Figure 1: European gas scenarios: Different Russian imports



Source: McWilliams, B. et al. (2022). Preparing for the first winter without Russian gas. Bruegel Blog, 28 February. https://infogram.com/figure-1-european-gas-scenarios-different-russian-imports-1h7g6k0kxoyj02o

The European Commission estimates that **LNG and pipeline import diversification using existing infrastructure** could replace 60 bcm of Russian gas as early as the end of 2022.[6] The coordination of joint purchasing for the EU as well as Ukraine, Moldova, Georgia, and the Western Balkans will be supported by the EU Energy Platform.[7] The EU's initial conception of the Energy Union project, launched in 2015 in the context of Russia's hostile geopolitical moves in Ukraine and gas supply disruption in previous years, was also centred around a joint purchasing scheme for gas. The project enjoyed limited success, however. This was partly due to weak engagement by Member States dependent on good political and economic relations with Russia.[8] However, **joint purchasing** by the EU could be a very important instrument to secure supplies in the immediate context of a crisis as it **reduces the difference in negotiating power** between single Member States and big supplier companies and third countries.

In the event of a total stop to Russian gas deliveries, a significant part of the reduction in gas demand would likely be achieved by a **short-term switch from fossil gas to coal and nuclear for both power and heat generation**.[9] While coal and nuclear plants might have to run higher production hours to compensate for limited gas supplies, planned decommissioning should only be postponed if regulatory agencies indicate this would be indispensable for supply security in the short term. It is crucial to **ensure that the responses to the current situation do not derail coal or nuclear phase-out schedules** in Member States as the underlying environmental and economic reasons for these phase-outs have not changed. Regarding nuclear power, the fighting at and around Ukraine's nuclear power plants has again highlighted the enormous security risks posed by nuclear power generation for all of Europe.

A major European Commission contribution to the drive to cut energy demand is the **EU "Save Energy" communication**, which includes the **nine-point plan "Playing My Part",** developed together with the International Energy Agency (IEA). The communication features short-term oil- and gas-saving measures such as improving heating system operation via awareness-raising campaigns, incentivising energy audits within industry, reducing motorway speeds, and encouraging the use of non-car transport options.[10] Some Member States, including Belgium and Italy, have already launched national campaigns to harness short-term energy savings. Overall, the European Commission estimates that a 5% reduction in gas (13 bcm) and oil consumption (16 million tonnes of oil equivalent (Mtoe)) could be achieved with such measures. While mobilising short-term savings potential is crucial in the current situation, it seems optimistic to assume that the full potential of these measures can be realised as they **depend heavily on implementation by Member States, as well as actions by individuals and companies**.

In the longer term, it is clear that the **green transition is the best response to the need to reduce Europe's reliance on fossil gas and fossil fuels**. According to the European Commission, the implementation of the Fit for 55 package alone would reduce EU gas consumption by 30%, equivalent to 100 bcm by 2030. The REPowerEU communication and statements by Member States indicate that there is room within the present situation for greater ambition on renewables and efficiency.

The potential for accelerating the deployment of renewables, energy renovations, and the installation of heat pumps to substitute Russian fossil gas in time for the coming winter is, however, limited. Measures that would be helpful in this context include the **fast-tracking of permits for renewable energy installations** as proposed by the European Commission. The focus on rooftop solar energy is certainly welcome given that it can be scaled up much more quickly than technologies such as wind turbines. Even so, the European Commission estimates that accelerating the roll-out of rooftop solar installations by 15 TWh in 2022 could only save 2.5 bcm of fossil gas, which amounts to 1.6% of fossil gas imports from Russia.

With regard to **accelerating building renovations and the installation of heat pumps,** however, the REPowerEU package is **unambitious**. Front-loaded financing via the new REPowerEU chapters within national Recovery and Resilience Plans (RRPs) is unlikely to take effect before the coming winter, while changes in the regulatory framework conditions such as higher minimum energy performance standards for buildings, to be negotiated as part of the revision of the Energy Performance of Buildings Directive (EPBD), will likely take until 2023.

Apart from **speeding up the energy transition – a no-regrets option** that should be the EU's default approach regardless of external developments – it might also become necessary to implement certain emergency measures that the EU would never consider outside a crisis situation, such as the lowering of thermostats by 1°C. According to European Commission estimates, this measure could alone save 10 bcm of fossil gas.

In order to ensure warm homes this coming winter, EU Member States might also need to opt for demand curtailment at the industry level, i.e. **fossil gas rationing for**

energy-intensive industries. The likelihood of such measures being introduced is increasing in the context of Russia's moves to cut off gas deliveries to individual Member States. Within German industry, for instance, the substitution of domestically produced ammonia with direct imports has been identified as the measure likely to result in the largest gas savings.[11] According to the Bruegel analysis cited above, industry curtailment could cover 43% of the necessary demand reduction in the event of a complete Russian supply stop, though at substantial economic cost.

National emergency plans for this purpose already exist under the EU's Security of Supply Regulation. The European Commission also announced that it will propose a **coordinated demand reduction plan** with pre-emptive voluntary curtailment measures to be activated before the advent of a full-blown crisis and a guidance document on the prioritisation of non-protected customers. In the event of massive demand curtailment, it is crucial that protection is also extended beyond the value chains critical for security, food, and health and safety. Such measures also have to be taken in a coordinated fashion in the spirit of European solidarity as **individual Member States are likely to be very differently affected by Russian supply stops** as a result of both infrastructural legacies and Moscow's piecemeal approach.

Besides cutting consumption, ensuring an **adequate level of fossil gas storage across the EU** is crucial as 25-30% of gas consumed in the winter heating season is taken from storage.[12] With gas prices hitting record highs, operators currently have little incentive to buy gas for storage. This means that the market alone cannot be relied upon to deliver adequate storage levels. If gas prices were to fall (e.g. as a result of Gazprom flooding the market), storage operators would be left holding the bag. Given the short time window to build up sufficient storage levels, **the European Commission's proposal of a minimum gas storage obligation** of 80% in 2022 and 90% in later years, backed with incentives such as higher rebates and guarantees for operators, is to be welcomed. This measure is to be fast tracked through the legislative process so that it can already take effect by the next winter.[13]

The EU is also set to allow **temporary relief for companies facing liquidity difficulties** as a result of higher energy prices, with special attention paid to gas utilities facing contract disruptions. While it is understandable that some utilities might need short-term relief to prevent their collapse, the current proposals fail to ensure that recipients of such relief will lower their exposure to price volatility in the medium- to long-term by reducing reliance on fossil gas. **Conditions should therefore be attached to the provision of this form of aid,** including realistic plans enabling utilities to reduce their exposure to fossil fuels and shift to no-regrets alternatives such as renewable energy and storage. Any exemptions to normal state aid rules should require beneficiaries to prove that the **aid will not hinder the achievement of the EU's climate objectives**, as stated in the Guidelines on State Aid for Climate, Environmental Protection and Energy (CEEAG).

While the REPowerEU package is light on relief for energy-poor households, the "toolbox" published in October 2021 already contains a range of **extraordinary measures such as maximum prices (caps) and consumer energy subsidies to keep energy affordable**.[14] Given that the high-price environment is likely to persist for some time, such measures continue to be justified. However, the fact that they serve to **weaken the demand reduction effect of high prices and promote additional carbon emissions** in fossil-based energy systems means that they need to be carefully designed and strictly time limited. In the context of limited gas supplies, the scenario of a subsidy bidding contest between governments should also be avoided as this raises prices for everyone without enabling significantly higher imports. (See Chapter 5 for a more in-depth discussion of this issue.)

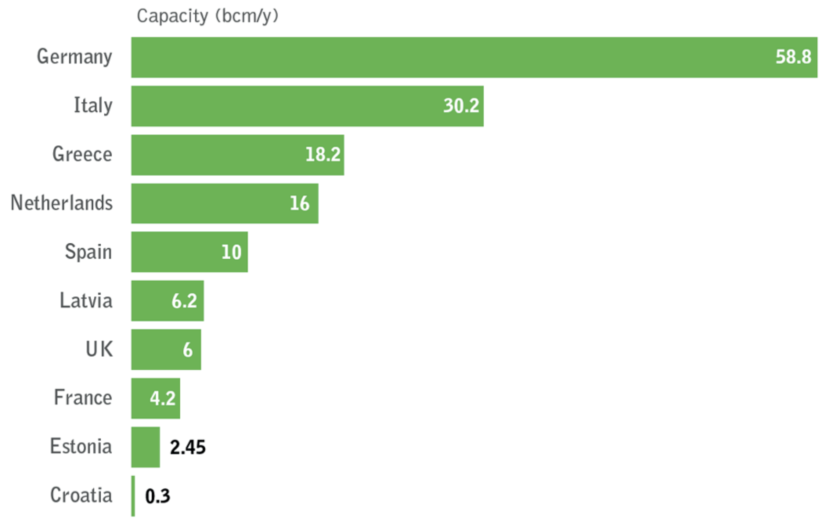
Finally, EU Member States need to **commit to showing solidarity in distributing fossil gas supplies** in the event that bottlenecks cause shortages in countries that are particularly dependent on Russian gas. This means, for instance, delivering fossil gas from storage or non-Russian import routes to partner countries that cannot ensure adequate heating, even at the expense of industrial production. Most Eastern European countries – as well as Germany – are highly dependent on Russian gas imports. A notable exception is Romania, which has substantial domestic production. In previous gas supply crises such as the 2008-2010 gas shortages, demonstrations of solidarity among EU Member States were limited. The European Commission is rightly calling on Member States to **conclude solidarity arrangements** without delay. How well the EU can weather a worst-case supply disruption will in the end depend on the willingness of its Member States to pull together in the face of unprecedented Russian aggression.

Using the next investment cycle wisely

In developing a medium-term response to the war in Ukraine, the question of how best to use the next investment cycle requires careful consideration. There is a high risk that **decisions taken now to reduce dependence on Russian gas will lead to additional and unnecessary carbon lock-in** in the future. Member States' policy responses include fast-tracking new LNG terminals, speeding up new gas transmission pipelines, and scaling up fossil gas production in Europe or partner countries. Many of these initiatives are short-sighted. **Over-reliance on fossil fuel imports,** together with international market volatility, has already **contributed significantly to the current geopolitical crisis**, to say nothing of the additional security risks posed by climate change.

The REPowerEU Action Plan proposes **reviving several fossil gas projects** from the Union List of Projects of Common Interest (PCI) that were previously rejected. It also identifies **10 billion euros' worth of additional fossil gas projects to be funded**, including four new LNG terminals. This is a complete course reversal given that the 2021 revision of the Trans-European Networks for Energy (TEN-E) Regulation was supposed to spell the end of EU funding for new fossil gas import infrastructure. The German government has taken a step further with the passing of the LNG Acceleration Act (*LNG-Beschleunigungsgesetz*) in May 2022. This law will **permit the construction of up to twelve new LNG terminals** and waives the environmental impact assessment requirement for these projects.[15] The government is also set to directly subsidise the LNG terminals at Brunsbüttel and Wilhelmshaven that are currently under construction. The fact that these far-reaching decisions are being taken extremely quickly and without a proper cost-benefit analysis incorporating environmental as well as security of supply considerations is highly concerning (see Figure 2).

Figure 2: Europe's LNG rush: Breakdown of announced boosts to LNG import terminal capacity, including expansions of operating terminals



As of 16 May 2022, not all newly-announced projects have confirmed their planned capacity volumes, including a proposed FSRU terminal in Estonia with expected capacity of ~2.5bcm/y.

Source: Global Energy Monitor. (2022). *Europe Gas Tracker*. https://www.datawrapper.de/_/hqMis/

It is clear that new import infrastructure such as **LNG terminals would not contribute to ameliorating supply shortages in the short term** as they would only come online in several years. While new LNG terminals would reduce dependence on Russian pipeline gas in the medium term, the costs for climate policy would be high as the **viability of these projects depends on long-term supply contracts** that can span more than 20 years. Qatar, for instance, has already announced that it would only be willing to supply gas to Germany on the basis of long-term contracts, which would allow it to expand fossil gas extraction.[16] German energy company RWE has recently concluded a 15-year supply contract for US LNG to supply the country's planned LNG terminals.[17] The expansion of LNG import capacity will lead to an increase in such contracts, as well as the **development of further gas fields to supply the tight global LNG market**. The new EU External Energy Engagement Strategy, for instance, explicitly incentivises new gas production in Africa destined for export to Europe.[18]

The usefulness of this additional import capacity is highly uncertain. The **Fit for 55 package is expected to deliver 100 bcm in gas savings by 2030,** while the EU's existing 21 LNG terminals are currently operating at only 30-70% capacity despite record high import levels.[19] The EU has already embarked on an extensive gas supply diversification strategy, both in the wake of the last energy crisis in 2008-2010 and under the Energy Union project launched in 2015. This funded many of the gas infrastructure projects now in place that are capable of bringing alternative supplies to Europe. The Artelys analysis cited earlier in this paper finds that this existing infrastructure, together with the measures proposed in the Fit for 55 package, is **sufficient for the EU to largely wean itself off Russian gas by 2025, with only one new LNG import terminal needed** in Finland to supply the Baltics.[20] Moreover, there is competition over terminal sites, and decisions in favour of LNG terminals are often decisions against the green ammonia terminals necessary for scaling up hydrogen import capacity.[21]

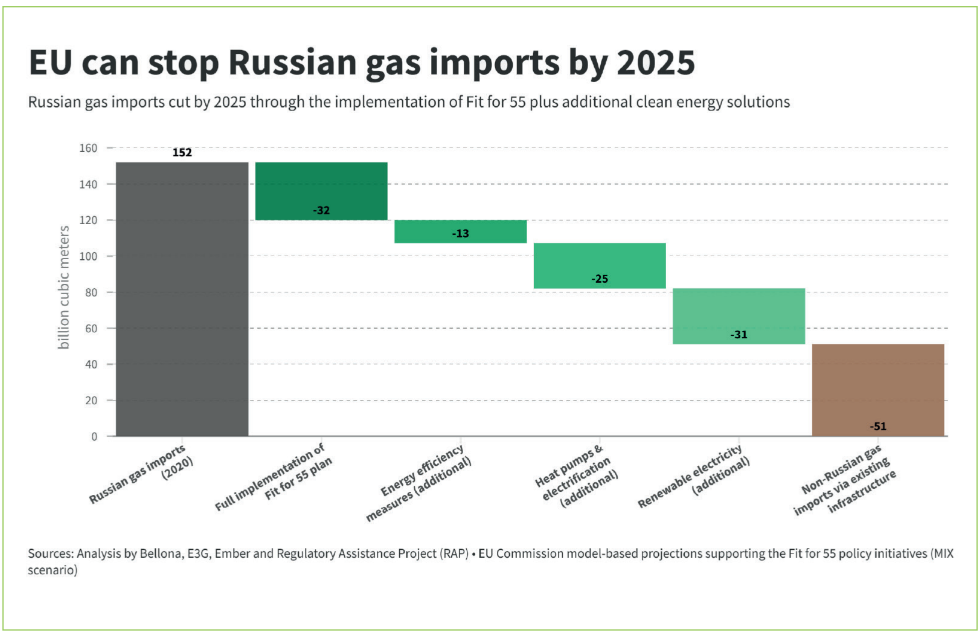
Even if limited investment in new gas transport infrastructure is needed to adapt the European energy system to manage without imports from Russia, such **far-reaching decisions should never be taken lightly or without a detailed cost-benefit analysis**. Neither public nor private funds are unlimited, and any investment into fossil gas transport infrastructure is money that could have been used to decrease reliance on fossil gas through other means. This point is especially crucial in relation to new LNG terminals as these projects are currently planned as fossil only, despite unspecified retrofit plans to allow green hydrogen importation in the mid-term. To avoid **unnecessary lock-in effects and greenhouse gas (GHG) emissions**, the current LNG terminal expansion plans pursued by the European Commission and several Member States should be carefully re-evaluated. In addition, floating storage and regasification units (FSRUs) should always be given preference over fixed land-based terminals. FRSUs enable import capacity to be scaled up more rapidly and are easier to dismantle as EU gas demand declines, meaning that they are less likely to become stranded investments.

The European Commission moreover envisions scaling up the **production and import of renewable gases** to directly replace fossil gas. The REPowerEU Action Plan sets an annual target of 20 million tonnes of green hydrogen and ammonia by 2030, most of which will come from imports. This almost quadruples the Fit for 55 ambition of 5.6 million tonnes and will be backed by measures such as fast-tracking financing, extending the scope of Carbon Contracts for Difference in industry, and a considerable push towards hydrogen partnerships. This will help replace Russian fossil gas, but not entirely as the high-value end uses of hydrogen do not fully correspond with current fossil gas uses. While green hydrogen is a critical enabling technology for the energy transition, such a massive ramp-up is concerning as it is not clear it can be accomplished **without endangering the energy transition of third countries or lowering hydrogen production standards**. Weakening the criteria for green hydrogen production to enable higher full-load hours for electrolysers or scaling up the production of blue hydrogen, generated from the steam reduction of fossil gas, might **negate the climate policy benefits** that hydrogen promises (see Chapter 3).

The European Commission also **proposes to more than double the EU's biomethane production target** from 17 bcm to 35 bcm by 2030. (For comparison, biomethane production totalled around 3 bcm in 2020.) This is concerning as the current generation of biogas – from which biomethane is produced – is already approaching environmentally unsustainable levels.[22] In several EU countries, biogas production is currently based on energy crops – usually annual monocultures such as corn – which are fertiliser- and land-intensive.[23] Importantly, however, most of the EU's current 220 TWh of biogas and biomethane production is in the form of raw biogas. **Biomethane production could therefore in principle be significantly increased simply by upgrading** existing biogas production facilities, sidestepping the need for additional biomass and land. **Strong bioenergy criteria** must be integrated into the current revision of the Renewable Energy Directive to ensure that only residues and wastes are used as feedstocks and sustainable production potentials are not exceeded.

A recent analysis by Bellona, Ember, E3G, and the Regulatory Assistance Project (RAP) has shown that the **EU could end its dependence on fossil gas imports from Russia by 2025 without new fossil gas import infrastructure or increasing biomethane or hydrogen production further than planned.** Energy efficiency, electrification, renewables, and flexibility solutions could cover two thirds of the shortfall, with fossil gas import diversification making up the rest (see Figure 3).[24] The above-cited Artelys study comes to a similar conclusion, comparing a "gas solutions" scenario relying on new floating LNG terminals with a "clean energy solutions" scenario. It finds that the **"clean energy solutions" scenario both allows a phase-out of Russian fossil gas imports as early as 2025 and is more cost-effective** than building new gas import infrastructure.[25]

Figure 3: Replacing Russian gas imports through the implementation of Fit for 55 plus additional clean energy solutions



Source: Brown, S. et al. (2022). *EU can stop Russian gas imports by 2025*. RAP, E3G, Ember, and Bellona Briefing. www.raponline.org/wp-content/uploads/2022/03/rap-e3g-ember-bellona-stop-russian-gas-2025-final2.pdf

According to the analysis presented in Figure 3, energy efficiency in the buildings sector could deliver an additional 13 bcm in fossil gas savings by 2050. Ramping up heat pump installations and heating electrification could achieve an additional 25 bcm. This could only be achieved via the full implementation of what is planned under the Fit for 55 package, as well as the adoption of more concrete measures to bring forward savings.[26] The realisation of this vision would require **much greater efforts than those**

proposed in the REPowerEU package, particularly in energy efficiency and the heating sector. (See also the discussion in Chapter 4.)

The REPowerEU package as a whole appears not to respect the Energy Efficiency First principle here. Admittedly it makes available frontloaded funding for energy renovations and sustainable heating systems via the Recovery and Resilience Facility (RRF) – which is to be welcomed – and also includes a much-needed initiative to address skills shortages. Where it **fails, however, is in making concrete regulatory proposals to advance the heating transition** and ensure that renovations bring buildings up to a standard compatible with the aim of climate neutrality. The package features useful suggestions for EU co-legislators, including strengthening minimum energy performance standards for existing buildings and bringing forward the withdrawal of subsidies for fossil fuel boilers via the EPBD by two years to 2025, as well as stricter EU eco-design requirements for heating systems that would have the effect of phasing out the installation of "stand-alone" fossil fuel boilers by 2029. However, these remain **suggestions with uncertain chances of success.** Meanwhile, the European Commission has been willing to propose concrete legislative amendments in other areas, including the exemption of new gas and oil infrastructure from the Do No Significant Harm principle if judged necessary for energy supply security. The provision of free energy consultations for households is another energy-saving measure with immediate effect that is missing from the European Commission's plan.

The REPowerEU package is also **remarkably unambitious on heat pumps**. Far from doubling deployment as claimed, the planned installation of 10 million heat pumps over the next five years would merely maintain current deployment levels of around 2 million heat units per year.[27] As noted above, the European Commission **falls short of proposing the phase-out of new fossil gas boilers and an end to fossil heating subsidies**, even though these regulatory measures would both promote the installation of heat pumps and contribute to reducing the EU's dependence on fossil gas, with immediate effect.

The **European Commission's proposals are stronger on renewables**, which could deliver an additional 31 bcm of fossil gas savings on top of the Fit for 55 targets (see Figure 3). The package includes useful measures in this regard, such as fast-tracking permitting, introducing a solar rooftop obligation for new buildings, and raising the EU renewable energy target. **Particular efforts are needed to speed up wind power deployment**. While current market trends are already set to deliver more solar capacity by 2030 than targeted in the Fit for 55 package,[28] wind power deployment is currently lagging behind. Of the required annual average of 30 gigawatts (GW) for this decade, only 18 GW is currently installed per year.[29]

The European Commission estimates that, in order **to phase out Russian fossil gas imports, 210 billion euros in additional investments will be needed up to 2027.** The REPowerEU package relies mainly on repackaging existing funds, such as unclaimed RRF loans and transfers from the Cohesion Policy funds and the Agricultural Fund for Rural Development. The **only truly additional financing provided is the 20 billion euros to be mobilised by auctioning allowances from the Market Stability Reserve** that would have otherwise been taken off the market. This would weaken the EU's

Emissions Trading System (EU ETS) and set a dangerous precedent for future crises. Given the scale of the challenge, **joint borrowing by Member States** after the example of the response to the COVID-19 pandemic would be a much better way to raise additional funds without undermining the EU's prime climate policy instrument.

The European Commission is also calling on Member States to **impose windfall taxes on oil and gas producers**, which are currently making record profits on the back of high prices. According to the IEA, such fiscal measures could make available up to 200 billion euros in 2022.[30] As windfall taxes cannot be applied retroactively, Member States should ensure the rapid implementation of this recommendation and use the proceeds to invest in the energy transition and support energy-poor households. Another financing option that the European Commission regrettably fails to strongly promote in its strategy is the **abolition of fossil fuel subsidies. Such a measure could make a double contribution by reducing incentives to use fossil fuels and freeing up money** to be invested in the energy transition.

Infrastructure decisions that are taken at the present time by European institutions and Member States have to pursue the goal of phasing-out dependence on Russian imports. At the same time, **Europe and the world are dealing with multiple crises, and the climate crisis must not fade from attention**. According to the recently published Sixth Assessment Report of the IPCC,[31] half of the world's population is already at high risk due to climate change. As its climate targets are already lacking the ambition needed to limit global warming to 1.5°C, it is crucial for Europe to wean itself off Russian gas imports by accelerating the energy transition as much as possible rather than promoting further fossil gas lock-in.

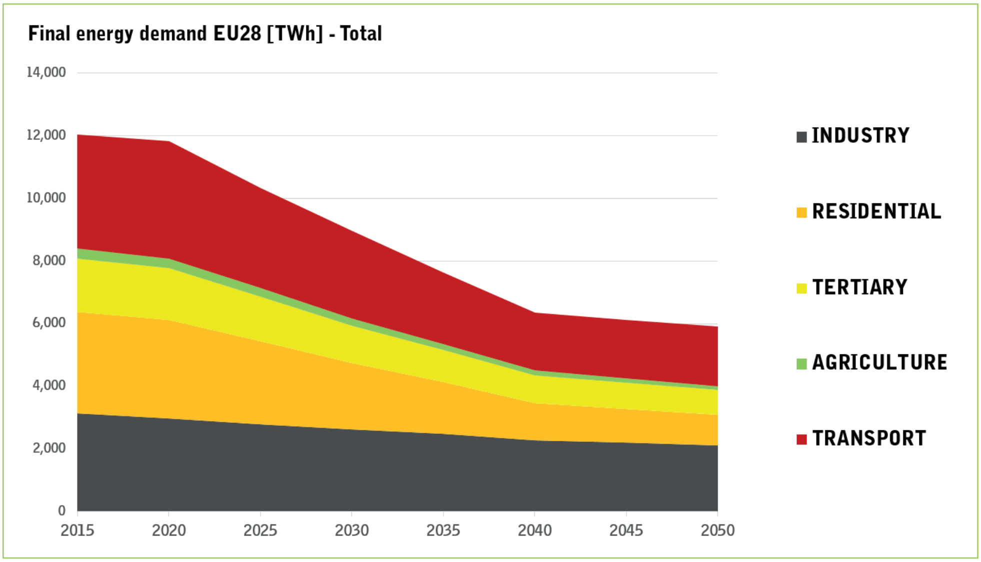
Chapter 2: Managing the long-term decline of fossil gas

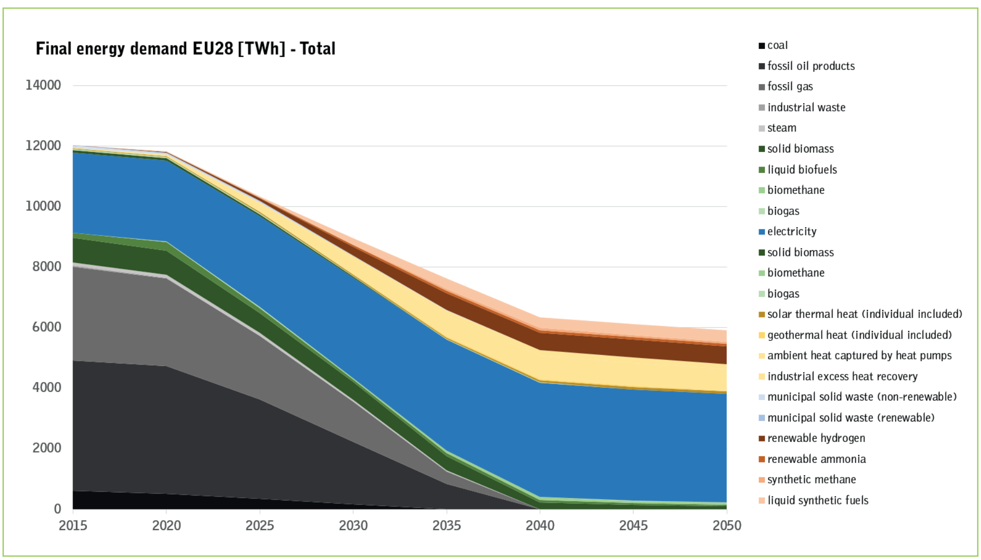
Phasing down fossil gas use as rapidly as possible

In order to transition to a climate-neutral economy and avoid the unnecessary consumption of its remaining carbon budget, it is clear that the EU must act urgently to stop unabated fossil gas use. The EU Climate Law, adopted in 2021, already sets the **de facto phase-out date for Europe's use of fossil gas of 2050 at the latest** by enshrining the target of net zero GHG emissions by this date in EU law. Other things being equal, the EU ETS will also at some point ensure a switch away from fossil gas through carbon pricing, though not necessarily within the timeframe needed to meet EU climate targets.

The Paris Agreement Compatible (PAC) scenario for energy infrastructure, developed by environmental organisations and climate experts, has demonstrated that in order to be compatible with the **Paris Agreement's 1.5°C target, the European Union would have to stop using fossil gas almost entirely by 2035** (see Figure 4).[32] In its Fit for 55 impact assessment, however, the European Commission foresees a decline in fossil gas consumption of only 32-37% compared to 2015 levels by 2030, rising to 96% by 2050.[33] This demonstrates that the **EU's current climate ambitions are not in line with the 1.5°C target**. The advantages of an accelerated energy transition for supply security have received renewed attention in the context of the Russian invasion of Ukraine (see Chapter 1). A stringent implementation of the PAC scenario would, for example, deliver a reduction in fossil gas demand by 2025 equal to Russian imports to the EU in 2021.

Figure 4: Paris Agreement Compatible scenarios for energy infrastructure





Source: Climate Action Network Europe. (2021). *Paris-Agreement-Compatible Scenarios for Energy Infrastructure.* www.pac-scenarios.eu

EU Member States such as the Netherlands, which is planning to close down its largest gas field in Groningen by 2023 and is promoting sustainable heating in "natural-gas-free districts",[34] are leading in this area. Denmark, France, Sweden, Ireland, and Portugal are likewise at the forefront of **international efforts to phase out oil and gas production** as members of the Beyond Oil & Gas Alliance (BOGA).[35]

There are, however, no EU-wide plans to aggressively reduce fossil gas consumption by 2050. Instead, **the European Commission and several Member States have adopted a fossil gas-friendly approach** on dossiers including the EU Taxonomy for Sustainable Activities and the Gas Package revision proposed in 2021. This risks funnelling considerable investment into new fossil gas infrastructure and **prolonging Europe's dependence on fossil gas** far beyond what would be compatible with a 1.5°C pathway.

At the same time, it is clear that a full fossil gas phase-out would be very challenging in the short term as a result of:

- the enormous investment challenge involved in scaling up building insulation and phasing in alternatives to gas heating
- the difficulties of substituting out fossil gas in industrial processes such as chemical, paper, and glass manufacturing
- uncertainty surrounding the development of technological alternatives such as green hydrogen and biogas, as well as the pace of electrification
- the problem of meeting peak demand (especially in winter) in a renewables-based energy system without fossil gas as a backup.

The fact that a certain level of fossil gas consumption may well remain in the system after 2035 makes it crucial to **reduce Europe's reliance on fossil gas in its main use sectors – heating, power, and industry – as quickly as possible** and phase in alternatives such as heat pumps, green hydrogen, and biomethane.

Infrastructure planning for success

A fossil gas phase-out would have fundamental implications for gas infrastructure planning that are not currently taken into account in infrastructure planning and development. The detailed gas infrastructure analysis recently published by Artelys shows that the **existing transport infrastructure for fossil gas is largely sufficient** to allow a phase-out of Russian gas imports by 2025, with only some loss of load in Finland, Estonia, and Latvia.[36] An earlier Artelys study showed that Europe's existing infrastructure is able to respond to a variety of supply disruption scenarios, with only very limited new infrastructure needed to address potential security of supply problems in South-Eastern Europe.[37]

Given the new drive to become entirely independent from Russian fossil gas imports, it is very likely that the EU will become far more reliant on LNG imports than it is at present. The studies cited above indicate, however, that, despite the current geopolitical crisis, the **EU does not need to considerably increase its fossil gas import capacities.** The reasons for this include declining EU gas demand and significant capacity underutilisation at LNG terminals, as well as the fact that two new LNG terminals in Greece and Cyprus will be coming online by 2023. Russia's war of aggression in Ukraine is likely to accelerate efforts to reduce gas demand even further. Even in the current situation, the EU's problem is not a shortage of gas import capacity but rather the tightness of global markets. Plans to complete the Nord Stream 2 pipeline, shelved following the invasion of Ukraine, now seem fundamentally misguided. In this context, any **plans to build new LNG terminals should be very carefully assessed for their necessity** in terms of security of supply, as well as their climate impact, before further path dependencies are created. (See also the discussion in Chapter 1.) If additional LNG terminals are judged to be necessary, FSRUs with short lifetimes are far preferable to land-based LNG terminals, which carry **higher risks of carbon lock-in and of becoming stranded assets**.

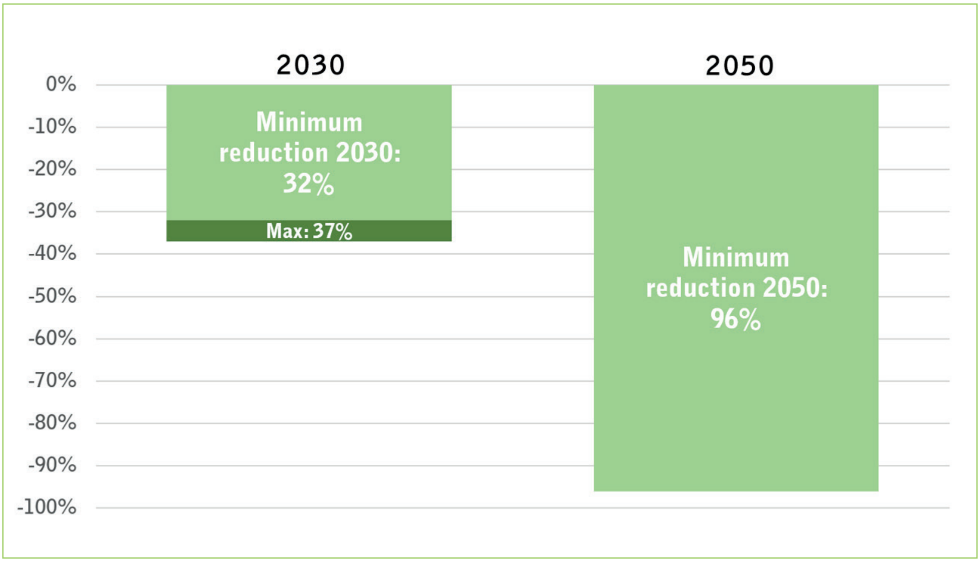
The EU has historically planned gas and power transmission grids separately and given transmission system operators (TSOs) a central guiding role in designing Ten-Year Network Development Plans (TYNDP) through ENTSOG. As a result, the **EU has built significantly more gas import capacity than it has ever used**.[38] Since 2013, the TEN-E Regulation has enabled nearly 5 billion euros of taxpayer-funded grants and subsidised loans for 41 fossil gas infrastructure projects by granting them PCI status.[39] The **current (fifth) PCI list still contains 20 fossil gas projects**,[40] many of which had uncertain prospects prior to Russia's invasion of Ukraine but will now be facilitated as a matter of priority.

The recent revision of the TEN-E Regulation sets the direction for the selection of the projects to be included in the sixth PCI list in 2023. The fact that the revision **finally mandates the joint planning of power and gas grids** and that the fossil gas infrastructure category has been abolished are welcome developments. At the same time, **little has been done to address the conflict of interest** inherent in allowing the grid operators that earn a regulated rent on infrastructure to plan that same infrastructure.[41] The TEN-E revision will also facilitate public funding for fossil gas infrastructure via new categories, such as **smart gas grids**[42] and retrofitting pipelines to carry **fossil gas blended with hydrogen,** which risks cementing the EU's reliance on fossil gas. The TEN-E revision also fails to spell the end of EU funding for new fossil gas import infrastructure: ENTSOG and the European Commission have identified fossil gas projects amounting to 10 billion euros to be financed via the RRF as part of the REPowerEU package.

Overall, **gas infrastructure planning in the EU is still fragmented** and the EU's influence limited as it can only set a direction through the projects it funds as PCIs. At the national level, there is no obligation on TSOs to even engage in the joint planning of gas and power grids, and **Member States have substantial leeway in pursuing fossil gas projects,** which are often seen as important for security of supply. While the European Investment Bank (EIB) decided to stop financing fossil fuel projects in 2019, the EU and its Member States are still spending billions of euros in public funds on new fossil gas pipelines and LNG terminals.[43]

In continuing to expand fossil gas infrastructure, particularly in light of falling gas consumption within EU gas demand scenarios, the **EU has essentially been planning itself into climate policy failure** for some time. With REPowerEU, gas demand will fall even more quickly (see Figure 5). At the same time, a massive expansion of import capacity is planned. The unnecessary build-up of new gas infrastructure creates the risk of both **stranded assets,** the costs of which would be borne by the public, and **carbon lock-in** by developing an incentive to use more fossil gas, and for longer, than would otherwise be the case.

Figure 5: Change in fossil gas final energy consumption compared to 2015



Source: European Commission. (2020). *Stepping up Europe's 2030 climate ambition*. Impact assessment for 55% GHG emission reduction by 2030. European Commission.
https://eur-lex.europa.eu/resource.html?uri=cellar:749e04bb-f8c5-11ea-991b-01aa75ed71a1.0001.02/DOC_1&format=PDF

To plan for climate policy success, electricity, methane, and hydrogen networks should be developed jointly in a way that optimises the energy system and avoids unnecessary investments while still meeting climate as well as security of supply objectives. **Clean energy solutions should be prioritised,** and any new gas infrastructure (whether for methane or hydrogen) must be in line with climate targets and subject to strict sustainability criteria. Fossil gas projects should no longer receive public funding except where they are essential to security of supply.

To ensure that EU network planning does not undermine its own climate objectives, **TYNDP scenarios should be developed by an independent body** with the aim of staying within a 1.5°C-compatible carbon budget. All new EU-funded infrastructure projects, and in particular PCI projects, should **respect the Do No Significant Harm criteria** as defined in the Taxonomy Regulation as well as being **subject to a sustainability assessment covering full expected life-cycle emissions**, including from methane leakage. The climate and environmental impact of gas projects should be evaluated against the cleanest available technology rather than against coal or oil projects as is current ENTSOG practice. Biogas projects in particular should only be eligible for PCI status if they ensure that only locally sourced, sustainable agricultural and forest waste and residues are used as feedstock.

EU gas demand scenarios show that fossil gas consumption is set to decline significantly over the coming decades. At the same time as stopping investment in new fossil gas infrastructure, the EU should thus make provisions for the **decommissioning of fossil gas networks, especially distribution grids**. This is crucial to reduce gas demand as infrastructure creates path dependencies and the EU currently has much more extensive gas distribution grids than will be needed in a decarbonised future. Net-zero scenarios foresee very limited use of hydrogen or biogas to heat buildings, meaning that **extensive gas distribution grids need to make way for cleaner and more electrified energy systems,** leaving only smaller, isolated distribution grids to provide fully green hydrogen or sustainable biogas. The Gas Package proposed at the end of 2021 does not include any obligation on gas distribution system operators (DSOs), or indeed TSOs, to evaluate the need for such decommissioning.

Revamping Europe's energy system

Europe's gas and energy infrastructure will need to change fundamentally in the future. It is therefore crucial that policy-makers set the right regulatory conditions for the next investment cycle in infrastructure as this will still be in place in 2050, by which point the EU intends to be climate neutral. The **reduction and phase-out of fossil gas will need to be accompanied by a rise in electrification**, particularly in the heating and transport sectors via the more widespread adoption of heat pumps and e-mobility, and by a **power system centred on renewable energy, storage, and flexibility options** to cover this increased demand. A revamp of the entire energy system is essential to the successful transition to climate neutrality and necessitates a re-evaluation of the role of fossil gas.

While overall gas consumption will decline, there will still be high demand peaks as the share of renewables in the power system rises and more consumption is electrified. This will occur particularly during the cold months, when heating demand rises and solar power generation declines. In the power system, such demand peaks can arise in a matter of minutes or seconds, while in the heating system peak demand times arise for days or hours.

In order to deal with these demand peaks, a **limited number of fossil gas power and heating plants may be needed as a safety net.** Failure to ensure this could mean shortfalls in electricity generation and heating disruptions affecting millions of households. In some cases, there might be no alternative to replacing coal with fossil gas plants in the short term. A case in point is the lignite-fired Nováky power plant in Slovakia, which supplies district heating to the Upper Nitra region and is scheduled to close in 2023.

This does not, however, make fossil gas a "transition fuel", as is often asserted by politicians and the gas industry. Rather than supporting the transition to climate neutrality, fossil gas is a necessary evil that should only be used where climate-friendly alternatives cannot be ramped up in time. **New investments into fossil gas power plants lock in future CO_2 and methane emissions**. Greening their operations gradually through hydrogen blending has very little impact on their GHG emission intensity.

Any new fossil gas power and heating plants should therefore be subject to **strict operating permits.** These should ensure that new installations are ready to switch to 100% renewable hydrogen by 2035 at the latest and that their GHG emissions do not exceed certain limits, for instance the 270g of CO_2 per kilowatt-hour (kWh) criterion defined by the EU as the Do No Significant Harm threshold.[44] Where the market is unable to provide sufficient financing due to the worsening profitability of gas power plants,[45] targeted instruments can provide the necessary investment incentives while operating purely as a safety net, with remuneration awarded for the **provision of capacity rather than power**. More generally, alternatives to planned projects, for instance under national RRPs and Operational Programmes, should be explored wherever possible in order to **minimise the lock-in of future gas demand through new plants**.

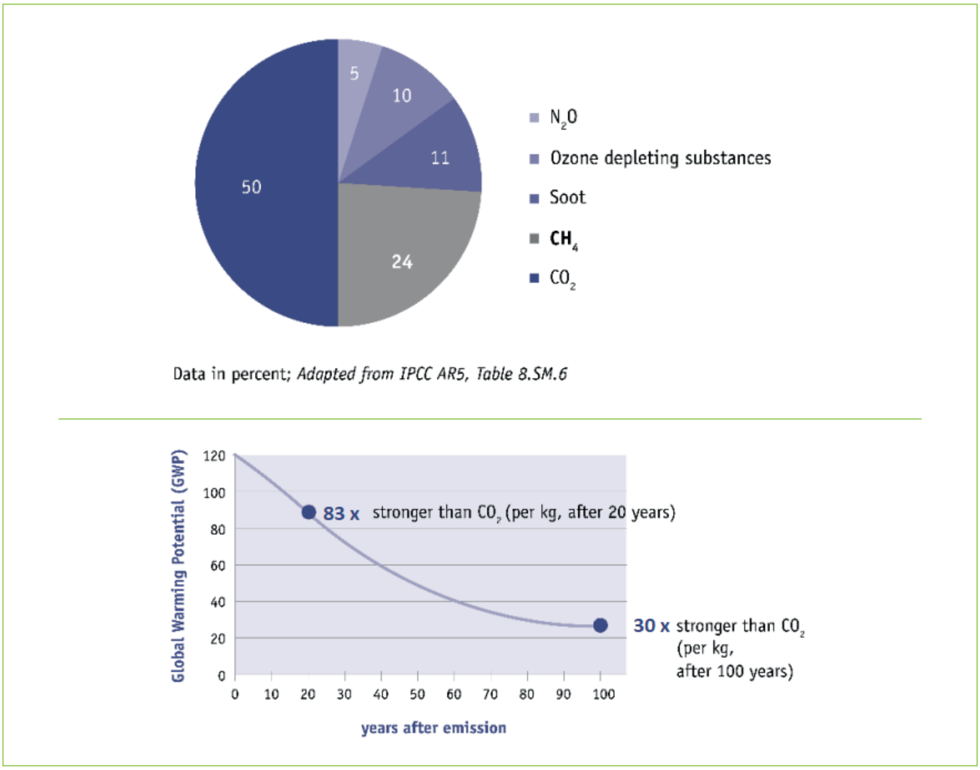
To reach a climate-neutral energy system, **the rapid replacement of fossil gas by alternatives is essential**. In the **heating sector**, this will involve the use of more sustainable solutions such as energy efficiency, sufficiency, heat pumps, biogas, and industrial waste heat. Gas distribution grids should then be scaled down accordingly. The use of blended or pure hydrogen in the heating sector will undermine the transition; this scarce resource will instead be needed to decarbonise other sectors where no alternatives are available, such as industry or certain transport subsectors. In the **power sector**, a massive scale-up of renewables – combined with energy storage, flexible demand-side management, and greater interconnectivity between national grids – is needed to ensure resource adequacy and reduce the need for thermal back-up power plants. In the long term, any remaining back-up gas power plants must run exclusively on green hydrogen in order to be compatible with climate neutrality. In **industry**, green hydrogen can be used as a fuel for high-temperature processes and as a feedstock, along with its derivatives such as ammonia. As the heating sector currently accounts for the lion's share of EU gas consumption, massively **improving the energy efficiency of buildings and heating appliances is also a key enabling condition** to bring down heating demand peaks and reduce gas demand. Improving energy efficiency in industry processes is also essential.

In this context, the fact that EU policy focuses on replacing fossil gas with renewable and low-carbon gases instead of **increasing competition between gases and other energy solutions** such as electrification, energy efficiency, and system flexibility options that can make gaseous fuels redundant is problematic.

Far from clean: the problem of unreported methane emissions

The necessity of reducing and eventually phasing out fossil gas is underscored by the **problem of methane leakage, which is not currently reflected in the GHG inventories** reported to the United Nations Framework Convention on Climate Change (UNFCCC). The main component of fossil gas, methane, is a particularly dangerous greenhouse gas. When it escapes directly into the air rather than being burned and turned into carbon dioxide, **methane has 83 times the global warming potential of CO_2 over a 20-year period** (GWP-20) and 30 times over a 100-year period (see Figure 6). Methane emissions have already contributed 0.5°C to the global warming observed to date and are set to contribute 0.3°C more by 2030 under a business-as-usual scenario.[46]

Figure 6: Contribution of methane (CH4) to global warming (left); Climate effect of methane after 20 and 100 years



Source: Intergovernmental Panel on Climate Change. (2021). Climate Change 2021: *The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press. https://www.ipcc.ch/report/ar6/wg1/

According to official figures, the energy sector[47] accounts for about 20% of methane emissions in the EU.[48] However, this is likely an underestimate as these figures do not take upstream emissions into account. Of the fossil gas consumed in the EU, **90% is imported, and 75-90% of the methane emissions resulting from these imports occur in third countries**, before the gas reaches EU borders.[49]

The **gas industry generates methane emissions along the entire value chain,** from extraction to final use. At extraction, fracking tends to produce substantially higher methane leakage than conventional production methods due to the high number of small wells. During transportation, high pressure in the transport network can cause methane leakage to occur along weak spots in the pipeline such as shut-off valves, compressor stations, or transport fans.[50] In addition to these unintentional leaks, emissions are also caused deliberately: by pressure relief (venting) or incomplete flaring.[51] Finally, methane often escapes directly from boreholes both during and after extraction. Recent satellite measurements have found that half of the world's 100 largest methane leaks can be traced to oil, gas, and other heavy industry.[52] The methane emitted globally by these sectors is equivalent to the **annual combined CO_2 emissions of Germany and France** when the GWP is assessed over a 20-year period.

The EU **gas industry is currently not under any obligation to independently measure methane leakage** from the infrastructure it operates, or to repair leaks once they are detected. The fact that data on methane emissions reported to the UNFCCC are based on industry estimates – with practically no regulatory oversight or third party verification requirement – means that actual methane emissions are being under-reported. This artificially improves the declared GHG-intensity of fossil gas.

The leakage rates identified by scientific publications that rely on measurements as opposed to estimates tend to be higher than those declared by industry. According to the IEA, global methane emissions from the energy sector are 70% higher than stated in official statistics.[53] Indeed, the first independent measurements taken at US gas plants show 60% higher leakage rates than those published by the country's Environmental Protection Agency.[54] This adds up to leakage rates of around 2.3%, based on the total volume of gas delivered by the United States.[55] Current satellite measurements are even more troubling, showing rates of up to 3.7%.[56] Behind the averages there are clearly individual cases of industrial worst practice, which lead to even higher emission rates.

The situation is likely to be less severe in the EU than the United States, where the widespread use of fracking increases emission rates. A recent methane imaging campaign has nevertheless been able to find a **large number of unchecked leaks within the EU's gas infrastructure**.[57] With regard to **supplier countries**, unchecked methane leakage **is almost certainly much higher** than official figures suggest. Gazprom, for instance, reports very low leakage rates: 0.29% of the gas transported and 0.02% of the gas produced by the company. However, new satellite measurements have found several methane "ultra-emitters" along major gas pipelines leading from Russia to Europe, such as the upstream Russian pipeline system that fuels both the Yamal and Nord Stream 1 pipelines.[58] **Substituting pipeline with LNG imports is also likely to be associated with high methane emissions** as additional leakage can occur during liquefaction and regasification.

Looking at GWP over 20 years, we can see that fossil gas loses its climate advantage over coal as soon as between 2.4 and 3.2% of total production volume escapes into the atmosphere.[59] It is therefore **far from obvious that fossil gas is a cleaner alternative to coal**. There are also concerns about the climate footprint of gas-fired power plants with carbon capture and storage (CCS)[60], as well as blue hydrogen production[61] as some studies conclude that they do not bring significant climate benefits compared to the unabated burning of fossil gas when methane leakage is taken into account. This is still an open scientific debate, however, with other studies finding that blue hydrogen production exhibits climate impacts comparable to green hydrogen if methane emissions are kept very low and CO_2 capture rates are above 90%.[62]

The **incoming EU Methane Regulation will address some of these issues** by requiring gas and oil infrastructure operators to measure and report their methane emissions at facility and site level; these figures would be subject to independent verification.[63] The regulation will also ban routine venting and flaring and require operators to periodically check for and repair leaks. This is the first regulation of its kind, aside from legislation adopted in certain US states such as Colorado. Strong regulation on methane emissions is particularly relevant in the context of the current crisis as **measures to avoid leakage, if successful, directly increase the amount of methane available** for power, heating, and industrial use.

While such regulation is urgently needed, according to the European Commission's proposal it will only apply to infrastructure within EU borders.[64] Despite the fact that the **vast majority of leaks occur in the imported fossil gas and LNG supply chain, the regulation fails to cover imports.** It also fails to include the petrochemical sector, one of the largest consumers of fossil oil and gas. The European Parliament picked up on these gaps in its own-initiative report on the methane strategy,[65] calling on the European Commission to extend the new requirements to "the entire supply chain in the energy and petrochemical sectors".[66]

The **European Commission has resisted calls for including imports**, citing concerns about the verification of emissions and enforcement in third countries.[67] The EU has adopted mandatory import restrictions in the past, however – for example on goods produced using forms of modern slavery and forced labour, illegally harvested timber, and unsustainable biofuels, as well as within recent legislative proposals on deforestation and the Carbon Border Adjustment Mechanism (CBAM). Given these precedents, it is unclear why a similar approach was not taken here. In order to be effective, it is essential that the incoming **Methane Regulation covers all of the methane emissions resulting from the EU's fossil gas consumption.**

In the medium term, and analogous to CO_2-pricing via the EU ETS, **methane emissions should be priced in** to reflect the true environmental impact of fossil gas, as well as "low-carbon" gases such as blue hydrogen and biomethane. Such a price should be based on the **measured methane leakage rates** of the different gases. Where precise measurements are not available, rates should be **estimated by an independent third party**, leaving individual gas producers and importers the opportunity to demonstrate lower emissions via more accurate measurements.[68] Using this measurement or estimate, imported gases could then be priced at the EU border, for example via the CBAM, while EU-produced gases could be priced via the EU ETS. Another policy option would be to introduce a methane import fee alongside an EU-internal excise duty on methane.[69]

Chapter 3: The decarbonisation potential of hydrogen

Keeping hydrogen green

With the European Commission's Hydrogen Strategy,[70] published in 2020, the EU was already on track for an ambitious target of 10 million tonnes of renewable hydrogen production by 2030. Under the plan outlined in REPowerEU, this has been raised to 20 million tonnes, to be delivered via domestic production and increased imports. In the context of this **rush towards hydrogen**, it is important that the regulatory framework is designed in such a way as to ensure that the growing hydrogen economy supports decarbonisation efforts rather than raising GHG emissions.

Only green hydrogen, i.e. hydrogen produced from 100% renewable electricity through electrolysis, can be produced entirely without GHG emissions. **Other forms of hydrogen must be treated with caution**, despite often being often portrayed as necessary transitional solutions or capable of achieving net-zero emissions. There are considerable **questions surrounding the climate balance achievable by blue hydrogen** in particular, which is produced by steam reforming fossil gas and capturing the CO_2 emitted as a by-product. While some studies find that it has a worse climate balance than unabated fossil gas,[71] others conclude that its climate benefits are comparable to green hydrogen.[72] In any case, near-climate-neutral blue hydrogen production – implying very low methane leakage and high CO_2 capture rates – remains to be demonstrated. Even if it were possible, stringent regulation would be required to ensure that these conditions are observed in practice. By default, blue hydrogen projects will not even qualify as "low carbon" as defined in the Gas Package proposals published by the European Commission in 2021.[73]

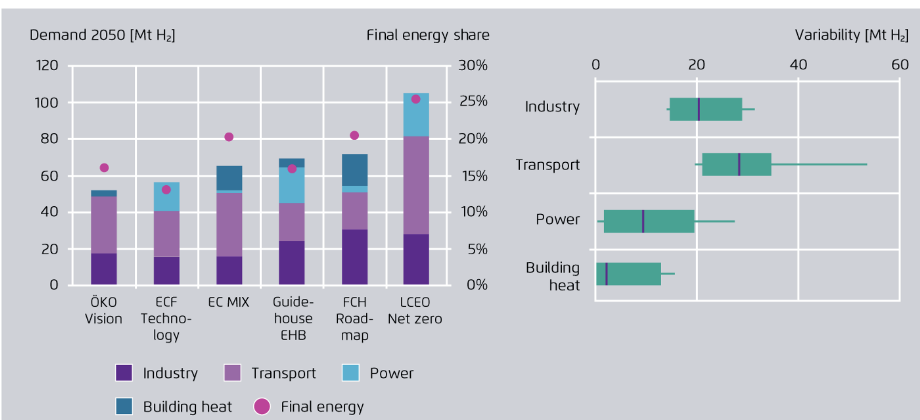
Electrolytic hydrogen produced from grid electricity varies widely in its climate impact depending on the average GHG intensity of the power mix and the (increasing) efficiency of the electrolysis process.[74] The necessary green power share would have to be even higher if upstream emissions were taken into account. It is **currently impossible to produce green hydrogen using grid electricity in the EU without additional regulation**.[75] The situation is of course different for off-grid electrolysers connected to dedicated renewable energy installations. As power systems progress towards very high shares of renewables and thus massively reduce their emission intensity, the GHG balance of hydrogen from electrolysis produced partly from grid electricity will improve.

Regulation around hydrogen production must therefore be designed very carefully to ensure that hydrogen electrolysis uses renewable energy where and when it is produced, for instance via power purchase agreements with renewable energy providers or via directly connected renewable energy installations. However, measures simply requiring renewable electricity to be used for electrolysis would be **insufficient**

without the addition of new renewable energy capacity to match the demand for green hydrogen production. If hydrogen electrolysis were to suck in unlimited renewable energy from the grid without the development of increased capacity, **fossil and nuclear power plants would have to increase production to compensate, leading to higher carbon emissions** and other negative environmental and health impacts.

The PAC scenario for energy infrastructure referenced in Chapter 2 forecasts that the annual demand for hydrogen to decarbonise the industry and transport sectors alone will reach 673 TWh in the EU27 plus the United Kingdom by 2030.[76] This closely corresponds to the target of 20 million tonnes of green hydrogen by 2030, the equivalent of 660 TWh of hydrogen, formulated in the REPowerEU communication.[77] To put these figures into context, **Germany's power consumption** in 2019 was 507 TWh.[78] Hydrogen scenarios from other organisations predict even higher demand, particularly if the gas is expected to play an important role in the heating, road transport, and power production sectors.[79] Under a range of 1.5°C-compatible scenarios, 13-27% of EU energy demand would have to be covered by hydrogen by 2050 (see Figure 7).[80] This poses the danger that hydrogen production will **cannibalise the renewable electricity needed for direct use** – such as covering regular power demand or electrification in the heating and transport sectors, which is consistently more efficient than converting power to hydrogen – and highlights the importance of limiting hydrogen use to priority sectors.

Figure 7: Estimates of EU27+UK hydrogen demand in European net-zero scenarios for 2050



JRC (2020), Guidehouse (2021a), COM (2020)
Note: EC MIX = European Commission, Impact Assessment SWD (2020); Öko Vision = Öko-Institute; FCH Roadmap = Fuel Cell and Hydrogen Joint Undertaking 1.5C scenario; ECF Technology = European Climate Foundation "Net Zero by 2050"; Guidehouse EHB = Gas for Climate "European Hydrogen Backbone"; LCEO Net Zero = Joint Research Centre "Low Carbon Energy Observatory". Final energy share is calculated by subtracting non-energy demand, adjusting transport to 75% of demand and power to 40% of demand.

Source: Agora Energiewende, Agora Industry. (2021). *12 Insights on Hydrogen.*
https://static.agora-energiewende.de/fileadmin/Projekte/2021/2021_11_H2_Insights/A-EW_245_H2_Insights_WEB.pdf

Aside from the use of 100% renewable energy, a second criterion is thus needed to ensure that hydrogen is truly green: **electrolysis capacity must be matched by additional renewable energy capacity**, either connected to the grid or directly connected to the electrolyser. Requiring additionality from hydrogen producers is particularly important as capital is typically no longer the bottleneck to renewables development. As such**, relying solely on demand-side instruments such as certification and green gas quotas will not help to increase renewable power production**. Rather, the development of new renewable energy infrastructure is being held back by siting issues, including resistance from local citizens' initiatives.

In order for hydrogen to be classed as a renewable fuel of non-biological origin under the EU Renewable Energy Directive (RED), it should be essential for both of these criteria (100% renewable power and additionality) to be met. If either of them are weakened, the large-scale production of green hydrogen would actually increase emissions and hamper sector integration efforts. This would have a **devastating effect on the credibility of the "green hydrogen" label**, essentially relegating it to greenwashing hydrogen production that is ultimately based on fossil electricity. Given the speed with which green hydrogen production needs to be scaled up to meet projected demand, such a scenario must be avoided. In this context, it is highly worrying that the European Commission's proposed rules for green hydrogen production, released shortly after the publication of the REPowerEU package, are set to allow **several exemptions from the additionality principle** that, according to some observers, negate the climate benefits of renewable hydrogen.[81]

Ideally, **grid-connected electrolysers should be operated to benefit the grid**, for example to absorb high feed-ins from renewables that would otherwise be curtailed and store them in hydrogen, with possible later reconversion to electricity. In the EU, these cycles of high and low renewables production are generally mirrored by wholesale electricity prices. It is therefore crucial that support policies for electrolysers include incentives to operate them on the basis of these prices, i.e. depending on weather conditions and grid utilisation, rather than supplying steady demand, for instance in industry. A **useful safeguard** to ensure that electrolysers only operate during periods of high renewable energy production could be to **limit their permissible full-load hours**. This gives them an economic incentive to run only when power prices are at their lowest, i.e. when there are renewable energy surpluses in the grid.

The **criteria for low-carbon gases**, including blue and pink hydrogen (from nuclear power), also need to be carefully designed to make sure that they **deliver actual climate and broader environmental benefits compared to fossil gas**.[82] The definition of a "low-carbon gas" as one that emits 70% less GHG than a fossil fuel comparator as employed in the European Commission's gas market reform proposals of December 2021 is insufficiently specific. It fails to distinguish between different types of hydrogen and, in particular, neglects to include the **environmental damage associated with nuclear-powered electrolysis**. The **upstream methane emissions** of natural gas, which at present are not reflected in the calculations, should also be taken into consideration, and blue hydrogen should be required to fulfil additional criteria related to its methane leakage and CO_2 capture rate.

A **robust system of guarantees of origin (GO) covering green and other forms of hydrogen is an essential foundation** for a variety of policy measures needed to develop the incipient hydrogen economy. It enables customers to select climate-friendly gases over other gases, lends meaning to instruments such as green hydrogen quotas, and ensures that hydrogen imported to meet EU demand does not incentivise unsustainable production methods in third countries. It is also important in the design of funding schemes, providing a yardstick allowing premium funding to be made available to green hydrogen projects. One issue that should be addressed in this context is that the **current GO system does not account for life-cycle emissions**. However, there is an urgent need for a robust life-cycle emissions assessment of the different types of hydrogen, particularly given the role of methane and hydrogen leakage.

Given the probability of there being insufficient renewable energy to both decarbonise all sectors and ensure sufficient green hydrogen production, **non-green hydrogen is likely to play a role in the energy transition.** Blue hydrogen in particular might be needed to **decarbonise existing grey hydrogen** production, which typically involves steam reforming fossil gas without CCS. This would require the appropriate management of the problems of methane leakage and low CO_2-capture rates.

In addition to its problematic climate balance, it is **unlikely that blue hydrogen will keep its current cost advantage over hydrogen electrolysis for long.** Carbon prices are set to rise, high gas prices are likely to persist, and electricity will most probably become cheaper as renewables increase and electricity taxes are lowered to support electrification. Estimates made before the 2021 gas-price surge already suggested that **green hydrogen could be at cost parity with today's fossil hydrogen production in the 2030s.**[83] In fact, green hydrogen has been cheaper to produce than grey hydrogen since 2021 due to the spike in fossil gas prices.[84] **Blue hydrogen production implies additional costs related to CCS and carbon capture, utilisation and storage (CCUS) on top of the usual costs of grey hydrogen production**, casting doubts over its long-term economic viability beyond 2030. Any investments into non-green hydrogen should thus be driven by market demand as opposed to being subsidised out of public coffers.

Subsidy instruments such as **Carbon Contracts for Difference (CCfDs) for industry will be an important tool to scale up green hydrogen production** by incentivising industrial consumers to enter into supply contracts, thus creating secure demand. The market is unlikely to deliver the investments needed since sufficient green hydrogen demand is unlikely to materialise quickly enough given that production is not competitive at current market prices. As a matter of principle, CCfDs should **only be awarded to industrial consumers for purely green hydrogen** in order to ensure that subsidies are not diverted to non-green hydrogen production.

While the EU Hydrogen Strategy[85] puts a clear emphasis on green hydrogen, the revised EU State Aid Guidelines and the General Block Exemption Regulation published by the European Commission give **substantial leeway to Member States to subsidise non-green hydrogen production**. The revised TEN-E Regulation likewise[86] does not require electrolysis projects receiving EU funding to produce purely green hydrogen.

Building hydrogen infrastructure that is fit for purpose

While market regulation will act as the "software" of the hydrogen economy, **infrastructure will act as its "hardware"**, underpinning its functioning. To enable a competitive market, **transport infrastructure** (i.e. pipelines or terminals for liquefied hydrogen and ammonia) and **storage sites** (i.e. tanks or geological formations such as caverns) need to be built up to allow consumers to receive a reliable supply from a variety of different producers and importers.

The nature of the transport and storage infrastructure that is developed now has **wide-ranging implications for the market of the future**, particularly for the sectors in which hydrogen will be used. As long as crucial questions about future hydrogen demand remain unresolved, it will be difficult to make decisions on pipeline and storage capacity and the connection of demand centres. This presents a dilemma as market regulation and infrastructure planning need to be developed urgently. Given the long timescales involved in EU decision-making, **creating the necessary planning certainty to enable the right kind of infrastructure investment** is crucial.

At present there are two competing visions for hydrogen grid development. The much-discussed **European Hydrogen Backbone** proposal, developed by 23 European gas transmission system operators (TSOs), represents one of these visions.[87] This proposal foresees significant investment of 43-81 billion euros by 2040 into a **large network of 40,000 km** of hydrogen pipelines. Of these, 69% would be converted from existing pipelines, while the remaining 31% would have to be constructed. Crucially, the Hydrogen Backbone project proposes initially converting pipelines to carry **blended hydrogen, to be undertaken in the 2020s,** but offers **no clear timeline for conversion to pure hydrogen**. The proposal is also based on two assumptions: that 80 TWh of blue hydrogen will be produced annually by 2030, alongside 100 TWh of green hydrogen,[88] and that gases will remain the EU's primary heating fuel, with annual demand of 600 TWh by 2050.[89] The **blue hydrogen would be used primarily in industrial installations**, which often have existing connections to grey hydrogen producers, while the renewable hydrogen would be used in other sectors. Overall, the Hydrogen Backbone proposal is strongly oriented towards **supplying Northwest European markets**.

The second vision, broadly espoused by this Expert Group, argues for a much **more limited infrastructure build-up, based on an evidence-based hierarchy of applications** for limited hydrogen supplies and developed by independent experts rather than relying on the expertise of the gas industry. The goal should be to **use as little blue hydrogen as possible** given its questionable climate benefits. This would mean that much less hydrogen would be available in total in 2030 than the estimates developed by gas industry stakeholders and featured in the REPowerEU plan. **Hydrogen network planning should also be integrated with power and methane grid development** in order to optimise the energy system as a whole. This would help avoid unnecessary investments and allow for the **replacement of fossil gas with electricity-based alternatives** wherever possible.

The first stage of hydrogen use will likely be at the industrial cluster level, for example in ports and refineries or in the steel and petrochemical industries. Initial infrastructure development should thus focus on **connecting these clusters with green hydrogen production facilities** rather than creating stable blue hydrogen demand by building dedicated infrastructure. The second stage would be to **connect these clusters with each other and to geological storage sites** (e.g. caverns or depleted gas fields). In the German case, for instance, a significant portion of production and import capacity will likely be located in the north with its easy access to ports and wind energy, while the main industrial demand centres are located in the south. These connections should be made with **pure hydrogen pipelines.** Blending should be ruled out, and the use of hydrogen in the heating sector accepted only as a last-resort option.

The problem with a **large initial investment into blending** is that it **does not provide a clear decarbonisation pathway for fossil gas**. Blending 20% green hydrogen by volume with fossil gas only delivers a negligible GHG emissions reduction, of 6-7%.[90] **Investing in blending also presupposes the use of hydrogen in the heating sector**. Instead, the goal should be to build up pure hydrogen pipelines where needed and at the same time **begin shutting down obsolescent fossil gas transmission and distribution pipelines**.

The EU institutions are, unfortunately, sending mixed messages regarding the future role of hydrogen, risking a massive misalignment of public and private investment. On the one hand, the EU Hydrogen Strategy **clearly prioritises the use of hydrogen in industry and transport** (aviation, shipping, and heavy-duty road transport)[91] and the proposed revision of the RED[92] sets hydrogen targets for the industry and transport sectors only.

On the other, the revised TEN-E Regulation is set to allow **EU financing of pipeline conversion to blending until 2027,**[93] and the European Commission's gas market reform proposals of December 2021 **would require TSOs to accept 5% blended hydrogen** by volume at gas pipeline interconnections between Member States from October 2025.[94] According to these proposals, the cross-subsidisation of hydrogen infrastructure by existing gas consumers, subject only to minor conditions, is also to be permitted. This approach would effectively lock in blending and the use of hydrogen in the heating sector. Similarly, the revised Alternative Fuels Infrastructure Regulation sets the conditions for **widespread hydrogen use in road transport** without a prior analysis of likely demand. The regulation will require Member States to build hydrogen refuelling stations, including for light-duty vehicles, every 150km along the Trans-European Transport Network (TEN-T) Core and Comprehensive networks by 2030, to be financed with public funds.[95]

The European Commission argues that hydrogen blending and widespread use in road transport are needed to kickstart the hydrogen economy. This overlooks the fact that **there is already a well-defined hydrogen demand of 257 TWh in industry, which is currently satisfied almost exclusively through carbon-intensive fossil hydrogen and fossil gas.** While this demand ought to be decarbonised through the exclusive use of green hydrogen, the EU's domestic target production capacity of electrolytic hydrogen is likely to be insufficient to achieve this.[96] Instead of focusing on priority uses such as industry, the EU is pursuing a course that, by contrast, would be likely to lock in hydrogen demand in non-priority sectors that can only be met by relying on blue hydrogen and **prolonging the EU's reliance on fossil gas while obliging taxpayers and gas consumers to bear the cost burden**.

The European Commission seems to be repeating the mistakes of the past in **allowing gas industry stakeholders a central role in planning their own infrastructure**, despite the obvious conflict of interest. It has put industry in charge of the European Clean Hydrogen Alliance, tasked with drawing up a list of hydrogen projects eligible for public funding.[97] The gas market reform proposals published in 2021 created new bodies that will have a central role in planning hydrogen infrastructure via the TYNDP process: the European Network of Network Operators for Hydrogen (ENNOH) and a new umbrella organisation for distribution system operators.[98] These bodies are largely made up of the same stakeholders responsible for the current oversized gas grid and the Hydrogen Backbone proposal, which can be understood as an industry mission statement.

Instead of letting industry continue to plan the development and conversion of European gas networks, **infrastructure planning should be subject to independent oversight** and, as a matter of principle, be oriented towards achieving the EU's climate targets. In addition, European network planning should be accompanied by public consultations from the outset, and additional data transparency obligations should be imposed on TSOs and DSOs.

Fleshing out a hydrogen import strategy

Europe's overall dependence on energy imports will fall considerably during the shift to a climate-neutral economy. At the same time, it is clear that the bloc will still need to **import significant amounts of gaseous fuels, in particular hydrogen and its derivatives**. Even though Europe is set to develop into a leading market for green hydrogen production, predicted hydrogen demand is so high that all available scenarios involve imports.[99] The extent of these remaining energy imports will depend on a number of factors, including progress on energy efficiency, green power, and electrolysis capacity, as well as the extent of electrification, particularly in the transport and buildings sectors. In light of the need to reduce dependence on fossil gas imports from Russia, the **REPowerEU strategy aims for 10 million tonnes of hydrogen imports by 2030,** marking a significant increase in ambition.

Switching from fossil fuel to hydrogen imports will involve a **significant realignment of energy partnerships**, with shifts to new exporting countries accompanied by different risks and trade-offs. The European Hydrogen Strategy[100] takes a proactive approach to this, exploring hydrogen partnerships to secure future import sources and offering financing in addition to R&D and regulatory support through instruments like the European Neighbourhood Policy, the Western Balkans Investment Framework, and the Africa-Europe Green Energy Initiative. **Ukraine and North Africa are cited as priority partners for hydrogen development** due to existing pipeline connections and local potential for renewable energy generation, among other reasons. While mentioning several possible exporting countries, the **strategy is still vague and unspecified**, with significant gaps and problematic Eurocentric assumptions. The new EU External

Energy Engagement Strategy, published as part of the REPowerEU package, aims to achieve a massive increase in EU hydrogen imports via hydrogen partnerships without a clear plan how to address these issues.[101]

The Hydrogen Strategy uncritically endorses a proposal by industry association Hydrogen Europe to **source half of Europe's green hydrogen demand by 2030 from Ukraine and North Africa alone**. Of the 40 GW of electrolyser capacity to be built in these countries, 32.5 GW would be used in the production of green hydrogen for the European market. The remaining 7.5 GW would supply domestic markets – primarily to produce green ammonia, which would then presumably also be destined for export to Europe.[102]

This arrangement, purely theoretical at this point, smacks of exploitation. It **completely disregards the renewable energy needs of partner countries**, as well as their own hydrogen needs for decarbonisation, which will be not insignificant given the simultaneous phase-out of fossil fuels. Most of the renewable energy produced in partner countries will be needed to cover local electricity demand and extend reliable access to power to the parts of the population that are still without it. In the event that it is instead used to produce hydrogen for Europe, the likely consequence will be the scaling-up of existing fossil power plant operations to compensate.

Generally seen as **one of the most promising future hydrogen exporters**, **Morocco**, for instance, has an official renewables target of 64% by 2030.[103] This target will be difficult to achieve if the country is coaxed into producing massive amounts of hydrogen for European markets through financial aid and trade benefits. Morocco's chemical industry will likely also be a significant buyer of locally produced green hydrogen.

The EU's hydrogen diplomacy must therefore **carefully balance the bloc's own hydrogen needs with the demands of the energy transition in third countries**. It must be clear to all that Europe does not intend to secure advantageous access to some of the world's most attractive hydrogen resources while simply ignoring the consequences suffered by its trading partners and global efforts against climate change. The interests of transit countries must also be taken into account.

Given that green hydrogen production is in the early stages of development and very technology- as well as capital-intensive, **current hydrogen import expectations are likely overblown** and might not materialise. The conditions to attract significant private sector interest are currently lacking as green hydrogen production costs are still high, and the eventual development of EU demand remains uncertain. **Significant hydrogen exports to Europe will only become more likely over the longer term** – probably not before the 2030s or even 2040s – once hydrogen economies in partner countries and regions have been firmly established and local needs covered. In the short and medium term, the EU should thus focus on **establishing local production and technology leadership while limiting hydrogen demand to high-priority uses**.

Due to the sizeable uncertainties involved, it would also seem prudent to **develop shipping import capacity in parallel to hydrogen pipelines** in order to diversify import routes. While shipping hydrogen or its derivatives in liquefied form is more expensive and less efficient than pipeline transport, it offers the advantage of being **less vulnerable to supply disruptions**. Ammonia is particularly promising as a hydrogen transport vector as it has a higher energy density and requires less energy to be kept in a liquid state than hydrogen.

This has **considerable implications for LNG terminals**, as well as their associated regasification plants, storage facilities, and transport pipelines. To accommodate climate-neutral energy imports in the long term, existing LNG terminals but would need to be rebuilt or at least extensively adapted to liquefied hydrogen or ammonia. The proposed Alternative Fuels Infrastructure Regulation, however, simply requires Member States to build new LNG terminals at a number of maritime ports,[104] even though the EU already has extensive fossil gas import infrastructure. The regulation features **no requirement for these terminals to be reconstructed for hydrogen at some point or be built hydrogen-ready**. The same is true for the newly planned LNG terminals under REPowerEU. This constitutes a rather glaring gap in the EU's hydrogen import strategy.

While Ukraine and North Africa have rightly received significant attention, it is unclear whether the predicted hydrogen exports from these sources can actually materialise, given local energy needs as well as political uncertainties. **A more realistic strategy for the EU would be to pursue a variety of hydrogen import avenues in parallel.** This would help avoid developing too much reliance on any one exporter or drawing massive hydrogen volumes that might hamper local energy transitions. Hydrogen export potentials in the **countries of the Energy Community and the Eastern Mediterranean region** in particular are underexplored and barely considered in the Hydrogen Strategy and the new External Energy Engagement Strategy.

The EU should also take care **not to overlook low-hanging fruit closer to home**. Spain and Portugal, for instance, are both explicitly planning to become green hydrogen exporters. The development of offshore wind, an ideal source of renewable energy for electrolysers, is currently focused on the North Sea region even though countries such as Cyprus or Malta have excellent offshore wind potential. There is also a lack of concepts to better integrate Eastern and South-Eastern European countries into the common energy market and stimulate local green hydrogen production. If these regions were better connected and part of an EU-wide push towards a green hydrogen market, energy security would become less of a concern, shifting the focus from the search for alternative supply routes for fossil gas to the further expansion of renewable energy.

The **United States and Canada are particularly promising future hydrogen exporters**, on the condition that the conversion and transport costs of shipping liquefied hydrogen can be brought down. Studies have found huge potentials for green hydrogen export in North America,[105] with some estimates placing US annual production capacity at up to 1,937 TWh by 2050.[106] The United States could **cover its entire energy needs with domestic renewables** and still have enough left over to produce **more green hydrogen than Europe could ever hope to use**. This would of course only be possible if the country massively increased its renewable energy generation and decreased per capita energy demand. The United States and Canada also have enormous potential for blue hydrogen production, which is less desirable from a climate policy standpoint (see the discussion above).

With the EU set to become one of the world's largest hydrogen import markets, EU hydrogen regulation needs to consider the **effect it will have on other producing**

countries. The EU needs some form of regulation to ensure that it imports the least emissions-intensive blue hydrogen available. Otherwise, **EU demand could in effect promote the build-up of possibly climate-unfriendly blue hydrogen production abroad**. A related issue is that exporting countries might choose to export green hydrogen to the EU to meet environmental standards while using blue hydrogen or fossil-based electrolytic hydrogen domestically. This would also be a net negative for the climate.

A **robust GO system as outlined above is essential** to judge the sustainability and climate balance of green and other forms of imported hydrogen and to guide consumer choices. In practice, however, EU standards will be difficult to apply and verify outside of EU borders. **Strong international standards are thus crucial to underpin the international hydrogen trade** and ensure that an ill-advised hydrogen boom does not make the climate crisis worse. The EU should thus lead by example with strong sustainability criteria – not only for green but especially for blue hydrogen – and participate constructively in the development of the GHG emission intensity methodology of the International Partnership for Hydrogen and Fuels Cells in the Economy (IPHE).[107] As demonstrated by a recent study, the current IPHE proposals would lead to a **considerable underestimation of the methane emissions associated with blue hydrogen** production.[108]

The Expert Group recommends that the EU adopt a **measuring and pricing approach to hydrogen** rather than, for example, a blanket ban on blue hydrogen imports. Under this approach, the emissions intensity of hydrogen would be measured, or estimated by an independent third party where this is not feasible.[109] With the help of the resulting figure, imported hydrogen could be priced at the EU border, for example via a future revision of the proposed Carbon Border Adjustment Mechanism (CBAM), while domestically produced hydrogen could be priced via the EU ETS. The key advantage of this approach is that it would **create an incentive for third countries to reduce the emissions intensity of blue hydrogen**, which the EU will very likely rely upon to least some extent.

Integrating carbon and methane pricing via the EU ETS and CBAM has the advantage of being compatible with WTO rules as the same conditions would apply to domestic and foreign-produced hydrogen.[110] This approach could also help **protect the fledgling European hydrogen industry from being outcompeted** by countries with lower costs and less stringent environmental standards. There is a particular risk of hydrogen production moving to China, which is currently investing massively in hydrogen research and industrial development and has access to significant renewable energy capacity (e.g. via the Three Gorges Dam).

Chapter 4: Managing the transition to sustainable heating

Creating the right enabling conditions

The EU's **building stock is currently responsible for approximately 36% of the bloc's CO_2 emissions**. Taking into account the fact that almost 50% of the EU's final energy consumption is used for heating and cooling, of which 80% is used in buildings, the potential for decarbonising this sector is massive.[111] **Fossil gas, the single most commonly used heating fuel in the EU,** covers 42% of final energy demand for heating and is responsible for the **lion's share of its emissions**. In total, about half of the fossil gas used in the EU goes to the heating sector.[112] In the context of the war in Ukraine, reducing the consumption of fossil gas for heating purposes is thus one of the most important policy levers to quickly achieve **independence from Russian gas imports**. Unfortunately, concrete measures to mobilise this potential more rapidly than planned for with the Fit for 55 package are largely missing from the REPowerEU strategy. The possibility to frontload energy efficiency investments via the Recovery and Resilience Facility is a notable exception (see Chapter 1).

The key challenge in developing a climate-neutral heating sector is to **move the sector as a whole away from the use of gaseous fuels**. It will not be enough to simply replace fossil gas with alternatives such as biomethane or hydrogen as there are limits to how much of these energy sources can be sustainably produced. **Blending would only prolong dependence on fossil gas** given that a gradual switch to complete hydrogen heating is not possible for technical reasons. Beyond a roughly 10-20% volume share of hydrogen, which produces only negligible GHG emissions reductions, end-use appliances and pipelines would need to be replaced or adjusted to cope with higher shares or pure hydrogen.

It is crucial that we set the direction towards climate neutrality as soon as possible. The decades-long lifetimes of its infrastructure and equipment mean that the **heating sector is slow to move to climate-friendly alternatives**. Far from reducing the role of gases in heating, however, the current policy direction threatens to actually expand or at least preserve their role. The gas market reform proposals of December 2021 seem entirely focused on **promoting competition between fossil gas and other gases** rather than electrification-based alternatives such as heat pumps.

This strategic direction risks increasing **dependence on fossil gas in district heating** as countries phase out coal, thereby locking in significant fossil gas consumption for decades to come. Several Member States are already using EU funds from the Just Transition Fund, the RFF, or the Cohesion Policy funds to finance new gas heating systems.[113] There is also a **lock-in risk related to individual heating systems** as households that switch to modern gas boilers now have little to no incentive to switch to heat pumps in the foreseeable future.

An **integrated strategy** is needed to address the challenge posed by the heating transition, creating the **right conditions for switching to sustainable options** such as heat pumps, scaling up **energy renovations**, and using the **heating system as a balancing and storage option** for district electricity grids during periods of excess renewable energy production. The heating transition thus necessitates effective governance across several political levels as well as the active involvement of stakeholders such as energy and housing companies, particularly at the municipal level where concrete decisions about local heating systems are taken. **Instituting long-term heat planning by municipalities**, with appropriate support by central governments, is thus essential to enable a heating transition on the ground (see also the discussion below).

Regardless of the energy source used, a key enabling condition for the heating transition is the implementation of the Energy Efficiency First principle by improving the insulation of existing buildings. There is huge efficiency potential in the EU's building stock, where renovation rates have remained at around 1% for years despite political objectives to at least double this number. Three quarters **of European buildings are classified by the European Commission as "highly energy inefficient"**.[114] A marked increase in deep energy renovations would massively reduce energy demand for heating in general, thereby also reducing fossil gas use and blunting the impact of switching district heating grids from coal to fossil gas. Building insulation is also particularly important to ensure the optimal operation of low-temperature heating systems such as heat pumps.

Voluntary measures such as financing programmes, already in place for some time, have to date failed to raise renovation rates to the levels needed. The introduction of **minimum energy performance standards** (MEPS) as proposed by the European Commission in the Energy Performance of Buildings Directive is thus a **necessary measure to raise renovation rates** and enable the transition to sustainable heating. MEPS should introduce a target date for the achievement of minimum efficiency standards, starting with the least energy-efficient buildings. The REPowerEU package suggests **raising the ambition of MEPS by requiring existing buildings to reach energy class D** by 2030. While this is a welcome improvement, the timeline would need to be sped up considerably to keep to a 1.5°C pathway. The European Commission stopped short of making concrete legislative proposals to strengthen MEPS, however; it remains to be seen whether the EU Council and the European Parliament will pursue this further.

Increasing the deployment of **heat storage** is another enabling condition. This is **particularly important in the context of electrification** and to ensure the viability of low-temperature district heating grids. Heat storage is widely used in Denmark and the other Nordic countries but rarely in central Europe. The development of heat storage capacities, of crucial importance given their ability to help stabilise electricity grids, should be subsidised at the national level

The EU and its Member States also need to **rethink energy pricing in order to narrow the gap between electricity and fossil gas prices**. High electricity prices are still a major barrier to electrification in most markets. While electricity will become cheaper as the share of renewable energy increases, **EU electricity prices are still much higher than gas prices.** This is partly due to fossil fuel subsidies and electricity taxes.[115] The gap could be narrowed by shifting energy taxes and charges from electricity to fossil gas and by introducing carbon and methane prices on heating fuels to reflect their environmental impact. In order to **offer renewable heating technologies such as heat pumps a level playing field** and make them an economically attractive investment for EU citizens, improvements in the price environment are essential.

Developing the right sustainable heating options

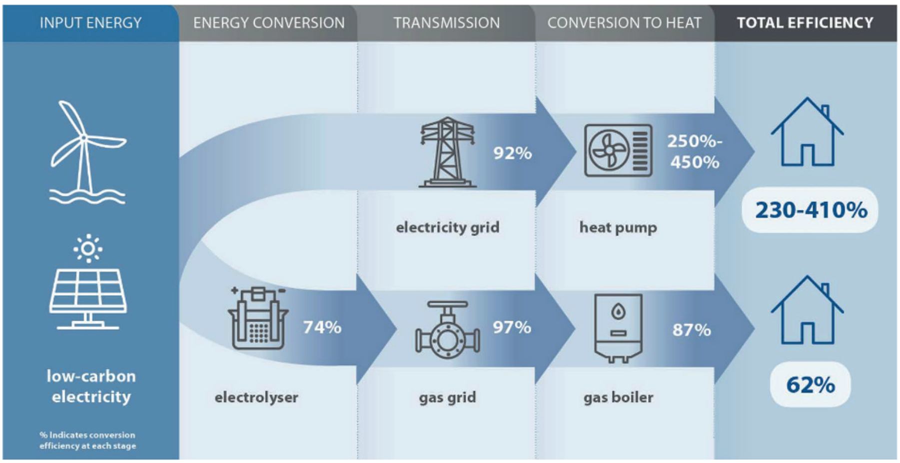
The key challenge in decarbonising heating is to reduce reliance on fossil fuels and increase the share of renewables. According to a range of scenarios compatible with climate neutrality that deliver net-zero emissions by 2050, the **EU buildings sector must reduce its fossil fuel use by 33-50% by 2030**.[116] Reducing GHG emissions from buildings by 50% or more in that timeframe will require the replacement of 10-35% of existing individual fossil fuel boilers and heating stoves, mainly by heat pumps, district heating, or other renewables.[117] According to these scenarios, **the use of fossil fuels for heating must essentially be phased out by 2050**, accompanied by a significant increase in the use of electricity.[118] While biomass, biomethane, and synthetic fuels such as hydrogen all play a role in future decarbonisation scenarios, **not all renewable heating options are equally sustainable and deserving of policy support**.

Bioenergy already accounts for 60% of the EU's total renewable energy production. Three quarters of the energy it generates is consumed by the heating and cooling sector.[119] The use of bioenergy in this sector is growing,[120] despite concerns that **current levels are already exceeding the capacity of Europe's natural resources**. Forests in particular are suffering due to overexploitation for primary woody biomass, in addition to the effects of climate change.[121] The increased renewable energy target proposed in the revised RED in 2021, to be raised again following the REPowerEU package, will likely fuel this trend further given that the **sustainability criteria were not strengthened sufficiently** to ensure that bioenergy is only produced from fast-decaying wastes and residues. Biomass heating is also associated with significant air pollution and negative health effects,[122] while biomethane will be needed more urgently for high-temperature processes in other sectors as fossil fuels are phased out, similar to hydrogen. To be sustainable in the long term, the use of **bioenergy should be limited to covering demand peaks** as far as possible in place of fossil fuels.

The main political focus in the heating sector should be on the promotion of other green heating options. **Green hydrogen and heat pumps are most often cited in this context**, with gas industry and buildings sector stakeholders in particular pushing for the use of hydrogen. While it may well be necessary to rely on a certain amount of green hydrogen in the heating sector to ensure security of supply, especially in existing gas-based district heating systems given its compatibility with high-temperature grids, this should be a last resort option. As outlined in Chapter 3, **hydrogen availability will be limited, and it will be more urgently needed to decarbonise the industry and transport sectors**.

In addition, **hydrogen-based heating is far less efficient than heat pumps**. Between the hydrogen production process, storage, transportation, and combustion for heat, 38% of the input energy is lost. Heat pumps, on the other hand, only require a small amount of power to draw in ambient heat from the air, ground, or water (see Figure 8). As such, they are able to reach efficiency levels of 230-410%, meaning they can produce 2.3-4.1 kWh of heat for every kWh of power they use. Moreover, **heat pumps are already being routinely installed** in new buildings, whereas pipelines and household appliances for use in green hydrogen-based systems are still undergoing testing.

Figure 8: Comparison of the efficiency of heat pumps and hydrogen boilers



Note: The above diagram shows the indicative efficiency of using a given amount of low-carbon electricity in delivering heat for buildings.

Source: UK Committee on Climate Change. (2018). *Hydrogen in a Low-Carbon Economy*, page 26.
www.theccc.org.uk/wp-content/uploads/2018/11/Hydrogen-in-a-low-carbon-economy-CCC-2018.pdf

Running on electricity, heat pumps draw heat either from the outside air (air-source) or geothermal energy (ground-source). While **geothermal heat pumps are more efficient** than air-source heat pumps, they are also **more expensive to install** due to the need for underground piping. In rural areas, where it is comparatively easy to install ground-source heat pumps, it is already very common for new buildings to be connected to the electricity but not the gas grid. Installation is understandably more difficult in built-up areas given the extent of ground coverage, leading to **air-source models being by far the most common type of heat pump**.[123]

A key advantage of heat pumps is that they can **contribute to balancing the power grid**, for example by acting as thermal storage batteries, thus supporting the further deployment of renewable energy production and sector coupling. For this to work, **heat pumps must be combined with buffer tanks controllable by the power system operator**. Unlike bidirectional charging stations for e-cars, smart-grid-ready heat pumps can only contribute to power system flexibility by being switched off for a few hours during peak times to lower demand in the grid.

Promoting heat pumps also boosts EU economic growth – particularly important in the context of the COVID-19 pandemic – as these products are widely developed and manufactured in Europe. The heat pump industry as a whole currently employs 225,000 people in Europe.[124] Given their advantages over other sustainable heating options, **EU policy should clearly be oriented towards increasing the uptake of heat pumps**, both for individual and district heating use, to the greatest extent possible.

While the market for heat pumps is growing quickly, a key factor inhibiting their broader uptake is cost. The **initial investment required for a heat pump is much higher than for a fossil gas boiler, for instance**. Operating costs are also currently higher: gas electricity price ratios generally favour gas, weakening the economic case for heat pumps. These costs are expected to fall significantly in the coming years, however, as the technology develops.[125] In Germany, for instance, **heat pumps are set to beat gas boilers on operating costs by 2025** in light of an upcoming reduction in the renewable energy (EEG) surcharge currently included in the electricity price, combined with the carbon pricing for heat and transport introduced in 2021.[126] A recent study comparing the future costs of several residential heating technologies finds that **air-source heat pumps will be the least expensive heating technology in 2050**, at least 50% cheaper than hydrogen-only technologies.[127]

Another limitation of heat pumps is that they **require well-insulated houses and surface heating systems such as floor or wall heating** rather than traditional high-temperature radiators to run at optimum efficiency. With a market share of 25% in 2020, heat pumps are already among the most commonly installed space heating systems in new buildings, where this can be taken into account during construction. In some markets, such as Finland, 70-80% of new dwellings are equipped with heat pumps.[128]

For existing buildings that were built to different standards, however, this poses a significant challenge. Ideally, heat pumps would only be installed after a building has been properly insulated and the heating system exchanged. While these investments make general sense from an energy efficiency perspective, they add considerably to the **high upfront costs of installing a heat pump**. Given the slow speed of energy renovations, it will likely also be necessary to replace fossil heating systems with heat pumps in existing buildings that do not meet this standard.

A recent study has shown, however, that the **highest efficiency standard is not necessary for heat pumps to be cost-competitive** with gas boilers. Even in the German market, where household electricity prices are high, heat pumps break even with gas boilers in partially energy refurbished buildings, defined as buildings with a heating demand of 120 kWh/(m²a).[129] The situation will improve further if taxes and levies on electricity are reduced and as fossil gas becomes subject to increased carbon pricing. New **high-temperature heat pumps** will also enter the market in 2022 and might work in the existing building stock, although it is difficult to assess their potential as technical details have not been made public.[130]

Aside from their already widespread use in individual heating, **large-scale heat pumps can also be integrated into district heating systems**, which are currently overwhelmingly based on combined heat and power (CHP) plants and fuel boilers burning fossil gas, coal, or bioenergy. The Heat Roadmap Europe project, which models heating transitions in 14 European countries, has for instance found that **large-scale heat pumps could cover 12.5-19% of total heat demand in 2050**, with a total installed capacity of 95,000 Megawatts thermal (MWth), mainly in urban areas.[131] The study also found a **large potential of accessible low-temperature excess heat** from unconventional sources such as computation and data centres, metro stations, and wastewater, equal to more than half the current district heat production in the countries studied.

Switching district heating systems to sustainable alternatives poses even greater technical challenges than converting individual heating systems, however. **Large-scale heat pumps and waste heat require low-temperature grids** with lower efficiency losses. Existing district heating systems, in contrast, are practically all based on high-temperature grids supplied by some form of combustion. **Replacing an entire district heating grid without disruption to heat supply would be challenging** in itself, but, for the optimal functioning of the new low-temperature system, the buildings belonging to the heat network would ideally have to be **refurbished with insulation and low-temperature radiators** at the same time. In the short-to-medium term, there might thus be no alternative to using gases for district heating, especially where coal-based district heating systems are scheduled for imminent phase-out. Bioenergy could also provide sustainable district heating in cases where it can be sourced sustainably from the local region, using waste and secondary biomass.

Geothermal district heating is another promising option to supply urban areas where geologic conditions are suitable. According to the EU-co-funded Geothermal District Heating (GeoDH) project,[132] over 25% of the EU population lives in areas suitable for geothermal district heating, which is much higher than the potential recognised in EU countries' National Renewable Energy Action Plans. The technology is already competitive in many regions, with over 240 geothermal district heating systems operating in 22 European countries.[133] There is still **considerable unused potential, however, particularly in Central and Eastern Europe** due to geothermal activity within the Carpathian basin, where geothermal district heating could deliver temperatures high enough to work with existing district heating systems.[134] This would provide an immediate option to replace fossil fuels, which should be prioritised over investments in new fossil gas district heating systems.

Removing barriers to sustainable space heating

There are currently around **110 million individual gas, oil, and coal boilers installed in the EU**. Gas boilers account for the lion's share, with 88 million installed units.[135] By 2050, these will all need to be replaced with sustainable solutions such as heat pumps or solar thermal boilers. For climate neutrality by 2050 to remain in reach, 10-35% of these fossil heating systems would already need to be replaced by 2030, equalling about **11-39 million residential heating system replacements**.[136] These figures do not take into account new fossil fuel boilers; these still have a sizeable market share, with about 3 million residential gas boilers installed per year in the EU.[137]

Phasing out fossil gas in the heating sector is therefore an enormous investment challenge. **Millions of home-owning households will have to invest their own money** in switching to different heating systems. The same goes for the **housing companies and private landlords** who own the properties occupied by 30% of the EU population and **do not have strong incentives to invest** into heating system replacements that benefit their tenants while they carry the costs (split incentives). While necessary to massively **improve the energy efficiency of Europe's building stock** – both to bring down fossil gas consumption and to enable the optimal functioning of low-temperature heat sources – energy refurbishments to improve insulation face the same financing barriers. While no "silver bullet" solution exists, there are **a variety of measures the EU and its Member States should take** to accelerate the replacement of individual fossil fuel heating systems with sustainable alternatives and remove bottlenecks in their deployment.

As noted above, **narrowing the gap between electricity and fossil gas prices is critical** to accelerate the uptake of sustainable heating in expanding market segments (e.g. air-source heat pumps for new buildings) and foster greater deployment in new ones (e.g. existing buildings).

While **subsidies for renewable heating** exist in almost all EU Member States,[138] they are **not enough to redress this price imbalance** and make heat pumps widely affordable to EU households. A study by the European Environmental Bureau (EEB) has found that, if an average middle-income family of four switches from a fossil fuel boiler to a heat pump under existing price levels and incentive programmes, the payback time through savings on bills will only be acceptable (defined as 8 years or less on an investment of €10,000) in 8 EU Member States.[139] In the meantime, **20 out of 27 EU governments are still subsidising the installation of new gas boilers**. The study calculates that **70 billion euros in subsidies**, or 4.7 billion euros annually over a 15-year period, would be **needed to incentivise the switch of all the gas boilers in the EU to heat pumps**. This amount would be reduced to 20 billion euros if a carbon tax of 100 euros per tonne of CO_2-equivalent was introduced. While the proposed new EU ETS for heating and transport is unlikely to produce such high prices for a while, it would go some way towards making heat pumps more competitive in comparison to gas boilers.

Apart from greatly increasing subsidies for heat pumps and abolishing subsidies for fossil heating systems, decision-makers should **ban the installation of new fossil heating systems**. Given average lifetimes of 20 years or longer, it is clear that new fossil-based installations will undermine the aim of a carbon-neutral buildings sector. Recognising this, the IEA has recently recommended banning the sale of gas boilers by 2025.[140] While Austria and Germany have already banned the installation of new oil heating systems, **only the Netherlands has banned new gas boilers** as well.

In the absence of action by Member States, **EU ecodesign rules should fill the gap** and protect the climate neutrality objective enshrined in EU law by effectively **ruling out new oil and gas boilers via ambitious energy efficiency standards**. The revision of the Ecodesign Regulation proposed by the European Commission in 2021, however, is set to allow the continued installation of new fossil gas boilers for at least the next decade.[141]

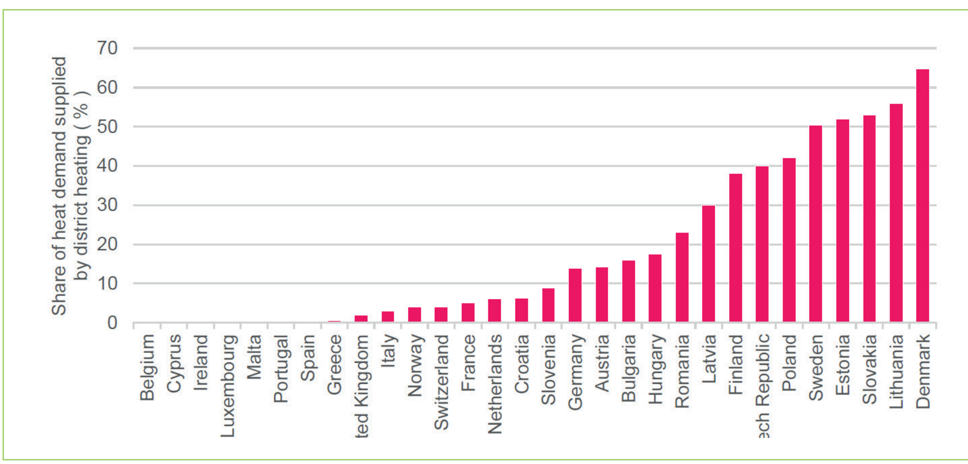
Heat pumps in particular also face non-financial hurdles, including widespread negative views fuelled by preconceptions about their reliability under very cold conditions and worries about skyrocketing electricity costs. Part of the response should therefore involve awareness-raising campaigns among the general public that serve to dispel the myths that have developed around this technology. In this context, it is also crucial to give customers the chance to actively participate in electricity markets as providers of flexibility so that they are able to make full use of the advantages of heat pumps.

Another significant bottleneck to the deployment of heat pumps is a **shortage of skilled labour**. Interested homeowners often report serious difficulties in finding qualified specialists to install heat pumps.[142] It is very important to increase the number of skilled workers to manage the twin challenges of energy renovation and the installation of sustainable heating systems. The European Commission estimates that an **additional 160,000 green jobs could be created in the EU construction sector by 2030**, although enabling policies to increase energy renovations and sustainable heating replacements are needed to realise this. The heating transition would deliver a much-needed boost to the construction sector, which has also suffered as a result of the pandemic and where more than 90% of the operators are small and medium-sized enterprises (SMEs). These workers will also need the **right qualification schemes to implement the heating transition on the ground**. While the European Commission has announced a welcome upskilling initiative to support this as part of the Renovation Wave Communication[143] and REPowerEU, professional bodies and training institutions at Member State level will ultimately need to implement it, whether within the education system or in the form of professional training.

Greening district heating

District heating covers around 12% of EU heat demand and is distributed very unevenly, (see Figure 9). Over **5,000 district heating systems exist in the EU, overwhelmingly based on fossil fuels and fossil CHP**, with some newer systems using biomass.[144]

Figure 9: Share of total heat demand in the residential sector covered by district heating



Source: Ramboll. (2020). *District Heating and Cooling Stock at EU level*. W. E. District. www.wedistrict.eu/wp-content/uploads/2020/11/WEDISTRICT_WP2_D2.3-District-Heating-and-Cooling-stock-at-EU-level.pdf

The **district heating sector,** while relatively small compared to the share of heat demand provided by individual space heating, allows **significant steps to be taken towards sustainable heating** because of the scale of investment decision-making (i.e. large heat suppliers rather than individual households). However, short-term opportunities to decarbonise district heating systems are limited as there is no standard business case for sustainable district heating on the horizon.

The key problem, as outlined above, is that **established district heating systems typically rely on high-temperature grids, while sustainable district heating solutions often require low-temperature grids**. Switching between the two systems is challenging given both the number of consumers dependent on a particular network and the difficulty of carrying out construction work in densely built urban environments, where this applies. As district heating systems are **highly dependent on local factors** related to the urban environment and regulatory context in which they are situated, as well as the available renewable heat sources, there is **no one-size-fits-all solution for green district heating**.

The **business case for sustainable district heating could, however, be markedly improved with a change to subsidy regimes**. Subsidy policies currently provide an advantage to fossil CHP in particular but also to biomass over large-scale heat pumps or waste heat. In Germany, for example, the various subsidies for fossil CHP add up to 1,425-3,790 euros per kW of installed capacity, while no comparable financial incentives for large-scale heat pumps exist.[145] These **payments are far higher than the investment costs of CHP plants** and they also cover a proportion of the fuel costs. Additional subsidies are available for the construction of heat storage facilities and district heating networks, regardless of the fuel used. This preferential treatment of fossil CHP over renewable heat exists in many EU Member States. At its root lies the provision for **funding "highly efficient" CHP enshrined in the Energy Efficiency Directive (EED)**, according to which efficiency improvements of 10% and upwards for larger plants or even 0% for small installations are enough to make a fossil CHP plant eligible for support. This imbalance in financial incentives needs to be addressed as it essentially makes it more **economical to invest in district heating based on fossil fuels rather than renewable energy** and greatly reduces the risks for operators of switching from coal to gas, despite a worsening outlook for fossil gas plants.[146]

New financing instruments such as **risk-insurance schemes** for – often municipal – investors can help mitigate the uncertainties involved. At the same time, it **must be ensured that there is no economic benefit to the expansion of fossil heating supply for municipalities**. At present, a proportion of the high subsidies for CHP and district heating ends up in municipal budgets. This results in problematic incentives for municipal decision-makers, who are then more likely to decide in favour of fossil energies in urban land use planning, municipal heating statutes, and many other administrative decisions.

The orientation of **heat system planning** towards climate targets, including climate neutrality by 2050, should be made a **legal requirement for municipalities and municipal heat providers**. It is necessary to chart a path towards the decarbonisation of this sector and initiate the conversion to renewables, but only where and when it makes sense to do so. Municipal heat planning has a **long tradition in countries such**

as Denmark, Austria, the Netherlands, and Switzerland, but is still only used haphazardly in large parts of the EU.[147]

As municipalities have to take far-reaching and complex decisions accompanied by **major risks of lock-in due to sunk infrastructure costs and long-term supply contracts,** long-term planning is all the more crucial. For example, municipalities must determine the areas of their territories that might be suited to heating networks and those in which building-specific heating might be a better solution. Waste heat sources need to be identified and land for renewable heat generation secured. Renewable heating needs space, but municipal land use plans typically do not include such a category. **Long-term heat planning at the municipal level is necessary in order to comprehensively assess the various requirements** and find the best solutions for specific local circumstances.

The coordination effort required to achieve this will necessarily **span several levels of** government and must involve stakeholders such as **housing companies and municipal energy providers.** This level of involvement is essential as changes to heating, electricity, and gas grids, as well as heat sources and energy renovations, must all take place in parallel. Municipal heat planning must also be underpinned by a **strong governance system with expertise and financial support offered** at a central level as smaller municipalities in particular are often not equipped with the necessary capacities.

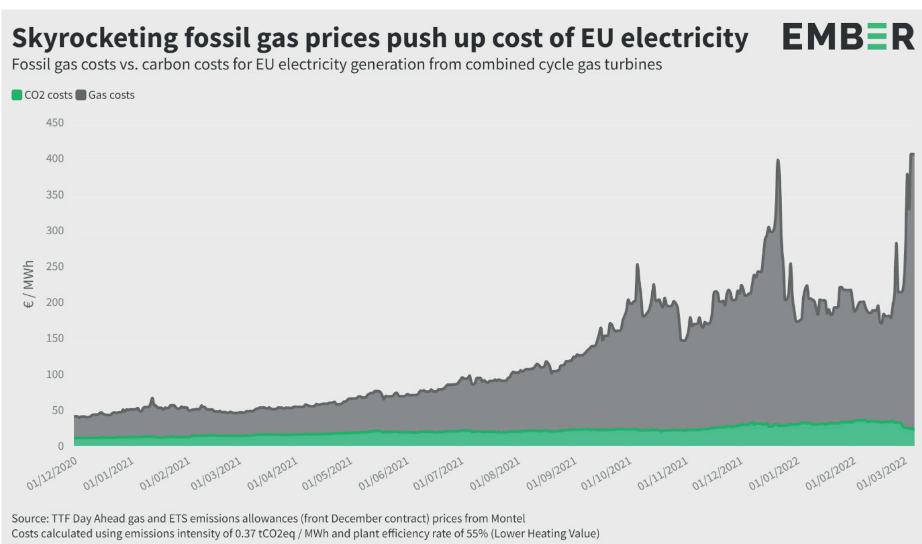
Key elements of such a system would include **providing access to essential data** from energy companies and buildings sector stakeholders; producing **standardised technical catalogues** detailing planning parameters; GHG intensity as well as investment and operating cost ranges for different technologies; and support for **case-specific feasibility studies**. In addition, regional and local authorities may require increased municipal financing for planning purposes and training in **the technical knowledge needed** to approve and support projects.

Chapter 5: Addressing the socio-economic impacts of phasing out fossil gas

Ensuring the affordability of energy

The rise in energy prices seen throughout 2021 has highlighted the importance of energy affordability within the energy transition debate. Gas prices reached unprecedented levels, particularly around August 2021, which also caused a 300-400% rise in wholesale power prices in several EU Member States. Climate policy has often been blamed for this development in the public debate. **In fact, carbon prices played only a minor role in the price swings, which were mainly caused by external events** (see Figure 10). Given the new geopolitical uncertainties and potential fossil gas shortages resulting from Russia's invasion of Ukraine, the current high price environment could persist for quite some time.

Figure 10: Fossil gas versus carbon cost comparison



Source: Ember. (2022).

Among the main factors causing the price rise over the last year were a **cold winter and spring** 2021/2022 in the northern hemisphere; this led to the depletion of European gas storage, which reached its lowest levels in ten years. At the same time, a warm summer in Europe and the lifting of COVID-19 restrictions increased demand globally, with prices and demand particularly high in Asia and Latin America. **Europe is a "swing state" on the LNG markets**, meaning that if prices are high, shipments go to Asia and supply to Europe is restricted. Capacity to increase imports from Norway was limited, and Russia, operating in the context of ongoing German deliberations over the approval of the Nord Stream 2 pipeline, which it argued would increase gas supplies to Europe, declined to help relieve the supply shortage.

Furthermore, in December 2021 and **as a precursor to its invasion of Ukraine**, Russia took the unprecedented step of **cutting gas deliveries via the existing Yamal-Europe pipeline system** for a period of more than two months. In addition, Europe's biggest gas storage facility, located in Rehden in northern Germany and owned by Gazprom, was **completely empty for the first time ever at the beginning of winter** 2021/2022 as the result of an abrupt stop to deposits. The link between these developments, the geopolitical tensions because of Russia's aggression against Ukraine, and surging gas prices is clear. As a result of the ongoing war in Ukraine, Russian gas supplies could be cut off entirely, forcing Europe to rely on LNG imports at record prices and further exacerbating the situation (see Chapter 1).

There is no commonly agreed definition of energy poverty, and several indicators are used to measure its different aspects. It is nevertheless clear that the scale of the problem is already considerable. A quarter of European households were already struggling to pay energy bills before 2022, and many faced disconnection for non-payment of bills due to the 2021 energy price spike.[148] According to one measure, **nearly 34 million Europeans were financially unable to keep their homes adequately warm in 2019**.[149] One prominent definition of energy poverty is "the inability to secure an adequate level of energy services in the home". **Energy poverty is present in different forms in all EU countries**. However, it is particularly acute in South-Eastern Europe, driven primarily by low incomes but also poorly insulated homes. Energy poverty is **highly correlated with being at risk of poverty generally** and worryingly also with social exclusion, meaning that the energy-poor often have little recourse to support measures or having their grievances addressed.

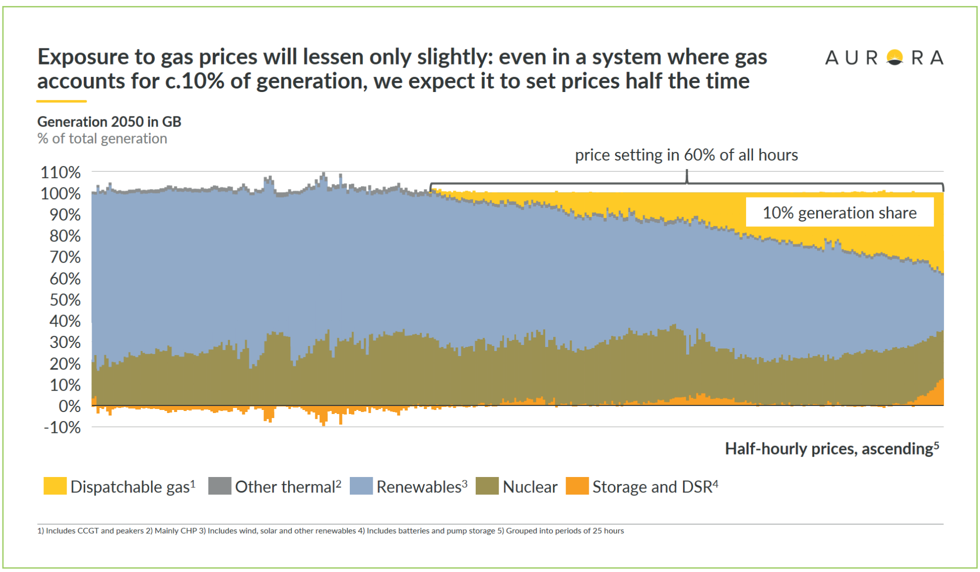
Rising energy bills increase the cost burden for low-income households more than taxation, for instance, which is typically structured progressively so that the richer pay more. The costs of energy infrastructure and clean energy programmes are added to electricity bills – for instance through grid charges and feed-in tariffs – and make up around 40% of the average European household energy bill.[150] The **distributional impacts of these policies deserve greater attention**, as exempting certain users such as energy-intensive industry from contributing to these costs places a greater burden on other groups such as households.

While it is clear that climate policy is not to blame for current price trends, there is little doubt that **carbon pricing will contribute to rising (fossil) energy prices in the future**. The supplementary **EU ETS for heating and transport** proposed as part of the

Fit for 55 package in particular will increase costs for households by adding carbon prices to heating and fuel bills. In order to ensure a fairer balance, a recent analysis[151] shows that EU legislators could enforce mechanisms within the new proposals to bind suppliers more effectively to the "polluter pays" principle.

Rising fossil gas prices will **continue to drive up power prices for the foreseeable future, even as the share of fossil gas in the power mix is reduced**. Stepping up investments in renewables, energy efficiency, and energy storage capacity is important for the energy system as a whole to provide supply security. However, it **will not automatically bring down power prices** because the least cost-competitive power plants are used for marginal price-setting. **Flexible power generation will continue to be needed** to provide security of supply by covering periods with little to no renewable energy generation. Even if this flexible power source, which at the moment is usually fossil gas, only accounts for 10% of generation throughout the year, this 10% will be used for price-setting for 60% of the hours according to a simulation by Aurora Energy Research (see Figure 11).[152] Switching to green hydrogen for back-up power generation might have a similar effect as it is very costly to produce, even if it remains unaffected by rising carbon prices.

Figure 11: Impact of power generation share of different energy technologies on price-setting



Source: Aurora Energy Research. (2022).

Without structural changes such as energy refurbishments or heating system replacements to bring down consumption, **rising heating costs could have massive adverse impacts on energy-poor households**. While low-income households benefit more from renewable energy and energy efficiency programmes than better-off households, **they face significant barriers to participation in these programmes**. Poor homeowners typically do not have the financial means to pay for energy renovations, while tenants have little to no influence over these types of decision. In social housing, governments are typically involved, meaning that progress can only be made if the political will is there. In privately owned housing, the problem is more acute due to split incentives between tenants and owners.

In response to this challenge, a number of European countries – including the United Kingdom, France, Slovenia, Ireland, and Austria – have made use of **Article 7 of the EED, allowing the ring-fencing of energy refurbishment programmes** for low-income households. This provision is currently purely voluntary. Introducing a specific requirement to deliver savings to low-income households would help address the **structural causes of energy poverty**.

Rising energy prices can lead to **considerable social disruption, as shown by the "yellow vests"** ***(gilets jaunes)*** **protest movement in France**. Impacts are particularly severe for energy-poor households, who might be caught in a "Catch-22" situation where they are being **"incentivised" through higher prices to do something they cannot afford in the first place,** such as installing a different heating system, undertaking an energy renovation, or buying an electric vehicle. Imposing additional burdens on these groups would be unfair and, in many cases, would fail to promote actual emissions reductions. Instead the consequence could be a **backlash against the energy transition** as a whole.

Policies aiming to drive fossil gas out of the market through pricing or finance the energy system transformation through higher grid charges therefore have to be **accompanied by social policies compensating energy-poor households and keeping energy affordable**. If an EU-wide emissions trading system for heating and transport is introduced, this must be accompanied by the ambitious implementation of the **Social Climate Fund** in order to avoid negative impacts, particularly in Member States with low average household incomes. **Emergency support measures** are justified **as a crisis response** to keep households from being disconnected, but they must be strictly time-limited to avoid turning into an energy consumption subsidy. In the long run, it is crucial to address the structural causes of energy poverty by improving the housing stock and **ensuring that low-income households can benefit from energy renovation programmes**.

Fossil gas heating: an energy poverty trap

Fossil gas used to be seen as a solution to energy poverty. Prior to the current price spike, gas tended to be comparatively cheap; it also causes less air pollution than the coal or wood stoves that are still widely used, particularly in Central and South-Eastern Europe. This **view of fossil gas as cheap and affordable is still widespread,** and is also the narrative typically promoted by the gas industry.[153]

The current gas price spike shows the **volatility and susceptibility of gas prices to political tampering**. In the future, the **impact of carbon pricing** (and possibly methane pricing) will raise fossil gas prices even further. In addition, the possibility of cross-subsidising hydrogen grids via the network charges paid by gas consumers will raise energy prices for these consumers, without significant benefits for the vast majority of households.

The **installation and operating costs of heat pumps**, on the other hand, while still comparatively high, are **expected to fall considerably in the coming years** as the technology develops (see Chapter 4).[154] Even in Germany, with its high taxes on electricity, heat pumps are set to beat gas boilers on operating costs by 2025.[155]

Taking the long view, heat pumps seem a much better heating option than fossil gas, both for their obvious **climate benefits and from a cost perspective**. Installing new gas boilers, by contrast, will likely lock consumers into paying ever-higher heating bills. This is particularly problematic for energy-poor households, who tend to be particularly exposed to higher energy prices as a result of living in poorly insulated houses and typically being unable to afford heating system replacements.

By continuing to promote fossil gas heating through public funds, **a trap is created, locking low-income consumers into fossil heating** while wealthier consumers remain able to opt out if it becomes unaffordable. Despite this, billions of euros of EU funding are still spent on fossil gas heating, often as **part of broader energy efficiency or energy poverty measures**.

This is a **long-standing issue, particularly in relation to EU Cohesion Policy and the Just Transition Fund**.[156] As part of the EU's efforts to mitigate the negative economic effects of the COVID-19 pandemic, the new Recovery and Resilience Facility is also being used to allocate significant new funding to gas investments, for example in the Czech Republic, Italy, Poland, Bulgaria, and Romania.[157] These **investments into district heating and gas boilers are typically framed as energy poverty measures** in the national RRPs and are also often labelled as contributing to the required 37% climate share of RRP expenses, despite promoting fossil fuel lock-in. **Policies that address the structural challenges causing energy poverty**, on the other hand, do not feature prominently in the RRPs.

In addition, **EU subsidy rules favour the financing of fossil fuel CHP plants**, which are classified as "highly efficient" in the EED and given preferential treatment under the EU's State Aid Guidelines (see Chapter 4). **No such preferential treatment exists for large-scale heat pumps**. This has led to skewed subsidy schemes in many Member States, where fossil heat and particularly fossil CHP receives higher subsidies than green heating solutions.[158]

There is thus a **fundamental conflict in the EU's current approach to energy poverty**. While some support measures are being put into place and Member States are obliged to address energy poverty as part of the National Energy and Climate Plan process, the continued support and **preferential conditions for gas heating runs counter to the long-term interests of energy-poor consumers**. Using public funds to finance gas heating systems also creates new equity issues as EU taxpayers effectively finance investments that will undermine climate policy objectives and/or end up as stranded assets in the long term.

Conclusion

The EU must put an end to unabated fossil gas use by 2050 at the latest to comply with its climate neutrality objective. To stay within the Paris Agreement target of 1.5°C, the use of unabated fossil gas would have to end significantly earlier – by 2035. This report has outlined the implications of this challenge for the management of the energy transition in a way that protects security of supply and energy-poor consumers as well as the climate. Current EU policies run the risk of prolonging dependence on fossil gas rather than decisively moving towards alternatives, particularly in the heating sector. As a response to Russia's war of aggression against Ukraine, the EU is also pushing for a wave of new fossil gas import projects, many of which will likely be unnecessary given declining EU gas demand. Decision-makers should thus take a much more active approach to phasing down fossil gas use as soon as feasible while building up a sustainable, carbon-free energy system.

Policy recommendations

Securing energy supply while promoting climate ambition

Accelerating the energy transition is the best way to reduce dependence on Russian fossil gas imports. The Fit for 55 package alone would reduce EU gas demand by 30% by 2030. The initial reaction of the EU and its Member States in relation to scaling up renewable energy deployment, as well as raising the 2030 targets for energy efficiency and renewables, has been positive. The gas savings potential in the buildings sector remains underleveraged in the REPowerEU package, however. Considerable additional savings could be mobilised by means of concrete measures to speed up energy renovations and heat pump installations, for instance frontloading EU funding and fast-tracking projects. Financial support for gas heating systems should be replaced with investment support for clean heating.

The upcoming investment cycle must be used very carefully to avoid perpetuating future gas consumption and carbon lock-in. Limited public and private funds should be channelled into no-regrets options that protect the climate and reduce gas consumption, such as the deployment of renewables, energy efficiency, electrification, energy storage, and demand flexibility. New gas import infrastructure projects such as LNG terminals should only be permitted after a thorough EU-level assessment proving they are absolutely essential for security of supply despite declining EU gas demand. Where they are judged necessary, floating storage and regasification units should always be given preference over fixed land-based terminals as they allow import capacity to be scaled up more rapidly, at lower cost, and with a shorter project lifetime. Existing plans to build new fossil gas power and heating plants should be re-evaluated and replaced with green alternatives wherever possible.

EU Member States need to practice solidarity in distributing limited fossil gas supplies if bottlenecks cause shortages in countries that are particularly dependent on Russian gas. In previous gas supply crises such as the 2008-2010 gas shortages, demonstrations of solidarity between EU Member States were limited. The European Commission is rightly calling on Member States to conclude solidarity arrangements without delay. How well the EU can weather a worst-case supply disruption will ultimately depend on the willingness of its Member States to pull together in the face of unprecedented aggression by Russia.

Infrastructure planning for success

In addition to ensuring security of supply, all future energy infrastructure planning should be oriented towards achieving climate neutrality by 2050 at the latest. The scenarios underlying the Ten-Year Network Development Plans (TYNDPs) should be developed by an independent body rather than ENTSO-E and ENTSOG, thus avoiding the conflict of interest inherent in a procedure in which scenarios are produced by the same grid operators who earn a regulated rent on the infrastructure they build and operate. The review of the TEN-E Regulation is a step in the right direction, but oversight by the European Commission, the European Union Agency for the Cooperation of Energy Regulators (ACER), and the European Scientific Advisory Board on Climate Change needs to be implemented to the fullest extent in order to safeguard the compatibility of infrastructure planning and climate targets. The TYNDP scenarios should prioritise energy efficiency and demand response solutions and consider storage and power-to-X. In addition, European network planning should be accompanied by public consultations from the outset, and additional data transparency obligations should be imposed on transmission system operators (TSOs) and distribution system operators (DSOs) to provide background data and insights into methodological choices. TSOs and DSOs should also be required to assess the future decommissioning of fossil gas infrastructure in light of falling EU gas demand.

Joint planning of electricity, fossil gas, and hydrogen networks should be required at the national level, analogous to the new requirement for joint EU-level network planning contained in the revised TEN-E Regulation. If separate planning continues at the national level, the likely result will be a mismatch between EU-level and national plans in a landscape that is already fragmented. In particular, national planning processes will likely plan for more methane and hydrogen infrastructure than needed if the electrification of sectors currently using fossil gas is not taken into account.

All new EU-funded infrastructure projects, and in particular PCI projects, should respect the Do No Significant Harm criteria as defined in the Taxonomy Regulation and be subject to a sustainability assessment covering the full expected life-cycle emissions, including from methane leakage. The climate and environmental impact of gas projects should be evaluated against the cleanest available technology as opposed to being compared to coal or oil projects as is current ENTSOG practice. Biomethane projects should only be eligible for PCI status if they ensure that only sustainable, locally sourced agricultural and forest waste and residues are used as feedstock. Any new fossil gas power and heating plants should be required to demonstrate convertibility to 100% green hydrogen and submit concrete plans on how to source hydrogen.

Hydrogen infrastructure planning should be based on an evidence-based hierarchy of future applications. Hydrogen use should be limited to applications where it has a better climate balance than existing alternatives, or where it is more economical than alternatives with the same climate effect. Where this is not the case, alternatives such as energy efficiency and the direct use of electricity should have priority. For its part, electricity infrastructure planning needs to take into account the additional demand that will emerge through the large-scale electrification of transport and heating, as well as the installation of large electrolyser capacities.

Hydrogen infrastructure planning should not repeat the mistake of building more infrastructure than is needed. Rather than building up a large “hydrogen backbone” grid from the start, initial hydrogen infrastructure development should focus on connecting industrial clusters to electrolysers, adapting the existing gas pipeline infrastructure where possible. Only in a second step should these clusters be connected with pure hydrogen pipelines, allowing transport over longer distances. Blending hydrogen into natural gas distribution grids is detrimental to the availability of scarce green hydrogen volumes for the sectors without a decarbonisation alternative and should not be pursued.

Actively phasing down fossil gas use

EU energy policy should aim to increase competition between gases and other energy solutions such as electrification, energy efficiency, and other system flexibility options that can make gaseous fuels redundant in many of their current applications. The EU's current approach to foster gas-on-gas competition runs the risk of disadvantaging non-gas options, which will become increasingly important in a changing energy system. The taxation and network charge systems in many Member States should be reformed to place higher levies on gas rather than electricity, making electrification a more attractive option.

Companies or public entities receiving EU funding should be required to publish long-term decarbonisation plans that are in line with EU climate targets and reach net-zero emissions in 2050, as well demonstrating that the funding they receive is used for purposes that are compatible with this plan. The EIB Group's PATH framework methodology, currently restricted to highly carbon-intensive activities, should be expanded to all EIB lending and EU funding for companies above a certain size. The requirement for municipalities receiving support under the Just Transition Mechanism to develop Territorial Just Transition Plans should be expanded to all municipalities benefitting from EU funding sources such as the Cohesion Policy funds.

A full coal-to-gas switch must be prevented in as many district heating systems as possible as this leads to significant carbon lock-in and greater dependence on fossil gas imports. New investment into gas heating should be avoided in the event that alternatives such as the better insulation of buildings served by district heating, the direct use of sustainable renewable heat, or the integration of heat pumps are possible. Current national subsidy schemes and EU funding for fossil combined heat and power (CHP) should be phased out and replaced with support for sustainable heating, low-temperature grids, and heat storage. Municipalities should be required to conduct heat system planning that explores renewable alternatives to fossil gas.

Deep energy renovations of European buildings must be massively scaled up in order to reduce the energy and gas demand of the EU's old and inefficient building stock. Important policy options include mandatory minimum efficiency standards and an increase in grants and other support schemes, as well as large-scale upskilling and awareness-raising campaigns. Building insulation is key to both reducing overall heating and cooling demand and enabling low-temperature heating options such as heat pumps. As poor insulation is a major contributing factor to energy poverty, efficiency programmes should target energy-poor households as a matter of priority.

The deployment of renewable energy production and heat storage must be accelerated to enable the electrification of the heating sector. Without sufficient heat storage capacities, it will be impossible to meet peak heating and cooling demand when renewable energy production is low without the use of gases or other combustible fuels. In the event of a lack of sufficient renewable energy generation capacity, fossil and nuclear energy will likely be used for hydrogen electrolysis, making it impossible to ensure that hydrogen is climate neutral and/or not associated with highly radioactive waste.

In the medium term, the environmental costs of methane emissions should be fully included in the price of all gases used as energy sources via a methane charge. The methane emissions intensity of fossil gas, biomethane, and blue hydrogen in particular should be measured or, where measurement is impossible, estimated by an independent third party with the support of modern technologies including satellite and drone-based monitoring. Where measurement of fugitive methane emission is unfeasible, estimates should be based on default values oriented towards typical industry practice, leaving individual gas producers and infrastructure operators the possibility of demonstrating that their methane emissions are lower than the default value via better measurements.

The methane emissions of imported gases should be priced at the EU border, applying the same methane price as for EU-produced gases to ensure compatibility with WTO rules. The EU should use its influence as a major current importer of fossil gas and likely future importer of blue hydrogen to give incentives to reduce upstream methane leakage occurring in third countries. This could be implemented via the Carbon Border Adjustment Mechanism, for instance, while EU-produced gases could be priced via the EU Emissions Trading System. Another policy option would be to introduce a methane import fee alongside an EU-internal excise duty on methane. EU gas imports should additionally be subject to a methane performance standard.

Policies with an impact on energy prices, such as carbon and methane pricing or infrastructure development financed via grid charges, should be accompanied by social policies compensating energy-poor households and keeping energy affordable. This is particularly relevant in the context of the current high gas price environment, due at least partly to Russia's invasion of Ukraine and likely to persist for some time. As a crisis response, emergency support measures are justified to keep households from being disconnected, but they must be strictly time-limited to avoid turning into energy consumption subsidies. In the long run, it is crucial to address the structural causes of energy poverty by improving the housing stock and ensuring that low-income households can benefit from energy renovation programmes. If an EU-wide Emissions Trading System for heating and transport is introduced, this must be accompanied by the ambitious implementation of the Social Climate Fund in order to avoid negative impacts, particularly in Member States with low average household incomes.

Building up a sustainable hydrogen economy

Green hydrogen will be a scarce commodity. As such, its use should be limited to applications where no viable decarbonisation alternatives exist, such as high-temperature industrial processes, shipping, and aviation, as well as the substitution of fossil-based chemicals. Despite the enormous global renewable energy potential, there are considerable limitations on how much green electricity can be made available for hydrogen production. This depends on the speed of practicable deployment and capital costs of renewables, as well as competition between electrolysis and other end uses such as direct electrification. Import volumes will likely be considerably lower than envisaged in the REPowerEU plan since many hydrogen-producing countries will need hydrogen and renewable electricity to cover their own energy demand as a first priority. Applications of hydrogen where decarbonisation is feasible via direct electrification, such as passenger cars and heating, should therefore not receive any public support.

The EU should pursue a variety of hydrogen import avenues in parallel so as to avoid relying too strongly on any one exporter or drawing massive amounts of hydrogen and renewable power that might hamper the local energy transition in partner countries. While possible import partners such North African countries and the Ukraine have rightly received significant attention, green hydrogen export potentials in Spain and Portugal, as well as the Energy Community countries and the Eastern Mediterranean region, should also be pursued. While pipeline imports are economically more attractive, developing shipping terminals for hydrogen and ammonia imports should also be considered to allow for the massive increase in hydrogen imports the EU plans to obtain by 2030 as a response to the war in Ukraine.

Public support should only be available to green hydrogen projects. While other "colours" of hydrogen will likely play a role in the transition, they come with substantial disadvantages such as GHG emissions or toxic radioactive waste, as well as additional costs, for example for the establishment of the carbon capture and storage (CCS) infrastructure used in blue hydrogen production. The development of non-renewable hydrogen projects should therefore be driven by market demand instead of being subsidised from public coffers. Blue hydrogen in particular has a poorer climate balance than fossil gas according to some studies. Current gas customers should not be required to finance this infrastructure via grid charges, particularly if it is used to supply industrial facilities.

Support schemes for electrolysers should aim at incentivising hydrogen production at times of high renewable energy generation. This can be achieved, for instance, by limiting the number of production hours for electrolysis. Such a limit could be adjusted to the increasing shares of renewables in a specific power system. The additionality principle – i.e. the obligation for electrolysers receiving public funding to build additional renewables capacity to replace the electricity used – is essential to enable the development of a hydrogen economy that fuels the expansion of renewable energy as opposed to cannibalising it.

Robust criteria for renewable hydrogen should be established at the EU level to ensure that hydrogen electrolysis does not hamper the energy transition. Renewable hydrogen must be produced with additional renewable energy capacities in order to ensure that hydrogen electrolysis does not use up the renewable energy needed to decarbonise regular power consumption. The electricity used for hydrogen electrolysis should only be considered as 100% renewable if a temporal or geographical correlation to green energy generation is ensured via a power purchase agreement, a direct connection to a renewable energy installation exists, or at times when electricity production in a given power system is 100% covered by renewables.

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ECOLOGY

The future role of gas in a climate-neutral Europe

Report based on the discussions of an Expert Group convened by the Heinrich-Böll-Stiftung European Union and Environmental Action Germany (Deutsche Umwelthilfe)

It is clear that the European Union must put an end to unabated fossil gas use by 2050 at the latest to comply with its climate neutrality objective. To stay within the Paris Agreement target of 1.5°C, the use of unabated fossil gas would have to end significantly earlier – by 2035. The present report is based on the discussions of the Expert Group on the Future Role of Gas in Europe convened by the Heinrich-Böll-Stiftung European Union and Environmental Action Germany (DUH) from 2020 until 2022. It outlines the implications of this challenge for the management of the energy transition in a way that rapidly phases out Russian gas imports, protects security of supply and energy-poor consumers as well as the climate. The report finds that current EU policies run the risk of prolonging dependence on fossil gas rather than decisively moving towards alternatives, particularly in the heating sector, and recommends a much more active approach to phasing down fossil gas use as soon as feasible while building up a sustainable, carbon-free energy system.

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