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AGAINST HYDROGEN BLENDING

BUILDING THE UK'S HYDROGEN ECONOMY NEEDS A MORE STRATEGIC APPROACH

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Blending hydrogen into the UK's gas grid is the wrong approach to building the hydrogen economy. A 20% blend could increase household gas bills by 7–20%, while only reducing emissions by a maximum of 7% – and likely a lot less. Blending could greenwash fossil gas, in turn derailing heat decarbonisation. A fairer, more strategic approach is required to support hydrogen deployment in sectors most needed for net zero.

The UK government is exploring whether to permit hydrogen blending of up to 20% in the gas grid. E3G sets out the case against doing so:

> **Blending does not encourage strategic deployment of hydrogen** in sectors where it is the primary option for decarbonisation, such as heavy industrial processes, aviation and storage for power generation. Without a strategic vision for the hydrogen economy, blending risks locking in hydrogen for inefficient uses like domestic heating, at the expense of other sectors.

> **Blending could hike energy bills for households and industry.** Blending could increase household bills by anywhere between 7 and 20%, with a wide range of variables influencing the outcome. For the average medium property, a 16% increase in gas prices would represent a bill increase of £192 per year.

> **Blending risks derailing domestic heat decarbonisation.** Blending could risk greenwash if the public are told "gas has gone green", when hydrogen-ready boilers will burn fossil fuels for decades. This could delay investment into genuinely zero carbon heating and curtail strategic decisions about the future of the gas grid, including its repurposing or decommissioning.

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What is blending and why has it been proposed?

Today, hydrogen is mostly used as a feedstock for industrial processes and almost exclusively produced from fossil fuels. It can play an important role in the UK's net zero transition if produced in less carbon-intensive ways – primarily via electrolysis, powered by renewable energy. Green hydrogen will need to replace fossil fuel-based uses, and can help decarbonise sectors like heavy industry, aviation, and seasonal storage for power generation.[1] Experts do not support its widespread use to heat homes: it is inefficient, expensive and brings safety risks.[2] The House of Commons Science and Technology Select Committee concluded hydrogen will have at most a limited role in replacing fossil gas to heat homes.[3]

At present, very small quantities of hydrogen can be mixed in the gas distribution network – up to 0.1% by volume. In 2023, the UK government is expected to decide whether to allow this share to rise to 20% by volume (7% by energy, due to different calorific value). Blending is considered a "transitional option" to support the creation of hydrogen market.[4] The decision would depend on "whether blending meets the required safety standards, is feasible and represents value for money".[5] There are ongoing trials to assess the safety and feasibility of blending, and the value for money assessment (initially planned for autumn 2022) is expected in 2023.

The potential benefit of blending, according to the government, is to act as a "sink" for excess supply and provide a short-term route to market for hydrogen producers, removing some of the early commercial risks between new suppliers and end-users. The government notes that blending "may only have a limited and temporary role in gas decarbonisation as we move away from the use of natural gas".[6] Due to hydrogen's lower energy density per volume, a 20% blend could lead to only 7% reduction in emissions – and only if the hydrogen is produced from renewable electricity.[7] The reduction is likely to be lower in the UK, where the focus is on "blue hydrogen" produced from fossil gas, which is likely to release emissions in the form of methane leakage.

[1] Climate Change Committee, 2023, **Delivering a reliable decarbonised power system**

[2] UK Parliament, 2022, **Hydrogen is not a Panacea for reaching Net Zero, warn MPs**

[3] UK Parliament, 2022, **Hydrogen is not a Panacea for reaching Net Zero, warn MPs**

[4] UK government, 2022, **Hydrogen transport and storage infrastructure**

[5] UK government, **UK Hydrogen Strategy**

[6] UK government, **UK Hydrogen Strategy**

[7] IRENA, 2022, **Global hydrogen trade to meet the 1.5 C climate goal: Part II - Technology review of hydrogen carriers**

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Hydrogen blending – a permission or a target?

The government has not suggested the 20% blending allowance would be viewed as a target, and many experts are sceptical about it being reached. This however differs from the interpretation of gas network companies. Network industry body the Energy Network Association recently published *Britain's Hydrogen Blending Delivery Plan*, which sets out "how all five of Britain's gas grid companies will meet the Government's target for Britain's network of gas pipes to be ready to deliver 20% hydrogen to homes and businesses around the country from 2023, as a replacement for up to a fifth of the natural gas currently used".

Hiking energy prices for households and industry

As hydrogen is more expensive than fossil gas, any volume of blending will increase bills. However, the precise cost impact of blending is highly uncertain. It will depend on several factors, including the price of hydrogen (and the electricity or gas used to produce it) and the cost of repurposing infrastructure and end-user appliances to use hydrogen safely. Precisely how much household bills will increase depends on policy choices – including the level of the blend, government policy to support production, storage and transport, and billing mechanisms. Under the "hydrogen levy" proposal set out in the Energy Bill, some production costs will be levied on energy consumers from 2025.[8]

Hydrogen production costs

A major factor influencing how much blending will increase bills by is the cost of the hydrogen being blended into the grid. Projections vary, including depending on whether the hydrogen is produced via electrolysis using grid electricity or dedicated renewables, or via steam methane reformation of fossil gas. If hydrogen costs twice as much per unit as the gas it is being blended with, it will cost 7% more to deliver the same energy to consumers using a 20% blend than it would using fossil gas alone.[9] Other estimates suggest the hydrogen could be three to four times as expensive as the fossil gas it replaces.[10] For hydrogen produced from grid electricity, a 20% blend could lead to a cost increase of 20%

[8] E3G, 2023, **The case against the hydrogen levy**

[9] A 20% blend replaces only 7% of the energy content of fossil gas. For hydrogen production costs twice, three or four times that of fossil gas this translates to 7%, 14% or 21% higher cost for blended gas to deliver the same energy.

[10] UK government, 2021, **Hydrogen production costs 2021**; EEX, 2023, **Green hydrogen cost projections**

per kWh of blended gas in 2035, according to the Regulatory Assistance Project.[11]

As well as the direct cost of the hydrogen, there are system costs that may be passed onto consumers. These include production facilities and carbon capture and storage for blue hydrogen, or dedicated renewables for green hydrogen. Therefore, lower cost estimates may be conservative as they may not incorporate such additional costs being passed on to households.

This is in line with analysis outside the UK. Fraunhofer IEE suggests a 20% blend in European gas grids can increase household costs by up to 16%.[12] For a medium property in the UK, such an increase would translate to an increase in gas bills of £192 per year.[13] According to the study the cost to industrial users would be even higher, on average 24%.[14] Blending therefore poses significant risks – of both hiking energy costs in a cost-of-living crisis, and undermining the competitiveness of industry.

Billing mechanisms

Since hydrogen has a lower energy content per unit volume than fossil gas, a 20% hydrogen blend has only 86% of the energy content and heat output of pure gas.[15] A greater volume of the blended mix must be burnt to create the same heat output. The current gas billing mechanism measures the volume of the gas burnt. This would require updating to reflect varying calorific values of blended gas, to prevent additional costs being passed on to consumers due to the increased volume burnt. The share of blended hydrogen in the grid would vary according to hydrogen production levels and industrial hydrogen demand. The billing mechanism would therefore need to consider dynamic changes in calorific value. We note this could be a complex process for gas operators to incorporate into existing mechanisms and will require new metering practices.

Infrastructure costs

The 20% limit has been chosen as the maximum amount that could be blended into the grid without requiring expensive conversions or widespread

[11] Regulatory Assistance Project, 2023, **How much would hydrogen for heating cost in the UK?**

[12] Fraunhofer IEE, 2022, **The limitations of hydrogen blending in the European gas grid (PDF)**

[13] Estimated by E3G in April 2023. Based on Ofgem estimates of gas usage by a medium sized property (12,000 kWh), and calculated using the current price cap (£0.10 per kWh and daily standing charge of £0.28).

[14] Fraunhofer IEE, 2022, **The limitations of hydrogen blending in the European gas grid (PDF)**

[15] Hydrogen Science Coalition, 2023, **Putting facts into perspective on hydrogen's role in the energy transition**

replacement infrastructure due to hydrogen embrittlement of steel pipes and fittings. However, even low volumes of blending can cause costs for end-users. These include compression infrastructure to allow its transportation, and de-blending hydrogen so it can be used by industrial consumers.[16] The European Commission estimates "the costs for end-users and infrastructure operators to adapt to a 5% blend level would amount to around €3.6bn per year".[17] A major technical review by National Renewable Energy Laboratory highlighted that "hydrogen increases fatigue crack growth rates in commonly used pipeline steels […] Recent research has shown that fatigue crack growth and fracture resistance can degrade even with low partial pressures of hydrogen."[18]

The hidden cost of blending: delaying heat decarbonisation

Using hydrogen for heating is not a strategic use of resources. Green hydrogen for heating would require around six times the amount of renewable energy as heat pumps, which is more than the amount required to decarbonise the entire electricity grid.[19] This enormous demand could undermine the ability to ensure a secure supply of renewable energy for other sectors. Furthermore, the cost of operating a heat pump would be around one-sixth of the cost of green hydrogen.[20]

The government is considering a 20% blend as a short-term, transitional way to shore up demand as the hydrogen economy develops.[21] This is a different policy decision to allowing a complete gas network conversion to carry pure hydrogen; and allowing one does not mean that the other will materialise. However, this conflation can lead to people believing that widespread use of hydrogen for heating is around the corner, in turn delaying consumer decisions on readily available clean heat alternatives.

[16] Fraunhofer IEE, 2022, **The limitations of hydrogen blending in the European gas grid (PDF)**

[17] European Commission, 2023, **Implementing the RePower EU Action Plan**

[18] National Renewable Energy Laboratory, 2022, **Hydrogen Blending into Natural Gas Pipeline Infrastructure: Review of the State of Technology**

[19] Rosenow, J., 2022, **Is heating homes with hydrogen all but a pipe dream? An evidence review**

[20] Hydrogen Science Coalition, 2022, **Hydrogen for heating? A comparison with heat pumps (Part 1)**

[21] UK government, 2022, **Hydrogen transport and storage infrastructure**

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Blending and hydrogen boilers create confusion

The government is not due to decide on the role of hydrogen for heating until 2026, after a series of trials that are still to be completed. However, some gas networks and boiler manufacturers are advertising blending as a step towards 100% hydrogen heat, which could create confusion among installers and consumers.

National Grid states "hydrogen is considered an ideal alternative" for heat decarbonisation.[22] While noting 100% hydrogen for heating is not viable yet, it suggests blending is a stepping-stone in this direction. Worcester Bosch have told business customers that: "When the government begins to increase the amount of 'green gases' into the UK gas grid, your customers can be confident their new [hydrogen-ready] gas boiler will run for its lifetime without any wholesale changes to switch to an electric boiler for example."[23] This can leave installers overconfident about the future of the gas network and hydrogen heating, in turn leading to potential misinformation being passed on to consumers.

The Competition and Markets Authority (CMA) review of consumer protection in the green heating and insulation sector identified several market practices of concern.[24] These include "greenwashing" and misleading messaging about hydrogen-capable boilers alongside lack of upfront pricing information and misleading claims around product benefits, including from businesses offering heat pump and solar products.

We are concerned that allowing nationwide hydrogen blending will add the following challenges to the decarbonisation of domestic heating:

> **Greenwash and consumer confusion.** Blending could create greenwash as the public are told that "gas has gone green", when in fact hydrogen-ready boilers will continue to burn fossil fuels for decades to come.

> **Under-investment in clean heat supply chains.** Blending could encourage heating appliance manufacturers to invest according to assumptions that hydrogen will play a more significant role in heating than is realistically expected. As a result, capital investment, skills and long-term plans could be mismatched with necessary heat pump and heat network deployment.

[22] National Grid, **Heating our homes with hydrogen** (webpage accessed 1 June 2023)

[23] Worcester Bosch, **Hydrogen-fired boiler** (webpage, accessed 1 June 2023)

[24] Competition and Markets Authority, 2023, **Consumer protection in the green heating and insulation sector**

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- **Consumers could end up spending more** by first purchasing a hydrogen-ready boiler, before switching to a heat pump or heat network in the case that a secure hydrogen supply is not available for their home.
- **Delayed strategic choices around the future of gas infrastructure.** Strategic choices are needed regarding the network locations to re-purpose, new infrastructure to build, and decommissioning. Blending hydrogen is likely to slow down this process by extending use of fossil fuel infrastructure.

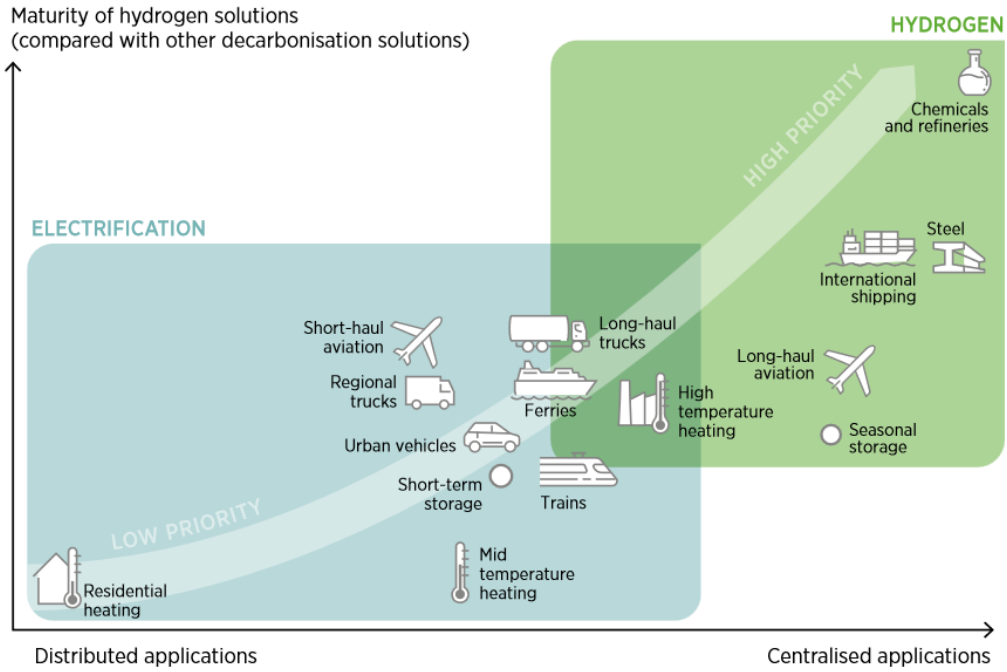
Greenwashing messaging about hydrogen use in boilers

The CMA highlights four areas of concern about businesses marketing boilers as "hydrogen-blend" or "hydrogen-ready" which can constitute greenwashing:

- **Use of labels and messaging which could mislead consumers**. Marketing hydrogen boilers creates the impression that they will run on hydrogen blend immediately or in the near future, which is unlikely and at best possible from 2025.
- **Inaccurate or incomplete information about hydrogen rollout**. This includes being unclear about the uncertainty around deployment; inaccurately describing hydrogen rollout in definitive terms; and erroneous statements around hydrogen production.
- **Inconsistent, incorrect descriptions of boilers' ability to use hydrogen.** Lack of standard terminology can confuse consumers. For example, the term "hydrogen-blend" boiler is used by some businesses to refer to a boiler that is technically identical to standard boiler, but marketed as capable of running on 20% blend.
- **Unclear benefits of voluntary certification.** Some businesses are adopting a voluntary certification that their boilers can operate with a 20% hydrogen blend. It is unclear what additional benefit this certificate has, given that since the 1990s there have been legal requirements to test all gas boilers in the UK with 23% hydrogen blend.

A more strategic approach is needed

Zero-emission, green hydrogen is likely to be a scarce, premium commodity for decades to come. Developed wisely, it can underpin competitive zero-emissions heavy industry like steel, fertilisers and industrial processes including glass, chemicals, and cement.[25] To reap this opportunity, and prevent stranded assets and wasted money, it must be strategically deployed (Figure 1).



Source: IRENA, 2022, **Geopolitics of the energy transformation: The hydrogen factor**

Figure 1: IRENA green hydrogen prioritisation chart

Without a strategic long-term vision for the hydrogen economy, blending risks locking in hydrogen for less efficient uses. Once gas networks and boiler manufacturers have invested in making their assets and supply chains hydrogen-ready, they will have an interest in ensuring pay-back on these investments. Thus, although the government views blending as a "transitional" phase towards a more strategic hydrogen economy, more clarity is needed regarding the long-term direction of hydrogen use. Blending in the UK also have implications for cross-border gas trade and energy security. Cross-border blending limits are under discussion in the EU and likely to fall between 2% and 3%.[26]

[25] IRENA, 2022, **Green hydrogen for industry: A guide to policy making**

[26] European Council, 2023, **Gas package: member states set their position on future gas and hydrogen market**

There is an argument that blending hydrogen can reduce risks for hydrogen producers at times when industrial demand is limited. However, there are other ways of addressing this challenge of balancing supply and demand. Indeed, in the first instance, early production of clean hydrogen should be prioritised to replace the grey hydrogen currently used in industrial processes.

Rather than permitting nationwide blending, specific user applications can be targeted through demand-side policies, incentivising the prioritisation of strategic uses. This will help concentrate hydrogen production in areas of significant demand like industrial clusters, where supply and demand can be secured.[27] The government has acknowledged the benefits of a zoned approach: since "demand for low carbon hydrogen will likely be concentrated in large industrial clusters during the 2020s, these sites could 'anchor' early demand and foster an initial market for hydrogen close to supply".[28] We encourage the government to undertake a mapping and identify regions where this may be more likely to inform this process and ensure investment in infrastructure is guided to maximise efficiency.

A strategic approach to building the hydrogen economy

Blending hydrogen into the gas grid is not a "no regret" means to build a market for hydrogen producers during the early development of the hydrogen economy. End-users in strategic industries will need certainty of a secure supply of hydrogen, but there are various other ways the government could provide this.

> **Encourage the development of "hydrogen clusters" and incentivise co-location of production and demand.** It is key that blending, if permitted, is limited geographically to encourage strategic hydrogen deployment. Boosting hydrogen storage capacity can address early demand-side risks, while targets for hydrogen use in industry can give confidence to hydrogen production facilities.

> **Exclude blending from government support schemes.** Current government subsidies exclude hydrogen used for blending under the Low Carbon Hydrogen Agreements – the instrument to support producers. It is critical that this remains the case to encourage strategic co-location and align blending with government's vision of it being an off-taker of last resort.

> **Produce a long-term road map** providing clarity on the future shape of the UK's hydrogen economy. This will help encourage strategic investment in

[27] World Economic Forum, 2020, **Industrial clusters are critical to getting to net-zero. Here's why**

[28] UK government, 2022, **Hydrogen Strategy update to the market: July 2022**

supply- and demand-side technologies – and avoid stranded assets in sectors where hydrogen does not end up being used for decarbonisation.

> **Use early low-carbon hydrogen to decarbonise existing grey hydrogen.** Rather than blending hydrogen into the gas grid, the first priority uses should be replacing high-carbon grey hydrogen in the industrial processes where it is currently used.

> **Find a fair funding solution for the hydrogen economy.** Address unanswered questions on how the fledgling hydrogen economy is paid for. Paying via energy bills, rather than general taxation (or directly by industrial users) is a regressive approach.

About E3G

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E3G builds broad-based coalitions to deliver a safe climate, working closely with like-minded partners in government, politics, civil society, science, the media, public interest foundations and elsewhere to leverage change.

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