E3G

BRIEFING PAPER FEBRUARY 2025

DECISIONS ON UK HYDROGEN HEAT
THE COST OF FURTHER DELAY

CHRIS GALPIN

Hydrogen will play a crucial role in decarbonising power and some heavy industry. However, hydrogen is a poor option for domestic heating and would substantially increase consumer bills relative to other heating technologies. Promptly ruling out further public spending on domestic hydrogen heating will be critical to secure affordable energy bills, and to enable effective long-term transition planning for networks and workers.

Further delay risks billions of pounds of unnecessary gas network investment and expansion – increasing consumer bills and further inflating the liabilities associated with disconnection and decommissioning. It also undermines efforts to give workers a say in their future and plan a transition which guarantees good quality, unionised jobs for decades to come.

The UK must act quickly to put the public interest before those of gas network shareholders. Government has promised to consult in 2025. To keep bills down for consumers, government should follow this consultation with a clear decision by the end of 2025 – providing clarity before the start of the next gas network price control.

To secure affordable energy bills, now and in the long term, the UK should:

> **Rule out further public subsidy for domestic hydrogen heating.**

> **Prevent unnecessary gas network spending to stop further energy bill rises.**

> **Limit future decommissioning costs by halting gas network expansion.**

> **Develop a long-term transition plan for gas networks and gas workers.**

> **Ensure all consumers can access other low-carbon heating solutions.**

E3G

THE WEAKENING CASE FOR HYDROGEN HEATING

The case for hydrogen heating has weakened since E3G's previous hydrogen factsheet in 2021.[1] In particular, hydrogen production costs have proven to be towards the upper end of predictions, increasing the impact hydrogen would have on consumer bills.[2]

Hydrogen heating also faces fierce competition. A range of other more affordable low-carbon heating technologies are already available to consumers. These options include a variety of heat pumps and other electric heating solutions, as well as heat networks and biomass boilers.

The primary challenges for domestic hydrogen heating remain:

1. **Affordability:** Hydrogen heating would increase energy bills – likely more than doubling heating bills, while other low-carbon heating options offer substantially better value for money (see Table 1).
2. **Energy security:** Widespread hydrogen heating would leave the UK highly reliant on gas imports. This would undermine the benefits of achieving the Clean Power mission and leave the UK vulnerable to future gas price spikes.
3. **Safety:** Hydrogen is leakier and more explosive than methane. The proposed mitigations for these risks are impractical and disruptive for consumers, such as cutting 4 × 4 inch holes in consumers' walls.[3]

Overall, there is very little to recommend the use of hydrogen for domestic heating. This is reflected by clear consensus among independent experts: over 50 independent studies have now concluded there is no public policy case for hydrogen in domestic heating.[4] In October 2023, the National Infrastructure Commission reached the same conclusion, following exhaustive analysis as part of the second National Infrastructure Assessment.[5]

[1] E3G (2021). **Hydrogen: Factsheet Series**

[2] V. Siekkinen (2024). **The difference between hydrogen visions and the reality: Investment values**

[3] Hy4Heat (2021) **Safety Assessment Conclusions Report**, p83

[4] J. Rosenow (2024). **A meta-review of 54 studies on hydrogen heating**

[5] NIC (2023). **Second National Infrastructure Assessment**

More details on the affordability, energy security and safety challenges associated with hydrogen heating are set out below. Supplementary details can also be found in E3G's 2021 factsheets[1] and the Annex to this briefing.

Hydrogen is expensive

Strike prices for electrolytic, low-carbon hydrogen are currently £241/MWh[6] – over three times the price of carbon-intensive fossil-derived hydrogen (~£70/MWh)[7] and nearly three times the latest strike price for offshore wind (£81/MWh).[8] The high cost of low-carbon hydrogen is driving further loss of confidence in hydrogen's role beyond core applications in chemical feedstocks, seasonal energy storage, transport fuels and high-temperature industry.[7]

The retail cost paid by consumers is likely to be even greater. Estimates from the UK Fife "H100" trial suggest hydrogen heating would more than triple bills relative to heat pumps, as shown in Table 1. Even under the government's more optimistic 2021 production cost estimates, hydrogen heating would still likely more than double consumer bills.

Table 1: Comparison of running cost estimates

Heat source	Estimated retail cost (per kWh heat)	Source
Hydrogen boiler	11.1–22.2 p/kWh	RAP, based on UK government 2021 production cost estimates[9]. Adjusted to per kWh of heat with assumed 90% efficiency.
	25.6–46.2 p/kWh	UK Fife "H100 trial".[10] Adjusted to per kWh of heat with assumed 90% efficiency.
Heat pump	5.0–8.1 p/kWh	E3G, based on current costs, not accounting for likely future reductions in retail electricity costs
Fossil gas boiler	~7.0 p/kWh	E3G, based on current costs and assumed efficiency of 90%.

[6] UK Government (December 2023). **HAR1 successful projects**

[7] Financial Times (May 2024). **Lex in depth: how the hydrogen hype fizzled out**

[8] UK Government (September 2024). **Contracts for Difference (CfD) Allocation Round 6: results**

[9] Regulatory Assistance Project (2023). **How much would hydrogen for heating cost in the UK?**

[10] Ofgem (2021). **Amended Project direction: H100 Fife SGN**

For hydrogen heating to be adopted by consumers, it would need to receive significant, indefinite subsidy to bring running costs into line with other heating options. The gap between hydrogen costs in the H100 trial and heat pump running costs is at least 17.5 pence per kWh of heat output. A subsidy at this level for all households on the gas grid would cost nearly £40bn every year (£1,800 per household).[11]

Hydrogen for domestic heating is incompatible with energy independence

Meeting the UK's low-carbon hydrogen needs will be challenging and expensive even without competing demands for heating. Modelling by the National Energy System Operator suggests hydrogen demand will reach 138 TWh per year even without usage for heating.[12] Producing this hydrogen from renewable sources would require nearly 150 TWh of renewable electricity. This is more than the UK's entire current renewable electricity output (136 TWh in 2023).[13] Using hydrogen for heating would more than double this requirement again, as shown in Figure 1.

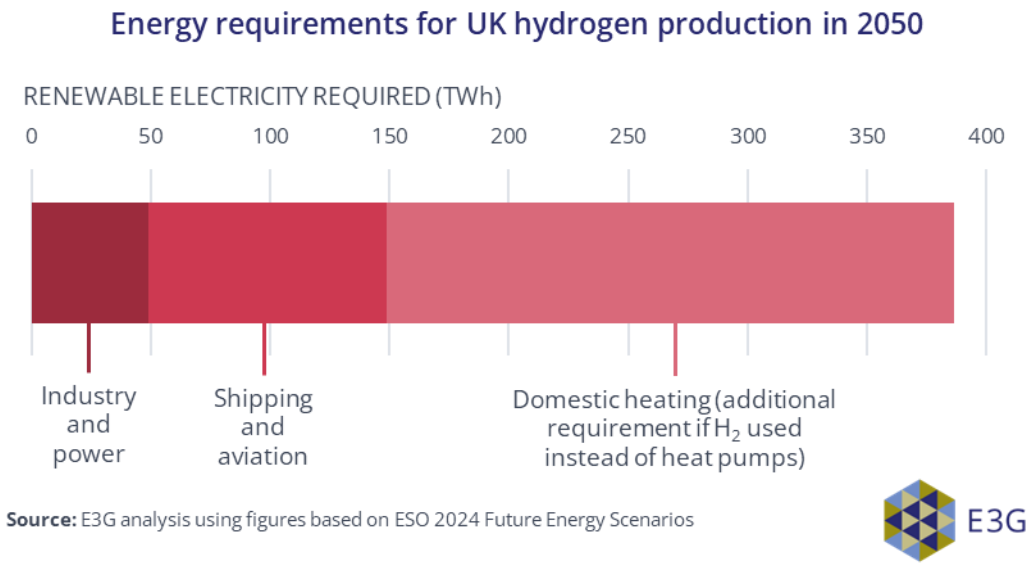


Figure 1: Using hydrogen for heat could more than double UK's 2050 hydrogen needs

[11] E3G analysis based on average household gas usage of 11,500 kWh per year (Source: Ofgem (2025). **Average gas and electricity usage**), implying heat demand of ~10,350 kWh. There are over 22 million households connected to the gas grid. (Source: CCC (2016). **Heat in UK buildings.**)

[12] ESO (2024). **Future Energy Scenarios: Pathways to Net Zero** (Electric Engagement scenario)

[13] UK government (2024). **Digest of UK Energy Statistics (DUKES): renewable sources of energy**

If the UK is not able to meet demand for hydrogen using renewable sources alone, it will need to rely either on hydrogen imports, or hydrogen derived from fossil gas (which would also need to be imported). Other forms of low-carbon heating are more efficient uses of the UK's renewable energy resources, and ruling out hydrogen heat could allow the UK to become a net energy exporter.[14]

Using hydrogen in homes is less safe than the alternatives

Hydrogen faces inherent safety challenges relative to methane. Hydrogen leaks more readily, is more explosive, and is harder to detect. These challenges may not be insurmountable, but the solutions proposed to date introduce alternative issues and concerns for end-users. Safety assessments conducted for UK hydrogen heating trials recommended any room containing hydrogen gas pipework should include a non-closable vent of 10,000 mm^2 or more (4 × 4 inches), as well as a range of other measures including the provision of hydrogen detection alarms.[15]

Alternative heating technologies such as heat networks and heat pumps are much safer and already widely used. Moving away from gas offers an opportunity to reduce the frequency of gas explosions and save lives.

Two of the three attempted UK hydrogen heating trials have now collapsed because of safety concerns, local opposition and a lack of sufficient hydrogen production.[16] Inability to deliver even relatively small, highly subsidised trials highlights how challenging it would be to roll out hydrogen boilers more widely.

[14] E3G (2025). **The UK's clean power mission: Delivering the prize**

[15] Hy4Heat (2021) **Safety Assessment Conclusions Report**

[16] UK government (2023). **Hydrogen village trial: open letter to Gas Distribution Networks (Dec 2023)**

E3G

THE COST OF DELAYING THE INEVITABLE

The 2021 Heat & Buildings Strategy acknowledged that a strategic decision on the role of hydrogen for domestic heating is needed to ensure "efficient, effective and affordable mass decarbonisation".[17] Despite this, the decision was kicked into the long grass, with no commitment to act until 2026. Statements by previous government ministers indicated a clear view on the right outcome – but no political will to face up to opposing vested interests.[18]

The new government has now promised to consult in 2025.[19] This is a positive step – so long as it is promptly followed by a clear decision before 2026. Further delay risks higher bills for consumers, undermining efforts to deliver a just transition for workers, and harming investment in UK manufacturing.

Uncertainty risks increasing energy bills even further

Maintaining gas distribution networks currently costs UK consumers over £4.5bn per year.[20] Planning ahead is key to ensuring consumers get a good deal. Gas network infrastructure has a regulatory lifetime of up to 45 years[21] – so network planners need to consider what the energy system will need in 2050 and beyond.

Network planners consider the highest plausible scenario for future gas demand and ensure network investment is sufficient to meet this demand. However, lack of a clear direction on hydrogen heating undermines this planning, potentially driving up energy bills for consumers. Overestimating future gas demand means spending more than we need to – and increasing energy bills as a result.

Until hydrogen heating is ruled out by government, networks will argue that widespread hydrogen heat constitutes a "plausible" future demand scenario and use this to push for additional spending on a more expensive network. Indeed, some have already done so in their business plans for the next price control, with

[17] UK government (2021). **Heat and buildings strategy**, p11

[18] Sustainable Times (2023). **Energy Minister's Controversial Stance: Hydrogen will have a 'very small role' in heating UK homes**

[19] UK government (2024). **Committee on Climate Change 2024 progress report: government response**

[20] Ofgem (2024). **GD2 Price Control Financial Model**

[21] Ofgem (2021). **RIIO-2 Final Determinations – Finance Annex**

E3G

proposals to spend funds on preparing for hydrogen blending or transitioning networks to hydrogen.[22,23] This wasteful gold plating would benefit gas network shareholders at the expense of consumers. Cadent's business plan also notes "significant costs" associated with hydrogen repurposing were already incurred during the current 2021 – 2026 price control.

Analysis for the UK government estimates it will cost at least £22bn to repurpose distribution networks for hydrogen, and notes this estimate is subject to "considerable uncertainty" which could see costs increase substantially.[24] Without a prompt decision on hydrogen heat, the UK risks sleepwalking into increasingly expensive and unnecessary investments. This unneeded spending could be avoided by a prompt decision to take hydrogen heating off the table.

Indecision also undermines forward planning for gas network decommissioning and disconnections. Steps can be taken now to minimise these future costs and ensure they are recovered fairly – but only if a decision is taken ahead of time. [25] Actions which could minimise future costs include: limiting further network expansion, spreading cost recovery over a longer time period, identifying innovative alternative uses for gas network assets, or establishing where assets can be safely left in place. However, as long as gas networks can argue hydrogen may play a role in domestic heating, they cannot be relied upon to adequately plan for network decommissioning.

Kicking the can down the road will lead to consumers paying billions more to manage these costs, when earlier action would have led to lower bills. Other countries with substantial gas networks have already taken steps to prevent further expansion – for example the Netherlands ended connections for new buildings in 2018.[26] The UK has so far failed to introduce similar measures, on the basis of claims that networks could be used for hydrogen in future.

The energy regulator will issue final determinations on the gas distribution network price control for 2026 – 2031 in the final quarter of 2025.[27] A clear

[22] Cadent (2025). **Cadent RIIO-3 Business Plan** (e.g. p80, 98)

[23] Northern Gas Networks (2025). **NGN RIIO-GD3 Business Plan 2026-2031** (e.g. p35, 36)

[24] UK government (2018). **Hydrogen supply chain: evidence base**, p80

[25] Rosenow et al. (2024). **The elephant in the room: How do we regulate gas transportation infrastructure as gas demand declines?**

[26] CE Delft (2022). **The natural gas phase-out in the Netherlands**

[27] Ofgem (2024). **RIIO-3 Sector Specific Methodology Decision for the Gas Distribution, Gas Transmission and Electricity Transmission Sectors | Ofgem** (p25)

E3G

government decision ahead of this point would enable the regulator to take a firm line with networks and keep bills lower for consumers.

A proactive plan is essential to protect jobs and support workers

Lack of planning also risks threatening the job security and conditions of workers in gas networks. But with a properly planned, union-led approach, the transition could be managed – and could even deliver beneficial outcomes for workers.

Gas networks will not decline significantly in size until the late 2030s or early 2040s.[28] Many who currently work in the sector will retire or move to other employment naturally over this timescale. But this will not be the case for all – and until a strategic decision on heat is made, new workers joining the sector risk being misled as to its long-term future.

The first step in ensuring a fair and just transition is being honest with workers and giving them time to plan their own future. Burying heads in the sand may provide reassurance for now but will lead to worse outcomes when the rug is eventually pulled by economic reality. Instead, workers and unions must have a say in setting out a vision for how workers can be supported to transition into sustainable long-term roles – starting now.

Government must also act to ensure new opportunities created as part of the Clean Power mission are unionised and deliver better conditions. The development of an Energy Skills Passport is a welcome first step.[29] However, energy communities need a clearer transition and opportunities plan, backed by assurances that ensure no worker will be left behind.

This vision is achievable. Even without a role for hydrogen in domestic heating, there will still be substantial economic opportunities in the wider hydrogen economy. And the transition to a low-carbon economy is set to create thousands of new, high-quality jobs.[30] Government must ensure these are in the right place, at the right time, to ensure existing gas workers are well-placed to benefit.

Uncertainty harms investment in growth sectors

In May 2024, the Public Accounts Committee concluded that indecision on the role of hydrogen for heating is undermining investment in other low-carbon

[28] Regen (2024). **Who will pay for gas network decline and decommissioning?**

[29] UK government (2024). **Delivering a skills passport for the Clean Energy Transition**

[30] CBI Economics (2024). **Can the transition to net zero be the UK's economic hero?**

heating technologies.[31] Uncertainty is holding back private investment not only in home upgrades themselves, but also in the new low-carbon manufacturing jobs supported by this demand.[32] The UK low-carbon heating market could potentially be worth over £7 billion per year by 2028[33] – but faces a number of barriers to achieving this potential.

It is critical that the new government puts an end to this uncertainty as soon as possible. Otherwise, the UK risks missing out on manufacturing investment in heat pumps as investors instead look overseas to more predictable markets.

What does a strategic decision need to address?

Allowing markets to run their course would eventually de facto rule out hydrogen heat. But while there is no need for a formal "ban" on hydrogen boilers, the government does need to act to ensure prudent use of public money.

The strategic decision on hydrogen must set out the parameters for where the line is drawn: which infrastructure investment might credibly be needed, and which is excessive? Does the government have an appetite to bet public money on the unlikely prospect of a change in the evidence? Or is now the time to curb further public spending on an increasingly unlikely (and unnecessary) prospect?

An effective strategic decision will need to set out:

> Whether hydrogen for domestic heating usage should be eligible for subsidy via the Hydrogen Production Business Model.

> Whether hydrogen infrastructure required solely for domestic heating usage should be eligible for subsidy via the Hydrogen Transport and Storage Business Model.

> Key assumptions to be used for future strategic spatial and network planning.

> Whether consumers should delay purchasing other low-carbon heating systems to "wait for hydrogen", and whether this should be viewed as a reliable decarbonisation strategy.

[31] Public Accounts Committee (2024). **Decarbonising home heating**

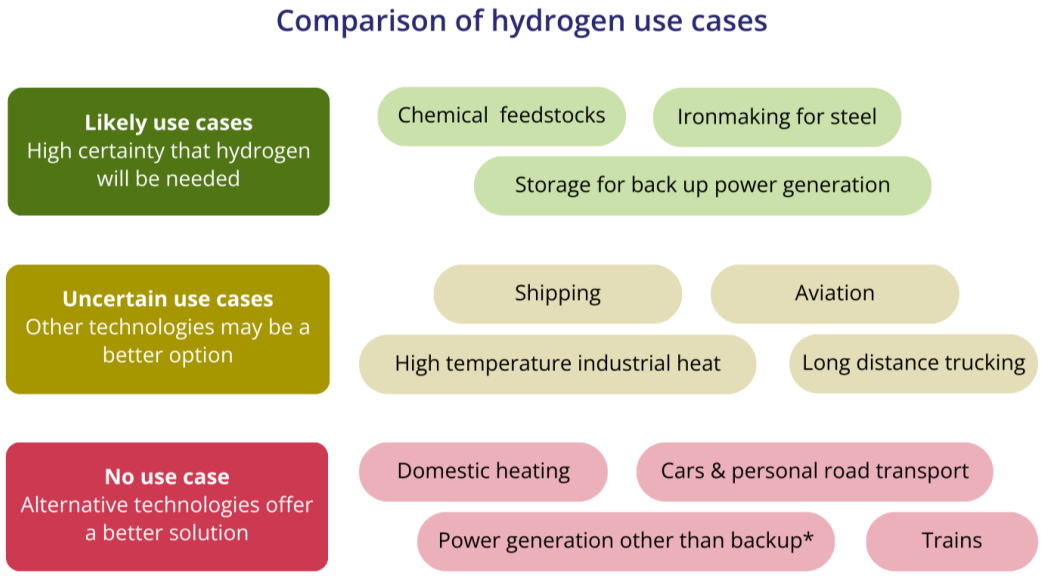
[32] E3G (2024). **Lower Carbon, Better Jobs: Stories from the heat pump factory floor**

[33] E3G analysis based on average heat pump installation cost of £12,600 and >600k installations per year.

The government should additionally commission the development of a long-term transition plan for the gas network. This plan should set out how to ensure a socially just and fair transition – considering the impact of gas network costs on energy consumers now and in the future, as well as how the gas workforce will be supported and protected.

An alternative vision for UK hydrogen

While hydrogen is unlikely to play a role in domestic heating, this does not mean it will not play a critical role in delivering decarbonisation. Hydrogen will be critical to supporting a reliable clean power system and transforming the UK's fortunes producing low-emissions materials such as steel. But hydrogen's high cost and limited availability means its use will need to be carefully prioritised. Figure 2 sets out where hydrogen is likely to play a role – and where it is not.



Note: * The category "power generation other than backup" includes co-firing of hydrogen with other fuels such as fossil gas, or the use of "hydrogen ready" gas power plants for baseload power generation

Source: E3G assessment based on review of available evidence, including: IRENA, **Policies for green hydrogen** (webpage); Liebreich Associates, 2023, **Hydrogen Ladder Version 5.0**; Rosenow, J., 2024, **A meta-review of 54 studies on hydrogen heating**; E3G, 2025, **The UK's clean power mission: Delivering the prize**

Figure 2: Comparison of the viability of hydrogen use-cases

E3G

RECOMMENDATIONS

Failure to promptly rule out hydrogen for heating risks driving up consumer energy bills and undermines effective planning for key national infrastructure. To protect energy consumers and keep energy bills low, both now and in the longer term, government should:

> **Rule out further public subsidy for hydrogen heating**. Hydrogen heating should be added to the list of "non-qualifying offtakers" for the Hydrogen Production Business Model.

> **Prevent unnecessary gas network spending to stop further energy bill rises**. The Hydrogen Transport Business Model should only support the hydrogen infrastructure required for industrial and power users, and should not support infrastructure which relies on the use of hydrogen for heating to be viable. Future strategic spatial and network planning should assume hydrogen heating usage will be minimal.

> **Limit future decommissioning costs by halting gas network expansion**. The government should place an immediate moratorium on new gas network connections and require gas networks to plan ahead for decommissioning.

> **Develop a long-term transition plan for gas networks and gas workers**. This plan should set out how network decommissioning costs will be both minimised and funded, and how workers will be supported and protected through the transition. The plan should be developed jointly by government, Ofgem, networks and trade unions representing gas workers. Adherence to this long-term transition plan should be a condition of future RIIO price controls.

> **Ensure all consumers can access other low-carbon heating technologies**. The Warm Homes Plan should set out a clear strategy to ensure all households can access other low-carbon heating. This should include actions to help manage upfront costs, such as grants and low-interest finance.

> **Prioritise hydrogen for strategically important end-uses**, backing up a clean power system and providing security for key industrial processes such as steel, cement, ceramics and chemicals.

E3G

ANNEX – HYDROGEN HEAT FAQS

E3G's previous hydrogen heat factsheet[34] outlined the main arguments against widespread hydrogen heating. This FAQ addresses a couple of additional arguments put forwards since the publication of our previous work:

> Could hydrogen heating help manage seasonal energy demand?

> Will hydrogen heating be substantially cheaper in industrial clusters?

Q: Could hydrogen heating help manage seasonal energy demand?
A: No, hydrogen to power is a better option for managing seasonality.
Hydrogen will play an important role in long-term balancing for the energy system. However, the most effective approach for managing seasonality will be to use hydrogen for power generation, not to burn it in domestic boilers.

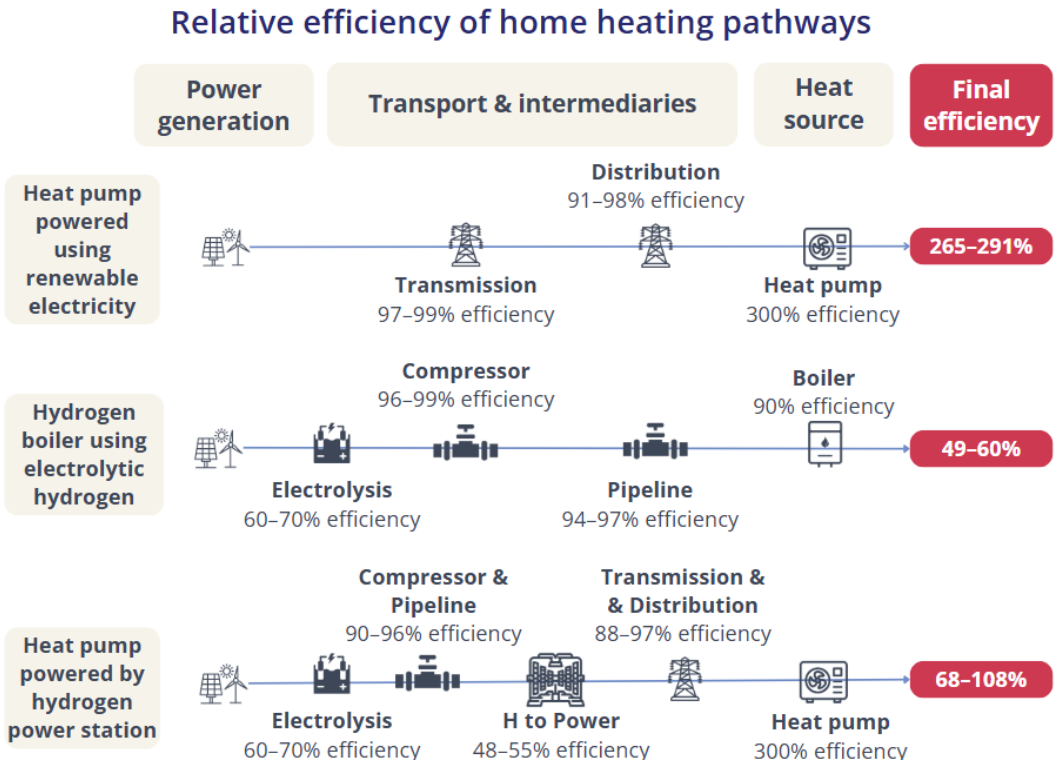
Burning hydrogen in boilers is much less efficient than running a heat pump, even if the electricity used was generated in a hydrogen power station. As shown in Figure A1, heat pumps are over 4 times as efficient as a hydrogen boiler when using renewable electricity directly – and remain 1.1 to 2 times more efficient when relying on electricity generated in a hydrogen power station.

As a result, using hydrogen for heating would lead to far larger variations in seasonal energy demand than relying on heat pumps. This would drive an increase in the need for energy generation, transport and storage – all adding to overall energy system costs borne by consumers.

Further insulating homes will also help to mitigate seasonal variations in energy demand. Research in 2018 suggested that cost-effective investments in energy efficiency and low-carbon heating could reduce energy demand by 25%.[35]

[34] E3G (2021). **Hydrogen: Factsheet Series**

[35] J. Rosenow et al (2018). **The remaining potential for energy savings in UK households**



Sources: Sterner et al. (2024). **19 Import options for green hydrogen and derivatives - An overview of efficiencies and technology readiness levels**; Council of European Energy Regulators (2020). **2nd CEER Report on Power Losses**; UK government (2023). **Electricity Generation Costs 2023**; Royal Society (2023). **Large Scale Electricity Storage**

Figure A1: Relative efficiency of home heating pathways

Q: Will hydrogen heating be substantially cheaper in industrial clusters?
A: Price variations in clusters are unlikely to overcome the substantial cost disparity between hydrogen and other options for low-carbon heating – particularly where sufficient hydrogen storage is available.

The argument for hydrogen heating in industrial clusters relies on assumptions that hydrogen prices in these clusters will fluctuate – and may occasionally be available at substantially lower than average prices. While fluctuations likely will occur, it is exceptionally unlikely they would be frequent or substantial enough to overcome the cost disparity with other low-carbon heating.

The average price of hydrogen within a cluster will naturally tend towards the level needed to generate a return on investments in hydrogen production, transport and storage infrastructure. As set out above, this means hydrogen boilers will generally be significantly more expensive to run than a heat pump.

Fluctuations in price at different times and locations will occur in response to shifting supply and demand, creating the potential for times when prices are lower. However, these fluctuations are unlikely to be large enough to make hydrogen cost competitive, and major price dips will be exceptionally rare. The only cases where hydrogen prices would decrease substantially within a cluster are where all of the following criteria are met:

> All local hydrogen storage is full.

> Industrial and power demand is fully supplied.

> There is insufficient network capacity to cost-effectively export hydrogen to other clusters with hydrogen demand.

These situations should be exceptionally rare, as frequent low pricing would discourage investment in hydrogen production or encourage further investment in industrial end-use. If at least one of these criteria is not met, then other end-users within an industrial cluster will be willing to pay more for this hydrogen than domestic heating users. This competition would keep prices from falling low enough to make hydrogen heating an attractive option on a regular basis.

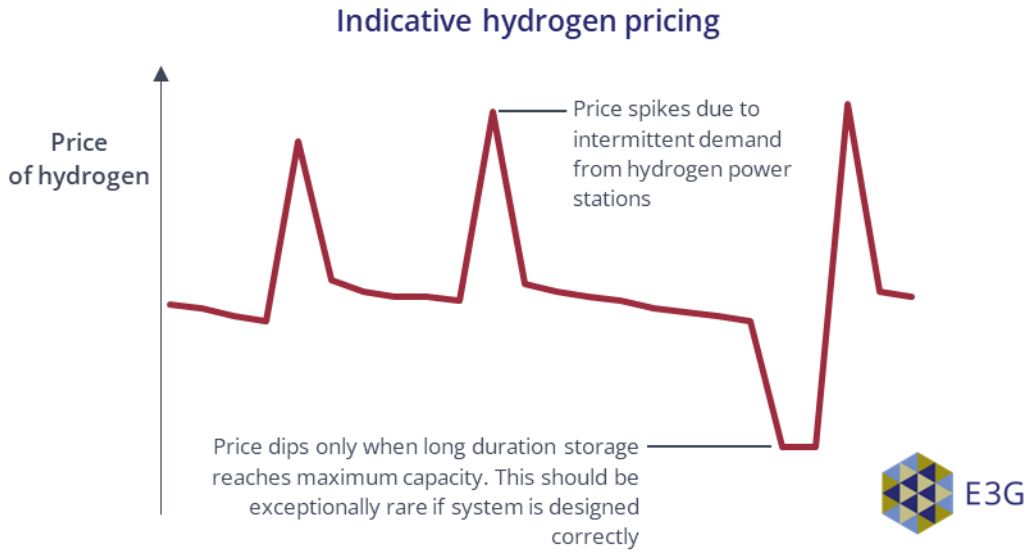


Figure A2: Indicative hydrogen pricing within an industrial cluster

Even if these price dips were sufficient to make hydrogen temporarily cost-effective, the rarity of these events limits the potential benefits for domestic heating users. To use hydrogen flexibly (i.e. only during price dips) consumers would need to rely on a different form of heating when hydrogen prices are at

their usual levels. This eliminates any purported capital cost savings associated with hydrogen, as the consumer must ensure their alternative heating system is sized to meet their entire needs. Industrial clusters may also be particularly well suited to heat networks, further reducing the case for hydrogen to play a role.

As such, domestic hydrogen heating in industrial clusters would still require extensive subsidies to maintain competitiveness with other low-carbon heating options. Investing in high-volume long-duration hydrogen storage would be a better approach to managing hydrogen availability within clusters. This large-scale storage will also be crucial for maintaining a reliable clean power system.

About E3G

E3G is an independent climate change think tank with a global outlook. We work on the frontier of the climate landscape, tackling the barriers and advancing the solutions to a safe climate. Our goal is to translate climate politics, economics and policies into action.

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.

More information is available at **www.e3g.org**