How much would hydrogen for heating cost in the UK?

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It seems increasingly likely that the mass use of hydrogen for heating is a disaster in the making. As we have pointed out before, all independent analyses see no major role for hydrogen heating and the fundamental physics means that, compared to electrification, it is an inefficient and costly option. These facts are compelling in and of themselves, before we even think about the practicalities of converting local areas to hydrogen one at a time, an issue that has come to the fore in proposed UK trials.

Yet hydrogen heating is still being discussed in political circles, with the UK government talking about 'hydrogen-ready' boilers and holding back its decision on the role of 100% hydrogen for heating to 2026. If policymakers were to push through hydrogen for home heat, what would it actually cost?

Our analysis, and that of others, suggests bills would go up by at least 70%, with a doubling or more of bills a likely outcome. With high running costs being an almost guaranteed outcome of burning hydrogen for heat, it may make sense for policymakers to cut losses early, withdraw from this idea and focus on known and proven clean heating technologies.

High system costs

The inefficiency of making and burning green hydrogen, which is produced using renewable electricity, is well documented and would lead to unavoidably high costs compared to using heat pumps. As far as we are aware, the only time that 100% hydrogen for heat looked cost-effective compared to heat pumps was in a 2018 Element Energy report for the National Infrastructure Commission. It is important to note that the work, however, analysed costs for blue hydrogen, which is made using steam methane reforming of fossil gas with carbon capture and storage, and didn't meet current carbon targets because of significant fugitive emissions.

The gas price crisis has highlighted why blue hydrogen is a poor idea for costs and energy security: The UK would end up even more exposed to volatile fossil fuel prices and imports, given ever-decreasing UK gas production and the energy losses of potentially 40% associated with the production of blue hydrogen from fossil gas. Conversely, making buildings more efficient and electrifying them could have significant cost and energy security benefits.

Never has green hydrogen compared favourably to electrification on a cost basis. For this reason, the UK Climate Change Committee's 'balanced pathway' sees hydrogen as playing only a limited role, in certain areas only and only in hybrid systems where, for example, a heat pump is 'backed up' by hydrogen in concentrated areas with other hydrogen use.

The Climate Change Committee has recently provided further advice on the role of hydrogen for heat: "Developments since our Sixth Carbon Budget advice, on the evidence regarding

hydrogen's impact as an indirect greenhouse gas and the spike in international and UK fossil gas prices, provide further support for the limited role for hydrogen in buildings decarbonisation."

At a system-wide level, hydrogen for heating looks to be an expensive, inefficient and insecure option.

High running costs

Once a local authority or a business with a large estate, for example, reaches a point where it starts clean heating delivery, it has to think about actual running costs. Real-world examples are naturally limited but, the UK Fife 'H100' project, which is looking to deliver hydrogen to homes via a new gas grid for the first time, cites a hydrogen cost of £229.5/MWh to £416/MWh. This is around two to four times more than the current (gas crisis) price cap level and around five to ten times more than pre-crisis cap levels.

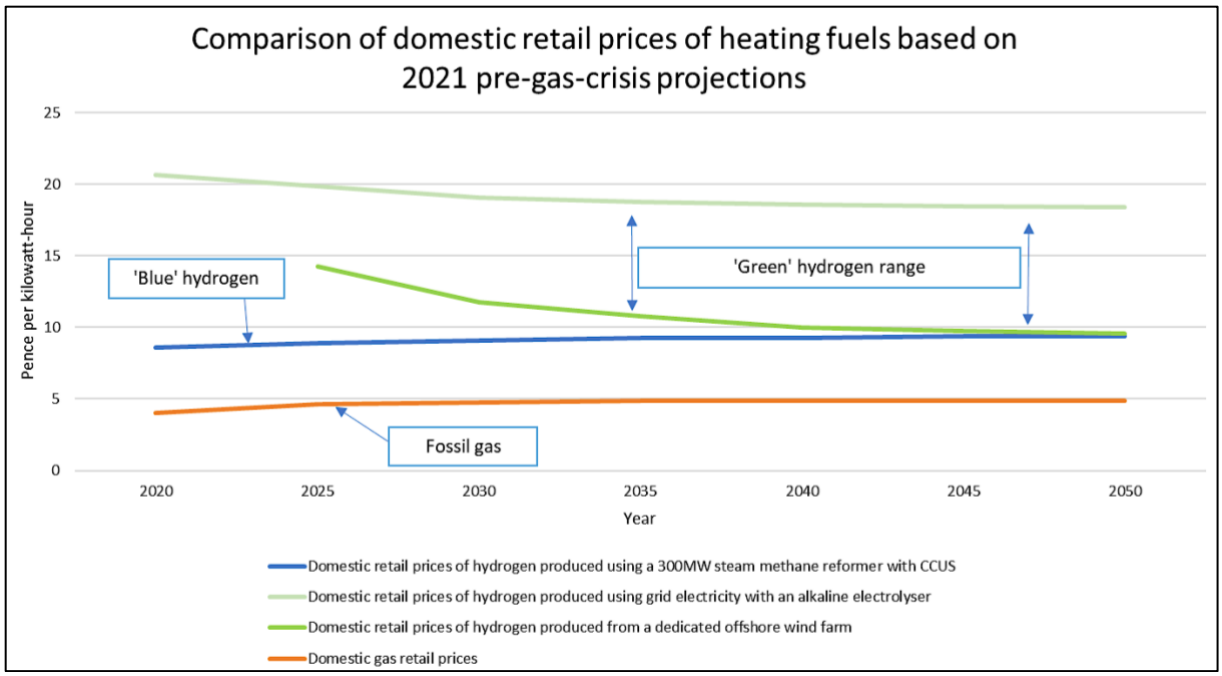
Using one project does give an indication of current costs but admittedly may not be representative of hydrogen costs at scale and in the future. There are two other available UK sources that can help.

The MCS Charitable Foundation employed consultants Cornwall Insight to consider the cost impacts of using hydrogen for heating. Their analysis showed that the average long-term cost change from switching from fossil gas to hydrogen would be a 70% bill increase. As if this long-term cost increase wasn't shocking enough, this number doesn't include the costs of converting the network or any hydrogen storage or system balancing costs, which could be significant due to the UK's seasonal swings in heat demand.

The other available data source on costs is the UK government's own hydrogen cost projections. We have used these projections alongside the government's long-term retail gas cost projections and added a charge of 2.67p/kWh to simulate the non-wholesale cost elements. This per-unit charge estimate is based on Ofgem's price cap data and includes things like supplier costs and profits and network charges. Although it's not perfect, it is probably conservative, owing to the complex nature of hydrogen storage and system balancing, which may well add even more to our cost data.

We have used pre-gas-price-crisis data for hydrogen costs and retail fossil gas costs, as the government has not updated the hydrogen costs since they were first published in August 2021. What this means is that, currently, green hydrogen may look relatively cost effective compared to short-term fossil gas prices, even if it is still more expensive. Our approach compares apples with apples and takes a long-term view. **Please see the note at the end of this article for more information.**

As the graph below shows, our analysis concluded that all hydrogen options are expected to be significantly more expensive than continued fossil gas use. The bottom line is the domestic retail gas price. The blue line depicts the cheaper blue hydrogen option, which is still significantly higher than fossil gas.



Source: RAP analysis based on BEIS Hydrogen Production Cost Projections (2021) and HM Treasury Green Book Supplementary Guidance: valuation of energy use and greenhouse gas emissions for appraisal (July 2021 update)

The green lines represent the costs of hydrogen produced using electricity. The lighter green is based on grid baseload electricity and the darker green is hydrogen produced using dedicated offshore wind farms. If hydrogen were to be used for heating, a potential outcome would be a combination of these two production methods, basically a combination of average and optimistic costs. Dedicated offshore wind is the cheaper option, but still leads to roughly doubling bills. The hydrogen produced from grid electricity would be around four times as expensive as fossil gas. Averaging these two costs leads to a rough tripling of bills.

There are many variables here but all projections, including the government's own numbers, see hydrogen as being significantly more expensive than fossil gas over the long term. For green hydrogen, an assumption of somewhere between two and four times the pre-gas-crisis prices seems highly probable if buildings used 100% hydrogen in place of fossil gas.

Blending hydrogen: smearing costs, losing value

In an attempt to grow the UK's hydrogen production market, the UK government is currently considering whether it should support smaller amounts of hydrogen to be blended into the gas grid to provide producers of hydrogen with guaranteed demand as the market grows. Beyond the potential issues of lock-in, based on the above numbers, the costs of blending could actually be significant.

For 2035, we estimate that, if hydrogen in the gas grid reached 20% as the gas networks are proposing, this could lead to a cost increase of 20% per kWh of gas if this hydrogen is produced using grid electricity. If this was hydrogen produced by dedicated offshore wind, it could still increase cost by 8% compared to pre-gas-crisis rates. The cost implications will depend on the level of blending and the type of hydrogen, but blending any amount of hydrogen would increase costs as it is always more expensive than fossil gas.

Concerningly, the current proposal is for a UK hydrogen levy to be placed on consumer bills — whether the hydrogen is put into the grid or not. This is alarming because it means that

energy billpayers could end up subsidising industrial polluters by funding hydrogen for industry, whether or not any of the energy being subsidised reached households.

If the blending proposal does go ahead, it also means that for any hydrogen put into the grid, the specific and significant value of the clean hydrogen for no-regret industrial applications would be lost.

'RAPping' up

The system-level costs of using hydrogen for heating are already known to be poor. Our analysis, and that by others, suggests that the running costs of using hydrogen for heating would be excessively high, increasing bills from between 70%, likely a low estimate, to 300% or more. A doubling or more of bills compared to business as usual is a very plausible outcome.

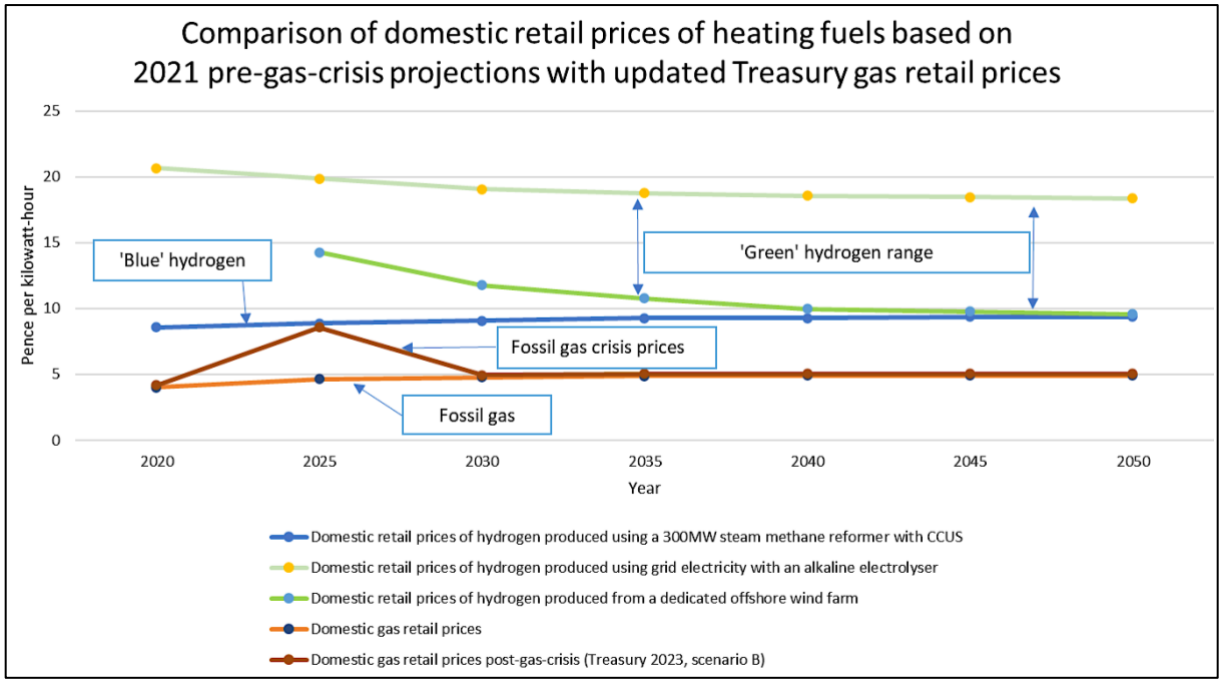
Genuine clean heating options, including heat networks and heat pumps, are known to already have similar, and potentially lower, running costs than fossil gas. Combinations of heat pumps with solar photovoltaic panels can even significantly reduce bills. Scaling up the rollout of these tried and tested technologies — which are repeatedly seen to be cost effective at a systemic level and a running cost level — should logically be the focus of buildings and clean heating policy.

Authors' notes on the gas price crisis price impact

In order to provide a longer-term view, for our analysis we used UK government numbers from August 2021 for hydrogen costs (most recent available) and the previous version of the Treasury's Green Book data for energy and emissions (July 2021 update).

Since these figures were published, the fossil gas price has increased significantly, which in turn would have increased the price of blue hydrogen (made from fossil gas). In the short term, this could also have had the impact of making green hydrogen appear relatively more cost effective. However, because the government has not updated its hydrogen costs, using the 2021 hydrogen costs alongside more recent 2023 fossil gas price updates would not have been a fair comparison.

We also note that, as hydrogen is unlikely to be used for heating at scale any time soon, a longer-term view makes more sense. For completeness, an additional graph below includes a line representing the more recent Treasury Green Book domestic gas retail prices, although we only include the five-yearly data points reflecting the hydrogen cost data. Most important to note is the long-term fossil gas price is predicted to be only fractionally higher than in our main graph above, increasing from 4.9 to 5.03p/kWh in 2050. As such, we are confident that our assumptions and conclusions are sensible.



Source: RAP analysis based on BEIS Hydrogen Production Cost Projections (2021) and HM Treasury Green Book Supplementary Guidance: valuation of energy use and greenhouse gas emissions for appraisal (July 2021 update) and more recent Green Book Supplementary Guidance: valuation of energy use and greenhouse gas emissions for appraisal (January 2023) for post-gas-crisis fossil gas retail prices