Hydrogen for home heating is a terrible idea

By Gabriel Levy, *People and Nature*, Oct 30, 2020 (Gabriel Levy is an environmental writer in Britain and publisher of *People and Nature*. He is also a 'left-wing' anti-Russia writer.)

A plan to pipe hydrogen, instead of natural gas, to millions of UK households is being pushed hard by the fossil fuel industry. It sounds 'green' but it could wreck efforts to make homes truly zero carbon, using insulation and electric heat pumps.

Oil and gas companies support switching the gas grid to hydrogen, as a survival option in case of decarbonisation, as hydrogen is usually fabricated from gas. But the hydrogen strategy cuts across the approach recommended for years by housing policy wonks and architects: to use insulation to slash the amount of heat needed, and install electric pumps (which work like fridges in reverse).

Leeds Trades Union Council (TUC) last month launched a campaign in favour of retrofitting homes with high-quality insulation and heat pumps. It's an issue many people can unite around – those fighting for better housing and tenants' rights, campaigners against fuel poverty, trades unionists fighting building industry cuts, and all of us who want to tackle climate change. And there's a choice to be made we cannot avoid.

If the gas grid is switched to hydrogen, that will block *for good* the electrification-and insulation approach, that heats homes better, more cheaply, with technology that we know works, and is truly zero-carbon. We cannot have it both ways. We will be locked into extra dependency on fossil fuels, instead of speeding the shift away from them.

The gas-to-hydrogen switch is being planned in north-east England by Northern Gas Networks (NGN): its H21 project would convert 3.7 million homes and businesses by 2035, and 15.7 million by 2050. NGN is asking the government to fund an engineering study for it. This article is a guide to the debates and to more information. It covers:

- hydrogen and its drawbacks;
- whole system solutions: existing technologies to decarbonise heating
- the government's no-strategy strategy and how we could resist it; and
- industry lobbying.

There is a short appendix with a non-technical guide to the technologies:

Hydrogen and its drawbacks

Hydrogen is touted as a 'green' fuel internationally because governments seek industry-friendly paths to decarbonisation and oil and gas companies offer this false solution. The International

Energy Agency (IEA) last year published a report on hydrogen which noted active support for hydrogen as fuel by the Chinese, Brazilian, Indian, Australian and many European governments.

In July of this year, the European Commission published its "hydrogen strategy for a climate-neutral Europe", which advocates state support for hydrogen to replace gas in industry and transport. The report also mentions household heating as a possible use, as does the European Hydrogen Alliance's declaration. *Much of this is based on a totally unproved assumption: that technology to produce zero-carbon hydrogen can be made to work at scale. That is a long way off, and may never happen.*

There are two supposedly carbon-free types of hydrogen: 'blue' hydrogen made from natural gas, from which the carbon is removed and stored; and 'green' hydrogen made by electrolysing water. Neither has ever been used at large scale.

At the moment, about 70 million tonnes of hydrogen is produced per year globally, and 98% of it is 'grey' hydrogen, made from natural gas … *without* carbon capture. So it emits a huge amount of greenhouse gases – almost as much as the aviation industry. (See below for more details on the technologies.)

Large-scale 'blue' or 'green' hydrogen production is far away for three types of reasons.

1. *Cost*. The European Commission estimates that 'blue' hydrogen would cost €2 a kilogramme at today's prices, and 'green' hydrogen €2.50-€5.50/kg, compared to €1.50/kg for existing 'grey' hydrogen.

2. *Technology*. 'blue' hydrogen needs carbon capture and storage (CCS) technology that does not yet work at scale anywhere. Transporting hydrogen might not be the walk in the park that some companies claim, either, this presentation suggests.

3. *Resource use*. 'Green' hydrogen uses huge quantities of electricity and water.

Take the NGN project. It would by 2050 need 8 million tonnes of hydrogen per year, equivalent to 300 Terawatt hours (TWh) of electricity.

To supply that amount of 'green' hydrogen, Friends of the Earth says, would need 140 Gigawatts (GW) of wind-powered electrolyser capacity – compared to a current total UK wind capacity of 22 GW (which supplies about one fifth of the UK's electricity). Plus the same amount of water as is used by 1.2 million homes.

If 'blue' hydrogen were used instead, 60 plants, as big as the world's biggest, would have to be built … fitted with that CCS technology that is still in development.

I am not arguing that hydrogen – especially 'green' hydrogen – could never be used, during and after the transition away from fossil fuels. But now, it is not a priority or a game-changer.

Today, most hydrogen is used in oil refining and fertiliser manufacture. Hopefully, much of this current use will disappear, along with fossil-fuelled industries. There may well be new uses, because low- or zero-carbon hydrogen might be the best substitute for fossil fuels e.g. to make

steel. Hydrogen is also good for storing energy. *But why, in any sane world, would you start by searching for new ways to use hydrogen, as governments are trying to do now?*

Why would you even think about using hydrogen to heat people's homes – when technologies that work, that are already in use (retrofitting, electricity and heat pumps) could do the job better? You wouldn't. Unless you were seeking ways of wringing the last few bits of profit out of oil and gas production.

Whole-systems solutions: existing technologies can decarbonise heating

There is nothing radical about proposing insulation and electric heat pumps to replace gas for households. Recent reports by the Institute for Public Policy Research (advocating a national investment programme), Friends of the Earth (reiterating the value of heat pumps against hydrogen) and the Carbon Trust (on London, arguing that "heat pumps are the primary technology choice") make the case. For a working retrofitter's view, see the Sure Insulation site.

Government and parliamentary reviews, too, have found that heat pumps and insulation are the way to go. (They have also looked at a hybrid heat pump system, in which a heat pump provides heat for 85% of the time, but switches to a gas boiler during colder periods.)

The government's business and industry department (BEIS) did a big review of home heating options in 2018. It concluded that, first, there should be a "growth in no or low-regrets low carbon heating" measures, including heat pumps, biomass boilers and solar water heaters. But BEIS said that, long term, all technologies had to be looked at – and kept the hydrogen option open, by commissioning the engineering company Arup to do a feasibility study.

The parliamentary Committee on Climate Change also did a big study on hydrogen in 2018, and concluded that it is "best used selectively, where it adds most value alongside widespread electrification" – and providing CCS could be got to work properly. Most urgent, the CCC pointed out, is "strategic certainty about how the decarbonisation of heat will be delivered in the UK". (The detailed analysis for the CCC was done at Imperial College. It showed that a hydrogen-based approach would be more expensive, especially if the aim were zero carbon, and that up-front investment makes more sense to stop emissions. There is more from Imperial on "smart and flexible heat" here.)

All this paperwork underlines that an integrated approach is needed. Buildings need to be upgraded and insulated; different types of heat pumps and different installation methods are called for; expertise and training have to be developed; in some areas, district heating networks make sense.

This is exactly the sort of thing local government has always done, and the neo-liberal assault on local government makes it harder. That's discussed in research of heat systems governance by Janette Webb (see her articles including "New Lamps for Old", "Emerging linked ecologies for a national-scale retrofitting programme" and one on why heat decarbonisation cannot be done by markets).

The no-strategy strategy, and how to oppose it

In the face of this pile of evidence that, more than anything, home heating needs a strategy – the government has avoided adopting a strategy. It "has yet to make any firm decisions about which pathways it prefers", this report on the Renewable Technology site explained in July.

The politics of this is very clear. In the face of climate crisis, the government must choose between an integrated strategy, best implemented through local government, relying on existing technology … or a no-strategy strategy that takes the lead from powerful private companies with unproven technology.

The no-strategy strategy fits with this government's maniacal, neoliberal hatred of the public sector – one of its few ideological principles. That was what motivated its no-strategy strategy on coronavirus testing and tracing, with devastating results, costing tens of thousands of lives.

A heat decarbonisation strategy will have to be fought for in opposition to the government – just as health workers, scientists and others have had to fight for a coronavirus strategy. This is why the Leeds TUC initiative, which appeals to local government to act, is welcome.

The Leeds TUC has recognised a techno-fix for what it is – damaging to society and the labour movement. Its campaign could be a focus for all who want to tackle dangerous climate change.

If you are in a trade union, an environmental campaign group or a community organisation, please discuss the Leeds TUC's document and the actions it proposes. If you are in a union, you could challenge trade union leaders' support for the oil and gas industry's hydrogen initiative.

Instead of such support, the labour movement should:

First, embrace technologies that are in society's best interests – which for heat decarbonisation means retrofitted insulation and heat pumps;

Second, demand that firms producing filthy-dirty 'grey' hydrogen take action to reduce the horrendous levels of greenhouse gas emissions they produce; and

Third, urge that future hydrogen use be limited to applications that are socially useful and don't add to the climate crisis.

This approach could and should be part of a broader perspective of just transition, now starting to be discussed by workers on the North Sea where the gas is produced.

Lobbying on steroids

The H21 project is at a crossroads. The companies who sponsor it – NGN, the gas network firm Cadent and the Norwegian oil company Equinor – got state funding for a series of initial reports: £9 million from the Ofgem Network Innovation Competition (NIC) in 2017, mainly to fund safety assessments; and another £6.8 million in 2019 to test the technology at a specially-built site at Spadeadam. (Update from a H21 manager here.)

But H21's plea for a much larger dollop of state funding – £125 million, half the cost of a Front End Engineering and Design (FEED) study, originally scheduled to start this year – has not so far been heeded, despite the "urgency" explained in the H21 North of England report (available here, although temporarily (October 2020) missing).

Meanwhile, the government has announced another project – to support an industrial complex on Teesside, making 'blue' hydrogen for transport – that could be an alternative source of demand for natural gas being pumped from the North Sea … and has as little as H21 to do with tackling the climate emergency.

Despite the question marks over H21, the oil and gas industry's lobbying machine in support of hydrogen for heat decarbonisation is trundling on, with greater force than ever. In July, the All Party Parliamentary Group on Hydrogen issued a report urging "more ambitious" support for hydrogen, including "mandating hydrogen-ready boilers by 2025". And in August, the gas industry "scored a success in persuading the Environmental Audit Committee [of the House of Commons] to back its plans for using hydrogen […] in domestic heating", the 100% Renewable UK blog reported.

The committee chair, Philip Dunne MP, deceitfully suggested that hydrogen is "the most cost-effective option" for "parts of the UK energy system".

Tom Baxter, a chemical engineering researcher, questions the pro-hydrogen arguments in this article.

Gas network companies have also jumped on the post-Covid financing bandwagon, asking for a huge state hand-out for conversion to hydrogen. And cement manufacturers – who, like energy companies, need carbon capture and storage – have joined the queue for state funding.

These relentless lobbying efforts are funded by a range of companies including hydrogen, transport, carbon capture, gas network, engineering and chemical firms as well as oil and gas. Their greenwash proliferates through the Decarbonised Gas Alliance and Hydrogen Strategy Now.

Some good research on these lobbyists' methods, by academics at Exeter University and Imperial College, warns of "the capacity that incumbents have to promote their storyline".

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Find out more about the Leeds TUC initiative:
■ Retrofit Leeds homes with high-quality insulation and heat pumps: a plan and call to action, by Leeds TUC
■ Leeds trade unionists: zero carbon homes can help tackle climate change, by People & Nature

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Hydrogen. Quick technological catch-up

Hydrogen is the most common, and lightest, element in the universe, but only exists on earth combined with other elements. People started fabricating hydrogen from compounds and using it e.g. for balloons in the nineteenth century. Today there are three main types of hydrogen:

■ 'Grey' hydrogen. Fabricated by removing the hydrogen (H) from methane i.e. natural gas (CH_4), or from coal. This is how 98% of hydrogen is currently made. It is extremely emissions-intensive. For every tonne of hydrogen made from gas, 10 tonnes of carbon dioxide (CO_2) goes into the atmosphere; for every tonne from coal, 19 tonnes of CO_2.

The 70m tonnes of hydrogen produced in 2018 caused 830m tonnes of CO_2 emissions, the IEA calculated. That's a healthy chunk of the world total of 42 billion tonnes – about the same as total emissions from Indonesia plus the UK – and nearly as much as the global aviation industry, which emitted 915m tonnes in 2019.

Most hydrogen produced now is used for oil refining, and ammonia production to make chemical fertilisers. Some is used as part of synthetic gas products, mainly for manufacturing steel, or methanol.

■ 'Blue' hydrogen. In this process, instead of CO_2 being emitted into the atmosphere, it is captured and stored. The capture process, steam reformation, is straightforward for about 70% of the emissions and gets really tricky above and beyond about 85%.

Steam reformation splits methane into CO_2 and synthetic gas (carbon monoxide plus hydrogen); in the second stage, the synthetic gas is mixed with steam; more CO_2 is removed and hydrogen produced. Other similar processes are partial oxidation, which uses oxygen in the air as an oxidant instead of steam, and autothermal reforming, which combines both methods.

Note on carbon capture and storage. This can also be used in gas- and coal-fired power stations. Usually the carbon is captured after the fuel has been burned. Then, as with carbon from hydrogen production, it has to be transported and stored. CCS has been in development for about 40 years, but there are still only 20 projects in development in the world. Only two of these ever actually functioned, and one of those two (Petra Nova in Texas) was mothballed in August. (A good analysis is here.) CCS is greenwashed as the key to 'green power'. Some politicians, and some international climate talks documentation, claim that bioenergy with CCS could play a big role in global decarbonisation, but climate scientists and engineers think that is nonsense.

■ 'Green' hydrogen. Produced by electrolysis of water. The electricity could come from fossil fuels (in which case it would not be green), nuclear power or renewables. The process is proven, but is very energy intensive and very inefficient.

If electricity from renewables were to be used, this could be the most "carbon light" way of producing hydrogen. But huge targets for 'green' hydrogen production are sometimes published without being reconciled with other huge targets for renewably-produced electricity. Is producing hydrogen ever going to be the best way to use this electricity? The IEA says that just to produce the 70m tonnes of hydrogen the world economy uses annually would need 3600 TWh of electricity, more than total European consumption. The electrolysis also needs huge amounts of water – 9 litres for each kilo of hydrogen.

Gazprom, the Russian gas company, sees potential in producing hydrogen by methane pyrolysis, a related technology.