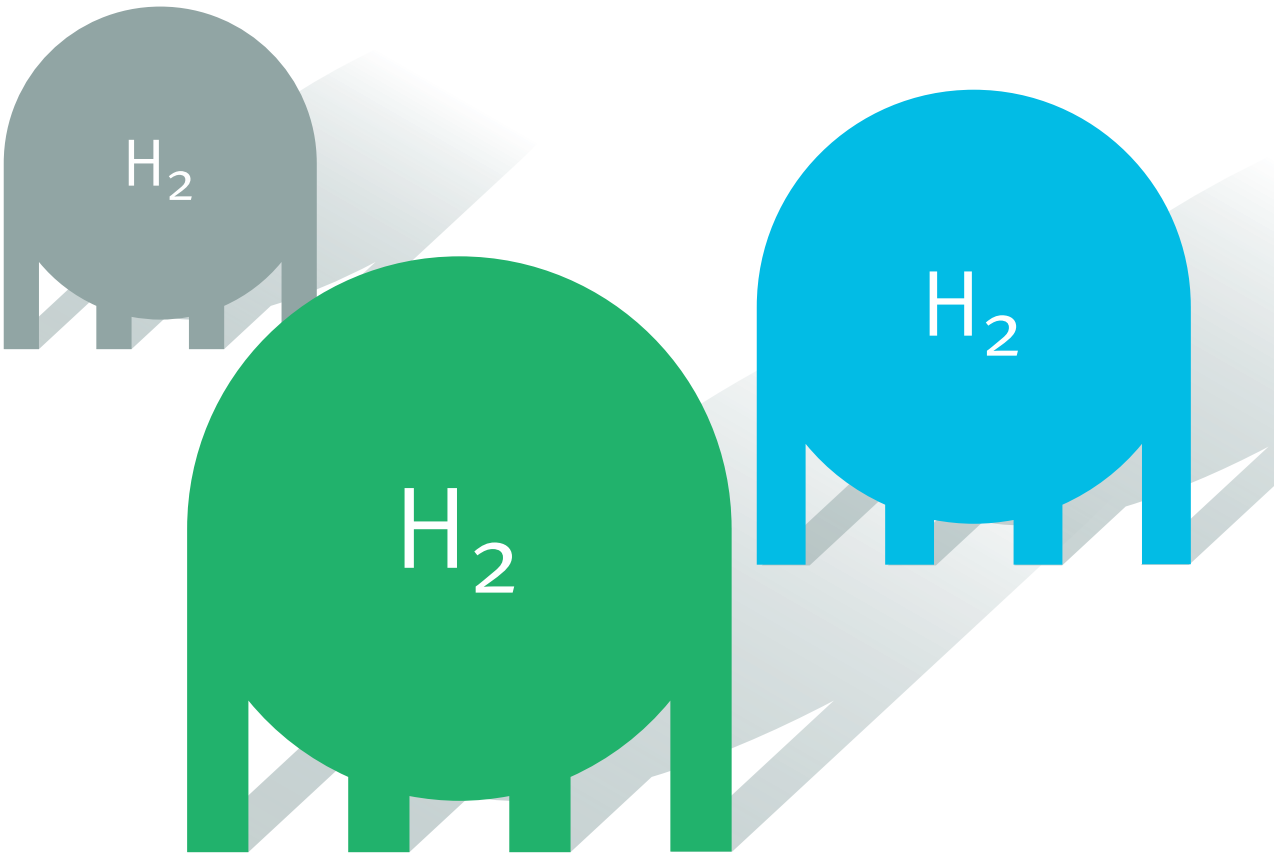
green alliance...

Hydrogen's role in a clean power economy



Introduction

> **“Hydrogen is generating considerable hype.”**

Hydrogen has been dubbed as critical for a low carbon economy, particularly for applications where significant power is needed, but it is no panacea for achieving net zero.

It is a gas that can be used either as a fuel or an ingredient for many industrial processes, producing water and nitrogen oxides when burnt. When made with renewable electricity, it has close to zero lifecycle emissions. However, when released directly into the atmosphere, through leaks or venting, it can have significant global warming impact.

Thanks to its highly flexible zero emission potential, hydrogen is generating considerable hype. But there is growing recognition that directly electrifying processes wherever possible will always be more efficient. Electrification is three to eight times more efficient for surface transport for instance.[1] And it is more cost effective.[2] Although hydrogen will still need to play a “small but important role in decarbonisation”, according to the Climate Change Committee (CCC) its use will need to be well planned and appropriate.[3]

Here, we outline the current state of the UK’s hydrogen economy and the scale, geographies and factors that will shape its future.

How is hydrogen produced?

Hydrogen can be made through different production processes.

Grey hydrogen – traditional

For grey hydrogen production, natural gas is used as both a fuel and a feedstock. The gas is separated into hydrogen and CO_2 with additional gas used to fuel the high temperature process. This is used in oil refineries and to make chemicals.

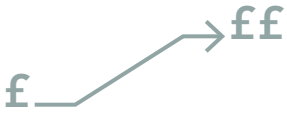
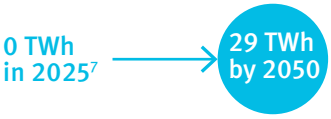
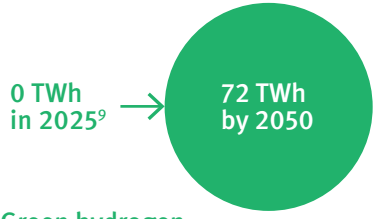
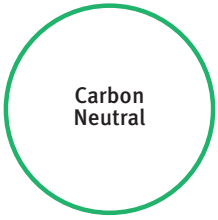
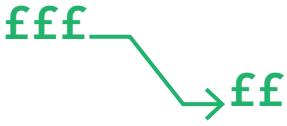
Blue hydrogen – stop gap

Making blue hydrogen follows the same process as grey hydrogen but with the addition of carbon capture and storage (CCS) to reduce emissions. This capability is being built in some industrial clusters, meaning industries located close to each other can share CCS infrastructure.

Green hydrogen – the future

Manufacturing green hydrogen uses renewable electricity to separate hydrogen from water using an 'electrolyser'. As the energy is derived from renewable energy sources, it will be carbon neutral. This is now being produced in small scale facilities.

Future production, costs and climate impact

How the share of UK production is likely to change over time	Climate impact	How the cost of green, blue and grey hydrogen could change
 **Grey hydrogen** Scaling down as blue and green hydrogen become available[4]		 Currently the cheapest method but costs are expected to rise with carbon and gas price volatility[6]
 **Blue hydrogen** Scaling up depends on available CCS		 More expensive than grey hydrogen but currently cheaper than green hydrogen; the extent of price drop depends on CCS availability
 **Green hydrogen** Scaling up depends on available renewable energy		 Currently most expensive but projected to be cost competitive with blue hydrogen by the 2030s-40s although depends on the price of renewables[10]

Transport and storage

Hydrogen needs to be kept under high pressure at low temperature and is prone to leakage. This can be reduced by producing it close to where it is used.

Pipelines
Main transport method

This is suitable for short and long distances, with lower leakage rates, but requires expensive infrastructure. Pipelines allow hydrogen to be used away from industrial clusters and other production sites. A combination of new and repurposed gas pipelines can be used. The potential scale of a future pipeline network is unclear.

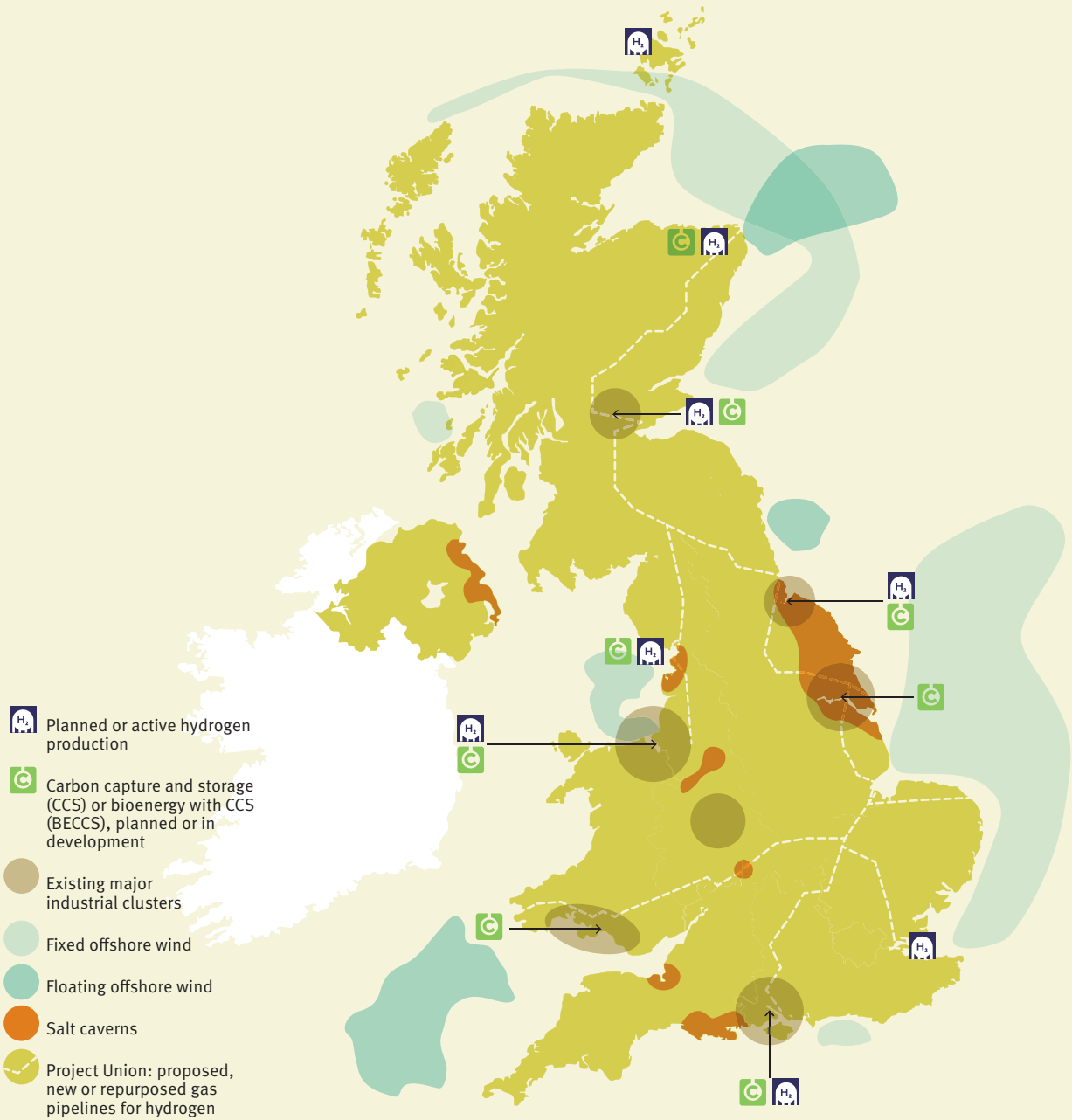
Compressed or liquified in tankers
Secondary transport method

This is expensive and energy intensive but needs less infrastructure. Liquified hydrogen is especially prone to leaks (around ten to 20 per cent) and so should only be used when necessary.[11]

Geological storage
Main storage solution

Salt caverns for large scale storage have high potential and are already under development in the UK. Other storage options, such as depleted gas reservoirs, require further testing.

Where in the UK is hydrogen produced, transported, stored and used?



Note: Locations are approximate. Some icons refer to regions rather than specific locations.

The UK is building a low carbon hydrogen economy

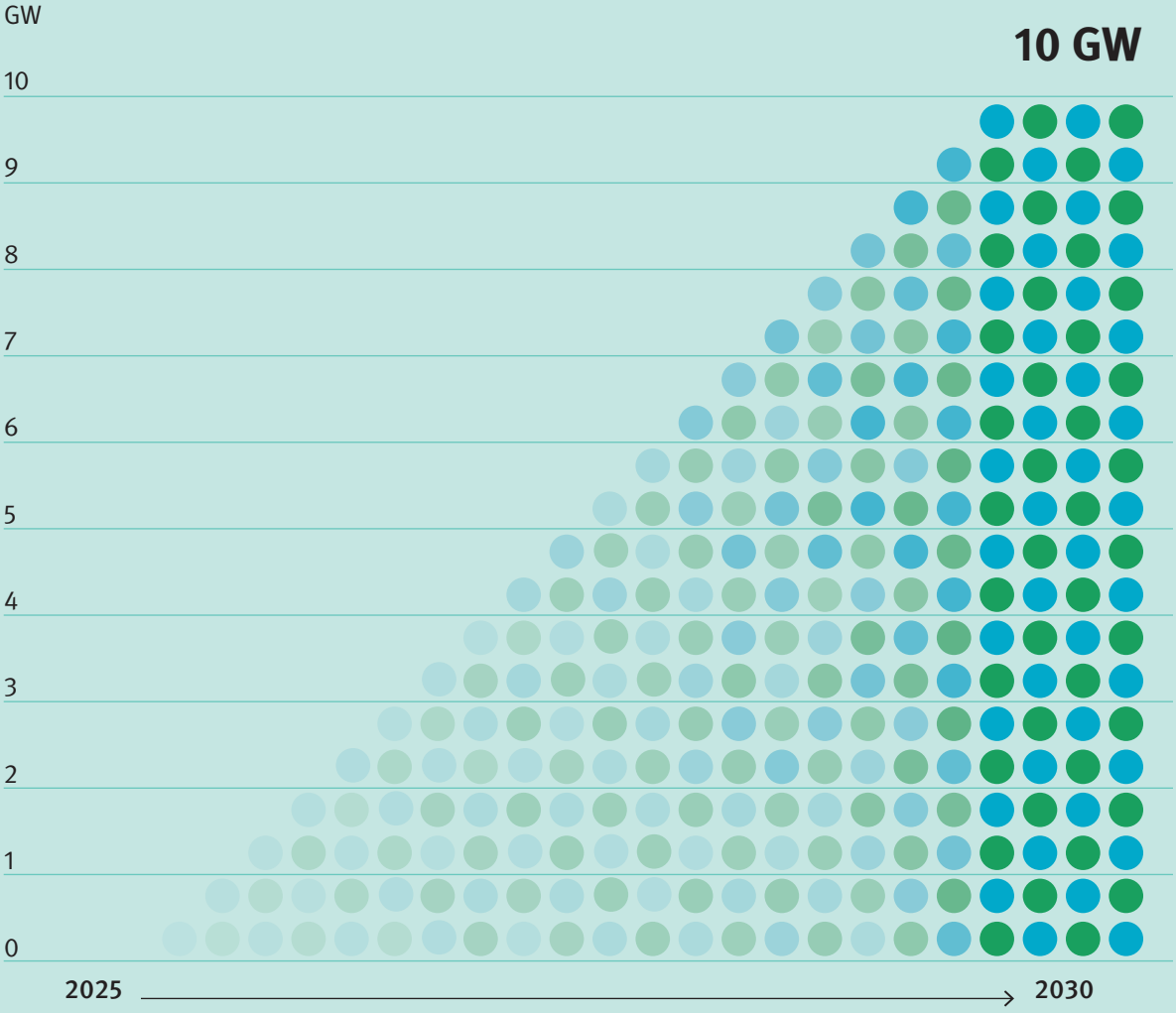
In 2023, the UK government committed to develop 10GW of capacity for low carbon hydrogen by 2030 (blue and green hydrogen) with at least half coming from green hydrogen.[12] The current government has since committed to support hydrogen production through the National Wealth Fund.

Low carbon hydrogen is expensive to produce. To derisk and stimulate production, the government holds Hydrogen Allocation Rounds (HARs), awarding 15 year contracts to producers, similar to the contracts for difference scheme used to accelerate renewable energy generation in the UK.[13] The first HAR will produce 125MW of capacity.[14]

To qualify for the HAR, hydrogen must be sold directly to end users and meet the government's Low Carbon Hydrogen Standard, an emission threshold for hydrogen to be considered 'low carbon'.

The Department for Energy Security and Net Zero (DESNZ) is expected to update the 2021 Hydrogen Strategy in the near future.

A big increase in low carbon production is needed to meet the 2030 target[15]



How the business model works

The UK's green hydrogen economy is still in early development.

To kickstart domestic green hydrogen production and cut risks for producers and investors, the government's Hydrogen Production Business Model follows a similar approach to the contracts for difference scheme which has accelerated renewable energy generation in the UK.

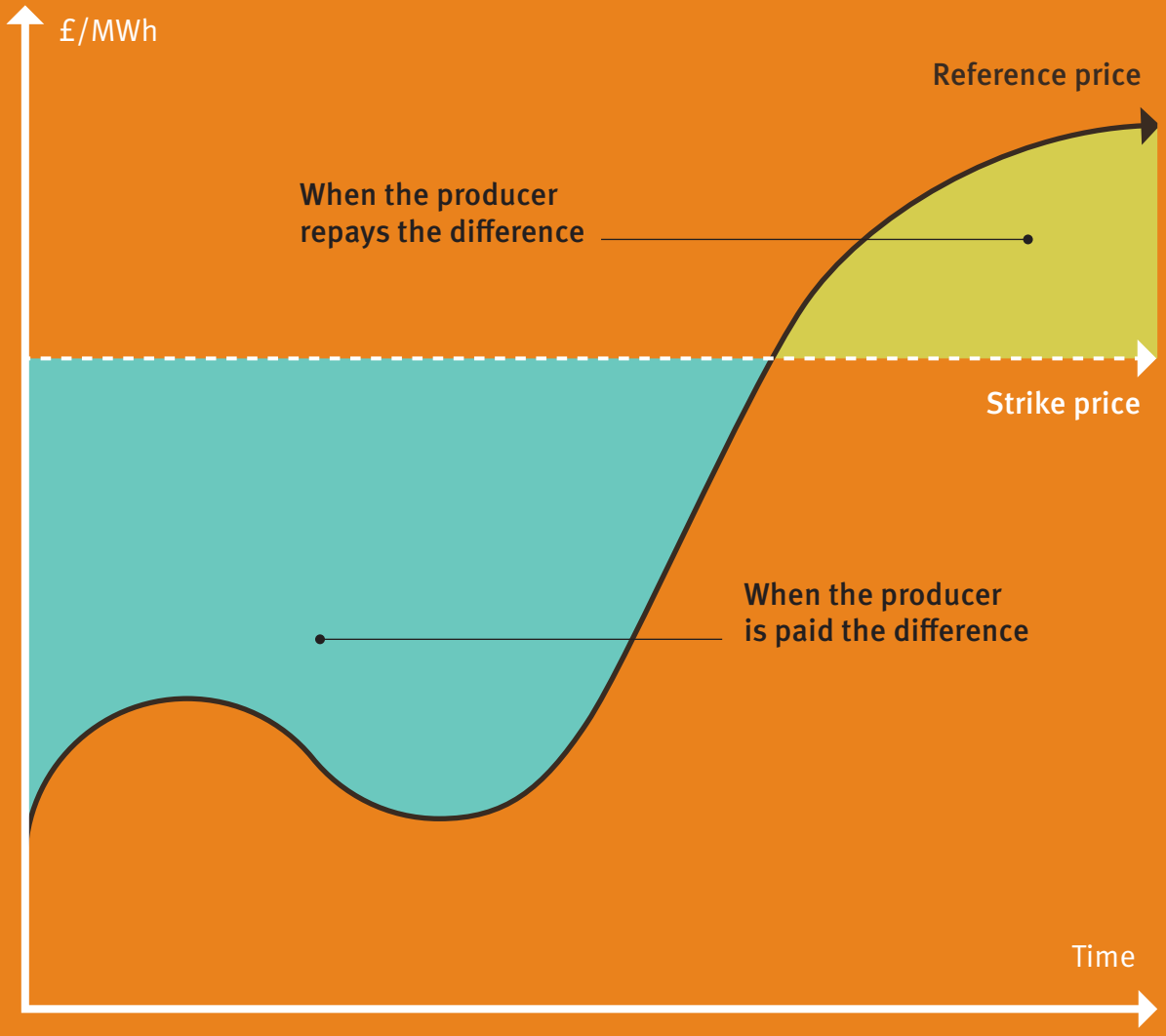
The business model guarantees a fixed price at a competitive rate, which will not face market volatility, ie the 'strike price'. Producers are paid the difference between the strike price and the reference price, which is based on the market price for hydrogen or the gas price, depending on circumstances.

When the strike price exceeds the reference price, producers receive a top up payment. If the reference price rises above the strike price, the producer repays the difference.

So far, there have been two Hydrogen Allocation Rounds using the Hydrogen Production Business Model.

A guaranteed price for producers

The Hydrogen Production Business Model



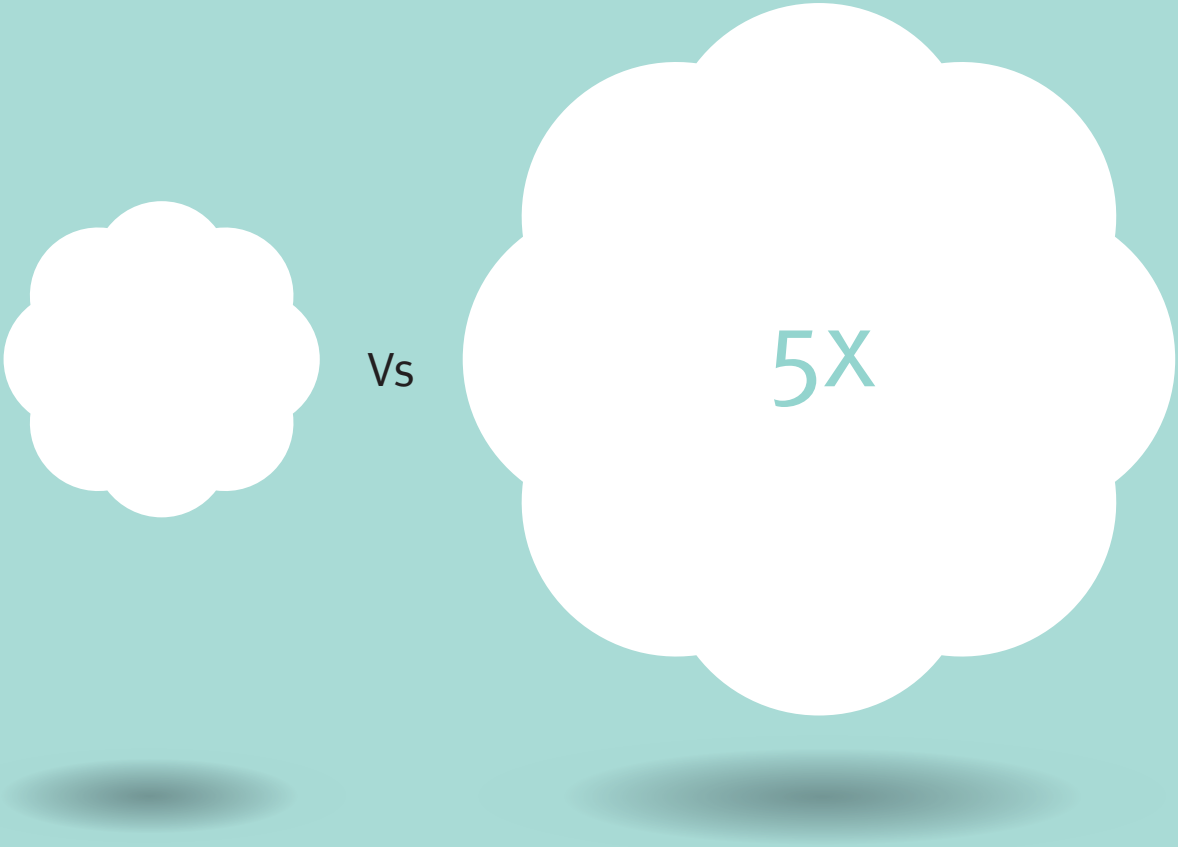
The hydrogen leakage problem

One of the main risks associated with hydrogen is leakage due to its small molecules. If released unburnt, it is a short lived climate pollutant.[16] This is in part due to its effect in increasing the lifetime and warming impact of methane, a potent greenhouse gas, as hydrogen reacts with hydroxyl radicals, slowing the removal of methane in the atmosphere.

If hydrogen leaks exceed 19 per cent, the climate impact over a 20 year period can be higher than from burning natural gas, making the switch to hydrogen very risky in relation to climate change.[17]

Where hydrogen is necessary, there should be strict leakage mitigation measures. While leakage rates are likely to be much lower than this in most circumstances, applications requiring several transport and processing stages are more vulnerable to leaks which could add up to significant overall emissions.

Leaked hydrogen has a much higher climate impact than natural gas



Greenhouse gas emissions from 1MWh natural gas burned

Greenhouse gas emissions from 1MWh hydrogen leaked

Hynet North West: the hydrogen economy in practice

HyNet is a project located in an area spanning the north west of England and North Wales, focused on decarbonising local industry through low carbon hydrogen production and CCS. It aims to reduce industrial reliance on fossil fuels by supporting a shift towards hydrogen.[18]

It is a useful case study to examine the success of co-locating energy production, hydrogen generation, transport and storage infrastructure and end use industries.

However, HyNet includes proposed hydrogen blending with natural gas for homes and businesses which we advise strongly against due to leakage risk and as it is more efficient and cheaper to electrify home heating.

But HyNet does show how a local hydrogen economy could be created, which could be replicated in other industrial clusters.


CO_2 storage
Liverpool
Manchester
Flint
Low carbon H_2 production
Industrial CO_2 capture
Northwich
Underground H_2 storage
Chester
Industrial CO_2 capture
Wrexham
Initial phases of H_2 pipeline
Future phases of H_2 pipeline
CO_2 transportation and storage system
Industrial H_2 user
Flexible H_2 power generation
H_2 blending for homes and businesses

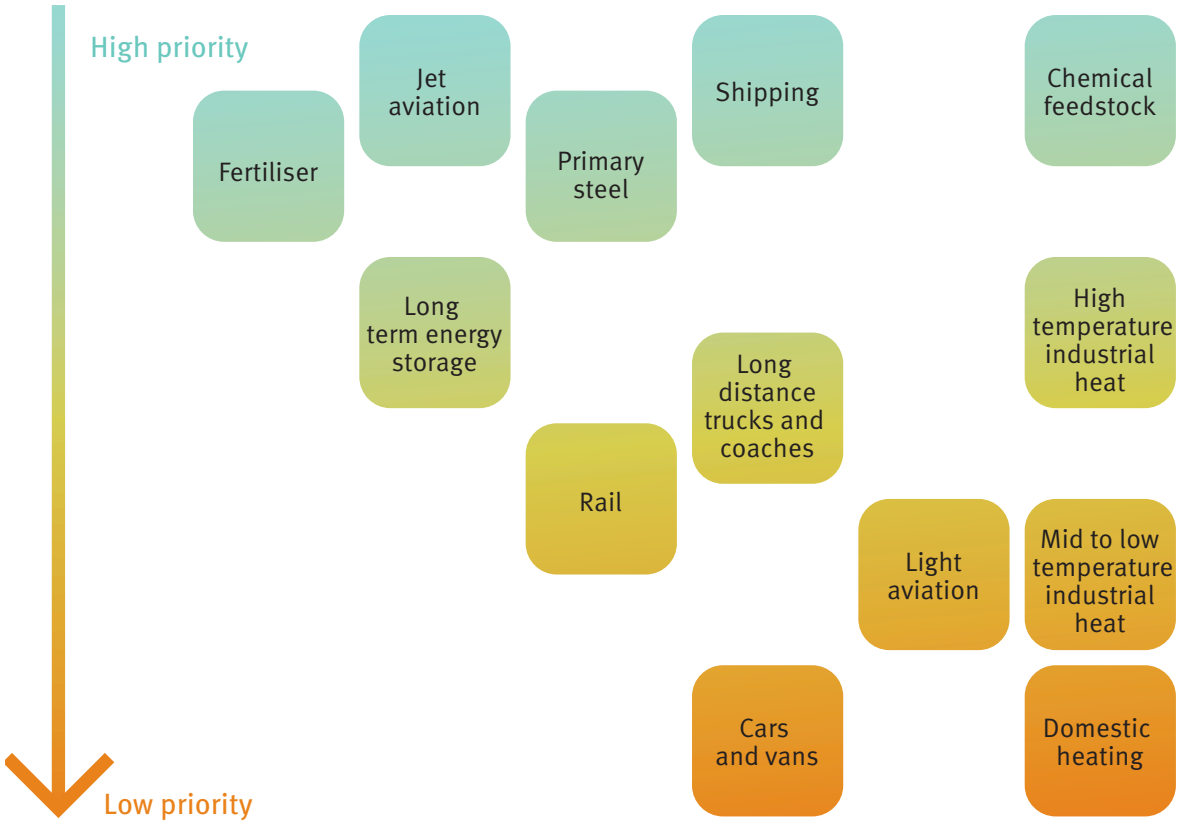
Where to use hydrogen

Due to the risks associated with leakage and the energy intensive process of producing green hydrogen, it should only be prioritised for industries unable to decarbonise through other means like electrification.

It is not a solution for all industrial decarbonisation, but it is a good alternative for energy intensive industries like steel, glass, ceramics and aviation. Hydrogen is also a crucial ingredient in the manufacture of certain chemicals and can be used for large scale renewable energy storage.

But where electrification is available and appropriate, it should always be the first choice, especially for surface transport and home heating.

Prioritising use



Endnotes

1 T J Wallington, M Woody et al, 2024, 'Green hydrogen pathways, energy efficiencies and intensities for ground, air, and marine transportation', Joule, vol 8, pp 2,190-2,207

2 D Cebon, 2020, *Hydrogen or electron economy?*, The Centre for Sustainable Road Freight

3 Climate Change Committee, 2025, *The seventh carbon budget*

4 DESNZ, 2025, 'Hydrogen production and demand in the UK, 2022 to 2024'

5 J Moberg, S Bartlett, 2022, *The mirage of blue hydrogen is fading*, Green Hydrogen Organisation

6 K Schelling, 9 August 2023, 'Green hydrogen to undercut gray sibling by end of decade', BloombergNEF

7 Climate Change Committee, 2025, op cit

8 J Moberg, S Bartlett, 2022, op cit

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10 House of Commons Science and Technology Committee, 2022, The role of hydrogen in achieving net zero

11 A Arrigoni and L B Diaz, 2022, *JRC technical report: hydrogen emissions from a hydrogen economy and their potential global warming impact*, European Commission

12 Department for Energy Security and Net Zero (DESNZ), 2023, policy paper, 'Hydrogen production delivery roadmap'

13 Renewables UK, 2023, *Demystifying the hydrogen business model for electrolysis*

14 DESNZ, December 2023, 'Hydrogen production business model/net zero hydrogen fund: HAR1 successful projects'

15 DESNZ, 2023, op cit

16 Briefly, the warming potential of increased hydrogen concentrations in the atmosphere occurs via three mechanisms: 1. increased interactions between hydrogen and hydroxy radicals, which would otherwise react with methane and break it down into carbon dioxide; this leaves fewer hydroxy radi cals, prolonging the lifetime of methane and therefore increasing its warming effect; 2. higher concentration of tropospheric ozone, which is a greenhouse gas; 3. higher concentration of stratospheric water vapour, which increases global warming. The total impact of hydrogen on global heating is a function of the residence life of hydrogen in the atmosphere, which is currently estimated at two years, and the total volume of hydrogen released unburnt into the atmosphere.

17 This compares the Global Warming Potential over 20 years of hydrogen and the direct emissions (carbon dioxide, methane and nitrous oxide) from burning natural gas.

18 HyNet North West 'Unlocking a low carbon future', hynet.co.uk

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Green Alliance
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