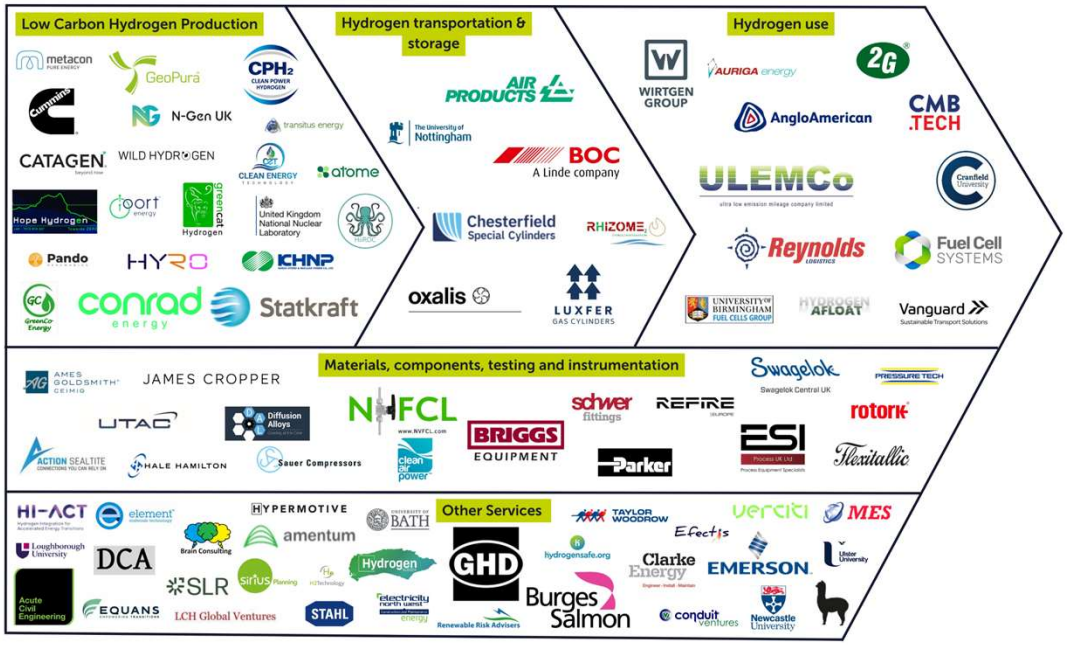
Hydrogen, the current position

Dr. Emma Guthrie, Hydrogen Energy Association
Tuesday 11th March 2025

Hydrogen Energy Association
Formerly the UK Hydrogen and Fuel Cell Association

About the HEA

Hydrogen Energy Association



Representing the UK's hydrogen's supply chain for >15 years

Member organisations cover the supply chain, encompassing all aspects of hydrogen and its applications. We have universities, SMEs, UK manufacturers and wider stakeholders among our members.

The HEA is a key focal point for national and international engagement on hydrogen and its activities for UK plc and UK businesses. We are a trusted voice into government.

Convening the Hydrogen Coordination Forum.

Why Hydrogen?

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Hydrogen is versatile and can be utilised in various ways.
These multiple uses can be grouped into two large categories:

1. Hydrogen as a feedstock / process gas.

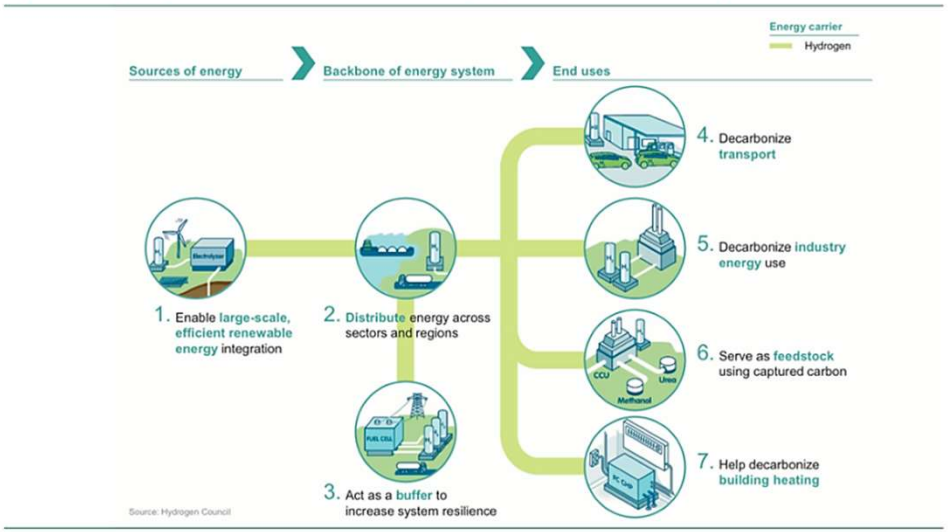
A role whose importance is being recognized for decades and will continue to grow and evolve.

2. Hydrogen as an energy vector enabling the energy transition.

The usage of hydrogen in this context has started already and is gradually increasing. In the coming years this part will grow dramatically.

The versatility of hydrogen and its flexibility is why hydrogen can contribute to decarbonise existing economies.

Figure 2: Hydrogen has seven roles in decarbonizing major sectors of the economy



[Hydrogen Europe Home]

Why Hydrogen?

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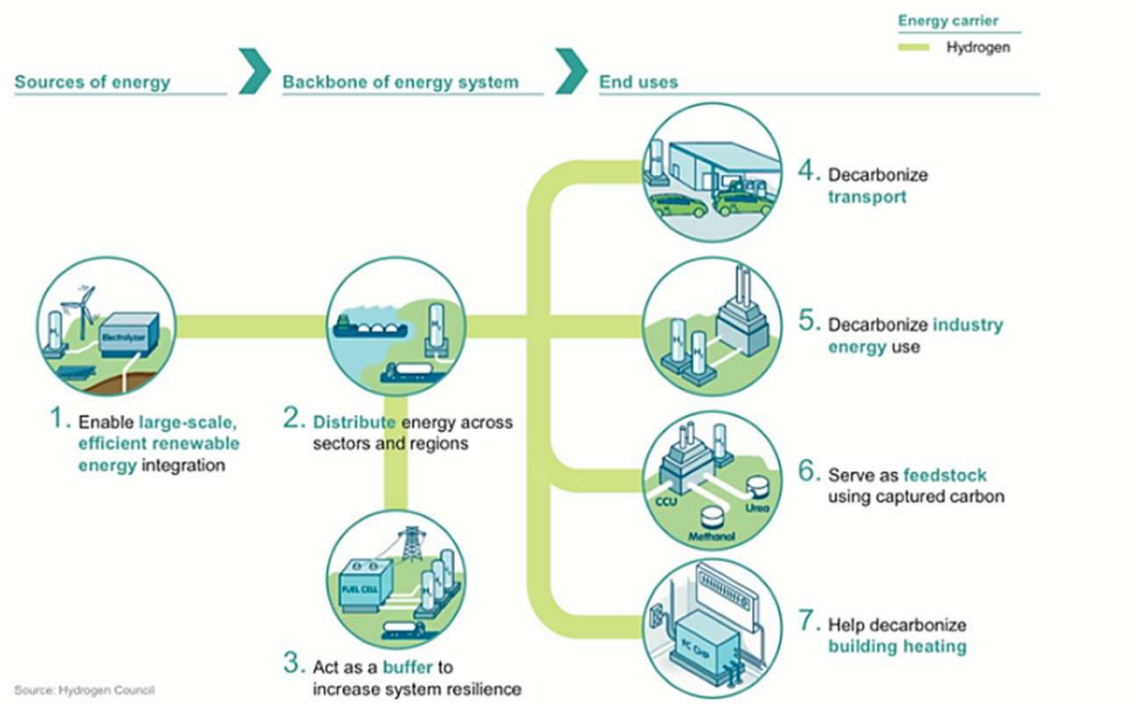
Figure 2: Hydrogen has seven roles in decarbonizing major sectors of the economy



[Hydrogen Europe Home]

Where does it come from?

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Hydrogen does not typically exist freely in the atmosphere and needs to be extracted from other feedstocks. The production methods and feedstocks vary and each has different impacts on the environment and associated costs.
Today – these various methods are often assigned different colours – here's a few examples:

Green Hydrogen

Green hydrogen is mainly produced by splitting water (i.e., water electrolysis) using electricity generated from renewable energy sources (RES). The reason it is called green is that there is no CO2 emission associated with the hydrogen production nor with its usage. When used in a fuel cell, the only by-product of its use is the pure water that was originally used in its production. Renewable hydrogen is generally more expensive than blue hydrogen, though prices are becoming more competitive. Although "green" hydrogen often refers to electrolytic hydrogen produced using electricity generated from renewable energy sources, it can also refer to hydrogen produced via different methods using other renewable sources such as biogas, biomethane, bio-waste and other renewable sources, these methods are less common than water electrolysis but also result in either very low or zero emissions.

Blue Hydrogen

Blue hydrogen refers to hydrogen derived from natural gas, which is a fossil fuel, however, most (albeit not all) the CO2 emitted during the process would be captured and stored underground (carbon sequestration) or bound in a solid product (such as bricks) and utilized. This is called carbon capture, storage and utilisation (CCSU).

Grey

Grey hydrogen is produced from fossil fuel and commonly uses steam methane reforming (SMR) method. During this process, CO2 is produced and eventually released to the atmosphere.

[In a nutshell | Hydrogen Europe]

Pink

Pink hydrogen is generated through electrolysis of water by using electricity from a nuclear power plant.

Purple

Purple hydrogen is made though using nuclear power and heat through combined chemo-thermal electrolysis splitting of water.

Red

Red hydrogen is produced through the high-temperature catalytic splitting of water using nuclear power thermal as an energy source.

Electrolysis of water

H_2O

$2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$

Steam Methane Reforming (SMR)

CH_4

$CH_4 + H_2O \rightarrow CO + 3H_2$

Hydrogen Myth Busting

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Hydrogen has a rich heritage and has been used in industrial manufacturing for over **a century**. Large-scale industrial production and use of hydrogen began in the **early 20th century**, primarily for applications in **chemical processing and refining**.

- **1910s-1920s**: Hydrogen was used in the **Haber-Bosch process** to produce ammonia for fertilizers, revolutionizing agriculture.
- **1930s-1950s**: The petrochemical industry started using hydrogen for **hydrocracking** and **hydrotreating** in oil refining. Hydrogen has since played an important role in petroleum refining – producing the current range of low sulphur fuels to meet air quality standards
- **1960s-1980s**: Expansion into **methanol production** and **rocket fuel** for space exploration.
- **2000s-Present**: Growing use in **fuel cells**, **green hydrogen production**, and **decarbonization efforts**.

Other Industrial applications:

- Hydrogen is used in **float glass** manufacturing and as a reducing agent in certain ceramic processes.
- **Iron & Steel Production**: Used as a reducing agent in Direct Reduced Iron (DRI) processes, replacing coal-based methods to lower CO_2 emissions.
- **Welding & Heat Treatment**: Hydrogen is used as a shielding gas in welding and in heat treatment applications.

This wealth of experience means that the safe production, transport and use of hydrogen is well know and understood.

Hydrogen Myth Busting

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Hydrogen gas is dangerous to store and use

Arguably one of the most common concerns raised when discussing the use of hydrogen is that, as a flammable gas, it can be easily ignited and as such far too hazardous to be stored either in refuelling stations or within a pressure tank. Yet, hydrogen is no more dangerous than other flammable fuels or the batteries used in electric cars. In fact, vehicles with pressure gas storage tanks are nothing new. With millions of on-the-road miles driven over the last few years, an existing global multi-billion industry transporting and making hydrogen for many decades, the automotive industry seems to be more than sufficiently convinced that hydrogen can be stored safely, with Toyota for example having received approval from Japan's Ministry of Economy, Trade and Industry (METI) to self-inspect and manufacture hydrogen tanks for FCEVs.

(Sources: HIRINGA, EDP, HE-REVOLVE's Hydrogen Special Report)

Hydrogen energy is not all that energy efficient

While hydrogen is the most abundant element in the universe, here on Earth, it typically needs to be extracted from water or organic compounds. This is not particularly different from the diesel and gasoline used in combustion engines which are produced from refining and cleaning crude oil (a process which actually heavily involves the use of hydrogen). While hydrogen is currently extracted from natural gas and is already a multi-billion dollar global industry used in a wide range of industrial applications, it is also produced via renewable sources such as solar, wind or biogas without the need to use fossil fuels.

(Sources: HIRINGA, EDP, HE-REVOLVE's Hydrogen Special Report)

Hydrogen is really too expensive

The price of green hydrogen has fallen in recent years and it is expected that the reduction will be even higher over the next decade, making it truly competitive against other energy solutions. António Vidigal from EDP Innovation reinforces that the cost of H2 is not so much in the technology or in the infrastructures: "The main component of the cost of green hydrogen is the renewable energy from which it is produced via electrolysis, which corresponds to 70% of the total." It is necessary to have good renewable energy resources, and to optimize the solar and wind mix.

(Sources: HIRINGA, EDP, HE-REVOLVE's Hydrogen Special Report)

In a nutshell | Hydrogen Europe

Hydrogen Myth Busting

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Hydrogen is too explosive!

You may think of the hydrogen bomb or atomic weapons of mass destruction when you hear hydrogen, but the process for making such bombs is the opposite to electrolysis for example which is about splitting the water molecule. Even the Hinderburg accident in 1937, often remembered for the fact that the zeppelin floated due to hydrogen, is unrelated to the gas itself. The most accepted explanation indicates that it was the flammable components on the paint that covered the zeppelin – not hydrogen, which dissipated in seconds – that caused the fire in the aircraft structure.

(Sources: HIRINGA, EDP, HE-REVOLVE's Hydrogen Special Report)

Hydrogen is not completely ecological

In fact, we can take on hydrogen with different colors, and you can read more here. In the production of gray hydrogen, which still dominates the international landscape, gases are released into the atmosphere. And in the case of blue hydrogen produced by the same steam reforming technique, these pollutant emissions are captured for subsequent storage, but there is a small percentage that escapes to the atmosphere in the process.

Green hydrogen however is produced 100% by renewables

In a nutshell | Hydrogen Europe

How does hydrogen support the UK's low carbon vision?

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UK context for Low Carbon Energy

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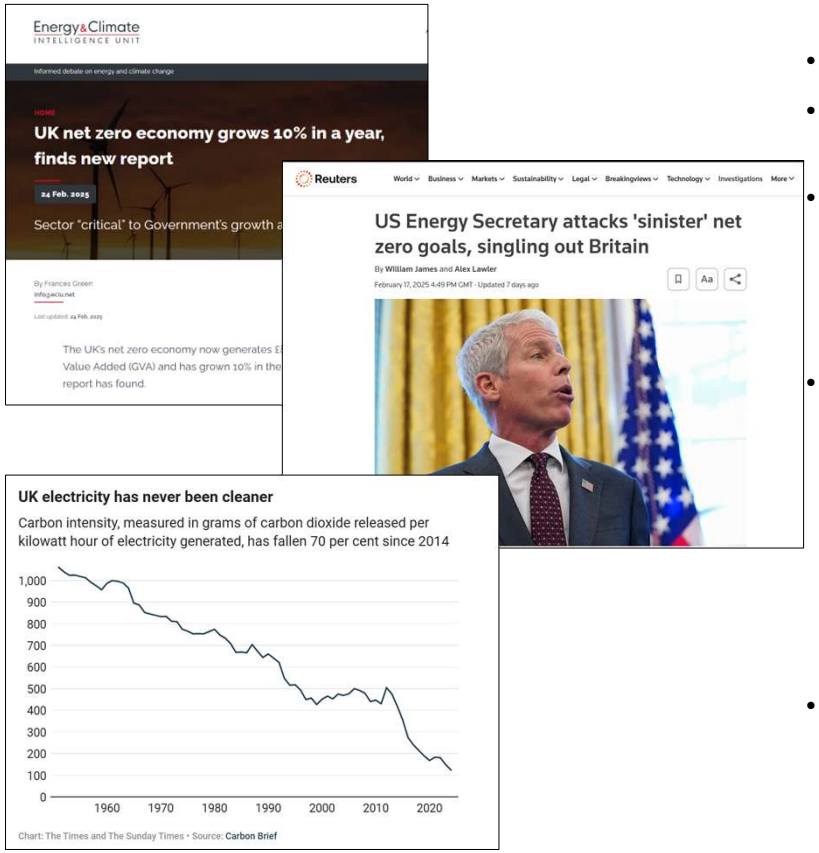


- **We live in dynamic times**
- **UK is moving forward with ambitious targets for decarbonisation against the background of a changing global environment**
- In this month alone:
  - U.S. Energy Secretary referred to a pledge to achieve net zero carbon emissions by 2050 as a "sinister goal", & criticised UK government's attempts to hit clean energy targets.
  - Recent report that stated the UK's net zero economy has grown 10% in a year.
- **UK has a rapidly changing energy mix with ambitious plans to further decarbonise:**
  - In 2024, renewables climbed to a record 45% of UK energy mix.
  - 2025 is likely to be the first year where UK wind power overtakes gas generation.
  - The UK is #3 in Europe and #6 Globally for most attractive renewable energy investment and deployment opportunities (EY June 2024).
  - Ed Miliband, the UK Secretary of State for Energy Security & Net Zero has set the goal of 95 per cent of electricity coming from clean sources by 2030.
- **So, despite some shifts in global positioning, we still see strong commitment from the UK in driving forward a cleaner, low carbon economy,**

Delivering UK jobs and growth

£11 billion

is the UK economic opportunity out to 2030 Teesside, across North-West & North Wales, Humber, Scotland and South-West, and many more

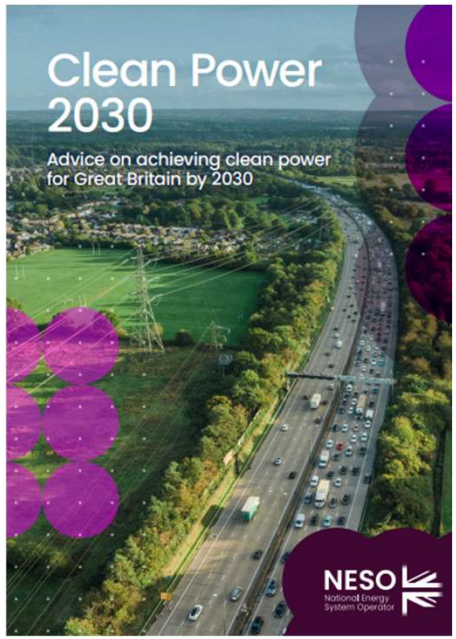
>20,000 jobs by 2030

Estimated workforce demand across the hydrogen value chain. These jobs will encompass engineering, construction, manufacturing service sectors etc.
*H2 skills Alliance/ HII

- Existing skills in oil and gas and manufacturing can help us provide global leadership in hydrogen.

Hydrogen_Skills_Alliance_Plan25_final.pdf

Delivering energy resilience



- Hydrogen allows us to balance supply and demand as we work towards our 50GW of offshore wind by 2030, with hydrogen storage as a vital buffer.
- In 2022 alone, there were 200 occasions when National Grid ESO had to pay Scottish wind farms to shut off their turbines, adding £800 million to consumer electricity bills and increasing greenhouse gas emissions by 1.3 million tonnes.
- Savings of £38bn have been identified if hydrogen is used to store energy to balance offshore wind and solar when the wind isn't blowing, and the sun isn't shining.
- NESO on Clean Power by 2030: New dispatchable low carbon technologies, such as hydrogen, add significant value to the system, with even relatively small levels of operational capacity materially reducing the overall challenge for the rest of the programme

Delivering net zero

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- The UK will not achieve its decarbonisation ambitions without hydrogen.
- Hydrogen's key role is in hard to abate sectors, where electrification is not possible – heavy industry, heavy duty transport (road, shipping, aviation) and power.

Where can hydrogen add value?

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Hydrogen for Power

- Hydrogen available in the power system could achieve lower emissions at a lower cost than a system without hydrogen.
- Long duration energy storage, supplied primarily by hydrogen, could provide between £13 billion and £24 billion in savings to the electricity system between 2030 and 2050.
- Multiple roles – e.g. fuel for low carbon flexible generation technology; a decarbonisation pathway for existing unabated gas power plants
- Industry and Government exploring how Hydrogen for Power could be brought forward

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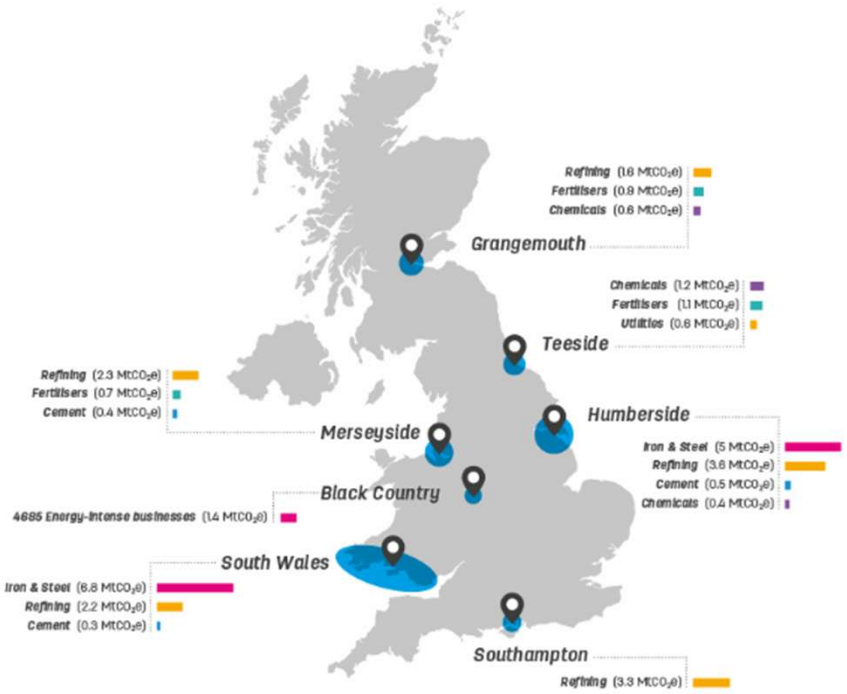
Hydrogen for Industry



- Up to 50TWh of demand in industry could be met by low carbon fuels, primarily hydrogen, in 2035.
- Industry is scaling up to delivery a minimum of two decarbonised industrial clusters by 2025, and four by 2030, including the Acorn cluster in Scotland.
- Teesside and HyNet (Merseyside) clusters first.
- Government is providing project specific support through various funding streams and across various sectors, including food processing, ceramics and steel.
- Parallel funding of £20 billion over 10 years for CCUS.

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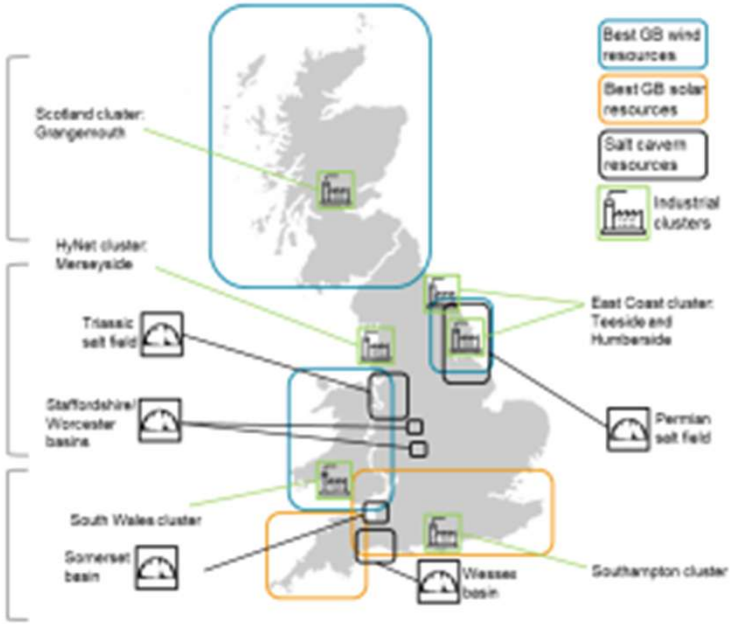
Hydrogen Transportation & Storage



Transportation will be needed to link together production, storage, industrial clusters and other applications

(Source: Delta EE – Hydrogen as an Energy System Asset, June 2022)

- New business models for hydrogen transportation and storage infrastructure are being developed
- Support for gas pipeline transportation will be via a Regulated Asset Base model with a complementary external subsidy mechanism
- Storage, primarily geological, will be supported via private law contracts to deliver revenue floor
- Additional measures will be needed to facilitate non-pipeline distribution.

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Hydrogen for Transport

Sources (Clockwise from top left: ITM Power and Shell, ULEMCo, Fuel Cell Systems

- UK home to the world's first hydrogen fuelled aircraft
- Funding to support a range of transport for which electrification is difficult / not feasible
- £200m zero carbon freight trials recently announced.
- ~£100m Clean Maritime Competition supporting over 100 projects, 40 of which focus on hydrogen or hydrogen derivatives
- One of Europe's largest fleet of Hydrogen buses in operation in Scotland.

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UK Hydrogen for Heat / Blending

- Potential for blending of up to 20% hydrogen by volume into the GB gas distribution networks
- Extensive trials are taking place to confirm the feasibility of hydrogen for heat.
- The H100 Fife project is testing 100% hydrogen for heating in 300 homes
- Hydrogen for heat plans still evolving

First Minister opens Scotland's first hydrogen homes

The First Minister John Swinney has hailed the opening of Scotland's first hydrogen homes as a 'shining example' of how the country is leading the way in solutions to tackle climate change.

FEATURED

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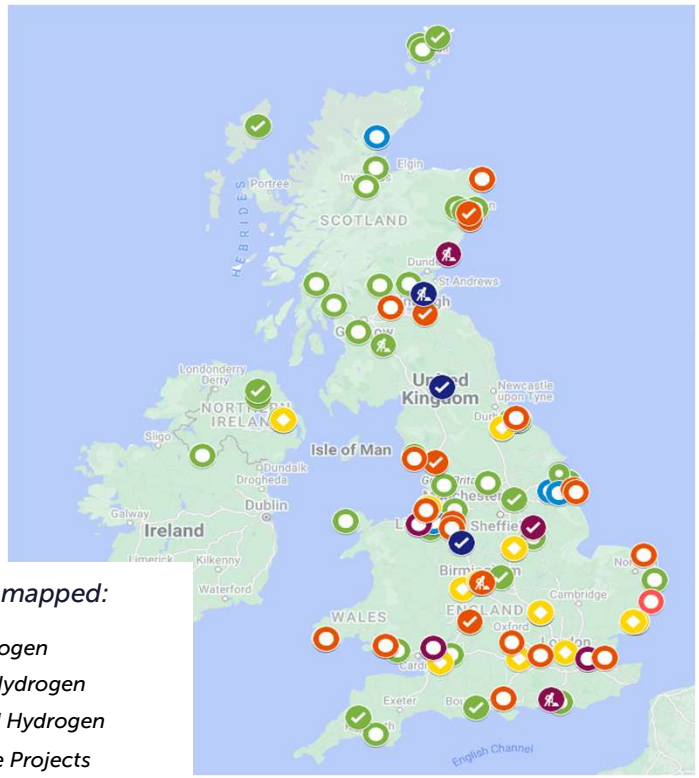
UK Hydrogen projects map



What projects are mapped:

- *Electrolytic Hydrogen*
- *CCUS-enabled Hydrogen*
- *Nuclear-enabled Hydrogen*
- *H2 Infrastructure Projects*
- *Hydrogen-Powered Transport Use*
- *Commercial & Industrial Use Projects*
- *Hydrogen for Domestic Heating Projects*

- Over 70+ low-carbon hydrogen production projects, post FEED, mapped
- Aberdeen H2 Hub (400MW), Cromarty Hydrogen Hub (300MW), Lowestoft hydrogen production facility (200MW) and Hybont (250MW) are some of these pioneering projects will be the first at scale electrolytic projects online
- Many industrial use projects advancing rapidly with HEA members and their partners across the country - e.g. JC pears, Kimberly-Clark, Budweiser Brewery
- Key hydrogen mobility examples such as Fleetwide Conversion for Aberdeen City Council, and Teesside Transport Hub with various HEA members involved, including ULEMCo

https://ukhea.co.uk/uk-hydrogen-project-map/

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How to get there?

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Scaling Up Supply & Aligning to Off-takers

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- Hydrogen production target of 10GW by 2030, with 6GW from electrolytic hydrogen
- £240 million Net Zero Hydrogen Fund to provide capital support

- Hydrogen Business Model providing price and volume support to de-risk operation
- Low Carbon Hydrogen Standard provides basis of certification scheme
- Aligning demand to key off-takers is key....

Expanding beyond our borders – building the export case

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What is the UK Hydrogen Innovation Opportunity?

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Hydrogen Innovation Initiative

When both direct and indirect economic benefits are considered, the global hydrogen economy has the potential to be worth $8 trillion by 2050.

HII is working with >250 companies and 10 sector bodies in the UK, to coordinate innovation in 9 critical technology areas across:

10x10 - Secure 10% global market share in 10 years

Delivering benefits to the UK economy:

£70bn
Annual revenue by 2050

410,000
High value jobs created and transitioned by 2050

10x
Investment into UK hydrogen technology supply chains

Addressing four focus areas

Built on five critical technology supply chains

[Home - Hydrogen Innovation Initiative]

Scaling up the hydrogen economy

Whole systems approach

Building supply chains

Cost down

Skills growth

'Quick Wins' to accelerate progress

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Engagement between local authorities and industry

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HEA 2025 ANNUAL CONFERENCE

Investing, Innovating and Implementing – 4-5th June

SPEAKERS

Our annual conference is a renowned meeting point where the UK Hydrogen industry networks with key sector stakeholders.

ATTENDANCE

500 delegates will be coming together for the gala dinner and the conference, hosted at the prestigious QEII Centre, Westminster, London.

UNSOLICITED FEEDBACK FROM 2024

"It was a great event and we are very pleased with having taken such an active role in the proceedings. It has generated a huge amount of interest."

Opportunities for facilitated engagement between local authorities and industry players

EXHIBITION

Our impactful exhibition hall, with 30+ exhibitors, is at the heart of the conference, maximising brand visibility.

Hydrogen is at the heart of the UK's energy transition

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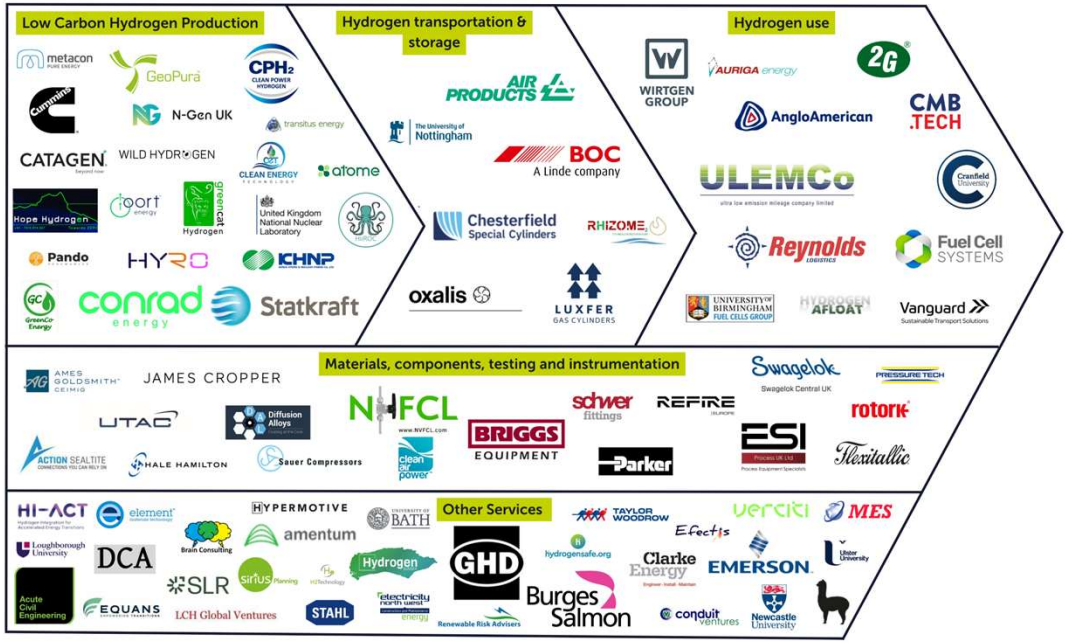

- The UK has world leading companies, projects and deployments
- Our hydrogen economy is primed for growth
- We need to move at greater scale and speed on all fronts.
- Success will mean clean growth, greater energy resilience and accelerated progress towards net zero

The HEA is the voice of the UK hydrogen sector, driving its growth

Thank you

ukhea.co.uk

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