Welsh Parliament
Senedd Research

Hydrogen in Wales 2024
Research Briefing

July 2024

www.senedd.wales

The Welsh Parliament is the democratically elected body that represents the interests of Wales and its people. Commonly known as the Senedd, it makes laws for Wales, agrees Welsh taxes and holds the Welsh Government to account.

An electronic copy of this document can be found on the Senedd's website:
research.senedd.wales

Copies of this document can also be obtained in accessible formats including Braille, large print, audio or hard copy from:

Welsh Parliament
Tŷ Hywel
Cardiff Bay
CF99 1SN

X: **@SeneddResearch**
Senedd Research: **research.senedd.wales**
Subscription: **Newsletter**

Welsh Parliament
Senedd Research

Hydrogen in Wales 2024
Research Briefing

July 2024

Author:
Matthew Sutton

Senedd Research acknowledges the parliamentary fellowship provided to Matthew Sutton by the Natural Environment Research Council (NERC) which enabled this article to be completed.

Hydrogen is the smallest and most abundant element in the universe. It may also offer a means to decarbonise some of the most polluting parts of the Welsh economy.

This research briefing provides an overview of the current hydrogen sector in Wales. It looks at where hydrogen is currently produced and its use in Welsh industry. It explores proposals that, if built, would increase Welsh hydrogen production by orders of magnitude by the end of this decade.

It also considers the role that hydrogen may have in transport, industry, heating, and energy storage; as well as the need for hydrogen distribution and storage networks if those end-uses are adopted. The briefing also discusses the impact of recent hydrogen policy decisions by both the Welsh and UK Governments.

Contents

1. Introduction

The first hydrogen fuel cell was invented by **Swansea scientist Sir William Grove** in the 1840s. Almost 200 years later, hydrogen power is receiving renewed interest as a potential tool in the global push to net zero.

Hydrogen is the smallest and most abundant chemical element in the universe. It can be used as a fuel via a high temperature reaction with oxygen that produces water. Unlike fossil fuels such as oil, methane (commonly referred to as 'natural gas'), and coal, hydrogen combustion does not produce greenhouse gases such as carbon dioxide and hence does not directly contribute to anthropogenic climate change i.e. caused or influenced by people.

Hydrogen production and use in industrial processes is well-established in Wales. Low carbon hydrogen production and uses outside of industry are much more limited and it remains unclear how widely hydrogen will be adopted in future. In February 2020, organisations advocating for the development of hydrogen in Wales launched **HyCymru**, the Welsh Hydrogen Trade Association.

2. Welsh & UK Government Policy

In 2020 the Welsh Government published a **Hydrogen Pathway and Action Plan** that benchmarked the Welsh hydrogen industry and provided ten objectives to support its development during the 2020s. These objectives include creating hydrogen demand in the transport sector, establishing large-scale hydrogen production, and engaging with stakeholders.

The report acknowledged that the Welsh Government is limited in its influence on hydrogen projects in Wales, stating:

> ...some of the decisions that will impact the deployment of hydrogen in Wales will be determined on a national level by the UK Government, including the decarbonisation of heat

In June 2022 the Welsh Government provided **an update on progress** towards the objectives in its summary of responses to the original consultation. This report stated:

> Overall, progress is being made against most of the objectives, albeit with relatively limited additional deployment activity involving hydrogen over the past two years given the pandemic and lack of clarity on UKG [UK Government] funding

Welsh Government also provided £2m for hydrogen feasibility and development studies through the **Hydrogen Business Research & Innovation for Decarbonisation (HyBRID) fund** in 2021.

Hydrogen features in other Welsh Government plans, including the:

- **2021-25 net zero plan for Wales**, which discusses possibilities for fuel switching to hydrogen across a variety of end uses;
- **National Transport Delivery Plan (NTDP) for 2022-27** considers possible hydrogen applications in the transport sector; and
- **Heat Strategy for Wales** looks at hydrogen applications for industrial and domestic heating.

The UK Government published **its own Hydrogen Strategy** in 2021. It has funded numerous hydrogen production, research, and end-use projects in Wales, which are discussed in greater detail throughout this briefing. Its **Hydrogen Production Business Model** sets out a public subsidy for hydrogen production "to overcome the operating cost gap between low carbon hydrogen and high carbon fuels".

3. Hydrogen production

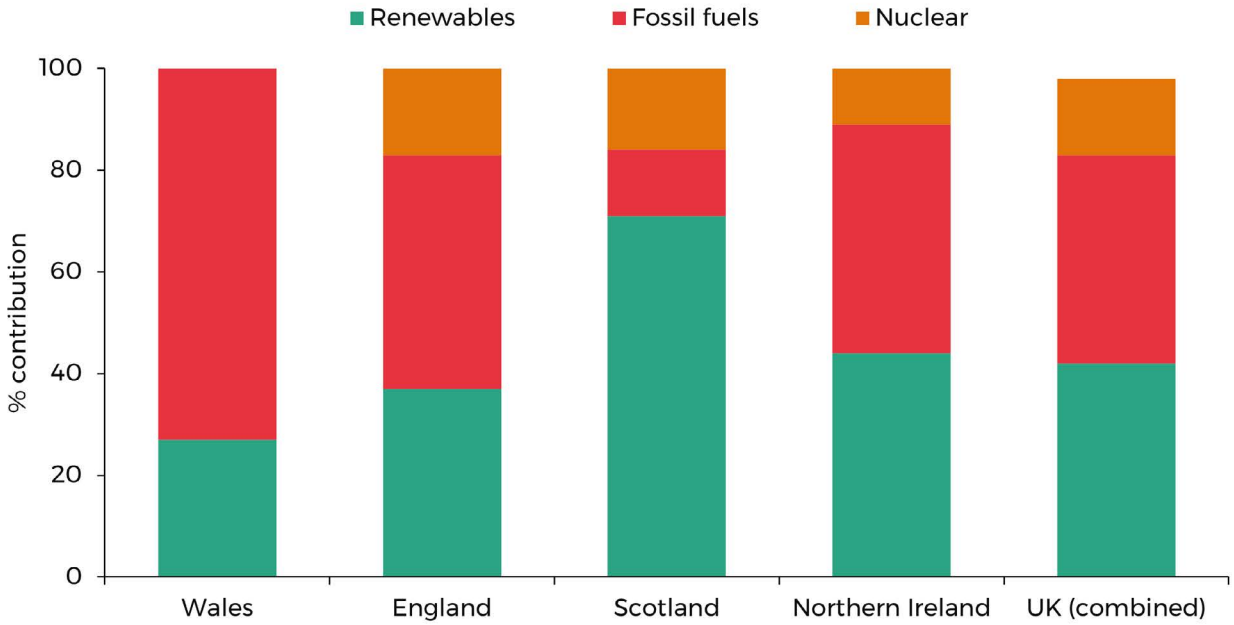
Natural hydrogen deposits are neither abundant nor widespread on the Earth, therefore hydrogen is usually manufactured using more accessible resources, such as water and methane. This can be done using several different processes, some of which are described below.

Green hydrogen

Green hydrogen (also called 'electrolytic hydrogen') is produced by electrolysis, where water molecules are split into hydrogen and oxygen in an electrolyser using electricity. For this process to be 'green', the power source for electrolysis must be renewable-sourced electricity, such as wind or solar. Green hydrogen production results in no direct carbon dioxide emissions and therefore does not directly contribute to anthropogenic climate change.

Green hydrogen production is well-suited to areas with excess renewable electricity generation capacity. Several planned projects have a direct 'private wire' connection to specific renewable energy generation, such as solar or wind farms (detailed in a later section). The **latest data show** that Wales produces significantly more electricity than it consumes, but renewables contributed only 27% to total generation in 2022, compared to 42% for the UK as a whole. This is the smallest proportion in any UK nation, as shown in the chart below.

Figure 1: Proportional contribution of renewables, fossils fuels, and nuclear energy to total electricity generation in UK nations in 2022.



Source: **Department for Energy Security and Net Zero**

Grey hydrogen

Grey hydrogen is produced by steam methane reforming (SMF), which involves methane and steam reacting at high temperatures. This process produces carbon dioxide and hence contributes to anthropogenic climate change. At present, grey hydrogen is often (though not exclusively) created as part of the industrial manufacturing of ammonia fertilisers in the Haber-Bosch process. This process is responsible for **around 1.2% of global carbon dioxide emissions**.

Blue hydrogen

Blue hydrogen, like grey hydrogen, is produced by SMF. However, in blue hydrogen production most of **generated CO_2 is captured at source and permanently stored**. This means that blue hydrogen could be considered 'low carbon'.

In the present UK-context, blue hydrogen remains a hypothetical process as there are no permanent CO2 storage facilities, though the **UK Government plans** for some to be operational by 2030.

Current and future Welsh hydrogen production

Hydrogen production for industrial processes is carried out across a variety of sites in Wales. The vast majority of this production is grey hydrogen produced via SMF. According to Welsh Government's **2020 baselining report**, grey hydrogen production takes place at sites in Barry, Clydach, Llanelli, Newport, Port Talbot, and Pembroke. Several of these production sites supply Tata Steel.

Large-scale green hydrogen production does not yet exist in Wales. In 2023 the University of South Wales (USW) and the hydrogen company Protium **installed a 100kW electrolyser** at the USW Hydrogen Centre in Baglan, Neath Port Talbot. This installation can produce 40kg hydrogen per day, which **existing data suggests** would be enough to supply a hydrogen-fuelled bus for around 570km of travel. Protium has **said it intends to build** a 2.5 MW capacity electrolyser in South Wales by the end of 2024.

Several large-scale green hydrogen production facilities are being progressed across Wales as of July 2024. In December 2023 the UK Government selected two Welsh projects for funding in the **first hydrogen electrolysis allocation round** (HAR1). **HyBont in Bridgend** will consist of a 5.2MW electrolyser (5.2MW) and solar farm; and the 14.2MW **West Wales Hydrogen** electrolyser in Milford Haven is the third largest of 11 successful UK HAR1 projects by capacity.

RWE is planning to submit a planning application for **the 'Pembroke Phase I' 110MW electrolysis plant** in Pembroke in **summer 2024**, which would have a capacity over one thousand times greater than the Baglan electrolyser. 'Pembroke Phase II' is a planned 200MW green hydrogen production facility RWE are also developing 'Pembroke Phase II', a planned 200MW green hydrogen production facility that was awarded funding from the **UK Government's Net Zero Hydrogen Fund** in 2024. These RWE project and the West Wales Hydrogen project form part of the **Milford Haven Waterway Future Energy Cluster**, which aims to provide 20% of the UK Government's low carbon hydrogen production target by 2030. These projects may be supported by **floating offshore wind farms in the Celtic Sea**.

Figure 2: Pembroke oil refinery, on Milford Haven Waterway, forms part of RWE's plans for green hydrogen infrastructure in South West Wales.

Protium is involved in a **proposal to install a 17.5MW electrolysis facility** alongside a solar farm and a wind turbine at Budweiser's brewery in Magor, Monmouthshire. It undertook an **informal community consultation** in September 2022, but has not yet sought planning permission for the project.

A 15MW electrolysis plant was **planned by Statkraft** at a former Royal Navy Armaments Depot in Trecwn, Pembrokeshire. However, the project was **paused indefinitely in March 2024** because "obtaining the necessary grid connection will take a number of years, considerably longer than initially anticipated".

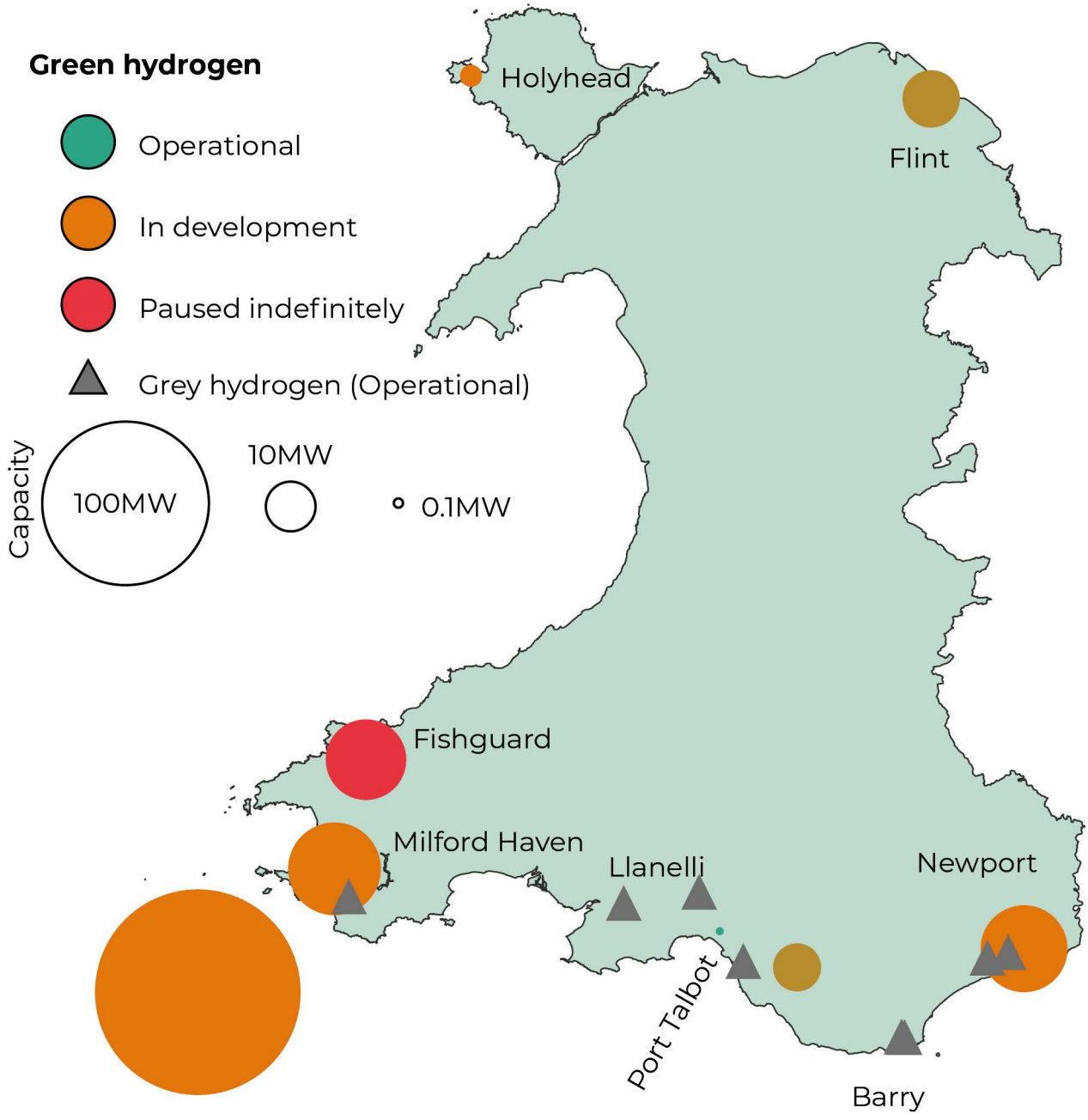
In North Wales, **Menter Môn** seeks to develop the **Holyhead Hydrogen Hub** to supply transport activities at Port of Holyhead. As of July 2024, the project was developing an outline business case and seeking **£3.8m funding from the North**

Wales Growth Deal, which was jointly funded by the Welsh and UK Governments.

In June 2024, Flintshire County Council **granted planning permission** for a **7.5MW electrolyser** that would supply green hydrogen to decarbonise the Kimberly-Clark Coleshill Mill in Flint. However, less than a week after being granted planning permission, **the BBC reported** that Kimberly-Clark had begun consulting on proposals to permanently close the facility in 2025.

Current and planned hydrogen production facilities described in this section are shown in the map below.

Figure 3: Map of hydrogen production projects in Wales depicted with circles coloured by project status and area scaled by capacity.



The UK Government funded several Welsh hydrogen production projects through the **Low Carbon Hydrogen Supply 2 competition** in 2022:

- **Compact Syngas Solutions Ltd**, based on Deeside, was awarded just under £300,000 to develop modular SMR hydrogen production units for transport end-uses;
- **Actuation Lab** was awarded just under £3m to develop and manufacture valves intended to reduce hydrogen gas leakages in future pipelines. The company is based in Bristol but is partnered with USW; and
- The **ERM Dolphyn project** is led by Environmental Resources Management (ERM) Ltd. It was awarded over £8.6m for a commercial scale demonstration of green hydrogen production from floating offshore wind. ERM aims to have a project operational in the Celtic Sea, 60km west of Milford Haven, by the end of 2028. It **plans to test** the viability of offshore hydrogen production near Milford Haven in November 2024. This test will use an fossil fuel generator to power an electrolyser and is intended as a step towards the on-site production of hydrogen at floating offshore wind farms.

The UK Government has also set an ambition for the UK to have **10GW total hydrogen production capacity by 2030**, with at least half of that being green hydrogen.

4. Distribution & Storage

Hydrogen molecules are too small to be transported through existing methane gas infrastructure, so any large-scale future uptake of hydrogen will require new infrastructure for distribution between sites of production and end-use. This could be on a small scale, such as transport from an electrolytic production plant to an adjacent power station, or larger-scale for uses such as private hydrogen fuel cell vehicles.

Pioneer 1, the only operational green hydrogen electrolyser in Wales, **contains and distributes hydrogen in storage containers**. These can be transported to end users.

The UK's gas transmission system is privatised. **National Gas Transmission** (NGT) owns and operates national high pressure gas transmission system and supplies the four regional companies. **Wales & West Utilities (WWU)** is the sole distributor in Wales. WWU owns and operates medium-low pressure distribution networks and connect end-users to the national gas supply.

NGT proposed a **UK-wide hydrogen distribution network** called Project Union in 2022. The network would connect the UK's **Industrial Clusters**, including South Wales, to a hydrogen supply. This project would involve a mixture of retrofitting existing pipes and building new ones. NGT was **awarded £5.6m by Ofgem** in 2023 to further develop Project Union.

WWU **announced a feasibility assessment** for a hydrogen distribution pipeline in South Wales called HyLine Cymru in 2022. HyLine Cymru could distribute hydrogen from centres of production (e.g. Pembrokeshire) to areas of highest use (e.g. Port Talbot steelworks) and is proposed to connect to NGT's Project Union.

Cadent, a regional gas distributor based in England, is developing a similar project as part of the North West Industrial Cluster called **HyNet North West**. This project aims to build a hydrogen distribution network centred around a blue hydrogen production site near Ellesmere Port. HyNet North West will initially only deliver hydrogen to sites in England, but Cadent says it intends to extend this North Wales in future phases. Cadent **plans to submit** a Development Consent Order for the hydrogen pipelines in 2025. As HyNet will use blue hydrogen, it will be dependent on **carbon capture and storage (CCS)** in order to be net zero. HyNet's initial Welsh presence will consist of CCS and transportation infrastructure with permanent storage of carbon dioxide in disused gas fields in Liverpool Bay – development consent order for the associated carbon dioxide pipeline was **granted by the UK**

Government in March 2024.

Hydrogen a has low volumetric energy density compared to methane, meaning that burning the same volume of gas produces a lower energy output. As with pipelines, it is often not possible to store hydrogen in the same natural or artificial storage sites used for methane.

A **2022 study by WWU** investigated whether suitable sites for large-scale hydrogen storage could be found close to South Wales. WWU suggested that suitable storage exists in natural geological formations in the southern Celtic Sea and eastern Wessex Basin (central Dorset).

5. End Uses

In many of its end-uses, hydrogen competes with electrified alternatives. For example, hydrogen boilers and electric heat pumps are both potential options for decarbonising heating; grid-scale energy storage can involve hydrogen-fired power stations or battery grid storage; and hydrogen-based transport competes with battery electric vehicles. Therefore changes in the economic and policy landscape of electrification options, particularly the price of batteries, may have significant consequences for the viability of hydrogen end-uses. The Welsh Government's **most recent net zero plan** focusses on hydrogen **end-uses in freight vehicles** (including shipping and HGVs) and in the **decarbonisation of the South Wales and North West Industrial Clusters**.

Transport

Most transport policy is **reserved to the UK Government**. The Senedd does however have competence in **certain devolved areas**. Notably, the Welsh Government operates most rail services in Wales through Transport for Wales (TfW) and took responsibility for infrastructure on the **Core Valley Lines from Network Rail in 2020**.

Road transport

The UK Government **plans to end the sale** of petrol and diesel cars and vans by 2035, and **by 2040 for HGVs**. Battery-electric and hydrogen fuel cell vehicles are net zero alternatives to vehicles with internal combustion engines.

Two models of hydrogen car are **available for purchase in the UK as of July 2024**: the Toyota Mirai and Hyundai Nexo. **Riversimple,** is the sole hydrogen vehicle manufacturer operating in Wales (based in Llandrindod Wells). The company has received public funding, including a **£1.25m grant from the UK Government** in 2019 and **£250,000 from a subsidiary of the Development Bank of Wales** in 2021. Riversimple's vehicles are not yet commercially available and **the company states** that in future they "will be offered to customers on a subscription basis".

The Welsh Government's **Hydrogen Pathway and Action Plan identifies** that government support for hydrogen refuelling infrastructure development is necessary to meet its hydrogen objectives. According to h2stations.org, there are **13 operational hydrogen refuelling stations** in the UK as of July 2024, but many of these are not open to the public. The closest public hydrogen refuelling stations to Wales are in Swindon and Birmingham. Riversimple's test vehicles use a private

hydrogen refuelling station in Abergavenny **operated by Element 2**.

The **Welsh Government's NTDP** sets several goals for hydrogen transport. The Welsh Government aims to "decarbonise the TrawsCymru fleet by the end of 2026" including "capital investment in both battery electric and hydrogen fuel cell electric vehicles". The NTDP **contains four hydrogen bus projects**: Swansea Bay, Pembrokeshire, TrawsCymru T5 (Haverfordwest-Aberystwyth), and TrawsCymru T6 (Swansea-Brecon), with implementation timescales of 2023 to 2026. Hydrogen buses, powered by the Protium 1 electrolyser in Baglan, were **trialled in Swansea and Port Talbot** during summer 2023.

WWU also conducted a **trial of hydrogen vans** in early 2024, supplied by Protium's Pioneer 1 electrolyser.

The Advanced Manufacturing Research Centre (AMRC) Cymru **has established** a Hydrogen Electric Propulsion System (HEPS) testbed in North Wales, funded by a £600,000 grant from the High Value Manufacturing Catapult in 2021. According to an AMRC spokesperson, the aim of the testbed is to:

> ...support businesses who want to make the net zero energy transition to hydrogen electric propulsion systems by giving them a facility where they can use advanced manufacturing techniques to assemble and verify their product and then eventually integrate it in their vehicles

Hydrogen vehicles compete with electric alternatives. Electrification is more energy efficient than using green hydrogen as energy is lost when using electricity to produce hydrogen, and again during its combustion. In February 2024, **the Guardian reported** that more than 1 million electric cars had been sold in the UK over the previous 20 years, compared to less than 300 hydrogen vehicles. A **2019 modelling study** commissioned by the UK Climate Change Committee (CCC) suggested that, in terms of infrastructure costs, hydrogen would be the cheapest way to decarbonise HGVs. Rapid charging infrastructure would be more expensive than hydrogen infrastructure, but would have lower annualised costs.

Rail

The Welsh rail system is partially devolved, detailed in a **2024 Senedd Research briefing.**

The UK Government plans to **end the use of diesel-only trains by 2040.** Rail decarbonisation can involve switching from diesel trains to zero emission alternatives. These can include: electric traction (overhead lines), electric batteries, and hydrogen fuel cells. A **Railway Industry Association Report** from

2019 estimated that the cost of electrification (electric traction) in UK railway infrastructure projects varied from £0.7m-£2.5m per single track km. Using hydrogen or battery-electric trains substantially reduces the cost of replacing diesel trains, because there is no need to significantly modify railway infrastructure, such as adding overhead line equipment and modifying bridges and tunnels. Hydrogen trains would require refuelling whereas battery-electric trains would need to be charged.

The Welsh Government's **net zero plan** reports the energy efficiency (energy output divided by energy input) of different zero emission methods for powering trains, which is reproduced in the table below.

Table 1: Energy efficiency of net-zero train power technologies.

Technology	Efficiency
Electric traction (overhead lines)	80%
Electric batteries	65%
Hydrogen fuel cells	25%

Source: **Net Zero Wales plan**, Welsh Government

There are currently no hydrogen trains operating anywhere in the UK. The only electrified rail lines in Wales are the South Wales Main Line between Cardiff Central and the Severn Tunnel; and parts of the Core Valley Lines, which **TfW says** will be fully electrified by the end of 2024. Hybrid diesel-battery electric trains have been used on the Borderlands (Wrexham-Bidston) Line **since April 2023.** The remainder of the Welsh railway can only accommodate diesel trains.

The world's **first hydrogen-only trains** were introduced in Lower Saxony, Germany, in 2022. However, the state-owned public transport operator **announced in 2023** that it would be replacing its remaining diesel trains with battery-electric models instead of hydrogen, stating "battery trains are cheaper to operate".

A **2020 Network Rail report** recommended that hydrogen trains should be used to decarbonise the Heart of Wales and Cambrian Lines because both are long-distance rural routes. Battery-electric trains were preferred on the shorter Ebbw Vale and Conwy Valley Lines, with overhead electrification recommended in all other cases. TfW **indicates that it is undertaking development work** on the electrification of the South Wales Main Line between Cardiff Central and

Swansea by 2029, extending to Milford Haven in the future. The UK Government announced **funding for electrification of the North Wales Coast Line** in 2023 as part of 'Network North', though **Rail Magazine reported in June 2024** that "The Department for Transport confirmed that work has yet to start on a business case for the project".

In 2022 the Welsh Government **commissioned Ballard and Arup** to produce a report with TfW investigating the viability of hydrogen trains in Wales. During Plenary in November 2023, then-Minister for Climate Change, Julie James, s**tated that the report had**:

> ...identified several rail lines in north Wales as most suitable for trials for hydrogen trains, including the Heart of Wales line, the Cambrian line, the North Wales Coast, and the Conwy Valley lines

Figure 4: The Cambrian Line, which connects Aberystwyth and Pwllheli to Shrewsbury, is a possible candidate for hydrogen trains.

Aviation

The UK Government set decarbonisation goals for the aviation sector in the **Jet Zero Strategy** in 2022, including the use of hydrogen aircraft, sustainable aviation fuel (SAF), and electric planes. The report describes ongoing research

and development into hydrogen aircraft, including **Airbus' plan** to bring the first hydrogen-powered commercial aircraft to market by 2035.

In its **National Transport Delivery Plan**, Welsh Government said:

> We strongly encourage the UK Government to bring forward proposals to drive up fuel efficiency, encourage the development of new zero emission aircraft and accelerate the supply and uptake across the UK of SAF from non-agricultural sources

Welsh Government objectives (Transport)

In the 2020 **Hydrogen Pathway and Action Plan**, the Welsh Government set five objectives related to the transport sector. The table below details these objectives and progress to-date as of June 2024.

Table 2: Welsh Government hydrogen transport objectives, timescales, and progress towards them.

Objective	Timescale	Progress to date (July 2024)
Deploy 200 hydrogen fuel cell buses in a town/ city	Before 2025	Two hydrogen buses **underwent trials in Swansea** in summer 2023.
Establish Wales as an early market for fuel cell vehicles	Before 2025	Two hydrogen cars are **available UK-wide**, but there are **no public hydrogen refuelling stations** in Wales. Riversimple are based in Wales but not yet commercially operating.
Create high value jobs via an innovative vehicle manufacturer and associated supply chain with new fuel cell electric vehicle production plants in Wales	Before 2025	**Riversimple is based in Wales**, but its cars are not yet available to the public and it has not stated when this will occur. No other hydrogen vehicle production sites are based in Wales.

Objective	Timescale	Progress to date (July 2024)
Attract new automotive industry activity to Wales and develop new fuel cell vehicles for public sector fleets	Before 2025	No Welsh public sector vehicles currently use hydrogen fuel cells. The **Hydrogen in Wales report** says that Riversimple has memorandums of understanding with local authorities.
Attract fuel cell train demonstration and testing activities to Wales while providing anchor demands for hydrogen in transport	Before 2026	No hydrogen train trials are currently taking places in Wales. The Global Centre for Rail Excellence in Onllwyn is **due to open in 2025** to support "**the design and development of imaginative new technologies and concepts**", but has not announced plans to trial hydrogen trains as of July 2024.

Source (Objectives and Timescales): **Hydrogen in Wales Pathway and Action Plan**

Industry

Grey hydrogen is produced and used in several industrial processes in Wales (**outlined previously**). Industry as a whole **accounted for 27%** of Wales' total carbon dioxide emissions in 2022, the largest single component of which (**43% in 2016**) comes from iron and steel production. Low carbon hydrogen could supplant grey hydrogen in existing industrial processes such as oil and nickel refining. Hydrogen could fully **replace coking coal** in the reduction of iron ore to pure iron in steel production. Additionally, hydrogen could supplant fossil fuels as a source of **industrial heat in high-temperature furnaces and kilns**, where electrification is most challenging.

The Welsh Government's **net zero plan states** that "Hydrogen may provide one of the few ways to decarbonise heavy industry through fuel switching". In **Heat Strategy for Wales**, it says that "...development of hydrogen for industrial heat in Wales is contingent on building the evidence base from UK-wide industrial and hydrogen strategies". The Heat Strategy also sets out an industrial hydrogen policy:

> Low carbon hydrogen hubs are established and serving high-temperature industrial processes and local users where appropriate.

This headline consists of two Welsh Government actions:

- We [Welsh Government] will continue to support hydrogen innovation local to our hydrogen hubs, and map industrial heat demand across Wales; and
- We will engage our energy network operators on the plan for hydrogen in industrial areas, the infrastructure needed, and the opportunities for renewable electricity generation.

UK Government has funded several industrial hydrogen development schemes. The **Industrial Hydrogen Accelerator (IHA) Programme** funded numerous projects in 2022 that "demonstrate end-to-end industrial fuel switching to hydrogen". Two Wales-only and one cross-border project were funded by the IHA Programme, which are detailed below:

- The **H2JUICE project** in Cardiff was awarded almost £373,000 to test the feasibility of supplying hydrogen produced by sewage sludge at DWCC Cardiff East Waste Water Treatment Works to Princes, a food and drink industry end user;
- **Ash Waste Services**, who operate waste processing depots in Wrexham, Chester, and Ellesmere Port, were awarded almost £176,000 to test the feasibility of switching 50% of its equipment to hydrogen; and
- Over £399,000 was awarded to **ROCKWOOL Ltd in Bridgend** to investigate the use of hydrogen in stone wool insulation manufacturing.

Industrial Clusters

The UK Government has focussed industrial decarbonisation on areas with high concentrations of manufacturing industries, termed '**Industrial Clusters**'. The **South Wales Industrial Cluster** (SWIC) is the only one located wholly within Wales and stretches from Milford Haven to Newport. The **North West Industrial Cluster** (NWIC) is located primarily in North West England, though some of its projects incorporate areas of North Wales including Deeside and Wrexham.

SWIC, a partnership of 47 organisations, outlined its decarbonisation plans in a **2023 report**. It includes plans for hydrogen production in sites across South Wales, but particularly focussed around Milford Haven. The report discusses **HyLine Cymru**, a project by Wales and West Utilities, which will "transport that hydrogen away from Milford Haven into the middle of the SWIC". SWIC also states that one of its priorities is the urgent development of the South Wales electricity grid and hydrogen infrastructure. The SWIC Report identifies hydrogen policy drivers for the UK and Welsh Governments:

- Accelerated hydrogen availability to be progressed (UK and WG);
- Increased support and advocacy for hydrogen infrastructure development plans (WG only); and
- Water supply for hydrogen strategic plan needed (WG only).

Heating

This section addresses the heating of residential and commercial buildings, rather than **industrial heat**. Hydrogen could be used as a partial or full replacement of methane in heating buildings. Use of pure hydrogen in heating would require the construction of a **dedicated hydrogen distribution network**, and for consumers to install hydrogen-ready boilers.

The UK Government had planned to gradual upscale the size of **residential hydrogen heating pilot projects**, starting with a **neighbourhood-scale scheme** for around 300 houses in Fife in 2024. Two village-scale trials in England were cancelled in 2023 due to **local opposition** and **lack of sufficient hydrogen supply**. WWU **were involved** in plans for a larger town-scale hydrogen pilot that has been **postponed until after 2026**, when the UK Government will make "strategic decisions on the role of hydrogen in decarbonising heat". In its **October 2023 Assessment**, the National Infrastructure Commission, an executive agency of HM Treasury, advised that "Government should not support the rollout of hydrogen heating".

In its **Heat Strategy for Wales** the Welsh Government does not support the widespread adoption of hydrogen in heating Welsh buildings. It cites high costs, limited supply, leak risks, distribution logistics, and emissions of nitrous oxides as reasons for this. However, the Heat Strategy does set out three proposed actions related for the use of hydrogen in heating:

- We [Welsh Government] will publish a preferred hydrogen policy position for Wales and we will work with UK Government to ensure the Low Carbon Hydrogen Standard fully reflects our statutory decarbonisation commitments;
- We will use our evidence base and policy positions to influence UK Government policy on hydrogen – ensuring that the approach adopted, for instance regarding the hydrogen levy and hydrogen ready boiler mandate, supports our plan for a just transition to low carbon heat in Wales; and
- We will continue to develop our hydrogen evidence base to better understand energy demands across Wales, and the potential role of hydrogen to support a just and sustainable decarbonisation and engage with communities and

stakeholders to maximise the benefit of local opportunities.

'Blending' is the mixing of some proportion of hydrogen into existing gas distribution networks. Distributing blended hydrogen-methane gas would mean modifying or replacing existing gas pipelines to accommodate a different gas pressure and to prevent leakage.

Blending was supported by the UK Government in a **December 2023 strategic policy decision**, with potential for commercial-scale hydrogen blending into the UK gas network from 2025-26. UK Government support for blending is on the basis of cost stabilisation, rather than decarbonisation. The report states:

> The primary strategic role of blending is not to decarbonise the existing gas network or to facilitate a transition to heat decarbonisation... the main objective of blending would be to support hydrogen production in a targeted way where it has potential to reduce risk and cost at a project or system level.

Grid-scale energy storage

The majority of electricity in Wales is produced by burning methane. This process produces carbon dioxide and other pollutants, contributing to both climate change and air pollution. The UK Government, which has reserved powers related to electricity generation, currently plans for the **UK electricity grid to be wholly decarbonised by 2035**. However, renewable power sources supplemented by nuclear cannot consistently match electricity demand because of the intermittency of wind and solar energy. Flexible, decarbonised generation is therefore required to stabilise a renewable-dominated net-zero grid. Hydrogen power plants could be involved in meeting this flexible demand, alongside methane power stations retrofitted with CCS, and grid-battery storage.

Hydrogen power stations could meet demand by burning either green hydrogen that was produced when electricity supply exceeded demand ('Gas to Power to Gas'), or by burning blue hydrogen ('Gas to Power'). Both options are inefficient compared to instantaneous use of renewable electricity because energy is lost during hydrogen production and again during combustion. In its **2021 Hydrogen Strategy**, the UK Government estimated that hydrogen demand for power would be 0-10TWh in 2030, rising to 25-40TWh by 2050. The **International Energy Agency say** that hydrogen "has potential for the seasonal storage of renewable energy".

Using hydrogen for power generation would also require sufficient large-scale storage. Hydrogen storage is discussed in an earlier section of this brief.

Alternatives methods of meeting flexible energy demand in a future net-zero electricity grid include:

- Pumped storage hydro (PSH). **Two of the UK's four PSH plants**, and 74% of total its total 2.8GW capacity as of July 2024, are located in North Wales;
- Electric battery storage. **RenewableUK says** 4.4GW of storage was operational in the UK in May 2024, and there is a further 91.2GW at all other stages of development; and
- CCS-equipped fossil fuel power stations. These do not currently exist in Wales or the UK, although SSE Thermal has **announced plans to construct one** in England 'by the mid-2020s'. Similarly, CCS can be fitted to waste-to-power plants, and UK Government is supporting this at **enfinium's Deeside plant**.